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AMERICAN SELF-PROPELLED CARRIAGES.

THE final competitive run of motor carriages in Chicago, which was made on November 28th, seems at first to have been very disappointing, although, as a matter of fact, it was probably as successful an exhibition as could have been made, considering the comparative novelty of practical motor carriages, and considering also the very unfavourable conditions of the weather and the roads. As mentioned in the article in THE ENGINEER of November 22nd, the date of the trial was changed from November 2nd to November 28th, on account of the number of applications for a longer time in which to put the finishing touches on the machines. The number of entries originally made was about ninety, but the practical machines entered and those actually built for the competition numbered probably less than a score. About a dozen were finally entered for the trial, but of these only six started, and of these six carriages two made the entire trip, one nearly completed it, and three withdrew after making short runs. It must be remembered, however, that some of the carriages which failed to start for the competitive run for various reasons are practical and commendable machines, which have been used more or less extensively by their owners and builders. Of these something will be said further on.

TABLE A.

Competition of Motor Carriages at Chicago, U.S.A., November 28th, 1895.

	Duryea.	Mueller.	Roger.	Morris and Salom.	Sturges.	De La Vergne.
Power.	Gasoline.	Gasoline.	Gasoline.	Stor. batt.	Stor. batt.	Gasoline.
Start, a.m.	8.55	10.06	8.59	9.03	9.01	8.56
Finish, p.m.	7.18	8.53	6.20	12.15	1.25	10.26
Total time	10.23	10.47	9.39	3.12	4.24	1.30
Time of stops	2.30	0.30	1.30	0.12	1.22	—
Running time	7.53	9.28	8.09	3.00	3.02	1.30
Distance run, miles	54.36	54.36	40	12	13	4
Average speed, miles per hour	7	5¾	5	4	4¼	2¾

The route was changed from that originally planned, being from Jackson Park, in Chicago, to Evanston and back by a different route, the distance being 54·36 miles, with three relay stations at distances of 14, 26, and 44 miles from the starting point. The first part of the route was along a well built boulevard, followed by asphalt, brick, stone block, and wooden block pavements for short distances, and again by another boulevard; thence to Evanston the road was sandy and gravelly, in some parts very rough, and in others very soft in wet weather. Through Evanston there were about 3½ miles of good smooth wooden block pavement, followed by good macadam roads nearly all the way back to the starting point, except for short stretches of asphalt, stone block, and one short piece of unimproved clay road, which is almost impassable in wet weather. The entire route was practically level, the only grades of any steepness being the short approaches to bridges over the railways and the Chicago River. The roads are wide, the turns not sharp, and of the whole distance only about five miles were bad even in wet weather. Tramway tracks are laid on some of the streets traversed, and on about twenty streets which the carriages had to cross.

A heavy storm of wet sticky snow prevailed a day or two before the date of the trial, sufficient for sleighing in the parks, and on November 28th the roads were covered with snow and slush, fully 6in. deep, being thus in very bad condition for carriages with or without horses.

The carriages taking part in the competition, and a summary of their performances, are shown in Table A.

(1) *Duryea motor carriage.*—This was the four-wheel carriage with gasoline motor illustrated and described in THE ENGINEER of November 22nd. It weighs 1000 lb. complete, and has been used somewhat extensively. It dislocated its steering gear soon after starting by running over a snow bank, and fifty-five minutes were consumed in making repairs, after which it ran on to Evanston, about twenty miles, without a stop. On the return trip it was delayed four minutes by running into an overturned sleigh, and then went two miles on a wrong road, during which time a stop of fifty-five minutes was made to repair the sparking apparatus. Supplies were taken in at two relay stations, and the engine consumed three and a-half gallons of gasoline and nineteen gallons of water. Two persons were carried. This carriage was built by the Duryea Motor Wagon Company. It is said to have developed 4-horse power and a speed of twenty-seven miles per hour on the testing machine already described, and it has attained a speed of sixteen miles per hour on good roads. It carries a supply of gasoline sufficient for about 100 miles run on good roads. In the carriage used the power is transmitted from the gears to the rear axle by a chain, but in the new carriage belts and gears will be used. The price quoted is from £200 to £400.

(2) *Mueller motor carriage*—Fig. 1.—This is a four-wheel carriage, driven by a Benz gasoline motor. The trip was uneventful in the way of accidents or delays, no failure occurring, and the stops being mostly for the purpose of examining the machinery to see that all was right, or to take on supplies. Three gallons of gasoline were taken at each of the relay stations. The carriage had three passengers for the greater part of the distance, and then two passengers. This carriage was built by the H. Mueller Manufacturing Company.

(3) *Roger motor carriage.*—This was a four-wheel park phæton—closely resembling the carriage shown in Fig. 5—fitted with a Benz gasoline motor and imported from Paris. It worked satisfactorily, but was unable to do its best, owing to its steering gear having been damaged by a collision with a cab driven by a man who did not regard the motor carriage with favour. This damage caused it later on to run into a sleigh, damaging one of the wheels. Eventually the motor gave out, and the carriage came to a standstill, although it was then ahead of the Mueller carriage, and was well on its way on the return trip. Three delivery wagons for city work, fitted with Roger motors, have been put in trial service in New York and Philadelphia. [These are Roger parcel vans with Benz motors.—ED. E.] The wagon weighs 2300 lb., is fitted with a motor weighing 625 lb., and can carry 1300 lb. of goods or parcels and a supply of rectified petroleum sufficient for seventy-five hours' run. The wheels are of wood, with rubber tires, but wire wheels were used in the park carriage taking part in the competition. This latter carriage started to run from New York to Chicago before the race—nearly 1000 miles by road—but after travelling about 140 miles had to give up on account of the terrible condition of the roads, owing to snow and mud. It was then sent on by rail. This carriage was entered by R. H. Macy and Co., and carried two persons.

(4) *Sturges motor carriage.*—This was a three-seated sulky, for six persons, and weighing 2750 lb. in running order. For this run the rear seat was removed to make room for more batteries. It was built at the time of the Chicago Exhibition of 1893, by Mr. Harold Sturges, and has been in use more or less since that time. It is shown in Fig. 3. This carriage is mounted on four wheels, the front wheels being 3½ft., and the rear wheels 4ft. diameter. In the body were thirty-six storage battery cells, with a capacity of 250 ampère hours, the power stored being equivalent to 23 electrical horse-power. The motor was of 3-horse power, and the power was transmitted to the axle by single-reduction gearing. The cost of such a carriage is approximately £300. This carriage has a speed of three to ten miles per hour on good roads, and its battery should carry it seventy miles on a hard level road without re-changing, but owing to the condition of the roads and the lack of adhesion due to the 6in. of snow, causing the wheels to slip very badly, nearly double the usual power was exerted, and the carriage travelled at a speed of only four miles per hour, the batteries becoming exhausted after a run of thirteen miles. Nevertheless, no accident or breakage occurred, and Mr. Sturges states that during the past summer he ran the carriage at a speed of ten miles per hour on a smooth road, with only 3-horse power, giving a running capacity of seven hours, or about seventy miles.

(5) *Morris and Salom motor carriage.*—This was a storage battery carriage of a style which has been in experimental use for some time, but which is handicapped by the ridiculous name of "electrobat" bestowed upon it by its builders. As the severe conditions of the road had not been anticipated, and a sufficient supply of batteries had not, therefore, been sent to the relay stations, the carriage made an experimental run of only about twelve miles, and then went back to the testing room without a stop, using its own power. The batteries were changed twice during the run, the time consumed in changing the four 150 lb. boxes being five minutes in each case. This carriage, shown in Fig. 4, weighs about 1600 lb., but a somewhat smaller one, weighing 1200 lb., was used in the competition. The reduction of weight was effected by the use of steel tubes for the frame, and wire wheels. There are four sets of twelve chloride cells, supplied by the Electric Storage Battery Company, having a capacity of 50 ampère-hours per cell. When pushed into place automatic connection is made with the controller, which is operated by a hand wheel in front of the seat, and gives four rates of speed by various groupings of the batteries with the motors. The battery capacity is sufficient for

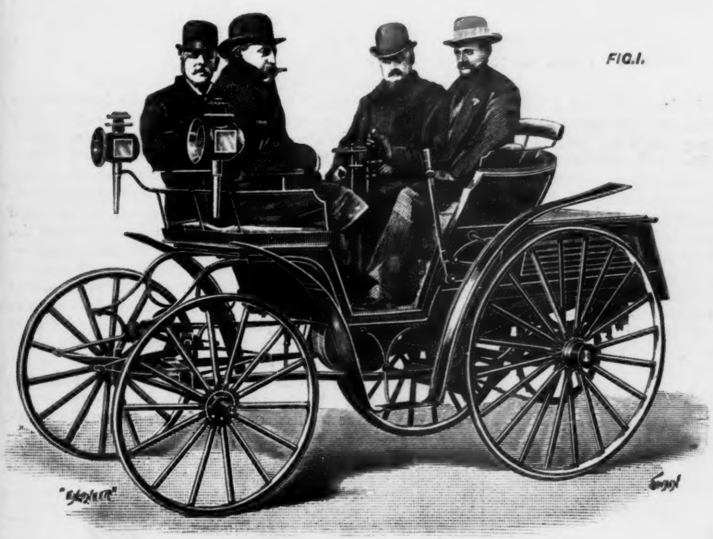


FIG.1.

MUELLER CARRIAGE WITH GASOLINE MOTOR

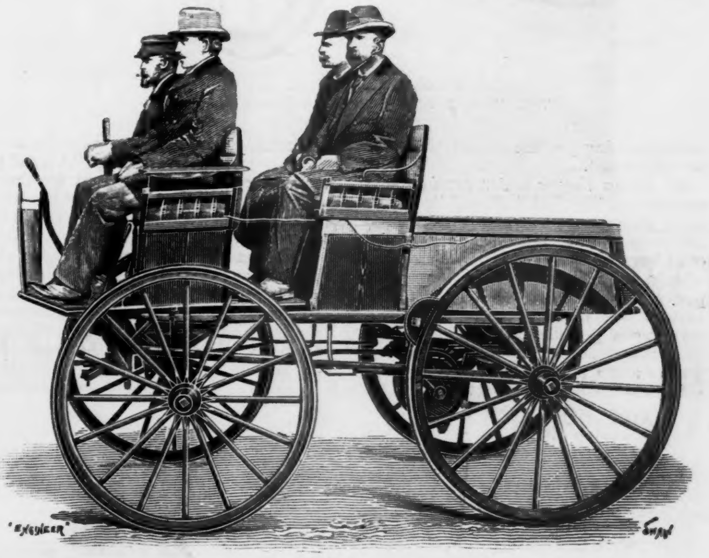


FIG.3

STURGE'S STORAGE BATTERY CARRIACE

twenty hours' run, and a speed of twenty miles per hour is said to be practicable on good roads. There are two Lundell electric motors of 1½ nominal horse-power, driving by pinions on the armature shafts the driving gears attached to the front axle. The steering is done by shifting the rear axle, which method is said to work very well. The carriage illustrated has wooden wheels, the front ones being 40in. and the rear wheels 28in. diameter. The carriage seats two persons, and was built by Morris and Salom. Storage battery carriages which have to change their batteries on the trip are seriously handicapped for ordinary use when compared with carriages having battery capacity for the entire trip, or carriages using gasoline motors, whose tanks can readily be replenished.

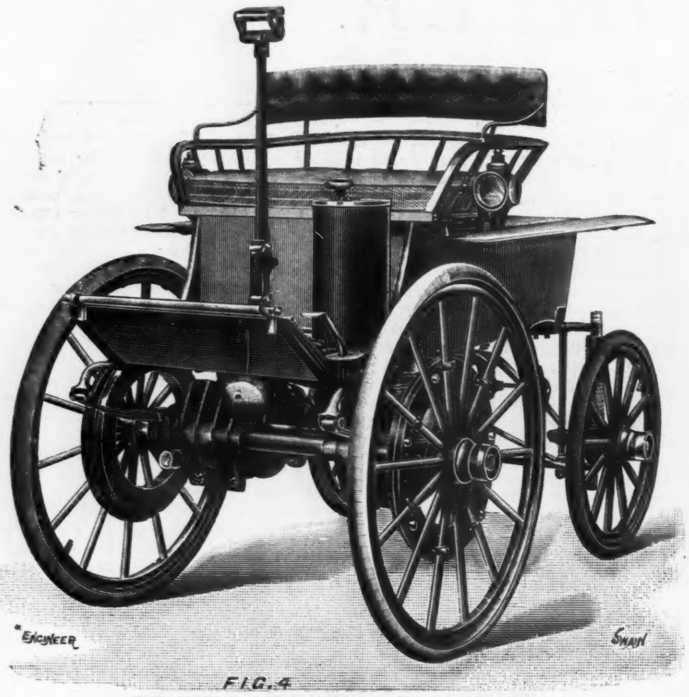
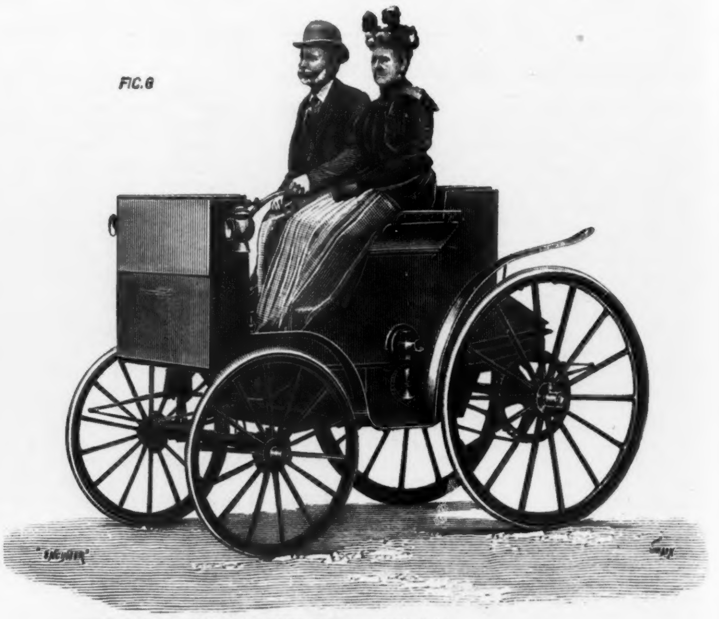


FIG. 4

THE MORRIS AND SALMON STORAGE BATTERY

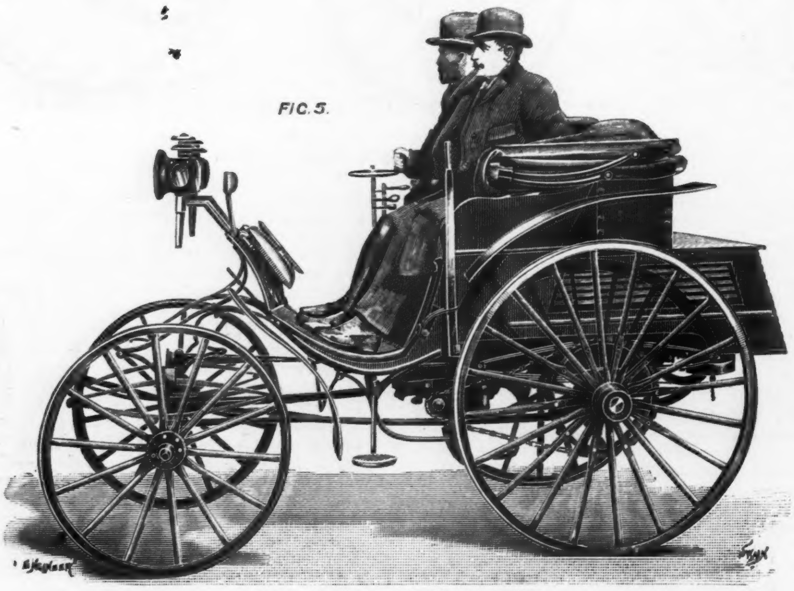
FIG. 6



THE LEWIS MOTOR CARRIAGE AT CHICAGO

(6) *De La Vergne motor carriage.*—This was another gasoline carriage, but it slipped its wheels so badly in the snow that the man in charge soon abandoned the race, and so ran the machine back to its shed after a short run of 1¼ hours. The carriage, as shown in Fig. 5, has four wheels, and seats two persons. It is fitted with a 4-horse power gasoline engine, having the cylinder and jacket cast in one piece. The engine runs at 350 to 400 revolutions per minute, a muffler stifling the noise of the exhaust, and a condenser disposing of unconsumed gas so as to prevent unpleasant odours. There are no belts, and the power is transmitted to the axle by a chain-and-sprocket wheel. The tank and exploding battery are under the front seat, the tank holding a three days' supply of gasoline. The engine and gearing are mounted complete in an iron frame ready to be fitted to the carriage, and the weight of the machinery is about 300 lb. About 30 lb. of water are required for the cylinder jacket for a run of ten hours. The total weight of the carriage is about 1000 lb. Some large hunting drags, seating six persons, have been built, weighing 1800 lb., and have two-cylinder engines. The engines are built by the De La Vergne Refrigerating Company, and the carriage bodies were supplied by different carriage builders. Five other competitors were expected to run in this race. Haynes and Apperson broke one of the wheels of their gasoline carriage in making a sharp turn to avoid a cable tramway car while on the way to the starting point. Max Hertel broke the steering gear of his gasoline carriage; and Banske and Brothers—gasoline—A. G. Ames—steam—and George W. Lewis—gasoline—could not get their carriages ready in time.

FIG. 5.

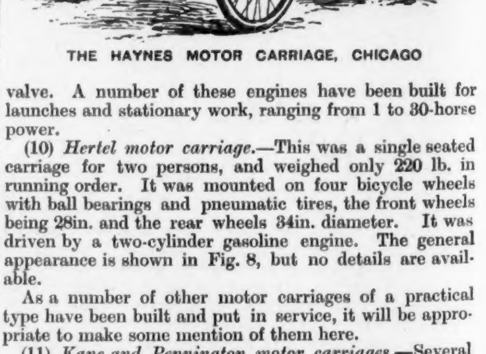


DE LA VERGNE MOTOR CARRIAGE

(7) *Lewis motor carriage.*—This is a four-wheel, single-seated carriage, which was built in December, 1894, and is fitted with a patent gas vapour engine invented by Mr. George W. Lewis, and quite extensively used for launches, stationary engines, &c. The engine is of 2-horse power, with a single vertical cylinder, and is placed in a case behind the seat, a chain connecting the sprocket wheel on the shaft driven by the engine with the larger sprocket wheel on the rear axle. A small generator and the battery which furnishes current for the igniting spark are behind the seat, while in front are the gasoline tank—which holds a supply for about 100 miles' run—and the six-gallon water tank for circulating water in the cylinder jacket. The fly-wheel on the engine shaft drives the sprocket wheel shaft by a friction pulley, there being slow-speed and high-speed gears, and the noiseless friction gears being of raw hide. The engine runs at 300 to 500 revolutions per minute, and the speed can be changed by the gears without affecting the speed of the engine. The front wheels are 32in. diameter and the rear wheels 44in. diameter, all built of wood and fitted with heavy solid rubber tires and roller bearings of special design. Iron braces maintain the spacing between the sprocket wheel shaft and the rear axle, and these braces are adjustable as to length so as to regulate the tension of the driving chains. The front wheels have pivoted hubs, with rods leading to a central vertical steering shaft having a goose-neck handle. The cost for fuel is said to be about ½d. per horse-power per hour. The weight of the carriage is 1250 lb., and its appearance is shown by the view in Fig. 6, which is taken from a photograph furnished by Mr. Lewis. A double-seated carriage of the same general type weighs 1500 lb., and is fitted with a 4-horse power two-cylinder engine weighing 450 lb. and developing 6-brake horse-power. The seats are placed back to back.

(8) *Haynes carriage.*—The first Haynes carriage was built in the winter of 1893-94, mainly for experimental purposes, and is shown in Fig. 7. It is a single-seated carriage for two persons, and weighs 1052 lb. in running order. It is mounted on four 28in. wire wheels, with 1¼in. solid rubber tires. The maximum speed is about ten miles per hour. The motive power is a 2-horse power gasoline engine, built by the Sintz Gas Engine Company, the power being transmitted by sprocket wheels and chains to a countershaft, and thence in the same way to the rear wheels. The carriage will run 50 miles at ordinary speeds with one charge of gasoline. A somewhat larger carriage, built for the Chicago competition—but which met with an accident, by which one of its wheels was damaged the day before the race—was a two-seated trap seating four persons. This weighed about 900 lb. in running order, and was mounted on four 36in. wire wheels fitted with 2in. pneumatic tires. A 4-horse power double-acting balanced gasoline engine, built by Haynes and Apperson, was used, and the power was transmitted in the same way as in the older carriage. In the Sintz engine the gas and air are mixed in the lower end of the cylinder—which opens into a chamber containing the crank space—and the mixture then passes to the closed upper part of the cylinder through a port which is opened as soon as the body of the plunger piston reaches the lower end of its stroke. The mixture is then compressed in the clearance space above the piston, and is exploded by an electric spark as soon as the piston has reached the end of its up stroke. The gas generator holds about a pint of gasoline, and the feed is regulated by an automatic needle valve. A number of these engines have been built for launches and stationary work, ranging from 1 to 30-horse power.

FIG 7.



THE HAYNES MOTOR CARRIAGE, CHICAGO

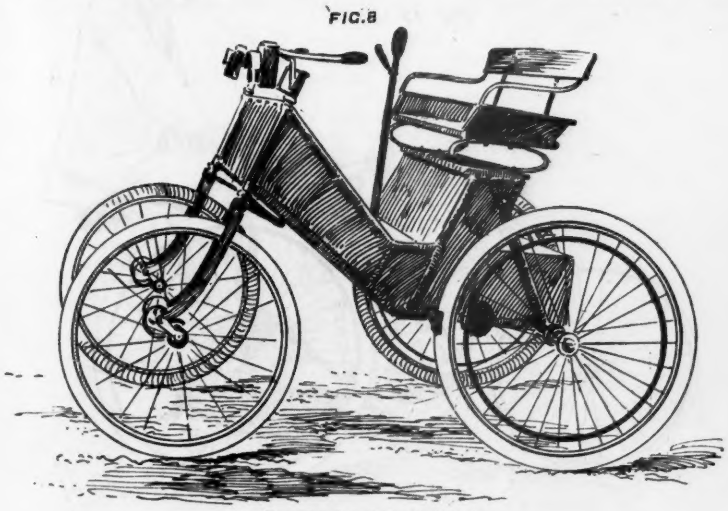
(10) *Hertel motor carriage.*—This was a single seated carriage for two persons, and weighed only 220 lb. in running order. It was mounted on four bicycle wheels with ball bearings and pneumatic tires, the front wheels being 28in. and the rear wheels 34in. diameter. It was driven by a two-cylinder gasoline engine. The general appearance is shown in Fig. 8, but no details are available.

As a number of other motor carriages of a practical type have been built and put in service, it will be appropriate to make some mention of them here.

(11) *Kane and Pennington motor carriages.*—Several carriages fitted with the Kane and Pennington gasoline engines were originally entered for the competition, and in view of what has recently been said about these motors in the English papers, it is to be regretted that none of the carriages actually ran. Figs. 9 and 10 give some details of the engine—Fig. 9 being reproduced from the *American Machinist*—while Fig. 11 shows the Elston

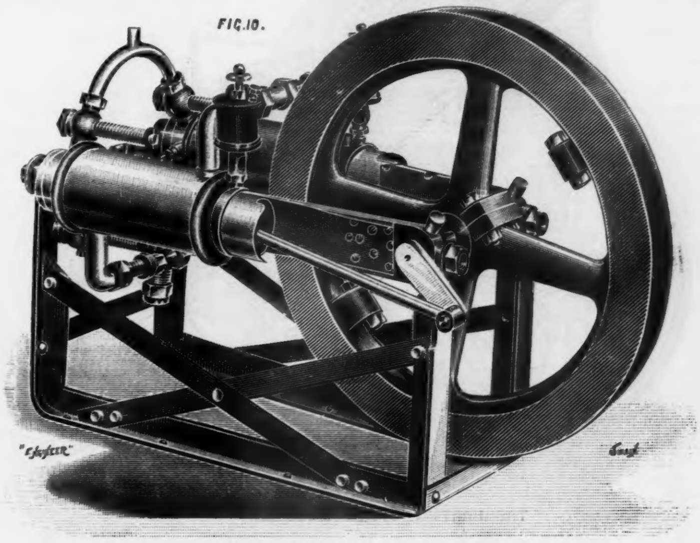
carriage, and Fig. 12 shows the Racine carriage, the former having a 4-horse power and the latter a 2-horse power Kane-Pennington engine. Ordinary gasoline or kerosene oil flows by gravity from the tank to the engine, and is exploded by an electric spark, the consumption of fuel being about $\frac{1}{10}$ gallon per horse-power per hour. The cylinders are drawn steel tubes, with spring rings to the piston. The $\frac{3}{4}$-horse power engine has one cylinder, the 2-horse power two, and the 4-horse power four cylinders. The following particulars of this much discussed engine are extracted from an article in the *American Machinist*, by Mr. Randol, who had seen the carriages and engines.

FIG. 8



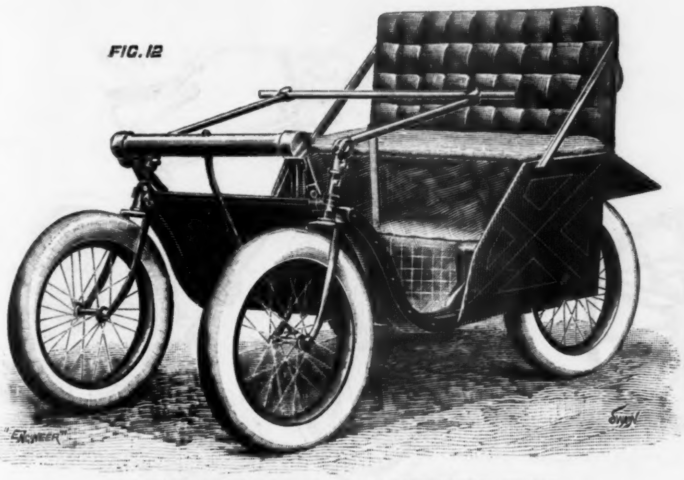
THE HERTEL MOTOR CARRIAGE

FIG. 10.



THE KANE-PENNINGTON GASOLINE ENGINE

FIG. 12



RACINE CARRIAGE WITH KANE-PENNINGTON ENGINE

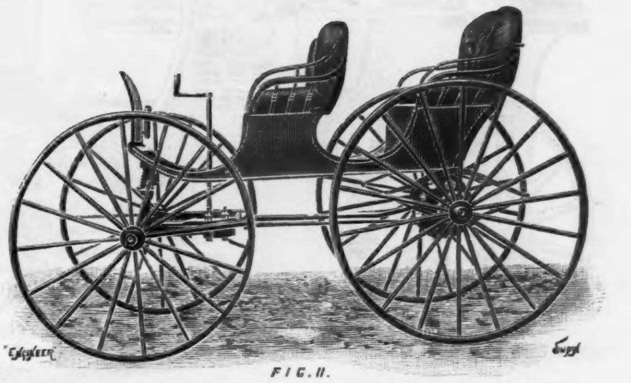


FIG. 11.

ELSTON'S CARRIAGE WITH KANE-PENNINGTON ENGINE

In some way, so far wholly unexplained, the great heat which in other explosive engines manifests itself as an inconvenient bye-product, to be taken care of as best it may, is in the Pennington engine transformed into useful effect on the piston. I know that when the long, thin first spark is not put through the charge the engine becomes weak and hot, and that when this first long, thin spark, this "mingling" or "ripening" spark, as Mr. Pennington calls it, is used, a common gas engine, with its carburetter eliminated, gives twice its ordinary effect on the crank. I know also that all the experts who have been employed by capitalists to examine this engine have been first incredulous and then amazed, and finally enthusiastic, and I have therefore decided to let this first paper stand as it is, because it correctly exhibits not only my own experience, but the experience of all others, both learned and simple, upon a first examination of the motor. This two-spark mechanism of the Pennington motor actually does not cost five cents, and yet when applied to the "Regan" gas engine, largely built up to the present time by the Kane establishment at Racine, it doubles the power of that motor. It is in the igniter, and in the double spark, or rather in the effect of the first spark, apparently, that the efficiency of the Pennington motor lies. In the Victoria, Fig. 12, the motive power is chain geared, with two reductions, first to an intermediate shaft, then to a variable speed shaft, and last, from the variable speed shaft back to the drivers, each wheel being independently driven, as there is no through shaft for either the rear or front wheels, the Victoria design being on strictly bicycle construction lines. The reduction from the engines to the driving wheels is 4 to 1 for the slow speed, and 2 to 1 for the quick speed. The upright hand lever has three positions; standing upright, the engines are disconnected from the driving wheels; hand lever to right gives 4 to 1 reduction to drivers; hand lever to left gives the quick drive, which is a 2 to 1 reduction from the motors to the drivers.

The Victoria engines have a fly-wheel, and the right-hand crank wrist is prolonged to form a handle; the intermediate shaft sprocket wheel is loose and may be clutched to the shaft by moving the upright lever. When not clutched to the shaft the engines run without moving the vehicle; to start the engines one complete turn of the engine shaft is made by hand, and it then continues to run from the action of the engines until either the oil or the spark-producing current is shut off. After the one revolution by hand the riders mount the seat, and a movement of the vertical lever clutches the sprocket to the variable speed intermediate shaft, and the Victoria at once begins to move.

The consumption of common kerosene oil per hour per horse-power indicated is about one-tenth of one gallon, or about two quarts per hour for $4\frac{3}{4}$-horse power. Pennington's 2-horse power motor weighs $17\frac{1}{2}$ lb., and his entire Victoria weighs less than 400 lb., of which perhaps 140 lb. or 150 lb. belongs to the motive power and reducing gear. It will easily transport a load of 800 lb., making a total weight of 1200 lb.

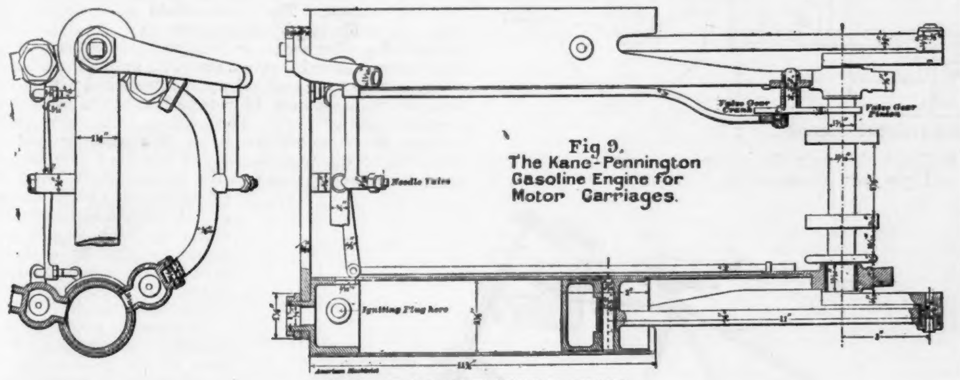


Fig 9.
The Kane-Pennington Gasoline Engine for Motor Carriages.

PLAN OF KANE-PENNINGTON ENGINE

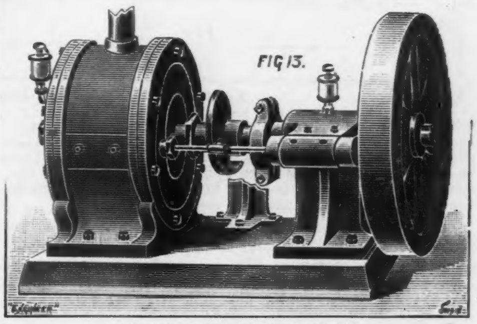
It will be observed that the cylinder proportions of the engine are not at all those common to gas engines, $2\frac{1}{2}$in. cylinder diameter by 6in. stroke forms the standard unit. But a much greater digression is shown in an engine now under test, having a $2\frac{1}{2}$in. diameter with 12in. stroke single cylinder, in which the terminal pressure is reduced almost to atmosphere, with a fuel gain of about 45 per cent. over the $2\frac{1}{2}$in. by 6in. cylinder dimensions.

Referring to Fig. 9, there is next to nothing in the way of description or explanation to give. The oil admission is simply a screw-controlled needle valve, which is very simple and gives no hint of its two-current refrigerating powers. The cylinders are made of steel tubes, ground inside in a primitive engine lathe, and steady rest rig, dry, and almost certainly not a very close approximation to a cylindrical form. The pistons, I was told, were drop forgings. They would be more easily made in grey iron. The piston rings are grey iron, less than $\frac{1}{16}$in. thick, with halved joining. The pistons and open cylinders appeared to be wholly free from any deposit, and were bright and clean. The trunk pistons are a very slack fit in the cylinders, perhaps $\frac{1}{32}$in. small. The workmanship generally was fair, and the designing was specialised with a very high degree of ingenuity, as I need not say when it is remembered that a 58 lb. locomotive—motor bicycle—made a mile in fifty-eight seconds on a street pavement.

The machine which made this run of a straightaway mile in fifty-eight seconds is shown in Fig. 17. To avoid the weight of reducing gear the diameter of the cycle wheels is dropped to 22in., and to give adhesion and avoid puncture the pneumatic tires are made 4in. diameter, after Pennington's specifications, and cannot be injured by a hammer and nail in skilled hands; the attempt to drive the nail into the inflated tire results in a simple rebound of the nail, the tire remaining intact.

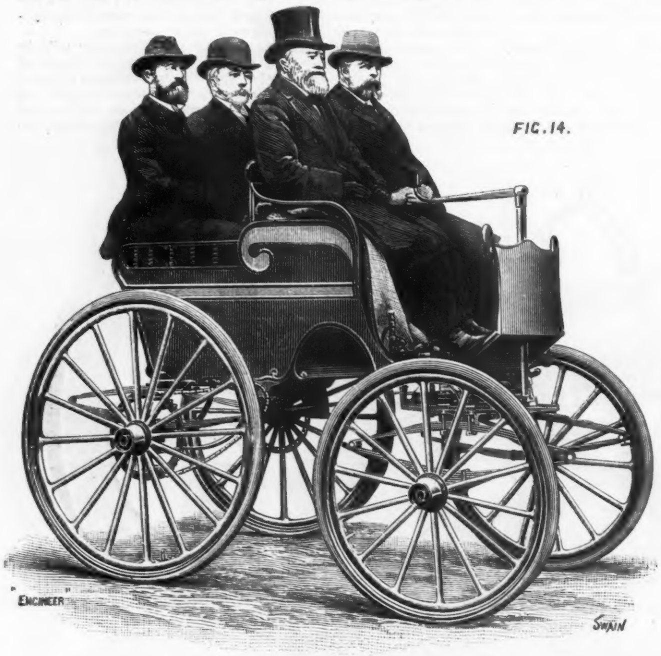
The passenger on the bicycle feels the impulse of each stroke of the engines, just the same as on a little stern-wheel steamer; aboard the Victoria the heavy fly-wheel equalises the motion, and the individual piston impulses are not distinguishable. The kerosene is carried in the long tube on the top of the dashboard, Fig. 12, and passes through the tubular framing of the body to the motors. The motors themselves are of the 4-stroke cycle variety, and make one outboard working stroke, and one inboard, idle, cylinder-clearing stroke, then an outboard charging stroke and an inboard charge-compressing stroke in sequence; the valve operating crank is driven by a pinion and spur 2 to 1 reducing gear on one side, with a cross lever transfer to the other cylinder. With the 6in. stroke cylinder the exhaust is very audible, though not disagreeably so. With the 12in. stroke cylinder the noise of the exhaust is not noticeable. There is no visible discharge of vapour, and no evident odour except in case of an over admission of oil, and an over admission of oil leads to an immediate loss of efficiency, which makes its continuance an impossibility. The one great mystery is the coolness of the naked cylinders, which should be red hot at the end of the first twenty strokes or so of a run. Chemists are familiar with the establishment of low temperature pressures, but pressures established by explo on are not cold as a rule, and the gas engine has always been hot.

FIG 13.

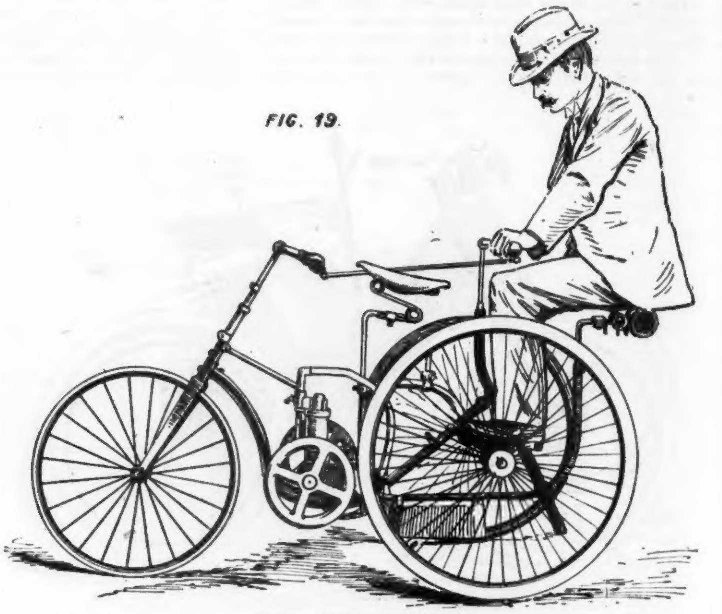


THE HARTLEY ROTARY ENGINE

The Kane-Pennington shops are making or have made general trials of the water-jacketed cylinder; the $2\frac{1}{2}$in. by 12in. expansion engine is jacketed and piped with top and bottom natural circulation pipes to a small water tank which a run of some length did not seem to heat very much. The cylinders run perfectly well naked, with no cooling element more than their inevitable exposure to the atmosphere. There is evidently some heat-absorbing or



THE HARTLEY STEAM CARRIAGE



MAXIM MOTOR TRICYCLE

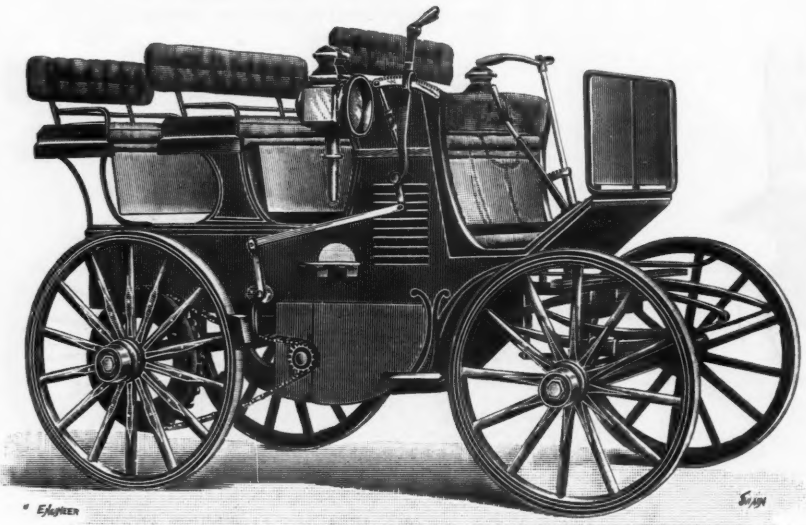
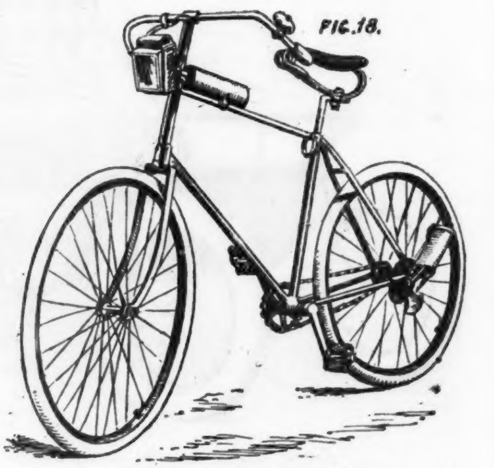


FIG. 15

HOLTZER-CANOT ELECTRIC CARRIAGE



THE RIOTTE MOTOR BICYCLE

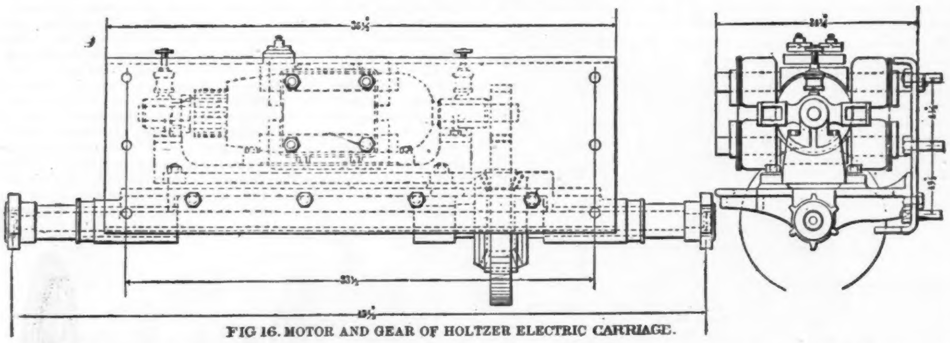
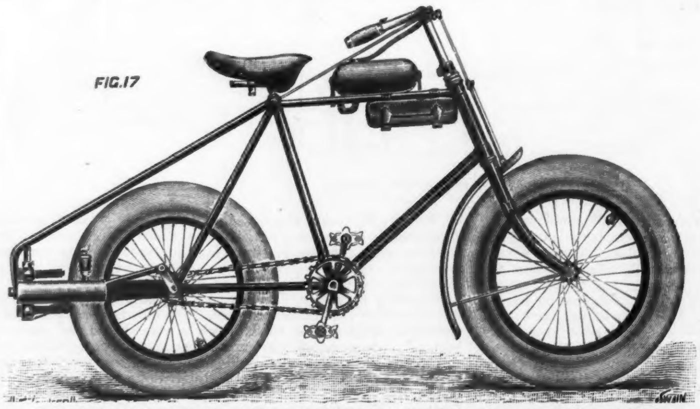


FIG 16. MOTOR AND GEAR OF HOLTZER ELECTRIC CARRIAGE.

diverting or abstracting element or operation in the Kane-Pennington engine not commonly present in the gas engine, and it is difficult to see what this can be, if it is not the truth that the heat of the cylinder walls is absorbed by the incoming charge previous to the moment of the ignition, or else transformed into work on the piston, as it seems impossible that the gases after ignition should be otherwise than very hot indeed. Cards from the 2½in. by 12in. motor are promised, and these may give some clue to the thermal conditions of the Kane-Pennington motor in action.

(11) *Hartley motor carriage.*—This is one of the few steam motor carriages, and uses a rotary engine of the general style—shown in Fig. 13—except that a second cylinder replaces the fly-wheel. The carriage is shown in Fig. 14. It is mounted on 36in. front and 44in. rear wheels, provided with pneumatic tires and ball bearings. The weight is 500 lb., with 250 lb. more for the engine, boiler, and machinery. The boiler is 16in. diameter and 20in. high, placed at the front of the carriage, and the valve gear is operated by an excentric.

(12) *Holtzer motor carriage.*—A heavy drag, weighing 5100 lb., was built to order last spring by the Holtzer-Calvt Electric Company, and carries six or seven persons. The running gear is heavily and substantially built, and the wheels have ball bearings. The carriage and its machinery are shown in Figs. 15 and 16. The batteries are contained in the body and under the front seat, and the top of the body which supports the two rear seats is hinged, so that it can be thrown up, leaving the cells and all connections accessible for examination or repair. The batteries comprise forty-four chloride cells, 250 ampère hours, with a nominal discharge rate of 25 ampères. The cells are arranged in four groups of eleven each, and are connected to the motor through a series parallel controller, which puts the groups in multiple series, and multiple gear respectively, giving three speeds—5, 8, and 15 miles an hour. These are operated by the lever shown alongside the steering shaft, and locked in the various positions by engaging with a notched sector and spring latch. This arrangement gives three well-defined speeds, and no rheostat is needed. Though put to severe tests in climbing hills and running on heavy roads, the batteries have proved equal to the requirements. The body is made waterproof and painted with acid-proof paint, to prevent damage in case of the breaking or slopping over of a cell. The motor is a 4-pole series-wound of 7½-horse power capacity, and weighs 450 lb. Its speed at full load is 250 revolutions, and its efficiency 89 per cent. A phosphor bronze armature pinion engages with a carefully cut intermediate gear, the shaft of which is divided and connected through a differential gearing, allowing the wheels to run at different speeds when rounding corners. The intermediate shaft drives the hind wheels directly by chains, one on each side. The motor and gearing are protected by a light leather casing. For convenience in backing a reversing switch is mounted on the sector of the controller and interlocked with it, so that the motor cannot be reversed until the controller lever is placed at "off." The carriage lamps have each a 10-candle power electric light. The steering gear is connected to the movable hubs of the front axle, heavy crank levers being geared to the steering shaft, which is provided with a bicycle handle. A toothed segment with a spring latch is also arranged, so that by a slight pressure of the foot the operator may lock the front wheels at any angle.



MOTOR BICYCLE, WITH KANE-PENNINGTON TWO-CYLINDER GASOLINE ENGINE

This article would be incomplete without some reference to the application of motor engines to bicycles and tricycles, in which line a great deal has already been done.

(13) *Kane - Pennington motor bicycle.*—The bicycle shown in Fig. 17 has been described above in the description of the carriages and engines of the same firm. It has a 22in. driving wheel, with two cylinders at the back end of the frame. In the tandem machine the frame extends forward beyond the front handle bar of the single machine shown. Still another machine, of the style

shown, has vertical cylinders behind the rear wheel, driving a horizontal shaft projecting beyond the top part of the frame and carrying a silk-bladed screw propeller. This third machine weighs 58 lb.

(14) *Riotte motor bicycle.*—This is an ordinary bicycle with an oscillating cylinder, having its piston-rod attached to a crank disc on the rear axle. Oil is exploded in the rear of the piston, the small tank on top of the frame carrying a supply sufficient for 75 miles run. The weight of motor, oil and battery is only 9 lb. A speed of 20 miles per hour has been made on a good level road, and fair speeds up grades of 4 per cent. This machine is shown in Fig. 18.

(15) *Maxim motor tricyle.*—The machine shown in Fig. 19 is a tandem tricycle, fitted with a three-cylinder engine of the Otto cycle type, leaving only one-sixth of the revolution without impulse. The cylinders are of cold-drawn seamless steel tubing, $\frac{1}{16}$in. thick. The battery for the exploding spark is under the rear saddle, and has nine chloride cells, weighing about 12 oz. The gasoline tank holds a supply for 60 miles, and is under the frame. The motor weighs about 32 lb., and the whole machine not more than 100 lb. The power developed is 1½-horse power. This machine was built by H. P. Maxim.

(16) *Simonds' motor velocipede.*—The machine designed and built two years ago by C. L. Simonds is shown in Fig. 20. It has a porcupine boiler with 28 square feet of heating surface, and carrying 100 lb. pressure. Naphtha is the fuel, and a supply sufficient for 100 miles run is carried. The engine has two cylinders, with cranks set at 90 deg., and the rear axle is driven by a sprocket wheel and chain. The machine can run at ten miles per hour, and can ascend grades with two passengers. There are two pumps, one to feed the boiler, the other to blow the air blast through the naphtha. Under the boiler are five burners, so arranged that they can be used singly if desired. The exhaust steam passes through a feed-water heater, and is then delivered to the naphtha flame, where its presence stifles the noise. The total weight is 450 lb.

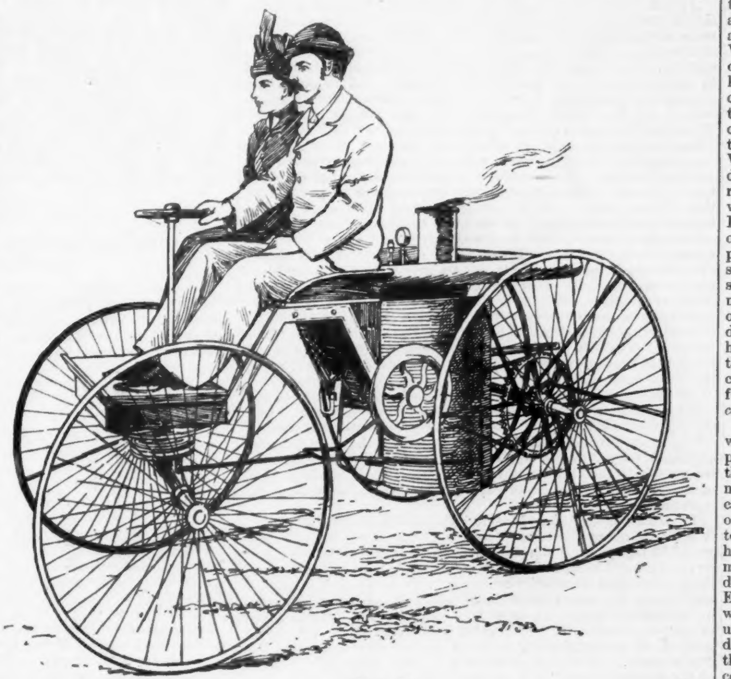


FIG. 20.
SIMOND'S STEAM MOTOR VELOCIPEDE

(17) *Motor delivery carts.*—Finally there is the application of mechanical power to small delivery carts of the form made by the Benz Co.—worked by the driver—are now being extensively used, and to which power has already been applied experimentally. In the Tinklam cart the driver sits with his back to the box, while in the Warman cart he sits facing the box.

It will be seen by what has been said in this article that there are in actual use a number of motor carriages of different types, and the competition run conclusively proved that some of them are capable of service under extremely unfavourable conditions. The impulse which has been given to the motor carriage within the past few months has had the inevitable result of deluging the Patent-office with a flood of applications for patents on motor carriages and carriage motors, and it is said that over 500 patents have been issued since the first announcement of the competition. Probably only a small number of these are of any practical value, but from the practical interest which has been shown by carriage builders, motor builders, &c., it is pretty certain that many important improvements will be introduced, and the motor carriage made a commercial as well as a scientific and a mechanical success.

One important result of the introduction of such carriages in the United States will be to increase very forcibly the growing demand for good roads. The great army of bicyclists and persons interested in making, selling, and using bicycles has already done a great deal in securing the construction of proper roads in certain districts, and in forwarding the "good roads movement" generally. This will now be reinforced by those interested in making, selling, and using motor carriages. Persons using horse carriages have been largely apathetic, from the reason that horses can go almost anywhere, and these persons have to be educated up to the point of seeing the expense and trouble incidental to driving or hauling on bad and muddy roads.

THE ENGINEER IN NAVAL WARFARE.

In this country many writers have produced many books more or less romantic dealing with naval warfare as it is supposed that it will be in the future. It is a noteworthy fact that none of these writers have handled the subject from the engineer's point of view. We hear the voice of the captain, the artillerist, the torpedo man, and the artist, but the engineer has been silent. We come across the statement that "Mr. Cross-Head maintained steam at full pressure," but no one thinks of saying how. We are told that "Mr. Side Lever, finding one of his engines blown to pieces by a shell, effected repairs in three hours, and just saved the ship from capture," but there is silence as to the details of this wonderful operation. In a word, the engineer has been virtually ignored. But there is more than this. It is indisputable that in naval warfare the engineer's department will play the most important part; but hitherto the engineer has been allowed to say very little as to his wishes.

Now, in the United States naval engineers think very much as they do in this country. They are treated with scant justice. One man has, however, carried the war into the enemy's camp, and delivered a series of lectures at the Naval War College at Newport. As an introduction to what follows, we quote here from the New York *World*:—

"During the summer a problem of great national interest was discussed at the Naval War College at Newport: How should the Navy of the United States be manœuvred, in event of attack upon the New England coast by a superior fleet of British vessels? Able officers were called upon to furnish plans of defence and to tell what should be done in the hour of great danger. These plans were laid before the college in the form of lectures, in which the writers, with full knowledge of the powers of our various vessels, discussed all the intricate phases of the problem. Among those detailed to a plan of defence was John R. Edwards, of the Engineer Corps, one of the most brilliant officers in the service. He wrote in a popular style, and so mercilessly exposed weak spots in our present organisation of the navy that his lectures raised a storm in the service, which has not yet subsided. Every effort was made to prevent these lectures from reaching the public, but repeated appeals to Secretary of the Navy Herbert have secured them for the *World*. The Secretary, after reading the lectures himself, concluded that they were of such general interest that he overruled the official objections to their publication."

We give Mr. Edwards's first lecture in a slightly condensed form. It will be seen that he has had to deal with certain assumed conditions laid down for him, much as conditions are stated for the admirals carrying out our own naval manœuvres.

PROBLEM.

May 10th.—War is imminent. The enemy is assembling at Halifax. He is expected to descend upon the New England coast. His probable plan is to occupy the coast and chief cities from Portland to Boston, thereby seconding certain movements of his land forces. His success depends upon his completing this occupation before June 10th, and maintaining it until July 10th. The force destined for this purpose is one or more fleets whose total is three times that of our fleet, and 20,000 men in fifty transports. Our available force is ordered to assemble for the present in Nantucket Sound.

May 20th.—War is declared. A fleet leaves Halifax, occupies Provincetown, and blockades Boston May 23rd. Is composed of six battleships, eight armoured cruisers, eighteen cruisers, twelve gunboats, aud twelve torpedo boats. Gains and keeps touch with our fleet, wherever it may be, by means of scouts. Our force is five battleships, five armoured cruisers, fifteen cruisers, ten gunboats, ten torpedo boats, and one ram. A heavy monitor at Boston, a light one at Portsmouth, and another at Portland are to be retained at those points. We learn that a much larger force of the enemy is about to leave Halifax. It sails thence May 25th, blockades Portland, occupies Casco Bay, and gains touch with its Provincetown fleet May 27th. Is composed of ten battleships, fifteen armoured cruisers, twenty cruisers, twenty gunboats, twenty torpedo boats, and fifty transports carrying 20,000 troops of all arms. Design plan for meeting this demonstration. Show best disposition of our forces, and describe in detail our preparations for the campaign.

Mr. Edwards, in answering this problem, devoted his first lecture to the work of naval engineers before going into action. He, in fact, tells the story of what he assumes would happen, as though the events had really taken place. He said:—

Qualities of command.—Early in April the Secretary of the Navy and the admiral commanding the defence fleet had several protracted consultations with the Engineer-in-Chief in regard to the threatening aspect of affairs on the New England coast. Imperative orders were given the Bureau of Steam Engineering to put the machinery of every war vessel in the highest state of efficiency. Unlimited expenditures were authorised, and instructions given to effect such alterations as would make each vessel a most reliable fighting machine; but every improvement suggested in any vessel had first to receive the approval of the admiral in command. The Commander-in-Chief of the defence fleet in urgent terms requested the Engineer-in-Chief to nominate as fleet engineer an officer who possessed the following requirements:—Ready in resource and of engineering constructive ability; not over forty-five years of age, yet quick of judgment and with a broad knowledge of the plans of our various types of ships; capacity for work, and rare executive ability; with considerable sea service, and great love and knowledge of his profession; of some personal magnetism; and of great will power and fixedness of purpose. Nearly every chief engineer on the active list applied for this duty, but by reason of age their requests were denied. It was urged by the admiral, who was under fifty-five years, that no one of any staff corps who had served in the last war should, on account of their age, do active work at sea. Line officers might go as a commander of a vessel, but then they should only be sent on battleships and armoured cruisers, or as flag officers. It was recalled to mind that Admiral Farragut's fleet engineer was only thirty-three years of age when the forts below New Orleans were passed, and in looking across the sea it was observed that the English Admiralty only appointed as Engineer-in-Chief of their great and powerful navy a comparatively young man. Of course, they are continued in office when they show matchless talents for the work.

The age of the fleet engineer.—Some difficulty was found in securing a man to fill the post of fleet engineer. It was regarded by the Secretary as next in importance to that of a fleet captain. An examination of the January Register showed that every man on the chief engineer's list was beyond the age limit set by the admiral. With great earnestness the Engineer-in-Chief urged that the admiral's wishes be respected in regard to the request for a fleet engineer. The old officers insisted on being sent. A very able fleet engineer was ordered, who was over fifty years of age. Within two weeks he physically collapsed under the great strain of almost continuous day and night work. During that period he had rendered invaluable service to the fleet, and some of the changes made under his supervision had an important effect upon the result of the great naval battle fought off the Massachusetts coast. His successor was one of the young officers who had been trained under the personal supervision of the Engineer-in-Chief. With such a preceptor, it was but natural that he had acquired decision and quickness of judgment, and a confidence which was ready to assume great responsibilities. Thoroughly conversant with the definite policy which had actuated the work of the Bureau of Steam Engineering, he knew the strength and weakness of our ships so far as their structural arrangements and motive power were concerned. Incessant work for a dozen of years in studying marine engineering questions, both at the Bureau and at sea, made him no stranger to the duties before him. He had made one cruise at least as a virtual chief engineer, although the official records showed that he served as assistant. Within a few days the Commander-in-Chief was impressed with the fact that in his fleet engineer he had a most valuable assistant. Casting aside the traditions of the past, he showed himself a great man by overcoming the prejudices of his four decades of naval life. Into his full confidence this fleet officer was taken, and then he was given *carte blanche* to prepare for the inevitable battle.

Changes in the cruiser.—Here are some of the changes that were wrought:—One of the scouts were sent for several hundred bunker plates and frames of standard size, so that the upper bunkers of the several ships could not only be coaled more rapidly, but be made more habitable in action. Under the direction of the carpenter the holes in the deck planking were cut to a size scant of that required. Another scout was sent to the nearest seaport to Lynn to bring men and electric drill outfits for cutting additional holes in the protective deck. Doors for closing the openings thus made were ordered from Bethlehem and Pittsburg, the detail drawings having been made by one of the assistant engineers. Emergency chutes which opened directly into the several fire-rooms were built within the bunkers. These extended from above the upper bunkers through the protective decks, and had suitable doors for preserving the water-tight features of the vessel. To the great joy of all the gun crews, the deck pumps were disconnected and all sent to a navy yard, where they took up valuable room in one of the buildings, thus robbing the scrap-pile of its legitimate prey. The valuable space secured by the removal of these pumps was utilised in many ways. And the capture of one of the enemy's cruisers was due to the fact that one of our vessels was able to prolong the chase for several hours by reason of carrying thirty additional tons of coal in jute bags in the space formerly occupied by the deck pumps. Those pumps might have been of use when all the boilers were in one compartment. If the boiler space had then become flooded the deck pump might have been of service. But in a modern ship, where the boilers are in several compartments, it is not likely that all the fires are going to be put out at once. If such a calamity should occur, the quicker the crew took to the boats the better. Those who would remain with the pump would probably find a watery grave.

Increased height of smoke pipes.—Additions were made to the height of all the smoke-stacks. This excited some comment, as it was supposed that we already had tall funnels on our vessels. An examination of the Marblehead, a vessel which was said to have been ruined in appearance by her tall stacks, showed that their tops were only 57½ft. above the grate. Those who made a cruise in the Chicago previous to 1895 hardly recognised her with her new and tall stacks. In the eyes of the admiral she was beautiful with these tall shafts, for he knew that this was a mark of efficiency and that it increased her sea speed. The cruising speed of the fleet was materially assisted by this action and the efficiency improved. The fleet engineer gave warning in regard to the enormous quantity of top hamper with which only too many of our battleships are oppressed. An Engineer editorial of June 5th says:—"We have deck-houses and bridges and boats and cowls. These would be converted in five minutes by machine and quick-firing guns into matchwood. Probably this matchwood would be set on fire. No wooden structure of any kind should be permitted on the upper deck. This was the lesson of the Yalu. As to the funnel, it is clear that with anything like a smooth sea and a moderate range, machine guns could cut these off pretty short. The cowls and ventilators would be reduced to small scrap. The existence of a warship as an antagonist must depend in action on her fans, and we have never yet been on board a man-of-war in which the fan arrangements appeared to be the best possible." The blower arrangements were improved, but not to the extent that could have been done if more time had been given. Temporary provision was therefore made for the ventilation of the vessel should the ventilators be cut away by small shell. The vital wind shafts were so arranged that nothing the enemy could do would affect them. Was it not strange that the ventilating question had to be settled on the eve of battle?

Quality of the fuel.—An inspection by the fleet engineer of the bunkers of the several ships showed that they contained various kinds and qualities of coal. There were anthracites, containing from 2 to 14 per cent. of ash, and there were even mixtures of the red and white ash varieties. There were bituminous invoices which had been exposed to the weather, and whose hydrocarbons had in great part volatilised and passed off. There was even a quantity of fuel which resembled peat more than it did coal. The sizes varied from steamboat to barley buckwheat. He knew that the efficiency of the vessels would be impaired by the possession of such fuel, for in action, when it would be necessary to force the fires to their utmost, there will be no time to select coal. That within reach would be taken, and a mixture of the various inferior kinds found by the fleet engineer in the ships would have resulted in the rapid formation of clinker, which would contain a large percentage of unconsumed carbon, thus not only entailing a great waste of coal, but decreasing the efficiency of the boilers. This investigation resulted in a Board of Naval Engineers being appointed to determine the quality and character of the coal supplied to our war vessels on the Atlantic coast. Repeatedly during their many consultations the Engineer-in-Chief had impressed the admiral with the superiority of our vessels in "boiler power" over that of the enemy. It was shown that in battle our vessels would be kept moving, and that the enemy would be given no chance of preparing for a rush at full speed under forced draught; that our ships, with larger boiler power and with their increased ratio of grate surface, would be in an efficient state when those of the enemy would have their fires full of clinker, tubes choked, and firemen exhausted. Taking them class for class, our ships are more powerful in their machinery than the ships that will operate from Halifax. The accompanying table shows that the Indiana and Massachusetts are but slightly inferior actually to the battleships of the Royal Sovereign class; but, as our vessels are of considerable less displacement, it will take about 20 per cent. more power to give the first-class battleships of the enemy the same speed as the Indiana class. This they have not; and so it may be confidently accepted that so far as sustained speed is concerned our ships are at least equal to the best that the enemy can concentrate. When it comes to the Iowa, we have a ship that in boiler power is far superior to anything that can be brought against her in the battleship line, and is only inferior in boiler power to the armoured cruisers of the enemy. Coming to the armoured cruisers, the Maine, though larger than the vessels of the Australia class, is shorter and not such a good form for speed; but she has greater boiler power, and may be expected to maintain nearly, if not quite, as good speed as the Australia class. The New York is fully 15 per cent. more powerful than the Blake, and the Brooklyn has practically the same power as the Blenheim, so that the ships we have of this class are not at all inferior to those of the enemy. Coming down to the protected cruisers it will be seen that the Columbia and Minneapolis have fully 75 per cent. more boiler power than the first-class cruisers of the Edgar class, and while they will be of greater displacement when fully loaded, they are in point of speed and endurance unapproachable by any vessels of the enemy's fleet. The Olympia, though much smaller than any of the hostile first-class cruisers, has greater boiler power than any of them, and is, therefore, capable of doing any duty in scouting or raiding that could be expected of a ship in possession of the enemy, and owing to the superior design of her boilers, she could do this duty much more economically than could the ships of the enemy.

Comparison of the Boiler Power of Vessels of the U.S. and British Navies.

	Displacement.	I.H.P.	Grate surface.	Heating surface.	Ratio of heating to grate sur.
Royal Sovereign Class	14,900	11,500	731	20,348	27·8
Indiana	11,600	9,000	616	19,195	31·1
Iowa	12,000	11,000	756	24,038	31·8
Australia Class	5,600	8,835	514	15,502	30·1
Maine..	6,800	9,292	574	19,015	33·1
Blake	9,000	14,525	871	27,192	31·2
New York..	9,000	17,400	1052	32,958	31·3
Blenheim	9,000	21,411	1135	31,073	27·4
Brooklyn	9,000	17,000	1016	33,429	32·9
Edgar Class	7,700	10,517 12,851	812	24,908	30·7
Columbia	8,100	18,500	1408	45,221	32·1
Minneapolis	8,100	20,860	1520	50,147	33·0
Vulcan	7,000	12,062	564	15,861	28·1
Texas	6,800	8,600	582	19,912	31·8
Mersey Class	4,050	6,151	388	11,565	29·8
Charleston	4,050	6,666	436	15,577	35·7
Forte Class	4,360	9,274	575	15,641	27·2
San Francisco	4,300	9,913	577	20,135	34·9
Archer Class	1,770	3,754	222	6,836	30·8
Yorktown Class	1,800	3,400	220	8,092	36·8
Medea Class	2,900	9,268	526	13,264	25·2
Cincinnati Class	3,550	—	617	20,179	32·7
Apollo Class	3,550	9,274	575	15,641	27·2
Palas Class	2,600	7,469	410	11,025	26·9
Detroit Class	2,100	5,400	394	11,004	27·9
Buzzard Class	1,140	2,000	—	—	—
Machias	1,200	1,800	120	4,590	38·2
Royal Arthur	7,700	10,086	731	24,828	33·9
Olympia	5,800	17,000	828	28,300	34·3

It will be particularly noticed that in the three types of vessels in which the plans were purchased abroad we have not that marked superiority over our transatlantic cousins in horse-power.

Flooding compartments.—An inspection of the fleet showed that in some of the vessels no provision had been made for flooding every compartment. Fire is an element which will have to be fought by the crews of a war vessel, and the occasion may arise when a compartment will have to be flooded to save a ship. This was one of the lessons taught at the Yalu. An exceedingly able writer in one of the June numbers of *Harper's Weekly* speaks as follows upon this subject:—"When the fires began to burn fiercely on some of the Chinese vessels it was found that there was no means of flooding the compartment where the torpedo heads were stored preliminary to being brought into action. This was an added source of danger, and it became necessary to throw the torpedoes overboard at once. It is probable, as a result of this, that further improvements will be necessary in the construction of warships to avoid such action in danger." Without going into dock flood-cocks were attached to the hull and pipes fitted, and the defect of not being able to fill the compartments with water was overcome. Everything was subordinated to placing the boilers and engines in a state of maximum efficiency, for the Engineer-in-Chief had convinced the Secretary of the Navy that in a modern war vessel the motive power had become a weapon, and that for special purposes it was superior to the gun. Speed, and particularly its control, is the cardinal element of tactics. Ability to manœuvre is now more dependent upon the number, form, and position of the propellers and the shape of the hull than it is upon the skill of the commander. They are therefore the qualities and attributes of a weapon. But the motive power is more. It is a defence, and in many respects of more importance than the armour. It gives the commander the option of avoiding or forcing a contest, and with marked superiority in speed he may determine the strategy of the battle. There are other ways of rendering a ship useless than by killing the men at the guns. Continuous work in an ill-ventilated and contracted fire-room will cripple the efficiency of that steam weapon below the protective deck. That voyage of the Columbia across the ocean is going to be fraught with great results. What mysterious power suddenly gave our people confidence when they read of the splendid run of the matchless "pirate?" It was because the nation had a glimpse of the future, and was told that speed was *par excellence* the weapon of the ship of war. Those pillars of fire at night and those clouds of smoke by day which belched forth from the funnels of the Columbia between the Needles and Sandy Hook settled the speed question of our war ships for the remainder of this century. Those who think our ships go too fast are likely to find out that our people believe such critics move too slow. And those who complain of the excessive horse-power of our vessels will find few people to argue with them.

Floating workshops and repair ships.—There had been fitted out for the use of the defence fleet two floating workshops, or repair ships. They were called the Corliss and Fulton. The men in charge of the several tools had been so instructed and drilled that in case of the capture of the repair-ship some vital part of each machine could be disconnected very readily. The ships were in great part fitted with duplicate machine tools, in order that the continuance of any special work need not be interfered with, and in case it was found necessary to sink one of the vessels to prevent her from falling into the possession of the enemy one could still be available. The workmen were nearly all members of the New England Naval Reserve, and probably had no superiors in the world as rapid and skilful artisans. Trained in the use of small arms and rapid-fire guns and subservient of discipline, their work and conduct received the special commendation of the Commander-in-Chief. All repairs were made under the direction of a naval engineer, who had as his assistants some of the ablest mechanical engineers in New England. These men had voluntarily offered their services until the close of the war, and their patriotic employers had sent with them to the repair-ships the pride and pick of their several establishments. The equipment of the repair-ships was placed absolutely in the hands of the engineer-in-chief. In general it may be said that the outfit was of such a character that it was capable of fitting up any casting from a two-ton cupola. Any plate whose width was less than 48in. could be handled successfully, irrespective of length. Particular care was taken that the repair-ships were not loaded down with too many tools. They were not intended, nor was it possible, to make them floating dockyards. The impracticable suggestion to equip them in a manner resembling a ship-construction plant was not seriously considered. Plates which could not be conveniently handled aboard such a ship were too large to be manipulated anywhere except at a great shipbuilding plant.

Auxiliary naval repair stations.—As the usefulness of a repair-ship is greatest for service abroad, or when the fleet is operating at some distance from its base, the Navy Department, after mature deliberation, decided upon another method of making the ships efficient. The Secretary therefore ordered the engineer-in-chief to co-operate with the admiral in command, and to make the necessary arrangements to establish repair stations. The American Society of Mechanical Engineers and the Marine Engineers' Beneficial Association of the United States, through their executive officers, called upon the President and tendered their services, requesting particularly to work under the special direction of the engineer-in-chief. It was realised by the President that our only hope of success—with our naval force but one-third as powerful as that of the enemy—was in having our fleet maintained in the highest state of efficiency, so that our maximum force could be utilised for a decisive blow at almost any hour. Six of the best-appointed engine plants in Rhode Island, Connecticut, and Massachusetts which are accessible to the sea were turned into auxiliary naval repair stations. There the great bulk of the repairs of the fleets were made. Whenever the repair was of a small but important nature, but beyond the resources of the fighting-ships, orders were given in different shops to make several of the parts required. The new pieces were sent aboard by different despatch-boats, and it was quite certain that at least one part would reach the vessel it was intended for. The fire and engine-room watches of all the vessels were drilled and trained, so that each of the enlisted men could do the duties of the next higher rating. As a victory was looked for, the fleet engineer thus provided in part for future contingencies. He thoroughly realised the fact that the engineer's force would be well employed and under great pressure before, during, and after the battle. The collapse of many good men could therefore be expected, and provision had to be made for such casualties.

To man a captured ship.—He knew also that in the case of victory it would be reasonable to anticipate that some of the enemy's ships would be captured. Such ships would either have to be destroyed or prize crews placed on board to take them to an American port. Such crews must necessarily contain a large proportion of officers and men of the steam department, which could not be arranged under existing circumstances without crippling the fighting power of our own vessels. A very decided improvement was made in the method of communicating between the conning-tower and the engine-room. Changes were made in the size, shape, and location of the mouthpieces of the speaking-tubes. Additional mechanical telegraphs were installed, likewise a simple, reliable bell-pull. Those contrivances of the dreamer which may be a success of the morrow, but which are unreliable toys of to-day, were discarded. Suitable key-words for certain work were agreed upon. When it was found necessary to pass orders by word of mouth, single expressive terms which could not be misunderstood were employed. Our enemy had also swept from their decks the worthless contrivances for communicating with the engine-room, for a London engineering leader had warned them as follows:—"For example, what is the use of an elaborate series of speaking-tubes from the forward conning tower to the engine-room, down which no intelligible message can be transmitted, given under ordinary conditions when the engines are running, and which would be utterly useless in the noise of an action? What can be said in favour of electrical signalling arrangements which cannot be trusted even on a peaceful cruise? The engineer would take very good care to provide signalling arrangements which, if they did not permit the captain and the chief engineer to consult with each other, would not fail to tell the latter what the former wanted the engines to do." The fleet engineer and the several chiefs had given serious consideration to the best method of arranging the fire and engine-room watches. The admiral and his council of commanders, after mature deliberation, had decided that the organisation of the engine force could best be done by the chiefs of the respective ships. In general it was determined to arrange the watches as follows:—First, when chasing, or escaping from an enemy, or when making maximum speed for a protracted period, the men should be placed in two watches, so long as this did not continue beyond thirty-six hours. This was terrible work, when taking into consideration the circumstances under which the men lived. After battling with fires forced to their utmost, it was impossible for men to sleep and rest until they were freed of the strain and excitement. In order to have the men secure some rest between the watches, it would be necessary to work them six hours at a time. For a long voyage the men should be placed in three watches and then relieved of all drill and routine duties.

Too few coal handlers.—The chiefs of all our vessels have been urging that the coal passers be taken out of the powder division. In an official report the chief engineer of the Columbia wrote:—"The force of firemen and coal passers is not sufficient for natural draught, steaming with all boilers, except when coal is very convenient to the fire-room." This is what the chief engineer of the Chicago wrote upon the same subject:—"I deem it my duty to state that the *personnel* is entirely too small to admit of the proper care of the machinery and utterly inadequate to sustain the proper efficiency of the engineer department during an engagement. One-third of the department being transferred to the powder division leaves many important stations, such as stop valves, bearings, &c., without special attendance, which will lead to serious disaster during battle." Captain Mahan comments thus on this report:—"The above representation of the chief engineer shows, in my opinion, the necessity of a general consideration of the question of actual necessities of an engine-room in action. The efficient working of the powder division of the Chicago required that deduction from the engineer force." Is it not possible to help matters, both in the engine-room and on deck, by improving the arrangement of magazines, and the manner of supplying and hoisting ammunition? Surely some better way can be found than the present methods. The great weakness of the Columbia and Minneapolis, besides the arrangement of their coal bunkers, is the method of supplying ammunition, and if this defect were overcome the powder division could do more efficient work with fewer coal passers. More men could then be secured for the fire-room, where there would be urgent duties for them to perform.

Station bill when in action.—It is not probable that a naval conflict in the future will be prolonged beyond six hours. For that period, and for an hour or two before and after the battle, the entire engineer force will have to work continuously. Improvements can and should be made in the manner of supplying ammunition. If this were done, the powder division with one-sixth the engineer force could do better work than they now accomplish. Two-thirds of the force should be stationed in the engine and boiler compartments. With one-sixth on deck helping to supply shell to the guns, there would then be a remaining sixth to form an "emergency watch," which would be under the charge of an assistant engineer. This squad would look out for the fire hose, stop valve gear on deck, make repeated examinations of the bunker water-tight doors, observe the operation of every steam and hydraulic machine outside the engine and boiler rooms, inspect at intervals the leads of the steering gear, stand by to work the steering appliance from below if the deck gear should be carried away, be in readiness to effect temporary repairs or overhaulings to any inefficient or disabled auxiliary. As they would be picked men they might be able to render effective aid should any of the gun mechanism jam. It is almost impossible to tell of the many possible ways in which their services could be utilised. Mechanics are not to be found aboard a ship in the deck force. I have never seen a good vice hand outside of the engineer department aboard any of the fifteen ships that I have been attached to. There have been excellent blacksmiths, but they were neither capable nor anxious to do the work of either boilermaker or machinist. I am quite positive that, during the three years I was aboard the Petrel, we never had target practice without having some slight hitch in the breech mechanism of one of the 6in. rifles. This was not the fault of the guns, but it was due to stupid work on the part of some Wallabout recruit or Asiatic "beach-comber." Therefore, the usefulness of the "emergency watch" is vast in its possibilities, and if these men could have special drills in dismounting guns, &c., they might become an important factor in helping to determine the result of a battle. In the short space of time that was permitted to prepare for battle, the development of electric power for many purposes, suggested in the engineer department, could only in part be carried out. No better authorities on the question can be found than S. Dana Greene and W. S. Shallenberger, both formerly of the naval service, and the absence of some of the motors recommended by them was greatly regretted on all the ships on the day when they went into action and met the enemy.

PRODUCTION OF PIG IRON IN THE UNITED STATES IN 1895.

WE estimate the production of pig iron in the United States, in 1895, at 9,387,639 gross tons. This estimate is based upon the monthly blast furnaces reports made to the *American Manufacturer*, and published in our columns. These reports of production for the first eleven months of the year, 1895, with an estimate for December are as follows:—

Production of Pig Iron in the United States in 1895.

Month	Production. Gross tons.
January	705,329
February	619,317
March	697,144
April	668,713
May	691,216
June	701,567
July	772,423
August	833,256
September	860,130
October	938,498
November	934,449
December, estimated	965,597
Total	9,387,639

The estimate for December is on the basis of the daily production of November, that is, 31,148 tons a day, or 965,597 tons for 31 days. Owing to the special conditions at the close of the year, it is probable that production in December will hardly be up to the average for November, but the difference will be slight.

As to the probabilities of this estimate being correct, we need not speak to those who know so well the accuracy of these monthly reports. To those who do not, we may say that the statements are based on actual returns. For the first six months of the year the production, as shown in the above table, was 4,083,286 tons. The report of the American Iron and Steel Association gave a production for the same time of 4,087,558 tons, a difference of about 1-10 of 1 per cent.

The production of pig iron in 1895 is the largest year's production in the United States, the nearest approach to it being in 1890, when 9,202,703 tons were made. The yearly production of the United States since 1885 is as follows:—

Production of Pig Iron in the United States, 1885 to 1895.

Year	Production. Gross tons.
1885	4,044,526
1886	5,683,329
1887	6,417,148
1888	6,489,738
1889	7,603,642
1890	9,202,703
1891	8,279,820
1892	9,157,000
1893	7,124,502
1894	6,657,388
1895, one month estimated	9,387,639

As compared with 1894 there was an increased production in 1895 of 2,730,251 tons, or 41 per cent.

The production of the two halves of 1895 were as follows:—

	Gross tons.
Production 1st half 1895	4,083,286
Production 2nd half 1895	5,304,353
Total	9,387,639

That is, the production in 1895 has increased day by day until at the close of the year it is nearly a million tons a month.

Unless Great Britain shall greatly exceed any previous year's production, this is the largest year's production of pig iron in any country in the world. In 1882, the year of its greatest output, Great Britain made 8,586,680 tons. The make of the United States in 1895 will be 800,000 tons in excess of this. The make of Great Britain in 1894 was 7,364,745 tons.—*American Manufacturer.*

LORD ARMSTRONG ON MR. EDISON.—Replying to a correspondent, who had asked him his views regarding some alleged recent statements by Mr. Thomas Alva Edison as to his invention of instruments of destruction for service in war, such as ærial infernal machines, engines throwing water charged with electricity, improved water torpedoes, and a gun for the firing of dynamite, Lord Armstrong, writing from his seat in Northumberland, says:—"Cragside, Rothbury, December 27th, 1895. Dear Sir,—If the words attributed to Mr. Edison are correctly reported, which I greatly doubt, I must say that this great inventor is both hard to understand and extravagantly sanguine. Designs which exist only in idea are seldom of much account, and Mr. Edison would be more than human if his brain were capable of evolving matured inventions, of astounding potency in war, requiring no protracted trials to fit them for practical application. In such matters, models and laboratory experiments go for very little on this side of the Atlantic. Nothing short of trials on a scale of actual practice can be relied upon, and these, if made, would, from their nature, be incapable of concealment, so that the advantage of sole possession would speedily vanish. Transcendent inventions, even when coming from an Edison, should always be received with incredulity in the absence of tangible proof, and Lord Salisbury is himself too much of an electrician to be moved from his serenity by any threats of wholesale electrical destruction which Mr. Edison, in the fervour of his patriotism, may have uttered.—Yours sincerely, ARMSTRONG."

RAILWAY MATTERS.

The average speed of the Empire State express on the New York Central Railroad is now 53¾ miles per hour, while the average speed of foreign expresses is given as follows:—England, 51·75 miles; Germany, 51·25 miles; France, 49·88 miles; Belgium, 45·04 miles; Holland, 44·73 miles; Italy, 42·34 miles; and Austria-Hungary, 41·75 miles.

A locomotive boiler exploded on the Southern Railway at Emery Gap, Tenn., on December 13th. The engine was standing on a side track at the time, in charge of the fireman, the engineer and conductor having gone to the railway office for orders. The fireman was seriously injured, as was also a bystander, who was 100ft. away from the engine, and who was struck by a flying piece of iron.

An electric motor suit, covering the patents on the mounting of electric motors on car axles in such a way as to enable the gearing to drive the axle without transmitting shocks to the motor, has been brought by the Adams Electric Railway Company against the Lindell Railway Company, of St. Louis. Mr. Wellington Adams, one of the promoters of the defunct Chicago and St. Louis Electric Railway scheme, claims that his patents cover this method of mounting car motors, which is used by many companies.

A steel rail tramway for country roads has been proposed by Mr. John O'Donnell, of Lowville, N.Y., formerly State Railroad Commissioner, to facilitate traffic of wagons and other road vehicles. The rails are about ¼in. thick and 5in. wide in the tread, with a rib or flange about ½in. high on each side, the flanges also extending below the flat part of the rail, and being spiked to the longitudinal timbers upon which the rails rest. These timbers rest upon cross-ties on the sub-grade of the road, and gravel or broken stone is filled in up to the level of the rails. The cost of finished road is estimated at £600 to £1000 per mile, the latter being for a good macadam road. The timber and steel tramway is estimated to cost £500, the balance being for the paving.

Four railroad cars that made their first appearance in the Connellsville region last week coming over the Baltimore and Ohio Railroad are regarded as the beginning of what may revolutionise the designs and uses of freight cars. Each car was a combination suitable for the transportation of grain, coke, coal, stock or fruit. The construction is such that by the temporary removal of every other board in the sides of the car, a load of grain or stock can be brought east and a load of coke be taken west on the return journey. The bottoms of the cars are drop doors for the unloading of ores and fuels. The Campbell and House patent is employed. The *American Manufacturer* says, the cars were built at the South Baltimore Car Works, and are fitted up with air brakes, patent couplers, and all modern improvements. They were constructed by the Chicago and Blue Island Railway.

The Cornish mail train had a very narrow escape from being wrecked on the 27th ult. morning after passing Doublebois Station. The passengers were alarmed by a loud rumbling and violent jolting, which increased until the train stopped. It was then found that the engine, one of the Great Western Company's new powerful type with front bogie, had left the rails and dragged after it the first coach, an empty one. The accident occurred within a short distance of the St. Pinnock Viaduct, and the passengers, in realising the nature of their escape, highly commended the action of the driver, who brought the train to a standstill by the prompt application of the vacuum brake. The mails and passengers, who were shaken, but otherwise uninjured, were despatched to their destination by special train, and the line was cleared during the day.

A lift-span 421ft. long is proposed for the New Kansas City and Atlantic Railroad bridge across the Missouri River at Kansas City, Mo. The bridge is to occupy masonry piers and abutments built some years ago, and will have two 421ft. spans, one of which is the lift span. For this lift span steel towers will be erected on the piers, and the moving span or deck will move vertically up and down between them, its movement being effected by means of counterweights travelling up and down in the towers. The whole arrangement and operation is much like that of an ordinary window sash and its counterweights. *Engineering News* says:—It is calculated that eight men can operate the bridge by hand, and that the same can be accomplished mechanically by a small motor. The total lift of the span is 45ft. They will provide for a double-track railway 32ft. wide, a roadway 11½ft. wide on each side of the railway, and a sidewalk 5ft. wide on each side of the bridge, making the total width of the span 65ft. The bridge was designed by Mr. J. A. L. Waddell, M. Am. Soc. C.E.

Considerable interest was manifested in an experimental trip recently made on the Great Eastern Railway to ascertain what, if any, difficulties there would be in the way of running a through train from London to Cromer without stopping, if it should be decided to put one on. Owing to the number of severe gradients, junctions, curves, &c., together with a swing bridge, and a portion of the road being a single line, no very high speed is possible, but it was hoped that the distance of 138 miles could be covered in three hours. The engine selected was one of the company's standard single-wheelers, No. 1006, having 7ft. driving wheels, 4ft. leading and trailing wheels, cylinders 18in. by 24in., 1217 square feet of heating surface, 18 square feet of grate area, working at a pressure of 160 lb. per square inch, and weighing in working order 40 tons. *Moore's Monthly Magazine* says, the engine was fitted with a tender on six wheels, 4ft. diameter, carrying 3100 gallons of water, and weighing with coal and water, 35½ tons. The train consisted of eleven main line coaches, weighing in all about 140 tons. Thus the total weight to be hauled was at least 215 tons. Sunday, November 3rd, 1895, was fixed for the trial, and on that day the experimental train left Liverpool-street at 11·35½ a.m. Cromer was reached at 2.31, the whole distance having been accomplished without a hitch of any kind in 175½ minutes, or at an average speed of over 47 miles per hour throughout.

It is announced that Mr. Francis P. Cockshott, the superintendent of the Great Northern Railway, has just retired after fifty-five years of active service. The excellence of the Great Northern services to Lancashire, Yorkshire, and Scotland has been largely due to him, and his life may be said to be an epitome of English railway history. As a schoolboy he often rode on the footplate of "No. 1" of the Stockton and Darlington. He was on the first ship that ever entered Middlesbrough Docks. While yet in his teens he became private secretary to Mr. Edward Pease, M.P., treasurer of the Stockton and Darlington and Great North of England Railways, and in that capacity often attended meetings between Joseph Pease and George Stephenson. From Darlington, after a short training in the engineering shops at Shildon, he went to Scotland as goods manager and superintendent of the Edinburgh and Northern, afterwards known as the Edinburgh, Perth, and Dundee, whose trains from Leith were hauled up by a stationary engine through the Scotland-street Tunnel—now abandoned, the *Times* says, to mushroom growing—into the then new Waverley Station in Edinburgh. In 1851 he went to the South Devon, where the atmospheric system had only recently been abandoned. In 1858 he took charge of the Cornwall Railway also. There it was his lot to conduct Brunel, lying on his back on a carriage truck, to see for the first and last time his great Saltash Bridge completed. There, too, the intervention of a director, who urged him not to work himself to death, dragged him from the footplate of an engine which half an hour later ran off the line on a viaduct near St. Germans and buried itself and its crew in the mud of the Tamar. In 1865 Mr. Cockshott came to King's Cross to take up the position which he held until Tuesday last.

NOTES AND MEMORANDA.

According to a return of the cost of power in the Antwerp Exhibition of 1894 by gas, oil, and steam engines, it was the same for gas and for steam for engines of 50-horse power, namely, 0·49d. per indicated horse-power, producer gas being used. For 10-horse power it was also the same, namely, 1·06d. per indicated horse-power, but for 2-horse power it was 2·93d. for gas, 1·74d. for oil, and 2·91d. for steam. The small steam engines were thus very expensive steam pipe obstructions.

The *Electrical Engineer* says that on January 1st, 1895, the Edison Electric Illuminating Company had connected 7615-horse power of electric motors, but at the end of October it had no less than 11,263-horse power, an increase of 3648-horse power in the short period of ten months. The horse-power capacity thus connected includes, it would seem, a great many of the fan motors, but not all, as it is becoming a common practice for people to plug the small motors into lamp sockets without fuss or notice, and, of course, these do not appear on the returns. The company has 251,487 incandescent lamps connected and 3280 arcs. This would figure out in the neighbourhood of 25,000-horse power, so that one-third of the company's total connected capacity is now represented by motors.

At a recent meeting of the Geological Society, a paper on "The Alteration of certain Basic Eruptive Rocks from Brent Tor, Devon," was read by Frank Rutley. The author gave a detailed account of the microscopic characters of sections of rocks from Brent Tor, and discussed the history of the rocks, comparing them with Tertiary basic glass, and with the Devonian rocks of Cant Hill, which he described previously. He brought forward evidence in favour of the view that the original alteration of both the Brent Tor and Cant Hill rocks was palagonitic, and that while in the Brent Tor rocks the subsequent alteration of the palagonite into felsitic matter, magnetite, secondary felspar, epidote, and probably kaolin, and some serpentine and chlorite was complete, it was only partial in the case of the Cant Hill rocks.

Underground electric locomotives at the Marles colliery, in the Pas-de-Calais, each weighing three tons, draw thirty corves holding 15 tons of coal, at the rate of 16 kiloms. = ten miles per hour, thus taking the place of thirty horses. Of the two Saint-Augustin shafts, A and B, 4m. = 13ft. in diameter, at No. 5 seat of working, each shaft is provided with a vertical winding engine, one of 200-horse power and the other of 250-horse power. The A shaft has landings at depths of 210m. = 114 fathoms, and 260m. = 142 fathoms; and shaft B is fitted with rail guides and electric signalling apparatus. The whole Marles concession, which covers 2990 hect. = 7388 acres, has three other seats of working, all situated at Auchel, seat No. 3 comprising the Saint-Firmain and Saint-Abel shafts, and No. 4 the Saint-Emile shaft, 4m. = 13ft. in diameter, with its air shaft of 2½m. = 8ft. 3in.

At the last meeting of the Chemical Society a paper was read on "The Composition of the Limiting Explosive Mixtures of Various Combustible Gases with Air," by Frank Clowes, D.Sc. A series of experiments were made with mixtures in varying proportions of each combustible gas with air. A flame was brought into contact with each mixture, sometimes above and sometimes below, and it was noted whether the mixture burnt back independently of the external air. For each combustible gas there was thus obtained a lower percentage below which the mixture would not burn independently, and a higher percentage above which the gas burnt independently only when it was supplied with more air. The limiting percentages were as follows:—For methane, 5 and 13; for hydrogen, 5 and 72; for carbon monoxide, 13 and 75; for ethylene, 4 and 22; for water gas, 9 and 55; for coal gas, 5 and 28. It was also proved that many mixtures which were outside but close to the above limits, and which could not be fired from above, could be fired from below. Hence it is inferred:—(1) That the limiting explosive mixtures for different combustible gases vary widely. (2) That methane shows the narrowest limits, hydrogen the widest limits. (3) That the risks of a mixture being fired explosively increases with the different gases in the following order:—Methane, ethylene, coal-gas, water-gas, carbon monoxide, hydrogen. (4) That the risk of explosion is greater when the mixture is kindled from below than when it is kindled from above.

Last year's production of iron ore in Sweden amounted, according to the *Sveriges Officiela Statistik*, to 1,926,524 tons, being 445,036 tons more than in 1893, and that of manganese ore to 3359 tons. The quantity of iron ore put out, which shows an increase of 30 per cent., has never before been attained. The principal mine, Gellivare, which contributed 655.401 tons last year, against 306,594 tons in 1893, is followed by that of Grängesberg, with 401,513, against 261,865 tons. Moreover, the iron content of the ore put out increased from 54 per cent. in 1893 to 64·4 per cent. last year. Although the use of lake and bog ore is decreasing yearly, 689 tons were utilised in 1894, bringing up the total iron ore production to 1,927,212 tons. Last year 462,809 tons of pig iron were turned out, being 9388 tons more than in 1893. There was a falling off in the out-turn of iron blooms and billets, and also in that of Bessemer steel ingots, the respective quantities of which were 204,517 tons and 803,296 tons; but, on the other hand, there was a great increase in the production of steel ingots by the Siemens-Martin process, the quantity of which was 81,714 tons, being an increase of 1893 tons. Only 464 tons of crucible cast steel were produced, showing a diminution of 54 tons. Iron and steel bars, 146,786 tons; and iron and steel hoops, 78,092 tons, both show an increase, the last-named description especially, and while the 28,764 tons of wire rods show a falling off, plates, 10,850 tons, show an increase. The blast furnaces turned out an annual mean of 3192 tons each; and on an average each furnace remained in blast during 257 days in the year. The mean daily out-turn of a furnace was 12·43 tons. Charcoal practically constituted, as heretofore, the only fuel used; but for the production of a small quantity of spiegeleisen a little English coke was added.

An improved calorimeter, for the application of the method of mixtures in determining specific heats, is described by Mr. F. A. Waterman in the *Philosophical Magazine*. Mr. Hesehus's ingenious suggestion is acted upon, to maintain the calorimeter, after the introduction of the heated body, at a constant temperature by means of cold water, instead of measuring the rise of temperature of the calorimeter. This arrangement gets rid of the radiation error, and eliminates the "water equivalent" of the vessel. By dropping the cold water in, stirring is also made unnecessary. The method has been placed by Mr. Waterman upon a footing of equality at least with other methods, but his success may be partly due to other improvements. The body experimented upon is heated by a coil of wire conveying a current, and surrounded by ice. The initial temperature of the body may thus be regulated by simply maintaining the current at a certain strength, and this temperature can be kept constant for five or six hours together to within 0·1 deg. C. The body is then plunged into a silver calorimeter surrounded by the bulb of a delicate air thermometer indicating a difference of temperature of 0·01 deg. C. The cold water is contained in a copper vessel having the shape of an inverted cone surrounded by ice. In this manner the ice cannot melt away and leave a free space round the vessel. The water-dropping arrangement and the electric heater are mounted on vertical axes in such a manner that they can be quickly swung into position just over the calorimeter. After the heated solid or liquid has been dropped in, the warter-dropper is set to work, at first rapidly, and then slowly, until the body has assumed the original temperature of the calorimeter. For bodies of the same weight and the same initial temperature, the specific heat is then, *Nature* says, simply measured by the amount of ice-cold water necessary to cool them to the temperature of the room.

MISCELLANEA.

Oil fuel is to be tried on board the torpedo destroyer Daring in the forthcoming mobilisation of the vessels of this class.

We understand that Messrs. Siemens have ordered a very large feed thermal storage vessel, on the Halpin system, for their Woolwich works.

Science Progress for December contains, among other articles, "Theories of Electrolysis," "The Study of Ancient Sediments," and on "Mineral Transformation."

Messrs. J. and G. Thomson, of Clydebank, have been commissioned by the Spanish Government to construct two torpedo boat destroyers to attain a speed of 28 knots, while having on board a load of 75 tons. They are to be somewhat larger and of stronger scantlings than those built for the British Navy.

Models representing each type of warship of the United States navy are being made at the Washington navy yard. Seven men have been constantly employed for some time past in constructing these models, which cost from £200 to £1600 apiece. The model of the fast cruiser Columbia, now under way, is only 5ft. long.

A board of American experts, headed by Admiral Walker, has recommended, says the *Army and Navy Gazette*, that the rams in the new battleships Nos. 5 and 6 be placed 11ft. below the water-line, as in the Texas, in accordance with the English system. The Bureau of Naval Construction, in its plans for these vessels, placed the rams 5ft. below the line.

The coal shipping returns for the past year show that the clearances of the Scottish ports amount in the aggregate to 7,479,940 tons, compared with 5,341,012 in 1894; 7,928,994 in 1893, and 7,764,417 in 1892. The large shipments in 1893 was the result of the prolonged strike in the coal trade of the English Midlands, while the great falling off in 1894 was due to the four months' strike of the Scottish miners.

A test of mechanical filters is proposed in connection with the waterworks of Minneapolis. Mr. F. W. Capelen, city engineer, is reported to have been in correspondence with manufacturers of these filters, with a view of having 250,000 gallon plants of the various systems set up for an experimental test of six months' duration, without further expense to the city than the furnishing of power to such plants as require it.

Her Majesty's Consul at Bilbao has advised the Secretary of State for Foreign Affairs that the corporation of that city are prepared to receive tenders up to noon on January 30th, 1896, for the construction of a portion of the main sewer, the engineer's estimate for which is about £5738. Plans, estimates, specifications, and forms of tender for this work may be inspected at the Sanitation Department of the Bilbao Town-hall.

The Dismal Swamp Canal is to be reconstructed, and contracts are already awarded. This canal, built under a charter of 1787, extends from Norfolk, Va., to Elizabeth City, N.C., a distance of 48½ miles. The present width of 32ft. is to be increased to 60ft., and the depth is to be 10ft. throughout. The five locks will be reduced to 3ft., and the summit level will be cut down 7ft. The Deep Creek and South Mills locks will be 250ft. by 40ft., with 12ft. lift.

The Union Steamship Company's Royal mail steamer Scot, which left Southampton on the 21st ult., with the South African mails, put into Vigo on the 25th, having encountered very heavy weather in the Bay of Biscay, which appears, a daily contemporary says, to have loosened some bolts connected with the casing of the propeller shafts, necessitating the employment of a diver, who had to be brought from a distance, and whose services could not be secured for several days owing to the holidays.

The following public notice is posted at the railway stations between Waterloo and Hampton Court:—"One Pound Reward.—Lost, a black leather Despatch Case, with brass lock, marked, 'A. S., Admiralty,' containing a copy of the Navy Estimates for 1895-96, and a few official papers, but nothing of any negotiable value. It was left in a first-class carriage of the twelve o'clock night train from Waterloo to Hampton Court, on Saturday, October 19th, 1895." £1 reward is not likely to fetch this document.

The new Factory Act came into force on Wednesday. A notice calling attention to its requirements was posted on that day at all police stations and post-offices in the United Kingdom. The requirements specially mentioned are those which apply outside the factories and workshops already on the inspectors' registers—namely, the provision requiring all workshops to be registered; the provisions as to out-workers' list, and as to infectious diseases, which apply to persons giving out work to be done at the workers' homes, whether the place where the work is given out be a workshop or not; and the provisions as to accidents, which now apply to all workshops, including those in which only men are employed. The Home-office has issued ten separate abstracts showing the provisions of the law applicable respectively to textile factories, non-textile factories, workshops, white lead works, print and dye works, steam laundries, hand laundries, docks, wharves, &c., buildings in course of construction, and domestic factories and workshops.

On the 13th ult. a new suspension bridle bridge over the river Wye at Sellack, near Ross, was opened. The bridge has been erected on the site of the old ferry, and connects the parishes of Sellack and King's Caple. The engineer was Mr. Louis Harper, A.M.I.C.E., of Aberdeen. The bridge is composed of steel wire ropes of suspension type, with vertical rods, 2ft. apart, connecting the upper and lower ropes. The sides are protected by oak skirting and lattice panelling. The bridge has a camber of 3ft. It is supported by four cast iron columns 25ft. high, and is held up by anchor blocks and rails, secured by concrete. The clear span of the bridge is 190ft.; its total length, including approaches, being 228ft. It has a walking way of 6ft., and is 6ft. 10in. out and out. The flooring is of oak, overlaid with boarding of oak cross-pieces 1¼in. thick. There are red sandstone abutments—the material having been obtained from Sellack quarry—with forest stone coping. The bridge is 25ft. above the summer water level, and is 6ft. higher than the highest known flood level. The cost has been £900.

Notice is given, that on and after the 1st day of January, 1896, the lighthouse at the Admiralty Pier, Dover, and the light exhibited therein, and the bell sounded at the end of the Admiralty Pier, during foggy weather, will be altered as follows:—The existing lighthouse, coloured red, situate on the south side of the turret at the end of the Admiralty Pier, will be removed. The new lighthouse is situate on the north-western angle of the Fort carrying the iron turret at the end of the pier, and is of granite, and is surmounted with a lantern, painted white with a red top. The height of the Stone Tower of the new lighthouse is 23ft. 3in., and the wind vane at the top of the lantern is 36ft. 10in. above the glacis of the Fort at the end of the Pier. It has been designed by Mr. A. T. Walmisley, the engineer to the Dover Harbour Board. The height of the new light will be 55ft. at high water ordinary spring tides, instead of 44ft., the height of the light to be discontinued. The light will be a white fixed light, of 360 degrees horizontal range, with flashes at intervals of 7½ seconds, and has been supplied and fixed by Messrs. Chance Brothers, of Birmingham. The light will be dioptric, and will be exhibited from sunset to sunrise, and will be of the fourth order instead of the sixth order, and will be visible in clear weather at a distance of ten miles or thereabouts, instead of six or seven miles. A bell will be continued to be sounded in foggy weather, giving single strokes at intervals of 7½ seconds, but the bell will be larger and more powerful than that used at present.

FREE LABOUR ON THE CLYDE.

OWING to the Christmas holidays, which in the North run well into the New Year, there is necessarily a suspension of hostilities just now on the Clyde and at Belfast. The shops would be shut in any case for stock-taking, &c., and, consequently, day-to-day news on the subject of the dispute has been scarce. The daily papers are full of wars and rumours of wars, financial panics, and so on, and the engineers' strike has naturally been lost sight of to some extent. But it is there for all that, and this apparent calm is, it is to be feared, merely one of those lulls which proverbially precede the storm. The storm, too, will be a serious one, unless the Amalgamated Society of Engineers see fit to give in at the termination of the holidays.

Early in December we ventured to predict that outside intervention at that time would be unavailing; and, although we were almost alone in adopting this view, the result of the recent Conference has proved that it was the correct one. Personally we should have been very glad had our forecast proved erroneous, for anything which will tend to put an end to these disastrous struggles is to be welcomed. But though the efforts of the Lord Provost of Glasgow, the Lord Mayor of Belfast, and Lord James, were exceedingly praiseworthy, neither the masters nor the trade union leaders were ripe for conciliation, compromise, or concession. The masters formally put into words the offer—which every one knew beforehand—they were willing to make, and the union leaders recommended the men not to accept it. When the men decided by vote to follow the advice of their leaders, the public became very indignant with them, for it was admitted that the masters' offer was reasonable. But the public have failed to realise the influences which were brought to bear on the men to induce them to record their votes against accepting the masters' terms. If, however, we take the trouble to look below the surface, and examine the circumstances under which the voting was carried out, a very strong side light is at once thrown on the motives of the men.

It will be remembered that the offer of the masters, roughly speaking, represented a shilling a week rise for the Belfast men, and two rises of one shilling each for the Clyde men. The Union officials straight away took the vote in Belfast, and their argument with the men was that the latter would be fools to accept a shilling advance when the Scotchmen had been offered two. The men thought that there was an injustice somewhere, and voted energetically against returning to work. But as a matter of fact the masters' offer was reasonable enough, for on the Clyde wages are much lower than at Belfast, and even with the two-shilling rise in the former locality the difference will not quite be made up.

The voting on the Clyde was held over until the result at Belfast was declared, and this at once strengthened very materially the hand of the agitators in that locality. But, apart from this, they had already a strong case, or one, at all events, which they knew would appeal to the men very strongly. They told them that if they wished to return to work at once, only a very few of them would be able to be taken on before the holidays, and this was perfectly true. Engineering shops which have been idle for some time can only be re-started gradually, however busy the masters may be. So the agitators pointed out to them that the result of voting for the masters would mean that they would get neither wages nor strike pay for the best part of a month, for if some were taken on during the fortnight up to Christmas they would all be without employment for the fortnight which followed. Now, as hundreds of the unfortunate strikers had been living with their families on from 8s. to 12s. a week, and such credit as they could get for the last two months, and the highest pay that any of them had received was 16s. a week, they naturally did not care to face the best part of another month with neither strike pay nor wages. So those who went to the poll—rather over half the total number—nearly all voted against the masters' propositions, while the others were afraid to vote at all.

It is notorious, however, that the real feeling of the men on the Clyde is to return to work, and after the holidays, when the considerations above referred to will no longer hold good, one may expect that this feeling will at once become much more manifest. The masters have been aware of it, at all events for some time past, and of late their deliberations have in a great measure been devoted to discussing the best methods of adequately protecting such of their men as may wish to resume work.

It is the old history of the shipowners and waterside labourers repeating itself in the engineering trade, and while engineering masters have not at the present time an organisation on the lines of the Shipping Federation, the policy adopted by the Amalgamated Society of Engineers is fast driving them in that direction. Working men will always throw in their lot with a powerful trade union if the masters also encourage the leaders of that organisation, and after all there is no reason why they should not, provided it is well managed and is carried on in the interests of the men. In practice, however, it has been shown over and over again that the men will stand at the hands of a trade society injustice and tyranny of a worse character than the hardest of masters would ever dream of applying, even if the law would allow him to do so. But there comes a point at which the pressure put upon the Union member by his officials is too strong even for the most docile of his kind, and under such conditions he decides to join hands with the masters if the lattter are willing. This has taken place often enough of late years, and in each case where both sides have acted loyally, capital and labour have in co-operation succeeded in getting along and in vanquishing their common enemy the trade agitator. So far, in the engineering trade, this sort of arrangement has only been carried out between isolated firms and their men. The present strikes will therefore afford the first instance of an association of engineering masters actively attempting to protect their men from a trade union.

It is stated that very strong preparations are being carried out for the protection of the men who wish to return to work after the holidays, and that sleeping accommodation is already being supplied on a large scale on the premises of more than one firm. That the masters are right to give their men a chance in this way there can be no doubt; but it is a sign of the times that, to enable an English workman to accept work on his own account, and earn an honest livelihood with comparative safety, these elaborate and costly precautions should be necessary. It is also significant that this should be happening in a district where hitherto the masters have habitually encouraged unionism by dealing only with the society officials when any question as to labour arose. Up to the present they have ignored the non-unionist; but now, at all events, they seem prepared to offer him his due. And the justice of this policy is obvious, from the moment that it is clear that the union officials no longer represent the feelings of the men.

It is now admitted very generally that these strikes originated in a bid for popularity on the part of the more pronounced "new unionists" among the labour agitators of the society; and it is urged in some quarters that something of the sort was necessary to draw attention away from the bad financial state of the Amalgamated Society of Engineers. Were these strikes to be successful, no doubt this Union would materially strengthen its hold over the men, and be able forcibly to increase its levies and subscriptions, for a time at all events. From all accounts this Union is sadly in need of an impetus of some sort at the present, for it is no secret that, in spite of its large income, it has been living on its capital for some time past, and, to put it clearly, is in one sense in a state of insolvency. Some few weeks back a full financial statement was drawn up by an actuary who from time to time has had to examine in detail the affairs of this society, and the contents of his report have found their way into the Press. From it we learn that the money in the hands of the whole of its branches at the present day would not suffice to pay much more than 10 per cent. of its liability under its superannuation fund alone. Had subscriptions remained at 1s. a-week, its liability would amount to no less than 2½ millions sterling; but by dint of raising the subscriptions to 1s. 6d., and by unjustly lowering the superannuation grants and increasing the age at which their members became entitled to receive their pensions, the society's net deficit stands at the present day at the appalling figure of nearly 1½ million pounds. This deficit in its funds is not a legal liability, and the unfortunate men who for years have been putting their money into what they believed to be a solid fund, have no redress now that it turns out that the fund has practically vanished.

It is perhaps encouraging to be able to say that Mr. Alfred Sellicks, the president of the Amalgamated Society of Enginners, left London on Tuesday for Belfast, to take part in negotiations which it is hoped will lead to a settlement. Mr. Sellicks has gone as a representative of the executive of the executive council of the society, with full power to treat with the employers on behalf of the engineers.

Under such circumstances it is high time that the masters should step in and endeavour to come to some sort of an understanding with their men in the trade, whether unionists or not. For a trade society which has so wantonly squandered the money of its subscribers cannot possibly be said to represent the interests of its members, and the men's destinies ought not to be left in its hands. Whatever the result of the present disputes may be, they will at all events have served to have opened the eyes of both masters and men as to the hollowness of an organisation which, under the title of the Amalgamated Society of Engineers, has been held up as a model trade union. What then must be the conditions of less perfect organisations of the kind?

SIR EDWARD HARLAND

SIR EDWARD HARLAND.

IN our last impression we gave a short account of Sir Edward Harland's life. We now publish a portrait which will we have no doubt be regarded with melancholy interest by a very large number of our readers. The circumstances of his death were very sad. Sir Edward had been in excellent health. He retired to rest about 11 p.m., and when half undressed he had a fainting fit from which he never rallied, passing away quietly very early on Christmas morning. He leaves no children. The news of his death was received with the utmost sorrow in Belfast and the neighbourhood, where Sir Edward was very popular.

THE LANARKSHIRE AND DUMBARTONSHIRE RAILWAY.

THIS line, extending from Stobcross, in Glasgow, to Dumbarton, a distance of 13¼ miles, is now well advanced towards completion, and affords every indication of being ready next summer for goods traffic, and a little later for passenger traffic. A glance at the map of Scotland at once shows the importance of the new route to Bowling and Dumbarton, which was commenced three years ago, and which will give access to Balloch by the joint line to that busy tourist terminus.

The principal works on the new line are the canal diversion at Bowling, now completed, with the exception of the 70ft. span swing bridge for carrying the railway traffic across the entrance to the canal.

The foundations of the swing bridge are completed, and the superstructure is finished in the girder yards of Sir William Arrol and Co., Glasgow, ready for erection at site. The boilers are in position, and the engines—by the Glenfield Co., Kilmarnock — are also erected beneath the arches of the viaduct connecting the swing bridge with the line.

A feature of interest are the two tidal culverts near Dumbarton, each formed of concrete, and having four 15in. tidal flaps to permit the drainage of the land above the line, whilst preventing flooding by the incoming tide. Each tidal culvert is furnished with an overflow safety wall, which permits a high tide to pass over it and flood the land above the railway rather than cause damage by excessive pressure on one side of the embankment only.

The remaining work of interest is the extensive additions and alterations now in progress for Dumbarton Station, where, owing to the character of the foundations, care is needed. The line is well provided with sidings. At Whiteinch a parallel line of siding is being laid down 2¼ miles in length, at lower level, and connected with the numerous shipyards at this point. At Dumbarton a siding is under construction into Messrs. Denny's shipyard. Numerous bridges of small span occur on the route by Sir William Arrol and Co., Arrol's Bridge and Roof Co., both of Glasgow; by Messrs. Alexander, Findlay, and Co., Motherwell; and by Messrs. Somervail and Co., Dalmuir.

The permanent way, which is now nearly completed, is in accordance with that adopted on the Caledonian Railway, viz.:—90 lb. rails, 45 lb. chairs and sleepers 2ft. 8in. apart, each creosoted with three gallons of oil. The engineer is Mr. Charles Formam, M.I.C.E., with Mr. J. Wolfe Barry, C.B., as consulting engineer. The resident engineers are Mr. C. R. L. M. Bond and Mr. John Ferguson, the contractors being Messrs. Robert McAlpine and Co. and Messrs. Hugh Kennedy and Sons, both of Glasgow.

THE MANCHESTER ASSOCIATION OF STUDENTS OF THE INSTITUTION OF CIVIL ENGINEERS will have their ninth annual dinner on January 22nd. Mr. J. Wolfe Barry, C.B., F.R.S., a vice-president of the Institution, has promised to attend. These anniversaries are attended by many of the older members of the Institution, resident in Manchester and the neighbourhood. Sir Edward Leader Williams, President of the Association, will take the chair.

AN OLD BATTLESHIP.—On the 22nd December the old naval reserve ship Castor, which has recently been replaced by the modern cruiser Medusa, took her departure from North Shields for Sheerness in charge of two powerful tugs. The Castor was for many years a familiar object in Shields harbour, and formed a picturesque relic of the obsolete type of man-of-war vessel. Built in 1821, the Castor is therefore seventy-four years old, and during the early part of her career she passed through a number of stirring experiences. She took part in the bombardment of St. Jean d'Acre, when several of her crew were killed and many wounded. Shields harbour has been the resting place of the Castor for the last thirty-four years, and during that lengthy period her alarm guns have thundered forth some scores of times, startling the inhabitants on both sides of the river with the unwelcome news of shipwreck.

ELECTRO-PNEUMATIC AUTOMATIC BLOCK SIGNALS

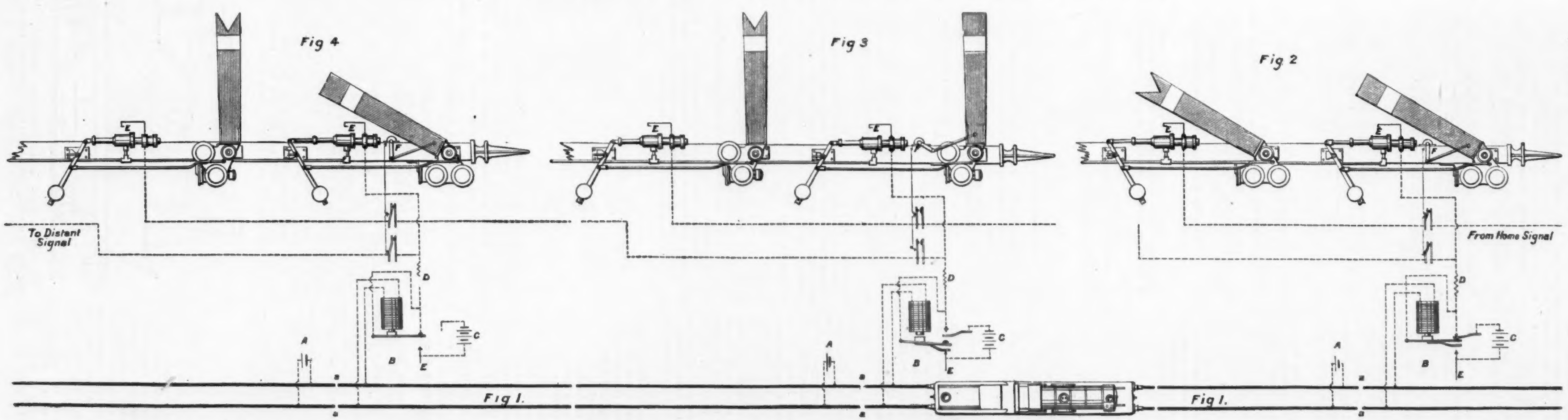


Fig 4 Fig 3 Fig 2 Fig 1. Fig 1.

ELECTRO-PNEUMATIC AUTOMATIC BLOCK SIGNALLING.

In February, 1894, Mr. George Westinghouse, jun., wrote a letter to Mr. W. F. Allen, the Secretary of the American Railroad Association of New York, on the subject of electro-pneumatic automatic signalling. In view of the great extension of this system in the United States, and of the attempt now being made to introduce it on this side of the Atlantic, we cannot but think it opportune to reproduce the greater part of this letter—slightly altered to suit English practice—as follows:—

It is now universally conceded that no single subject demands more urgent consideration than the adoption of proper signals for the safe running of railway trains. From the beginning of the operation of railways, the necessity for two all-important safeguards was at once apparent—(1) A proper system of signals for warning the engine-driver of danger ahead, and (2) apparatus to enable the engine-driver to stop his train in the shortest possible distance. The solution of the latter problem, the stopping of trains in the shortest possible distance, it may safely be said, has reached a point where further possible improvement, so far as results in quick stopping are concerned, will be unimportant so long as the friction between wheels and rails is the limit of retardation.

Proper signals to warn the engine-driver of danger ahead means a system of signals which shall indicate the exact condition of every foot of the line, and shall comply with the following general requirements:—(1) When the line is clear, and there is no danger, the signals shall be so displayed, and in such an unmistakeable manner, that an engine-driver will have no doubt of his right to run ahead at the high speed now demanded. (2) If the line is obstructed, a warning signal shall be automatically displayed, advising the engine-driver that at a distance ahead he will find a signal at danger beyond which he must not pass. (3) The signal system shall be so organised that the opening of a pair of points, the removal or breaking of a rail, or the fouling of the main line by a car on a siding, shall automatically cause warning and danger signals to be displayed. (4) In the event of any accident to the signal apparatus, the signals must automatically assume a position indicating caution or danger.

In signal installations with block signals moved by hand power, it has been necessary and customary to have signals normally at danger, thus requiring an effort of the operator to move a signal to safety on notice of the approach of a train, and, on some lines, block signals have been so arranged as to remain at danger from their counterweights, unless held in the safety position. Instances where these signals have been fastened by the operators in the safety position when there was actual danger, and where they have cleared the signals when they should not have done so, have been sufficiently numerous to show that this method of working does not meet the requirements. It has been suggested that all of the automatic block signals should be normally at danger, and only cleared in front of a train, if the track ahead be clear. Such an arrangement of automatic signals in blocks of from one-fourth to one-half mile apart would be very disadvantageous, for the reason that engine-drivers would be constantly under the impression that there was danger and thus be unable to run with confidence. Again, gangers, inspectors, and others would be unable to tell whether the system was in operative condition or not, as is so readily the case where the signals are normally held at safety only when every essential part is in working condition.

From the beginning of the introduction of disc signals operated by the well-known and well understood electric track circuit system, there seems to be a natural prejudice against the disc or banner form; and therefore, in perfecting a comprehensive system of signalling apparatus, the first question to be determined was the character or form of signal to be employed. It took but little time to disclose the fact that long experience had practically led to the general adoption of a semaphore signal, the position and indication of which is determined by the eye at a greater distance than any of the other forms of signals which have been used, while the question of colour is eliminated for at least one-half of the twenty-four hours. A semaphore signal the form and shape of which has been evolved by long experience, is of considerable weight, is always exposed to atmospherical conditions, because the view of its positions must be unobstructed, and is, or should be, so counterweighted that it will assume its danger position in the event of a break in any of its connections. The power required to move such a signal with certainty to its various positions is considerable, and it was found to be greatly beyond the capacity of ordinary electric batteries, though such batteries have furnished an adequate power for the tripping of devices for the utilisation of weights arranged to turn disc signals.

The long and successful use of compressed air naturally suggested its employment as the motive force for the movement of the signals, a supply being obtainable along the whole line through a main pipe fed by pumps located from ten to twenty miles apart, at convenient stations where steam power already exists, and which would furnish compressed air for any number of signals, and also provide the power necessary to move switches. Experience had fully demonstrated that compressed air could furnish an adequate power, and that electricity could be used to bring that power into operation for the movement of both switches and signals, and that, by the utilisation of the rail circuit, and the proper arrangement of signals, a thoroughly safe and practicable system could be applied to railways, meeting the foregoing general requirements, and which would be automatic in operation and safer than any system of signals dependent upon men for their movement.

The automatic pneumatic system of block signals.—With the foregoing general remarks, I will now describe the automatic pneumatic system of block signals, first applied to the Pennsylvania Railroad between East Liberty and Wilkinsburg in 1884, extended to Pittsburgh in 1889, and from Wilkinsburg to Stewart Station in 1892, covering a distance of sixteen miles. All of these signals have been in constant daily use, and the very first ones erected are in use without any alteration except an improved relay in connection with the track circuit. The track of each of the main lines is divided into electric circuits varying in length from one-quarter to one-half a mile. About 50ft. to the rear of each section is a post carrying two semaphore signal blades. The upper one, according to the general practice of to-day, is the danger or "home" signal, painted red, and governing the section immediately ahead, and the lower is the distant signal, painted green, and working in harmony with the danger signal of the next section. Each semaphore is operated by a cylinder 3in. in diameter, fitted with a piston, the rod of which is connected so as to move the signal to its clear position when air pressure from the main line is applied to the piston, that being the normal position of all signals when the track is clear for the movement of trains.

The accompanying drawing fully illustrates the foregoing. The original drawing showed the signal posts on the other side of the line, according to American practice. The drawing here appended has been modified, so as to correspond withEnglish practice. Fig. 1 represents two electric sections of track, and portions of two others. At the points *a* are fish-plates made of wood, to electrically separate the rails of one section from those of the adjoining. At A is what is called the "Track Battery," having one of its poles connected to one line of rails, and the other to the opposite line of rails. At B are electric instruments called "Relays," or devices used for switching the current from a more powerful battery C for the operation of the valve mechanism of the signal cylinders. These "relays" are electro-magnets having wires connected to the rails, so that when the two lines of rails of an electric section are not joined together by the wheels and axles of a vehicle or otherwise, the current from the battery A will flow through the rails and through the wires of the relay magnet, causing it to attract its armature, so as to connect the battery C with the electro-magnet of the signal cylinder. Fig. 2 represents the top of a signal post with its two blades in the safety position, indicating that the section which it governs, and the one immediately ahead of it, are unoccupied. Fig. 3 represents the signal at danger, caused by the presence of a train, as shown on Fig. 1, which causes the current of the battery A of that section to flow through the wheels and axles of the engine, thereby cutting off the current from the relay magnet of that section. In this manner the circuit from the battery C is interrupted, so as to permit the air in the cylinder operating the danger or upper signal to escape, upon which occurrence it assumes, by the action of its counter-weight, the position shown indicating danger. The movement of this signal arm interrupts the circuit governing the lower signal, which also assumes the horizontal position. The circuit governing this second or cautionary signal is extended to the home signal of the preceding section—Fig. 2—so that when the danger signal on the same post with the cautionary signal assumes the normal or safety position, the cautionary signal still remains in the horizontal position until its home signal—top signal of Fig. 2—is also cleared. Fig. 4 shows the upper or danger signal in its normal or safety position, and its lower or cautionary signal in its horizontal position, acting as a cautionary or "tell-tale" signal to the home or danger signal of Fig. 3.

When the train reaches the next section to the right, it causes both signals of Fig. 2 to assume the danger position, while those at Fig. 3 remain at danger until the last car of the train passes from that section, whereupon the upper or danger signal resumes its safety position, still leaving the other signal to indicate the condition of the signals in Fig. 2. A section through the signal cylinder, its magnet and valves, is annexed. Air pressure from the main pipe enters through the connection A and passes through passage T to the interior cavity C. This cavity contains a valve S P held closed by a spiral spring, and the spindle of this valve is prolonged upward and inserted in the spindle F of the armature B. The lower part of this spindle F is formed into a conical seat to act as an exhaust valve. As soon as a current coming from the relay battery passes through the coil of the electro-magnet M, the armature B is attracted and brought down. The spindle F then closes the exhaust passage and pushes the spindle S P off its seat, so as to admit compressed air through the passage E to the space above the main piston P. This piston is thereby lowered, putting the signal to "clear."

When the electric circuit is again interrupted, the armature B is released and pushed upwards by the spiral spring surrounding the spindle valve S P; the admission of air to the cylinder S C is thereby cut off and the exhaust passage opened, thus allowing the air above the piston P to escape through H, and the piston is then raised by the action of a counterweight, putting the signal to "danger." Each signal blade carries an appropriately coloured lens, which covers a light when the blade is in the horizontal position, showing red for the upper signal and green for the lower signal, and exposing the white light for both signals when they are in the position to indicate that the track is clear. An air pressure of about 60 lb. is maintained in the pipe along the track, and the batteries are placed in wells located near the signals.

From the preceding description it will be seen that so long as the two lines of rails forming the track of a section are joined electrically by the wheels and axles of a vehicle or otherwise, the appropriate signals will remain at danger to guard such section. Where points are included in the line, a switch box is arranged in connection with each pair of points in such a manner that its movement will cause the proper signals to indicate danger, and enough of the track of each siding is included within the track circuit to ensure the display of danger signals in case a car on such siding fouls the main line. It will also be seen that the removal or breaking of a rail will interrupt the track circuit and thus set the proper signals to danger. A rupture of the air pipe will permit the air to escape from all of the cylinders, and thererby set all signals to danger; and the failure of the battery of either the track or signal magnet will cause the air to escape from the signal cylinder, and thus set the corresponding signal to danger. There has been perfected and used to a limited extent an arrangement whereby the points of any section may be automatically locked in such a manner that they cannot be moved after a train has once passed the signals governing such section, and until the train has passed into the next section. It will be seen that, as arranged on the Pennsylvania Railway, each danger signal has a warning signal the length of a section from it. When running at sixty miles an hour or more, the distance required within which to stop a train is often greater than would be available if the danger signal had not a cautionary signal to notify the engine-driver of its position. The system as described shows that the cautionary signals are from one-quarter to one-half mile distant from the danger signals, so that the engine-driver receives timely warning to stop.

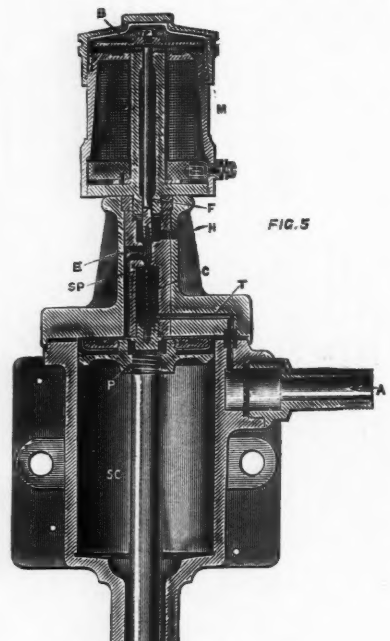


FIG. 5

While it is possible that some of the details of the apparatus described may be still further modified and improved—in fact, some alterations of the valve of the signal cylinders, and in the relay magnets, have already been made, and are now being introduced as substitutes for the earlier mechanism—the fact remains that the principles involved in this system described are the true ones, and the mechanism will be found, with proper care, to be reliable and efficient under all conditions. It should be borne in mind that this system has been devised to take the place of what is generally known as the "block system," requiring signal boxes wherein operators, guided by proper telegraphic instructions, display appropriate signals to govern the movements of trains. It has been found, especially in England, where the block system was first developed, and its use enforced by the Government, and where the traffic is very heavy, that these cabins, to afford absolute safety, require to be located so close together that the cost of operation and maintenance is a serious burden. Frequent failures of the operators to display the proper signals, or to correctly interpret the communications from the different cabins, led to the development and use of systems which are exemplified by that known as the "Sykes," wherein such operators are required to co-operate before either one may give a clear signal for an approaching train. It would seem at first that such a system would be an absolute safeguard, but it has been found necessary, under certain circumstances, where these stations are a considerable distance apart, to give, under general rules, engine-drivers written orders to proceed with caution past a danger signal until a clear signal at the next cabin should indicate a right to proceed at full speed. A serious defect in this system has been shown by instances wherein engine-drivers, after receiving orders to proceed with caution past danger signals, have been deceived by finding the next signal clear—owing to the operator being asleep—while the block was still occupied by a train which had been permitted to pass, a condition which may repeat itself at a critical time so long as an operator has the power to permit his signal to remain at the clear position when the track ahead is occupied or obstructed in any manner.

In all block systems requiring operators, the first cost where the blocks are located at the telegraphic stations is moderate; but when the time arrives that such cabins must be within one mile of each other, the cost of operation and maintenance becomes so great as to place such a system out of consideration. On the twenty-five miles of the Pennsylvania Railroad between Jersey City and Amboy Junction, equipped last year with the automatic pneumatic system of block signals, twenty-three signal cabins have been discontinued, dispensing with the services of forty-six men. The pneumatic signals require for their care and maintenance ten men, leaving a large margin for the employment of competent men to maintain the automatic system in the most perfect condition.

By placing the pneumatic blocks from one-fourth to one-half mile apart, the capacity of a railroad is sufficiently increased, as compared with the ordinary cabin block system, to fully cover the first cost of such signals. The rules adopted governing the use of these signals require an engine-driver to stop his train in obedience to a danger signal. He is, however, permitted to proceed with caution after a delay of one minute, until his movements can be governed by the next signal. It frequently happens that the engine-driver of a train can observe the position of the semaphore signal of the next two or three sections, and thus the movement of trains is greatly facilitated with absolute signal protection.

List of Automatic Electro-Pneumatic Signals in U.S.A.

Date.		Signals.	Slots.
1893.	Central Railroad of New Jersey	475	54
1891.	Chicago, Burlington, and Quincy	20	—
1891.	Chicago and Northern Pacific	52	—
1893.	Chicago and North-Western	58	—
1883.	Fitchburg Railroad (the first installed)..	11	—
1892.	New York Central and Hudson River ..	161	—
1893.	Pennsylvania Railroad, New York Division	374	98
1884-1892.	,, Railroad, Pittsburg Division	203	—
1893.	Philadelphia and Reading	16	—
1885.	Southern Pacific	40	—
		1410	152

JOHANNESBURG ENGINES.

On page 12 we illustrate one of the four large pumping engines recently constructed for the Johannesburg Waterworks Company by Messrs. James Simpson and Co., of Pimlico. These engines are triple-expansion Worthington pumping engines, each capable of easily delivering 1,000,000 gallons per twenty-four hours against a head of 450ft. They are to work with a steam pressure of 150 lb. per square inch, and the high-pressure cylinders are fitted with cut-off valves having expansion plates adjustable by hand whilst working. The sizes of the cylinders are 8½in. high pressure, 13in. intermediate pressure, and 21½in. low pressure, with a stroke of 18in. Each engine exhausts into a jet condenser, below which the air pumps are placed directly in line below the low-pressure cylinders. The main pumps are a feature in the design, being extremely compact and specially designed with a view to transport. They are fitted with small Worthington valves, which can be easily examined from manholes on the castings. The plungers are of cast iron working in gun-metal bushes. The piston and pump rods are steel, and the air pump rods delta metal. All the bushes are case-hardened steel, and all working pins are also case-hardened. No air vessel beyond that shown on our illustration is required, owing to the extremely uniform flow of water which is obtained from these pumps, where one side commences to take up the load as the other side comes to rest.

The foundations required are very light, and it is a great advantage not to have any of the machinery below the floor level, but all in full view. The cylinders are all covered with mahogany lagging, and with the copper pipes, and the other bright parts, the engines present a fine appearance, and do the builders great credit. It may be of interest to our readers to know that these four engines were built entirely from the raw material in the short period of eleven weeks, the first engine being complete in five weeks, the second in seven, and the third and fourth with a fortnight intervening. Messrs. Simpson and Co. have now made over 200 Worthington engines for every service conceivable, including sewage, water, main drainage, and irrigation, and it is a proof of the completeness of the equipment of their factory that these engines were built ready for shipment in so short a space of time.

ALMANACKS AND CALENDARS FOR 1896.

Messrs. E. R. and F. Turner, of Ipswich, and 82, Mark-lane, have sent a handsomely got-up day-to-day tear-off calendar, carried on a tastefully arranged background, upon which is printed an almanack for the whole year. Six of Messrs. Turner's specialities relating to flour milling are illustrated upon the background by nicely executed drawings, and on the back of the large card is a selection of postal and other information and calendar for 1897.

The Hunslet Engine Company, Leeds, send a nicely-executed monthly tear-off calendar, the background of which carries small but beautifully clear photographic representations of five of the contractors' and other locomotives made by the company.

Calvert's Mechanics' Almanack and Workshop Companion, which is sold for 4d., has, as usual, sixty-four pages of well-selected contents, including the almanack of dates and events.

The Quickest Telegram on Record.—An article of exceptional interest, entitled "The Telegraph Systems of the World," appears in the *Windsor Magazine* for January. As an example of "what can be done in the way of transmission when the wires are free and the operators waiting," the writer says:—"Some years ago, at a telegraphic *soirée* in the Albert Hall, a feature of the evening's amusement was the sending of a message to Teheran, in Persia, and back. A sending and receiving instrument had been put up in the hall and connected with the wires of the Indo-European Telegraph Company. This line crossed the Channel by cable to Germany, and then by land lines ran over Germany, South Russia, Caucasus, Armenia, and Persia, to Teheran. At Teheran the wire was joined to a second line of the company, returning to London by the same route. The lines were cleared for the experiment, and, at a given signal, the key of the sender was pressed by the Prince of Wales. The instant that the button of the instrument was touched, click went the receiver. The current had been to Persia and back!"

LETTERS TO THE EDITOR.

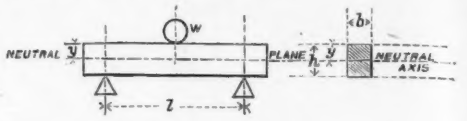
(*We do not hold ourselves responsible for the opinions of our correspondents.*)

TRANSVERSE LOADS ON BEAMS OF MILD STEEL.

Sir,—In reply to the letter, dated 18th inst., of your correspondent "Transverse," I trust the following will be of service to him:—

Rankine tells us "the transverse strength of a beam may be found by equating the greatest moment of flexure expressed in terms of load and length to the moment of resistance of the cross section where that moment of flexure acts." "Transverse" desires transverse strength of a 1in. by 1in. section on 12in. bearings.

Take wrought iron for comparison with the authorities quoted by "Transverse"—



Moment of flexure $= M_o = \frac{W\,l}{4}$ for central load. Moment of resistance to bending $= M_R = \frac{f\,I}{y}$. f = modulus of rupture. I = moment of inertia. y = distance of neutral plane or axis from the plane in which the stress acts.

The value of y is to the cross section, in proportion to its depth, viz., $\frac{y}{h}$. Therefore M_R for bending, and considering the depth of section $= \frac{f\,I\,h}{y}$.

The values of I for similar sections are related as their breadths and the cubes of their depths, viz., $b\,h^3$; therefore I for cross section $= \frac{I}{b\,h^3}$.

The moment of transverse resistance of the cross section becomes $\frac{f\,I\,h}{b\,h^3\,y}$, and as the value of $I = \frac{b\,h^3}{12}$

$$M_R = \frac{f\,b\,h^3\,h}{12\,b\,h^3\,y}.$$

$\frac{y}{h}$ for rectangular sections is always $\frac{1}{2}$; therefore $M_R = \frac{f\,b\,h^3\,2}{12\,b\,h^3}$.

The resistance of flexure, *i.e.*, the lateral adhesion of fibres, is related to similar cross sections as their breadths and the squares of their depths.

Thus we have the moment of resistance of the cross section $= M_R = \frac{f\,b\,h^3\,2\,b\,h^2}{12\,b\,h^3} = \frac{f\,b\,h^2}{6}$.

To equate M_o with M_R we have $\frac{W\,l}{4} = \frac{f\,b\,h^2}{6}$, and $W = \frac{f\,b\,h^2 \times 4}{6 \times l}$.

Rankine gives modulus of rupture for wrought iron as 42,000 lb.; so, to consider the inch square section 12in. long, we have $W = \frac{42{,}000 \times 1 \times 1^2 \times 4}{6 \times 12} = 2333\cdot\dot{3}$ lb. $= 1\cdot0416$ tons ultimate strength.

This exactly coincides with one of the authorities quoted by "Transverse," and I think that when your correspondent uses the same value for modulus of rupture in each of the formula he quotes, he will find them agree pretty accurately. For instance, Molesworth gives $\frac{4\,K\,B\,D^2}{L}$, in which K = 68 cwt. is the coefficient of rupture, not the modulus. Compare this formula with the working I have given, and they will be found to be the same, excepting that Molesworth has evidently divided the modulus by the 6, and gives a coefficient.

68 cwt. × 6 = 45,696 lb. modulus of rupture, as against 42,000 used by Rankine.

If "Transverse" inserts correct value of f or K for any material with which he wishes to work, he should find no further difficulty.

"Transverse" also asks for explanation of Molesworth giving E = 10,000 for cast iron in "Beam Deflection":—

	E in lbs.	Ult. tens. strength in lbs.
Molesworth (beam deflection)	22,400,000 ..	—
,, page 23	18,400,000 ..	—
Humber	18,000,000 ..	16,000
Anglin, average	14,100,000 ..	15,332
Rankine, minimum	14,000,000 ..	13,400
,, average	17,000,000 ..	16,500
,, maximum	22,900,000 ..	29,000
Seddon, minimum	12,000,000 ..	11,200
,, average	17,000,000 ..	20,160
,, maximum	23,000,000 ..	33,600

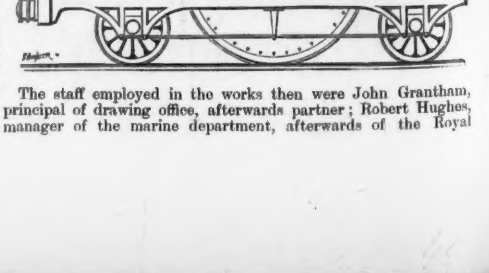
I think from these figures that Molesworth probably took a figure so high on the assumption that only such cast iron as would stand a high tensional stress should be used for beams. This, however, should not trouble "Transverse," as he may readily arrange E to suit such tests as he may specify.

Kendrick Edwards.

157, Onslow Drive, Dennistoun, Glasgow, Dec. 23rd.

EARLY LOCOMOTIVES.

Sir,—I send you a drawing of the 10ft. wheel locomotive designed by John Grantham, draughtsman at Mather and Dixon's North Foundry, Liverpool. They were marine engineers, which may account for the outside view resembling a steamer; the driving wheel splashers like a paddle-box, and the handrail plates brought to the buffer planks shaped like the stem of a vessel and intended to take the wind pressure off the front end of the engine. The great diameter of the driving wheel shows that Brunel had something to say about it, perhaps ordered it to be made twice the size of any other then made; everything with him must be greater than ever done before as the Great Western Railway, the Great Western Steamship, the Great Britain the first iron and first screw steamer; and lastly, the Great Eastern, both screw and paddle steamer, which he did not live to see under steam.



The staff employed in the works then were John Grantham, principal of drawing office, afterwards partner; Robert Hughes, manager of the marine department, afterwards of the Royal

Arsenal, Woolwich, and inspector of steamships; Mr. Banks, locomotive foreman, well known at Derby, on the Midland Railway; Mr. Buddicomb, first locomotive superintendent of the Grand Junction Railway, and of the Locomotive Works at Rouen, France; Josiah Kearsley, first locomotive superintendent of the Midland Counties; George Harrison, first locomotive superintendent Scottish Central, and manager at Brassey's, Birkenhead; Mr. Potts, afterwards of the firm of Jones and Potts, Newton-in-the-Willows, locomotive builders, where the first solid locomotive wheel was made by the wheelsmith Frost.

All the above-named were apprentices and journeymen with me in my time. William Tait, of the firm of Tait and Mirlees, Scotland-street, Glasgow, was the erector of the 10ft. wheel locomotive. I worked mate with him on the same engine. Tait was manager of Neilson's Hyde Park Locomotive Works, Glasgow, in 1845, and his mate—John Wilson—was manager from 1864 to 1884 under Mr. James Reid, sole owner of Neilson's Works. James Smith scarf welded the 10ft. tires. The crank axles were forged at the Mersey Forge when Mr. Norris was manager, and turned by Charles Ackers. Ned Bursing turned the rims and tires on a large lathe, driven by the gearing of the boring mill. I remember having worked on the same lathe, that they had to cut a curved piece out of the shop wall for clearance.

As to the question, "Was the 10ft. locomotive ever built?" in the discussion on the construction of locomotives in the "Transactions" of the Institute of Civil Engineers for 1849, volume viii., Robert Stephenson said he did not attach much importance to the size of the wheels. The 10ft. wheel had been abandoned on account of the difficulty in getting up the speed of trains at starting. Mr. Henry Maudslay observed that nothing had been said as to the proportionate length of stroke. He wished to ask whether, instead of decreasing the diameter of the wheels, a proportionate length of stroke had been given, a great advantage at starting would have been obtained. Mr. R. Stephenson thought that Mr. Maudslay had started an interesting point. The proportionate length of stroke to the capacity of cylinders had not, he believed, been yet correctly ascertained.

The following twelve individuals, I find, bear testimony that two or more locomotives with 10ft. driving wheels were built:—Brunel, Stephenson, Snowball, Maudslay, Gooch, Sturrock, Dean, Wood, Sheward, Bucknell, Wyatt, Crampton. If I was to tell them that the 100 miles an hour Grasshopper, with sandwich frames, was the last 10ft. wheel locomotive, I should be contradicted, as Mr Greenly said. The Cornwall beat that speed on her trial trip down Madeley Bank; we got 120 miles the hour out of her with 8ft. 6in. wheels.

Book makers are apt to make mistakes like myself. Mr. Stretton has much to say on the subject; perhaps he will not thank me for correcting him. In answer to his letter of October 16th, about Mather, Dixon, and Co. re-lining engines and the actual design of them, and about the blue print of the disc wheel, there was no Bath-street Foundry in 1838. John Jones left Bath-street to be manager at the Old Swan Foundry, near Liverpool, in 1835, and never was manager at Mather, Dixon and Grantham, North Foundry, but joined Mr. Potts in partnership at Newton-in-the-Willows about 1839.

I was at the opening of the Liverpool and Manchester Railway, in 1830, as a boy. I was bound apprentice to Mather and Dixon for seven years, James Aspinal, afterwards Mayor of Liverpool, signing my indenture, and I remained with them until 1842, when the works closed, and all the locomotives were built in my time. I put up the first vice in Crewe Works, 1843, built several engines at Crewe, Edge Hill, and Nine Elms; was manager of Salford Rolling Mills, 1854, and rolled the first steel tire ever rolled, Krupp men standing by while I worked the mill. For nine years I was foreman erector for Sharp, Stewart, and Co., when I put the first injector on an engine on the St. Helens Railway; Mr. Robinson was with me, of Sharp, Stewart, and Co. I was manager twenty years to Neilson and Co., Hyde Park Locomotive Works; twenty-five years member of the Association of Engineers and Shipbuilders, and forty years member of the Manchester Association of Engineers.

165, Onslow Drive, Dennistoun, Glasgow, JOHN WILSON.
December 23rd, 1895.

ELECTRIC LIGHT ENGINES.

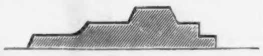
SIR,—It seems to me that the elaborate and interesting description of the great installation at Deptford, published in THE ENGINEER for the 20th ult., affords room for a discussion on the pressing and important question, What is the best type of engine for driving dynamos?

To begin with, I think we need not complicate matters by considering the smaller types of engine. I have carefully watched the progress of electric lighting, and I have no doubt at all that the small manufacturer of current cannot in the future compete with the great establishments. Electricity is a commercial commodity now-a-days, not a scientific toy. It must be made and sold at a profit, and this can be best done on the large scale, like cotton cloth, or locomotives, or ships. Thus, for example, the standing charges will be practically the same for an output of 500, 750, and 1000 units. The larger output will demand more coal, and more interest and depreciation. That is all. Under these circumstances, I think we may regard 500-horse power as the smallest engine worth considering, and 2000-horse power as the largest that it will be convenient to use. Now these figures include just that class of marine engine most frequently used. The engines indicating 500-horse power to 1000-horse power in cargo steamers may be counted by the thousand. I do not hesitate to say that for every land engine or mill engine of over 500-horse power made in this country, twenty marine engines are turned out, and it is this that has placed Scotch, English, and Irish marine engines in the very front rank of mechanical engineering. An enormous experience concerning them is available. The marine engine has to run for days and even weeks at a time without being stopped for a moment, and it undergoes most severe trials of endurance in a gale. In order that it may discharge its duties, many special features, apparently very trifling, really very important, are adopted. The marine engineer knows what is wanted. The stationary engine builder does not, simply because, first, he has not the experience; and secondly, because no one wants mill engines to run day and night for weeks. All these things point to the conclusion that the marine engine is the best for driving dynamos, and that the proper man to build such an engine is one accustomed to that class of work. I do not wish to belittle the Corliss or any other type of mill engine, but that does not prevent me from saying that the marine engine is *the* type.

Take now the engine designed by Mr. d'Alton for driving the 1000-unit Ferranti. Here we have a type of compound marine engine which is very similar to those designed by Mr. Humphries for the great Atlantic steamer City of Rome—namely, three independent compound engines driving a triple crank shaft. The cylinder proportions are different and the details different. Much the same type was used for years by Mr. W. Allan, of Sunderland, the major difference being in the condensing arrangement.

It is no joke to run an engine indicating 1500-horse power at 156 revolutions per minute. That speed puts Corliss gear out of the field at once. I very much doubt if any builder of land engines has yet produced an engine of 1500-horse power which runs at nearly that speed. I may be mistaken on this point, but I think not. All the great firms, such as Musgrave, Hicks Hargreaves, &c., use Corliss gear, or, at all events, some form of trip gear, and that pins them down to about 90 revolutions per minute as a maximum. But 156 revolutions is quite common with such marine engine builders as Humphreys and Tennant, Maudslay, Sons, and Field, Hawthorn, Leslie, and Co., and, indeed, any firm building engines for warships. The land engine builders can know nothing by experience about these high speeds, which can only be maintained with success by the aid of very special methods of construction, which, of course, are not given broadcast to the world. It remains, of course, to be seen whether Messrs. Plenty have had all the knowledge needed. But it is very much in their favour that they have already built marine engines, and I believe I am right in saying that Mr. d'Alton has himself had a large experience. So we may take it for granted that the Deptford engine will be all right.

I am very pleased to see that you, Sir, have done justice to the marine engine and the marine engine builder in what you have already said, and all that you have said I fully endorse. So much concerning the type of engine most likely to run without giving trouble. It remains to be considered that the marine engine always runs with a constant load, and the electric light engine does not, and herein lies a difference that may be puzzling and troublesome. As all trip gear is excluded by the speed, how are we going to regulate? Now, from a somewhat extended experience with electric light engines of considerable power, I have come to the conclusion that governing can best be done by the throttle valve, the cut-off being regulated by hand. Thus, for example, the small cylinder may have Meyer's slide valves, which admit of being partially relieved of pressure; a good governor will do the rest. In order that my view may be taken at its proper value, I must explain what is constantly overlooked. The load on an engine driving a dynamo scarcely varies at all for long periods. An engine starts, we shall say, at 500-horse power; it will be run for a couple of hours at that, then the load goes up to 750-horse power in the course of a few minutes; then there is steadiness for a while, and then it runs up again by a jerk. The power diagram of an engine will be somewhat like this, and for this the hand adjustment of the cut-off answers quite well. The throttle valve will have little or nothing to do between whiles, if the steam pressure is kept steady. The little diagram I have sketched must not be confounded with the station diagram, which is very different, because several engines are used, and as each is loaded to its full capacity another is started.



I know that several discussions have taken place as to the relative merits of cut-off and throttle-valve regulation, but to my mind they have all turned on a question of the most secondary importance—namely, which best saves coal. But in a great electric light factory, the first point, and the middle point, and the last point is that the current shall be supplied steadily without interruption. If this can be done year in and year out with a saving of coal well and good, but no saving will compensate for bad current, the smallest interruption of current, or any fluctuation in pressure or quantity.

To sum up, I repeat that the marine engine is the exemplar for electric light engines, and that throttle-valve governing, properly done, will, in the long run, prove more satisfactory *to those whose houses are lighted* than will any other system.

Glasgow, December 30th, 1895. D. U. M. BARTON.

SIR,—In spite of the many interesting remarks made in your last issue upon the new 1000-unit machine at Deptford, to an impartial reader many of the generalisations therein contained appear both hasty and inaccurate. It would be interesting to know exactly what meaning you can attach to the phrase "marine type of engine," unless it chances that it is your intention to include any vertical inverted engine working on more than one crank in that category. It is hardly a work of such insuperable difficulty to construct a three-crank vertical engine that we need resort to marine engineers to ensure its fitting construction, whilst the special points that do require minute attention, viz., fly-wheel and governor regularity, are just those in which marine engine makers can have acquired little or no experience. It is therefore somewhat surprising to find a statement of this nature in a paper with a reputation to maintain. It would be hard to find in modern, well equipped electric light stations one engine in twenty that has been turned out by a firm devoting themselves exclusively to marine work.

Similarly it is significant that even on board ship the many electric light engines in use are in the great majority of cases turned out by firms who do not undertake general marine work, but who devote themselves to high-speed or other engines. In view of these facts, your statement that engineers must resort to the marine engine builder for a successful electric light engine, seems to have neither substance nor shadow behind it. It is not so in fact, and were our practice reconsidered there is nothing to show that an alteration in that direction would ensue; and in spite of the ungenerous and unwarranted slur upon our stationary engine makers, it will be found that the electrical engineers of to-day are too wide-awake to leave the manufacture of their engines to the tender mercies of the marine engine maker. With regard to the engine anent which these unfortunate remarks occur, the designers have evidently carefully considered one point, steadiness of running; it would appear that this has been done at the expense of many others, and to many it will appear entirely questionable whether six cylinders, and the consequent increase of expense, frictional loss, and liability to break down, are in any way necessary to ensure those results so highly lauded in your article of the 20th inst.

The arrangement adopted is doubtless extremely efficient for securing an even turning moment. It must be remembered, however, that the large weight of the reciprocating parts in a high-speed tandem engine having short connecting-rods introduces large irregularities and reversals of the effective piston thrust due to inertia. These would have been absent or decreased had the single cylinders replaced the tandem arrangements. On the whole, therefore, it is extremely doubtful if the engine described will give a more uniform turning moment at reduced loads than would a good triple-expansion engine fitted with an arrangement by which the governor controlled the steam admission—and thereby the work done—in each cylinder; whilst such an arrangement would dispense with three cylinders and three valves, and have considerably added to the stability of the combination.

With regard to the shortness of the connecting-rod, an evident oversight has been made in describing the ratio to the crank. The proper ratio should be about $4\frac{3}{4}$ times the crank. With regard to the regularity of rotation at reduced loads, it must be remembered that if the load fell from 1500 indicated horse-power to 500 indicated horse-power, the energy fluctuation, rising from, say, 5 per cent. to 12½ per cent. at the same time, then, although the apparent irregularity of rotative effort rises to 2½ times its original amount, yet the fly-wheel irregularity has not been increased. This is due to the fact that any irregularity of angular velocity corresponds to a given addition or subtraction of a definite amount of energy of the wheel. A greater percentage of irregularity at a lower power does not actually in all cases correspond with a rise in total energy gained or lost by the wheel during a period. In fact, in any such engine, since the steadiness must be sufficient to ensure regularity at the heaviest loads, provided that the coefficient of fluctuation of energy does not rise faster than in inverse proportion to the load, the angular variations do not become larger at the lighter loads. ROBERT A. BRUCE.

6, Cyprus-street, Bolton, December 24th.

[We publish our correspondent's letter because it raises questions worth discussing. The Deptford engines are essentially of the marine type. On this point no builder of marine engines can have the smallest doubt. The three distinct engines were only adopted after mature consideration of the conditions to be fulfilled, and as a result of extended experience with various types of engine. If Mr. Bruce will turn to page 608 once more, he will see that we have said nothing that can be taken as a slur on engine builders. We have said, first, that our marine engineering is the best in the world. Can Mr. Bruce dispute this? Secondly, that many of our stationary engine builders must be classed below some of the continental builders. Is not this true? Where is the British marine engine builder that can be classed below the foreign marine engine builder? The interest of Mr. Bruce's letter centres, however, in the discussion of the means of producing regularity of turning under extreme variations of load, a point on which very wide differences of opinion exist.—ED. E.]

ASSOCIATION OF WATERWORKS ENGINEERS.

SIR,—The response I have had to the publication of my letter of the 16th November last in the professional journals on the above subject has been so satisfactory that I am encouraged to take further steps to bring the scheme to a successful conclusion. I have therefore much pleasure in announcing that a meeting will be held in the Exchange Hall, Smithy-row, Nottingham, by the kind permission of the Mayor, on the 11th January, 1896, at one p.m. (1) to discuss generally the subject of forming a Waterworks Engineers' Association for Great Britain; (2) to elect a provisional president, secretary, and committee, with powers to draw up rules and bye-laws, and to take such other steps as they may think desirable to establish the Association upon a sound basis; (3) general business; (4) to receive a paper on the Cologne Waterworks, by Mr. C. H. W. Biggs.

D. M. F. GASKIN, M. Inst. C.E.

Municipal Offices, Nottingham,
December 27th.

AN OLD BAND SAW.

SIR,—I am extremely pleased to find your notice of the band saw machine in the Thames Ironworks sawmills. I may tell you it is now more than twenty years since it was fixed. The first one I designed for Messrs. Samuda Bros., Poplar. I took the order for that, also the one at the Thames Ironworks. I only had a little piece of wood ¼in. scale as model of the worst piece of backing—teak—which had to be cut. I saw the first piece cut, and the machine made the cut as perfectly as though it had been at work for months; the timber being lined on both faces. The mill foreman started the saw into the cut on one side, and a mere lad guided the saw out on his side. I begged the first slab, which was about 26ft. long; the cut was made in about ten minutes. It could have been made in less time had the workmen known the machine. Before the first machine—Messrs. Samuda Bros'.—was made, a good saw-mill machinist, one of the first of the day, said it might be put on the scrap heap at once, it would not answer.

London, December 18th, 1895. J. HAMILTON.

SELF-PROPELLED ROAD CARRIAGES.

SIR,—Whence all this bother about a name for these? When one sends for a carriage at present one does not say, "Bring the 'horse brougham' or the 'horse dog-cart,'" nor does one generally remark, "I'm going into town on the 'cable drawn tramcar.'" Let the coming carriages be simply called "carriages," and if necessary for definition at any time let us call them "traction carriages," following the analogy of traction engine. But above all things let us not render life more hideous in word as well as deed by coining such hybrid sounds—I cannot call them words—as "autocar," "motocar," nor travel in the future in, as it were, a negative, such as a "nonequine." W. T. F.

Forfar, N.B., December 30th, 1895.

STOREY'S DEAD WEIGHT SAFETY VALVE.

SIR,—In your article appearing on page 646 of your issue of December 27th on the above subject, you ascribe to Mr. Lavington E. Fletcher the design of both the arrangements of dead weight safety valves for kitchen boilers, whereas the patent enclosed safety valve has been designed and patented on behalf of the National Boiler and General Insurance Company, Limited, Manchester, with the object of overcoming the difficulty of efficiently protecting the simple form of valve from damage and clogging by soot when fixed directly on the boilers in the flues. We shall be much obliged if you will kindly insert this in your next issue.

ISAAC STOREY AND SONS.

BULL'S METAL LAUNCH.

SIR,—Referring to your interesting notice of the Bull's metal launch that we built recently for Messrs. Siemens, for use with the cable ship Faraday, we notice one error which, with your kind permission we would like corrected, in the beam of the boat, which is not 3ft. 7in. but 7ft. 3in. Were it not that our Mr. Des Vignes is so celebrated for fast and narrow river launches, we should not ask you to make this correction, but we think that under these circumstances it is just as well to point it out.

G. F. G. DES VIGNES AND CO.

17, Victoria-street, December 30th, 1895.

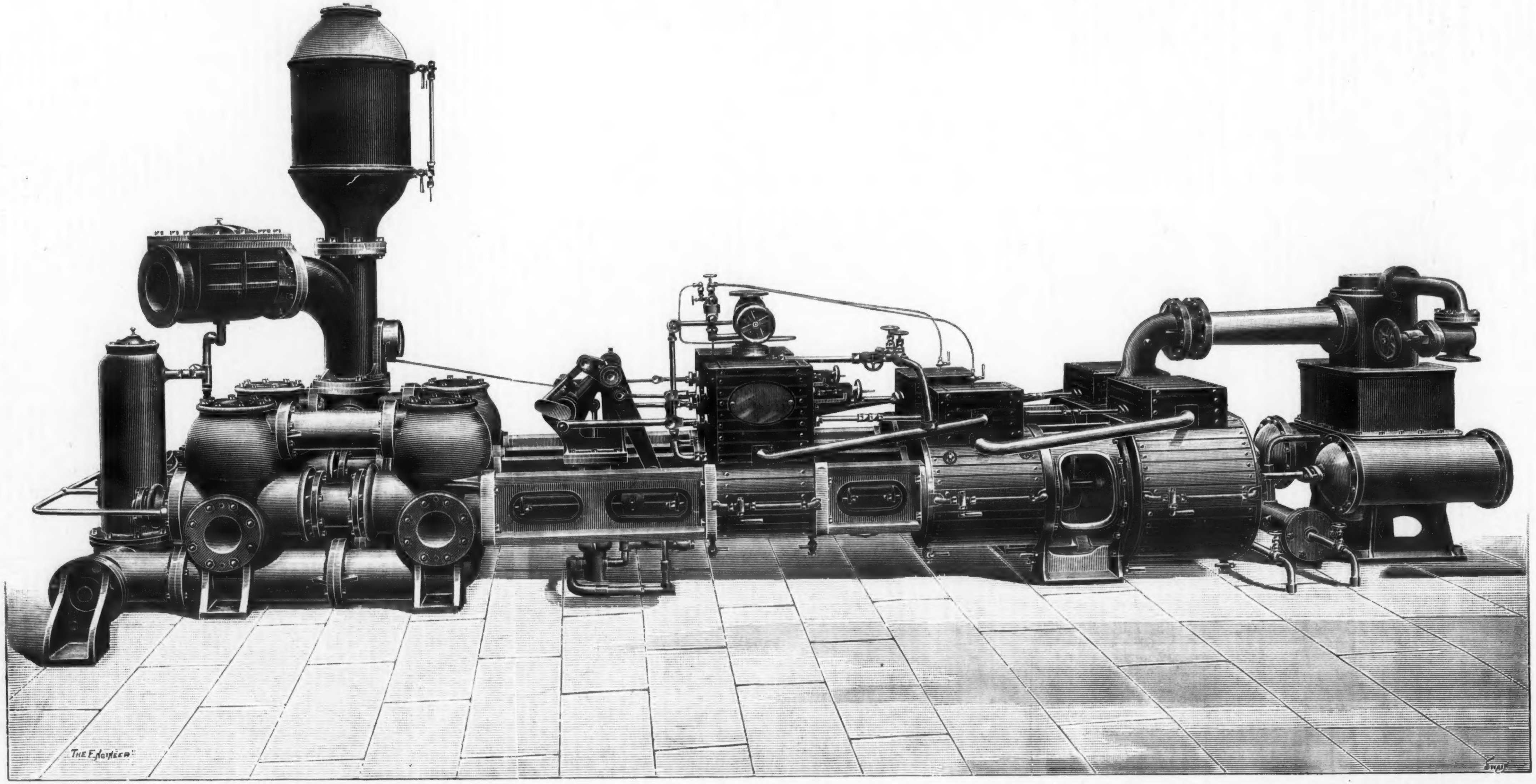
TRADE AND BUSINESS ANNOUNCEMENTS.—Messrs. Barry and Higham, consulting and constructional engineers, have moved to 15, Great George-street, Westminster, S.W.—Mr. E. H. Birley, of 80, Deansgate, has been appointed agent in Manchester for the products of Messrs. John Spencer and Sons, Ld., Newburn Steel Works, Newcastle-on-Tyne.—Messrs. F. Wiggins and Sons, mica merchants, wish to notify that owing to the great increase of business necessitating additional warehouse room, they have purchased No. 103, Minories, and that during the demolition and rebuilding of that and their old house, No. 102, Minories, they have taken temporary premises at Nos. 62 and 63, Minories—opposite—where for the next twelve months all communications should be addressed, or to their other establishment, 10, Tower Hill, London.—Messrs. Matthew Shaw and Co., 81, Cannon-street, have converted their business into a private limited company.

HOW THE CABLE WAS CARRIED ACROSS AUSTRALIA.—A writer on "The Telegraph Systems of the World," in the January issue of the *Windsor Magazine*, gives the following graphic account of the difficulties involved in carrying a cable across Australia:—"It was the year before the Eastern Extension carried its cable to Hong-Kong that it concluded to go on to Australia, on condition that one, or all of the Colonies combined, would lay a land line across the continent to meet it. This offer was accepted by the South Australian Government. This colony then numbered 170,000 inhabitants; it was in debt heavily for railroads and telegraph lines in the settled parts of its territory, but it bravely set aside the money for the new undertaking. The work was begun early in 1870. All but two or three hundred miles of the two thousand from Adelaide on the south to Port Darwin, the cable terminus on the north, was through a land of either the worst reputation or utterly unknown, save from the reports of the one explorer who, with infinite risk and hardship, had traversed it nearly ten years before. The expedition was to be baffled by nothing, however, They carted every inch of their wire, most of their poles, all of their supplies, across a country often waterless, and so hot that the thermometer burst and the pork melted in the brine. They saw their cattle die of hunger and thirst. They were forced literally to crawl through miles upon miles of scrub of the most exasperating character. The natives harassed them constantly, stealing their supplies, threatening their finished work, and rigging up their insulators as spear-heads, to use when the native boomerangs were not up to the occasion. The northern portion of the work was once abandoned, so hopeless did it seem. Again, terrific floods drove the expedition entirely from the field. In spite of the loss and discouragement, the line was finished in two years and a half."

TRIPLE-EXPANSION WORTHINGTON PUMPING ENGINES, JOHANNESBURG WATERWORKS

MESSRS. JAMES SIMPSON AND CO., LONDON, ENGINEERS

(*For description see page 10*)


THE ENGINEER
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PUBLISHER'S NOTICE.

**** With this week's number is issued as a Supplement a Four-page Working Drawing of a Dredger and Hydraulic Spoil Elevator and Conveyor on the Baltic Ship Canal. Every copy as issued by the Publisher contains a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it. Price 6d.*

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TO CORRESPONDENTS.

Registered Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

**** In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and bearing a penny postage stamp, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

**** All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

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H. B.—*(1) There is no examination. Anyone can write C.E. after his name if he pleases. (2) Write to the Secretary of the Institution of Civil Engineers, 25, Great George-street, Westminster.*

A READER.—*In reply to your question, the following are the dimensions of the cupolas at Derby:—The outside diameters are 5ft. 6in.; inside diameter at centre of tuyeres, 2ft. 10in.; internal diameter at the hearth, 3ft. 4in. There are five tuyeres at the bottom, 3in. square, and three at the top 2in. square, all being arranged to spread the blast over the surface.*

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF JUNIOR ENGINEERS.—Friday, January 10th, at 8 p.m. Paper: "Problems connected with the Working and Testing of Gas Engines and Hot-air Motors," by Professor T. Hudson Beare, Honorary Member.

LIVERPOOL ENGINEERING SOCIETY.—Wednesday, January 8th, at 8 p.m. Paper: "Combustion in Marine Boilers," by Mr. J. R. Fothergill, M. Inst. N.A., M. Inst. Mech. E.

THE ENGINEER.

JANUARY 3, 1896.

1896.

WITH the New Year come hopes, aspirations, resolves—hopes that business will be better, aspirations towards higher professional positions, resolves to avoid mistakes and deserve success even should it not be attained. Are our readers justified in believing that the year just begun will be more prosperous than that which has just passed away? The answer rests on many important considerations. We may be told that as trade is better all round in the aggregate, it ought to be better for the individual. On every side, indeed, we hear the voices of returning industries. Yet such a reply may miss the truth at which it aims. It does not follow that because trade is good on the whole, or bad on the whole, it must also be bad or good for the individual. We have only to keep our eyes open to see exceptions. Let us consider, then, what it is that in the present day—in the closing years of the nineteenth century—makes for success; and to do this we must extend our survey, and, balancing fact against fact, opinion against opinion, consider what is the position of trade in so far as it most nearly concerns engineers, whether civil, engaged in the construction of roads, railways, harbours, canals, or drainage works; or mechanical engineers, doing work too multitudinous in variety to classify or marshal.

The whole world is at war—not the war of armies or fleets, but none the less war. Capital contends against labour, labour against capital; capitalist fights capitalist in trade competition; workman fights against workman in ways which have nothing to do with mere competition. There be men who deplore the facts, who denounce the existence of this warfare, as though nothing good could be said of it; and yet it is far from clear that without it the world would make any progress. Development and civilisation depend for their existence on emulation. The advantages derived from competition are clear to all who think. But even though we admit that trade warfare is an unmitigated evil, it none the less remains for us to take the world as we find it, and consider how we shall go down into the arena and fight with the best chance of success. Turning to labour—to the working man—we find that he has adopted in all its possible fulness the principle of combination. The isolated labourer has small chance at the present day of getting the best treatment he deserves at the hands of his fellow man. In this there is nothing new. The individual has always been weak. History tells us that the authority of the tyrant always depended on a combination of certain individuals who supported the Throne. The people groaned, perhaps, but they achieved nothing until they combined. The great truth that union is strength is fully appreciated; but it is recognised even more clearly that isolation means annihilation. This is the era of combinations, co-operations, unions of all kinds. We see on the one hand, labour combining and fighting to attain its desires—desires which are as often as not apparently sentimental, or irrational and unwise. Thus, for example, strikes are carried on for augmentation of wages, the dead loss of wage incurred being more than could be made up by half-a-dozen years' receipt of the sum in dispute. The capitalist has begun to realise the fact that if he is to hold his own he, too, must combine; and the names of half-a-dozen important federations will suggest themselves to most of our readers. Many political economists will maintain that such combinations of employers are wrong in principle and to be deprecated. Once more the answer is that, right or wrong, they seem to have become indispensable. For ourselves, we believe that more than ever will be heard of them during the coming year; and further that instead of doing injustice to the working man, they may prove his best friend by steadying employment, and preventing the outbreak of petty little wars in districts. Instead of a perpetual, more or less purposeless skirmishing, we shall either have peace or a great war fought out to the bitter end. The very magnitude of such a conflict will be sure to deter the opposing parties from entering upon so tremendous a struggle. Strikes, although we do not believe that they are so disastrous as some persons think, certainly injure the trade of this country; but Great Britain does not stand alone in this respect. The great strike at Carmeaux, for example, seems to show on what uncertain ground the French manufacturer walks. The most destructive and mischievous strikes have occurred in the United States. We venture to think, however, that we shall not only have capital but labour on our side when we say that every great Federation of Employers tends to prevent the occurrence of strikes, and in so far is a commendable thing. But it is not in federation alone that British trade may seek help. We have said that the individual being weak has small chance of attaining success, and this statement admits of a very wide application. The great manufacturing establishments are ruining the small fry. Day by day we find companies carrying on the work done not so long since by individuals. The mutual help of numbers, be it with their purse or their brains, is invaluable. Work can be carried on more cheaply and sold to better advantage by a number of capitalists combined than by one man. A notable example of this is supplied by coal mining. The little pit with an output of fifty to a couple of hundred tons per day cannot live. It is only the great collieries, with pits winding from 1000 to 1200 tons a day, and provided with the newest and most perfect machinery and appliances for sinking, pumping, winding, washing, and screening coal, that can make a profit. Ten individuals, each with £10,000 capital, undertaking to mine and sell coal, each working one colliery, would probably lose every farthing in a year or two; but the ten combined, putting £100,000 into a single colliery, would, with good management, get a fair return for their enterprise. Herein lies in the present day the secret of success. It may all be summed up in one word—combination. But it must not be forgotten that combination carries within itself an element of danger. It is a very simple thing for a number of persons to combine together to attain a given end, but—and herein lies the risk—the combination must have a head. We see private establishments carried on for years with great success. Then in time a change is forced upon its owners, the concern is converted into a limited company, and but too often failure ensues, and this usually because of divided counsels and procrastination. In trade, as in warfare, it happens constantly that a decision must be formed suddenly, or at least with but scant time for thought. When there is one man at the head of affairs there is little difficulty in doing this. If a Board meeting has to be summoned, and the question discussed in all its bearings, hours and days may be wasted when minutes are invaluable. It is in the slowness and unwieldiness of limited companies and syndicates that the isolated manufacturer finds his chance of living; and it will be seen on examination, we think, that the affairs of all the fully successful limited manufacturing companies are guided by one or two masterly and masterful men. How often is it said, and with perfect truth, that the chairman of such and such a company has made it what it is.

But if it be true that combinations of capital are largely dependent for success on those who rule, it is not less true of combinations of workmen. The leaders of the unions have enormous powers for good and evil in their hands. The trade of England during the present year will be prosperous or not as the Union leaders please. This is a startling statement, and it is not true of every year; it is true of the present situation. There is no room to doubt that a very heavy demand will be made in the immediate future for those things which engineers, using the word in its widest sense, produce. Japan and China will need rails, bridges, locomotives, guns, ships, engines. Argentina is certainly better as a market than it has been for years. Africa will make large demands in the early future. In this country there is an enormous accumulation of capital practically idle. If only labour consents to employ that capital and make what the world wants, then trade will not only be good, but excellent. It is true that there are ominous signs, evidences of that delirium which sometimes seizes nations. From the United States come alarms. In Africa something approaching revolution exists, and women and children are being sent out of Johannesburg, that flourishing city called into existence like a palace in the Arabian Nights. In the East we have a situation at once deplorable and next to impossible of prompt settlement. Such conditions are no doubt most unfavourable to trade. They are the antithesis of civilisation, and yet, in the words of a veteran statesman, we may say that nothing but common sense is wanted to determine these quarrels, and give us peace. We believe that in the long run the counsels of common sense will prevail. It is not the interest of any nation to fight; there is no prospect of mutual gain. A European war is always possible, but it is to the last degree improbable. France has her hands full in Madagascar, Italy in Abyssinia, Russia's eyes are set on China; all the fighting that any nation can want is to be had in plenty outside of Europe. All the indications point, war rumours notwithstanding, to a busy year for us. "Almost all branches of the engineering trades are actively engaged," say Messrs. Matheson and Grant, "and subject to the maintenance of peace, the year opens with better prospects than at any time since 1890. The unexpected dispute that has been sprung upon this country by the United States, may retard the general revival, towards which most trades were advancing, but the causes of improvement are too numerous and wide-spread to allow of any long postponement. For while on almost all previous occasions of revival, the recovery has been due to or has coincided with improved demands from America, on this occasion the stimulus comes entirely from our home, Eastern, colonial and foreign markets outside American influence." But it is evident that the Union leaders can spoil everything. If they make demands which masters, with foreign competition before them, must refuse, then the end will be disaster. A strike or two like the Glasgow and Belfast struggle would soon settle the question. To sum up, the time is one of combination. Only the great concerns can work to advantage. The exceptions to the rule—there always are exceptions—are the works conducted by men whose ability, energy, tact, and consummate talent constitute each a host in himself. The prospects of a great demand in the immediate future are excellent; but the demand will not reach Great Britain only, nor will Great Britain be able to fix her own price. That will be settled partly by competitive nations, partly by the leaders of the trade unions. If the latter are reasonable, all will be well; if not—the Deluge.

CIVIL ENGINEERING.

The profession of the civil engineer has during the year 1895 been more interesting in connection with its promises than in the realisation or greatness of its performances. More particularly during the past three or four months the employment barometer in the Westminster business chart has been higher than for some considerable time; and unless political difficulties which are threatening supervene, there are indications of a good deal of work for the civil engineer, mostly, however, abroad. At home there are at present several railway and waterworks projects of some magnitude in course of execution, and there are numerous smaller projects in the nature of sewage disposal, sewerage, small waterworks, and a few small and branch railways; but the total value of the whole lot does not probably reach ten millions sterling. A good deal of this work will take three or four years to complete, so that the home work at present in view does not offer very much reason for great expectations.

Canal engineering, which during the past few years has shown promises of revival, is still only promising, and even that chiefly in the form of improvement works not very likely to be taken in hand with sufficient vigour to make itself felt. Several of the more important projects, such, for instance, as the Birmingham and Worcester and Bristol Channel or Thames and Severn schemes, have taken the form of a compromise between a mere repair and reconstruction, instead of the execution of an important and complete scheme, or have been dropped, as in the case of a large northern counties amalgamation and improvement scheme which has virtually fallen into the hands of a railway company.

The Manchester Ship Canal, although improving in earning powers every quarter, has not encouraged other schemes of the kind, and, with the exception of a few of the more energetically managed canals, such as those of the Grand Junction Canal Company,[1] few of the many miles of existing English inland waterways can be said to be of much money-earning value. There is, however, without any doubt, a gradual awakening to the possibilities of many of these old lines of canals, and it may be expected that with the completion of some of the improvement works now in progress, and with the successful development of one or other of the means of slow-speed propulsion of canal barges now under trial, that canal transport will in the not very distant future again take a notable share of the slow and heavy traffic of the country. Our readers will have been kept pretty well acquainted with what is going on in this branch of engineering by their perusal of our occasional summary of information concerning "Harbours and Waterways," and with some of the more important projects and aspects of these branches of engineering as they have occurred during the past year we have dealt at more length on page 17.

Some tunnel works of considerable magnitude have occupied attention during this year, more particularly the Glasgow Harbour Tunnel and the Blackwall Tunnel;[2] the latter, which is the largest cylindrical iron-lined tunnel ever constructed under the bed of a great river, may be expected to be opened for traffic before the end of the present year. We dealt with it so fully in our last issue, that it is unnecessary to refer to it at any length here.

A tunnel which has been an exceedingly difficult one to construct, namely, the Sequixquiac Tunnel, for the drainage of the Valley of Mexico, was completed in October last, and the partial drainage of Lake Texcoco[3] by the new canal 29½ miles long, and the tunnel 6¼ miles long, has commenced, the drainage water passing into the Gulf of Mexico. A large tunnel project of the immediate future is the Simplon Tunnel, to which we referred in our last impression, the final arrangements having been made for carrying it out. We have fully described the chief engineering features of this big boring,[4] but we may mention that between the terminal points at Brieg in the Rhone Valley and Douro d'Orsola on the Italian side, the total length will be a few feet over 12¼ miles, or nearly three miles more than the St. Gothard. About two-thirds of the length from Brieg to Isello, in the Val de Vedro, will be driven straight upon a rising gradient of 1 in 500 for 9260 yards, to a short level piece of 656 yards at the summit, and thence on a falling gradient of 1 in 143 for 11,148 yards to the mouth on the Italian side. The contract price for the works is £1,900,000; the time allowed, 5½ years; and £200 per day for earlier completion or for delay.

Rapid progress is being made with a tunnel of very considerable interest to Londoners, namely, that of the Waterloo and City Electric Railway[5] under the Thames. Of the total length of this line the chief parts have been completed, including the whole of the portion which is under the Thames. The citywards heading is now past the *Times* office, and the watery section near Waterloo Station is progressing under air pressure. The engineers, Messrs. Galbraith and Greathead, and Messrs. Mowlem and Burt, contractors, are to be congratulated upon the rapid and successful advance they have made towards the completion of this railway. On the construction of tunnels of this kind a long promised paper was read by Mr. Greathead at the Institution of Civil Engineers on the 19th November[6]. Capital has at last been subscribed for the Central London Railway, and a commencement has been made towards realisation of this much needed means of communication between the City, the West of London, and Shepherd's Bush. The Hudson River tunnel must again be referred to as one of the partially completed works remaining in abeyance.

During the year the Glasgow Central Railway, of which Messrs. Forman and McCall are the engineers, has been nearly finished; the Glasgow District Subway, of which Mr. Simpson is the engineer, has been commenced and will be worked by cable; and the Glasgow Harbour Tunnel and Railway, under the same engineer, has been completed. In both the latter cases, iron-lined tunnels constructed on the shield system have been adopted.

Africa is at the present moment providing occupation for a good many engineers in the construction for the surveying for railways. Amongst these is the railway which has been commenced in Sierra Leone from Freetown to the interior. This will be about 100 miles in length, and is being constructed on 2ft. 6in. gauge. Another is being constructed from Lagos to the interior, and will be 120 miles in length. This line includes a bridge ¾ mile in length for connecting the port of Lagos with the mainland. Both these lines are being constructed under Mr. W. Shelford, M. Inst. C.E., by the Colonial Office, and the Lagos Railway will, no doubt, soon be followed by others in this country, teeming with wealth in natural products only waiting to be brought to the coast.

A much longer railway, and one of great importance, though perhaps not likely to be so immediately profitable, is the Uganda Railway,[7] for the construction of which Mr. George Whitehouse, M. Inst. C.E., has gone out as chief engineer. This line will probably be 670 miles in length, and already materials have been sent out for the construction of the first lengths. In China there is much hope of railway work, and English engineers have a good reason to expect that a large share of it will fall to them, some extensions being already in the hands of Mr. C. W. Kinder, M. Inst. C.E., whose name is so much associated with all that has been done in China in railway engineering.

So much progress has been made during the year with the construction of the Lancashire, Derbyshire, and East Coast Railway, that the greater part of the section between Chesterfield and Lincoln, together with the branch lines in the colliery districts between Langwith Junction and Beighton Junction will be ready in a few weeks for coal traffic. The part between Lincoln and the East Coast yet remains to be commenced, and that part which was included in the first plans between Chesterfield and Warrington will not be made. The parts which are most rapidly nearing completion are those between Chesterfield and Tuxford. The line, of which Mr. R. Elliott Cooper is the engineer, is being constructed by Messrs. Pearson and Sons, and comprises a great deal of very heavy work in cuttings, tunnels, and bridges, some of which we hope to illustrate at any early date.

Several other railways are being built in Scotland, including the East Fife Central Railway, of which Messrs. T. Meik and Sons are the engineers, and which is to open up new mineral fields. The Burntisland New Dock, under the same engineers, is to be commenced in the spring, and will cost £300,000. The Highland Railway extension to Kyle Akin, with a loop to Inverness; the Edinburgh new station, including the Haymarket and Calton Tunnels, for which Messrs. Blythe and Cunningham are the engineers; and the Lanarkshire and Dumbartonshire Railway, under Messrs. Forman and McCall, are making rapid progress towards completion.

In India a great deal of railway work has been completed in the last few years and a great deal is now under survey and in course of construction, a slight increase in the estimates for this purpose having been made and passed last year. The Adam's Bridge Railway project, to which we referred in our annual article last year, has been the subject of two official reports[8] since that date, but no steps have been taken towards its realisation.

Since we were writing last year the heavy floods in the Upper Thames, and particularly at and above Kingston, have caused criticism of the Richmond sluice and weir, and some hopes were raised that the proposal to erect near Hammersmith a similar set of sluices would be realised. It was, however, found that the reasons alleged by Hammersmith as to decrease in tidal water had no foundation in fact, and that another reason for the construction of the weir, which, no doubt, would beautify the river above Hammersmith, would have to be found.

A Bill is in Parliament this year for a big weir with sluices across the Dee at Chester, the object being in this case to prevent the pollution of the river above by the tidal waters that now pass up.

The floods last year showed once more the necessity for placing the whole watershed of the Thames under the authority of the Conservators, or some body specially formed, so that the whole watershed may be properly and differentially rated to pay for the necessary works of regulation. These rates would, however, not be very great, for at the same time that large storage and regulating reservoirs are being made for this purpose, they would provide the means of storing the water for the London water supply. This subject was considered by the Commission of 1892[9], and the valuable evidence then given ought to be utilised in this direction.

The project is one of great importance to Ceylon and Southern India, but its cost, including that of about twenty miles of bridgework, much of it of a very simple order, however, will, it is to be feared, keep it in abeyance for some time.

The completion of irrigation works on a very large scale by English engineers in Egypt[10] has added to the debt of that country to engineers for the amelioration of its cultivation difficulties. The great Nile reservoir irrigation project which is to do so much for Egypt, and in the way of which the ruins of Philæ[11] stand, has made small progress during the year, but that little progress encourages the hope that the interests of Egypt may not be sacrificed either to narrow prejudices or to international jealousies which have stood in the way.

A grand piece of irrigation and waterworks engineering, namely, the Periyar Irrigation Works, which is also a water supply and water power works, was completed this year, a work which included the construction of one of the high dams[12] of the country.

During the year the light railways question has been very much to the front, and a very largely attended international railway congress[13] held its meetings in the Imperial Institute last June and July. Since that time the Board of Trade has held an inquiry on the light railways question, and the report of a Committee appointed was published[14] in February last. This report did not very much help Mr. Bryce, then president of the Board of Trade, and since that time little has been done on the subject officially, but Mr. Ritchie, President of the Board of Trade, has visited Belgium and France with a view to obtaining his own notions of this subject on the spot. A conference has also been lately held in Westminster, headed by Sir Albert Rollit, and supported by many who are of opinion that light railways would be a great help to agriculture. There is no doubt they would in some localities, not very numerous, be a direct help to agriculture, but in most parts of the country they would only indirectly help by increasing or preventing decrease of rural populations, and by making possible a system of co-operation as to collection of farm produce and requirements as followed in Belgium. The construction of light railways can only be entered upon, however, where the total cost will be the costs of construction, and this can never be the case until parliamentary procedure[15] has been considerably modified, and Board of Trade rules and regulations changed to meet the requirements of light, slow, cheap railways.

In a great many parts of the country that help which has been hoped for, though more or less vaguely, from light railways will be very much more readily and cheaply afforded by means of mechanical road carriages and vans. By means of such vehicles, weighing with their load of passengers or goods not more than about two tons, and capable of speeds of say eight to ten miles an hour and two to three miles per hour up hills, farmers, carriers, and postmasters, would be placed in possession of all that is necessary to provide a service of vehicles on country roads which would have the regularity of a light railway service, but would possess much greater flexibility and far greater economy. From £100 to £500 per mile spent on improvement of country roads, where they are not already good, would with mechanical road carriages be in many parts more effective than from £100 to £2500 per mile spent on light railways.

The largest graving dock in the world, viz., that of the Southampton Railway Company at Southampton, was opened during the summer by the Prince of Wales. It has been constructed by Messrs. Lucas and Aird, is emptied by two pumps, 4ft. in diameter, by Messrs. John and Henry Gwynne, which lift over 540 tons of water per minute, and it is 750ft. in length, 87ft. 6in. wide at sill level, 112ft. 6in. at quay level, and has a maximum depth of 35ft.

Among the familiar problems yearly growing in difficulty of solution is that of the disposal of town refuse in London and the other large towns in this country. The old methods of sorting, utilising, and destruction have become obsolete. The refuse which in past days used to be sold to brickfield owners and men of the type of Dickens' Mr. Boffin, is no longer saleable, but towns have to pay heavily for the work of its disposal. The design and construction of refuse destructors has become an important branch of sanitary engineering, and the best design for furnaces for this work is yet a matter to some extent of opinion, more especially when the utilisation of the waste heat becomes a matter of importance. Where destructor furnaces are not employed the sanitary disposal of refuse, more especially from towns situated within the watershed of one or more of them, is a matter of great difficulty, and the conservators of rivers such as the Thames need have placed in their power summary jurisdiction to prevent serious pollution which is now possible.

In one of the most interesting and characteristic addresses which grace the proceedings of the Institution of Civil Engineers, Sir Benjamin Baker referred to some questions with regard to the Institution which have long occupied the attention of many of its members although the Council has paid but little heed to them. When the Charter of the Institution was first drawn up there were only 156 members; there are now 6794 of the various classes. These members are scattered all over the world and a considerable number hold important positions in different parts of this country. The conditions necessary to a sound representative government of the Institution have thus very materially changed, and some modifications have therefore become absolutely necessary in the constitution and rotation of the Council and its members in the bye-laws, as to voting for the members of the Council in the numbers to be placed on the balloting list, and in some of the customs as to elections within the Council.

MECHANICAL ENGINEERING.

In mechanical engineering there is little that is new to record. Three principal subjects have been discussed and considered and received all the attention available. These are water-tube boilers for the Navy, the acceleration of railway travelling, and self-propelled common road carriages. In one sense, the action of the Admiralty in adopting the Belleville boiler is of transcendent importance. Although the boiler is in use in the French navy, nowhere outside England has resort been had to it on anything like a crucial scale. It is not that it is being fitted to two great warships alone—although that would constitute an experiment remarkable for its magnitude—but that its universal adoption in the future forms a portion of the Admiralty programme. Our own views and reservations on the subject are well known. We do not believe that the boiler is either so bad or so good as its enemies and its friends respectively would have us believe. But bad or good, we think that it is not beyond the resources of British mechanical engineers to produce a boiler which ought to do its work as well and give as much satisfaction as anything that a French engineer can produce. English engineers have, however, in some sense themselves to thank. The situation had beyond question become intolerable. From one cause or another the Scotch boiler as modified to meet naval requirements would not stand the forced draught needed to get large quantities of steam from it. No English water-tube boiler was available to take its place. In considering the action taken by Mr. Durston and the Admiralty, it is constantly forgotten that, however bad the Belleville boiler may be, it is hardly conceivable that it will be worse than the boilers now in the Navy, if we judge by past experience. No one says that the Belleville boiler will break down or give trouble with natural draught. It is on all fours so far with the Scotch boiler. It is said that if pushed it will fail. That remains to be seen; but even if it does it cannot fail worse than the boiler whose place it is about to take. In dealing with the Belleville boiler we have said ere now that it is a steam-generating apparatus, not a boiler in the ordinary sense of the word, and it and its appurtenances must be dealt with as a whole. Because it was not so dealt with the s.s. Ohio has not been a success; but the major trouble was due in her, not to the boiler but to the feed-pump, which was entirely unsuitable for the work it had to perform. With ordinary boilers, so long as there are feed-pumps available to "slap it into" the boiler, everyone is satisfied; but the feed cannot be "slapped into" a Belleville boiler anyhow. This is not, as any mechanical engineer will see, necessarily a defect. In a word, the Belleville boiler must be dealt with in a special way because it is a special steam generator, and this is no more a radical defect than the circumstance that the boiler of a steam fire-engine cannot be handled like that of a tug-boat is a defect.

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[1] THE ENGINEER, 8th November, 1895, page 451; 20th December, 1895, page 616.

[2] THE ENGINEER, 1st November, page 450; 27th December, page 635.

[3] These drainage works were described in THE ENGINEER, vol. lxxv., page 224.

[4] THE ENGINEER, January 4th, 1895, page 1.

[5] THE ENGINEER, 26th July, 1895, page 34.

[6] THE ENGINEER, 22nd November, 1895, page 500.

[7] THE ENGINEER, 13th September, 1895, page 255.

[8] THE ENGINEER, 5th December, 1895, page 556.

[9] See THE ENGINEER, Vol. lxxiv., pages 466, 474, and Vol. lxxvii.

[10] THE ENGINEER, 20th and 27th September, 1895, pp. 275, 301, and 1st November, page 427.

[11] *Illustrated London News*, some interesting illustrations and particulars recently appeared.

[12] THE ENGINEER, 18th October, 1895, page 382, and 6th April, 1894.

[13] THE ENGINEER, 5th and 12th July, 1895, pp. 1, 29.

[14] THE ENGINEER, Vol. lxxix., pp. 95, 113.

[15] THE ENGINEER, Vol. lxxix., p. 204.

Concerning "express" water-tube boilers, their use is not only extending, but it has come to be regarded as indispensable in all the lighter craft which have to run at high speeds. There are a number of such boilers now recognised as out of the region of theory. Among these, to say nothing of the Yarrow, the Thornycroft, and the Normand, are those of Mr. Blechynden, Mr. Mumford, Mr. White, Mr. Des Vignes, and one or two others. In the United States there are a number of water-tube boilers claiming recognition, many of which possess features anything but commendable in English eyes, as, for example, a multitude of screwed and running joints, and pipes so contorted that to clean them seems impossible. While on the subject of joints we may call attention to the revival of the copper wire joint first devised by Jacob Perkins, of steam gun fame. The credit for this revival is very largely due to Mr. Mumford, of Colchester. It is, of course, easy enough to say of it, "Oh, we knew of it all along;" but the fact is that it has not been used, and that at this moment it is not everyone who knows how to make a proper copper wire joint—a joint, it is perhaps right to add, that must not be confounded with a wire gauze joint.

In the United States a modification of the Babcock and Wilcox boiler is being used for marine purposes, especially in lake steamers, and an endless variety of express boilers are being fitted into launches, and yachts, and small craft, and for each it is claimed that it is very much the best of its kind in the world. At this side of the water Mr. Howden's system makes steady if slow progress, and the same may be said of the induced draught system made by Messrs. Sir John Brown and Co. A most successful application of induced draught has been effected by Mr. Bevis in the paddle steamer Queen of the North, already fully described and illustrated in our columns.

The necessity for the use of pure feed-water is daily becoming more fully recognised, and all ships are now fitted with the filtering and purifying appliances of Weir, Normandy, Mudd, Maudslay Sons and Fuld, and many other makers. In the Navy "The Compactum" of Messrs. Kirkaldy seems to enjoy most favour at present. It is to be fitted in the Sultan, Hannibal, Jupiter, Illustrious, Minerva, Gladiator, Andromeda, Recruit, Vulture, Foam, Desperate, Mallard, Fame, and also fourteen complete sets for first-class torpedo boats, and feed-water filters for H.M.S. Talbot. The six torpedo destroyers Sturgeon, Skate, Starfish, Handy, Hart, and Hunter have all been similarly fitted.

In the marine engine little that is novel has been achieved, and the same thing may be said of steam engines generally. Joy's hydraulic gear is gradually creeping into use, and during the year we have illustrated a gear which has been devised by Mr. Marshall and used with great success by Messrs. Fowler, of Leeds. The system of constructing high-pressure compound engines, like triple-expansion engines with the intermediate cylinder left out, continues to give excellent results, and is growing in favour as a means of improving the performance of steamers with ordinary compound engines, with a minimum of alteration and expense.

It can scarcely have escaped our readers that the performance of mill engines appears to be gradually improving. A competition exists among the more eminent makers, who manifest a desire to break the record, and the tests which are now carried out by such men as Mr. Crosland, Mr. Longridge, and others, have been so systematic that the results obtained, however startling, are commonly irrefragable. At the same time it must be admitted that much remains to be settled before any satisfactory and consistent theory of the steam engine can be proposed, the influence of the steam jacket being especially puzzling. The jacket committee of the Institution of Mechanical Engineers has not yet reported. Bearing on cylinder condensation is the statement that Mr. Henry Davey has designed and is constructing a very powerful pumping engine on a new principle; nothing less, in short, than a compound engine working on the Cornish cycle, and with very special arrangements for heating the feed-water. We shall illustrate this engine in an early impression, and till then we shall say nothing more about it. In high speed engines the only new departure appears to be the Peache engine, made by Messrs. Paxman, Davey, and Co., of Colchester. The engine has been so recently illustrated and described in our columns that we need not further refer to it.

A very remarkable traction engine has been constructed by Messrs. Burrell, of Thetford, which seems to set certain well-known mechanical laws at defiance. In this engine speed is first got up in the gearing, and then let down again, roller bearings being used in a way which would not be intelligible without the illustrations which we hope to publish in a little time. The result is that the engine in the quick speed will haul as much as two other engines did in their slow speed. The true influence of ball and roller bearings does not appear yet to be understood. Very careful experiments have been carried out with a bicycle, in which the axle bearings were got up with the utmost care and perfectly lubricated. In spite of the small size of the axle, however, it was found that in practice the resistance of the machine was incomparably greater than that of a precisely similar bicycle with ball bearings. It is impossible by any manipulation of figures to explain why these things should be, but there they are, nevertheless.

Our friends in the United States tell us that they have taught us in this country how to run trains at high speed. It remains to be proved that the contention is sound. But we are willing to admit that men like Mr. Buchanan have achieved great things. Two noteworthy facts about American locomotives for high speeds are worth stating; one is that at the other side of the Atlantic engines of very great size are employed—engines with 50 per cent. more heating surface at least than is used in this country; another is the very heavy consumption of fuel; and, lastly, the great height of the centre of gravity above the rails. It is quite true that no locomotive has ever been overturned unless by the sinking of a rail, so long as it kept the track, and it can easily be shown that the higher the centre of gravity the less is the bursting effort of the engine on the road; but it must not be forgotten that the lurching of the engine augments as its centre of gravity is raised, and that this lurching tends to force down the rails, to break the springs, and otherwise to do mischief. There is, in a word, a happy medium which should be observed, and no doubt very great care must be used in packing up roads on which these exceedingly lofty structures run at speeds of seventy miles an hour or over. When we read of the velocities attained according to some of our American contemporaries, we often wonder whether Professor Osborne Reynolds is prepared to modify some of the statements contained in an able series of articles on "Limits of Speed" from his pen which appeared in our pages some few years ago. Concerning the race to the North, it has been so fully dealt with in our pages already by Mr. Rous-Marten, who will have something more to say on the subject by-and-bye, that it is not necessary to do more than name the matter here.

The movement in favour of self-propelled vehicles for use on common roads has become too forcible to be resisted. It is not confined to those who would use such carriages for pleasure purposes, nor to a single county. Omnibus companies regard with pleasure any scheme for getting rid of the horse; and the advantages conferred on street traffic by the substitution of steam, oil, gas, or electricity for animal power are far too obvious to require explanation. There are obvious reasons why we should not attempt to indicate here the direction in which success is most likely to be attained. It is expedient, if not necessary, that we should confine ourselves to describing what is being done, instead of attempting to prepare a forecast of what will be done. In another page our readers will find an account of the latest developments of the self-propelled road carriage, "Auto-car," "Non-equine," "Motor-car," or whatever name popular taste will finally confer on the horseless vehicle. Here we shall content ourselves with stating a few historical facts which are not generally known.

We have only to read what has been published concerning the work done by Gurney, Dance, Maceroni, and several others to learn that a very considerable success was achieved. Such a carriage, for example, as the Autopsy was not a toy; and Hancock's steam omnibus, the Enterprise, which plied between Paddington and the Bank, was a very real and practical machine. Why the use of steam on common roads was abandoned supplies a curious episode in history. About the years 1828 and 1830 locomotion by horses had been brought to the greatest perfection of which it was capable. The mail coach roads which traversed the country were the finest highways in the world. An enormous number of horses specially bred for the purpose was engaged in working mail coaches which embodied every perfection that the art of the coach builder could devise. On the crack mail routes the average speed, including stops to change horses, was ten miles an hour. The regulation time for changing was one minute. Much galloping was done, and to obviate certain abuses an Act of Parliament was passed in which was a clause which enacted that all the four horses of a mail coach must not gallop at once, under a penalty. The proprietors of the coaches got over this difficulty by providing in each team one first-class trotter, who was known as the "parliamentary horse"; he cost as much money, probably, as any other two, but he could trot as fast as they could gallop. It was felt, however, that the limit had been reached, and that no acceleration of the mails was possible. It was to get over this difficulty that Hancock, Dance, and others devoted themselves. The mail coach proprietors, horse breeders, coachmen, and a whole host of persons more or less closely interested in the enormous coaching and posting trade of the country, were quite astute enough to see that if the steam carriage was a success the days of the horse-drawn mail coach were ended. The result was an intense opposition. But this would have been overborne by the national necessities had it not been for the advent of railways, which provided a means of transport infinitely superior to anything that could be put on the highway. All the capital and enterprise of the country went into railways, and no more was heard for many a day about steam on common roads. When Boydell, Burrell of Thetford, Smith of Coven, Aveling of Rochester, and Fowler of Leeds came on the scene, they worked on entirely different lines; but it is worth notice that the opposition they had to encounter arose mainly with the turnpike trusts. Curiously enough, the traction engine in 1862 and for some time subsequently could travel about the country without paying turnpike dues. It is very erroneously assumed that it was the proprietors of horses who have practically penalised the traction engine, but this is not the fact. The horse and his fright have been used as pegs to hang contentions on, but if only the traction engine users had in the first instance made friends with the turnpike authorities, instead of fighting them, much trouble would have been avoided, and the self-propelled road carriage would be an accomplished fact instead of something yet to come.

In locomotive construction little or nothing new has been accomplished during the year. The tendency is to fit all fast running engines with bogies. The bogie is by no means a special favourite with locomotive superintendents. It is very heavy; it adds about £150 to the cost of an engine; it requires a good deal of scheming to combine it with inside cylinders more than 18in. diameter; and it costs something for maintenance. But the civil engineer likes it. There is no question that the bogie spares the permanent way. It relieves cross-stresses, it does not tend to burst curves, and the leading wheels seem to settle down and consolidate the road. The very heavy loads put on driving wheels now and for some years past are borne very well by steel rails; but tracks are not composed of steel rails only, and the civil engineer of a line has to think of sleepers, chairs, and ballast, as well as rails. The quicker a train runs and the heavier the engine the greater the good done by the bogie, and we believe that in the near future all express engines for main lines, with cylinders not less than 18in. in diameter, will have bogies.

As to boiler construction, we hear of little that is new. The boiler is the most costly and troublesome part of a locomotive. It is now, however, what it was thirty years ago, and no one seems to be able to effect an improvement. Various more or less remarkable devices have been tried on the Continent, but the results do not seem to supply a departure from normal practice. Mr. Holden, however, on the Great Eastern Railway, is using Serve tubes with much success. He has now a four-coupled express engine, No. 712, fitted with his apparatus for burning liquid fuel. The boiler, which is fitted with Serve tubes 2¼in. external diameter, has been successfully fired with oil alone, without the necessity of a fire-brick construction in the fire-box, the bars remaining as in a coal-burning engine, but simply covered with a layer of about 6in. of broken fire-bricks. The consumption of fuel in this engine has been 17 lb. of oil per mile. The steam is first raised to a pressure of 20 lb. per square inch with wood. The liquid fuel storage at Stratford has been improved, and the plant now consists of underground reservoirs of 37,000 gallons capacity, from which the oil is pumped by means of a rotary pump into a high-level tank of 4000 gallons capacity, from which the engine tanks are filled by gravitation. The ribs in the Serve tubes act not only as collectors and transmitters of heat but as retarders, owing to increased skin friction. The result is a considerably reduced temperature in the effluent gases.

Concerning the compound locomotive, the evidence is so conflicting that it is quite impossible to arrive at any conclusion except that it is at least as good as the non-compound engine. In the United States it enjoys high favour on some lines, on others it will not be employed at any price. Nor is there any tangible reason available for its success in the one case and its failure in the other. So far as we can arrive at any conclusion, it is that when engines are regularly heavily loaded compounding will effect a saving in fuel of about 9 per cent.; when an engine has light loads to haul compounding is a direct source of loss, the cylinder capacity being much too great. Thus an engine may run for a month on variable traffic, losing one day what has been gained another, and this is, we believe, the main cause of the difference of opinion. We are quite aware, however, that it does not cover the whole ground of discussion in this country or abroad. Some discussion is now taking place on the subject of grates in the United States, and we learn with surprise that in some cases "as much as 200 lb. of coal are burned per square foot of grate per hour." As a matter of fact, however, we do not believe this possible. A draught sufficiently powerful to do this would carry the coal off the bars bodily. Coal may ostensibly be burned at that rate; but we believe a large percentage goes up the chimney unconsumed. It is not remarkable that, under such conditions, an augmentation of grate area is desirable. We have so often dealt with American train speeds, that it would be waste of space to touch on them here. It is noteworthy, however, that the single driver engine is at last coming into favour at the other side of the Atlantic.

Although we have dealt with electricity in another place, we must refer here to the greatest experiment ever made in electric traction. We refer to the 90-ton electric locomotive working in the Baltimore Tunnel. We have given particulars of its performance on several occasions. From a recent report, however, we learn that during a recent test it hauled a train weighing about 1300 tons through the tunnel, the electrical energy transmitted to it being 3000-horse power, which does not speak much for economy.

During the past year there have been a few remarkable boiler explosions, and a number which have done very little harm. The Redcar catastrophe is an example of one type of failure. An explosion very remarkable for its fatal consequences occurred in the United States at Detroit, on the 6th of November. A boiler used for driving printing machines burst. It was one of two horizontal tubular boilers 5ft. in diameter, and 14ft. long, externally fired with oil. The greatest reticence has for some reason been observed. We know little more than that the five-storey building fell down, and that thirty-seven persons were killed. Another terrible explosion occurred at Denver on the 18th of August, when a boiler used for working the elevator and heating the Gumry Hotel gave way, demolishing the building and killing twenty-two, and severely injuring about twenty other individuals. Prudence suggests that in the United States boilers should be put on the top of the buildings instead of in the cellars. On the 18th December a dreadful accident occurred on board the new American line steamer St. Paul. A cast steel elbow in the main steam pipe leading to the starboard engine blew out, allowing steam from the boilers, which were under pressure of 130 lb., to fill the engine-room. This resulted in the killing of five men outright and the scalding of four others so badly that they died in the course of the day, while four others had to be taken to a hospital. The accident took place in New York a short time before the hour of sailing. The explosion took place while the main stop valve, 17in. in diameter, was being opened to admit steam to the jackets. Little damage was done except the smashing of the glass in the skylight and the breaking of the short pipe leading from the throttle valve to the cylinders. The main steam pipe, it is said, is of copper, with a number of expansion joints to render it elastic, and the condensation from pockets in the steam main is removed by means of traps. The steam pipe was only under pressure of 130 lb. at the time of the accident, while 200 lb. is the pressure carried when at sea. From the facts gathered it would seem that water-hammer caused the accident.

During the past year an enormous development of the cold transport and cold storage system has taken place. Probably the British farmer has no greater foe to dread than the refrigerating engineer. We can do no more here than refer in general terms to what is being done in this direction. The Haslam Foundry Company, of Derby, for example, during the past year has fitted up with dry air refrigerating machinery, worked on the compressed air principle, one steamer to carry 2000 tons of meat; four steamers to carry 1000 tons each; two steamers to carry 500 tons each; one steamer to carry 400 tons; and has in progress machines on the dry air system for fitting up three steamers, each to carry 1000 tons of meat; two steamers, each to carry 600 tons of meat, or an equivalent amount of dairy produce. Two of these steamers are for the P. and O. Company, for its new boats China and India, which, we believe, will be among the largest and most improved mail boats in the world. In addition to this the company has supplied a number of machines to the Austrian Government for use on their men-of-war, on the compressed air principle, and also for a number of men-of-war and cruisers for the Russian Government. It appears, therefore, that the dry air system is by no means extinct. The company, however, does not confine itself to air machines. It is fitting the s.s. Southern Cross at the present time with a new patent ammonia compression machine; this boat will carry 2000 tons of meat. With regard to shore machines, which have been erected on the ammonia compression and absorption systems, the company has supplied sixteen large ammonia machines, the most important works being the large stores at the East and West India Docks, to hold 4000 tons of meat; a large store at the North-Eastern Railway Company's Docks, Hull; one large size machine at Meux and Co.'s Brewery, London, equal to 85 tons refrigeration; two large 50-ton machines have been supplied and fixed at the Broxburn Oil Company's Works; and Young's Paraffin Oil Works, in Scotland. But perhaps the most interesting contracts which the company has taken are for the Gladstone Meat Company, Queensland; for the Australian Chilling and Freezing Company, New South Wales; and one for the Melbourne Freezing Company, Victoria. These three plants will be capable of freezing 1000 tons of meat each per month, and are to be fitted with a newly patented corrugated brine battery. A similar plant has also been supplied to the River Plate Fresh Meat Company, London, for its works in South America; and the company will in a short time erect a large chilling plant for the Corporation of the City of London, for chilling 2074 sides of beef per day. This plant will be the first of its kind applied in this country, and we shall probably illustrate it in an early impression.

But even a statement such as this gives a very inadequate idea of what is being done. Thus, 322 ice making and refrigerating machines have been sold by the Linde Company during the year. These 322 machines possess a refrigerating effect equal to that produced by the melting of about 7000 tons of ice every twenty-four hours. The total number of Linde machines sold up to the end of the present year has reached the enormous figure of 2400, the refrigerating capacity being equal to about 60,000 tons of ice melted per twenty-four hours. Of these about 1300 are in use in breweries, the remainder being used for meat freezing and storage, ice making, and a multiplicity of other purposes. The Linde machines are much used on board ship for the carriage of frozen meat, dairy produce, &c. We may specially mention the large meat carrying vessels of Messrs. Turnbull, Martin, and Co., the New Zealand Shipping Company, the British India Steam Navigation Company, and R. M. Hudson, of Sunderland. Another application of the Linde system now receiving considerable attention is in the conversion of existing compressed air machines. These conversions are taking place in Australia and New Zealand, as well as in this country, As an example, we may cite the Mersey Dock and Harbour Board, who are now having a compressed air machine converted to the Linde system. When this is done two tons of coal will chill more beef and in a better manner than can now be chilled with ten tons of coal. This is no mere guesswork. The Dock Board have now three Linde plants in operation, so that the result of working is well known. In Australia a marked advance in meat freezing has been made this year by the successful opening of the new freezing works of the Queensland Meat Export Company, at Townsville and Brisbane. The machinery was supplied by the Linde British Refrigeration Company, which has also orders for similar plants for Rockhampton, Bowen, Geelong, and many other places. There has also been a distinct advance in this country in the application of machinery for ice making; with proper appliances it can be produced at a much less cost than it can be imported. Linde plants are now being erected at Boston, Aberdeen, and Hull. For real ice skating rinks the Linde British Refrigeration Company has brought out a very simple arrangement for freezing the surface. There are neither cells nor pipes, so that the first cost of the plant is much reduced. Several skating rinks are now being laid down on this system. Several other firms, including Messrs. Louis Sterne and Co. on the De la Vergne system, are engaged in the construction of freezing machinery.

Messrs. J. and E. Hall, of Dartford, who are among the pioneers of refrigerators, have fitted during the past year, and have in progress, machines on their patent carbonic anhydride system — one large machine for the Government Gunpowder Works, Waltham Abbey; three installations for the Russian Government Gunpowder Works; second installations for the South Australian Government, Queensland Government, Victorian Government, West Australian Government; a large cold store adjoining Smithfield Market, for the London and India Docks Joint Committee; and also for Messrs. Lovell and Christmas, the Bristol Docks and Harbour Board, and the Bolton Corporation; an oil cooling plant for the Assam Railway and Trading Company; a plant equal to 200 tons of ice per day for Messrs. Mann, Crossman, and Paulin; a plant equal to 200 tons of ice per day for Messrs. Truman, Hanbury, and Buxton. For the National Skating Palace Company, Limited, London, the refrigerating machine and new patent ice flooring have been supplied, and also for the Glasgow Real Ice Skating Palace, Limited, to say nothing of a large number of small installations. Amongst ships fitted we may mention the s.s. Gothic, previously fitted with their carbonic anhydride machinery—she brought the first successful cargo of chilled beef from New Zealand during 1895, the prices realised being equal to that for American chilled beef—H.M. Niger Coast Protectorate steam yacht for preserving provisions, &c.; H.I.H. the Czar's new yacht, the s.s. Standart; the new White Star Liner s.s. Georgic, fitted to carry 3000 quarters of chilled beef; the s.s. Doric for the same company; Messrs. Houlder Brothers and Co.'s s.s. Ovingdean Grange, to carry 2000 tons of frozen meat. The firm are now fitting the s.s. Urmiston Grange, to carry 2000 tons of frozen meat; s.s. Elstree Grange, to carry 2000 tons frozen meat; s.s. Langton Grange, to carry 3000 tons frozen meat; Messrs. J. B. Westray and Co.'s s.s. Duke of Sutherland has been supplied with a machine to replace a cold air machine; T. B. Royden, of Liverpool, s.s. Indraghiri, to carry 2000 tons of frozen meat; the Hamburg American Steamship Company, refrigerating machines for seven new ships about to be built; Chargeurs Reunis Co., three ships now building. It will be seen from these figures that the refrigerating business is rapidly assuming enormous proportions, and it is satisfactory to note that the great bulk of it is placed in English hands.

Within the limits at our disposal it is impossible to notice many developments which mechanical engineering is undergoing, in various directions. But before taking leave of this branch of our subject, we wish to call attention to a somewhat suggestive fact. In the United States there appears to be a large demand for a variety of machines, and appurtenances of machines, and apparatus, about which we hear next to nothing in this country. Inventors not only seem to be prepared to meet every want, but they take measures to create that want. They tell manufacturers, for instance, that they would be much better off if they had such and such a thing, and then they supply the thing. As an example of what we mean, we may say that in a recent issue of *Power*, we find nine advertisements relating to improvements in indicators and their appurtenances; five tops for steam exhaust pipes; ten steam separators; sixteen feed-water heaters; and injectors, water gauges, grates, damper regulators, and such like without end. All these things are different. How is it that in this country the trade done in such matters is apparently very small? We fear that the mechanical engineer in this country does not lay himself out to make a good thing and sell it to nearly as great an extent as his rival in the United States. There are many things that the steam user would take and be glad to have if they were brought properly before him. Stop valves, for example, are, it may be said, insignificant details. How many really first-rate stop valves fit for large powers are there at this moment available at a moderate price? Anyone can make a valve suitable for low pressures. Why should it be so difficult to get hold of a sight-feed lubricator that will stand high-pressure steam? Dozens of things about which next to nothing is known in this country are made and sold by hundreds in the United States. We can do no more than give our readers a hint; possibly some of them may see their way to act upon it. But we cannot help adding that to produce a good thing, and to fancy that purchasers will be found, although no particular care is taken to make it known, is certain to end in disappointment. It is the want of publicity that spoils trade, a fact which our American brethren have fully mastered.

WAR MATERIEL.

In war materiel battleships claim the first place. The class of heavily clad battleships constructed by Sir W. White, and especially exemplified in the Royal Sovereign and Majestic classes, remains the fashionable type, the horizontal armour, barbette mounting, and other features being found, more or less, in the navies of most Powers, including Austria, Brazil, Italy, Japan, Russia, and the United States. France has at last condescended to adopt guns mounted in pairs instead of singly, in her Charlemagne type. This, however, is no new story, most of the ships referred to having been long laid down, although the most powerful vessels are only now coming into commission, or are still under construction. The favourite ship, however, at present, is a swift cruiser carrying an entire armament of quick-fire guns, and trusting mainly to her great powers of attack, although furnished with an armoured deck, shields to her guns, and in many cases with an armoured belt. This class of ship owes its importance in a great measure to the development of quick fire, and as is naturally to be expected, the most notable examples have been turned out at Elswick, such as the Esmeralda, whose power of fire has been recently noticed by us, the Buenos Aires, whose firing trial we recently reported, and the Blanco Encalada. Our own cruisers are, however, of a different type. Their displacement is enormous, in the case of the Terrible and Powerful reaching 14,200 tons. The French have followed a very different line, the displacement of the largest French battleship, the Bouvet, being 12,200 tons, the largest new French cruiser being the Pothuau, of 5345 tons. This is a decrease compared with the Dupuy de Lôme, which was 6297 tons. These are all less even than the Esmeralda, above referred to, which is building for Chili, and is 7300 tons. Russia led the way in large cruisers with the Rurik, which recently visited Portsmouth, of 10,923 tons, and she is now building the Rossia, of 12,130 tons. Here again the line to which we call attention has been followed for some time. It remains true, however, of the present moment. Our cruisers carry large supplies of coals and ammunition, and considerable quantities of armour in the form of horizontal decks and so-called casemated gun positions, which may be described as cells with thick shields in front, and thin walls, completely enclosing those in board—walls which are sufficiently strong to keep out splinters, and probably sufficiently complete to keep out gas from shells bursting near, but, as some naval officers think, increasing the difficulty of maintaining efficient fire control. In the United States ships the gun positions are surrounded by a double wall of thin plating, with many doorways cut through both walls, but not opposite to each other. By this means the fire is more under the immediate control of the commanding officers, and the guns may be protected from splinters, though not from gas, for there are many entrances to the position open at all times. Electric power is now applied to the working of guns on board ship. This has been done at Elswick, and in France by Canet, and is to be seen in the mountings of the 9·2in. guns for the Powerful and Terrible at the arsenal, as well as elsewhere.

France has had brought home to her the evil of allowing different sets of authorities to add to, or modify the designs of ships, the Hoche, and ships of the Magenta, Charles Martel, Requin, and other classes having had their stability so far interfered with as to jeopardise their safety. Happily for them this was discovered in time to prevent any such catastrophe as occurred with our ill-fated Captain. Great waste of money and loss of intended efficiency had to be accepted, and the ships were in a considerable measure cut down, the Brennus going back to dock just when she was expected to take her place in the fleet. The photographs we published in July showing the changes made in the Hoche give a good idea of what is necessary in others, though in a less degree. The after military mast is removed, being replaced by a light mast, parts of the superstructure are cut down and the armament is slightly curtailed.

The main cause of the mistakes has been the wish to accumulate gun positions, and to give them high command above the sea. The French designers and constructors were not to blame, but the system of allowing their designs to be "tinkered" by those whose knowledge of construction was inferior to their zeal to obtain great offensive powers.

It is questioned whether the same action has not been carried out in the United States, and whether some of their ships, with their imposing array of gun positions, might not be found deficient in stability if tested. Certainly we may learn from the difficulty of multiplying guns placed in armoured positions to hail any extension of quick fire to pieces of larger calibre. The Elswick 8in. quick-fire gun is now supplied in cruisers, and may be said to be afloat, and liable to be encountered in action. This is probably the largest gun in which quick-firing can be performed by hand, but this does not prevent the principles of quick-fire, in modified form, being applied to heavier guns. The principle of quick-fire may be said to be carried out to the fullest extent, indeed, only in small arms, where fixed ammunition carrying its own ignition is automatically carried on a band to the breech of the piece, which loads and fires itself at the rate of 600 or even 900 rounds a minute. With increase of calibre the automatic action gives way to semi-automatic, where the ammunition has to be thrown by hand into the breech, the next step is the separation of the brass case from the projectile, a principle which came early into use in England, and at last in spite of long maintained refusal, has been accepted abroad. At a higher stage the brass case has to be discontinued and asbestos packing relied on, but still the rapid opening and closing of the breech by the single movement of the arm may be maintained, and the speed of loading and firing greatly accelerated. The importance of this may be appreciated when we remember that each extra gun involves carriage and armoured protection, with all the complications involved in the crowding of gun positions and increased tonnage. The enormous displacement exhibited by our new cruisers has suggested the question whether it would not be well to make some, at all events, on the lines of those turned out at Elswick. That is to say, to sacrifice the great supply of coal, and other special arrangements, for the sake of obtaining the great fighting powers and high speed that it has been shown possible to secure in a cruiser of comparatively small displacement. Such a cruiser would surely be of the greatest value, though her limited coal supply would prevent her from taking the long voyages that might be accomplished by her larger, much more costly, and less formidable sister. The efficiency of quick-fire depends on the use of smokeless powder, and we may congratulate ourselves that while cordite has given us such trouble in manufacture, the finished article as issued for service has so far proved itself thoroughly stable and safe under the most trying conditions, while it has given excellent ballistic results; in fact, to say that it has established its character as thoroughly, probably more thoroughly than any other smokeless powder, is hardly to do justice to it. On the Continent smokeless powders, chiefly based, like cordite, on the combination of nitro-glycerine and cotton, are used, but in the United States, strange to say, so great is the distrust of such powders that nothing better than a semi-smokeless powder of unsatisfactory behaviour has been allowed to be used on board ship. It seems probable, however, that before long the United States naval authorities will cease to keep their ships at so crushing a disadvantage, and satisfy themselves that the dangerous and treacherous element nitro-glycerine alters its character in the condition in which it exists in cordite. On the other hand, the United States Navy have been forward to adopt high explosive bursting charges for their shells; recent experiments, however, instituted owing to reports from the seat of the Chinese and Japanese war, showed that powder produced greater effect than wet gun-cotton, and it is anticipated that powder will be reverted to in America.

Passing on to armour, we find the United States, far from lagging behind, is here in the very front of the race of progress. England is found refusing to use nickel for thick or medium armour, because she could in an early stage make harder and cheaper plates without it. Other nations saw the value of the great toughness promised by nickel if certain difficulties of working could be mastered, and have been rewarded by making, we fear, better armour than ourselves. It is not easy to compare trials made under different conditions in different countries, though shrewd suspicions may be entertained. Here, however, is a definite fact. In the United States a really good nickel treated plate will defeat a Holtzer 6in. projectile. Till our treated plates do the same we are apparently left behind. Then, while we seldom test really thick treated plates, the United States authorities do so and have achieved most striking success with them, especially with what are called "double forged" plates made by Carnegie. Double forging is the natural remedy for crystallisation and weakness produced in very thick plates by the Harvey process, but double forging is untried in this country.

At length, however, we are glad to hear that our armour-plate manufacturers are alive to what has been done abroad, and are making efforts to push forward. At the Atlas Works—Brown's—nickel steel experimental plates are in course of manufacture, which will be ready for trial in a month. One of them has been forged after cementation by a process which is doubtless very similar to the re-forging carried out in the United States, though taken up some time since—before the American results were known here. Messrs. Vickers are also alive to the desirability of developing nickel-steel armour, so that we may shortly hope to see good results.

While hitherto neglecting nickel in vertical armour, we have happily succeeded in making thin nickel steel plates for decks and structure of ships with peculiar properties, and consider that in them we have a strong element embodied in construction. Passing on to shot, even the excellent Carpenter projectiles of large calibre, made in America, appear now to have been beaten by those known as the Wheeler-Sterling make. We know of no achievements in this country to compare with what these projectiles have done. Hadfield, for example, has made excellent shot, both forged and cast, and we should be glad to hear of achievements rivalling or beating those in America; perhaps if we made and tested on the large scale carried out in the United States we might have such records to show.

With ever increasing velocities we might have expected to have had to record bursts of guns during the year. This has not been the case either in England or on the Continent. The smokeless powders lend themselves to the achievement of very high velocities, combined with a low maximum pressure. In *Brassey's Annual* for 1895 the 8in. Elswick quick-fire guns, 44·6 calibres long, had muzzle velocities of 2260 and 2813, with 210 lb. shot. Canet has a 5·91in. (15 cm.) quick-fire gun, 60 calibres long, with 2822 foot-seconds muzzle velocity, with a projectile weighing 88·19 lb. In a new table just brought out this is increased to 2953 foot-seconds velocity. The Canet gun is a specially long coast piece. A 12 cm. (4·12in.) gun carried to the extreme length of 80 calibres is seen also with a velocity of 3281 foot-seconds. With any given powder and length of bore, English and Russian guns ought to take the lead in energy if desirable, seeing that in these countries only have wire guns come in. The highest velocity in a regular service British quick-fire piece is 2456, achieved by the 4in. wire gun. This is a piece of only 40 calibres long.

It can hardly be said that the year has shown good results for the very small bore rifles adopted by almost all military Powers. The bullet has a smaller diameter than a common cedar pencil—in the British service 0·303in. Its trajectory is very flat, and its velocity was said to be so high that bone splintered into shreds. Some trials on carcases showed that singularly little harm was done in perforating flesh, but it was explained that in living bodies the inelastic moisture present was violently thrown outwards, and enormous holes made. This was illustrated in lecture experiments with moist clay and the like. This was too readily accepted, suspicion should have been aroused by the fact that wild animals grazing did not always find out when they were hit; and still more direct evidence was afforded us when a collier, shot through the thigh in a riot, walked about for an hour or two fancying that he felt something, but not troubling much about it. Now evidence has poured in from opposite quarters of the world to the effect that the small bore is singularly deficient in stopping power. It might be said, indeed, to have the opposite effect, for a retreating Chinee is thought to have had his pace rather accelerated as a rule when struck by a Japanese small bore bullet. Medical reports from England, the Continent, and America, show that the wounds made both through flesh and bone give generally remarkably little trouble, and heal with great rapidity. Our troops recently sent to Ashanti have been armed with the old Martini carbine of 0·45in. bore, nor can we wonder. Savages who have not had the advantage of hearing the lecturer prove the effect of the bullets to be so terrible, would, we fear, take little or no notice of bullet wounds made by the 0·303in. bore, unless they struck in a really vital place, such as the brain or heart, and these organs are perhaps not specially large in savages. Seriously, something will have to be done about the small bore bullet; perhaps the partial removal of nickel covering may cause setting up of the bullet to a reasonable size on impact. If this is contrary to the Geneva Convention, might it not be laid down that a civilised soldier must retire from action after a certain number of hits, say, two or three? For it appears that even this number have not always caused serious inconvenience at the time.

HARBOURS AND WATERWAYS.

The chief feature of the past year in connection with accommodation for the shipping trade has been the numerous works that are now in contemplation or in progress for the purpose of adapting tidal rivers, harbours, and docks to the continually increasing size and draught of vessels; and the attempt that is being made, and to a great extent successfully made, by our continental rivals to attract to their ports commerce of which hitherto we have had almost a monopoly.

In providing for the demands of modern steam vessels, Southampton, under the energetic management of the South-Western Railway, has taken the lead, and has already stolen from Liverpool a large slice of the American traffic. The graving dock which was opened during the year is claimed to be the largest in the world. The other works for giving quicker facilities to the navigation are making rapid progress, and already the large increase in the trade which is taking place at this port justifies the inception of these works.

Liverpool also has not been standing still, considerable progress having been made with the new lock and other works for making provision for deep-draught vessels. A new passenger station at the Prince's Landing Stage has been opened and the river dredged, so as to allow the large steamers to land their passengers at the stage without the use of a tender. The dredging operations on the bar have been continued, and this no longer affords an obstacle to the navigation, there being now 24ft. at low water, of spring tides over a width of 1400ft.

Considerable activity in works of improvement has also been going on at the coal ports in Wales. Not only is the Bute Dock Company providing for deeper draught vessels and more shipping accommodation, but a new company is applying to Parliament for powers to construct a deep-water dock. A new dry dock of large dimensions is also in course of construction. Further works are also contemplated at Swansea; and at Port Talbot the works for making the new deep-water dock and approaches, for which Parliamentary powers were obtained last session, have been commenced. This dock, which it is expected will be completed in two years, will afford an outlet for a large coalfield which is to be opened out. Llanelly also has a Bill coming on next session, giving power to construct a new cut and dock entrance, and otherwise improving the access to the port; and the Great Western Railway Company is contemplating improving the entrance to its dock.

At Hull the North-Eastern Railway Co. has already commenced making improvements in the docks of which it became owner last year; and other works of considerable magnitude are in contemplation. At Grimsby it has been announced by the Manchester, Sheffield, and Lincolnshire Railway Company that the dock accommodation is to be considerably enlarged; but the alteration will be principally for the benefit of the fishing trade. At Boston, where it is expected there will be a considerable increase of traffic when the East and West Coast Railway is opened to Lincoln, the river is to be deepened throughout, so as to give 27ft. at high water of spring tides. At Leith the construction of the new sea wall and the works for the new dock have been proceeded with, the difficulties which arose owing to the death of the first contractor having been overcome. The new Cessnock dock on the Clyde, although not finally completed, has been partially made use of. Preston also is seeking further power to improve the working accommodation at the dock and the approach from the sea. The Bridgwater Trustees have given instructions for a report to be made as to the best means of improving the navigation of the river Parrett, in which a considerable coasting trade is carried on, but which, like all other ports, is calling out for deeper water. The Bristol Corporation have made very little advance during the past year in the various schemes which have been proposed for providing for deep draught ships. The whole matter, including the dockising of the Avon, has been referred to Mr. Wolfe Barry, but his report has not yet been presented.

The Lower Thames has long been the subject of complaint, owing to the alleged insufficiency of depth of the navigable channel to the various docks on the river. In consequence, an important inquiry as to the condition of the Lower Thames for navigable purposes has been held during the past year by a Commission appointed by the Board of Trade under the powers of the Conservancy Act of the previous session. The shipowners had made allegations as to the shoaling of the channel and the necessity for dredging, and expressed a strong opinion that the depths and widths which the Thames Conservancy had adopted as a standard for their dredging operations were not sufficient. After holding several days' inquiry, the result arrived at was that the evidence as to the condition of the river was so conflicting, and the charts in evidence so untrustworthy, that it would be impossible for any satisfactory report to be made until the river has been surveyed. This was accordingly done during the summer, partly by the staff of the Admiralty, and partly by that of the Conservancy. The result of this survey shows that the increasing difficulties of navigation arise more from the increase in the draught of the steamers navigating the river than from any shoaling of the channels. In fact, the survey shows that the navigable channels of the Thames are quite 2ft. deeper than they were supposed to be, and that since the date of the last chart there has been a material improvement going on in the condition of the river. It does not seem to be a very creditable condition of affairs that in an important navigable waterway like the Thames the only existing official information that the Commissioners could obtain to assist them as to the navigable depths was from soundings obtained by a partial survey made in 1883 and published on the Admiralty Chart. The report of the Commissioners has not yet been made known.

With regard to the floods in the Upper Thames, a report has been issued by a Committee of the Conservancy which was appointed to investigate the charges made at numerous meetings held in the early part of the year throughout the district, to the effect that if the Conservators had exercised more activity in their control of the river, the effects of the great floods of November, 1894, might have been very considerably mitigated. In this report the Committee contend that they have no powers enabling them to carry out works for controlling or dealing with floods, and no funds to devote to any such purpose, their business being solely to maintain the navigation. They point out, however, that the works which have been carried out for the improvement of the navigation have materially aided in improving the discharging capacity of the waterways. The old and inefficient weirs have been replaced by those of more modern construction, provided with gates drawn up by suitable gearing, and having waterways considerably larger than the old weirs, the flood-discharging capacity of the new weirs being equivalent to a rainfall of 0·12in. in twenty-four hours in the upper part of the river, equal to 4500 millions of gallons at Teddington, or ten times the summer flow. More than £50,000 has been spent on dredging and deepening the channel during the last twenty years. The Committee further point out that houses and other buildings have been erected within the limits of what has always been the natural flood level of the river.

Floods, such as those of November, 1894, are very exceptional, and to provide relief from these would require works of great magnitude, the cost of which would be very severely felt in the district; while any systematic attempt at enlargement of the sectional area of the river, and the lowering the level of the water, would have to be approached with care, as such a proceeding might seriously affect the agricultural land adjacent to the river, by draining away much of the subsoil water. There are, however, works which could be carried out at a moderate cost, which would tend to mitigate the inconvenience caused by the frequent floods which now occur. As funds to carry out these can only be provided by rating the land and property, it is suggested that the local authorities and landowners, if they want relief, should apply to Parliament to constitute some representative authority, with power to levy rates and carry out works.

One notable event of the year has been the completion of the piers at the mouth of the Tyne, which have been in course of construction for the last forty years. No public ceremony has been inaugurated to celebrate this important and almost national work.

Although the traffic on the Manchester Ship Canal is a long way from reaching the amount on which the original estimates were based, yet it steadily continues to increase. The sea-going tonnage for ten months of this year amounts to 891,134; the first six months averaging 80,125 tons a month, and the last four 102,566 tons a month. Regular services have been established with Calcutta, Madras, and Colombo. Steamers have also come from China and Australia, and several cargoes of this season's cotton from America, and the quantity imported direct from Egypt shows that already a firm trade with this country has been established. Timber imports have increased, which shows that the building trades round Manchester are now largely supplied by vessels coming up the canal. The dried fruit trade from the Mediterranean, and Seville oranges used in the marmalade factories in Manchester, are now imported direct by means of the Canal. The receipts have reached a sufficient sum to cover the working expenses and cost of maintenance. Several outstanding difficulties have been settled during the past year, including the long-pending dispute with Warrington; and a decision was given in the law courts in favour of the company as to its liabilities with reference to the Upper Mersey. The London and North-Western, and Lancashire and Yorkshire Railway companies have been completing the works necessary to put those railways in direct communication with the canal, so that goods may be placed direct on the two systems at the docks.

In inland waterways there is very little progress to report. The decrease in the tolls, leading to a diminution of income, brought about by the Board of Trade at the instigation of the traders, appears to have checked the outlay of money in those canals in which the greatest disposition to move with the times has been shown. The Leeds and Liverpool Company is spending a considerable amount in making its waterway better for navigation, but the rate of improvement has been checked in order to await the issue of the large reduction which is expected in its income from the decreased rates at which it has now to carry goods. So also the Aire and Calder, although it obtained powers this session to make some improvements in the system at Leeds, appears to be waiting the course of events before proceeding with the canal, for which powers were obtained two or three years ago, for connecting the system with that of the

Sheffield and South Yorkshire. This latter company, which after a gallant struggle succeeded in wresting the canal out of the hands of the Manchester, Sheffield, and Lincolnshire Railway Company, has succeeded in raising sufficient money to pay the railway company the amount finally settled on for the purchase of the undertaking. The railway company, however, appears to have got the best of the bargain, for not only has it obtained a large sum in cash, but also such a controlling influence on the directorate as to paralyse any attempt at improving the canal so as to make it an independent competing means of transport. At any rate, although six years have elapsed since the Act was obtained incorporating the new company, no works of any importance have yet been carried out.

The river Ouse, which connects Lynn with Bedford, has for a very long period been used as a canal from above Earith, but the locks and other works had been allowed to go to ruin. The navigation was purchased some time ago by Mr. Simpson, who at once commenced to put the works in repair and dredge the channel, and during the past year this has been completed, and steam barges are now able to trade between Lynn Dock and Huntingdon, St. Neots, and Bedford—a distance of 73 miles. The scheme for connecting this waterway by a short cut with the Grand Junction Canal has not been again revived.

One important step in the revival of inland water communication has been accomplished by the Act passed this session for forming a public trust for taking over the Thames and Severn Canal, which extends from the Thames at Lechlade to the Stroudwater Navigation, and thence to the Severn below Gloucester. The Trust consists of representatives of the navigations amalgamated, of the Gloucester and Sharpness Dock Company, Birmingham Canal Navigations, Wilts and Berks Canal, and the County Councils of Gloucester, Wilts, and Berks. A portion of this canal had practically become derelict, and the owners proposed to close it. The new Trust are taking steps to have the canal put in working order, and there is a prospect of this leading to further developments in the same direction.

The proposed purchase of the three short canals which connect the Grand Junction with Birmingham, and for which Parliamentary powers were to be obtained. has fallen through for the present.

The improvements which have recently been carried out in the Belgian and German ports point to the conclusion that the commercial rivalry between Great Britain and those countries is becoming more and more intense. Already there has been a rapid development of the German mercantile marine. The improvements of the harbour at Hamburg, which have been effected at a cost of £400,000, allow vessels of the first-class now to enter that port, the twin-screw steamer Palatia, drawing 26ft., having navigated the Elbe just recently. Cuxhaven is having extensive works carried out, with the object of making it a port of call for Transatlantic boats. The Weser has been trained and deepened between Bremen and Bremerhaven, so as to allow vessels drawing 16½ft. to reach the former place, and a deep and spacious harbour made at the latter. Already the tonnage of sea-going vessels entering the port has increased from 94,000 to 641,000 tons. The river traffic has also increased in greater proportion. The new basin at Bremerhaven is being enlarged to receive vessels drawing 32ft., and this work is expected to occupy the greater part of next year. As regards the Baltic ports, Lubeck is to be connected with the Elbe by the Elbe-Trave Canal; the fairway between Stettin and Swinemunde is to be dredged out so as to give a depth of 22½ft.; the navigable channel between Konigsberg and Pillau is also undergoing improvement. Russia is constructing a new harbour at the mouth of the Neva. The completion of the Dortmund-Ems Canal will open a market in the Baltic for the Westphalian coalfields, which may seriously affect the export of that mineral from this country.

The most notable event of the year, however, was the opening of the North Sea and Baltic Canal, or, as it has been officially named, the "Kaiser Wilhelm Canal," and, although there has been considerable traffic through the canal, it has not come up to the expectations of the authorities, especially the foreign trade, three-fourths of the vessels using the canal being engaged in trading to and from Hamburg.

The scheme for training a channel through the estuary of the Seine, and for deepening the approaches and improving the accommodation at Havre, and also for making a deeper lock, after having been before the French Legislature for some years, finally passed both Houses, and the funds necessary for carrying out the works voted in the early part of this year. An account of the proposed works will be found in THE ENGINEER of July 26th.

Belgium has also during the year made an important advance in the improvement of her internal navigation by voting the necessary credits for opening a ship canal to Brussels by way of the Scheldt and the Rupel, and the enlargement of Willebroeck Canal; and also in her sea communication by making a commencement with the proposed new port at Heyst, which is to be connected with Bruges by a ship canal. The reduction of the port charges at Antwerp will further tend to attract trade there.

The improvement of the communication between this country and the Continent has made progress during the year. On this side the new pier in Dover Harbour has made considerable advance, and preparations are being made for commencing the construction of the mail packet water station which will involve the reclamation of about six acres from the harbour at the eastern corner of the Admiralty Pier. On the other side the widening of Calais Harbour has been nearly finished, the new pier on the east side having been completed to above high water; but the process of removing the old pier and deepening the extra width proceeds but slowly. It has also been decided to carry out further improvements at Ostend.

In Holland, a new deep-water lock has been constructed at the entrance of the Amsterdam Ship Canal at Ymuideu.

The proposal for forming the Canal des deux Mers between the Bay of Biscay and the Mediterranean has, during the last year, been again revived, and its claim prominently pushed forward by those having a local interest in it, and it has also been frequently favourably noticed by those who have not carefully considered its possibilities; but by responsible French officials and others who have paid much attention to the subject, the canal is considered as outside the range of practical possibilities. An account of the scheme will be found in THE ENGINEER of November 9th, 1894.

Another French canal scheme which has been revived during the year is that for connecting Marseilles with the Rhone, which is estimated to cost 3¼ millions, but it has not yet assumed any practical shape.

The immense traffic which passes along the Great Lakes of America has been afforded further facilities during the past year by the completion of the new lock and canal on the Canadian side of the Sault St. Marie Falls, and which it is expected will play an important part in attracting traffic through the Canadian Territory, and down the St. Lawrence. The new lock, by which the 18ft. fall of the Sault St. Marie is overcome, is capable of taking the largest vessels which navigate the lakes, being 900ft. long and 60ft. wide, with a depth of 20ft. on the sills. A canal has been cut across the island, about three-quarters of a mile in length. Beyond its large size as a canal lock, the distinguishing feature about it is the adaptation of electricity for the purpose of working the machines for opening and closing the gates. Power is acquired from two 45in. turbines, giving off 310-horse power. One of these is used for running the generators and the other the arc light dynamos which light the lock and its approaches.

A further development of electricity has been made on the Erie Canal, where an experiment has been made of hauling the canal boats by means of an attachment to overhead conductors, on the trolley system.

All hopes of completing the Panama Canal are not yet abandoned. A large staff of men are engaged on the works in keeping up the machinery and in carrying out experimental and preliminary works previous to active measures being taken to complete the canal if the necessary capital can be raised. Sir H. Tyler, who visited the country a few months ago, expressed the opinion that the completion of the canal is feasible, and by no means a hopeless project, either from an engineering or financial point of view. Mr. Colquhoun, who also has visited the canal, does not share in this sanguine view of the matter. According to Sir H. Tyler's account, all that is required is six years of time and £20,000,000 of money. He states that he found nineteen miles of the canal already completed, and that where the bed of the canal has been excavated it has only filled up to the extent of about 3½ft. since the works were stopped four years ago. The banks have not suffered materially, in consequence of the rapid growth of vegetation. The machinery is being carefully preserved, and there is sufficient of it on the ground to finish the canal. The number of men at work at the time of his visit was 1500, and about half as many more were expected shortly to arrive, and he was informed that it was intended to increase the number to 6000. The report of the engineer of the new company recently issued states that the surveys now being carried on demonstrate the feasibility of the construction of a dam for the purpose of forming a lake 200ft. above the level of the sea sufficient to supply the canal with water at all seasons of the year. The highest level of the canal has now been fixed at 131ft. above the level of the sea, and this is to be reached by five locks with a rise of about 33ft. each. It is proposed at first to cut the canal only 50ft. wide, and then let in the water from the lake, which will permit of dredgers being used to compete the excavation. All this, however, will depend upon the subscription of the necessary capital.

With regard to the Nicaragua Canal, very little has been done to forward matters during the past year. The commission appointed by the United States Government to report as to the feasibility of the canal and its cost, has recently reported that to complete the canal will require a sum of nearly 27 millions of pounds, or about double the company's estimate. They further express the opinion that to proceed on the information at present available would be impracticable, and that before any trustworthy opinion can be formed further surveys are necessary, which will require eighteen months of time and cost £70,000. In the meantime the works which have been already carried out are deteriorating, especially the dredged channel in Greytown Harbour, which is shoaling by sand drifts.

Ths Corinth Canal does not appear to be growing in favour, the traffic increasing very slowly. Several land-slips have occurred, by which traffic has been hindered. It is reported that the sides of the cutting in places are slowly disintegrating and crumbling away. The receipts barely cover the working expenses.

ELECTRICAL ENGINEERING.

ON looking back over the past year and comparing it with the year 1894, we are able to note a decided improvement in business, and the prospects for the present year are certainly brighter than those at the beginning of last year. The greatest development of the application of electric energy in Great Britain is, without doubt, in the business of supply of current for the purpose of electric lighting. Looking broadly at the subject, it must strike the observer that the growth in the supply of the electric current resembles very closely the growth of the great gas industry. Gas is now supplied from very large producing centres, usually outside the towns, or at least away from the neighbourhoods occupied by the wealthier classes, and at some distance from valuable commercial property. These great centres have gradually taken the place of the earlier and smaller producing centres. At present there is only one great producing centre for the supply of electricity which fulfils the required conditions of easy access for fuel, space for increase of size, and distance from valuable property, and that is the Deptford station. The bulk of the other stations, especially those supplying the metropolis, are situated in close proximity to valuable property, and are continually harassed by injunctions or by the fear of injunctions. The present system is at best but a temporary arrangement which must be done away with. Signs are not wanting of the approach of change, as current is even now being supplied to certain stations from others more favourably situated for the work. Machinery is even now standing idle while current is supplied from a distance.

Perhaps the most gratifying sign of the times is the solid basis upon which the supply of current is now placed. It is seen to be a financial success, and municipalities on all sides are taking up the work of public supply, and find that they can earn good profits and supply electricity at a very reasonable rate. The growth of demand is in new cases very rapid, and the increase of the capacity of the generating plant has become one of the most important branches for the builder of electric light machinery to follow.

There is, of course, no one rule which will apply to the design of all stations, and it is interesting to note the various forms which are taken by supply centres for different areas. Edinburgh, for instance, is using both the alternating and direct current for different districts, and the demand for light has far exceeded expectations. Glasgow is now well lighted; Halifax is using the high-pressure alternating system, with transformers in sub-stations; Nottingham and Dewsbury the low tension direct three-wire system, with accumulators; Great Yarmouth and Stafford have also municipal stations, all opened in the past year. In some cases the gas-producing station adjoins the new electric light station. Of this the town of Blackburn is an example; while at Leicester the new station was actually designed and laid down by the borough gas engineer, who has produced one of the finest stations in the country, having admittedly followed the practice of some of the continental engineers in erecting a fine building as well as installing good plant.

Wolverhampton has chosen the high-tension direct system of supply, and forms the fourth example in this country, the others being the Chelsea, the Crystal Palace, and Oxford Electricity Supply Companies. Wolverhampton, however, has made a step in advance, and uses a potential of 2000 volts instead of only 1000 volts, as is the case at Oxford. Portsmouth has almost created a record, for the station paid well even during the first six months, and is stated to be producing electricity at 2·3d. per unit, cost price; it is, as our readers will be aware, fitted with slow-speed alternators and rectifiers. With respect to the type of motors in use for driving the dynamos, the internal combustion engine is decidedly coming into greater favour. and the size of gas engines is steadily increasing. At Belfast tandem gas engines alone are in use, and appear to be very economical; and doubtless where both gas and electric supplies are in the hands of municipal authorities, this method of driving will come into still greater use. As the size of the units increases—for it must do so—we shall see whether the gas engine using either illuminating or producer gas will be able to increase in size, and to give results equal to those obtained by the use of steam.

The time has now arrived in many places when the capacities of the stations for supply are by no means equal to the present demands or to that which will be made in the near future, and engineers are looking for some means of increasing the capacity without great expense. In Bradford the question has been solved by the use of lamps of 230 volts, so doubling at one stroke the capacity of the mains. Difficulty was at first found in obtaining such lamps; but a satisfactory type has now been produced, and it seems very probable that this year we shall see a greatly increased use of distribution at 400 volts on the three-wire system. One of the difficulties at present in the way, however, is the jerry system of wiring often adopted and the low class fittings often used; these may be passable and not absolutely dangerous with 100 volts, while they might be distinctly unsatisfactory, and even the cause of fires, if double that potential were employed. More stringent rules will have to be followed if the proposed changes are carried out on a large scale. The lamps have been proved to have a life of 3000 hours in some cases, and although the average life would doubtless be considerably below this figure, it is a clear proof that manufacturers are well able to supply lamps of good quality. Such a change will doubtless lead to the use of special supply mains for arc lighting. The destruction of dust as an auxiliary means of supplying steam is also coming to the front. St. Pancras has installed a number of cells; but, perhaps, Shoreditch is the best example of the grouping of municipal works close together. Here the electric lighting station, with its dust destructors, is upon a site adjoining that reserved for the public baths and wash-houses and also the public library. The electric station will supply the whole of the steam, hot water and light required in the other two establishments, thus obviating altogether the necessity for boiler power in the baths establishment. Possibly in the near future we may find a case in this country where street electric tramways are owned by public bodies, and actuated from the large joint power and light station. It has become essential to success to use every means of promoting economy in production, and for this purpose superheating is coming into favour, and there are now in use several different methods of dealing with the steam. The large quantities of water required also cause great expense when the supply is bought from a water company, and this is leading to the sinking of numerous wells in generating stations, and an important saving in cost.

The electric light has, of course, very powerful rivals in the Welsbach and other forms of incandescent gas lights; and as the price of the fittings for the latter is diminishing, it becomes more than ever important to effect a saving in the cost of generating electricity wherever possible. A reserve of energy is essential to economy in working, and thermal storage is being put into use as a rival to the better known system of electrical storage, and may in some cases effect the desired result in a more economical manner. It is probable that in certain cases the use of producer gas, and the sale of the bye-products, would still further reduce the cost of the unit, and in this particular line it appears that the continental engineers are somewhat in advance of us.

The increase of the day load factor is still the great aim of all central station engineers, and the advantages of electric cooking and heating are being assiduously pressed upon the attention of the public. Already one theatre is heated by electrical radiators, and the use of electric cooking apparatus is steadily advancing. The public—and, indeed, many engineers—seem still somewhat incredulous as to the pecuniary advantages claimed for the system by its advocates; but its superior cleanliness and obvious absence from products of combustion will, we are sure, obtain for it a very extended use wherever public supply is at hand and cost a secondary consideration. One of the chief proofs that we have not yet found a perfect system of constructing the underground network of supply is the numerous street explosions which still take place. Doubtless these are for the most part due to the leakage of illuminating gas into the electric conduits; but the matter has occupied the attention of the Board of Trade on many occasions, and no very satisfactory means of coping with the evil has yet been discovered. Lately one or two serious fires have occurred at electric light stations, and one at least emphasises the disadvantage of using wood for important switchboards. The British practice on this point we consider is far ahead of the usual practice in the United States.

Passing now to the question of electric traction, we find that in London we are likely soon to be provided with several new underground railways of a type similar to the City and South London Railway. One of the most noteworthy points abroad is the fact that the Chicago elevated railroad, which many of our readers travelled upon during the Exhibition year, has entirely abandoned the use of steam, and has installed an electric plant instead; this result is due to the obvious economy obtained in the working of the Intramural Railway in the Exhibition grounds. Electric locomotives appear to be growing in favour; the first, constructed by the Heilmann Company, was not entirely satisfactory, and was considered by its makers as quite experimental, but two new ones will be in use this year on the Western of France Railway, and should give results of interest to all railway engineers. Experiments in the same direction are being made elsewhere in France, and also in Belgium, while in the United States an electric locomotive is now hauling both freight and passenger trains through a tunnel on the Baltimore and Ohio Railroad. No exact tests have yet been published relating to any of these novel engines, but doubtless in the course of the present year they will become available.

The state of agriculture in this country has called for careful consideration on the part of the Government, and among other things feeder lines of railway have been suggested. In this connection it is of interest to note the fact that electric traction is being used on the Nantasket Beach branch of the Old Colony Railroad Company, Mass., U.S.A., and we believe that in many cases light railways worked by electricity will find favour for agricultural districts ere long. Looking at the systems of street electric railways now in use, it appears that the overhead wire is the only one which has yet been found to pay. Reports from Birmingham state that the accumulator system is a dead failure financially, and is a millstone about the neck of the company. On the other hand, the St. Denis-Madeleine line in Paris appears to be satisfied with its battery system. In the latter case, however, it is very improbable that permission would be accorded for the use of an overhead wire.

Both Dublin and Bristol are using the aërial conductor, and the splendid series of illustrations of foreign practice, which have recently appeared, prove to persons who have had no opportunity of personal inspection that the overhead wire can be made an ornament, and not an eyesore, even in streets of good architecture. The prejudice against such wires will, perhaps, gradually disappear in this country, and the railways in South Staffordshire, the Isle of Man, Leeds, and elsewhere, prove that the system is well adapted to the requirements of the public. The well-arranged system in many German cities must certainly lead us to think that we are very much behind on this point. An electro-magnetic system used in Washington, D.C., has recently been acquired by the Westinghouse Company, and some such system may possibly meet the requirements of crowded thoroughfares in large cities, where the overhead wire cannot be used.

In dynamo construction improvements have been made in the method of winding direct current armatures, which have been highly spoken of by some of the chief dynamo builders, and are known as the regenerative type; hinged pole pieces have also been introduced. At Puteaux, near Paris, a large installation has been put down of fly-wheel alternators driven direct by slow-speed engines, and the details of the construction are much improved; while at Deptford a 1000-kilowatt machine has just been erected which has probably the largest output of any machine yet built. The Niagara power plant is approaching completion, and a somewhat heated controversy has been raised as to the authorship of the design, which is probably due to no one single individual.

As yet no very satisfactory motors for single-phase alternating currents which will start with the load on are available, and the best type appears to be procurable only on the Continent. At present there are motors used for driving ventilating fans supplied with current from the alternating circuits in London; but experience has shown that a motor nominally of about double the power of the work required must be put down if satisfactory results are to be obtained. The demand for high-speed engines for direct driving still increases, and has caused the production of one new type during the past year which bids fair to give very good results, as experience with an older type has been available as the groundwork of the new design.

Inventors still appear to consider that there is a field for the application of primary batteries for the production of light and power; the past year has seen a renewed attempt to use zinc in such a battery, and employ it for launch work. We fear that although zinc has been proved over and over again to be too expensive a fuel, that money will still be spent on the attempt to use it as a rival for coal; while abroad a new type of battery to produce electricity direct from combustion has met with only qualified success.

Water power plants are not very common in Great Britain, but a project has during the past year been brought forward to use a celebrated fall in Scotland for the production of power to be used in the manufacture of aluminium. The present year will probably see the question decided as to whether the falls are to be reserved as a natural piece of scenery or turned to commercial uses. In Germany the city of Munich has made use of part of the great water power of the river Isar, and will probably do so to a still larger extent in the near future. The great Niagara scheme can hardly be said to be a feature of last year's work, although, of course, its completion has been advanced.

Electro-metallurgy has made considerable progress. Perhaps one of the most important discoveries was that of the production of carbide of calcium while the attempt was being made unsuccessfully to produce metallic calcium, and this has resulted in the production of acetylene at a price far below that previously possible. The present year will doubtless see this gas used as a competitor in public favour with the electric light, or employed as a means of enriching coal gas for illuminating purposes. At present it seems, however, that a natural water power is almost essential for the economical working of the process of production.

Ozone produced electrically is rapidly coming into practical use as a very powerful bleaching agent, and work in Germany appears to prove that it will shortly become a commercial success.

The process of electro-zincing seems to be finding favour in place of galvanising, especially for the tubes of boilers for marine work, and the adhesion of the zinc to the surface of the iron appears far superior to that obtained by the older process. Cyanide of potassium and potassium zincate are also the principal factors in recent electrical processes. Electric welding on the Thomson-Houston process does not appear to increase so much in public favour in this country as in the United States, but a new process has lately been invented in Germany by which the electric arc is treated as a blow-pipe flame, by means of an electro-magnet, which is likely to give very good results, both for welding and soldering of many metals. The advantage of the latter process is that the portions treated are not damaged by operations in an open fire, as is, of course, the case in ordinary welding operations.

Road vehicles propelled by power will doubtless become very common in a few years; but whether it will be found possible to apply electric energy to this purpose economically is as yet somewhat uncertain. In the Paris-Bordeaux race for horseless carriages, an electric vehicle took part and performed the journey safely; but it is very doubtful whether the use of accumulators will be found satisfactory, and they will have a powerful competitor in the gasoline motor, which now appears to hold the first place in this particular branch of engineering.

Electricity has been recently applied in France to an improved form of submarine boat, designed for the purpose of discharging torpedoes; and in the United States, as well as in Great Britain, ingenious applications of the electric motor have been made to the rudders of small boats. The latter type of apparatus being easily detachable, seems to have a future before it for light pleasure boats.

In maritime affairs the application of electrical communication between lightships and shore has already made some progress; but a perfectly satisfactory solution of the problem still remains to be found. The North Sea Canal, opened last year, is now lighted along its banks by electricity; and the use of the light has become quite general for the passage of the Suez Canal.

A new type of instrument for the purpose of transmitting photographs to a distance and there reproducing them by line engraving suitable for printing has been brought out by an American, and the published results appear to show that the process is very satisfactory. Organs are now being fitted with electric apparatus of improved type, and a process of marking paper and fabrics by means of the electric current has been invented and put into use. Experiments on high frequency currents have been carried on by Tesla, Toepler, and others, and the electric discharge has been made a special study by Lord Armstrong.

Train lighting by electricity does not appear to make much progress; in fact, it has been discarded after fair trial by several of the large railway companies. It is therefore somewhat surprising to see the London, Tilbury, and Southend Railway taking the matter up anew, and we shall look for the results in the present year.

Electricity appears to be slowly taking up a proper place in medical treatment, but quackery is as yet by no means extinct, and the subject still requires more accurate experiment before its precise value as a curative agency can be known.

SANITARY ENGINEERING.

A remarkable report on the main drainage of the metropolis was very recently laid before the County Council by the Committee having the oversight of that work. The Committee began by saying they had to call "the serious attention" of the Council to the present state of the main drainage of London on the north side of the Thames, and to the necessity for works of a somewhat extensive character with a view to rendering the system more complete and effective for the purposes which it is required to fulfil. The chief engineer to the Council, Mr. A. R. Binnie, pointed out to the Committee that the population of London had increased by about a million since the main drainage system was designed, and that the drainage of certain outlying places had been taken in. From the figures which related to the subject, the chief engineer argued that the whole main drainage system was gradually becoming insufficient for its work. Since March, 1889, about twenty-three miles of new brick sewers had been constructed, as well as ninety-four miles of pipe sewers, and during the same period there had been an increase of 30,000 houses in London. The chief engineer, reviewing all the facts of the case, declared himself more strongly impressed than ever as to the necessity of proceeding with certain works. If this were not done, he feared that "the main drainage system would fall into disrepute." The Committee having carefully considered the subject, felt compelled to recommend to the Council that works of an extensive character should be undertaken to improve the main drainage on the north side of the Thames. The total expenditure involved was £745,000, to be spread over a period of four years. Notwithstanding the earnest representations of the engineer and the Committee, an amendment was moved by Mr. McDougall, that the general enlargement of the main drainage system was "not now necessary, but that local floodings need immediate attention." Mr. McDougall stated that the Council had already expended £165,000 on improving the main drainage north of the Thames, and "he did not believe further heavy expenditure was necessary." Adding this £165,000 to the £745,000 for the works recommended by the Committee, we get a total of £910,000. But in February, 1891, a joint report, presented by Sir Benjamin Baker and Mr. Binnie, proposed an outlay of £920,000 for drainage works north of the Thames. Of this amount, it would appear that £55,000 had been applied in the manner then proposed. Despite the strong arguments of the Committee, backed by professional opinion, Mr. McDougall's amendment was carried by a large majority. The decision is one to be wondered at, and has the appearance of postponing the evil day. Sir Arthur Arnold has stated that if the main drainage system of London is to be made efficient, an expenditure of £2,250,000 must be at once incurred.

A very valuable series of experiments on the purification of sewage has been carried out by Mr. Dibdin, the chemist to the London County Council. These experiments have already been described in our columns, and have the great practical result of showing that "the necessity for costly farms" in order to purify the sewage of towns no longer exists. The area for the treatment of the whole of the metropolitan sewage is reduced to 180 acres, or even as little as 120. The plan is one of scientific filtration, based on biological principles. The mode in which Mr. Dibdin deals with the sewage at the metropolitan outfalls has had a marked effect in improving the condition of the river. Of course the filtration process is preceded by the abstraction of the sludge, of which 2,000,000 tons are carried away annually to the German Ocean.

WATER SUPPLY.

BOTH with respect to the incidents of the past year, and the prospect of that on which we are now entering, the chief interest of the water supply question has its centre in the metropolis. To provide an adequate supply for a present population of five millions and a-half, apparently destined to increase to rather more than double that number in forty years, is a problem of vast importance. In 1894 the daily supply furnished by the eight metropolitan water companies exceeded an average of 189 million gallons, and latterly the quantity has been more than 200 million gallons. According to such data, a daily supply exceeding 400 million gallons will have to be provided by the year 1936, a date which cannot be considered so very remote. From time to time during this range of years, from whatever source the supply is taken, proportionate additions must be made to the daily volume, and works will have to be commenced in anticipation of the coming want. Of the danger of any delay in this respect a striking example was afforded during the past summer. In 1893 the East London Company brought in a Bill asking for power to raise £500,000 to be expended in the enlargement of their waterworks. The London County Council, by their representatives, urged that there was no need for any such enlargement, and the Bill was rejected. In 1894 the company brought in another Bill to the same effect, and this was carried. The works were commenced in the most prompt and energetic manner, but came a year too late to save East London from the disastrous effects of the drought which took place last summer. A Government inquiry, which ensued, into the cause of the failure in the supply was seemingly almost superfluous, unless it were to test Mr. Binnie's theory as to the existence of broken pipes, allowing a great part of the water pumped into the district to escape underground. But it is scarcely possible to avoid the conclusion that the lack of adequate reservoirs was at the root of the mischief, and that the great lesson to be learned is one which shows the peril of tampering with the water supply of a great city. The reservoirs of the East London Company were able to store a supply for a greater number of days than those of any other company, but they had not the assistance of a great natural reservoir like the Thames, except that it might draw ten million gallons per day from that source. Even with a big river at its back, any company must needs have filter-beds in proportion, and it is not desirable to take the river water when unusually turbid from the effect of floods. Hence there is a need in every instance for works proportionate to the population, and the East London Company had to provide for a larger population than any other company, while the number of "services" was greatly in excess. This company had the further misfortune of getting much of its supply frozen up through the intense frost of the previous winter. Other companies suffered more or less from the same cause, and there was great complaint throughout London that the mains were laid at an insufficient depth. In this case also a Government inquiry was ordered. But both with regard to the frost and the drought, serious inconvenience resulted in some of the country towns as well as in London; neither could it be said that the municipal authorities managed any better than the companies.

Of the eight Water Bills promoted by the London County Council, for the transfer to that body of the undertakings of tha Metropolitan Water Companies, two passed a second reading in the House of Commons and were referred to a Hybrid Committee, which was on the point of completing its labours when arrested by the dissolution of Parliament. Steps were taken by the County Council to have the whole of the eight Bills suspended, so that they might be revived in the coming session. But in October a report was presented by the Council's Parliamentary Committee, recommending that the Government should be asked to deal with the question of the Metropolitan water supply, or else to appoint a Royal Commission for the purpose. On this an amendment was moved by Mr. J. Stuart, that the Council should proceed with the Purchase Bills; that is to say, with the eight Bills for the transfer of the undertakings. This amendment was negatived by a majority of one, and so the entire project for buying up the water companies fell to the ground. A week later a resolution was adopted, calling upon the Parliamentary Committee to report as to the terms on which the Government should be asked to legislate with reference to the question of the London water supply. In accordance with this request the Committee subsequently recommended that her Majesty's Government should be invited to constitute by Act of Parliament a public authority for the water area supplied by the present companies, such authority to have power to negotiate for the purchase of the existing undertakings. This proposal was rejected, an amendment being adopted by which the Government were to be asked whether they would promote or assist legislation on certain lines, the fundamental principle being that the entire control of the water supply within the County of London should be in the hands of the County Council in conjunction with the City Corporation, the supply in the respective areas outside the county of London to be subject to the local authorities. In addition, the Water Committee were authorised to initiate negotiations with the water companies for the purchase of their undertakings.

As it is not very likely that the Government will take up the *rôle* assigned to them by the County Council, nor yet that the negotiations with the companies will have any practical result, the metropolitan water question will come before Parliament in the approaching session in the shape of certain Bills promoted by the companies, providing on the whole a very large amount of capital. The New River Company proposes the construction of new works, together with extensive improvements generally, and seeks power to raise £1,500,000. The Southwark and Vauxhall Company has a Bill authorising new works on a considerable scale at Walton-on-Thames, fresh capital to be raised to the extent of £750,000. But the most striking scheme of all, though only associated with the raising of £1,000,000 of capital, is that which is embodied in a Bill promoted by the Grand Junction, West Middlesex, and New River Companies. The plan is for the construction of extensive storage reservoirs in the neighbourhood of Staines, in part fulfilment of the scheme which was laid before the late Royal Commission on Metropolitan Water Supply by Mr. Walter Hunter and the late Mr. Alexander Fraser. In their report the Commissioners spoke approvingly of this project, designed when complete to furnish a supply equal to the demand at the end of forty years. The present project has reference to a shorter period—some ten years or more. The supply will be drawn from the Thames, at a point a little above the town of Staines. There is a Bill promoted by the Chelsea Company, for the construction of new works at Molesey and Surbiton, and the raising of £50,000 of capital, which stands over from the past session. A Bill promoted by the Lambeth Company, requiring £500,000 additional capital, is in the same position. Whether these Bills will be proceeded with is at present uncertain. There is one Bill emanating from the London County Council, but it falls short of anything in the shape of purchase, transfer, or a new supply. It is simply a measure requiring the East London Company to give the constant supply at such a pressure as will force the water to the top storey of the highest houses in that part of the district which is within the County of London. Penalties are prescribed in the event of default. There is a Bill of which notice has been given by some of the local authorities of the county of Kent, proposing the creation of a Kent Water Board, which is to buy up the works of the Kent Company, and the outlying portion of the Lambeth waterworks. But it would appear that the Bill will be dropped, in the absence of any attempt on the part of the London County Council to purchase the undertakings of the metropolitan water companies. Looming in the distance there is a scheme which overtops everything of a cognate nature. The London County Council are not yet prepared with a Bill to carry out the project devised by their chief engineer, Mr. A. R. Binnie, for bringing a supply of water to London from Wales. But the work of preparation is going on, and assistant engineers for completing the necessary surveys have been engaged for twelve months ending next Christmas. It appears not unlikely that notice of the Bill will be given next November. A certain amount of opposition to the project has been manifested in some parts of South Wales, especially in Glamorganshire; but, as recently shown in our columns, Wales has water enough and to spare, and need stand in no fear even if London went so far from its own watershed in search of a supply.

The progress of the water supply in the provinces has presented no very striking feature during the past year. In October the Glasgow authorities accepted a tender for the construction of the last section of the new aqueduct to Loch Katrine. When completed the new works will enable Glasgow to draw from Loch Katrine 100,000,000 gallons per day, in place of 42,000,000 gallons per day now drawn by the city. The appropriation of distant sources of water supply by large cities is giving rise to considerable discussion. As far back as 1869, the Royal Commission of which the Duke of Richmond was chairman, laid down the principle that no town or district should be allowed to appropriate a source of supply which naturally and geographically belonged to a town or district nearer to such source, unless under special circumstances which would justify the appropriation. It was also considered that when any town or district was supplied by a line of conduit from a distance, provision ought to be made for the supply of all places along such line. Some illustration of the need for observing the principles thus enunciated occurred in the recent session of Parliament. The Barnsley Corporation had a Bill for the carrying out of new works of water supply, and for power to direct and use the water of certain tributaries of the Little Don, also known as the Porter River. The Corporation of Sheffield put in a claim for some portion of the supply. Rotherham and certain other towns were interested, and there was a quarrel as to the possession of the drainage area. The House of Lords passed the Bill of the Barnsley Corporation, on the ground that Barnsley was in the valley of the Don, and had a right to a share in the water, whatever demands Sheffield or any other town might make. But the Bill was impeded owing to the dissolution of Parliament, and failed to pass the Commons. It was in consequence suspended. The Corporation of Sheffield have a Water Bill for the coming session, in which, as in the case of the Barnsley scheme, power is sought to deal with the waters of the Little Don. In addition to the supply taken by Sheffield, provision is to be made for supplying water to the Corporations of Barnsley, Rotherham, and Doncaster. There are several other Water Bills to come before Parliament affecting various localities, including Birmingham, Portsmouth, Chester, Derby, Brighton, Eastbourne, Reigate, and Huddersfield.

GAS SUPPLY.

Towards the middle of the year, the report of the Board of Trade Committee on standards for testing the illuminating power of coal gas made its appearance. The Committee recommended that the pentane-air flame furnished by a Dibdin Argand burner, having the form and dimensions set forth in the appendix to their report, and used in the manner there defined, should be accepted as giving the light of ten standard candles, and that this flame should be authorised and prescribed for official use in testing the illuminating power of the gas supplied by the London Companies. As far back as 1879 a Committee appointed by the Board of Trade had presented a report condemnatory of the sperm candle as a means for measuring the intensity of light; but the difficulty of finding a better standard had the effect of delaying a satisfactory conclusion for many years. Now at last the proper method seemed to be arrived at, though this was only adopting what had been proposed by Mr. Dibdin as far back as 1886. It remained for the Board of Trade to introduce a Bill to legalise and enforce the new standard. But the dissolution of Parliament and the change of Government threw back the course of legislation, and the Bill failed to appear. The County Council have lately been taking the matter up afresh, urging the Board of Trade to promote the required Bill in the coming session, so as to give effect to the recommendations of the Standards of Light Committee. The Board of Trade have not hitherto shown themselves very ready to move in the matter, and apparently would not object to see the enterprise undertaken by the County Council. But the latter have expressed an idea that there would be a greater probability of success if the Bill were introduced by the Board of Trade than by themselves. "The agreement of all parties" is desired, and as the mode of applying the standard involves some particular points, this "agreement" may not be so near at hand as could be desired. But it is high time that the notorious defects of the sperm candle were made to give place to a really scientific and accurate mode of measurement.

The consumption of gas in London, which showed a decline in 1892 and 1893, revived in 1894 with an increase of $1\frac{3}{4}$ per cent. There is more than one cause at work to affect the rate of consumption. Foremost we must place the electric light. The report of the Medical Officer of Health for the City of London shows that a year ago there were, in the civic area, nearly 3000 private consumers of electricity, using upwards of 136,000 incandescent lamps. Nearly 500 electric lamps had been placed in the public streets, displacing above 1300 gas lamps. It is impossible that a change of this magnitude can take place without some effect being produced on the quantity of gas sold by the gas companies. There are no indications in London that the popularity of the electric light is falling off. Its use is clearly extending, and may be expected to undergo constant development. But the marvellous growth of London has to be taken into account, and this gives the gas companies so wide a field that they can allow a considerable amount of competition without suffering sensible loss. The Gas Light and Coke Company, of whose district the City forms part, shows an increase of gas sold during the June half year of 1895 as compared with the corresponding period of 1894. Another matter for consideration is the economy effected by the use of improved modes of consuming gas for illuminating purposes. Incandescent gas burners produce a snowy, steady flame, and greatly reduce the consumption of gas in proportion to the amount of light. The result to the gas company is not altogether satisfactory, except that gas being found both cheaper and brighter than formerly, there is the less disposition to have it supplanted by the electric light. An element which tells directly in favour of the companies is the augmented use of gas for heating purposes, and also as furnishing a convenient motive power. The commercial production of acetylene is a fact of much interest, rendering this powerful illuminant available for the enrichment of coal gas, though it is held by many parties as secondary to the question of cheap gas.

Some startling accidents have occurred, owing to the blowing up of electric-lighting boxes under the streets. Early in the year Major Cardew, the electrical adviser of the Board of Trade, discovered that these were due to a deposit of the metal sodium on some of the insulators. Gas having intruded into the box, and water having attacked the sodium, the conditions of an explosion were set up, and the natural effect followed. The cause which led to the blowing up of the paving stones having been discovered, it was comparatively easy to prescribe the remedies. A yet more astonishing instance of the explosive force of gas mixed with atmospheric air was afforded in the neighbourhood of the Strand, where a leakage from a fractured gas main led to a disastrous explosion, wrecking a couple of houses, and causing the death of a gallant member of the Fire Brigade, as well as injury to other persons. Another form of mischief consists in the poisonous properties of coal gas, of which a painful instance has lately been afforded in the death of the Rev. W. E. Hurndall.

CHEMISTRY.

1895 must be reckoned a noteworthy year as far as the chemical world is concerned. Both scientifically and industrially great activity has been displayed, and substantial progress has been made. Nor is there any sign that a lull is about to occur. Should 1896 fail to produce anything absolutely original, it is at least certain that much excellent and necessary work will be done in developing and reducing to order those ideas in which the previous year has been fruitful.

Avoiding the futile and mischievous method of attempting to separate pure physical knowledge from those applications to the useful arts which are its immediate or ultimate outcome, we may nevertheless choose for the beginning of our survey a discovery from which no industrial advantage has yet emanated, and from which none is, as far as our present ignorance extends, likely to accrue. When the detection of argon as a constituent of common air was announced in the autumn of 1894, few supposed that the consequences of Lord Rayleigh's masterly observation of a small but constant anomaly would be as far reaching as they have since proved it to be. Not only has the isolation of this substance shaken to its foundations a chemical hypothesis—the periodic law—hitherto justified in every particular, but it has also led, in the hands of Professor Ramsay, to the discovery of another body—helium, and to the anticipation that a series of elements, resembling each other rather than any better known form of matter, may exist for the delight of the investigator and the tribulation of the chemical gerund-grinder. As to its properties, argon is as sphinx-like as ever; even in its preparation an abnormality occurs; nitrogen, which is at first readily removed from it by the action of heated magnesium, can finally only be eliminated with difficulty and repeated absorptions. The increasing slowness with which the last fraction of nitrogen is removed seems greater than can be accounted for by the diminishing pressure of the diluted gas, and craves an explanation. Parallel work with some gas other than argon as a diluent of the nitrogen is scarcely practicable, for red-hot magnesium is catholic in its affinities, but experiment with nitrogen alone at known low pressures is feasible enough. We commend the problem to the curious. In quite another field an attractive hypothesis has experienced a shock; the adornment of iron with sundry Greek characters is not to be received without question, and we are threatened in its place with carbides curious, complex, but mercifully unstable. The controversy here referred to is tending towards a middle path, and it may well be that from the store of facts accumulated by both sides a sound tenable theory of the constitution of steel may be worked out. The comparative quiescence of the conventional organic chemist, with his wearisome syntheses of insignificant substances, is matter for much thankfulness; in place of such futilities there has been useful work done in collating and systematising existing knowledge; and praiseworthy attempts are being made to gain an insight into the true constitution of carbon compounds as they exist in three-dimensional space and not on a blackboard more or less plane. Ringing the changes with hydroxyl groups and the like will be practised, we suppose, as long as the barbarous taste for bizarre pigments continues. Verily sexual selection has much to answer for.

The synthesis of useful organic products stands on a different footing. New drugs, special foods and stimulants may be produced and taken into use after proper observation of their physiological effect; but in this field no great addition to our knowledge has lately occurred. The chemical production of food stuffs is not yet, nor is it especially to be desired as long as plants continue to store diffused solar energy with an economy that cannot be approached by any other means. An illustration of the doubtful utility of seeking to produce a substance which is yielded by a natural organised material is afforded by the endeavour to prepare alcohol from chalk, coal, and water. Calcium carbide, itself a new commodity, is formed by the interaction of lime and carbon at an extremely high temperature, and evolves acetelyne on the addition of water, whence the building up of the alcohol molecule can proceed by well-known steps. But even with Niagara to help the synthesis, a field of barley and a few yeast cells may be safely backed to give the better output.

Although acetelyne from calcium carbide is unlikely to displace starch as a raw material for whiskey, yet it has undoubtedly a fair prospect of use as a lighting agent in special cases where compactness or easy transport is desired. In this case the electrician has materially helped a chemical industry, but an ill-return has been made by the chemist, who, by the aid of certain oxides, once stigma-

tised as "rare earths," and an atmospheric burner, is running electrical enterprise hard in the production of a light both good and cheap. Reverting for a moment to calcium carbide, it is interesting to note that the status of this substance for carriage is a matter of debate. Can it fairly be scheduled as "dangerous," or "explosive"? As far as we know, the heat of formation of calcium carbide, whether negative or positive, has not been determined; acetylene, its hydrogen derivative, is an endothermic body, and would probably be looked upon as in itself an explosive, apart from its capability of yielding an explosive mixture with air. The matter will eventually require some formal ruling.

Another chemical industry, intrinsically small, but of importance as being supposed to involve risk to life, has bulked large before the public eye during the past year. Oxygen manufacturers will be sorely hampered if a scare arise over the occasional accidents which have occurred with cylinders of the compressed gas. Within the last few days a chance dispute and trivial assault have led to the deliverance of an *obiter dictum* worthy of the J. P. of the comic papers rather than of a clear-headed stipendiary, and non-technical papers have hastened to add comments as temperate as they are intelligent. Seeing that the question is now under investigation by a competent committee of enquiry, it is to be hoped that ignorant clamour will be suppressed or left unheeded until a report has been issued.

Another matter eminently of topical interest is the attainment of very low temperatures and the liquefaction of gases usually regarded as "permanent." Here, again, it would be hard to draw a distinction between the scientific and industrial aspect of the subject. From the early days of Cailletet and Pictet, liquid oxygen has been known, and since that time several investigators, notably Wroblewski and Olszewski, have made accurate observations of its properties. In this country the public has been indebted chiefly to Professor Dewar for many popular expositions of the methods used for achieving these results, and for the interest which he has succeeded in arousing in those to whose munificence much new and costly apparatus is due, but it has been left to a German engineer to eclipse all previous attempts to translate the results of the laboratory into the language of the manufactory. The Linde process, as described by Herr M. Schröter, has been dealt with in these columns too recently to need lengthy comment in the present article, but it is worthy of more than cursory mention, inasmuch as it involves the novel application of important principles, which have been much overlooked or utilised but imperfectly by previous investigators. Its merit and interest largely consist in the fact that no subsidiary or intermediate cooling agent is necessary, Thus, at a stroke, the need for expensive and complicated apparatus designed for liquefying and evaporating various intermediary gases, *e.g.*, carbon dioxide, ethylene, and the like, is removed, and the *raison d'être* of such elaborate mechanism as that of which the Royal Institution has hitherto been justly proud, largely disappears. No doubt that enterprising corporation will wisely replace its obsolete apparatus with a modern and rational plant.

Some time after our publication of a description of the Linde process, Professor Dewar demonstrated, on a purely laboratory scale, the practicability of the method, using a pretty little apparatus consisting essentially of a reservoir of compressed air and a coiled copper tube, having a pinhole at its further end, a rough approach to cumulative cooling being obtained by allowing the air, cooled by expansion through the pinhole, to stream past the coils of the tube conveying a fresh supply of compressed air. The experiment can be projected on to a screen by the aid of a lantern for the benefit of a popular audience. The intellectual pleasure derived from the consideration of the Linde process is only momentarily dimmed by the regret that the distinction of devising it has not fallen to a fellow-countryman.

The heavier chemical manufactures have shown less progress than have those in which less capital is sunk, or which are new and more immediately dependent on recent discovery.

Such developments as have taken place in the alkali trade have been financial rather than technical. The electrolytic production of caustic soda and chlorine is in a better industrial position than in former years. The time of experiment is nearing its close and that of commercial manufacture is setting in. It is hard at present to judge which. if any, of the methods now at work is likely to prove capable of earning a dividend, and the difficulty is enhanced by the vigorous polemics of the exponents of rival processes, some of whom have not scrupled to attack their competitors on false grounds. The ridiculous and ignorant attacks on the Castner process—which is quite sufficiently handicapped by its intrinsic defects—on the score that the mercury needed in its working will permeate human organisms employed in carrying it out, furnish a case point. Of the Greenwood process, which at one time promised well, but little has been heard, and a semi-secret method, the Hargreaves-Bird, has yielded nothing more tangible than acrimonious discussion. In all cases the efficiency is still low, and the plant is cumbrous; but the former is being improved, and the latter is at least less in constant need of costly renewals than were the earlier apparatus for industrial electrolytics. With an allusion to an especially elegant application of a discovery in pure chemistry we will conclude an article already somewhat lengthy. Since the preparation of nickel carbonyl, Mr. Ludwig Mond has wrought unsparingly at the utilisation of this substance for winning nickel from its ores. He has now so far succeeded as to be able to work up 1½ tons of nickel per week from Sudbury nickel-copper matte. We offer him our congratulations on his perseverance.

DEFECTS have been developed in one of the 67-ton guns of H.M. first-class battleship Anson to such an extent that a new gun is to be supplied.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

LAST year opened with a drop in all classes of iron rolled by the "list" iron houses in this part of the kingdom of 10s. a ton, making marked bars £7, and the Earl of Dudley's quotation £7 2s. 6. Other classes of marked iron at the same time became proportionately lower. At the January quarterly meeting, the makers of unmarked iron formed an association with a view of strengthening prices. Bars at this time were £5 per ton, and quotations were raised nominally 5s. per ton. But the advance was not generally realised, and it was not until April that any appreciable improvement in trade took place. Between July and September the prices of unmarked bars were advanced three times by the Association, and the price went up to £5 15s., and even in a few cases £6. The full advance was not, however, maintained the last two months of the year, and in the closing month prices fell back to £5 10s. per ton. Both black and galvanised sheets have improved £1 per ton during the year. In April galvanised sheets advanced about 5s. per ton, the price becoming £9 10s. for 24 w.g., delivered Liverpool, and another 5s. rise was established before the end of that quarter's meeting, the quotation being £9 15s. to £10 per ton, f.o.b. Black sheets last January were selling at £6 5s. to £6 10s. per ton for doubles, and lattens £7 to £7 5s. During the first six months of the year they advanced proportionately to galvanised sheets, and in the second half of the year the improvement was a good deal more marked, owing largely to increased demand for galvanised sheets from India, South Africa, and Australia, and some of the States of South America. With the exception of common bars and sheets there were no marked advances during the year in finished iron, but hoops and thin strips have improved from £6 5s., which was the quotation at the opening of January, 1895, to £6 10s. at the present time, and tube strip from £5 5s. last January to £5 12s. 6d. at date.

The local pig iron trade has not seen much change in 1895, the greatest attraction having been in the prices of Midland pigs imported into this district, such as Derbyshire, Northampton, Lincoln, and similar metals. The chief imports took place in the second six months of the year, when Northampton forge iron rose from 39s. to 44s. per ton; Derbyshire, 39s. to 44s., and 45s. per ton now; and Lincoln iron to 44s. 6d. and 45s. net. Staffordshire cold blast all mine iron advanced about 7s. 6d. per ton, to 97s. 6d.; part mine pigs, from 40s. to 45s.; and cinder pigs 2s., bringing the price up to 37s. per ton.

That trade is on the up grade at date is shown by the character of the last returns for 1895 made to the Iron Trade Wages Board. This return was for the months of September and October, and declared the average selling price obtained for all classes of manufactured iron in that period to have been £5 12s. 7d. per ton, or an increase on two months previously of 2s. 4d. per ton; and it is believed that the average selling price for November and December when it comes to be declared by the accountants will show further improvement. The other four Wages Board returns for the year were as follows:—January and February, 1895, £5 13s. 5d.; March and April, £5 13s.; May and June, not declared; and July and August, £5 10s. 3d. The small advance of 2s. 4d. per ton in September and October average over the two preceding months, whilst the market reports of the same date stated that ironmasters were obtaining at least 10s. per ton advance on marked bars, and 15s. to £1 advance on sheets, is largely explained by the fact that marked bars and other classes of best iron were not advanced at all. Ironworkers' wages have remained at 7s. 3d. per ton for puddlers throughout the year, and millmen's wages in proportion.

The market is at present without any intimation from the marked bar makers of their intention to declare any advance in prices this month, and, the 1st of January being passed, it is believed that there is to be no change either before or at the quarterly meetings. The new year prices of the list iron houses may, therefore, be safely quoted at £7 for bars; hoops, £7 10s.; sheets to 20 w.g., £8 to £8 10s., 24 w.g. £9 10s. to £10, and 27 w.g. £11 to £11 10s. Best sheets are £1 10s. per ton above these rates, and double best £2 10s. Boiler plates are quoted £8 to £8 10s.; best ditto, £9 to £9 10s.; best best, £10 to £10 10s.: treble best, £11 to £11 10s.; and extra treble best, £14 per ton.

Satisfaction is generally occasioned by what is now understood to be the intention of the marked bar firms to make no change, and it is pointed out that if any advance had been declared the only result would have been to drive orders still more into the hands of the unmarked bar makers, a state of things the best houses are indeed particularly wishful to avoid. With trade in its present state, £1 10s. per ton is quite sufficient difference to exist between common and best bars, if makers of the latter are to secure orders, since the quality of what are termed "common bars" is much superior to what it used to be, and consumers will not now pay such great deal higher prices for best over common bars, as was once the case.

The marked bar makers have recently been experiencing a decidedly better demand than in the early part of 1895, and they will be wise if they continue to encourage orders by every means in their power.

Sheet iron prices open 1896 at £7 2s. 6d. to £7 5s. as the market price for doubles in the black state, the bulk of producers demanding the larger figure—lattens, £7 17s. 6d. to £8; and singles, £7 per ton. Galvanised corrugated sheets are £10 7s. 6d. to £10 10s.; and £10 12s. 6d. for 24 w. g., f.o.b. Liverpool, ordinary brands, and £11 to £11 10s. for best brands. Merchants profess to require 10s. per ton for black steel sheets over iron, which, upon the present basis, would make black steel doubles £7 12s. 6d. to £7 15s., and lattens £8 7s. 6d. to £8 10s., nominal. But the market generally declines to concede anything like so large a difference, declaring that the makers of the article only quote a difference of 5s., and in some cases only 2s. 6d. per ton, between iron and steel. Sheets for tray making by the Japanese are quoted £9 5s for material of Staffordshire make, and £8 10s. for South Wales sheets, delivered up here. Trunk making sheets, also for Japanese use, are quoted by merchants £8 7s. 6d. doubles, and £9 to £9 2s. 6d. lattens; while deep stamping sheets, such as are employed by the enamellers, and similar hardware manufacturers, are priced by middlemen at £8 10s., singles; £9 10s., doubles; and £11, lattens.

Structural engineers during 1895 have experienced a sensible improvement in demand, and at date structural iron work is in brisk request from India and South Africa, Japan, and some parts of South America. Most of the bridge builders in this district can now see their way to full employment over the first three or six months of 1896. There is one drawback to this otherwise bright picture, and that is, that unfortunately the contracts in many cases have had to be taken at prices that have only the smallest margin of profit, so keen is competition from the other parts of the kingdom. But this is a matter which will right itself as the trade revival continues and developes. In the railway rolling stock branch, and in wheels and axles, and general railway material, business was very quiet in the early part of the year, but since then good orders have come to hand, largely on export account, and the makers are now nearly all busy, and have excellent prospects. Machinists and engineers in and around Birmingham have been busy chiefly on mining machinery for South Africa and Western Australia, rolling mills for sheet and tube work, pumping and gas engines, lathes and arsenal tools, and shop tools of various kinds adapted to local requirements. The demand for steam engines and motors is still adversely affected by the improvements and increasing powers and adaptability of gas engines, and boilers are sharing this experience; but what the steam engine makers lose the gas engine firms and the electrical machinery firms get. These last are as full of work as they can well be, and the indications are all in the direction of a memorable year ahead for them. A current feature in the Birmingham machinery outlook that should not be passed over without satisfactory note is the great field—never before so large or so promising—for its employment which is assured for 1896, in connection with the cycle and seamless tube trades, and the increasing extent to which machinery is being used in the manufacture of every description of brass and copper goods.

I regret to have to record the death, at the age of 66, of Mr. James Caffer, of Walsall, for many years the secretary of the operative section of the Staffordshire and Midland Iron Trade Wages Board. Mr. Caffer was one of the most widely known ironworkers' agents throughout the kingdom, and his influence in iron trade labour struggles throughout Lancashire, South Yorkshire, Derbyshire, Staffordshire, and the Midlands generally, was once very great. He resigned his official connection with the Midland Board seven years ago, owing to paralysis, and was succeeded by Mr. Ancott.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—Apprehensions of possible foreign complications, and continued labour disputes at home, have had a somewhat depressing effect upon the opening of the year. The customary holiday interference with ordinary business and industrial operations—engineering and iron works and collieries being mostly closed over the greater part of the week, and the usual 'Change meetings little more than nominal—render it of course impossible to form any very sound estimate for the moment of the real condition of trade. So far as there is anything to judge by, the actual position is unchanged, both makers and manufacturers starting the year with plenty of orders on their books, and engineering shops for the most part similarly situated as regards work in hand; but the general tone is not so buoyant, and the immediate outlook for the future is not so satisfactory as it was a short time back.

Neither the iron nor the coal Exchange meetings at Manchester on Tuesday brought together an average attendance for the closing market of the year, and on both Exchanges business was extremely slow. In the iron market the business coming forward scarcely afforded any real test of prices, but for local and district brands of pig iron makers, who are mostly well booked for the next month or two, quote nominally late rates, and are for the present indifferent about new orders. Outside brands offering here are, however, decidedly easier, owing to the continued downward movement in warrants, and iron held in second hands especially is very irregular in price. So few transactions have been put through that it is difficult to give anything like reliable quotations, except that 45s. 6d. to 46s. net cash may be said to represent about the average for foundry Middlesbrough, delivered Manchester, with Eglinton about 47s. net prompt cash, delivered Lancashire ports.

For finished iron, makers, whose books are mostly well filled over pretty nearly the first quarter of the year, remain very firm at their full list rates, not quoting under £5 10s. for Lancashire, £5 15s. for North Staffordshire bars, £7 10s. to £7 12s. 6d. for sheets, and £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths of hoops, delivered Manchester district, and 2s. 6d. less for shipment.

In the steel trade, the position continues weak, ordinary foundry hematites being obtainable at 55s. 6d. to 56s., less 2½d., with Scotch steel boiler plates to be bought at £6 to £6 2s. 6d., and local makers quoting £6 5s. delivered Manchester district.

Only a hand-to-mouth sort of business is being done in the metal market, buyers holding back in the expectation of some reduction in list rates for manufactured goods, but as makers are not holding any meeting for the next week or ten days, prices, for the present at least, will remain unchanged.

For a few days prior to the holiday stoppages of the pits there has been a little extra push of orders in the coal market, chiefly, however, for house fire qualities; but the generally unsatisfactory condition of this branch of industry remains practically unchanged, with prices not more than maintained at late rates, and no indication of any possible upward move, except perhaps some stiffening upon the low figures recently taken for engine fuel, which is not quite so plentiful in the market as it has been. At the pit mouth average prices remain at about 10s. to 10s. 6d. for best Wigan Arley; 9s. to 9s. 6d. for Pemberton 4ft. and seconds Arley; 7s. to 7s. 6d. for common house coal; 6s. to 6s. 6d. for steam and forge coal; 4s. 6d. to 5s. for best slack; and 3s. to 3s. 6d. for common sorts.

Here and there rather more business is reported to be stirring in the shipping trade, but generally there is no real improvement, and prices continue quite as low as ever, ordinary steam not fetching above 7s. to 7s. 6d., delivered ports on the Mersey.

Barrow.—There is a steady tone at the close of the year in hematite pig iron, and although comparatively little business has been done in hematites during the holidays, there is a very good and strong feeling in the market, and there are indications that a much fuller and a more pressing demand for prompt deliveries of metal will be experienced with the New Year. Prices are slightly lower at 46s. 4½d. net cash sellers, buyers being at 46s. 4d. Makers' iron is nominally quoted at 48s. There are 36 furnaces in blast, compared with 31 in the corresponding week of last year. Stocks have increased during the week 4316 tons, and close at the end of the year at 274,700 tons, compared with 115,525 tons at the beginning of the year.

Iron ore is in steady demand at old rates, average qualities being quoted at 10s. per ton net at mines, with best descriptions at 12s. 6d. per ton.

Steel makers have been on holidays all the week, but all the mills at the Barrow works will be started on full time on Monday, with prospects of plenty of work for the year. Rails are especially brisk, and shipbuilders are beginning to ask for deliveries of plates.

Shipbuilders and engineers are very busy, and arrangements are in progress for a very busy year's trade. This is likely to be equally the case with important commercial work as it is at present on Admiralty work. H.M.S. Dons will be launched at Barrow on the 29th February, and a Clan liner is to be launched on February 1st.

The coal and coke trades are steady, and prices are firm. A fuller demand is anticipated.

The shipping trade is depressed. Exports from West Coast ports during the week represented 2405 tons of pig iron and 8307 tons of steel, compared with 780 tons of pig iron and 6006 tons of steel in the corresponding week of last year. The total shipments of pig iron during 1895 amounted to 272,615 tons, and of steel to 369,321 tons, comparing with 351,630 tons of pig iron, 379,273 tons of steel in the previous year.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

CHRISTMAS of 1894 was like a leaf out of the book of summer. Christmas of 1895 promised to be what is known as thoroughly seasonable. Snow began to fall on Christmas Eve, and next day the neighbourhood was white with a keen frost; but it did not last long, and now the weather is excessively mild, although there have been one or two very cold "snaps" in the interval.

Mr. Benjamin Pickard, M.P., and several other officials of the Yorkshire Miners' Association, were in conference on Christmas Eve with the management of the Hickleton Main Colliery Company, Bolton-on-Dearne, with a view to the settlement of a dispute which has existed since August 20th last. The conference took place at the Royal Victoria Hotel, Sheffield, and, after a prolonged consideration of the whole question, an agreement happily was arrived at. The question in dispute was the difference between the Cadeby Main price list and the Houghton Main price list. The colliery owners wished to adopt the former as the basis of wages, while the miners stood out for the adoption of the Houghton Main list pure and simple. The terms arranged are practically a compromise between the two lists, and the agreement is regarded as equitable by both sides. It is expected that work will be resumed early in the New Year.

In the coal trade generally not much disquietude is expressed with regard to the Rosebery arrangement expiring by effluxion of time in June next. With reviving commerce, both sides will be slow to encourage any tendency towards strife. The employers require peace to consolidate the fruits of waiting for the better times now believed to be at hand. The workmen are anxious to begin adding to their nest eggs in the savings banks, which were largely drawn upon, and in many instances completely exhausted, during the dispute, while the inadequate employment which has been given since prevented anything being done in the way of thrift during the last year. The miners' leaders, too, can do with a period of rest to get their unions into more effective condition. All round the indications are for a season in the Midlands devoid of grave industrial difficulty.

The death at Heysham, Morecamoe, of Mr. Samuel Marshall, formerly a Sheffield manufacturer, recalls some of the stirring incidents of the Trade Union outrages. Mr. Marshall was the inventor of the double-spring sheep shears, and in the development of machinery and other ways of facilitating the manufacture, incurred the displeasure of Broadhead, who was the Robespierre of the Sheffield Industrial Reign of Terror, which was crushed by Royal Commission. Mr. Marshall left Sheffield some seven years ago, and has since resided in the pleasant village close to the favourite Bradford health resort, in the sea inlet known as Morecambe Bay.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

APART from its being a holiday time, there is very little disposition manifested to do business, and the tone is less sanguine than it was a month ago, commercial men being less ready to speak good of the prospects of the early future, which they now consider to be uncertain. Almost every indication during the first half of last month was favourable to a continuation of the improvement, and to its being more pronounced than it was in 1895, but President Cleveland's manifesto appears to have altered all that, and though the disquiet created has somewhat subsided, the iron market does not show any recovery, and there is no doubt that a considerable time must elapse before confidence can be restored. It is unfortunate for manufacturers that this check should come just when they appeared to be "out of the wood," and when consumers were beginning in almost all branches to buy with some approach to freedom. But as it is, the year closed with rather a downward tendency in prices, the only department where they were maintained being the rail trade.

The large increase in stocks of Cleveland pig iron in December would itself not have tended to weaken the market, for that is always expected in the winter, and the excess of production is usually cleared off in the spring, when the export trade becomes brisk. Last winter the output exceeded the consumption by about 100,000 tons, so that the increase in December was not likely to have much detrimental influence on the market. Still, if we sum up the trade of the year 1895, there is not as much reason to be satisfied with it as might be expected, for make and deliveries of pig and finished iron were smaller than in the previous year, while stocks have increased to a greater extent. The average prices, too, except for rails, were below those of 1894, but the best feature of the year was that while in 1894 trade was on the downgrade, in the past year it was moving upwards, and the best prices were in the latter part of the year instead of the first quarter, as in 1894. The average number of furnaces in blast in the North of England in 1895 was 89, against 93 in the previous year, and the output was 63,000 tons less, but nevertheless the increase in stocks was larger, which would indicate a smaller consumption. The stock of Cleveland pig iron had gone up at a rapid rate in Connal's public warrant stores, for at December 31st the quantity held was 171,700 tons, the increase being 15,352 tons, and for the year 77,962 tons. Of hematite pig, 138,944 tons were held at December 31st, this being an increase for the month of 8157 tons, and for the year of 58,358 tons. Thus the aggregate increase in Connal's stock last year was 136,320 tons. Of Cleveland iron the largest stock ever held was 350,000 tons in September, 1888, and the smallest, 10,000 tons in September, 1892, just after the Durham strike. The average prices for the year have been for No. 3 Cleveland pig, 35s. 9d., which was the same as in 1894; for mixed numbers of hematite pig iron, 43s. 8d., against 44s.; and of manufactured iron, £4 15s. 2d., against £4 17s. 8d.

The price of No. 3 Cleveland pig iron was brought down this week to 36s. 6d. for prompt delivery, though most sellers asked 36s. 9d.; but there was no desire shown to either sell or buy iron for forward delivery in the present uncertain state of the market. Cleveland warrants have dropped to 36s. 5½d. cash, having fallen 4d. during the last day of the year. The commoner qualities of Cleveland iron have not shown so much weakness as No. 3, as they are scarce, and they are now relatively dearer than No. 3, circumstance which has not been observed for several years. Some people think that before the winter is over grey forge may be at a higher price than No. 3, as it has been more than once during the last dozen years. Mixed numbers of East Coast hematite pig iron are firm at 46s. per ton, that being only 1s. below the best price of 1895, but 4s. 6d. above the worst. Cleveland No. 3 iron has fallen more than that—3s.—and it is only 2s. 2½d. above the worst. Rubio ore is 12s. 6d. per ton, delivered at wharves on Tees, and the freights are easier. Blast furnace coke is steady at 13s. per ton, delivered Middlesbrough furnaces, or 14s. 6d. f.o.b.

The finished iron and steel trades are quiet, but steel manufacturers are by no means badly off for work, and it is only the holidays and stocktaking that limit operations this week. Especially is this the case with the rail manufacturers. The North-Eastern Steel Company are wells upplied with orders. The demand for steel girders is increasing, but low prices have to be taken to compete with the Belgian manufacturers, who can deliver as cheaply in London as any of the British manufacturers. Producers of steel plates and angles are well off for contracts, but generally the demand for iron plates and angles does not admit of full work at the mills, the revival having extended to these departments but to a small extent. Steel rails—heavy—are at £4 15s. net. Steel ship-plates are £5; steel boiler-plates, £6; steel ship angles, £4 15s.; iron ship-plates, £4 17s. 6d.; iron boiler-plates, £5 17s. 6d.; and common iron bars, £4 17s. 6d., all less 2½ and f.o.t.

The engineering industries show improvement in that the works are more fully employed, but in the matter of prices there is not much alteration. This year will probably see considerable developments in the engineering and shipbuilding industries of Tees-side, as Sir Raylton D xon and Co. have acquired the necessary land, and propose to lay down a graving dock. Sir Christopher Furness has become connected with the firm of Messrs. Westgarth, English and Co., marine, &c., engineers, North Ormesby, and the works are to be enlarged; indeed, it is reported that £50,000 worth of new machinery is to be added. Sir C. Furness is still negotiating for the purchase of another engineering establishment and a shipbuilding yard on Tees-side, and it is expected that the matter will be ripe for submission to the shareholders within the next two or three weeks. Messrs. Palmer's Shipbuilding and Iron Co., Jarrow-on-Tyne, has received an order from the British Admiralty for two 30-knot torpedo boat destroyers. Mr. John Blumer has this week retired from the firm of John Blumer and Co., shipbuilders, North Dock, Sunderland, and the business will in future be carried on by Col. Robson, and Messrs. Thos. R. and Wm. Blumer, sons of the retiring partner, under the old style. Messrs. Ashmore, Benson, Pease, and Co., Stockton, have secured an order for a large gasholder for Derby on their patent plan, and also one for Manchester. The Whessoe Foundry Company is supplying a large steel tank and telescopic gasholder to the Danish Gas Company at Aalborg, and also a variety of gas-making plant to the same company's Copenhagen works. The negotiations which have been for a considerable time in progress between Messrs. Bell Brothers and Messrs. Brunner, Mond, and Co., for the purchase of the soda works of the former, have been completed, and the property passed over to purchasers on Wednesday, together with a large tract of land, on which Messrs. Brunner will lay down an extensive plant, the new works to be completed by the end of this year, or early in 1897. Mr. Hugh Bell joins the directorate of Messrs. Brunner, Mond, and Co.

The holidays are limiting the production of coal, as the majority of the collieries in Durham and Northumberland are stopped this week, but last week was a fairly brisk period, and exports were good in spite of the stormy weather. Some of the Durham colliers having expressed dissatisfaction with the working of the Conciliation Board, and going so far as to propose its abolition at one of the general meetings of their association, the miners throughout the county have been asked to vote by ballot as to whether the Board shall be terminated. The returns of the lodges in some cases have been made known, and certainly are not in favour of a continuance, which is to be regretted.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

BUSINESS has been confined to narrow limits this week in consequence of the New Year holidays, which still continue to be everywhere observed in Scotland. In the case of works of any size and importance operations have been suspended during the greater part of the week. The pig iron market was held on Monday and Tuesday, and then closed till Friday afternoon, when it met for a couple of hours. Prices of pig iron warrants were depressed early in the week, a very considerable quantity of iron changing hands at declining rates. The market suffered in sympathy with adverse movements in stocks and copper. Scotch warrants sold from 45s. 8½d. to 45s. 3½d. cash, and 46s. to 45s. 5½d. one month. There was only a small business in Cleveland warrants at 36s. 9d. to 36s. 5½d. cash. Hematite was also quiet, Cumberland warrants being done at 46s. 3d. cash, and 46s. 6d. one month.

The prices of makers' pig iron are as follows:—Govan and Monkland, f.o.b., at Glasgow, Nos. 1, 47s.; Nos. 3, 45s.; Carnbroe, No. 1, 47s. 6d.; No. 3. 45s. 6d.; Clyde, No. 1, 50s.; No. 3. 47s.; Calder, Gartsherrie, and Summerlee, Nos. 1, 50s. 6d.; Nos. 3, 47s. 6d.; Coltness, No. 1., 53s.; No. 3, 48s. 6d.; Glengarnock, at Ardrossan, No. 1, 50s. 6d.; No. 3, 46s. 6d.; Eglinton, No. 1, 48s.; No. 3, 46s.; Dalmellington, at Ayr, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Shotts, at Leith, No. 1, 52s. 6d.; No. 3, 48s. 6d.; Carron, at Grangemouth, No. 1, 53s.; No. 3, 49s.

The shipments of pig iron from Scottish ports in the past week were 6013 tons, against 6194 in the same week of 1894, and of the total there was sent to Italy 460, Australia 335, Canada 25, South America 50, India 154, France 80, Germany 175, Spain and Portugal 55, other countries 25, the coastwise shipments being 4654 compared with 6194 in the corresponding week. At the time of writing the official returns are not available, but the pig iron shipments for the year have amounted in round numbers to 300,000 tons, compared with 248,000 in 1894. The coastwise shipments were 186,000, against 126,000 in 1894, and the foreign shipments 114,000 compared with 122,000 in the preceding year. From the figures it appears that our exports in pig iron are unsatisfactory; indeed, they are gradually declining year by year, and the West of Scotland is becoming much more of a consuming than an exporting district.

The finished iron and steel departments are necessarily quiet, merchant's offices having been closed, and works shut down a great part of the week.

Prices of coals have been low during the whole of 1895, and they are at present about the poorest level, main coal being quoted, f.o.b. at Glasgow, 5s. 9d. to 6s.; splint, 6s. 9d.; ell, 6s. 9d. to 7s.; steam, 7s. 6d. perton.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE Merthyr district was startled on New Year's Eve by the announcement that notices had been issued to the Plymouth colliers, about 3000 in number, to the effect that on and from January 31st all contracts would cease and determine. What the manager requires is the acceptance of a reduction of wages, which would about equalise the rate paid at adjacent collieries. This properly falls into adjustment by arbitration.

It has for some time been a subject of comment in the district that the ruling prices in the iron and steel trade are too low, and this has been forcibly shown during the last week by the auditor's report of the investigation of the iron masters' books. This report determines the continuation of present wages to the end of next quarter. Operatives express their dissatisfaction somewhat forcibly on the working of the scale, though the more reasonable hope that spring business will bring a change. Fairly large rail orders are in band, and there is a steady continuance of bar make in the principal works. Large cargoes of bar are coming in also from the North.

Taking the week, it must be regarded as a broken one in all industries, and in iron and steel particularly. At Swansea it was reported this week on 'Change that since the last meeting Scotch, Middlesbrough, and hematite pig were lower by 1s. per ton. Last quotations are: Glasgow, 45s. 4d.; Middlesbrough No. 3, 36s. 5d.; hematite, 44s. 4d. Other prices were as follows:—Welsh bars, £5 5s. to £5 7s. 6d.; sheet iron and steel, £6 5s. to £6 10s.; steel rails, heavy sections, £4 10s. to £4 15s.; light, £4 15s. to £5 10s.; Bessemer steel, tin-plate bars, £3 17s. 6d. to £4.

On 'Change, Cardiff, a different quotation ruled for bars, Bessemers being quoted at £4 2s. 6d. to £4 5s., and Siemens best from £4 5s. to £4 7s. 6d. There was no change in tin-plate prices, but I shall not be surprised at different rates prevailing in next week, as exports last week have been large, 82,078 boxes, while 71,925 boxes came in from works. Stocks are now down to 135,517 boxes. At Briton Ferry a good deal of work was stopped Christmas Eve, and was not resumed until Friday.

There was a good deal of animation at the Cardiff Exchange, and it was pleasant to note that a degree of hopefulness prevailed in the coal trade, and that prices were firmly maintained. Midweek this was very noticeable, and prices were as follows:—Best qualities, steam, for prompt shipment, 10s. 3d. to 10s. 6d.; and best seconds, 10s.; and ordinary seconds, 9s. 6d. to 9s. 9d.; dry coal, 9s. to 9s. 3d. Small steam continues a drug, and prices vary from 3s. 6d. to 5s., according to quality. The very best for bunkering purposes sells at 5s. to 5s. 3d. House coal is now in its old form, and prices are firm in all departments. Best house is quoted at 10s. 9d. to 10s. 11d.; No. 3 Rhondda, 9s. 9d. to 10s.; brush, 8s.; small, 6s. 3d. to 6s. 6d. No. 2 Rhondda is in great demand, as a useful coal, from 7s. 9d. to 8s.; through, 6s. 3d. to 6s. 6d.; small, 4s. 3d. to 4s. 6d. Swansea prices are:—Steam, best, 9s. to 9s. 6d.; seconds, 8s. to 9s.; No. 3 Rhondda, 10s. to 10s. 9d.; No. 2, 8s. 9d. to 9s. 6d. Monmouthshire best, 8s. 6d. to 8s. 9d.; seconds, 8s. to 8s. 3d.; best small, 4s. 6d. to 5s. 3d.; other qualities, 4s. to 4s. 3d. Patent fuel moderately good at Cardiff, Swansea, and Newport. One good cargo, of 2000 tons, left the last-named port this week for France. Prices unchanged. Coke at Cardiff is in a firm, healthy condition, prices 12s. to 14s. for furnace; foundry, 15s. to 15s. 6d.; special, 19s. 6d. Iron ore prices stationary. Cardiff prices: Best Rubio, 11s. 9d.; Tafna, 11s. to 11s. 3d.; Garucha, 10s. 9d. to 11s. It is not expected that any marked change will take place in this branch for a time, until the weather improves, though during the present week some good cargoes have come in.

Welsh industries have been honoured by the Queen this week in the person of their chief representative, Sir William Thomas Lewis, who has been created a baronet, in recognition of his great services in the coal and iron and steel trade.

It is too early for full statistics of the coal trade of 1895. This, however, may be stated, that for the eleven months ending November the exports amounted to 12,157,000 tons; and December, 1894, 999,000 tons, and we have for the twelve months ending November, 1895, 13,156,000 tons. The quantity for the same period of 1894 was 13,348,000 tons.

Pitwood continues inactive. Large cargoes are coming in, and it is expected that present prices—16s.—will be altered to 15s. 6d. or 15s. 9d. in a day or two, Cardiff.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THERE is actually nothing of interest or importance to be told with regard to the iron and allied trades this week, business transactions in the different departments having been very limited on account of the holidays.

The Silesian iron market has been comparatively dull, although prices maintain a firm tendency. But there have been less orders given out lately, and stocktaking and repairing at the works tends to increase the quiet tone which has recently been noticeable. However, the contracts booked during the preceding months will keep up a regular activity at the mills and foundries for some time to come. The prices realised for common forge pig were M. 50 to 51 p.t.; foundry pig, M. 50 p.t.; basic, M. 52 to 53 p.t. at works. The demand for finished articles of iron and steel likewise shows a slight decrease, but, on the whole, manufacturers report themselves pretty well supplied with orders of previous date. At the steel works a fair activity is going on, the requirements for railway and engineering purposes being rather large. For export there is not much doing, especially the business to Russia showing a falling off.

No appreciable improvement can be reported as regards the position of the Austro-Hungarian iron trade, the weight of business put through being extremely limited. There is never much doing at this period of the year, but the demand for iron and steel has been very small for some time past, and there is now a decided depression and dulness noticeable in iron circles, the more so because foreign competition is exceedingly keen. Quotations are, on the whole, unaltered, being for common forge pig, 46fl. to 47fl.; grey pig, 48fl. to 51fl.; Bessemer, 49fl. to 51fl.; ingots, 78fl. to 85fl.; Styrian bars, 105fl. to 112·50fl.; girders, 106fl. to 110fl.; heavy plates, for boiler-making purposes, 165fl. to 180fl.; tank plates, 135fl.; steel plates, 142·50fl.; galvanised sheets, 205fl. to 260fl.; all per ton. Tin sheets are quoted 28fl. per box.

Though there is a decided lull in the Belgian iron business, prices are not weaker, because manufacturers are, as a rule, so well supplied with contracts that they can afford to hold off from selling at the present. The plate makers have resolved at a recent meeting to firmly maintain their former quotations, only steel plates for export were reduced to 135f. p.t. Steel rails are very firm at 110f. p.t., f.o.b. Antwerp. Comparing prices of 1st November and 1st of December, no alteration whatever can be perceived. On the 1st of December there were twenty-seven blast furnaces in blow out of forty-three existing, ten producing ordinary pig, three foundry pig, and fourteen basic. Output of pig iron in Belgium was:—

	November.		January 1st to December 1st.	
	1895. Tons.	1894. Tons.	1895. Tons.	1894. Tons.
Forge pig	26,250	36,600	323,515	374,660
Foundry pig	6,600	8,700	77,620	74,920
Basic	34,500	31,800	357,780	375,460
Totals	67,350	77,100	758,915	825,040

There has been very little business doing on the Belgian coal market for some time past, but the cold weather which has now set in cannot fail to have a favourable influence, at least on house coal. For engine classes of fuel some pretty heavy contracts are expected to be given out after the 1st of January. Prices are firm all round. Regarding the Belgian business in coal and coke during the first ten months of 1895, there were imported in coal 1,238,340 t., against 1,133,765 t. for the corresponding period the year before; of these 621,793 t. came from Germany, against 585,019 t. for the previous year, while import from France was 349,854 t., against 295,282 t. In coke, import amounted to 329,943 t., against 269,362 t., 317,312 t. coming from Germany, against 260,490 t. for the same period in 1894. Export in coal was 3,854,767 t., against 3,686,129 t.; 3,020,589 t. were sent to France, against 2,905,002 t.; while 228,165 t., went to Germany, against 187,550 t. Export in coke was 710,133 t., against 724,593 t. last year, of which 123,394 t. were exported to Germany, against 128,895 t. for the corresponding period last year.

The tone of the Rhenish-Westphalian iron market is very confident. The activity in the raw and finished iron industry has naturally been decreasing before and after the holidays, and stocktaking will in many instances prevent a vigorous employment for the next fortnight, but a healthy business is expected to be done afterwards, and producers as well as dealers are entering the new year with much confidence. Pig iron, which has been in pretty regular request, shows much firmness in quotations. Forge pig, No. 1, is quoted, M. 48 to 52 p.t.; No. 3, M. 42 p.t.; hematite, M. 63 p.t.; foundry pig, No. 1, M. 65 p.t.; No. 3, M. 56 p.t.; basic, M. 50 p.t.; Bessemer, M. 54 to 55 p.t.; iron for steel making, M. 49 to 52 p.t., at works. For Luxemburg forge pig M. 45 p.t. is quoted. Demand in the malleable iron trade may be termed pretty lively, considering the season of the year. Prices, however, are for the present scarcely paying, and manufacturers are, therefore, anxiously waiting for the rise in quotations which the spring business is likely to bring. Bars have recently been offered at M. 103 to 111 p.t. Girders are extremely quiet just now. Plates and sheets, though less animated than before, are still in fair request. Wire and wire nails continue neglected; the same is the case with rivets. The employment of the tube foundries leaves pretty much to be desired, basis price remaining on M. 110 p.t.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

THERE was a fair attendance on 'Change to-day. Steam and house coal was in good demand at last week's prices. There is no change to report in the tin-plate trade. The manufactured iron and steel trades are easier. The pitwood market, if anything, is slightly easier. Notwithstanding the dislocation of business caused by the holidays, the shipments of coal and fuel have reached nearly 70,000 tons. The ship repairing trade is quieter than it has been for a considerable time. The rapid arrival of tonnage into the port, however, will doubtless give it a fillip, and we can safely predict that in the course of a few weeks the trade will have resumed that state of great activity which was characteristic of it during the whole of last year.

Prices ruling on 'Change to-day were as follows:—Coal, best steam, 8s. 6d. to 8s. 9d.; seconds, 8s. to 8s. 3d.; best house coal, 10s. 6d.; dock screenings, 5s.; colliery, small, 4s. 6d.; smiths' coal, 6s. 6d. Patent fuel, 10s. 3d. Pig iron: Scotch warrants, 45s. 4½d.; hematite warrants, 46s. 4d., f.o.b. Cumberland; Middlesbrough, No. 3, 36s. 5d. prompt; Middlesbrough hematite, 44s. 4d. Iron ore: Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel rails: Heavy sections, £4 15s.; light sections, £5 5s. Tin-plate bars, £4 2s. 6d. to £4 5s. Siemens tin-plate bars, best £4 5s. to £4 7s. 6d., all delivered in the district, cash, less 2½ per cent. Tin-plates: Bessemer steel coke, 9s. 3d.; Siemens coke finish, 9s. 6d. Ternes, per double box, 28 by 20c., 21s. to 22s. Pitwood, 16s. to 16s. 3d.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, December 26th.

THE last half of the current year has filled mills, shops, and factories with work at high prices. The sudden expansion of demand gave an impulse to mill and factory construction. If this demand does not expand, a collapse is inevitable. The furnaces are turning out ten thousand tons of pig iron per day more than January 1st, and as long delayed requirements will soon be filled, an accumulation is inevitable. Bessemer and billets have fallen to nearly cost. Coke is to be advanced to two dollars per ton January 1st. Last winter it sold at one dollar. Lake ore companies are all preparing to rush out ore at the rate of a million and a-half tons per month during the shipping season. Never was our steel and iron-producing facilities so perfect. Furnace production is close on to 220,000 tons. Rolling mill capacity is not as crowded as a month ago. Plate and structural mills are still running full time. Bar mills in some cases have returned to single turn. The banks are well supplied with money, but commercial demands are restricted. Copper is weak and declining. Stocks of tin are very large, and prices are weaker. Lead is declining, and heavy holders in the West are trying to unload. Anthracite coal mines will run half time. The soft coal mines are producing their maximum output. Lake navigation has ceased for the winter. All the lake shipbuilding yards will be crowded with work to meet next year's tonnage requirements. A general improvement in the industries is a reasonable expectation. The present dulness is the natural result of advancing prices and undue activity during the autumn months. Prices are everywhere weakening, but the room for a drop is contracted. After the opening of the year buyers will probably renew their engagements at the current quotations.

The panic in stock has had no effect on the industrial situation. A 3 per cent. bond Bill will perhaps be passed at Washington to fill up our purse. Large gold exports have decreased the stock to 68,000,000 dols. This has resulted in the bringing forward of a measure to increase tariff duties 25 per cent. on certain articles, and which will provide an additional annual revenue of 45,000,000 dols. Our high-class securities are now in better demand abroad, according to orders received by local brokers. Railroad earnings for ten months on 132 roads show an increase of seventeen million dollars in net earnings over 1894, same time. The demand for iron and steel is moderate, owing to declining prices. The enormous production has been promptly absorbed up to this time, but as to pig iron, there is now a surplus which must rapidly grow until the weaker furnaces will be forced out of production. There is nothing to discourage steel makers beyond weak prices in 1896. A conservative course will be pursued with regard to railroad construction. The latest authoritative statements on this subject are that minimum construction requirements will be attended to. This is the present conclusion, but it is liable to be most suddenly set aside for a very different one. The iron and steel makers hold to the belief that circumstances will yet arise that will make 1896 a phenomenal year. Prices have now receded to a very low point. Crude iron production has about reached high-water mark, but makers feel it hazardous to permit a large accumulation except those few whose cost of production is the lowest. Coke price for 1896 will be fixed this week, probably at 2 dols. Companies have been recently organised to construct over 2000 additional ovens as soon as the work can be done. Steel making capacity is also being enlarged, and by the close of 1896, the United States will have a steel production capacity that will cover probable require ments to the close of the century.

LAUNCHES AND TRIAL TRIPS.

On Monday, December 30th, 1895, Sir Raylton Dixon and Co. launched from Cleveland Dockyard, Middlesbrough, the fine steel screw steamer Wolfsburg, built to the order of the Hansa Steamship Company, of Bremen, under the supervision of Mr. D. Wulff, their superintendent engineer. The principal dimensions are: Length, 323ft.; beam, extreme, 42ft. 6in.; depth moulded, 25ft. She is built to Lloyd's 100 A1 class, spar deck rule, the poop, bridge, and forecastle decks being of teak. The captain, officers, and engineers are accommodated in houses handsomely fitted up on bridge deck, and the crew and firemen are berthed in commodious quarters in topgallant forecastle. Triple-expansion engines, built to German law requirements, will be supplied by Messrs. T. Richardson and Sons, Hartlepool, having cylinders 22½in., 38in., 62in. by 42in. stroke, with two large single-ended boilers, working at 200 lb. pressure. This is the seventh steamer Sir Raylton Dixon and Company have launched for the Hansa Company within two years, another steamer being on the stocks for the same owners. On leaving the ways the vessel was named Wolfsburg by Mr. W. L. Johnson.

On December 30th, Messrs. Ropner and Son, of Stockton, launched a steel screw steamer of the following dimensions, viz.: Length between perpendiculars, 280ft.; breadth, 40ft.; moulded depth, 18ft. 6in.; which they have built for London owners, and is a sister ship to the s.s. Chiswick, launched a fortnight ago for the same owners. The steamer is built off the part awning decked rule, with poop and raised quarter deck, her deadweight carrying capacity being 3000 tons on 17½ft. The saloon and cabins for captain and officers are fitted in the poop, the engineers' accommodation being amidship. She is built on the web frame principle, leaving the holds entirely clear for cargo, and has a cellular bottom and after-peak arranged for water ballast. The engines will work up to about 750 effective horse-power, and are by Messrs. Blair and Co., having cylinders 21in., 34in., 56in. by 36in. stroke, steam being supplied by two large steel boilers working at 160 lb. pressure. On leaving the stocks Miss Nina Florence Munro, of Billingham Hall, Stockton-on-Tees, gave her the name of Richmond.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

⁂ When patents have been "communicated" the name and address of the communicating party are printed in italics.

16th December, 1895.

24,044. Cycle and Roller Skates, A. Dorst, London.
24,045. Books, F. W. J. Webb, Southampton.
24,046. Heel-protector, J. Hatschek.—(*A. Molnár, Austria.*)
24,047. Measuring Gunpowder, J. Dawber, Pemberton, near Wigan.
24,048. Power Accumulator for Cycles, J. T. Towlson, Somerset.
24,049. Electrical Contacts, A. J. Moulart and A. de Galard, Brussels.
24,050. Looms for Weaving Cloths, J. H. Cunliffe, Rochdale.
24,051. Rings for Pistons, E. W. Batt and T. Gribble, Bristol.
24,052. Microscope Eye-Rester, G. P. Richard, Southport.
24,053. Tin Opener, A. Fenton, Birmingham.
24,054. Educational Word-builder, J. H. Towers, Hants.
24,055. Electric Cable Joint Boxes, R. C. Quin, Brighton.
24,056. Pedals for Cycles, A. I., A. I. B., and A. P. Maxfield, Birmingham.
24,057. Brackets, A. I., A. I. B., and A. P. Maxfield, Birmingham.
24,058. Manufacture of Ice, W. Antrobus, Manchester.
24,059. Recreation Appliances, R. Tatham, Liverpool.
24,060. Brakes, T. Hewett, London.
24,061. Boot Polisher, J. White and R. Jardine, Canada.
24,062. Turning or Sliding Lathe, W. and T. P. Longworth, Bolton.
24,063. Non-oleaginous Paints, J. C. Sellars, Liverpool.
24,064. Pencils, M. Plenderleith, Glasgow.
24,065. Refrigerating the Hold of Vessels, D. B. Walker, Glasgow.
24,066. Buttons, T. Marchant, London.
24,067. Ballasting Sleepers, C. H, Sadler, Petarth, near Cardiff.
24,068. Gas Burners, G. F. Sturgess, Leicester.
24,069. Ejecting Mechanism, E. J. Churchill and J. Ross, London.
24,070. Screw-making Appliance, &c., E. Ravet, London.
24,071. Railway Vehicle Couplings, G. W. Clayton, London.
24,072. Temporarily Binding Books, F. D. Hutchins, London.
24,073. Illuminant for Gas, J. C. Robertson and J. A. Wallace, London.
24,074. Dress Goods, S. Farrar and J. S. L. Whitely, London.
24,075. Body Parts of Lamps, G. H. W. Davis, Birmingham.
24,076. Ventilating Chimney Pots, J. Duckett and Son and J. Duckett, London.
24,077. Stretchers for Boots and Shoes, W. C. Alexander, London.
24,078. Tripod Stands for Cameras, H. H. Stannus, London.
24,079. Electric Railway Collectors, W. E. Parry.—(*J. Parry, United States.*)
24,080. Manufacture of Colour Lakes, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
24,081. Circular Sawing Apparatus, J. McGinn, London.
24,082. Dumb-bells, G. B. Winter, London.
24,083. Feeding-bottles, B. V. Hemming, London.
24,084. Stud for Collars, &c., J. A. Fischer, London.
24,085. Skirt Band Fastener, W. Hawthorn, London.
24,086. Parlour Game of Football, W. H. Mash, Waltham Cross.
24,087. Triggers for Small-arms, D. T. Seymour, London.
24,088. Distribution of Acetylene Gas, W. Synnock and G. Gosling, London.
24,089. Fork Cleaners, A. J. and W. C. Needham, London.
24,090. Pneumatic Tires, J. Dring and E. H. Jones, London.
24,091. Moustache-protecting Spoon, C. F. Cooper, London.
24,092. Night Signalling Apparatus, C. Vreede, London.
24,093. Walking-stick, W. Daniels, London.
24,094. Connecting Taps and Joints, C. J. Young, London.
24,095. Collapsible Case, R. W. Groom, London.
24,096. Incandescent Oil Gas Burners, W. G. Potter, London.
24,097. Charging Retorts, W. R. Herring and M. Graham, London.
24,098. Motor Dynamos, A. de Puydt and M. Poncin, London.
24,099. Wheels for Vehicles, A. Paul and E. D. de Siblas, London.
24,100. Fastening Leather Together, T. Cowburn, London.
24,101. Driving Gear for Carriages, T. Cooper, London.
24,102. Raising Sunken Vessels, G. H. Chappell, London.
24,103. Draught Excluder for Doors, F. Clasen, London.
24,104. Hydrometers, &c., F. D. McNally, London.
24,105. Spanners and Pipe Wrenches, T. Oakey, London.
24,106. Bogies for Rolling Stock, A. Spencer, London.
24,107. Heating Apparatus, F. Horridge, London.
24,108. Speed Gear, F. R. Simms, London.
24,109. Type or Surfaces for Printing, A. Oldham, Liverpool.
24,110. Deep-boring Apparatus, H. Lapp, London.
24,111. Ovens, J. S. Chambers and J. G. Seymour, London.
24,112. Dumb-bells, L. Metzger, London.
24,113. Protecting Water Pipes, A. R Pulling and F. J. Rivolta, London.
24,114. Means for Driving Velocipedes, A. Pellerin, London.
24,115. Illuminating Signs, W. Aubert, jun., London.
24,116. Tile, P. Rolef, London.

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24,117. Cushion for Billiard Table, B. W. Richardson, Harrogate.
24,118. Vehicle Brake, A. Rollason, Long Eaton.
24,119. Music-leaf Turner, J. W. Hill, New Brompton.
24,120. Construction of Tea-pots, G. M. Billington, Longport.
24,121. Photographic Dark Slides, H. Hodgetts, Birmingham.
24,122. Manufacture of Sulphur Dioxide, J. Enright, London.
24,123. Nippers for Spinning Machines, J. Neale, Wolverhampton.
24,124. Focussing Appliance for Cameras, J. Pearse, Exeter.
24,125. Cancelling Labels, Brands, &c., W. Davies, Guernsey.
24,126. Circular Knitting Machines, H. Clarke, Nottingham.
24,127. Coating Metals, T. M. Ash and H. N. Weldon, Birmingham.
24,128. Hold-fast for Clothes Lines, R. B. Blayney and H. Baxter, Liverpool.
24,129. Horseshoes, J. Reynolds, jun., Nottingham.
24,130. Collars for Personal Wear, E. Towell, Manchester.
24,131. Making Paint Brush Handles, C. Buckley, Huddersfield.
24,132 Anchor or Grappler for Mooring, A. S. H. Richardson, London.
24,133. Coin-freed Gas Meters, C. G. Beechey, Liverpool.
24,134. Tobacco Pipes, H. H. Mayor, Liverpool.
24,135. Re-reeling Printed Matter, E. S. and A. Robinson and W. E. Exell, Bristol.
24,136. Electric Trolley Governor, H. Brecknell and T. B. Holliday, Bristol.
24,137. Night-light Lamp, C. Kempton, sen., London.
24,138. Aluminium Vessels, C. A. Rittel and J. Hodgson, Manchester.
24,139. Flat-irons, C. A. Rittel and J. Hodgson, Manchester.
24,140. Stamp Holder and Ink Pad, J. H. Kleine, Manchester.
24,141. Preparing Photographic Baths, A. Marouby, Derby.
24,142. Pickers for Looms, J. and J. A. Slater, Manchester.
24,143. Lithographic Printing, G. H. Bamber and T. Warburton, Manchester.
24,144. Vessels for Storing Liquids, E. C. Thomasson, Worcester.
24,145. Spring Backs for Account Books, C. Yates, Manchester.
24.146. Hooks for Hanging Meat, &c., A. Millard, Swansea.
24,147. Beer Engines, B. Samuel and H. C. Coker, London.
24,148. Reversible Door-mats, W. C. Cunningham, Preston.
24,149. Safety Appliances for Elevators, J. A. Steven, Glasgow.
24,150. Hoists, J. A. Steven, Glasgow.
24,151. Automatic Electric Fog Signal, W. E. Penfold, London.
24,152. Combs and any Hair Ornaments, E. Westley, London.
24,153. Cheese, J. Rose, London.
24,154. Type-setting Apparatus, G. Barkea.—(*L. K. Johnson and A. A. Low, United States.*)
24,155. Exhausting Calorific Power, W. Schmidt, London.
24,156. Separating Fatty Matter, S. S. Bromhead.—(*V. Durant, Belgium.*)
24,157. Cameras, H. Casler, London.
24,158. Crushing Machines, R. H. Dundee and F. G. Jones, London.
24,159. Brakes, L. Pope, London.
24,160. Autographic Tablets, W. Assheton, D. Stewart, and C. J. Carroll, London.
24,161. Winding Thread, A. Caron and J. Estienne, London.
24,162. Brooches, J. A. Culver, London.
24,163. Manufacturing Mouldable Masses, L. Grote, London.
24,164. Foot Mats, O. Imray.—(*T. C. McPherson, United States.*)
24,165. Hardening Active Material, L. Epstein, London.
24,166. Electric Lamps, The Edison and Swan United Electric Light Company, Ld., and E. A. Gimingham, London.
24,167. Consecutive Numbering Head, H. Thiele, Liverpool.
24,168. Softening Water for Domestic Use, G. D. Yates, Liverpool.
24,169. Rubber Articles, H. G. Wolcott and J. P. Rider, London.
24,170. Playing the Game of Dominoes, H. E. Charnock, Liverpool.
24,171. Ammonium Salts, J. H. Darby, Liverpool.
24,172. Galvanic Batteries, A. C. Iwanowski, Liverpool.
24,173. Game Markers or Indicators, W. T. Nicholls, Great Yarmouth.
24,174. Looms, H. H. Lake.—(*A. E. Schmidt, United States.*)
24,175. Horseshoes, H. D. Shaiffer, London.
24,176. Sea Cocks, P. T. Perkins and T. Kingsford, London.
24,177. Water-tube Steam Generators, E. D. Meier, London.
24,178. Cycles, C. C. Fontaine, London.
24,179. Bottles and Stoppers for Wines, W. A. C. Waller, London.
24,180. Securing Elastic Tires in Place, C. Benz, London.
24,181. Folding-up Papers, H. E. Newton.—(*R. Hoe, United States.*)
24,182. Bending Printing Plates, H. E. Newton.—(*R. Hoe, United States.*)
24,183. Liquid Dispensing Apparatus, W. M. Fowler, London.
24,184. Azo Dye-stuffs, H. E. Newton.—(*The Farbenfabriken vormals F. Bayer and Co., Germany.*)
24,185. Boots, H. Dunkley, London.
24,186. Door Checks, T. Barnes and J. Mahoney, London.
24,187. Brush and Scraper for Boots, J. Mellor, London.
24,188. Cookers, M. E. Sheldon, London.
24,189. Cake Filling Machines, H. Hueg, London.
24,190. Signs, A. B. Gehman, London.
24,191. Swivelling Bearings for Shafting, C. Whitfield, London.
24,192. Oil Stoves, C. S. Snell, Saltash.
24,193. Ortho-nitro-toluene-para-sulphonic Acid, G. B. Ellis.—(*La Société Chimique des Usines du Rhône, anct. Gilliard, P. Monnet and Cartier, France.*)
24,194. Ortho-nitro-toluene-para-sulphonic Acid, G. B. Ellis.—(*La Société Chimique des Usines du Rhône, anct. Gilliard, P. Monnet and Cartier, France.*)
24,195. Para-amido-benzoic-sulpinide and Amides, J. C. Mewburn.—(*The firm of Dr. F. von Heyden Nachfolger, Germany.*)
24,196. Acetylene Gas, E. B. Pym and J. Gore, London.
24,197. Portable Buildings, A. Putney, London.
24,198. Mowing and Reaping Machines, E. Pratt, London.
24,199. Driving Gear for Cycles, E. P. L. M. Verdot, London.
24,200. Espalier Walls, W. Büsche, London.
24,201. Steam Engine Governors, A. L. F. Bayle, London.
24,202. Music Holder, H. Stanbridge, London.
24,203. Forced Draught Lamps, J. Y. Johnson.—(*R. Hitchcock, United States.*)
24,204. Constructing Wheels, E. M. F. L. S. Desbrière, London.
24,205. Automatic Window Fastening, R. C. Norman, London.
24,206. Sugar Mills, P. Gibson.—(*J. Gibson, Fiji.*)
24,207. Igniting Devices for Gas Jets, A. Neumann, London.
24,208. Anti-incrustation Devices, E. B. Parnell, London.
24,209. Blasting Cartridges, A. J. Boult.—(*M. Reuland, Germany.*)
24,210. Coin-freed Apparatus, A. J. Boult.—(*M. Nathan, Germany.*)
24,211. Coin-freed Machines, A. J. Boult.—(*E. J. Herrmann, Germany.*)
24,212. Transmitting Sounds, T. J. Howell and G. and P. R. Pocock, London.
24,213. Milk Churns or Receptacles, R. W. Welford, London.
24,214. Furnaces, E. Powell, London.
24,215. Disinfecting Water-closets, H. W. Plews, London.
24,216. Lighting Vehicles, G. Webb, jun., and L. J. Underwood, London.

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24,217. Da Costa's Range Finder, O. M. J. da Costa, Woolwich.
24,218. Flexible Frames for Cycles, C. Hassel, Manchester.
24,219. Metal Nails, C. E. Cole, London.
24,220. Cistern, A. L. Forster and R. A. Norton, Newcastle-on-Tyne.
24,221. Envelopes and Wrappers, S. Learoyd and J. Lewis, London.
24,222. Multiplex Telephony, D. Sinclair, Glasgow.
24,223. Pneumatic Roller Skate, M. V. Lyons, Cork.
24,224. Making Lac and Varnish, L. Knoche, Barmen, Germany.
24,225. Method of Stoppering Bottles, T. Morton, Lanarkshire.
24,226. Toy, C. L. Brook, Huddersfield.
24,227. Apparatus for Welding Metals, W. Pearson, Birmingham.
24,228. Fastening Windows, G. C. Fielder and R. Siddall, Manchester.
24,229. Brakes for Safety Bicycles, T. Hood, Manchester.
24,230. Looms, E. Hollingworth.—(*W. Wattie and G. F. Hutchins, United States.*)
24,231. Fire-grates, J. S. Elliott and W. Elliott, Birmingham.
24,232. Lifts and Hoists, C. Musker and A. Musker, Liverpool.
24,233. Phantom Minnows or like Baits, M. Carswell, Glasgow.
24,234. Organ Pipes, T. Arlidge, Bristol.
24,235. Road Vehicles, J. Brindley, W. Naylor, and C. L. N. Wilson, Wolverhampton.
24,236. Looms for Weaving Splits, E. Webster, Accrington.
24,237. Bearings of Washing Machines, T. Greves, Warwick.
24,238. Raising Sashes, J. Merrill and I. Leversidge, Sheffield.
24,239. Looms, T. Priestley, Bradford.
24,240. "Cannon-popgun," H. Abraham, London.
24,241. Coating for Metallic Wire, J. H. Richards, Birmingham.
24,242. Cranks for Safety Bicycles, T. Knowles, Manchester.
24,243. Covering Water-closet Cisterns, T. Curtis, Birmingham.
24,244. Vessels for Measuring Liquids, F. Rose, Glasgow.
24,245. Card for Weavers' Power Looms, J. Bénazet, Brussels.
24,246. Treating Ores, R. Thomson and J. and R. Addie, Glasgow.
24,247. Treating Ores, J. Addie, R. Thomson, and R. Addie, Glasgow.
24,248. Treating Ores, J. Addie, R. Thomson, and R. Addie, Glasgow.
24,249. Cycles, M. A. Lilly, Bristol.
24,250. Vertical Ball Bearing, R. J. Leeson, Newcastle-on-Tyne.
24,251. Game of Skittles, A. W. Bate and C. H. Bailey, Nottingham.
24,252. Pneumatic Tires for Cycles, H. A. Davis, Bromley, Kent.
24,253. Bedstead Knobs, G. E. Lancelott, London.
24,254. Sash Fasteners, G. H. Mountain, London.
24,255. Chin Rest or Holder for Violins, F. J. Strong, Birmingham.
24,256. Bricks or Blocks for Chimneys, C. Wagner, London.
24,257. Envelope, S. F. Alderson, London.
24,258. Disinfecting Water-closets, H. T. Gardner, Cirencester.
24,259. Self-acting Spring Wicket, W. Wharldall, London.
24,260. Steam Engines, A. R. Bennett, London.
24,261. Frost Nail for Shoes of Horses, L. Vincent, London.
24,262. Rings used for Guiding Reins, W. Burnell, London.
24,263. Substitution of Sheet Glass, J. Badon, London.
24,264. Resistance Switch Apparatus, Siemens Brothers and Co., Limited.—(*Siemens and Halske, Germany.*)
24,265. Rotary Motors or Pumps, R. G. Radford, London.
24,266. Boiler Furnaces or Flues, S. Fox, London.
24,267. Burning Aluminium Ornaments, W. Schreiber, Berlin.
24,268. Tidal Motors, J. F. R. Knobloch, London.
24,269. Tidal Motors, J. F. R. Knobloch, London.
24,270. Smokers' Pipe Cleaners, J. L. A. Aymard, London.
24,271. Protectors for Dress Busks, &c., C. Lambe, London.
24,272. Cellulose Manufacture, A. Duffek and A. Merrel, London.
24,273. Detachable Crank for Cycles, E. F. Wilson, London.
24,274. Bottles, W. A. Barrett, London.
24,275. Paper Making Machinery, T. A. Marshall.—(*G. Smidth, Denmark.*)
24,276. Bicycle Prop, E. Kircher and A. Watzl, Karlsruhe, Germany.)
24,277. Hand Cart for Iced Drinks, A. Hansen, London.
24,278. Photographic Objectives, F. R. von Voigtlander and D. Kaempfer, London.
24,279. Folding Shaft Joints, H. and C. E. Cowtan, London.
24,280. Patterns, J. C. Mewburn.—(*La Société Rueff et Compagnie, France.*)
24,281. Busk Fastenings, C. G. Beard.—(*G. Carcaut, France.*)
24,282. Preserving Vegetables, W. P. Thompson.—(*M. and A. Braumann, Germany.*)
24,283. Producing Pictures on Glass, F. Albrecht.—(*W. Knapp, Germany.*)
24,284. Emery Wheel Covers, G. Mayer and C. Schmidt, Liverpool.
24,285. Shirt Cuff Protector, D. Dolman, London.
24,286. Glass, A. J. Boult.—(*La Société Anonyme Belge pour la Fabrication des Emaux Artistiques, Belgium.*)
24,287. Securing Card Clothing to Iron Flats, C. Rothe, London.
24,288. Chimney Tops, L. Lloyd, London.
24,289. Ozone, C. J. Yarnold, London.
24,290. Restraining Horses from Kicking, H. Cave, London.
24,291. Pneumatic Tires for Vehicles, J. H. Barry, London.
24,292. Malting Apparatus, A. Deininger, London.
24,293. Nitrogenised Water, H. J. Haddan.—(*E. Freixa, Spain.*)
24,294. Candlesticks, D. P. M. Lloyd, London.
24,295. Steam Generators, W. Eaves, London.
24,296. Electric Transformers, A. B. Blackburn and W. L. Spence, London.
24,297. Moulding Pats of Butter, W. and W. Hucks, London.
24,298. Velocipedes, A. Gravier, London.
24,299. Driving Chains for Cycles, S. H. Crocker, London.
24,300. Conduit Tramways, J. More, jun., and G. Flett, London.
24,301. Frames for Cycles and Vehicles, J. R. Trigwell, London.
24,302. Process for Deodorising, &c., A. Guillemare, London.
24,303. Rollers for Printing Fabrics, A. Haley and W. T. Wilkinson, London.
24,304. Incandescent Electric Lamps, M. Bailey and J. Warner, London.
24,305. Potato Diggers, W. Groves, London.
24,306. Sash and Axle Pulleys, F. J. J. Gibbons.—(*E. A. Maginnis, United States.*)
24,307. Stops for Window Sashes, F. J. J. Gibbons, London.

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24,308. Attaching Handles to Broom Heads, E. J. Nowell and J. T. Ayton, London.

24,309. Raising Sunken Ships, F. E. Shean, London.
24,310. Tri-reflecting Carriage Lantern, R. H. Coppin, Croydon.
24,311. Air-tight Couplings for Tubing, D. Allan, London.
24,312. Aluminium Bicycle Frames, W. Pearson, Birmingham.
24,313. Blowing Glass Bottles, &c., F. F. Warren, Dublin.
24,314. Blowing Glass Bottles, &c., F. F. Warren, Dublin.
24,315. Puzzle Game, W. Francis, D. G. Day, H. Hunter, G. C. Weston, and G. W. Hunter, London.
24,316. Hollow Column for Bedsteads, G. Rogers, Birmingham.
24,317. Textile Fabrics, G. Douglas, Bradford.
24,318. Looms, C. C. Howland, Hyde.
24,319. Cloth-covered Printing Rollers, S. Pulman, Manchester.
24,320. Pneumatic Tires, T. Lockwood and W. H. Hanson, London.
24,321. Pneumatic Tires for Cycles, G. C. Mesuard and G. G. Scurfield, Sunderland.
24,322. Heat Non-conducting Coverings, J. C. S. McLay, London.
24,323. Extracting Pickles from Bottles, G. R. Downer, Chichester.
24,324. Composition for Ships' Bottoms, T. Sheppardson, Sunderland.
24,325. Strainer for Cooking Purposes, R. W. Welbank, Banbury.
24,326. Ring for Keys and Tablets, H. G. N. Gardner, London.
24,327. Horse Collar, F. Warner, Wednesbury.
24,328. Washing Brushes, G. Holmes, sen., and G. Holmes, jun., Derby.
24,329. Tube for Pneumatic Tires, J. Moseley, Manchester.
24,330. Table Condiment Receptacles, J. Sculthorpe, Liverpool.
24,331. Night Marching Instrument, W. W. C. Verner, Birmingham.
24,332. Hydraulic Checks, R. Hodges and S. Hill, London.
24,333. Cycle Brakes, R. H. Housman and F. W. Lanchester, London.
24,334. Chains for Chain Gearing, F. J. Smedley, Nottingham.
24,335. Wheels for Chain Gearing, F. J. Smedley, Nottingham.
24,336. Cycle Saddles, W. Brown and J. Read, Leicester.
24,337. Heating Water, L. A. Chevalet and W. Boby, London.
24,338. Cycle Tubes, O. Pihlfeldt and W. G. Garnett, Birmingham.
24,339. Manufacture of Tires for Cycles, A. Kunze, Liverpool.
24,340. Venetian Blind Cord Holders, W. Hitchin, Birmingham.
24,341. Preventing Waste in Wax Candles, A. J. Pursall, Birmingham.
24,342. Spiked Plates for Boots, E. and S. Brown, Birmingham.
24,343. Cycle Wheels, J. E. Thornton and W. H. Armitage, Altrincham.
24,344. Printing Fabrics, S. Schwabe and Co. and J. Gilbertson, Manchester.
24,345. Sewing Machine, R. Haase and S. Salinger, London.
24,346. Driving Chains and Wheels, H. Renold, Manchester.
24,347. Non-automatic Syphon Cisterns, W. H. Webster, York.
24,348. Boot Protector, W. J. Fox, Manchester.
24,349. Egg Boxes, J. Laing, Glasgow.
24,350. Hay-making Machines, J. E. S. Perkins and J. Harrison, Peterborough.
24,351. A Revolving Adjustable Spanner, Colin Brothers, Southport.
24,352. Non-slip Boot Tongue, J. H. Airey, Sunderland.
24,353. Printing Rollers, T. McKillop and J. Garnett, Glasgow.
24,354. Electrical Switches, C. M. Dorman, R. A. Smith, and H. G. Baggs, Manchester.
24,355. New Reflecting Stove, T. Bergmann, Brussels.
24,356. Indicating Rotary Speed, J. Wolff, Brussels.
24,357. Drilling Wood, &c., J. E. Leeson, Manchester.
24,358. Munitions of War, &c., W. G. Rothwell, Southport.
24,359. Folding Heads of Vehicles, J. G. Harrison, Birmingham.
24,360. Lasts, A. C. York and F. S. Readhead, London.
24,361. Spring Collar Stud, R. M. Dewar, London.
24,362. Bicycle Saddles, H. A. Christy, London.
24,363. Sounding Apparatus, S. H. James, London.
24,364. Self-threading Needles, V. Milyard and S. Davis, London.
24,365. Inhaler, The Anglo-Swedish Trading Association, Ld., and G. O. Rennerfelt, London.
24,366. Resonators for Stringed Instruments, D. Mayer, London.
24,367. Adjusting the Heights of Seats, H. Brooks, London.
24,368. Handling of Steel Plates, E. P. Martin and E. James, London.
24,369. Sifters for Chaff Cutters, R. Drake, London.
24,370. Chain Gearing, I. A. Timmis, London.
24,371. Plansifters, W. P. Thompson.—(*G. Luther, Germany.*)
24,372. Photographic Cameras, &c., C. Oliver, London.
24,373. Buckles, W. H. Edwards, Liverpool.
24,374. Couplings, D. J. Schulte and H. L. Donnelly, London.
24,375. Electric Arc Lamps, I. H. Hegner, Liverpool.
24,376. Home-trainers for Cyclists, J. Hutson, London.
24,377. Breech Mechanism, J. B. G. A. Canet, London.
24,378. Cleansing the Material in Filter-beds, J. Corbett, London.
24,379. Majolica Tiles, Vases, &c., O. Lauch, London.
24,380. Machine for Shaping Boxes, G. Patureau, London.
24,381. Apparatus for Charging Air, L. Denayrouze, London.
24,382. Separating Yarns, A. G. Brookes.—(*W. F. Draper, United States.*)
24,383. Gas Liquor Separators, S. Cutler, London.
24,384. Oil Atomiser for Gas Carburetters, S. Cutler, London.
24,385. Air Tubes of Pneumatic Tires, D. A. Martin, London.
24,386. Rubber Tires, G. C. Marks.—(*The Rubber Tire Wheel Company, United States.*)
24,387. Refining Alcoholic Liquors, D. Young.—(*C. Bullock and C. M. Reed, United States.*)
24,388. Magic Lanterns, S. P. Frampton, London.
24,389. Wood-block Flooring, W. T. Herbert and J. S. Hayes, London.
24,390. Photographic Cameras, A. A. Smith and J. Stuart, London.
24,391. Toy Animals, J. E. Bousfield.—(*Eisenmann and Co., Germany.*)
24,392. Dyeing Wool, M. Béraud and A. Lautmann, London.
24,393. Lamps, A. C. Miles and B. F. de Morgenstern, London.
24,394. Batteries, A. C. Miles and B. F. de Morgenstern, London.
24,395. Reservoir Penholders, A. Linck and J. Pacher, London.
24,396. Foot Warmers, J. McRae and W. Dale, London.
24,397. Securing Blind Cords, E. L. Robilliard, London.
24,398. Controlling Electric Currents, C. Pollak, London.
24,399. Envelope, C. Hugo, London.

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24,400. Puzzle, J. E. Evans, London.
24,401. Bed-rest, H. G. Monkhouse, London.
24,402. Sewing Machines, M. H. Pearson and Pearson and Bennion, Ld., Leicester.
24,403. Mowers, C. Hodson, Derby.
24,404. Buffing Wheels, H. A. Oldershaw, Leicester.
24,405. Elastic and Knitted Fabrics, G. Riley, Leicester.
24,406. Igniting Lamps, A. F. Richter.—(*W. Seippel, Germany.*)
24,407. Steam Rotary Motor, C. Burgess, Worcestershire.
24,408. Moulding Ceiling Cornices, &c., J. Light, Bristol.
24,409. Towels, W. H. Boyles and A. J. Curnow, London.
24,410. Manufacture of Wheel Tires, T. Sloper, Devizes.
24,411. Motors, C. T. Wordsworth, E. Wiseman, and J. Holroyd, Manchester.
24,412. Socketed Earthenware, C. J. H. Gradisky, Manchester.
24,413. Ridge Tiles for Roofing, C. J. H. Gradisky, Manchester.
24,414. Dress Suspenders, A. E. Garratt, Birmingham.
24,415. Damping Lithographic Stones, E. Tudor, jun., H. Grimshaw, and G. Daniels, Manchester.
24,416. Ball Bearing Boxes and Axles, J. Parr, Leicester.
24,417. Pneumatic Tires, S. Tweedale and J. Clegg, Manchester.
24,418. Purification of Oil, E. S. Wilson and E. Stewart, Liverpool.
24,419. Combined Cone Adjuster, W. Homer, West Bromwich.
24,420. Temperature in the Holds of Steamships, B. J. Maloney, Edinburgh.
24,421. Straining Water Pulp Apparatus, J. White, Glasgow.
24,422. Medical Spoon for Liquids, W. H. Bagley, Birmingham.
24,423. Tapestry Carpets, R. J. C. Mitchell, Manchester.
24,424. Loading Live Stock, W. J. Mead, London.
24,425. Pneumatic Tires, T. A. Hearson and W. Menzies, Surrey.
24,426. Drop-down Guns, W. Cashmore, Birmingham.
24,427. Hooks, T. R. Voce and B. Drysdale, Birmingham.
24,428. Guiding Driving Ropes, F. S. Rippingille, London.
24,429. The Over Bath Movable Washstand, A. Stunt, London.
24,430. Cornice Pole Rings, W. A. Rees, London.
24,431. Safety Pin, C. Bayer, London.
24,432. Boxes, A. M. Clark.—(*M. C. Söderlund, Russia.*)
24,433. Lifting Appliance, A. M. Clark.—(*M. C. Söderlund, Russia.*)
24,434. Vehicle Wheels, F. W. Shorland, London.
24,435. Thread Cutter for Spools, A. B. Sykes, London.
24,436. Pneumatic Tires for Cycles, S. Anyzewski, London.
24,437. Gas Lighters, The Anglo-Swedish Trading Association and O. E. Wollert, London.
24,438. Treadle Mechanism, &c., H. Gainswindt, London.
24,439. Valve Mechanism of Steam Engines, C. W. Thompson, London.
24,440. Manufacture of Sensitised Paper, W. Friese-Greene, London.
24,441. Pails, H. Goldberg and The Johannesberg Mining and General Syndicate, London.
24,442. Oil Lamps, L. E. Thornton, London.
24,443. Portable Electric Lamps, S. F. Walker, Cardiff.
24,444. Holders for Electric Glow Lamps, E. Hungerbühler and the Electrical Company, Ld., London.
24,445. Preventing Rucking in Shirt Fronts, G. A. Cartwright, London.
24,446. Brake, T. Brailsford, E. Wardle, and A. Hemsley, London.
24,447. Cyanide Solutions, C. M. Pielsticker, London.
24,448. Paper Fasteners, S. H. Crocker, London.
24,449. Lifts, C. A. Perkin and J. C. Cole, London.
24,450. India-rubber Tires, J. G. Ingram, London.
24,451. Upholstering Seats of Chairs, W. Vogler, London.
24,452. Gong Bells, N. T. Mills, London.
24,453. Hollow Projectiles, R. A. Hadfield and A. G. M. Jack, London.
24,454. Quick Folding Doors, J. C. Hudson, London.
24,455. Obtaining Pure Starch from Crude Starch, W. V. Siemens and O. N. Witt, London.
24,456. Treatment of Potato Starch, C. Hellfrisch, London.
24,457. Feed-water Filters, A. Harris, Liverpool.
24,458. Dog Muzzles, E. de Vargyas, Liverpool.
24,459. Earthenware Gully Traps, G. Brain, jun., London.
24,460. Ventilation of Drains, &c., B. S. Wagstaff, London.
24,461. Station Indicator, J. R. Hearnden, London.
24,462. Trays for Middlings Purifiers, J. Hunt, London.
24,463. Mediums for Igniting Coal Gas, T. V. Riordan, London.
24,464. Gas Lamps, F. L. Schulz, Hamburg.
24,465. Contact Button, A. C. Miles and B. F. de Morgenstern, London.
24,466. Indicators, A. C. Miles and B. F. de Morgenstern, London.
24,467. Incandescent Lamps, A. C. Miles and B. F. de Morgenstern, London.
24,468. Removable Covers on Cycle Seats, J. Maclachlan, London.
24,469. Cycles, A. Durey and L. Schreiner, London.
24,470. Valve Mechanism for Engines, C. W. Thompson, London.
24,471. Electric Circuits, V. A. Fynn and Easton, Anderson, and Goolden, London.
24,472. Electric Machines, V. A. Fynn and Easton, Anderson, and Goolden, London.
24,473. Incandescent Lamps, C. H. Stearn.—(*C. F. Topham, Switzerland.*)
24,474. Wheels for Carriages, &c., A. Reimann, London.
24,475. Polishers, R. H. Webb, London.
24,476. A New Rotary Steam Engine, F. Hamer, London.
24,477. Sewing Machines, H. H. Lake.—(*F. W. Merrick, United States.*)
24,478. Water Lifts, C. T. Burgess, London.
24,479. Compositions of Matter, R. D. Upham, London.
24,480. Brakes for Road Vehicles, F. W. Lucas, London.

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24,481. Spring Lock and Key, W. Meakin, London.
24,482. A Protector for Meat, Fish, &c., W. Poole, Somerset.
24,483. A New Weighing Machine, T. A. McKee, Dublin.
24,484. Collapsible Partition Screen, E. J. Sherman, Felixstowe.
24,485. Gas Meters, G. Haydon, F. H. Urry, and G. Sommerville, London.
24,486. Junction Marked Drain Pipes, M. Aspinall, Worthing.
24,487. Correspondence Cards, S. Learoyd, Huddersfield.
24,488. Soup Spoon, C. R. Williams, Newcastle-on-Tyne.
24,489. Making Sealing Wax, H. Bedford, Devon.
24,490. Puzzle, J. Scott and J. Davidson, Glasgow.
24,491. Safety Lamp Gauze Brushes, J. Aspinall, Barnsley.
24,492. Corrugated Hot Water Tanks, J. Leckie, Greenock.
24,493. Weaving of Textile Web Fabrics, J. Fulton, Glasgow.
24,494. Washing Machine, G. Davies, G. Shepherd, and D. Shepherd, London.
24,495. Cycle Frames, J. A. Beard, Birmingham.
24,496. Sewer Ventilating Lamps, J. E. Webb, Birmingham.
24,497. Crimped Fabrics, J. H. Macmillan and J. Mason, Manchester.
24,498. Churn Fastener, C. Chitty, Bromley.
24,499. Hydraulic Oil Seed Presses, G. P. Wallis, Leeds.
24,500. Watches, J. Roth Sohn, Manchester.
24,501. Photographic Appliances, G. Lecourt and J. Bové, Brussels.
24,502. Door Retainers, W. A. C. Waller, London.
24,503. Electric Insulators, R. Atherton, London.
24,504. Mortising Machines, T., R., and W. Lees, Manchester.
24,505. Mantles for Incandescent Gas Lighting, A. Taylor.—(*W. S. Taylor, at present on the High Seas.*)
24,506. Mowing and Reaping Machines, W. and T. Smith, Birmingham.
24,507. Mechanical Eraser, W. Pigot, Dublin.
24,508. Regenerators for Furnaces, H. Eckardt, London.
24,509. Hardman's Solution, G. Willcock and J. Hardman, Warrington.
25,510. Double-barrelled Winches, R. Roger, Leeds.
24,511. Pneumatic Tires for Cycles, H. Kesterton, London.
24,512. Baroque Work, E. A. Brinkmann and H. B. E. W. de Fonseca, London.
24,513. Bicycle Support, F. H. Ayres and H. Pitts, London.
24,514. Lamp Holders, R. Hacking and J. Bennett, London.
24,515. Boiler Furnaces, J. D. Ellis and J. Nodder, Sheffield.
24,516. Secondary Voltaic Batteries, L. Epstein, London.
24,517. Manufacturing Hydroxy Phenacetine-salicylate, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Bruning, Germany.*)
24,518. Door Hinges, Tonks, Ld., and J E. Tonks, London.
24,519. Spiral Railway, J. Horton and W. Horton, London.
24,520. Umbrella and Stick Clip, T. F. S. Tinne, London.
24,521. Photographic Printing Frame, G. Houghton, London.
24,522. Rotary Grinding Machines, P. J. Neate, London.
24,523. Apparatus for Heating Purposes, F. Horridge, London.
24,524. Curving Instrument, H. J. Wynne and A. H. Alexander, London.
24,525. Cycles, J. Price, T. Hann, and W. Bromley, London.
24,526. Pneumatic Tires for Wheels, P. M. C. Nivet, London.
24,527. Atmospheric Burners, F. Lamplough and The Automatic Heat Regulator Company, Limited, London.
24,528. Conveyor Chain, H. Hack and T. Piggott and Co., London.
24,529. Manure Distributing Machines, A. J. Boult.—(*E. Arnoult, France.*)
24,530. Glass Transfers, A. J. Boult.—(*P. A. J. Gasse, France.*)
24,531. Rollers for Glass, A. J. Boult.—(*P. A. J. Gasse, France.*)
24,532. Tack Drawer and Hammer Combined, H. Daws, London.
24,533. Bicycles, W. P. Thompson.—(*C. L. Travis, United States.*)
24,534. Necktie Holding Device, L. Dunning, Liverpool.
24,535. Filters for Artesian Wells, F. Pehlke, Liverpool.
24,536. Sights for Fire-arms, E. Edwards.—(*V. Kjaer, J. C. Johansen, and J. Zinn, Denmark.*)
24,537. Vehicle Wheels, A. Mange, London.
24,538. Fastener for Skirt Bands, J. R. Churchill, Derbyshire.
24,539. Electric Regulators, A. C. Miles and B. F. de Morgenstern, London.
24,540. Brackets for Axles and Shafts, C. C. Longridge, London.
24,541. Taps or Cocks for Water, &c., J. H. Blakesley, London.
24,542. Securing Milk Cans to Doors, &c., P. R. Pile, London.
24,543. Compensating Railway Signal Wires, F. B. Hart, Manchester.
24,544. Filtering and Purifying Oils, G. MacDonald, London.
24,545. Apparatus for the Loading of Guns, E. W. Lloyd, London.
24,546. Coatings of Earthy Oxides, R. Langhans, London.
24,547. Cycle Frames, W. L. Poole, A. Stone, and A. S. V. Turquand, London.
24,548. Guide for Roller Blind Cords, G. Geisselbrecht, London.
24,549. Luggage Labels, H. J. Hayes and J. B. Fisher, Norwich.
24,550. Reversing Rotary Engines, G. P. Grace, London.
24,551. Wheels, J. T. Bennett, St. Albans.
24,552. Manufacture of Baking Powder, J. Pleines, London.
24,553. Tires, G. C. Marks.—(*G. H. Chinnock, United States.*)
24,554. Centrifugal Machines, Manlove, Alliott, and Co.—(*E. E. A. Kuster, India.*)
24,555. Lamps for Burning Hydrocarbons, J. H. Iredale, London.
24,556. Devices for Electric Lamps, E. Jullien, London.
24,557. Machine Guns, F. A. L. Davidson, London.
24,558. Tips for the Sides of Spectacles, J. Benton, Manchester.

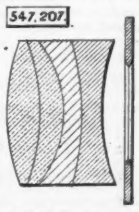
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

547,207. Lens for Optical Purposes, *C. P. Goerz, Schöneberg, and E. V. Hoegh, Wilmersdorf, Germany.—Filed July 18th*, 1895.

Claim.—A photographic objective consisting of four single lenses juxtaposited and cemented together, of which two juxtaposited lenses are positive and of different refraction, and two juxtaposited lenses are negative and of different refraction in such manner that a lens of less refraction is juxtaposited to a lens of higher refraction, for the purpose set forth.

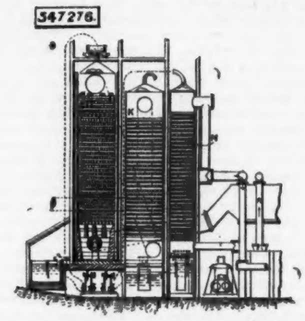
547,207.



547,276. Process of and Apparatus for Obtaining Ammoniacal Products, *L. Mond, Winnington, England.—Filed January 18th*, 1895.

Claim.—(1) The improvement in the process of extracting ammonia and tar from producer gases, and at the same time economically supplying hot air saturated with moisture at an elevated temperature to the gas producers, which consists in washing the gases with agitation in water to remove soot and dust and to condense the tar and the fixed ammonia, separating the free ammonia by means of an acid solution, passing the hot gases and water in prolonged contact with each other in reverse direction—whereby the gases are cooled methodically by the water and further ammonia and tar extracted and the water becomes heated—and passing this hot water and the air for the producer in prolonged contact with each other, in opposite directions, whereby the air is heated and saturated with moisture at an elevated temperature and the water cooled, and lastly, using the water over again to cool the hot gases. (2) In an apparatus for separating ammonia and tar from producer gases, the combination with a gas producer, scrubbers K and E for separating the ammonia, and a scrubber M for heating and saturating the air for the producer, and cooling the water for the scrubbers K and E. (3) In an apparatus for separating ammonia and tar from producer gases, the combination of producer A, scrubbers E, K, and M, and pipes and pumps connecting same, substantially as described.

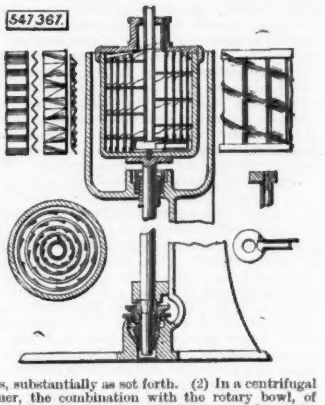
547276.



547,367. Centrifugal Creamer, *O. Anderson, Newark, N.J.—Filed June 16th*, 1894.

Claim.—(1) The combination with the rotary bowl, of plates arranged in circles concentric with the bowl and curved inward or having the concavities on the sides towards the centre of the bowl, and spirals formed at the sides of said plates to give an upward flow through the chamber between said circles of plates, substantially as set forth. (2) In a centrifugal creamer, the combination with the rotary bowl, of curved plates arranged vertically in annular series within said bowl, with openings between to allow an inflow of cream and an outflow of blue milk therethrough, and spiral partitions joining the plates of a series and giving upward movement to the separating fluids, substantially as set forth.

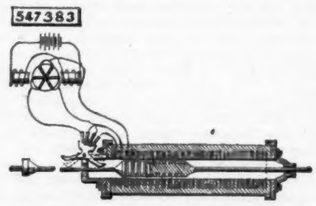
547367.



547,383. Reciprocating Electric Engine, *F. B. Rae, Detroit, Mich.—Filed May 31st*, 1892.

Claim.—(1) The combination in a multiphase reciprocating motor, of an electro-magnet having coils contained in different windings in the conductors forming the circuit of a multiphase generator, whereby a progressive field of force is produced in said magnet, a plunger for such magnet and a reversing switch, substantially as described. (2) In a multiphase reciprocating motor, the combination of an electro-magnet having a continuous iron core provided with a plurality of sets of coils contained in the different conductors of the circuit of a multiphase generator, a plunger for said electro-magnet, and a reversing switch operated by said plunger, substantially as described.

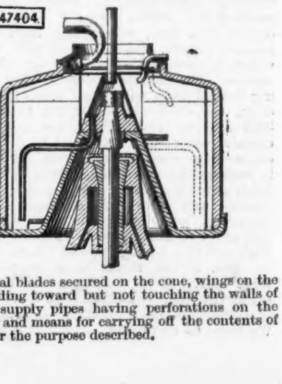
547383



547,404. Centrifugal Machine, *T. H. Springer, Philadelphia, Pa.—Filed March 16th*, 1895.

Claim.—(1) In a separator, a bowl having a conical centre, a spiral blade arranged on the cone, between the wings, feed pipes having perforations on the sides facing the centre of the bowl, and means for carrying off the contents of the bowl, as and for the purpose described. (2) In a separator, a bowl having a conical centre, spiral blades secured on the cone, wings on the cone extending toward but not touching the walls of the bowl, supply pipes having perforations on the inner side, and means for carrying off the contents of the bowl for the purpose described.

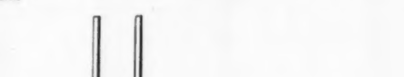
547404.



THE JENNY LIND.

WE illustrate this week an engine round which very great historical interest centres. The Jenny Lind was in a very large measure the forerunner of the standard type of English locomotive. We believe that most of our readers will admit that even in modern eyes there is much to admire in the design, and it is probable that the engine was on the whole the handsomest locomotive that had been built up to that date. The origin of the design is very instructive, and we are indebted to the private diaries of Mr. David Joy, which he has courteously placed at our disposal, for the following information.

In 1846 Mr. Joy was chief draughtsman at the Railway Foundry, Leeds, Mr. E. B. Wilson being head of the firm. Mr. John Gray was locomotive superintendent of the London and Brighton Railway. At the end of November, 1846, Mr. Joy was sent to Brighton to see him about an order for ten locomotives. Mr. Joy was employed for some time taking tracings from Mr. Gray's drawings and getting particulars. Then he travelled all over the line on various types of engines, among others, the curious locomotive with two pistons moving in opposite directions in each cylinder, designed by Bodmer. This engine some years subsequently ran off the road on the Lewes branch, killing both driver and fireman. The engine designed by Mr. Gray had six wheels, single drivers 6ft. in diameter, leading and trailing 4ft., cylinders 15in. by 24in., boiler 10ft. long by 4ft. 1in. diameter. The fire-box was square, 3ft. 4in. by 3ft. 4in., and 4ft. 9in. deep. There were 700 square feet of tube surface, and 79ft. of fire-box, and 11 square feet of grate; pressure 100 lb. There were two domes, both alike with square bases and lever safety valves. This engine was built by Hackworth, and ran very well, easily making forty miles an hour with heavy trains. There were on the line certain long boiler engines. These were much favoured, but those on the Brighton line rolled fearfully. Mr. Joy endeavoured to arrive at some conclusion as to what engine really would suit the line best out of all the types in use. He returned with the tracings of the Gray-Hackworth engine to the Railway Foundry, and began new drawings for two engines, Nos. 60 and 61. These had scarcely been begun when Mr. Gray left the Brighton line. The drawings were stopped, and orders were given that the Railway Foundry should submit designs for a new type. By Mr. Fenton's directions Mr. Joy began to scheme on the lines of the last locomotive built; one for the Leeds and Dewsbury line, with a boiler 11ft. 6in. long, outside cylinders, drivers far back, and trailing wheels behind the fire-box, and with as much heating surface as possible. About a dozen engines were sketched, and none of them appeared satisfactory. Mr. Joy went home on Saturday afternoon with his mind full of his subject, and in the evening he began scheming again, and prepared a sketch of the engine subsequently known as the Jenny Lind, so called after the famous singer whose name was just then in every one's mouth. At that time a low centre of gravity was deemed essential to steadiness. The Jenny Lind had inside cylinders 15in. by 20in., and single driving wheels 6ft. in diameter. The driving wheels had inside bearings; the leading and trailing wheels outside bearings. In order to get as wide a fire-box as possible, the inside frames stopped short at the box, as shown in the annexed sketch.



There were 800 square feet of surface, of which 80 were in the fire-box. The cylinders had the slide valves between them. The valve gear was the Stephenson link, the link being hung from the middle at one side only. Great care was taken to provide a free exhaust. The pressure was 120 lb., and the calculated weight full 21 tons.

On Monday morning Mr. Joy took his sketch to the works. It was at once approved, and he began detail drawings; various parts were strengthened, and the finished engine weighed full 24 tons. This was the origin of the Jenny Lind type, which remained for years the standard engine built by the Leeds Railway Foundry Company. It was the first high-speed really economical engine, the economy being due to excellence of workmanship and good proportion of parts; but mainly, no doubt, to the then excessive pressure carried in the boiler. To Mr. James Fenton is apparently due the credit of making the advance from 80 lb. or 90 lb., then usual, and 100 lb., then exceptional, to 120 lb. Mr. Joy says that he endeavoured to combine in the Jenny Lind all the good points of the Gray and various other engines, and we have here, no doubt, a design simple and harmonious. Our readers who are disposed to criticise it must not forget that in 1846 the design of the locomotive was in a chaotic condition; every one was feeling his way, and all manner of designs were tried, the locomotive as we have it being essentially a survival of the fittest. The Jenny Lind constituted a remarkable advance on what had gone before it, and held its own for years to come with what followed it, and this is not wonderful when we consider what the performance of the engine was in actual work.

In May, 1847, the first Jenny Lind, No. 60, on the Brighton line, was completed. The boiler was lagged with mahogany. The first run was made with it to Wakefield *viâ* Normanton, and returning, the engine was nearly run into by the Manchester mail train. The Jenny Lind was so much liked, that the Railway Foundry got numerous orders, and for some time built "Jennys" at the rate of one per week, a remarkable achievement in those days. A more powerful type of this engine was constructed with cylinders still 15in. by 20in., but with four driving-wheels instead of two, the diameter being reduced to 5ft. 6in.; the trailing driving-axle being as close to the fire-box as possible. In August, 1847, the last of the ten Jennys for the Brighton Company was finished. It had 6ft. 3in. drivers and 1000 square feet of heating surface.

Our engraving is reproduced from a photograph of a Jenny Lind which was on the Midland Railway. We are indebted for the photograph to Mr. Johnson. In May, 1848, it was decided that a competitive trial should take place between a Jenny Lind and another engine. The Midland locomotive chosen was built by Messrs. Sharpe, Stewart, and Co., and was known as the Jenny Sharpe. The following table gives particulars of the two engines:—

	Jenny Lind.	Jenny Sharpe.
Tubes	No. 124, 2in., 11ft. long ...	No. 161, 2in., 10ft. long
Surface	720 square feet	847 square feet
Fire-box	80 square feet	72 square feet
Total surface ...	800 square feet	919 square feet
Cylinder	15in. by 20in.	16in. by 20in.
Driving wheels	6ft.	5ft. 6in.
Weight loaded	24 tons 1 cwt.	21 tons 9 cwt.
Weight, tender	15 tons 13 cwt.	12 tons 11 cwt.
Total	39 tons 14 cwt.	34 tons
Load, 9 coaches 2 vans	64 tons	64 tons
Total load ...	103 tons 14 cwt.	98 tons

Average rise of road from Derby for 20 miles, 1 in 330
" " " " " " down, 1 in 330

The trip was from Derby to Masbro' and back. The trial took place on May 8th, 1848. The first run was made with the Jenny Sharpe. The average speed throughout was 49 miles per hour; up 1 in 330 it was 43 miles per hour. The total coke used, including getting up steam, was 16 cwt., or 44·8 lb. per mile; water evaporated, 10,290 lb., or 257 lb. per mile, and 5·7 lb. per pound of coke; pressure, 80 lb.; time of running, 50 min. 10½ sec. The next day, May 9th, the Jenny Lind made the same trip. Average speed throughout, 52 miles per hour; up 18 miles of 1 in 330 it was 47 miles per hour; total coke, including lighting, was 13 cwt., or 36·4 per mile; steam pressure, 120 lb.; time running, 46 min. 32 sec. The highest speed reached was 59 miles per hour. The highest speed reached by the Jenny Sharpe was 58·5 miles per hour. Two runs were then made with heavier loads, the total for the Jenny Lind being 139 tons 10 cwt., and for the Jenny Sharpe 133 tons 16 cwt. The total consumption was 13 cwt. by the first and 16 cwt. by the latter, the consumption per mile being 33·6 lb. for the Jenny Lind and 44·8 lb. for the Jenny Sharpe. The average speed of the former up 1 in 330 was 41 miles per hour, and for the latter 39·3 miles. Here was very conclusive evidence in favour of the higher pressure.

In a succeediug issue we shall give sections of the Jenny Lind. We have said enough, we think, to substantiate our statement that the type is one of unusual historical interest.

THE THEORY OF THE LUBRICATION OF PLAIN PARALLEL SURFACES.

By R. M. DEELEY, F.G.S., and C. E. WOLFF, B.Sc.

WITH the appearance of the paper by Prof. Osborne Reynolds, "On the Theory of Lubrication,"[*] may be said to date our knowledge of the action of viscous substances to diminish friction between relatively moving surfaces. Not that experiments had not previously been made. As a matter of fact, a vast amount of experimental data had been accumulated, but the results not only failed to agree among themselves, but also failed to agree with the general experience of engineers. The experiments of Mr. Beauchamp Tower, however, undertaken at the instance of the Institution of Mechanical Engineers, have served to explain the causes of most of these discrepancies. He found that much, very much, depended upon the way in which the lubricant was applied to the bearing, the friction depending upon the quantity and uniformity of the supply and distribution of the oil. Most of his recorded experiments were made in such a manner that the lubrication was what he called "perfect," *i.e.*, there was a comparatively thick film of oil maintained under pressure between the surfaces. When this was the case his results were strictly comparative, agreed better with the frictional resistances met with in such complex machines as steam engines, and were closely in agreement with hydrodynamical theory.

The theoretical results obtained by Professor Osborne Reynolds were published before Mr. Tower's experiments on collar friction and pivot friction were made. Professor Osborne Reynolds accordingly dealt with surfaces which, although they might be parallel under some circumstances, were not so when the loads were varied. On this account the friction was, generally speaking, in a great measure independent of the load, the mean thickness of the lubricating film remaining practically constant. The later experiments by Mr. Beauchamp Tower, however, were made on collar friction and pivot friction. In these experiments, although the faces were free to move to or from each other, they were constrained to remain parallel. Under these conditions there was a marked increase in the frictional resistance when the loads were increased; and to explain the facts it appears to us that some modification, or rather addition to, the theory is required.

In the present paper we hope to be able to show that the experimental results Mr. Tower obtained with plane parallel surfaces, and perfect lubrication, are also in agreement with theory. We will also discuss his experiments on collar friction. In them the rate of supply of the lubricant was so limited that the laws of solid friction were simulated.

Perfect lubrication.—We will, in the first place, discuss the theoretical aspect of the question, and then compare the theory with the experimental results. Fig. 1 shows two parallel planes of unlimited length and breadth, separated by a film of viscous liquid of thickness r. The upper plane C D is supposed to be fixed, while the lower plane A B moves in the direction of the arrow with a velocity V_1. By the definition of viscosity there will be a tangential resistance

$$F = \mu \frac{V_1}{r} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

whilst the total resistance

$$R = \mu \frac{V_1 A}{r} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where A is the area of the lubricated surface. The tangential motion of the fluid will vary uniformly from V_1 at A B to zero at C D. Thus, if F G—Fig. 1—be taken to represent V_1, then P N will represent the velocity of the fluid at P. To produce these conditions of motion the planes must have been in uniform motion for a sufficiently long period for the effects of inertia to have disappeared. When the surface C D is of finite extent, and A B is covered by a fluid, the effects of inertia persist; for fresh fluid is always approaching the fixed plane. In Fig. 2 the surface C D is of limited length, both parallel with and in a direction perpendicular to the paper. A B is flooded with oil. The oil at a distance from D is all moving at the speed V_1 of the plane A B. Before reaching the upper fixed plane, however, it feels the influence of the fixed end D of the upper plate, and some relative motion or distortion of the fluid is produced. At D the oil touching the plane is at rest, but instead of passing along between the surfaces—as in Fig. 1—in such a manner that the rate of distortion is everywhere the same, the momentum of the oil causes it to enter the space between the planes, so that the rate of distortion is much greater near the plane C D than it is near the plane A B; whilst at the end C the rate of distortion is approximately the same at all planes. In this case the lines E G are curved, and the areas enclosed, E F G, give the volumes passed at each section. It will be noticed that the areas at the entrance D are larger than those at the exit C, the excess of liquid escaping laterally owing to the small width of the plane C D in a direction perpendicular to the surface of the paper. When the planes are of large area, and are close together, the viscosity of the oil powerfully resists its escape at all points, and at the same time, by tending to make the rates of distortion equal at all points, causes the oil to accumulate and force the planes apart until the forces are in equilibrium. In this way, even when the opposing surfaces are parallel, a *pressure film* is maintained, and a considerable load may be supported by C D as long as A B is in motion. The resistance to the motion of the lower plane is then wholly due to the viscosity of the liquid film.

FIG. 1

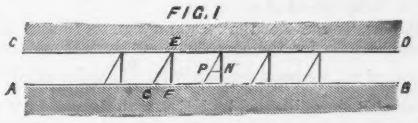


FIG. 2

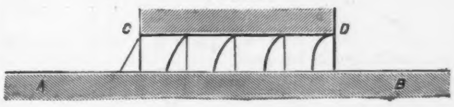
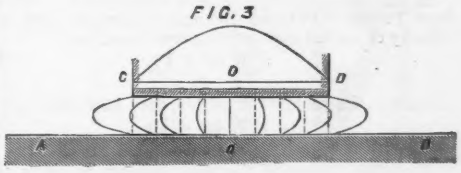


FIG. 3



We will, in the first place, attempt to indicate the conditions determining the volume v_1, introduced owing to the relative motion of the surfaces and the density of the liquid. The liquid—resting upon A B at points distant from the surface C D—is moving with a velocity V_1. At the point D it is thrown against the opening between the surfaces, much in the same way as water from the combining cone of an injector is thrown against the orifice of the delivery cone. Its power of entering is proportionate to the square of the velocity, and almost independent of its viscosity; for the oil or water by its adherence to C D resists the entrance of the liquid just as much as its adherence to A B assists its entrance. The volume entering, however, is not quite independent of the viscosity, for the greater the viscosity the more the liquid on entering, especially at low speeds, will approximate to the steady state of flow. When the energy is not sufficient to enable the liquid to overcome the pressure, no liquid gets between the surfaces, which then close together and may seize. On the other hand, when the liquid does enter, the volume entering is proportionate to

$$V_1 \; r \; b = v_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

r being the distance between the surfaces and b the length of the orifice. The conditions attending the flow of the escaping fluid may be well illustrated by taking the case of parallel surfaces approaching each other without tangential motion. The fluid has to be squeezed out from between the surfaces; and since there is no motion at the surfaces, the horizontal velocity will be greatest half way between the surfaces—Fig. 3[†]—nothing at O the middle of C D, and greatest at the ends. This is for planes of infinite length in a direction perpendicular to the paper. If in a certain state of motion—shown by the dotted lines in Fig. 3—the space between A B and C D be divided into ten equal parts by vertical lines, and if these lines be supposed to move with the fluid, they will shortly after assume the positions on the curved lines, in which the areas included betwen each pair of curved lines is the same as in the dotted figure. If it were not for the inertia of the fluid these lines would be —as they are approximately—parabolas. It is at once seen that the curved lines indicate the rates of distortion at different points, and, as force is required to maintain the rate of distortion constant, a vertical pressure, W, must be applied to force the liquid out. The pressure will be greatest at O and fall off towards the ends C and D, and would be approximately represented by the curve at the top of the figure. The volume discharged has been found by Professor Osborne Reynolds to be, for circular plates, in unit of time

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[*] "Transactions" Royal Society, 1886, page 157.

[†] Osborne Reynolds' "Transactions," Royal Society, 1886, p. 173

$$v = \frac{r^3 \mathrm{W}}{\mu a^4} k_1 \quad . \ . \ . \ . \ . \ . \ . \ . \ . \quad (4)$$

We will first consider the case of a bearing of infinite width and of length a in the direction of motion and loaded with a pressure W per unit of width. In this case, if the surfaces be supposed to approach without tangential motion, keeping parallel to one another, we shall have the volume v escaping

$$= \frac{r^3 \mathrm{W}}{\mu a^2} k \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (5)$$

the only difference between this and the case of a circle being in the value of the numerical coefficients. If we suppose the planes to be moving tangentially with a relative velocity V_1, the inflowing volume of oil will be proportional to $\mathrm{V}_1 \, r$, and must equal the quantity escaping.

We may, therefore, write

$$\mathrm{V}_1 \, r = k \frac{r^3 \mathrm{W}}{\mu a^2} \quad . \ . \ . \ . \ . \ . \ . \ . \quad (6)$$

$$\therefore \mathrm{V}_1 = k \frac{r^2 \mathrm{W}}{\mu a^2} \quad . \ . \ . \ . \ . \ . \ . \ . \quad (7)$$

$$\therefore \frac{\mathrm{V}_1^2 \mu^2 a^2}{r^2} = k \, \mathrm{V}_1 \, \mu \, \mathrm{W} \quad . \ . \ . \ . \ . \quad (8)$$

Now the total force R required to maintain the plates in steady motion is inversely proportional to r and directly proportional to $\mathrm{V}_1 \, \mu \, a$,

$$\therefore \frac{\mathrm{R}^2}{\mathrm{V}_1 \mu \mathrm{W}} \text{ is a constant, } \mathrm{C}^2 \text{ say,}$$

so that

$$\frac{\mathrm{R}}{\sqrt{\mathrm{V}_1 \mu \mathrm{W}}} = \mathrm{C} \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (9)$$

$$\text{and } \mathrm{R} \propto \sqrt{\mathrm{V}_1 \, \mu \, \mathrm{W}} \ . \ . \ . \ . \ . \ . \ (10)$$

and is independent of a.

If, now, we consider the case of a plane of limited width b, and assume for the moment that there is no lateral escape of oil, we must replace W by $\frac{\mathrm{W}}{b}$ and multiply the value of R thus obtained by b, *i.e.*, with the weight W distributed over b units of breadth, the resistance per unit breadth

$$= \frac{\mathrm{R}}{b} = c \sqrt{\mathrm{V}_1 \, \mu \frac{\mathrm{W}}{b}} \ . \ . \ . \ . \ . \ (11)$$

$$\therefore \mathrm{R} = c \sqrt{\mathrm{V}_1 \, \mu \, \mathrm{W} \, b} \ . \ . \ . \ . \ . \ (12)$$

and coefficient of friction

$$= \frac{\mathrm{R}}{\mathrm{W}} = \mathrm{C} \sqrt{\frac{\mathrm{V}_1, \mu b}{\mathrm{W}}} \quad . \ . \ . \ . \quad (13)$$

In the case of an ellipse of semi axes a and b, it follows from Professor Osborne Reynolds' equations that the velocity of normal approach is proportional to

$$\frac{r^3 \mathrm{W} (a^2 + b^2)}{a^2 \ b^2 \ \mu}$$

Therefore, the volume escaping, v, may he written

$$\mathrm{R} \frac{r^3 \mathrm{W} (a^2 + b^2)}{a^2 \ b^2 \ \mu}.$$

From this we get in the same manner as above (11) and (12)

$$\mathrm{R} = \mathrm{C}^1 \sqrt{\frac{\mathrm{V}_1 \ \mathrm{W} \, (a^2 + b^2) \, \mu}{b}} \quad . \ . \quad (14)$$

which in the case of the circle when $a = b$ reduces to

$$\mathrm{R} = \mathrm{C}^{11} \sqrt{\mathrm{V}_1 \, \mathrm{W} \, \mu \, b} \quad . \ . \ . \ . \quad (15)$$

The constant and, therefore, the values of R and the coefficient of friction, will vary with variations in the shape of the boundary of the surface, but is constant for surfaces of similar shapes. Hence, in the case of the ellipse, circle, and rectangle, we see that for similar-shaped surfaces the friction varies as the fourth root of the area of the surfaces.

The only experiments with which we can compare these theoretical results are those described in the fourth report of the Research Committee of the Institution of Mechanical Engineers on Friction.[*] In it are given the results Mr. Beauchamp Tower obtained with pivot friction. The pivot experimented with was of steel, had a perfectly flat end 3in. in diameter, and was pressed against a manganese bronze bearing in such a manner that the faces, although they could separate, were always parallel to one another. Fig. 4 shows the form of bearing used in these experiments. The bearing B formed a guide for the footstep, which fitted it loosely. The lubricant was supplied through a hole in the centre of the bearing, and was distributed by two radial grooves extending from the centre hole to within $\frac{1}{16}$in. of the periphery of the bearing surface. These two grooves were opposite each other, so that they lay on the same diameter. When the footstep was rotated the bearing rapidly took oil out of the supply pipe, and delivered it at the circumference of the bearing. It was then collected in an annular chamber surrounding the footstep, and returned to the centre by means of a small overflow pipe. The bearing therefore acted as a most efficient pump, causing a rapid circulation of oil through itself.

Before being used the surfaces were carefully made plane, and the machine allowed to run for a few hours. At first the oil came out dirty, showing that the surfaces were abrading each other slightly. As long as this continued the oil was run to waste, fresh clean oil being supplied to the centre. It was then allowed to run into the lubricating pipe, and the bearing became self-lubricating, continually using the same oil over and over again. The bearings were now completely separated by an oil film introduced from the two grooves by the motion of the footstep, and squeezed out again at other points by the pressure forcing the surfaces together. Although every care was taken to measure the friction between the surfaces, and to keep them in good condition, no attempt was made to ascertain the temperature of the bearing, or the viscosity of the oil used. Some resistance to motion must also have been offered by the oil film surrounding the cylindrical portion of the footstep; but, as the clearance is not given, and we do not know the viscosity of the oil, its magnitude cannot be calculated. We are, consequently, neither able to compare one experiment quite satisfactorily with another, nor yet to estimate with perfect accuracy the effects produced by varying speeds, for it would appear that the experiments made at each particular speed were made on different days at different temperatures, and probably with different samples of oil.

Assuming that the oil did not vary throughout the trials, and as the experiments were made with the same footstep and bearing, we may write from (9)

$$\mathrm{C} = \mathrm{R} \sqrt{\frac{1}{\mathrm{N} \ \mathrm{W}}} \ . \ . \ . \ . \ . \ . \ . \ . \quad (16)$$

N being the number of revolutions of the footstep per minute.

In Tables I., II., III., IV., and V., the values of C are given along with the speed, the load, and the frictional resistance. At low speeds with increasing loads C increases steadily, showing that the oil film is not keeping the surfaces properly apart, and that at this speed we are dealing with a very thin film and imperfect lubrication. At the higher speeds, however, C actually decreases somewhat until the heaviest loads are reached. It then increases with increasing loads. The decrease is probably partly brought about by the heating effect of the friction decreasing the viscosity of the lubricant, or it may be due to the fact that the force measured was partly due to the viscous resistance of the oil film surrounding the footstep. This would be proportional to the speed. The subsequent increase in the value of the constant in Tables II., III., IV., and V. we may regard as being due to the fact that the increasing load has made the film so thin that it cannot properly be called a pressure film.

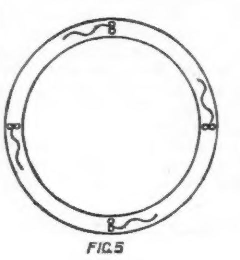

FIG. 5

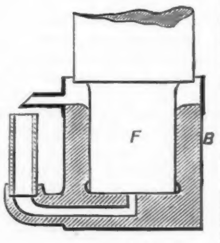

FIG. 4

Imperfect lubrication.—The only other reliable experiments on the friction of plain parallel surfaces are those on collar friction, also carried out by Mr. Tower[†] for the Institution of Mechanical Engineers. The lubrication, however, was imperfect. In these experiments the turning moment on a steel ring of rectangular section pressed between two gun-metal surfaces was measured. The annular bearing surfaces of the discs were 12in. inside diameter and 14in. outside diameter, giving on each disc an area of exactly 40 square inches, after deducting the oil channels. The method of lubrication adopted was one which is in practical use for collar bearings. It consisted of four grooves—see Fig. 5—cut in each face of the ring, ¼in. wide and ¾in. long, arranged in a diametrical direction, and so that each end of the grooves was ⅛in. inside the grooves of the bearing surface. From each of these grooves there extended in the direction of motion of the surfaces a shallow groove about $\frac{1}{10}$in. wide, and of a serpentine form, tapering away to nothing in about 3½in. length. These grooves were supplied by pipes into which the lubricant was dropped at carefully regulated rates. The magnitude of the friction depended considerably upon the rate of lubrication; but a minimum rate of lubrication was soon found with which the bearing would work safely, such that if the lubrication was less the bearing would show signs of seizing by rapid variations of friction and by a jerking of the lever; and if it was much more the friction, though less, was not reduced in proportion to the increase of the oil supply. The rate at which the oil was used varied from 60 drops to 120 drops per minute, the quantity varying with the speed and load. In the case of perfectly lubricated surfaces we found that the rate at which the oil was taken in between the surfaces was proportional to $\mathrm{V}_1 r$, being as much as the bearing could take. In the collar bearing experiments, however, the supply was limited, only just sufficient oil being used to prevent seizing, *i.e.*, rupturing the film. As the friction was found to be approximately independent of the speed, the film must have been allowed to increase in thickness at a rate proportional to the speed. It must also have had a thickuess inversely proportional to the load, on the assumption that we are dealing with fluid friction. Regarding it as a case of fluid friction, in which the film is of just sufficient thickness to prevent seizing, we find

$$c = \frac{\mathrm{R}}{\mathrm{W}} \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (17)$$

and is independent of N. This formula merely expresses the experimental results. In this way the value of the constant c in Tables VI. to IX. have been calculated.

From the formula

$$c = \frac{\mathrm{R}}{\mathrm{W}}$$

we may obtain another showing how the quantity of oil supplied varied, as compared to the quantity the bearing could have taken with perfect lubrication. As we are only dealing with one particular bearing, the variation of the friction with the dimensions may be neglected, and we get

$$c = \frac{\mathrm{R}}{\mathrm{W}}$$

and

$$\mathrm{R} \propto \frac{\mu \mathrm{V}_1}{r} \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (18)$$

$$\therefore \frac{\mu \mathrm{V}_1}{r \mathrm{W}} \text{ is constant}$$

$$\therefore \mathrm{V}_1 = k \frac{r \mathrm{W}}{\mu} \quad . \ . \ . \ . \ . \ . \ . \ . \quad (19)$$

and

$$k \frac{r^3 \mathrm{W}}{\mu} = \mathrm{V}_1 \, r^2 \quad . \ . \ . \ . \ . \ . \ . \ . \quad (20)$$

$k \frac{r^3 \mathrm{W}}{\mu}$ is proportional to the quantity the bearing would require for perfect lubrication. Consequently the oil supplied varied at a rate proportional to $\mathrm{V} \, r^2$ instead of $\mathrm{V} \, r$, in these experiments. And this rate of supply, according to Mr. Tower, was just sufficient to prevent seizing. In Table I., showing the results obtained with perfect lubrication at a low speed, C increases greatly with increase of load. Here the speed is not sufficient to carry in the oil, and we have imperfect lubrication. On this account we have added the values of c, which it will be seen are much less variable.

Table I.

Speed. Revs. per min.	Load. Lb. per sq. in.	Friction. Inch-lb.	C.	c.
50	20	2·77	·087	·138
50	40	4·61	·103	·115
50	60	7·07	·129	·118
50	80	10·25	·162	·128
50	100	15·48	·218	·154
50	120	18·72	·241	·156

Table II.

Speed. Revs. per min.	Load. Lb. per sq. in.	Friction. Inch-lb.	C.
128	20	1·13	·0223
128	40	1·54	·0215
128	60	2·26	·0258
128	80	3·59	·0355
128	100	5·48	·0484
128	120	7·02	·0566
128	140	9·23	·0690
128	160	12·82	·0897

Table III.

Speed. Revs. per min.	Load. Lb. per sq. in.	Friction. Inch-lb.	C.
194	20	1·44	·0231
194	40	1·74	·0197
194	60	2·15	·0199
194	80	2·56	·0206
194	100	3·13	·0225
194	120	4·41	·0289
194	140	6·10	·0370
194	160	7·69	·0427

Table IV.

Speed. Revs. per min.	Load. Lb. per sq. in.	Friction. Inch-lb.	C.
290	20	2·51	·0294
290	40	3·03	·0282
290	60	3·33	·0252
290	80	3·64	·0239
290	100	3·95	·0232
290	120	4·10	·0219
290	140	4·51	·0224
290	160	5·03	·0233

Table V.

Speed. Revs. per min.	Load. Lb. per sq. in.	Friction. Inch-lb.	C.
353	20	2·36	·0281
353	40	2·72	·0229
353	60	3·08	·0212
353	80	3·59	·0214
353	100	4·00	·0213
353	120	4·51	·0219
353	140	5·23	·0235
353	160	6·15	·0252

Table VI.

Speed. Revs. per min.	Load. Lb.	Friction. Lb.	c.
51	600	27·5	·046
48	1200	43·7	·036
42	1800	61·2	·034
44	2400	62·5	·026
48	2700	96·2	·035
43	3000	105·0	·035
50	3300	111·2	·034
50	3600	112·5	·031

Table VII.

Speed. Revs. per min.	Load. Lb.	Friction. Lb.	c.
70	600	38·7	·064
68	1200	57·5	·048
72	1800	72·5	·040
70	2400	90·0	·037
68	2700	90·0	·033
70	3000	102·5	·034
70	3300	106·2	·032
68	3600	155·0	·043

Table VIII.

Speed. Revs. per min.	Load. Lb.	Friction. Lb.	c.
87	600	25·0	·041
94	1200	60·0	·050
96	1800	62·5	·034
100	2400	85·0	·035
100	2700	95·0	·035
96	3000	105·0	·035
99	3300	118·7	·036

Table IX.

Speed. Revs. per min.	Load. Lb.	Friction. Lb.	c.
127	600	37·5	·062
124	1200	57·5	·048
126	1800	66·2	·036
145	2400	105·0	·043
142	2700	105·0	·038
120	3000	106·2	·035

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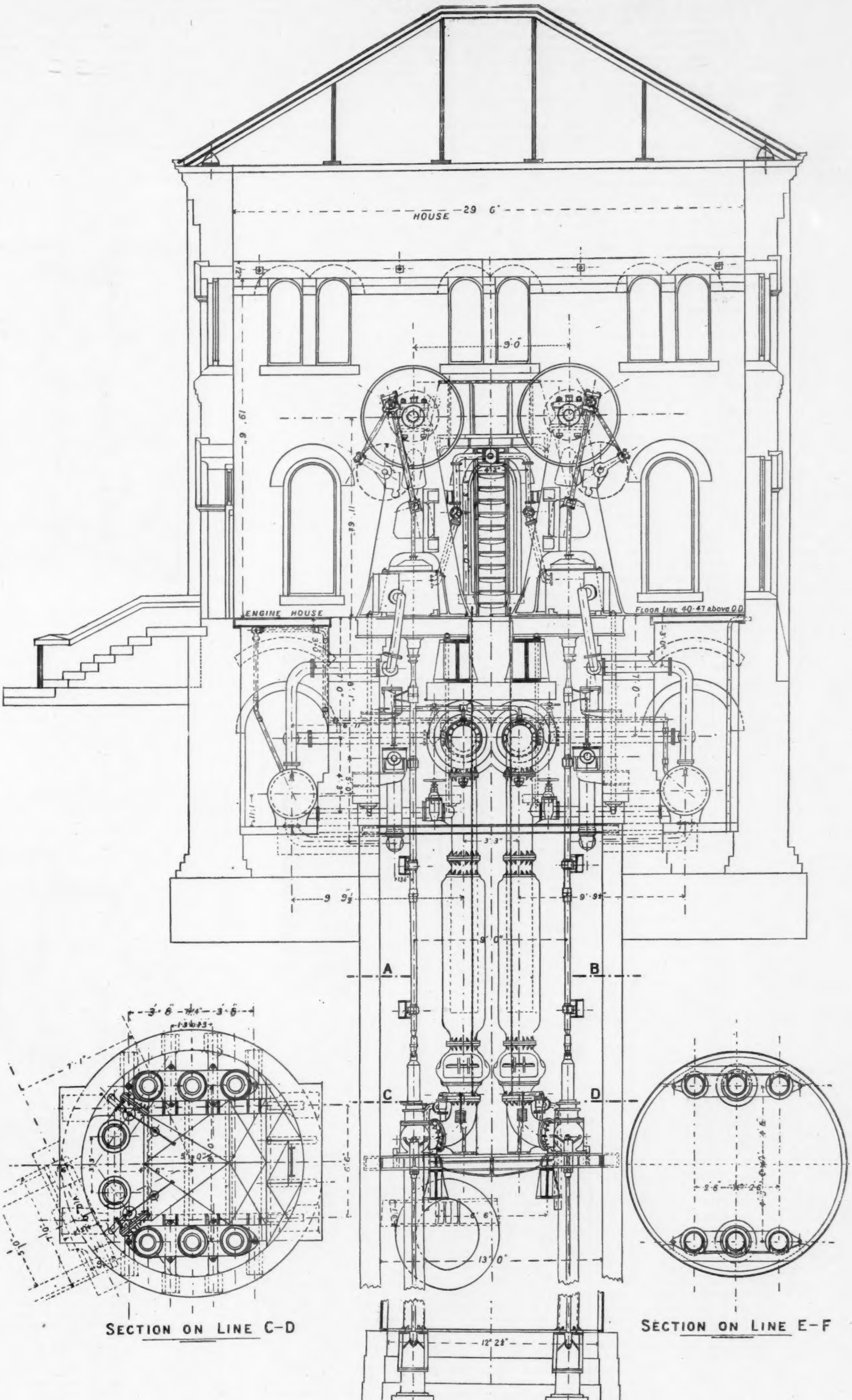
[*] "Proceedings" of Institution of Mechanical Engineers, 1891, page 111.

[†] "Proceedings" Institution Mechanical Engineers, 1888, page 173.

PUMPING ENGINES, COLCHESTER WATERWORKS

MESSRS. EASTON, ANDERSON, AND GOOLDEN, LONDON AND ERITH ENGINEERS

(*For description see page* 33)


HOUSE 29' 6"
9' 0"
19' 6"
ENGINE HOUSE
FLOOR LINE 40·47 above O.D.
7' 0"
3' 3"
9' 9½"
9' 9½"
9' 0"
A
B
C
D
6' 6"
13' 0"
12' 2½"
3' 6"
3' 6"
2' 6"
2' 6"

SECTION ON LINE C–D

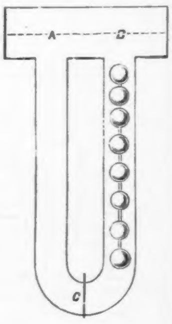
SECTION ON LINE E–F

CIRCULATION IN WATER-TUBE BOILERS.

THE literature of water-tube boilers has attained respectable proportions. It is at once precise and comprehensive. The conclusions arrived at by its authors are usually dogmatic—a fact which would save the student much trouble were it not for the circumstance that no two authorities agree. Just now we shall not concern ourselves, however, with anything save the phenomena of circulation in such boilers. We are about to place before our readers particulars of a series of most instructive experiments carried out by Mr. Yarrow. But it is necessary in the first instance to clear the ground, and explain the questions which it has been Mr. Yarrow's object to decide.

To shallow minds, circulation in a water-tube boiler presents no difficulties; to the physicist and the engineer the matter is one of considerable perplexity. We must, at the risk of being wearisome, go over old ground and write once more that which has often been written already.

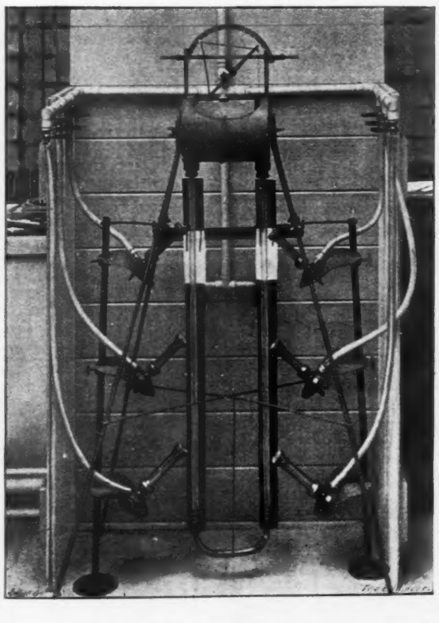
If water is heated in a U tube, it will rise in one leg and fall in the other, because the water in the heated leg expands, becomes lighter, and a given height of column will no longer balance a column of the same height in the other leg of the tube. An excellent illustration is supplied by nearly filling a U tube with water, and then cautiously pouring alcohol down one leg. It will be found that the column of alcohol and water is longer than the column of water alone. All this is plain sailing. When, however, the water has all been heated to the boiling point, and there is no longer a difference of temperature, how is circulation maintained? It is at this point that the two contending parties separate. The first party holds that the ascending leg containing steam and water, the column in it must be lighter than that in the descending or cold leg because that contains water alone. To which the opposing party reply that such reasoning reminds them of that of the boy who, being asked why bread and butter always falls butter side down, said that it was because that side was the heavier, for there was only bread at one side of the slice and bread and butter on the other side. Now we have already in the course of a series of articles on water-tube boilers, published in Vol. lxxvi. of THE ENGINEER, explained that under certain circumstances both parties are right. If the tube be so small in diameter that the bubbles of steam fill its cross section, fitting it like a piston, then the contents of the ascending leg will be both really and hydraulically lighter than the solid water in the descending leg. If, however, the bubbles are too small to fit the tube, then circulation cannot be produced by the difference in the actual weight of water in the tubes, because the hydraulic head is not affected. As this proposition has been strongly controverted, and, as we believe, because those who hold it to be unsound have failed to understand it, we may be excused for stopping here to put the facts before our readers. In B let us place a solid rod C. It is obvious that the weight of water in B will then be less than the weight of water in A; but, for reasons familiar to everyone with an elementary knowledge of hydrostatics, no circulation will ensue. But it may be urged that bubbles are not a solid rod. Let us then turn down our solid rod until it assumes the form shown in the sketch, and still the result will be the same. Nor would the effect be modified in any way if the rod was replaced by a string of balls continually drawn up through the tube in so far as they would secure that the column B was ligdter than the column A. But the rising of the balls, or of bubbles of steam, would cause circulation in quite another way by entraining water in B and dragging it along with them. We shall show presently that the result of a most remarkable experiment could not have been what it was if the bubbles really caused a difference of hydraulic head at opposite sides of the line C in the sketch. Circulation is due, then, when the bubbles are smaller in diameter than the tube, to a much more subtle cause or causes. The one is the continual cutting-off of the top of the column of the water at the surface by the escape of the bubbles; the other is the skin friction of the bubble entraining water; and the third is the piston-like action due to the approximate fit of the bubble in the tube. What, we may ask, is a bubble of steam or air? What is the condition of the water forming its sides? There is every reason to believe that the bubble wall is in a state of tension, and that a strict analogy exists between it and the walls of a soap bubble. As to the actual method of the formation of a steam bubble, of course no one knows anything in a proper scientific way.



So much said, we may go on, and add that wide diversities of opinion exist as to how circulation may be best secured in a water-tube boiler. Discussions on this point would fill volumes, and they are principally remarkable for the persistence with which opinions are advocated which have no real foundation in ascertained fact. We are constantly told that such and such a thing must take place; all the while no proof based on direct experiment is advanced of its soundness. Among all the things about which the world has been positive, about nothing has it has been more positive than that in all boilers cold places are essential to secure circulation. In the water-tube boiler especially downpipes or feeders have been freely adopted, and it has been asserted in the most positive and obtrusive fashion that they cannot be dispensed with. Now Mr. Yarrow in the first of his water-tube boilers, going with popular opinion, fitted four cold "downcomers," one at each end of the two tube chambers. After a time it was found that these down pipes were very much in the way in small craft, and so two of them were left out without any evil results. Then the other two were taken out, and again nothing happened. Delighted to find that the boilers took care of themselves without downcomers, Mr. Yarrow next proceeded to ascertain what really happened. For a considerable time he has been carrying out experiments at the Isle of Dogs with great elaboration and much outlay, and on Saturday last he invited to the works a large party of gentlemen interested in such questions, and showed them his experiments, which, it is proper to add here, all succeeded, notwithstanding that some of them are very delicate.

We cannot do better than reproduce here a descriptive paper written by Mr. Yarrow, a copy of which was handed to each one of his visitors. But, in the first instance, we wish to direct particular attention to two experiments which are of the greatest importance, namely experiments 1 and 5. The first shows what is at the first glance apparently incredible, namely, that a brisk circulation can go on in a U tube, heat being applied to the down side. The experiment moreover taught a lesson which is seldom demonstrated to the eye in a very clear way. Bubbles of steam were freely formed in the down pipe. They were carried downwards by the current, and as they descended they grew smaller and smaller, and finally disappeared. We have here an admirable object-lesson. Every student of Clark-Maxwell knows that if we compress steam isothermally it will liquefy, and that nothing but sufficient water is needed to secure the isothermal condition. There is, of course, plenty of water present here, but every student does not realise how small is the amount of compression which will produce liquefaction. The disappearance of the bubbles, their reappearance in the rising tube, and the great increase in the volume of steam produced, were eminently instructive. The lesson conveyed by Experiment No. 5 is, however, probably of more practical utility. Mr. Yarrow in his paper scarcely does it full justice. We have here three tubes. Calling the two rising pipes A and B, a rush first takes place up A, and a down rush through B. Then the phenomena reversed; the water and steam rose in B, and water descended in A, and this operation went on with much regularity. Each time a rush occurred water was thrown out of the upper receiver. Here, in fact, was priming pure and simple. When the downcomer was heated also, the current steadily ascended in both the rising tubes, and all priming ceased.

Fig. 1



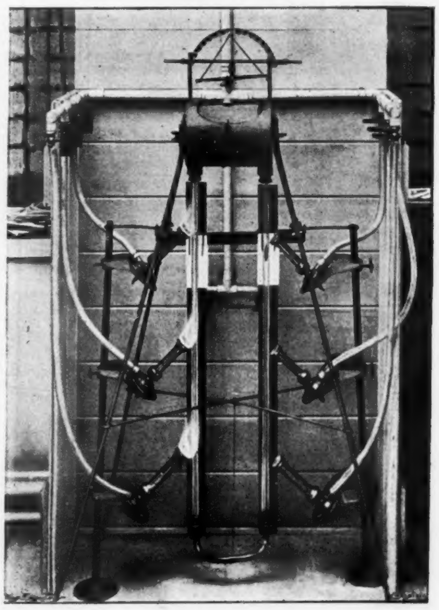
A multitude of deductions may be drawn from these experiments. We shall content ourselves with one for the present. Experiment No. 8 Mr. Yarrow stated was very delicate, the propellers requiring to be adjusted with extreme care, otherwise they would not revolve. It is to the credit of those who carried out the details that the propellers spun merrily on Saturday. The fact remains that the water circulation in any boiler depends on very small forces. A trifling obstruction in a tube will prevent circulation altogether. Given a clear way, and the water will course at high speed through the tubes, but block the road and the water stops. The circulation is produced by the equivalent of a small difference of head. It is quite sufficient for all purposes, but the flow of the water must not be impeded in any way. The straight tubes of the Yarrow boiler are just what is wanted. Another point which must not be overlooked is that the circulation largely depends, it would seem, for its efficiency on momentum. Start it which way we please in a U tube and it will continue. This is in itself proof that the circulating force is very small. The great lesson taught is that so long as the water is left a free way and is not hampered in any fashion, a water-tube boiler will take very good care of itself. A not less important lesson is the complement of this. It is that small interferences with freedom of circulation may readily bring about disaster. Experiment No. 1 showed the importance of keeping an equal pressure in all the tubes. Thus, if one riser out of a dozen was exposed to a little higher pressure than its fellows it would probably become a downcomer, or might work in gulps and get burned. Our readers will not be slow, we fancy, to draw other lessons. One they cannot miss. It is that the community of engineers is indebted to Mr. Yarrow for throwing light into dark places, and for so freely imparting information that he has only obtained for himself by a great outlay of time, and skill, and money.

Mr. Yarrow's paper runs as follows:—

Description of Experiments made at Messrs. Yarrow and Co.'s Works, Poplar, January 4th, 1896.

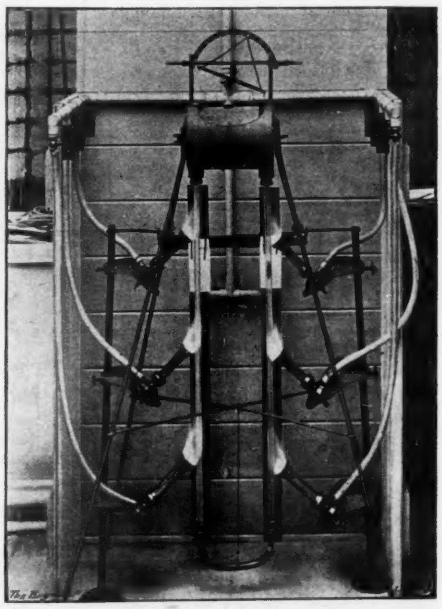
With a view to throw light on the circulation of water in water-tube boilers, Messrs. Yarrow and Co. have carried out numerous experiments, and considering that the results obtained would be of interest to engineers at the present moment, they determined to make them public. One point which these experiments prove is that the heating of down tubes actually accelerates the circulation and does not retard it, as is generally believed.

Fig. 2



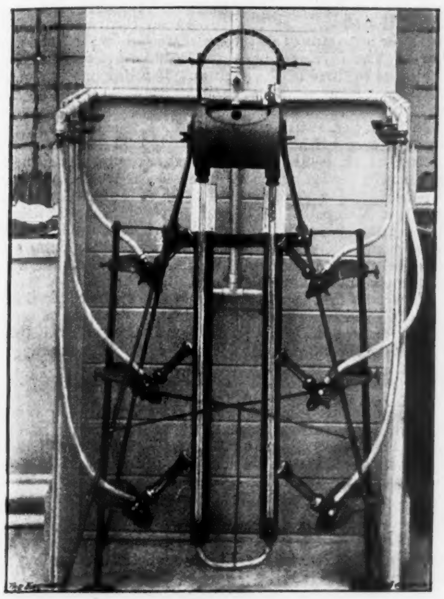
Experiment No. 1 is illustrated by Figs. 1, 2, and 3, which represent the same model under different conditions. This model consists of two vertical glass tubes attached to the bottom of a small tank, the tubes being united at their lower extremities by a copper bend. There are six Bunsen burners, three acting on each tube, and arranged so that they can be regulated at will. On the upper part of the model is a balance, one arm of which is suitably loaded, and from the other arm is, hung by a thread, a grooved ebony bob, which is suspended in the down tube in such a manner that the water when flowing downwards, acting on the bob, causes it to descend, depressing the end of the balance to which it is attached. Fig. 1 represents the model in its normal condition, before any heat is applied; Fig. 2 shows the effect when three lamps on the up tube are lit; and Fig. 3 illustrates the result when the three lamps on the down tube are lit in addition to the three acting on the up tube. This experiment does not indicate the speed of the current, but it shows very clearly any increase or decrease in the speed of the descending column of water, that is to say, the rapidity of the circulation. When the pointer is vertical, it is at zero; when it moves over towards the up tube side the figures are indicated as minus; when it moves towards the down tube side the figures are indicated as plus. The following are the results of carefully tried experiments:—When no heat was applied, the pointer indicated —45, as represented in Fig. 1. When only one lamp was acting on the up tube, the current was too intermittent to record a reliable result. When two lamps were acting on the up tube, the pointer indicated —12. When three lamps were acting on the up tube, the pointer indicated —5, as repre-

Fig. 3



sented by Fig. 2. When three lamps were acting on the up tube and one on the down tube, the pointer indicated + 10. When three lamps were acting on the up tube and two on the down tube, the pointer indicated + 15. When three lamps were acting on each side, as shown in Fig. 3, the pointer indicated + 20.

Fig. 4



These experiments clearly prove that the circulation gradually increased as more and more heat was applied, irrespective of the proportion of the total heat absorbed by the up and down tube. Further experiments showed that, within certain limits, the rapidity of the circulation depended solely upon the total amount of heat applied, irrespective of how this heat was divided between the descending and ascending columns.

Fig. 5

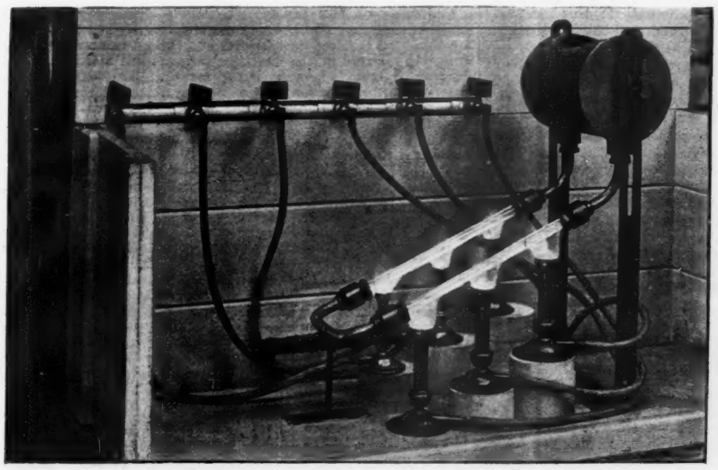
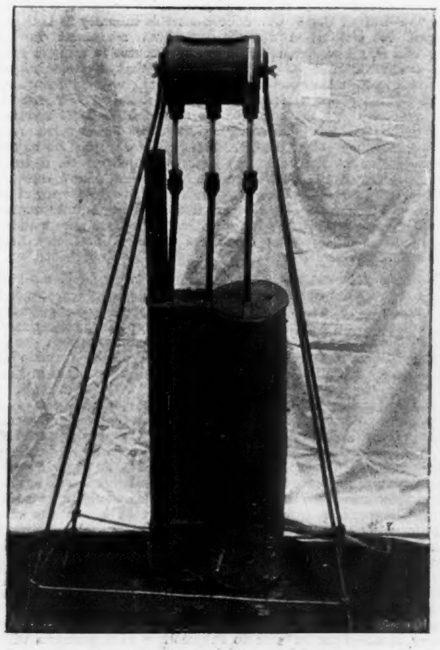
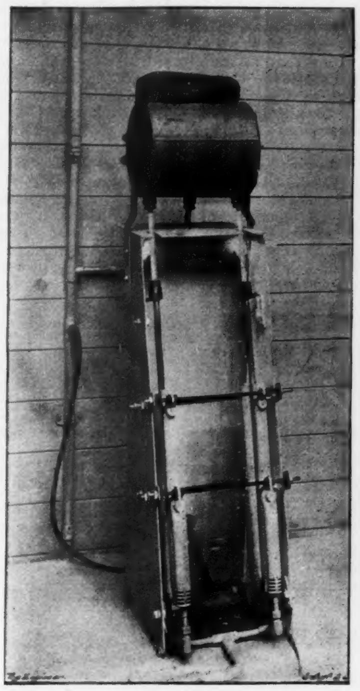


Fig. 6



Experiment No. 2 is illustrated by a similar model, Fig. 4. In the down tube is placed a small screw propeller, which, when revolving, actuates a vertical spindle, having at its upper end a worm, gearing into a small worm-wheel, as will be seen. This arrangement was made at the suggestion of Mr. Maxim, and it enables the speed of the current, under varying conditions, to be estimated. When two lamps were acting on the up tube the speed recorded by the propeller was found to be 28ft. per minute. When three lamps were acting on the up tube the speed was 36ft. per minute. When three lamps were acting on the up tube and one on the down tube the speed was found to be 42ft. per minute. When three lamps were acting on the up tube and two on the down tube the speed was 49ft. per minute. When three lamps were acting on the up tube and three on the down tube the speed was 55ft. per minute.

Fig. 7



These experiments confirm those previously described with the suspended bob, proving a gradual increase of speed in the circulating system as more and more heat was applied, irrespective of whether this heat was absorbed by the water in the up tube, or by the water in the down tube. It should be remembered that, owing to the resistance offered to the flow of water by the screw, the actual speeds, if no screw had been there, would have been greater than those above recorded. In addition to this, an allowance must be made for the slip of the screw. It must be borne in mind that in all the foregoing experiments circulation must have been set up by heat being first applied to the up current, which in all water-tube boilers is the case, those tubes nearest the fire being heated first, and thus circulation is established. These experiments also illustrated what has not yet, we believe, been referred to, viz., that any bubbles of steam formed in a descending column rapidly disappear; and it is more than probable that in a down tube moderately heated no steam whatever is formed, because as the current descends, the temperature of the water can rise without producing steam owing to the increased head of water and the higher temperature of the boiling point at the greater pressure. For example: under atmospheric pressure the water in the upper part of a tube would boil at 212 deg.; but the water in the lower part of the tube, if 4ft. long, would boil at 218½ deg.; consequently the whole body of water can be raised from 212 deg. to 218½ deg. while descending without producing any steam. This heat, thus absorbed, is given off by the conversion of a portion of the water into steam as the current ascends in the up-tube. In the experiment the bubbles could be clearly seen forming where the flames impinged, and, as they descended, to disappear, the steam parting with its heat and raising the temperature of the surrounding water.

Fig. 8

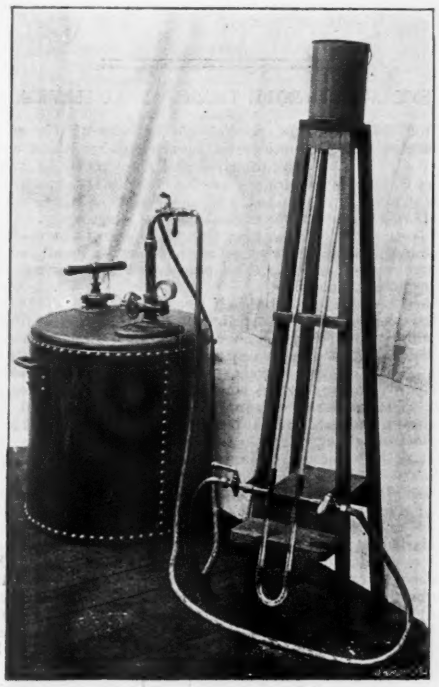
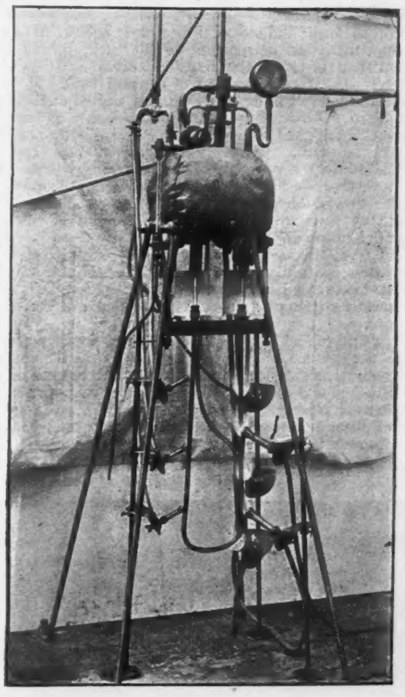
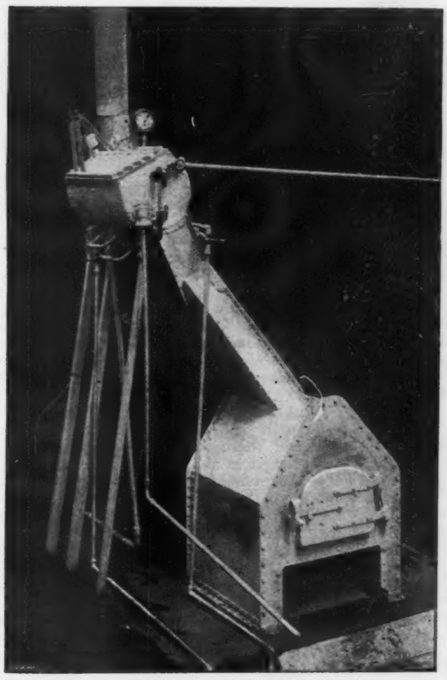


Fig. 9



Experiment No. 3 was illustrated by a model, Fig. 5, consisting of two glass tubes, placed at a small angle to the horizontal, their upper ends being connected to a small cistern and their lower ends united. The tube on one side was arranged to be heated by three Bunsen flames and the other tube also by three Bunsen flames of smaller size. When once the circulation was started in the up tube by the three larger flames, those acting on the down tube could also be lit and the circulation could be clearly seen to be accelerated.

Fig. 10



Experiment No. 4 consisted of a cistern, Fig. 6, from the bottom of which were led three tubes, the lower portions of which were of copper and the upper portions of glass. The three copper tubes were united at their lower extremities, being secured to a horizontal chamber. They were all situated in a gas furnace, lined with asbestos, heat being applied directly to the tube on the one side by means of several multiple Bunsen burners, the flames from which passed across the other two tubes and up the funnel which is seen in the photograph. This experiment more nearly approaches the condition of an ordinary Yarrow water-tube boiler, and it was seen that sometimes there were two down currents in the two cooler tubes, and one up current in the tube most heated, and at other times there were two up tubes and one down tube. In this model as much as 9 lb. of water per square foot of heating surface was evaporated.

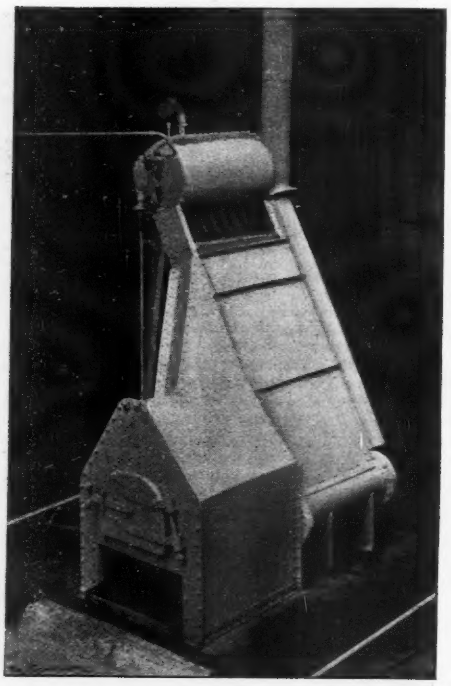
Experiment No. 5 consisted of two glass tubes, Fig. 7, projecting from a small tank, the tubes being nearly vertical. These glass tubes were united to copper tubes, at the bottom of these was a **T**-piece, to which a third tube of copper was connected, the upper extremity of which was secured to the bottom of the tank. The two composite glass and copper tubes were in front and the copper tube was at the back, this latter representing an outside down pipe. Multiple Bunsen burners were provided for heating all three tubes. On heating the two front tubes an up current was established in both, the copper tube at the back serving as an outside down pipe, and the speed of the current could be seen by watching the flow of water and steam in the glass tubes. When heat was applied to the downcomer at the back, it was clearly evident that the circulation was accelerated.

Experiment No. 6 consisted of a small tank, Fig. 8, from which were led two inclined glass tubes, united at their lower extremities. Provision was made to introduce a current of air from an air tank under pressure into either or both these tubes, as will be seen. When upward circulation had been established in the one tube, by introducing bubbles of air, then a further supply of air was admitted into the down tube, which air passed downwards with the water and then upwards in the up current, increasing the circulation, which was maintained even after the supply of air had been completely cut off from the tube containing the ascending column, the circulation continuing in the same direction, air only being admitted into the down tube.

All the foregoing experiments were made at atmospheric pressure.

Experiment No. 7 showed the action under a pressure of 150 lb. per square inch. It will be seen that at the upper part of the model, Fig. 9, is a steam chest, to the bottom of which was attached a **U** tube, fitted with glass at its upper extremities, so as to render the circulation visible. There were three small Bunsen lamps in connection with the one leg, and five large Bunsen lamps in connection with the other leg. It was found that if the circulation was once established by lighting the three small Bunsen flames on the one side, producing an up current on that side, then the five large flames on the down current might be started, increasing the circulation, which actually continued after the three flames in the up tube were all turned out. This extreme condition under which circulation can be maintained, we venture to say, is one which few engineers would believe possible, and confirms the views expressed by Professor Lambert and Mr. Maxim.

Fig. 11



Experiment No. 8, Fig. 10, was made on a full-size section of a water-tube boiler with straight tubes, working at a high pressure. At one end there was a furnace under forced draught by means of a jet in the funnel. The flame passed transversely across the group of tubes to the funnel, situated at the end opposite to the furnace. In the tube furthest removed from the furnace was placed a small screw propeller, and also a similar fitting in the third tube from the end, by which the direction of the current and its minimum speed could be estimated. On raising steam and forcing the fire the propellers were seen to revolve in a direction indicating a steady down current in either one or both of the tubes in which the propellers were introduced, previous experiments proving that a down current existed in the second tube from the end. It was found that there were never less than two down tubes in operation.

Experiment No. 9, Fig. 11, represented also a full-size section of a water-tube boiler having straight tubes, heated in the same manner as in the former case. The circulation was rendered visible by the upper part of the tubes being of glass. It could be clearly seen that an upward current was established in those tubes nearest the fire, water descending in those which were furthest removed from it, confirming the previous experiment.

It may here be remarked that the maximum evaporation obtained by Messrs. Yarrow and Co. when the circulation had been forced to a very high pitch, was 25 lb. of water per square foot of heating surface, but this being an uneconomical amount of forcing, is far beyond the range of what is desirable in practice.

Experiment No. 7 clearly proved that circulation was more efficiently maintained at a high than at a low pressure, it being found that the extreme condition of maintaining circulation by applying heat only to the down pipe was never certain, except with pressures over 50 lb. per square inch; between 30 lb. and 50 lb. this result was doubtful, and below 30 lb. it was not possible. The reason of this is probably due to the reduced velocity of the down current in the case of low pressures, owing to the greater bulk of a given weight of steam at low than at high pressures, all of which steam has to pass through the up tube; or in other words, there is less resistance to a given weight of water and steam at a high pressure flowing through a system of tubes than at a low pressure, on account of the lesser bulk of the water and steam in the former case. The exact arrangement of the propellers in connection with No. 8 experiment is seen by the sketch, Fig. 12, showing a section through the steam chest and one of the tubes containing the propellers. In order to obtain reliable data as regards the temperature of the tubes, which are exposed to the fiercest action of the fire, the following facts in connection with No. 8 experiment will be instructive, and to fully explain, reference must be made to the section, Fig. 13, through the tube nearest the fire. The lower end of a long rod was attached to the water chamber at the bottom, this rod passing up through the centre of the tube and thence through the top of the steam chest. At the upper end of this rod was a pointer, and a similar pointer was affixed to the steam chest itself, as will be seen, the two pointers being exactly in a line with one another. Thus, whatever difference in the relative lengths of the tube and the rod took place, it would be at once made evident by alterations in the position of the pointers in relation to one another. If thus the tube, owing to its being exposed to great heat, expanded more than the rod, it could at once be detected, and any such increased relative length would be an indication of an increased relative temperature. Now it was found that there was no visible difference in position between the two pointers, whether the fire was forced or extinguished, and as the rod passing up through the steam and water would have a temperature equal to that of the steam and water, it follows that the temperature of the tube is the same, or the difference, if any, is so trifling as not to be indicated by the means above described.

Fig. 12

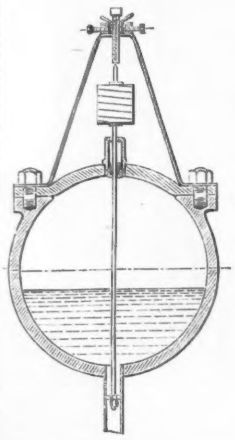
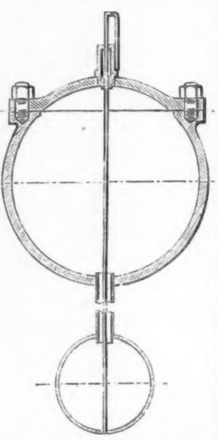


Fig. 13



This experiment conclusively proves that, so long as there is good circulation, no possible objection can exist to the adoption of straight tubes, as in a Yarrow boiler, owing to imagined necessity to allow for variations in length, due to differences of temperature. For all practical purposes, the temperature of all the tubes may be considered the same as that of the water they contain, in the same manner as in an ordinary marine or locomotive boiler, in which no special provision is made for differences in expansion of the tubes, although they are by no means all exposed to the same extent to the action of the heated gases. This experiment, which is confirmed by practical experience in the use of the Yarrow boiler, points conclusively to the fact that the curving of tubes in water-tube boilers—having good circulation—for the sake of allowing for variations in length due to variation of temperature, is quite unnecessary.

STEAM AND ROPE TRAMWAY AT HAVRE.

The older business portion of the city of Havre is connected with the residential suburb on the inland cliff, about a mile back from the river, and from 200ft. to 250ft. above it, by inclined streets unsuited for ordinary omnibuses, so that in order to establish a regular means of communication, some system of mechanical traction is necessary. This has been done by combining the principles of the balance incline with steam traction, on a plan shown in detail in our contemporary, *Le Genie Civil*, whence we have derived the following particulars.

The line, which is about half a mile in length—750 m.—is extremely crooked, the straight line distance between the terminal points being only about 500 yards, and the difference in height 230ft. For nearly two-thirds of the length it is laid along existing streets, the remaining part, about 300 yards, being carried in a curved tunnel in the chalk cliff. The gradients vary from 1 in 14½ to 1 in 9, and the minimum radius of curvature is 164ft. The line, which is single throughout, with the exception of a short crossing place at the lower end of the tunnel, is constructed like an ordinary cable line with an enclosed iron channel for the rope between the rails, with an open slot for the gripper, but the latter is only a rod projecting from the bottom of the car, to which one end of the rope is fixed, the other end being similarly attached to the second car. The line is worked as an incline without intermediate stoppages, the weight of the descending car contributing part of the power necessary for the ascent of the opposite one, which is, however, mainly effected by steam, so that the function of the rope is merely to tie the cars together. The descending car runs entirely without steam except in case of need, when it may be used in counter pressure.

The cars, which are intended to carry fifty passengers—twenty seated in a central compartment, and thirty standing in an outer covered platform—are carried on two axles, giving a rigid wheel base of 7ft. 3in., while the total length is 32ft., the platform for the outside passengers overhanging 12ft., and that at the opposite end which carries the boiler and feed pumps nearly 11ft. The boiler of the well-known Serpollet, weighing about two tons, has a heating surface of 87 square feet, with a maximum evaporating power of 1100 lb. per hour. It has been tested to 94 atmospheres, and has neither safety valve nor gauge glass. The working steam pressure is 15 atmospheres; the steam cylinders of 2⅜in. diameter and 5⅞in. stroke—60 mm. and 150 mm.—are placed outside the framing of the car between the axles, and drive the latter by means of an intermediate pinion shaft and pitch chains. The driving wheels, of 31½in. diameter, make one revolution to three of the engines. The link motion of the Waelschart form, as well as the brakes, are controlled by hand levers from the end platform. The connecting rope, made of extra quality cast steel wire of 108 tons tenacity, is 20 mm. in diameter, with an ultimate tensile resistance of 21 tons, which is fifteen times the maximum strain exerted by the fully loaded motor car when stopped on the steepest incline of 110 per 1000, or seven times that of two loaded cars pulling at both ends. It is run over 4¾in. grooved sheaves, placed 21ft. apart, and reverses over a 6½ft. pulley at the upper terminus, the ascending and descending lines being kept 8in. apart by another of the same size placed below and a little above to the reversing one.

The deadweight of the car is 9½ tons, or when fully loaded with fifty passengers, 13 tons, giving a resistance on the steepest incline of 110 per 1000. $13{,}000 \div 0{\cdot}11 = 1430$ kiloms., which for the maximum speed of 41m. per second gives $\frac{1430 \cdot 4}{75} = 76$-horse power as the necessary driving power.

At the steepest point of the road, however, the descending car is on a gradient of 80 per 1000, and supposing it to be empty the power exerted is $9500{\cdot}008 = 760$ kilos. in aid of the ascending load, and reducing the resistance of the latter to $1430 - 760 = 670$ kilos. Adding to the 150 kilos. for the friction of the rope, the necessary engine power becomes $\frac{(670 + 150) \cdot 4}{75} = 43{\cdot}7$-horse power, showing a saving of about 30 per cent. in power by the use of the connecting rope between the two cars.

Trade and Business Announcements.—Mr. B. H. Thwaite, F.C.S., A.M.I.C.E., announces that he has opened an office at 29, Great George-street, S.W.—Messrs, Isles, Limited, Steam Crane Works, Stanningley, near Leeds, have appointed Mr. H. Grunwell, M.I.C.E., as their agent in London for steam and hand cranes.—Messrs. W. F. Dennis and Co., inform us that they are removing to 23, Billiter-street, E.C.

Explosion on the Irish Mail Train.—When the Irish mail which left Euston on Wednesday morning at 7.15, had travelled to a point a few hundred yards north of Watford Station, a terrific explosion occurred in the luncheon car. At the moment of the occurrence breakfast was being served. The extraordinary event naturally caused not a little commotion amongst the passengers. Their apprehensions were increased as the train dashed into a tunnel, and for the moment the compartment was in darkness. Moreover, the report was followed by a large burst of flame, and repeated showers of red hot cinders from the boiler end of the coach, the burning portions of coal, and copious quantities of water covered the three travellers, and added to their alarm, which was not lessened when the carriage was fired by the falling ashes. The flames were, however, speedily extinguished, but it was impossible to pull the communication cord until the exit from the tunnel had been made. It was ascertained that a third of the saloon had been completely shattered, and the passengers were impressed with their marvellous escape. The train was brought to a standstill at King's Langley, and the occupants of the wrecked car were then transferred. The explosion is said to have had its origin in the cooking apparatus, but nothing definite is known as to the actual cause. The report was heard throughout the length of the train. The train was carefully examined at Boxmoor, where the wrecked car was left, and the train, being uninjured, was allowed to proceed to Holyhead.

Admirable.—It is the established policy of this journal to take no part in the discussion of purely political or partisan questions. But the results of the public discussion of such questions often become proper topics for consideration here. During the last ten days the possibility of a war with England has been precipitated upon the country, and in the excitement which greeted the President's message and some of the inflammatory speeches in Congress, very many things were said, and reached publicity in the daily Press, which had far better have been left unsaid. The stock-market panic which followed has at this writing apparently spent its force; and the indications are, that a wiser and more moderate temper is prevailing in the consideration of the questions in dispute on the part of both countries. War between England and the United States would be a terrible calamity to both, and indeed to civilisation itself. The best sentiment in both countries is, we believe, opposed to any recourse to arms to settle diplomatic differences. It is fortunate that the course now decided upon makes necessary a considerable delay before any more serious action can be taken; and it is to be hoped that during this delay the conservative sentiment in both countries may make itself felt in no uncertain way. So far as mere money matters are concerned, either nation could well afford to buy the whole of Venezuela a half dozen times over and present it to the other, rather than enter upon the uncertainties and enormous outlays of war. The humanitarian and economic aspect of the question must appeal also to every thinking man, and no words of condemnation can be too strong for those who from pure malice or from motives of cupidity seek to fan the flame of international discord.—*Engineering News.*

More Water-tube Boilers.—Although very little sea-going experience with water-tube boilers has been gained since their introduction into the service, the Admiralty appear to be determined to give them an all-round trial. Following in quick succession orders for these boilers of various designs were given for the Speedy, Sharpshooter, Spanker, and several of the torpedo boat destroyers. Then the Powerful and Terrible were taken in hand, and before the Sharpshooter had been fitted with Belleville boilers it was decided to supply the same type to the new vessels. Since then water-tube boilers have been approved for first and second-class cruisers, and it was concluded that the Admiralty would still provide locomotive boilers for battleships and torpedo boats. Only a few days ago, however, it was arranged that No. 80 torpedo boat at Devonport should have water-tube boilers, and since then it has been decided to remove the boilers from the cruiser Bellona, now attached to the Channel Squadron, and replace them with those of the water-tube type. The vessel will be removed from the Channel Squadron for this purpose after the next cruise. Her present boilers have not given satisfaction. The Bellona is only four years old, and although she has done very little sea service her boilers are reported to be considerably worn. The crowns of the combustion chambers of two of the boilers are bulged considerably, and although the vessel's efficiency may not be impaired up to a limited steaming power, it would not be wise to subject her to a pressure which, with other vessels, might be safely done. The cruiser Proserpine, building at Sheerness, is also to be supplied with water-tube boilers. It is stated that the Thornycroft type will be adopted in her case, and the boilers, together with the propelling machinery, will be made at Keyham Factory.—*Western Morning News.*

RAILWAY MATTERS.

Mr. Thomas Henry Ellis has succeeded Mr. C. S. Dennis as district passenger superintendent, at Darlington, for the North-Eastern Railway.

A verbatim report of the conference on light railways, held at the Westminster Palace Hotel on November 28th, has been issued by Messrs. Eyre and Spottiswoode.

It is said that some of the engines Messrs. Neilson and Co. are about to construct for the Midland Railway Company will have very large boilers and tanks. More boiler and more water would make the run from Nottingham to Carlisle possible without a stop.

The mail train which left Johannesburg on the evening of the 30th ult. for Durban, crowded with passengers, left the rails and was completely overturned while running past a sharp curve between Dannhausen and Glencoe, on the Natal line. The disaster was of a terrible character. Thirty-seven persons were killed and fifty others were injured, many of them dangerously.

When referring in our annual article last week to the Lancashire, Derbyshire, and East Coast Railway, on page 14, we stated that Messrs. Pearson and Son were the contractors for this line. This is true so far as Contracts 1 and 2—Chesterfield to Warsop and Beighton Branch—are concerned, but we find that Contract 3—Warsop to Tuxford—is let to Messrs. Baldry and Yerburgh, and Contract 4—Tuxford to Lincoln—to Messrs. Price and Wells.

The bill seeking powers to construct a tramway from Derby to Ashbourne, of which mention has already been made in The Engineer, has now been deposited in Parliament. It is for the construction of a single line commencing by a junction on the present lines of the Derby Tramways Company, and terminating at Ashbourne. The capital is put down at £70,000, divided into 7000 shares of £10 each. Under clause 31 of the Bill the cars must be moved by animal power. Application is to be made for the consent of the Board of Trade to the use of the overhead trolley system of electrical traction. The line is to be constructed within five years.

The locomotive driving tires in general use on the Great Eastern Railway are made of Bessemer steel, having a tensile strength of 40 tons per square inch, and the following composition:—Combined carbon, 0·350 per cent.; silicon, 0·083 per cent.; sulphur, 0·064 per cent.; phosphorus, 0·047 per cent.; manganese, 0·605 per cent.; iron—by differences—98·851 per cent. The wear on the tires of some six-wheeled coupled suburban engines in severe service was such that only 2197 miles was obtained per $\frac{1}{32}$in. reduction in thickness, the tires being 4ft. diameter. Consequently seventeen of these engines were fitted in January, 1892, with special hard steel tires, having a tensile strength of 48 tons to the square inch, and the results obtained up to their first turning were satisfactory. The average mileage was 47,134 for an amount of wear equal to $\frac{1}{4}$in. in thickness, or 5892 miles per $\frac{1}{32}$in. reduction.

Of the 364 tires which failed on our railways during the nine months ending September last, 15 were engine tires, 6 were tender tires, 3 were coach tires, 13 were van tires, and 327 were wagon tires; of the wagons, 249 belonged to owners other than the railway companies; 217 tires were made of iron, and 152 of steel; 10 of the tires were fastened to the wheel by Gibson's patent method; 9 by Mansell's patent method, 2 of which left their wheels when they failed; 2 by Beattie's patent method; 269 by bolts or rivets, 1 of which left the wheel when it failed; 72 by other methods, 1 of which left the wheel when it failed; and in 2 cases the method of fastening was not stated; 38 tires broke at rivet holes, 128 in the solid, and 198 split longitudinally or bulged. This very large excess of breakages through the solid is a further confirmation of the theory of the fracture of these tires given in the paper on the subject in the "Proceedings" of the Institution of Civil Engineers, vol. xlvii.

While the use of electrically welded rails in Boston has not been an entire success, some 6 per cent. of the joints breaking during the first winter they were in use, it appears from a valuable paper read before the Engineers' Club of St. Louis that in that city a great measure of success has been attained. Mr. Robert McCulloch, the author of the paper, states that of 2203 electrically welded joints on 3$\frac{1}{4}$ miles of double track in St. Louis, 72 joints or 3·27 per cent. have broken. Thirty-seven broke during the cold weather of the first part of last winter, and each was repaired by casting a mass of iron, around the broken part, a portable furnace being employed to melt the iron. During the second cold snap later in the same winter, 35 more breaks occurred, which have not yet been repaired. Seven of the joints opened nearly 2in. on breaking, while in others the crack was barely perceptible; the average amount of opening was about $\frac{1}{4}$in. During the warm weather of the past summer these cracks closed a trifle, but the amount of the movement was unimportant.

Under the new Bill for the East to West Railway, which has duly been deposited, the Derbyshire and East Coast Railway are applying for power to construct four branch railways and one deviation line, which will be comprised in their Chesterfield and Lincoln separate undertaking, for which powers were granted in 1895. The new lines are made up as follows:—Two branches in Nottinghamshire of a length of 1 mile 6 furlongs 6 chains, known as the Shirebrook branch; a short line in Derbyshire known as Cresswell branch; another line to the Colliery Railway of the Warsop Main Colliery, and another to the lines of the Barlborough Colliery. The deviation set forth in the new Bill is at Tuxford. It will begin by a junction with the company's line at Great North End, and finish by another junction with the Great Northern Railway at Tuxford Station. In addition to the above powers the company seek authority to make further access to their Langwith Junction Station, to purchase more land at Boughton, Warsop, and Sookholme in Nottingham, and Upper Langwith, and near Duckmanton Station in Derbyshire.

In reporting on the buffer-stop collision on November 27th, at London Bridge Station, on the London, Brighton, and South Coast Railway, when seven passengers are reported to have been shaken, the Board of Trade inspector says: "This slight collision with buffer-stops was due, as is now usually the case, to an error of judgment on the part of the driver of the train. If drivers would make it a rule to stop, at least, one carriage length away from the ends of terminal platforms or any obstruction on a platform line, and thus give themselves more margin than they do under present circumstances, a slight miscalculation would not necessarily involve a collision. Injuries to several persons are the almost invariable result of even the slightest buffer-stop collision, owing to the fact that passengers are usually standing up in the act of getting out of the carriages or collecting their things. The acceleration of speed referred to by the driver and fireman as having occurred just when the train should have stopped may have been due to either of two causes, viz.:—(1) The rails are said to have been rather wet, and the fireman in applying his hand-brake with full force to stop the train may have caused the wheels to 'skid,' and thus give the impression of the engine receiving fresh impetus; or (2) the guard's brakes may, as the driver suggests, have been released at that moment. The conversation which passed later in the day between the driver and guard certainly goes to show that the brakes on the rear van had not been applied with anything like full force previous to the collision; that guard's evidence as to the rebound of the train also tends in the same direction. However this may be, the train appears to have been well in hand as it ran alongside the platform; and, as I have said above, the driver must take the responsibility for not seeing that it was brought to a stand before it reached the buffer-stops."

NOTES AND MEMORANDA.

Last week's return of births and deaths in London and in thirty-two other great towns, states that the deaths registered last week in thirty-three great towns of England and Wales corresponded to an annual rate of 20·7 per thousand of their aggregate population, which is estimated at 10,860,971 persons in the middle of this year.

In a paper on the direct combination of nitrogen with metals, M. A. Rossel in the *Comptes Rendus* states that it has been found that if an intimate mixture of finely-powdered calcium carbide with magnesium powder is heated with free access of air, the metal is almost completely transformed into the nitride. Finely divided aluminium, zinc, iron, and copper act similarly.

In London 2735 births and 1707 deaths were registered last week. Allowing for increase of population, the births were 220, and the deaths 523, below the average numbers in corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes, which had been 17·5, 18·1, and 17·8 in the preceding three weeks, rose again last week to 20·1. During the four weeks ending on Saturday last the death-rate averaged 18·4 per 1000, being 5·4 per 1000 below the mean rate in the corresponding periods of the ten years 1886–95, the mild weather being unusually favourable.

Strong glass plates are bored through by means of rotating brass tubes of the necessary diameter, which are filled with water during boring. To the water there is added finely pulverised emery. Thinner glass can be perforated with holes in an easier manner by pressing a disc of wet clay upon the glass and making a hole through the clay of the width desired, so that the glass is laid bare here. Then molten lead is poured into the hole and lead and glass drop down at once. This method is based upon the quick, local heating of the glass, whereby it obtains a circular crack, the outline of which corresponds to the outline of the hole made in the clay. The cutting of glass tubes, cylinders, &c., in the factories is based upon the same principle.

A paper on "The Expansion of Argon and of Helium as compared with that of Air and Hydrogen" was recently read before the Royal Society by Dr. J. P. Kuenen and Dr. W. W. Randall. The gas-thermometer used for these experiments was such as could be easily heated by means of a "Ramsay and Young" vapour jacket. It consisted of a bulb sealed on to a capillary tube, which in turn was sealed on to a wider tube, provided with a mark. This mark is situated just outside the heating arrangement, immediately below the capillary tube. The inner mercury surface is made to coincide with this mark, and both this one and the outer surface are read on a scale with a telescope. The readings were duly corrected for capillary action, expansion of glass and mercury, and the part of the gas that is not heated. The results show that up to 240 deg. C., the highest temperature that was employed, the expansion of both argon and helium is very nearly the same as that of air and hydrogen.

A new heavy liquid has been discovered. Mr. S. L. Penfield describes its preparation in the December number of the *American Journal of Science.* Mix equal proportions of the nitrate of silver and thallium, and on heating the mixture it fuses at 75 deg. C., forming a clear mobile liquid of density 4·5, which mixes with water in all proportions. It can therefore be used to separate mineral particles of densities below 4·5. When still heavier particles have to be separated, the proportion of thallium may be increased. When the ratio is 3 : 4 the mixture fuses below 100 deg. C. and has a density of about 4·7 At 2 : 4 the fusing point becomes 150 deg. C., and the density 4·8; at 1 : 4 it is about 4·9, and fusion only takes place at 200 deg. Finally, when pure thallium nitrate is used, the point of fusion is 250 deg. C., and the density closely approaches 5. This high range of densities, together with the fact that the salts do not, *Nature* says, attack many minerals, make the liquid especially valuable for mineralogical purposes.

At the meeting of the Paris Academy of Sciences on the 23rd ult., the president announced that a biennial prize—20,000f.—which is in rotation in the gift of each of the five Academies, and which this year fell to the Academy of Sciences, has been awarded to M. Raoult for his discovery of the numerical relations between the molecular weight of a substance and the lowering of the freezing point and vapour pressure of its solvent. The other prizes were awarded as follows:—The Francœur prize to M. J. Andrade, the Poncelet prize to M. G. Robin, for his contributions to mathematical physics. In mechanics, the extraordinary prize of 6000f. was divided between M. Mottez—2500f.—for his work on the correction of ships' compasses; M. Houette—1500f.—for his aids to navigation; M. Gosselin—1500f.—for his method of studying the velocity of projectiles; and M. Baucher—500f.—for his study of the action of sea water upon metals. The Montyon prize was given to M. Galliot, for a new application of electric traction on canals; and the Plumey prize to MM. Pollard and Dudebout. The Fourneyron prize was divided between M. G. Marié and M. Lecornu, for their experimental and theoretical work on steam governors.

According to a paper on the temperature variation of the thermal conductivities of marble and slate, contributed to the *American Journal of Science* by B. O. Peirce and R. W. Willson, such a temperature variation does not exist; in other words, that marble and slate conduct heat equally well at all temperatures. The result is of some importance to the physics of the earth's crust, and the manner in which it was arrived at displays some ingenuity. Two faces of a slab of marble or slate were kept at different temperatures, and the fall of temperature between one surface and the other was determined by means of thermopiles. Now it is notoriously difficult to determine the temperature accurately at a certain point, and borings lead to errors in estimated depth. So the expedient was adopted of slicing the slab into a series of layers pressed together, between every two of which a thermocouple was introduced. The interstices were only a few tenths of a millimetre, and experiments with different intervals proved that the error in the temperatures observed did not exceed one or two degrees Centigrade. On plotting the temperatures and distances, the temperature was found to have fallen uniformly throughout the slab. If the conductivity had been higher at higher temperatures, the fall on the hot side would have been more decided. The temperatures ranged from 350 deg. C. to zero.

M. Osmond states that in highly carburised steels, containing more than 1·3 per cent. of carbon, quenched at temperatures above 1000 deg., there are two constituents, A and B, which differ widely in their properties. The constituent A is the ordinary, hard, strongly magnetic substance of which hardened steel containing 1 per cent. of carbon is almost exclusively composed. Its hardness is greater than that of orthoclase. B, on the other hand, is only about as hard as fluorspar, and, as far as can be judged by a study of its properties while mixed with A, is non-magnetic. M. Osmond, however, has been hitherto unable to prepare B free from A, although by quenching steel containing 1·6 per cent. of carbon at a temperature of from 1000 deg. to 1100 deg, in ice-cold water, he has obtained a mixture of A and B in about equal proportions. This mixture is comparatively very feebly magnetic. The constituents both contain carbon, and exist side by side in separate polyhedra. The author concludes that B is the allotropic form of iron—denoted γ—which is especially stable above 860 deg., and is present to the exclusion of the other forms of iron in steels containing 25 per cent. of nickel, or 12 to 13 per cent. of manganese, these steels being non-magnetic. *Nature* says the hard constituent A would then be the allotropic form β. The research will be hailed by the allotropists as affording most important evidence in favour of their theory.

MISCELLANEA.

The Science and Art Department has received through the Foreign-office a communication stating that an International Exhibition will be held in Brussels in 1897.

The full text of Mr. Chamberlain's recent despatch on the subject of trade between the United Kingdom and the Colonies, with the detailed list of commodities, is published, by direction of the Council, in the current issue of the *Journal* of the Royal Colonial Institute.

The Department of Science and Art has received through the Foreign-office a communication from her Majesty's Consul at Barcelona, stating that it is proposed to hold a Fine Art and Industrial Exhibition in that city, commencing on the 23rd April next.

The Leicester Corporation Waterworks Committee have, upon the recommendation of Mr. J. B. Everard, M.I.C.E., decided to adopt the system of electro-mechanical apparatus, invented and manufactured by Mr. George Jennings, Lambeth, London, to indicate and register between the new reservoirs and engine houses at Swithland, Hallgates, and Cropstone, the varying levels of water in the reservoirs.

We are informed that the Marine Department of the Board of Trade completed an extensive and exhaustive series of tests upon electrolytically formed seamless copper steam pipes made by Elmore's Patent Copper Depositing Co., Leeds, and as a result of which the Board of Trade inspectors have been instructed to pass this company's manufacture of steam pipes for use in passenger and other steamships built under Board of Trade survey.

The Admiralty have decided to maintain four of the new 27-knot torpedo boat destroyers in commission at Sheerness, for the instruction of engine-room men and the training of officers and seamen in the use of that type of vessel. Four are also to be kept in commission at Portsmouth, and a similar number at Plymouth; and it is the intention of the Admiralty to combine the twelve vessels annually for a series of exercises in the summer months.

With reference to the 113$\frac{1}{2}$ million tons of coal imported by France during the first nine months of 1895, and the excess of 113,490,000f. or £4,539,600 in value of coal exports over imports, the *Echo des Mines* observes that it is incomprehensible why the Government does not second the efforts of coalmasters, and concludes that "C'est sur l'Angleterre qu'il faut gagner à tout prix; c'est l'ennemi industriel. La Belgique reste comme la soupape de sureté."

A mill chimney collapsed on Saturday evening last at Burnley, resulting in the loss of three lives and serious damage to property. The chimney belonged to an old disused mill. It was built of rubble stone, and was about 60ft. high. Without any warning, it fell about seven o'clock, the bulk of the masonry falling on two shops, which were demolished. There were only five people in the two shops at the time, and three of these were killed, and the others seriously injured.

As we recently stated, an Electrical Lighting and Power Act has recently been passed at the Cape of Good Hope, authorising regulations for the safety of the public, and Mr. A. P. Trotter, B.A., M.I.C.E., Assoc. M. Inst. C.E., has been appointed Government electrician and inspector under it. On Monday evening a complimentary dinner was given at the Whitehall Club by about sixty of his friends, when the expression of their good wishes for his success in Africa was accompanied by a present of a handsome gold watch. Mr. Trotter leaves for Cape Town in a few days.

We are informed the Admiralty have accepted the tender of Sir John Jackson, of Westminster, for the construction of the Naval Docks at Keyham, Plymouth, which are to be proceeded with forthwith. The amount recently voted by Parliament towards the cost of these works is two millions sterling. The works will be carried out under the supervision of Major H. Pilkington, R.E., of the Admiralty, as chief engineer. Sir John Jackson is well known as at present carrying out the new harbour works at Dover.

A complete system of purifying atmosphere and regulating temperature is in operation at Chicago, for the switchboard room of the Telephone Company, where dust formerly interfered seriously with the connections on the switchboard. The air for the room is forced through a chamber, where it is thoroughly sprayed, then passed through rapidly rotating spiral coils, which strip it of superfluous moisture, and afterwards through a chamber kept at nearly uniform temperature by the use of ice or of heating apparatus, as may be required. Access to the switchboard room is through an ante-chamber, and the temperature of the room itself shows a variation of not more than two degrees in a month.

A special train arrived from Cardiff on the 5th inst. bringing a set of powerful pumps and the necessary boilers to begin work on the Cunard steamer Cephalonia. From other ports have come light railway wagons with plant for unloading and then raising the liner now stranded in the upper part of Holyhead Harbour. In addition, three steamers and a tender, accompanied by a powerful tugboat, are now grouped around her. The crews of the various steamers have been supplemented by some two hundred dock labourers, all of whom are engaged unloading and transferring her cargo to the several steamers. Powerful pumps are at work on the Cunarder, and as the water falls the goods released are immediately removed. As soon as space below is freed, divers will go down and endeavour to cover the holes in the torn plates, and when these are secured they will be covered with a strong solution of cement, to make her sufficiently seaworthy to be taken round to the Mersey. The rents in the bottom and sides of the great steamer are believed to be serious, judging from the quantity of water in her compartments, and it is considered remarkable that she remained afloat to reach Holyhead under the circumstances.

A remarkable and serious gas escape occurred in Lime-street, on Monday Police Constable Carter noticed a strong smell of gas opposite Nos. 24 and 27, and at once sent word to the gas company. Chief Inspector Wigley, with his assistant Mr. Stuvington, and a staff of workmen, were at once despatched to the spot, and there is no doubt that but for their prompt arrival a serious explosion would have occurred. The gas was cut off from the shops in the immediate vicinity, safety lamps being temporarily supplied by the company. Every precaution was also taken to prevent any contact between the gas and the electric light, a large number of men from the respective companies being on the spot. The work of breaking open the roadway to inspect the main was found to be very difficult owing to the heavy layer of concrete below the asphalte. During the operations a spark from the pickaxe of one of the men ignited the gas, the result being a tremendous blaze, which caused some commotion among those who witnessed it. The flame was eventually extinguished by being beaten with a sack. About three hours afterwards, however, the gas again became ignited, owing, it was supposed, to the same cause, and this being a more serious outbreak, it became necessary to communicate with the Fire Brigade, by whom the blaze was put out with the aid of one of the adjacent hydrants. It was not until after seven o'clock, the men having then been at work for about nine hours, that the fracture in the main was discovered, and it was then seen that the leakage had been caused by a heavy subsidence in the earth. The main where the breakage had occurred was resting on no foundation, and the subsidence was so large that a man could have crawled under.

DIAGRAM OF BETHLEHEM ARMOUR PLATE

Fig 1.

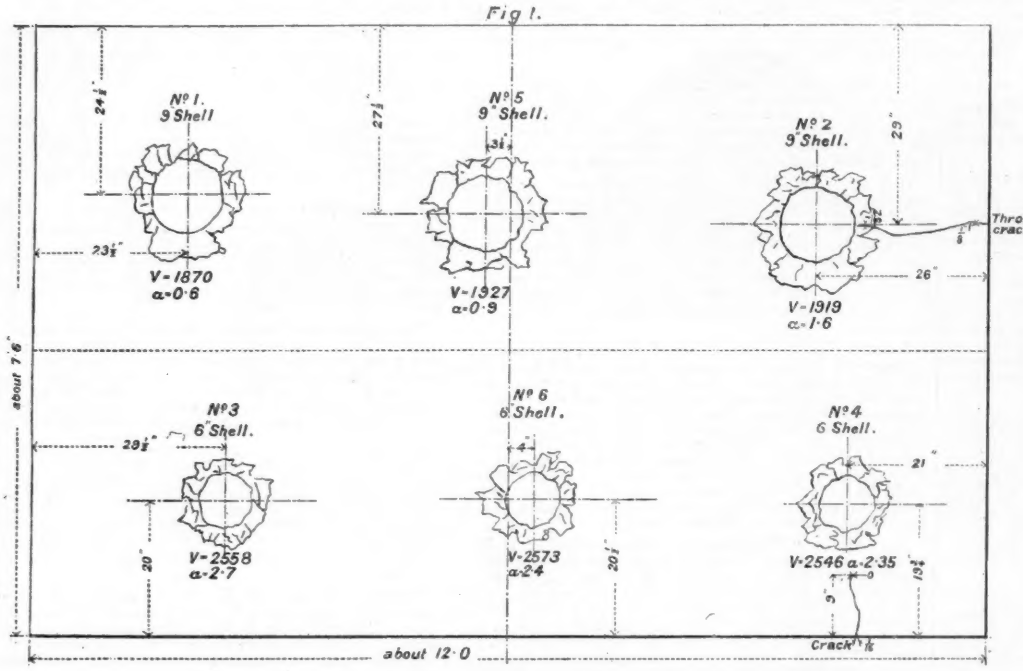
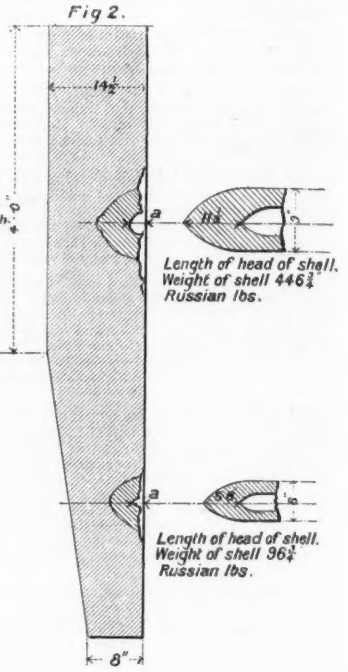


Fig 2.



AMERICAN AND RUSSIAN ARMOUR TRIALS.

We have long considered that we need to exert ourselves in the matter of armour in this country if we do not wish to be left behind other Powers, and in this position England of all nations cannot afford to be, because armour is mainly employed on ships. Indeed, both in quantity and in importance, armour on coast forts and inland forts bears no comparison to that on ships, and moreover is in most cases of a different kind from that which we mainly consider, namely, steel armour with a treated face. Possibly our misgivings may appear to some unreasonable, and due to a restless tendency to find fault with what is English and praise what is foreign. England has grand establishments for manufacturing armour, and makes enormous quantities of excellent plates, and with such establishments and experience, and with larger interest in the question than any other Power, it does not seem probable that we should allow ourselves to drop seriously behind other nations. We trust that at present we are not yet seriously behind, but we believe that we shall soon become so if we do not take decided steps to prevent it. Our manufactures are excellent, but we have lately shown a want of enterprise in developing our armour. We will give our readers our conclusions, and the grounds on which we base them. At the present moment, in the United States and on the Continent, nickel steel armour has almost wholly come in. In this country, on the other hand, we have apparently given up nickel except in the thin plates used in the structure of ships and in deck armour. Next, the application of the Harvey process to thick armour, say 12in. thick and over, has received comparatively little attention. Our great class of armour battleships building, of which the Magnificent is the first, are covered with 9in. plates on their sides, and though they have some of 14in. thickness on their barbettes, we have practically satisfied ourselves that a 9in. treated steel plate, which is about equal to 18in. of wrought iron, is as much as is worth while carrying on our sides. For this there is no doubt reason, inasmuch as the system of curved deck combined with it provides a second defence for the vital parts of the ship. In fact, no one can question that the side protection is admirable so far as these particular ships are concerned. Nevertheless, the fact remains that all this has caused thick armour to receive comparatively little attention, and it has its uses even on the barbettes of these ships. In America during the past year a series of trials in proof of supply of plates up to 18in. thickness has developed the manufacture of excellent armour, which is already carried in large quantities on actual ships. This armour has, we believe, all the hardness that we can give in this country, combined with the toughness which can only be obtained from nickel.

We have fallen into giving up nickel, because we found at a comparatively early stage of the manufacture of treated plates that we experienced difficulties with it, and were able to make rather harder plates without it. At that time, for our immediate wants, there was much to be said for turning out plates without nickel. For cruisers especially, hardness is valuable, and it was an object to push on quickly with our ships; but it has, unfortunately, followed as a consequence that we have neglected nickel. Unfortunately, nickel costs money, and unless a very decided and immediate advantage was apparent in adopting it, it would not be likely to be adopted, and no such decided advantage could be obtained without experience. Other nations persevered with nickel, and have reaped the benefit. They have got over any difficulties attendant on after operations, due to the presence of nickel, and they have secured great hardness combined with the toughness characteristic of nickel. This, of course, is a statement easily made, but we think that it is supported by the results obtained in experiments.

To pass next to another point. "Double forging" has come in in the United States, and the recent "record breakers," as they call them, have chiefly been double forged plates of Carnegie's. So far as we know, double forging has not been publicly tried in this country, yet surely it is a very natural process to apply to plates which have been exposed to a very high temperature for several days, during which crystallisation may have taken place. When we say it has not been tried in this country, we do not mean that makers may not have tried it privately. It is possible that some of the plates tested in our Government trials may have been double forged. We know of no reason why this should not have been done, indeed we have recently heard that Mr. Ellis is shortly going to submit for trial some nickel plates, one of which is double forged, but double forging has not been tested publicly in this country as yet.

Finally, we believe that we are distinctly behind America in the manufacture of armour-piercing projectiles. For all these unpalatable statements evidence is needed, and must be carefully taken. If shot and plates are both improved, it is evident that the result of firing such shot against such plates may not be apparent. Superiority, indeed, might be easily claimed for both shot and plates while both were inferior. For this reason it is desirable to try the shot of others against our own plates, as we have done in the case of Holtzer, and occasionally other makers, but it is a practice that may too easily be discontinued. At all events in Holtzer's 6in. shot we have an excellent international standard, which is good as far as it goes, seeing that this particular calibre has established an excellent character which Holtzer's larger projectiles have yet to achieve. The 6in. shot is of no use for the thicker plates above referred to, but it applies, at all events, to the thinner ones, and enables an estimate to be formed of the powers of shot made in America. In this country a 6in. Holtzer projectile, with a sufficient velocity, say 2000 foot-seconds, will perforate any 6in. plate which we oppose to it, and has done so with lower velocity. In the States a really good 6in. treated and double forged plate is now expected to defeat 6in. Holtzer projectiles. We will pass, however, to our immediate object, which is to record the results of certain experiments in Russia and America. We attach special value to the results of Russian trials, because they are, so far as we have had the opportunity of witnessing them, admirably conducted, and French, English, and American plates get dealt with in turn.

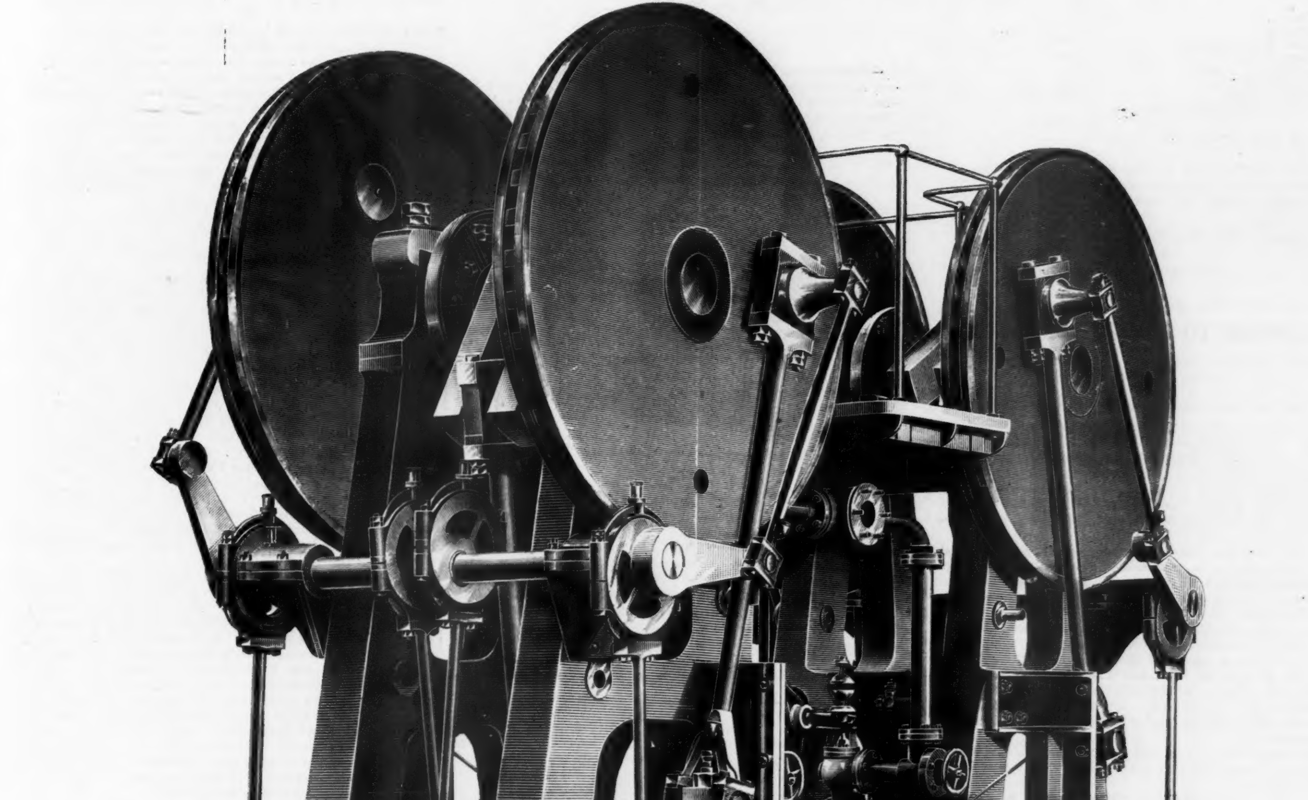
BETHLEHEM BARBETTE PLATE

We are now able to furnish a brief account and sketch of a trial of a Bethlehem plate, which took place on November 23rd and on December the 5th last. The plate is not a record breaker, nor is it double forged, but it must surely be pronounced to have behaved well. The fact is that it has not been tried at all as severely as is desirable to bring out special excellence. The plate was a Harveyed steel Bethlehem plate 12ft. × 7½ft. For a width of 4ft. the thickness was 14½in., for the last 3½ft. it tapered down to 8in., as shown in Fig. 2. The attack consisted of three rounds from a 9in. gun firing projectiles weighing 446¾ Russian pounds, or 403·3 English pounds, and three rounds from a 6in. gun firing projectiles weighing 96¾ lb. Russian, or 87·3 lb. English. The striking velocities and perforations are given in table A in next page.

It may be seen from this table that the perforating power was considerable, the maximum being 18·1in. of ordinary steel against this 14·5in. treated plate, and 14·8in. of ordinary steel against a part which was about 11in. thick. Six rounds were delivered. In every case the projectile broke up, and in only two cases was there any crack. We question if a better result than this could be

PUMPING ENGINES, COLCHESTER WATERWORKS

MESSRS. EASTON, ANDERSON, AND GOOLDEN, LONDON AND ERITH, ENGINEERS



shown with armour made in England. Yet this has been far surpassed with double forged plates.

TABLE A.

No. of. round	Calibre inches.	Weight of shot lb. English.	Striking velocity ft. sec.	Striking energy foot tons.	Perforation by Krupp's formula. Inches iron.	Perforation by Krupp's formula. In. steel ordina'y	Striking energy foot-tons per ton of plate.
1	9	403·3	1870	9777	21·7	17·3	475·6
2	9	403·3	1919	10290	22·5	18·0	500·8
3	6	87·3	2558	3961	18·3	14·6	192·7
4	6	87·3	2546	3922	18·1	14·5	190·8
5	9	403·3	1927	10390	22·7	18·1	505·3
6	6	87·3	2573	4007	18·4	14·8	194·9
							2060·1

We will now, however, give an excellent result with a single forged 15in. Bethlehem nickel Harveyed plate selected from the supply of the Indiana and Massachusetts armour, tested on February 19th, 1895, and reported by us in the issue of March 15th last, but which is well worth giving again, as we now have the photograph. The attack was made with two 10in. Carpenter projectiles weighing 500 lb. each. The striking velocity of the first was 1539 foot-seconds, and of the second 1940 foot-seconds; the striking energies being 8212 and 13,050 foot-tons, and the calculated perforations 16·2in. of iron or 12·9in. of steel, and 21·4in. of iron or 17·1in. of steel. The projectiles broke up as shown in the photograph, the estimated penetrations being 2in. and 6in. respectively. No cracking was perceptible, so it was reported, and so it appears as far as can be seen in the photograph. It will be seen then that these two results are remarkably good. In each case a severe attack has been totally defeated. We lay special stress on the last, as it is the case of a plate 15in. thick.

PUMPING ENGINES, COLCHESTER WATERWORKS.

WE illustrate above and on page 27 the pumping engines constructed by Messrs. Easton, Anderson, and Goolden, Erith Ironworks, and officially started by the Mayor of Colchester on the 7th of November, 1894.

There are two three-cylinder compound surface-condensing vertical engines placed directly over the well, each engine capable of pumping 70,000 gallons of water per hour to a total height of 247ft. The high-pressure cylinder is 14in. diameter, and the two low-pressure cylinders are each 20in. diameter, the stroke being 3ft. The crank shaft is placed over the cylinders, and has two disc fly-wheels keyed on to it.

The pumps are of the three-throw bucket-and-plunger type the rods being coupled directly to the tail rods of the steam pistons, each pump barrel being 11½in. diameter, and having a plunger 8¼in. diameter. The top box of the pumps is placed 30ft. below the engine-house floor, and is above the standing water level in the well. The barrels are placed 70ft. below the engine-house floor, and are connected to the top box by means of stand pipes supported by strong cast iron girders built into the well above the water level. Each engine is fitted with a separate air-pump 9in. diameter, 3ft. stroke, and surface condenser having 250 square feet of cooling surface. The exhaust steam passes through the tubes, and a branch off the delivery main fitted with a sluice cock regulates the amount of circulating water.

Steam is supplied by two Paxman patent economic boilers, 7ft. 6in. diameter, 12ft. 6in. long, having a working pressure of 125 lb. per square inch, and fitted with feed pumps and injectors. There is one flue in each boiler 2ft. 4in. diameter, and seventy 3in. return tubes the whole length of the boiler.

The well is 80ft. deep, 13ft. diameter at the top, lined with 14in. brickwork for a depth of 38ft.; below this it is lined with cast iron cylinders for a further depth of 30ft., and the remainder with 14in. brickwork. The standing level of the water is about 30ft. from the engine-house floor.

From an eight hours' trial recently made of the engines and boilers the following results were obtained :—

Mean speed of engines	31·5 revs. per min.
Mean boiler pressure	120 lb. per sq. in.
Mean vacuum	26in.
Total head of water	235·25ft.
Mean I.H.P.	107
Mean pump H.P.	91·04
Mechanical efficiency	85·09 per cent.
Feed-water per I.H.P. per hour	17·77 lb.
Feed-water per pump H.P.	20·09
Coal used per I.H.P.	1·75
Coal used per pump H.P.	2·05
Temperature of feed-water	75 deg. Fah.
Water evaporated per lb. of coal from and at 212 deg	12·13 lb.
Foot-pounds of work done per cwt. of coal consumed	107,692,848

The works were carried out to the designs and under the superintendence of Mr. J. Mackworth Wood on behalf of the Corporation of Colchester, Mr. Paxman being chairman of the Water Committee.

It will be noticed that the shaft carrying the excentrics is caused to rotate by two coupling rods from the main crank shaft. The arrangement is quite successful and satisfactory.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

METROPOLIS WATER SUPPLY—THE WELSH SCHEME.

SIR,—In the editorial review, in your issue of the 3rd inst., of engineering works now in progress or contemplated, you say with relation to the above scheme that "The London County Council are not yet prepared with a Bill to carry out the project devised by their chief engineer Mr. A. R. Binnie, for bringing a supply of water to London from Wales;" and as some misapprehension as to the authorship of the scheme appears to exist, we ask to be allowed to set the matter right.

The project for obtaining water for London from the rivers Usk and Wye, and delivering it by gravitation at an altitude of 300ft. above the Ordnance Datum on both the north and the south sides of the metropolis, is wholly ours, and was brought by us under the notice of the London County Council in July, 1892, as you will see by the accompanying pamphlet. The project attracted the attention of the Water Committee, and Mr. Binnie was directed to investigate it, and make a report as to its feasibility and cost, and to enable him to do this, we furnished him with detailed maps, plans, sections, and estimates of the entire works. Mr. Binnie has fully corroborated our views, and with some small variations, which in no way affect the principles of the scheme, has recommended it for adoption.

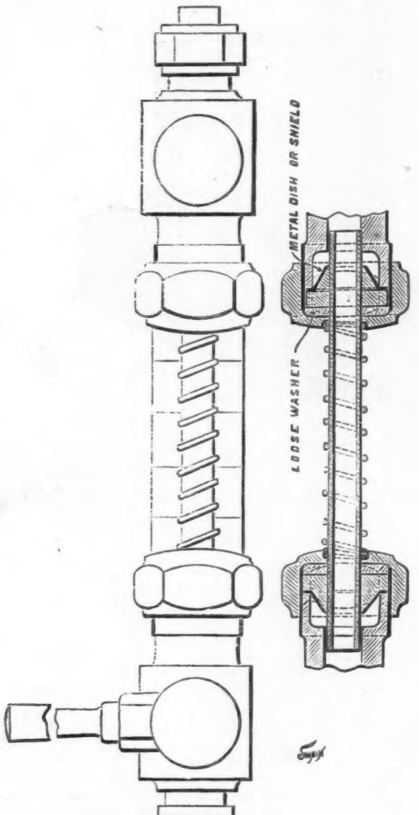
We have no reason to suppose that our position in the matter will be questioned, but we ask you to allow this communication to appear in your columns.

HASSARD AND TYRRELL, MM. Inst. C.E.

Westminster-chambers, Victoria-street, S.W.,
January 6th.

GLASS WATER GAUGE PROTECTOR.

SIR,—As at the present time the suitable protection of water gauge glasses is so much under notice, I enclose you a tracing showing a simple and inexpensive method I have designed for meeting the difficulty, and which may be of some interest to your readers. The tracing shows clearly the arrangement, which consists simply in encasing the outside of the glass with a wire spring, which is held in position by the ends resting in grooves formed in the nuts at the top and bottom of the glass. The wire spring forms a good support or backing to the glass, and when a breakage occurs it holds the pieces of glass together and prevents them being scattered about, it also keeps the glass at a more uniform temperature. As will be seen, as soon as the escaping steam and water have been shut off, the broken glass is easily removed by slightly compressing the wire spring, which may then be taken out of the recesses. We have had these guards in use on our locomotives for some time with very satisfactory results.



I have also devised an improvement in the packing by placing a conical brass shield round the conical part of the india-rubber—now almost universally used for packing glass gauges—the shield being flanged out so as to rest on the top of the glass gauge fitting; this prevents the india-rubber getting out of shape, and we find that it lasts very much longer, and has got rid of a good deal of trouble which we had in the original india-rubber rings before they were so protected.

F. W. WEBB.

L. and N. W. Railway, Locomotive Department
Crewe, January 4th.

SLIDE VALVE FRICTION.

SIR,—Referring to the letter from Mr. R. Collier on the above subject, in your issue of the 13th inst., I was pleased to see the question discussed, and will, with your permission, work out a case from actual practice. Fig. 1 shows a slide valve for a locomotive cylinder 18in. diameter by 24in. stroke, the steam chest pressure being taken at 140 lb. per square inch. The slide valve is shown in its position when the piston is at the end of its stroke, that is to say, when the crank is on its dead centre, corresponding to this position of the piston. The dimensions necessary for our calculation are indicated on the sketch. Fig. 2 shows portions of the curves for normal indicator diagrams, which have been taken from actual practice, the engine being in forward gear, cutting-off at 35 per cent. of the stroke. The travel of the slide valve corresponding to this will be about $2\frac{1}{2}$in. There will be nearly a constant pressure on the back of the slide valve equal to $9\frac{1}{4}$in. × 17in. × 140 lb. = 22,015 lb. Against this we shall have in the case of the port side A of the piston a varying pressure as indicated by the curve A A_1, Fig. 2; that is to say, from the commencement of stroke of the piston to its position when exhaust begins, viz., A_1, the mean value of the curve A A_1 is about 98 lb. per square inch, which it will be near enough to assume acts upon an area equal to that of this steam port, viz., $1\frac{1}{4}$in. × 15in. = 18·75 square inches, so that the total pressure will be 18·75 square inches × 98 lb. = 1837·5 lb. The travel of the slide corresponding to this being about $1\frac{5}{8}$in.; at the point A_1, the slide valve allows communication between the steam port A and the exhaust port B, so that there will be a varying pressure represented by the curve A_1 A_2, the mean value of which is about 40 lb. per square inch, and this acts upon a constant area $5\frac{1}{4}$in. × 15in. = 78·75 square inches, plus an area varying from $1\frac{1}{4}$in. × 15in. = 18·75 square inches maximum to zero minimum; the travel of slide corresponding to the curve A_1 A_2 being about $\frac{7}{8}$in.

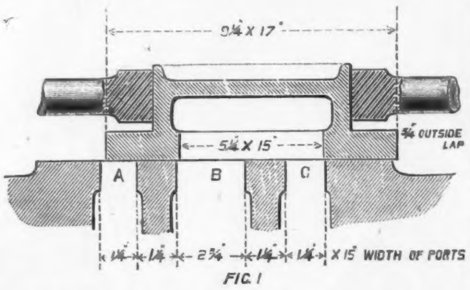


FIG. 1

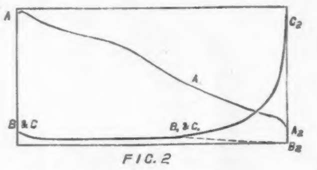


FIG. 2

But at the same time that this curve A A_1 A_2 is being traced on the port side A of the piston, another curve is being traced on the other side of the piston—viz., the port side C. So long as the slide valve allows steam to exhaust from the steam port C into the exhaust port B, that is to say, from the commencement of the stroke of the piston up to the point where compression commences, so long will there be a contrary pressure on the slide valve, as indicated by the curve B and C to B_1 and C_1, the mean value of which is about 6 lb. per square inch; this will act on an area equal to $5\frac{1}{4}$in. × 15in. = 78·75 square inches, plus an area varying from zero to $1\frac{1}{4}$in. × 15in. = 18·75 square inches maximum; the travel of the slide valve corresponding to this curve being about $1\frac{5}{8}$in. At the compression point the slide will have just closed the steam port C to the exhaust port B; after which there will be a varying pressure in the steam port C, as indicated by the compression and admission curve B_1 and C_1 to C_2, the mean value of which is about 24 lb. per square inch, and will act upon an area which it will be near enough to assume as equal to $1\frac{1}{4}$in. × 15in. = 18·75 square inches, while at the same time there will be a varying pressure on the exhaust, as already stated, due to the steam exhausting from the other steam port A into the exhaust port B. If it were not for this steam port A just coming into action when B is closed to C, the pressure line would drop in the exhaust, as indicated by the dotted line B_1 and C_1 to B_2. The travel of slide corresponding to the curve B_1 and C_1 to C_2 is about $\frac{7}{8}$in. The total work done in moving the slide valve through one complete stroke, that is to say, from any given position of the slide through its various positions and back again to the original position, will be approximately

$$\left[\left\{(22{,}015 - 1837{\cdot}5) - \left(78{\cdot}75 + \frac{18{\cdot}75}{2}\right) 6\right\} 1\tfrac{5}{8} + \left\{22{,}015 - \left(78{\cdot}75 + \frac{18{\cdot}75}{2}\right) 40 - (18{\cdot}75 \times 24)\right\} \tfrac{7}{8}\right] \frac{\mu}{12}$$

$$= (31{,}929{\cdot}21{,}875 + 15{,}785)\ \frac{\mu}{12}$$

$$= \frac{47{,}714{\cdot}21{,}875}{12}\ \mu = 3976{\cdot}2\ \mu \text{ foot-pounds.}$$

Where (μ) is the coefficient of friction between the slide valve face and its seating in the steam chest, taking this at the same value as Mr. Collier—viz., $\frac{1}{5} = 0{\cdot}2$ for dry surfaces, and $\frac{1}{8} = 0{\cdot}125$ for for surfaces moistened by the steam, we have respectively, $\frac{3976{\cdot}2}{5} = 795{\cdot}24$ foot-pounds, and $\frac{3976{\cdot}2}{8} = 497{\cdot}025$ foot-pounds.

The mean effective pressure on the piston is about 68 lb. per square inch, so that the work done on the piston during the above cycle of the slide valve will be $(18)^2 \times 0{\cdot}7854 \times 68$ lb. × 2ft. = 34,607·8656 foot-pounds, or say 34,608 foot-pounds. Let x and y represent respectively the work absorbed in moving the slide for dry and moistened surfaces, in percentage of the work done on the piston in the same time, then

$\frac{x}{100} = \frac{795{\cdot}24}{34{,}608}$ $\therefore x = \frac{79{,}524}{34{,}608} = 2{\cdot}29$ per cent. for dry surfaces,

and $\frac{y}{100} = \frac{497{\cdot}025}{34{,}608}$ $\therefore y = \frac{49702{\cdot}5}{3{,}6408} = 1{\cdot}43$ per cent. for moistened surfaces.

From this it would appear that about 2·29 per cent. of the work done on the piston is absorbed in driving the slide valve when the surfaces are dry, or about 1·43 per cent. when the surfaces are moistened. It will be observed that these figures agree very well with those obtained by Mr. Aspinall, and quoted by your correspondent—viz., 2·26 and 1·34 per cent. I have omitted to take into account the weight of the slide valve, which would probably weigh about 60 lb., or rather over half a hundredweight. If the valve was placed above the cylinder, so that the whole of this weight acted, we should have for dry surfaces $\frac{60 \times \frac{1}{5} \times 2\frac{1}{2}}{12} = 2\frac{1}{2}$ foot-pounds, and for moist surfaces $\frac{60 \times \frac{1}{8} \times 2\frac{1}{2}}{12} = 1{\cdot}56$ foot-pounds, which would require in this case to be added to the above result to be absolutely correct, but the difference is so small that it is inappreciable. If the slide is placed under the cylinders, according to the practice of the Great Eastern Railway, then to be absolutely correct in the above calculation we should take (22,015 − 60) = 21,955 lb., instead of 22,015 lb. throughout the whole calculation.

One of the chief advantages in placing the slide valves underneath the cylinders is that when the engine is running with steam shut-off, the valves will fall away from the port faces or valve seating, in which case they are not uselessly grinding away their faces and that of their seatings.

EDWARD J. M. DAVIES.

24, Harrington-square, London, N.W.,
December 23rd, 1895.

THE METRIC SYSTEM.

SIR,—Your leading article deals with this question on its general bearings, but permit me to say that you have either not read the evidence given before the Select Committee last year, or you have purposely treated it as of no account. Your presentment of the case is but a repetition of what used to be said some forty or fifty years ago, and by no means represents what has now to be considered.

Granted that the metre was originally based on a mistaken measurement, that it is really an arbitrary measure, it has now been standardised in the most accurate way, and every European country, except Denmark, Great Britain, and Russia, has adopted the metric system exclusively. All the Southern States of America, Japan, and other countries have followed suit. In the United States there is a growing disposition to adopt it; in 1890 the President transmitted to Congress a report adopted unanimously by an International American Conference, which recommended the adoption of the metric weights and measures now in use by the Governments and people of all the other American Republics, and most of the nations of Europe.

In 1893 the Consular officers of the United States were instructed to refuse to certify invoices of goods consigned to the United States unless the merchandise were invoiced in accordance with the metric system. Also in 1893 the United States superintendent of Standard Weights and Measures issued a bulletin to the effect that the international prototype metre and kilogramme had been accepted as the fundamental standards of length and mass, and that the customary units, the yard and the pound, would be treated as derived therefrom. At the present time a Government Committee of experts is considering the general adoption of the metric weights and measures. Actually countries representing a population of over 445 millions are now using the metric weights and measures, and there is good authority for saying that if Great Britain and her dependencies were to adopt them, they would be adopted throughout the civilised world.

I agree with you that some decimal fractions are inconvenient, but there is no system without some drawbacks; and when in certain cases it is quicker or better to speak of a third, a fourth, &c., it would be foolish not to do so. As the late Professor De Morgan said: "It is an abiding delusion of the opponent of decimals that he will suppose the decimalist to be under a contract never to use a common fraction." Decimals are not upheld as exclusively right, but rather as pre-eminently convenient. As to the convenience and accuracy of the metric system, the best testimony is that it is used exclusively in all scientific work.

The mere comparison of the metric units with those of our own system gives no adequate idea of the advantages of the one system over the other. For instance, in our weights and measures the units of length or bulk have little or no direct relation to those of weight, and sometimes the volume unit is a gallon, sometimes a cubic foot, and sometimes a cubic inch. There is no uniform basis on which to compare substances or results. But in the metric system it is well known that a cubic decimetre of water weighs a kilogramme; that a cubic metre of water weighs a ton, &c. We have only to multiply the volume or bulk of any substance into its specific gravity, and we know its weight. Conversely, if we know the weight of iron, brick, or other substance, we can easily find its volume by dividing the weight by the specific gravity. It is this intimate, simple, and rational relation of the several metric units and their derivatives which has had more to do with the general adoption of the metric system than any other consideration. But even you have failed to appreciate this manifest advantage, or you would not have quoted the example of the pump. Any one familiar with the metric system would know that litres, decalitres, cubic metres, or cubic centimetres of water can be immediately, and without trouble, converted into grammes or kilogrammes.

Your statement that "the history of the adoption of the metric system in France is very consistently kept in the background" is hardly fair. As a matter of fact, the very first witness before the Select Committee of 1895, Mr. Chaney, was questioned on this point. The chairman said: "In the report of the Committee on Weights and Measures—1862—there is a very elaborate account of the history of the metrical system; still I think it is very desirable to hear from you, as an authority upon the subject, a short account of the origin of the metrical system." Other witnesses were also questioned on the subject.

Undoubtedly the introduction of the metric system in France took a long time, and was attended with great difficulty. It is common knowledge; but we must remember that nearly a century ago the people generally were without education, and where there was ignorance there would naturally be prejudice. This, then, is not what should guide us in the present day; let us rather turn to any of the countries which have adopted the metric system during the last twenty years or so—for instance, Germany, Austria, and Sweden. Several witnesses stated that in neither of these countries was there any serious difficulty, and that the change was effected in a short time. In Germany an Act was passed in 1868 which made the metric system permissive from 1870 to 1872, and compulsory afterwards. Is it too much to suppose that with our present educational advantages our countrymen are less intelligent and less capable than those of other countries?

You say that in this country an Act was passed in 1864 which made the metric system optional. If you will be good enough to refer to the Act itself, you will see that it only allows contracts to be made in terms of the metric system, and that it does not authorise the use of the material weights and measures of that system. The Act passed in 1878 goes a step further, and authorises their use for purposes other than trade, and at the present day manufacturers are in this extraordinary position: Supposing a merchant in France orders a certain number of metres of cloth from a manufacturer in England, the latter cannot legally use a metre to measure it when made. He must "measure it in yards or feet, and afterwards recalculate the number of yards or number of feet which would make up the number of metres of the order"—*vide* Mr. Chaney's evidence. You urge us to take a practical view of the question, and I submit that this is not practical. In the face of the present keen competition abroad it is simply absurd.

There are many other points I could dwell on, such as the important effects on education, the urgent recommendations of British Consuls abroad, &c., but I should trespass too much on your valuable space. I must, however, correct your statement that probably "not more than a few hundred individuals manifest the smallest desire to possess" the metric system, and that the English-speaking world at large regards it "with supreme indifference." The facts are these:—

(*a*) All the Associated Chambers of Commerce of the United

Kingdom, as well as the four important chambers which are not members of the Association—Edinburgh, Glasgow, Liverpool, and Manchester—strongly advocate the adoption of the metric weights and measures, and have all passed resolutions in its favour. It was a strong deputation of these chambers which recently waited on Mr. Balfour, and he fully recognised the importance of the commercial interests they represented.

(*b*) All the leading School Boards of the United Kingdom have petitioned in favour of the proposed change, and the National Union of Teachers has unanimously passed a strong resolution in its favour. Masters of middle-class schools, including the head master of the City of London School, and other educational authorities, are also strongly in its favour.

(*c*) The Trades Councils throughout the country have taken a keen and intelligent interest in the question, and at several of their meetings it has been discussed in a practical way. At a Congress held in Glasgow, where there were 495 delegates, representing about a million and a-quarter members, and 418 different trades, a resolution in favour of the proposed change was carried unanimously, and the Parliamentary Committee was instructed to give its active support.

(*d*) The Incorporated Society of Inspectors of Weights and Measures have passed a strong resolution in its favour, and some members of this society gave valuable evidence before the Select Committee.

(*e*) Since the deputation to Mr. Balfour, the Metropolitan Grocers' and Provision Dealers' Association—essentially a gathering of retailers—discussed the question fully and critically at a general meeting, and passed a resolution in favour of the metric system being made compulsory.

(*f*) The County Council of Durham, representing a population of 750,000, and the borough and county borough of Leicester, have voted unanimously in favour of the change. Many engineers, shipbuilders, and manufacturers are also urging its adoption.

(*g*) I have already referred to what is being done in the United States. In Melbourne the Legislative Assembly adopted a motion in favour of a Universal or Imperial Union for the introduction of the metric system.

The question has grown so far, and it is growing. Within the last two months I have read hundreds of press notices and criticisms from all parts of the country, and I have been agreeably surprised to find that nearly all recognise the advantages of the metric system, and that those who hesitate to make it compulsory are influenced chiefly by the fear of inconvenience during the period of transition. In conclusion, may I express the hope that when you have had time to look over the evidence of Sir Benjamin Baker, Mr. Alex. Siemens, Captain Sankey—of Willans and Robinson—and others, given before the Select Committee, you will no longer oppose a reform which I sincerely believe we must adopt sooner or later.

J. EMERSON DOWSON.

[We have not one word to urge against the metric system. We have the strongest possible objection to Government interference. When the voice of the professional and trading people of Great Britain is unanimous, the metric system will be adopted. Until then, we accept Mr. Balfour's expression of opinion as correct and statesmanlike.—ED. E.]

EARLY LOCOMOTIVES.

SIR.—It is interesting to read the letter of Mr. John Wilson, page 11, and to have the views of one who has had such a long railway experience, I therefore trust he will throw more light upon the subject. Mr. Wilson gives a diagram to illustrate a design by Mr. Grantham; no doubt a large number of engines were designed, but Mr. Wilson does not say that the engine was ever made. In the writing of locomotive history I am always careful to refer to engines actually built. The books of Messrs. Mather, Dixon, and Co. show very clearly the engines built by the firm, but they do not give any details whatever of engines with wheels larger than 8ft. Mr. Wilson does not give any date, or maker's number, or for which line the design was intended. Messrs. Mather, Dixon's drawing of the Ajax, and also of the 8ft. wheel, are reproduced in your issue of October 25th, 1895, and also in the fourth edition of my book, "Locomotive Development," page 220, and probably Mr. Wilson can remember that engine when under construction. Undoubtedly there was one engine upon the Great Western Railway having a driving wheel of 10ft. diameter, but, at different times it had three names, Hurricane, Grasshopper, and Ajax, and this fact is the root of the whole question. Robert Stephenson did not say that there was more than one 10ft. wheel engine. Giving evidence before the Gauge Commission, August 6th, 1845, question 107, he stated "there was one of 10ft., I know." This answer proves that Stephenson did not know of more than one.

In these days, when we consider 85 miles an hour a high speed, and laugh at those who claim a speed of 100 miles an hour in America, it is rather astonishing to hear from Mr. Wilson that the Cornwall of 1847 went 120 miles an hour; but surely your readers will expect Mr. Wilson to furnish details as to length of run and the way in which the speed was timed. We are told by Mr. Wilson that it was on the trial trip down Madeley Bank.

The late Mr. Alexander Allan was the superintendent of the Crewe Works at the time when the Cornwall was built, and he was on the foot-plate when the trial trip was made; and a few years ago he lent me all the drawings of the engine and details of her working. I have now before me a letter written by Mr. Allan, in which he informed me that the highest speed attained by the Cornwall was on her trial trip when running down Madeley Bank; it was "79" miles an hour. That is my authority for the statement made in my book, page 99. Mr. Allan, who was in charge of the experiments, gives 79 miles an hour—surely a very different statement to 120 miles an hour. Probably Mr. Wilson will explain the important difference of 41 miles an hour.

Mr. Wilson is indeed quite in error when he supposes that I shall "not thank him for corrections." On the other hand, my object is to make my book as correct as possible; but in view of the letter I have from the late Mr. Allan, I certainly cannot accept the "correction" of speed in this case, as I do not believe that any locomotive engine in the world has ever run at 120 miles an hour.

When Mr. Wilson states that the Grasshopper had 10ft. wheels I quite agree with him, as it was but the second name of the Hurricane; but when he refers to it as "the 100 miles an hour engine," I must ask for some proof that such a speed was ever run. It is easy to write 100 miles an hour on paper, but it requires a great deal of attaining; in fact, it never has been attained by engines on rails. If Mr. Wilson thinks otherwise he should produce proofs.

CLEMENT E. STRETTON.

Saxe-Coburg House, Leicester,
January 6th.

SIR,—Somewhat late in the day there is at length laid before us by Mr. John Wilson in your issue of 3rd inst. a diagram which purports to be that of a 10ft. driving wheel locomotive—see page 10. This diagram may represent a design, but if so, that is all.

I fail to see Mr. Wilson's object in now producing this drawing, unless he is anxious to re-open this discussion, which, after having lasted for many weeks, has for a short time been lying dormant. Why did not Mr. Wilson produce his drawing before this? Mr. Wilson does not appear himself to be very certain about his diagram. In one paragraph he speaks of the engine as if it had really been built, and as if he had actually been present at its erection. In the very next paragraph he seems to throw doubt on the existence of such an engine altogether. What does he mean? Why does he not tell us whence the drawing came? What was the name of the engine, if it ever was made, and the maker's number? He gives no information by which his engine can be traced, neither does he say for what company it was built, nor does he give any details of any sort.

As to Mr. Wilson's reference to the allegation that there were two or more locomotives on the Great Western Railway with 10ft. driving wheels, I may say that, so far as I can ascertain, Mr. Stephenson did not say there were more than one. Mr. Wilson also mentions Mr. Dean's name, but as has already been shown, Mr. Acworth stated on Mr. Dean's authority that the Hurricane was the only 10ft. wheel engine on the Great Western line. Certainly there is no trace of any other in the records and books of the Great Western Railway. Mr. Wilson mentions an engine named Grasshopper? Is he, after all that has been written on the subject, still in ignorance of the fact that Grasshopper and Hurricane as well as Ajax were all one and the same engine?

Will Mr. Wilson favour us with details of the 100 miles and 120 miles an hour speeds he mentioned; and will he inform us who timed the running, and how it was done? This information would be interesting, and might be useful to our friends across the water who have not yet, so far as I know, reached a speed of 120 miles an hour.

D. H. LITTLEJOHN.

Dundee, January 5th.

SIR,—Those of your readers who are interested in this discussion will have derive much pleasure from the drawing supplied by Mr. J. Wilson, together with the explanatory letter, appearing on page 10 of your issue for January 3rd.

It will be observed that Mr. Wilson's letter and drawing not only prove the undoubted existence of the 10ft. wheel locomotives constructed by Mather, Dixon, and Co., but they are also proof positive on another point, viz., that some of the original broad-gauge engines were fitted with a prow in front.

In the "History of the G.W.R.," page 69, I stated, "Some of these early engines were provided with a projector in front, extending from the smoke-box to the buffer beam, and shaped like the bow of a ship." Up to now, although Mr. Stretton and his two friends have given your readers what they describe as full details of all the original broad-gauge engines, no mention appears to have been made by these three gentlemen of this prow-shaped projection. But the very fact that they did not deny that some engines were so fitted must have convinced students of locomotive history that other engines than those stated by Messrs. Stretton, Littlejohn, and Greenly must have existed, despite the extremely vehement repudiation of these three gentlemen.

Mr. Stretton is in another very awkward predicament, for, according to Mr. Wilson, I understand that he has stated that he has a blue print of a disc wheel made at Bath-street Foundry in 1838. Mr. Wilson, who certainly ought to know, says there was no Bath-street Foundry in 1838.

G. A. SEKON.

SIR,—With reference to Mr. J. Wilson's letter, I may state that I know for a fact that no such engine was ever run on the Great Western Railway. If such an engine, as Mr. Wilson illustrated it, was designed, was it built and did it work? In regard to the statement that the Cornwall ran 120 miles per hour, we laugh at the Americans and their records (?) of 112 miles per hour. The official record of the Cornwall was about 79 miles per hour. Mr. Wilson's letter does not prove that there was more than one 10ft. driving-wheeled engine on the Great Western rails. I would not like to say that there was not a 10ft. locomotive driving-wheel ever made, but I say emphatically that the Ajax on the Great Western Railway had a spokeless wheel which was only 8ft. in diameter.

London, W., January 6th. HENRY GREENLY.

SIR,—I find two slight errors in the printing of my paper on "Early Locomotives." The Grasshopper with sandwich frames was the *lost*, not the *last*, 10ft. wheel locomotive. The other should read, Mather, Dixon, and Co. *delivering*, not *relining*, engines.

JOHN WILSON.

165, Onslow-drive, Dennistoun, Glasgow, January 6th, 1896.

NAVAL ENGINEERS.

SIR,—Your outspoken protests against the present position leads me to wonder why the state of affairs revealed by the Lightning court-martial has not been commented on. Apparently during the trials there were one commissioned executive officer, two commissioned engineer officers, and two junior non-commissioned officers, and on failure of the commander, the command devolved on a non-commissioned officer.

The engineers are highly educated men, far above the average of naval officers; one has passed a special course at the Royal Naval College, both are in the prime of life—probably about thirty-six—have had years of sea service, and yet are required to serve under the orders of a man who is comparatively uneducated, and in any other relation of life would be so far beneath the chief engineer as to be only known as master and servant.

What would be thought of a railway management which could contemplate any emergency in which the locomotive engineer of the line, was required to take orders from, and ask the permission of a guard, before he could do anything? Yet such is the position of a naval engineer.

Your articles even scarcely show the importance of a naval engineer. The modern warship without the engineer is powerless; he alone knows how to propel and steer the ship, manage the guns and torpedoes, maintain the water-tight doors, and yet must do all this under the orders of an ordinary blue-jacket. Whilst responsible for more than one-third of the crew, he has not so much authority as the youngest sub-lieutenant. In most places it is recognised that authority and responsibility go together, but not so in the Navy, at least so it appears to a CIVILIAN.

January 4th.

PERMANENT WAY.

SIR,—Mr. Tratman discusses a very interesting question, the relative merits of the bullhead and flange rail, and he makes out a very good case for the latter. He will not convert English engineers, however. To use an Americanism, "We have been there." We have done all we could to make the flange or Vignoles rail a success, and failed. I take it that the word "success" can be defined in terms of money, and in that only. Now the flange rail system is in the long run more costly than the bullhead and chair system, and so has been rejected. It would be waste of time and space to tell the whole story over again. The broad facts can be very briefly stated:—Given a certain weight of steel, say, 85lb., to be made into a yard of rail, it is clear that if we put a large proportion of this in a bottom flange we shall have less left for the top. If we keep the top standard size, we must take it out of the web. The result is, of course, that the flange rail not being so deep as the bullhead, lacks vertical stiffness. To compensate for this the sleepers must be put closer together, and the ballast of the best. In America timber is much cheaper than in this country, and as Mr. Tratman tells us, the best flange railroads are apparently wooden decks on which the rails are laid, the ballast being of the best possible type. To get stiffness, the feebleness of the rail is helped by the excellence of the road bed. We have tried all this over here, and we find that in the long run we get a stiffer, and much cheaper, and more durable track with chairs and cross sleepers than can be had in any other way.

In the course of my life I have seen almost every system of permanent way tried that promised anything—from the Barlow rail on. The existing chair and bullhead is a survival of the fittest, and its adoption in the United States is only a question of time. I fancy Mr. Tratman knows very well what are the defects of both systems, but, lest he should have forgotten one, I may point out that in facility of repair, renewal, or packing up, the American system cannot compare with the English. I could remove and replace ten bullhead rails while Mr. Tratman was doing the same with one flanged rail; spiking cannot compare in efficiency with the securing of chairs with hollow treenails and driven bolts. If you unspike a flange rail you ruin the sleeper, and as to the screw spike system, it only manages to get along in the most watchful hands.

I quite agree with Mr. Tratman that the daily press of the United States makes too much of track defects, but, on the other hand, Mr. Tratman must know that it is one thing to pick out a few thousand miles of really first-class line and quite another to deal with 50,000 miles or so, much of it the worst track in the world.

The probability is that if we take an 85 lb. rail on the best portion of the Pennsylvania road, and a bullhead 85 lb. on, say, the Great Northern, it will be found that one road is as good as the other to run over. This being granted—and I do not think Mr. Tratman will dispute it—the only point remaining for consideration is relative cost. Will Mr. Tratman go into this question and let your readers know what the first cost and cost of maintenance per mill is on a first-class American line? I have no doubt he will, if he can, but I much doubt his power; at all events, I tried very hard a few years ago to get the requisite data, and failed; I was told, indeed, that from one cause and another it was not available. It is, of course, well known in certain circles that American railway finance is chaotic in the matter of detail. It is possible, however, that Mr. Tratman may be now able to supply the missing figures. If he can and will, he will give information not hitherto available in this country, or indeed, in the United States. The figures should give the total maintenance cost of, say, 100 miles of first-rate track for five years at least.

December 27th, 1895. SEXTUS.

ELECTRIC LIGHT ENGINES.

SIR,—As you have done me the honour to make a few editoria comments on my letter that appeared in your issue of January 3rd, I should feel obliged if you would allow me to reply to them. On reference to my letter it will be seen that I nowhere charge you with casting a slur on "engine builders." What I said was that a slur was put upon "our stationary engine builders." What I endeavoured to repudiate was the very unjust comparison that was made by you on page 608 of your issue of December 20th, 1895. You there say, "The necessities of electric lighting almost compel the adoption of a marine type of engine as the motor, and it is obvious that if we require a marine engine we should not place the order with a stationary engine builder, more especially as our marine engineering has no rival in the world, while many stationary engine builders must unfortunately be classed below some of the continental builders—the Sulzers, Vandenkerchoves," &c. &c.—to wit, in point of reputation.

I think most impartial critics will agree with me in thinking that though the excellence of our marine engineering is indubitable, the comparison is so made as to discredit to an unnecessary extent the merits of the stationary engine builder. In your appended criticism you ask, "Where is the British marine engine builder that can be classed below the foreign marine engine builder?" If by this you mean that any British marine engine builder, however bad, is better than any foreign builder however good, I fear that your question savours rather of blind patriotism than clear criticism. Waving these controversial points, which will be differently answered according to the individual bias of the critics, it is surely too much to say, in the teeth of such strong evidence to the contrary, that the necessities of electric lighting "almost compel the adoption of engines of the marine type." In the first place, such engines are only suitable in the case—admittedly one of large and growing importance—of direct-driven machines.

Now in America, where there are perhaps more electric installations than the whole of the countries of Europe together, the engines of the marine type might be counted on one's fingers; in our own country they are, to say the least of it, extremely rare. The only safe generalisation on this question is that in all probability the high speed engine will outlive and supplant the slow speed motors which are now receiving diminishing favour. "Of all forms of error prophesy is the most gratuitous," and yet in spite of this sage warning, it is without incurring very great danger that one ventures to predict that the stationary engine builder will continue to do the lion's share in the matter of manufacture of electric light engines in the future as he has done in the past.

6, Cyprus-street, Bolton. ROBERT A. BRUCE.
January 8th.

DROWNED PUMPS.

SIR,—It may be in the recollection of your readers that a few weeks ago the Dungannon collieries, Ireland, were suddenly inundated by an enormous body of water tapped from some old workings, and which unfortunately resulted in serious loss of life besides overwhelming the pumping machinery.

Mr. Donald Munro, the managing engineer of the colliery, advises us that they have been able to start the large Cornish duplex steam pumping engine, supplied by us to the colliery, and that it is working 60ft. under water. We think this will be of interest to those who have to do with underground pumping machinery, and shows in a remarkable manner the capabilities of the direct-acting type of engine.

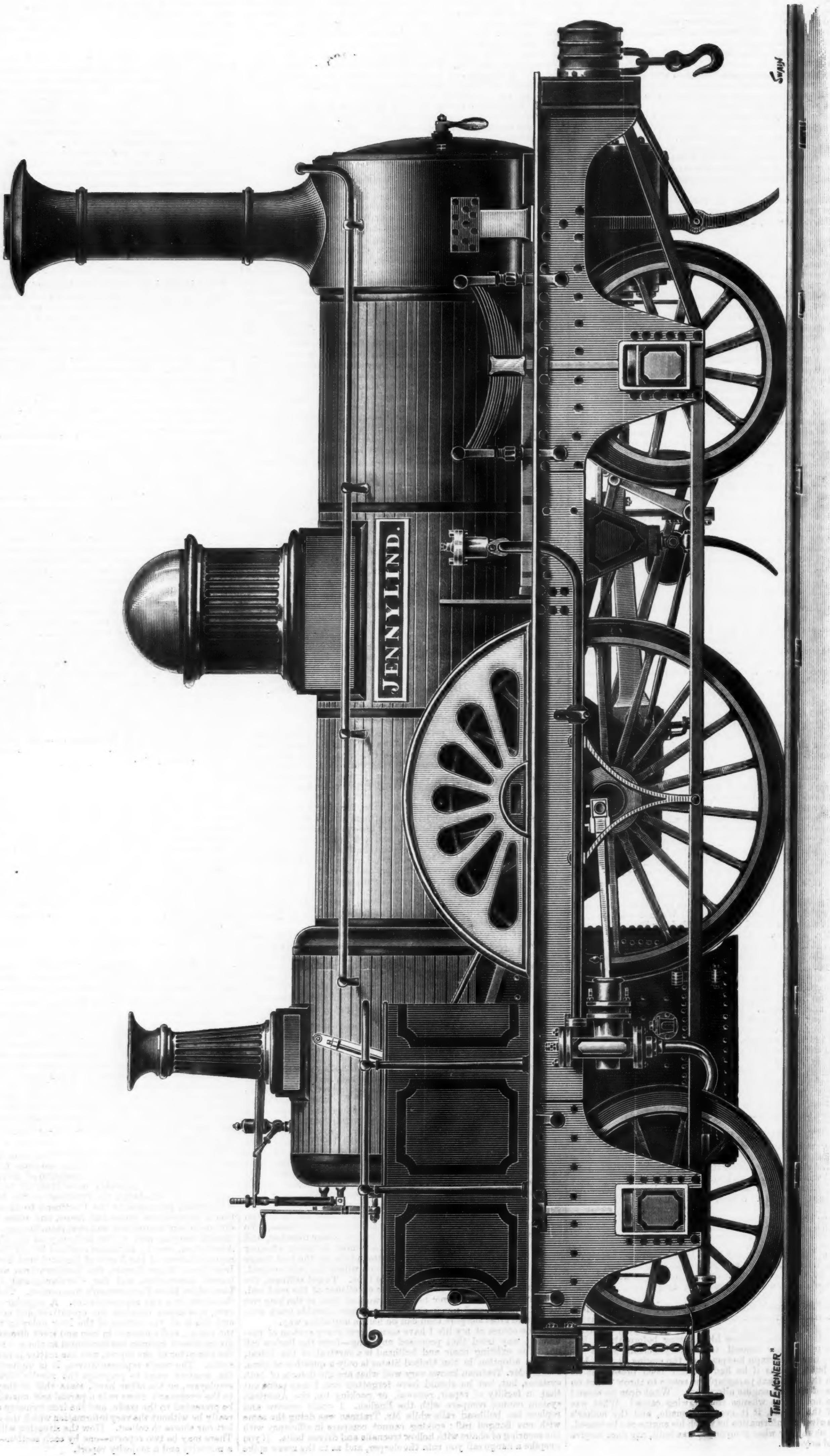
JOSEPH EVANS AND SONS.

Wolverhämpton, January 8th.

METALLURGICAL LABORATORY, KING'S COLLEGE.—We are requested to state that there are one or two free admissions to the evening classes in this department now available.

THE SLOOP PHŒNIX.—The Phœnix, sloop, at Devonport, has been moved into the Sound to have her compasses adjusted, in readiness for a six hours' preliminary trial of her machinery in the Channel. The vessel has not yet been outside the Hamoaze, as on being launched from Devonport Dockyard she was at once transferred to Keyham. Considerable interest will be taken in her steam trials, in consequence of her engines and boilers having been manufactured by and fitted in place by the Keyham Factory. She was laid down on the 26th July, 1894, and would have been completed in June last had it not been for the pressure of other machinery work not anticipated when Keyham's programme of work for the current year was mapped out. When ready for sea the total cost of the vessel will have been just over £66,000.—*Western Morning News.*

WAGES IN ENGLISH AND CONTINENTAL IRON TRADES.—We are still without the report for which the iron trade has been so anxiously looking of the joint deputation of ironmasters and ironworkers, which considerably more than six months ago, at the inspiration of Mr. Jacks, the President of the Bristol Iron Trade Association, journeyed to the Continent to investigate the question of ironworkers' wages and hours, and other competitive conditions in continental iron and steel manufacture. The deputation, though carrying with it the authority of the British Iron Trade Association, was by no means confined to that body, but included representatives of the North of England, and Scotch and Midland Iron Trade Wages Boards, the Northern Iron and Steel Manufacturers' Association, and the Cleveland, and Cumberland, and Lancashire Blast Furnacemen's Association. The delegation was, therefore, in a way representative. A singular dispute has, however, now arisen between the operatives' and employers' sections, and this is at the bottom of the long delay in the publication of the report, and comment in iron and steel circles is following. A divergence of opinion has developed at the last moment regarding the character of the report, and the matter is not an easy one to settle. The men's representatives, it is understood, declare that the masters want to prejudge the results obtained, while the employers, on the other hand, state that if they were to consent to the workmen's views only a partial and one-sided report would be presented to the trade, and the iron industry as a whole would really be without the very information which the deputation mainly left our shores to collect. How the situation will end is doubtful. There may be two reports—one by each section—or there may be a minority and a majority report.


JENNY LIND.
SWAIN
"THE ENGINEER"

PASSENGER ENGINE, MIDLAND RAILWAY, 1848

DESIGNED BY MR. DAVID JOY; CONSTRUCTED AT THE RAILWAY FOUNDRY, LEEDS

(For description see page 25)

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Student.—*It is the Technological Dictionary of the Physical, Mechanical, and Chemical Sciences—English-German and German-English. London: Symons and Co.*

Stocktonian.—*The last edition of Molesworth's Pocket-book gives the formulæ you require, but some knowledge of the subject is necessary as well as formulæ. Adams's little book on "Lattice Girders and Roofs"—Spon—may help you, but you had better consult also such works as Stoney's "Stresses on Girders and Roofs," and Claxton Fidler's "Bridge Construction."*

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of The Engineer.

MEETINGS NEXT WEEK.

The Institution of Civil Engineers.—Tuesday, January 14th, at 8 p.m. Paper: "The Sanitary Works of Buenos Ayres: Sewerage, Drainage, and Water Supply," by the Hon. R. C. Parsons, M.A., M. Inst. C.E. Friday, January 17th, at 8 p.m. Students' meeting. Paper: "Iron Tunnels," by Mr. W. O. Leitch, jun., Stud. Inst. C.E. Mr. J. Wolfe Barry, C.B., F.R.S., vice-president, in the chair.

The Institution of Electrical Engineers.—Thursday, January 16th, at 8 p.m. Presentation of premiums. Inaugural address of the President, Dr. John Hopkinson, M.A., F.R.S.

Society of Arts.—Tuesday, January 14th, at 8 p.m. Applied Art Section. Paper: "The Poster and Its Artistic Possibilities," by Gleeson White. Ernest Hart, D.C.L., will preside. Wednesday, January 15th, at 8 p.m. Paper: "The Making of a Great University for London," by Professor Silvanus P. Thompson, D.Sc., F.R.S. Lord Reay, G.C.S.I., G.C.I.E., will preside. Thursday, January 16th, at 4.30 p.m. Indian Section. Paper: "The Shan Hills—Their Peoples and Products," by Colonel R. G. Woodthorpe, C.B., R.E., Indian Survey Department. The Right Hon. George N. Curzon, M.P., will preside.

Royal Meteorological Society.—Wednesday, January 15th, at 7.45 p.m. Address: "Meteorological Observatories," by the President, Mr. R. Inwards, F.R.A.S.

THE ENGINEER.

JANUARY 10, 1896.

THE ARMOUR OF PEACE.

Si vis pacem, para bellum. Amidst the surrounding gloom, the United States threatening us, South African affairs most deeply involved, and the Emperor of Germany adding to the difficulty of the situation by his unguarded expressions of sympathy for the Boers, one characteristic of our position as a people shines prominently forth—we are alone in it. To many the knowledge of this fact would appear to involve a sense of uneasiness or insecurity. We would venture to combat the accuracy of this opinion. That we find ourselves alone in our position amongst the nations of the world, during such critical junctures as the last few weeks have afforded, is not to be wondered at. It is the natural corollary to the theorem of our position as standing alone amongst the nations in regard to instincts, tastes, and ambitions. It is the penalty of the greatness of our views in regard to empire.

We have always stood alone in this connection. The factors of imperial greatness, upon which the British empire rests and ever has rested, are exhibited in the Legend beneath the Royal Arms, "Dieu et mon Droit." Our confidence in the integrity of this national principle, which has actuated all the true political feeling of our country, and prompted every war in which we have been engaged, has never been shaken. When a crushed and writhing Europe appealed to Great Britain for relief from the military despotism of the Corsican Adventurer, what did this nation do? A fleet, such as the world had never before seen, was prepared, with such men as Nelson and Collingwood in command; the great Duke of Wellington was despatched with an army; and, without a dream as to increase of territory, or a thought as to self-aggrandisement, all the vast resources of the empire were employed, and all its mighty sinews were strained, to destroy Napoleon. This desired end was accomplished; arms were laid down, and battleships returned to their quiet berths at Hamoaze and Spithead. Where, amongst the other nations of the world can we find one that has been thus true to its principles of unselfishness and integrity after a successful campaign?

Strong in the confidence which such a legend as ours—"God and my Right"—can afford, we would reason temperately with those who, on the other side of the Atlantic, are seemingly careless as to the prospect of war; a war which, so far as one can judge, must, in the existing unpreparedness of the United States navy, terminate in disastrous consequences to her, and in the transfer of such of her warships as might be afloat after the expiration of hostilities, to the flag of Great Britain. It is, however, to the rational and peace-loving element of the States that we would confidently appeal. There is everything to lose and nothing whatever to be gained in a fratracidal war between the two great English-speaking races of the world. We are essential to one another, and war would dislocate all the racial, commercial, industrial, and social ties by which we are connected. Such a thing must never be.

But our national "Legend" involves a great deal. The factors of empire are not altogether of a sentimental character. Although designed with a view of upholding the grand principle of integrity which runs through them all, they are nevertheless associated with matters essentially material. This article is headed with the expression "Armour of Peace." Now, whether the curious spectacle of a whole Europe practically in arms should be regarded as a refutation of the old aphorism, *si vis pacem, para bellum*, or as an argument in its favour, is certainly a matter of opinion. But there can be no resonable doubt that, for an empire constituted as is ours, the expression "Armour of Peace" has but one signification. As applied to our Navy it is singularly appropriate. Welding together, as our Navy does, the many links in those chains which compose the imperial lines of communication all over the world, it occupies a position altogether non-aggressive. It is practically without a compeer, and has no occasion to threaten any one. It is thus unique as a protective element.

And here we are brought face to face with the most important feature of our subject. We have stated that our Navy should be regarded essentially as "Our armour of Peace." But in order to preserve its attributes of characteristic peacefulness, it must be relatively strong; and when we look around us in the increasing gloom which overshadows the early days of 1896, the necessity becomes more clearly imperative for an extensive overhaul of this, our armour of peace. We have not a word of complaint against either of the three administrations, which, without considering party politics, have, for the past nine years, laboured so successfully in the development of a magnificent fleet of battleships, cruisers, torpedo boat destroyers, and torpedo boats. We believe that the monies voted have been most judiciously expended. But ships, more ships, and still more officers, blue-jackets, and stokers are wanted. 40,000 more men should be added to the Navy forthwith, and the number of cruisers should be augmented by at least fifty. So far as regards battleships, we have already a considerable preponderance over those of any two foreign naval Powers; but in cruisers we are sadly defective. We want at least a dozen of the Buenos Ayres class, possessing 23 knots speed, which should be commenced forthwith. The country is ready, able, and willing,—nay, longing—to supply £50,000,000 if required. It should be voted forthwith. *Si vis pacem, para bellum.*

THE ROYAL ORDNANCE FACTORIES.

The *Times* has admitted into its columns correspondence relating to the constitution of the Royal Factories, to the quality and cost of the warlike stores manufactured in them, and to the nature of their accounts. The letters consist entirely of vague and unsupported charges, intended to serve as a base to the proposition that it is absurd to expect efficient and economic management of factories devoted to the production of military or naval stores, where such factories are not under military rule; and that the present organisation in some way has severed the connection which should exist between the military side of the War-office and the manufacturing departments. We should not have cared to devote space to the refutation of these absurd propositions, were it not for the mischief which such unsound statements are apt to produce when uttered in the columns of the leading journal. We imagine that it hardly requires any argument to show that the user of a watch need not necessarily be competent to direct the manufacture of watches, nor that people who are capable of enjoying a good dinner must, for that reason, be the most competent to cook it. We would rather address ourselves to an examination of the theory on which the present system of the supply of warlike stores is based; a theory which seems to be very generally overlooked, and especially by the military element, which the improved organisation has deprived of much power and patronage.

The production of warlike stores demands knowledge and experience more extensive than is to be found in any one individual, and the changes taking place are so rapid that any one officer confined to the duties of manufacture would soon get out of date and out of touch with the services to which he is supposed to belong. To meet these circumstances the production of military and naval stores has been divided into three stages. The first stage embraces the inception and design of new stores, the examination of new inventions and proposals, and the decision of doubtful points arising during manufacture or inspection. The duties connected with this stage are carried out by the Ordnance Committee, a body composed mainly of military and naval officers of distinction and on the active list, who serve on the Committee for a few years, and are constantly being replaced by men fresh from the fleets or from the active army, and who on that account are presumed to be cognisant of the current and ever-changing wants of the two services. They are aided in their deliberations by two civil engineers of the highest standing, by the chemists to the War Department and the Home-office, by the Director-General of the Ordnance Factories and his staff, by special military experts in the several arms of the services, and, in addition, not unfrequently by private manufacturers called in with reference to very special subjects. The practical work of the Committee is carried out at the butts at Woolwich Arsenal, at Shoeburyness, at Lydd, at Oakhampton, at Hythe, by the Excellent, and in the Royal Factories which are open to the Committee at all times for illustration of mechanisms, for processes of manufacture, and for carrying out experiments connected with the production of new stores.

The second stage embraces the mere manufacture of stores according to the sealed patterns and specifications recommended by the Ordnance Committee and approved by the Inspector-General of Ordnance, or by the Director of Naval Ordnance. It is this portion of the work, so much of it, at least, as is not confided to private manufacturers, which the late Mr. Stanhope decided to place in the hands of a civilian chief, and, in our judgment, the decision was eminently sound, and the principle should be further extended, as indeed was originally recommended by Lord Morley's Committee, till the military and naval elements in the executive are abolished altogether. It surely is as irrational to place a soldier or a sailor, who has had no technical training, and knows nothing about the management of workmen, suddenly in charge of a very large factory carrying on a varied and complicated manufacture, as it would be grotesquely improper to confide the command of a regiment or of a ship to a civilian. In both cases the person appointed may become efficient in course of time, but at the outset he would be merely an automaton, moved by the inferior, permanent, and technical staff, and their influence would be very difficult to shake off, especially under the old system when the appointments were made only for a few years. The Government should unquestionably select for superintendents and other subordinate officers, men who have had a thorough training in the management of large private works, who themselves know how best to conduct manufacture in all its details, and are judges of the amount of work men may be fairly expected to turn out. Throughout the *Times* correspondence we have alluded to, we have not observed that any question has been raised as to the competence of private manufacturers to turn out guns, carriages, ammunition, and other warlike stores; yet, with one notable exception, these firms are not under military direction, notwithstanding which no one can question the excellence of their products, and if this be so, why should not the Ordnance Factories achieve like results under entirely civil management?

The third stage of supply includes the most important and valuable Inspection Department. The essence of this is that it is entirely independent of the manufacturer, whether in the Government factories, or in private trade, but is directly dependent on the Inspector-General of Ordnance and the Director of Naval Ordnance, who are primarily responsible for the stores supplied from whatever source. In order to preserve this essential independence it is necessary that the two officers above named should be in no wise responsible for manufacture. They are responsible for designs and specifications; they are responsible for the stores accepted being in accordance with those designs and specifications; and their judgment should therefore not be fettered by the desire of screening the shortcomings of factories, for the economical conduct of which they might be also responsible. The Inspector-General of Ordnance selects his inspecting staff from officers of the army, generally the artillery, and makes the appointments for a short term of years. The actual viewing, gauging, &c., is done by civilian subordinates. The Navy follows a much wiser course, and makes its inspecting officers naval engineers, technical men, who have been trained to the work, and whose appointments are therefore practically permanent, because if an officer be changed his successor does not come raw to his duties but is familiar with them from the outset.

It is alleged by the writers whose statements we are traversing that the work turned out by the Royal Factories is bad and dear. With respect to the first charge it is evident, from what we have stated, that if the work be bad, the military and naval inspection departments cannot be doing their duty; but technical men are well aware that the charge cannot be maintained for a moment, it is too well known that the work of the Royal Factories is uniformly excellent, and it is a libel on the Inspection Departments to assert the contrary, for nothing can exceed the vigilance and impartiality displayed by them in accepting stores for the service. With respect to the cost of the work, the charges are as sweeping as they are vague and indefinite. The production accounts of the Royal Factories, published annually, tell us indeed the exact cost for the particular year of each store manufactured, but no such account is published of the cost of similar stores supplied by the trade; indeed, the tenders are kept confidential, so that the public has no means of judging, except in a few instances when, in the case of a few important manufactures, the prices gradually leak out, and in such cases the Royal Factories may be shown to work to advantage. Cordite, gunpowder, rifles, small arm ammunition, quick-firing ammunition, heavy guns, and such like, are produced more cheaply in them than by the trade; notwithstanding which we believe that if the factories were entirely under trained civilian management the cost is still capable of considerable reduction, and we have little doubt that when, in course of time, General Maitland's well laid plans are thoroughly carried out, considerable further economy will be realised.

There remains one other matter to touch upon, and that is the alleged involved and chaotic state of the accounts. A considerable familiarity with such matters leads us to the conclusion that the chaotic state is not in the accounts. The Accountant-General and the Director-General of Ordnance Factories have to appear annually, and publicly, before the Parliamentary Committee on Public Accounts, to answer for their stewardship of the national funds expended in the factories during the past year. The Committee is assisted by representatives from the Exchequer and Audit Department, and from the Treasury—experts, it must be remembered, in accounts; and yet, although the transactions dealt with cover an expenditure of some 2¼ millions of money, in many thousand distinct orders, the two responsible officers are able to satisfy all inquiries in a couple of hours of a single afternoon; and the greater part even of that time is taken up in explaining small slips and discrepancies, which the diligence and acuteness of Sir Charles Ryan's staff has been able, through the year, to detect. This does not look like a state of chaos, or of special difficulty in understanding accounts; although the evidence before the Committee does also show that efforts are being made to bring to a state of uniformity and accuracy as to cost keeping, accounts which years of military misrule had well nigh brought to a state of confusion.

The Royal Factories, it must be recognised, are weighted by considerations which do not affect private firms. With respect to the management of the personnel, vested interests have to be considered, together with the interferences of members of Parliament, on behalf of men possessed with votes. With respect to materials and productions generally, those that turn out defective in the slightest degree cannot be got rid of to advantage, as is possible from the factories of private firms. The Royal Factories are probably better conducted than most private establishments, they can no more claim perfection than any other human enterprises, and they certainly do not deserve the indiscriminate, we were almost going to say vindictive, charges which have been brought against them, and it is perfectly plain that the military element has a large preponderance in determining the nature as well as the quality of the national warlike stores; and can scarcely complain of being out of touch with the manufacturing departments.

THE THAMES AS A HIGHWAY.

THE London County Council have appointed a Committee who, with the assistance of the engineer, are to report on the possibility and means of restoring to the Thames its former importance as a highway. If by this is intended the revival of the steamboat passenger traffic on a commercial basis, we fear that the attempt will prove a failure. The decadence of this traffic commenced thirty years ago, and the circumstances which caused it are, despite of struggles by those concerned to overcome or ignore them, stronger to-day than ever. The old wherries, safe and well-managed as they were, and also the earlier steamboats, lost much of their monopoly when the Greenwich and Blackwall Railways were opened, and omnibuses introduced from the City to Westminster. But London Bridge Station and the old Minories terminus of the Blackwall line were difficult of access, and the high omnibus fares in those days from the Bank to Charing Cross and Chelsea left ample scope for the steamboats. So that there was not only a regular service of cheap boats between Chelsea and London Bridge, and thence to Woolwich, but there were hourly boats to Erith, Greenhithe, and Gravesend. This last service, except for holiday and pleasure traffic, was practically destroyed by the opening of the Tilbury line on the north bank and the extension of the North Kent and Greenwich lines to Cannon-street and Charing Cross. But there was still room for steamboats between Chelsea and Woolwich, for the omnibuses along the Strand were dear and uncomfortable, and the riverside districts below London Bridge were as yet inaccessible, especially such places as the Commercial Docks and Millwall. The opening of the District Railway was the heaviest blow to the system of up-river boats; and when the railway was extended *viâ* the East London line and Thames Tunnel to New Cross, the great convenience was obtained by Shadwell, Wapping, and Rotherhithe of half-hourly trains to Westminster. Finally, the branch from the Poplar Station of the Blackwall line to Millwall and North Greenwich opened communication with the remote and long neglected Isle of Dogs.

From the causes here enumerated, it appears hopeless to establish a remunerative service of steamboats to ply at all seasons of the year. This is much to be regretted for several reasons. It is certainly pleasanter on a bright day to take the river from the City, than to breathe the vitiated atmosphere of the underground railway. But it is not always bright weather, and moreover, by the time a passenger from the Bank, following the windings of Thames-street, has reached the deck of his steamer, he might have been able by railway to arrive at Westminster Bridge. The landing places *en route* are not so contiguous to the main streets, as, for instance, are those of the Seine boats in Paris, and in the latter city there is little opposition. Undoubtedly on the Thames the steamboats afford a convenient means of cross river communication. If the Archbishop of Canterbury desire to consult his ecclesiastical lawyer in the Temple, he can embark with advantage at Lambeth Palace; and if, armed with the advice so acquired, he has business at St. Saviour's, Southwark, with the Bishop of that diocese, he can reach the Surrey side of London Bridge from the Temple stairs more quickly than by any other means. But such combinations and conveniences will hardly support a line of steamers. It is not only the railways that have taken away the river traffic, but the cheap modern omnibuses. The low fares between the City and Westminster, while due partly to improved vehicles, are rendered possible only by the easy traction on the asphalte paving and by the low price of fodder. On this latter advantage depend almost entirely the dividends of the omnibus companies. The fact that without the steamboats Londoners would have few opportunities of seeing their river, is another reason why we wish to retain them. The larger part of our provincial and foreign visitors limit their easterly explorations to the Tower of London, and do not see that real greatness of our city, which only a voyage through the port of London can show them. It has been too much the fashion to sneer at the Thames steamboats as of a past and imperfect age. Their chief defects were the want of deck shelter, and the stuffy cabins, which rendered them uncomfortable on a cold or rainy day; but under the modern management of the Victoria Steamboat Association great improvements have been made in these respects. In regard to speed the old boats were as quick as could be permitted on a crowded river, and the oscillating engines — almost all made by Penn—were models of symmetry and lightness; and the boats were smartly handled.

It is possible that we have misjudged the purport of the County Council's action. It may be that it is their intention not merely to ascertain the likelihood of a profit in a renewal and improvement of the steamboat service, but to exploit the bolder idea of municipal enterprise. The prominent part taken by Mr. John Burns in the matter lends plausibility to this surmise, and it is also possible that the recent attempt of the directors of the Tramway Company to re-invest the capital of their shareholders in the steamboats, instead of paying to them the purchase money lately received from the County Council, may have suggested this view to the member for Battersea. The shareholders were wise in preferring hard cash to so speculative a venture. But much as we are inclined to deprecate the tendency to municipal socialism even in the working of tramways, we might be tempted to control our antagonism as ratepayers, and to criticise more tenderly a scheme for County Council steamboats if by that means alone the Thames were to be saved to us as a highway. We shall look with particular interest to the report of the Committee, and on the sequel.

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THE CLYDE ENGINEERING DISPUTE.

WITH the resumption of work in the shipbuilding yards of the Clyde after the New Year holidays—during which, of course, matters did not assume any new development—the idleness and dislocation in the engine shops have again become subject of anxious attention. It was expected by the engineers on strike that some non-union men would ask for employment, and pickets were on duty when the shops opened on Monday. However, their intervention was not required, as very few non-society men were to be seen near the gates. It is still apparently a moot point whether or not the masters really wish to employ non-union men, but it seems to be the case that in one or two instances preparations have been made which can only be explained on the grounds that non-union workers are expected, and that if any such apply to the foremen they will be engaged, provided they are eligible workmen. The apprentices in the Greenock and Port-Glasgow shops resolved during the holidays not to start work but to "stand by the men," and this they did for one day, but have since gone into their several shops. In Glasgow also there has been a disposition among the lads to cease work, but so far this has not actually taken place. The effect of such a step, in any case, would not be very marked one way or another in this most grievous dispute, and serious difficulties might arise in connection with the reinstatement of the apprentices after settlement of the dispute. The destination of Mr. Sellicks, the president of the Amalgamated Society of Engineers, who left London on Tuesday of last week, was not Belfast, as stated in the course of our article in last issue on "Free Labour on the Clyde," but Glasgow. His presence there, and the speeches which he and the local officials of the men's society have delivered throughout the Clyde districts, have not been in consonance with the spirit of the season which is sacred to "peace on earth and goodwill among men." On the contrary, they have been calculated to embitter, if possible, the present strained relationship between employer and employed, and to close still more firmly the door against conciliatory advancee. At one of the meetings the following resolution was proposed and unanimously carried :—"That this meeting of locked-out engineers and taxpayers bring under the notice of the Admiralty the criminal neglect and delay of the Clyde employers with regard to the completion of the national contracts." With regard to this, of course, the employers feel that it is a case of the pot calling the kettle black. The men are not entitled to describe themselves as a meeting of "locked-out engineers and taxpayers;" they are simply engineers on strike against what by very general consent is regarded as a fair enough offer for the settlement of a trade dispute. To accuse the employers of "criminal neglect and delay" because they refuse to do absolutely what the workmen demand is manifestly absurd, especially in view of the fact that the Executive Council of the men's society have still made no counter proposal to that which they rejected after the Glasgow conference. At present the society stands before the public as refusing all conciliation and rejecting all negotiation, and in that light they are more to blame for "criminal neglect and delay" than the employers.

THE RACE TO THE NORTH.

IT has been freely stated of late that the Midland Railway Company has no intention of entering into the contest for the shortest possible run to the North. The reason given for this self-restraint in avoiding railway racing is that it is more concerned about the comfort and regularity of its service than in landing its passengers a few minutes earlier at Modern Athens, or Aberdeen-awa'. There is sense in this suggestion, but it is not to be inferred from what has been said that the Midland directors are at all asleep. It is a large company, and although it may not be over-anxious to accelerate its expresses to phenomenal speeds, it is seeking in other ways to lessen the time taken in doing the run from St. Pancras to Scotland. It is certainly not behind other companies in providing powerful means of traction of the most efficient type, or in combining the maximum of safety with the minimum of lightness in the rolling stock. But it is at present contemplating quite as important a contribution to a quick northern run as in either of these directions. Our Sheffield correspondent has drawn attention several times to the new line the Midland Company has constructed from Wincobank, near that city, to Chapeltown, and pointed out the importance of that line, not merely to the district it serves, but as the first link in an alternative route to the North. The Midland is now continuing the line from Chapeltown to Barnsley. It has struck many people that the Coal Capital could not possibly be the terminus of this extension, and the directors themselves must have had it in their heads to carry on the rails so as to join the main line at some point at or near Bradford. If this were done not only would there be direct communication, which does not now exist, between Sheffield and South Yorkshire and Bradford, but the Midland route from London to Carlisle would be the shortest by nearly twenty miles. This part of the Midland main line, through the heavily populated manufacturing districts it traverses, is usually in a crowded and congested condition, and the fresh extension to which it is now being urged would relieve the Midland of this difficulty and put it right to the front in the struggle for the coveted Scotch traffic. Several deputations from various towns and districts concerned, representing Halifax, Huddersfield, Barnsley and Bradford, have recently waited upon the Midland directors, who, after hearing the statements put before them, have intimated that the proposals will be most carefully considered and the decision of the Board communicated as soon as possible. The people of Brighouse are anxious for the Midland directorate to adopt a counter scheme, the chief feature of which is a connection from Barnsley passing through Bilton, Bretham, Willsden, and joining the main line at Bentley. To effect this object the Brighouse Corporation are sending to Derby a distinct deputation, and are now endeavouring to get the Corporation of Huddersfield to take up their alternative proposal. In any view of it the prospect opened out by the extensions from Barnsley appears most inviting, and the expectation in the district is that the Midland directorate will not readily ignore it.

LITERATURE.

Bulletins of the California State Mining Bureau. No. 2, *Methods of Mine Timbering*, pp. 58. By W. H. STORMS. *No.* 6, *California Gold Mill Practice*. By E. P. PRESTON, pp. 85. Sacramento, California. 1894-5.

IN addition to the usual annual report dealing largely with statistical and administrative matters, the present State Mineralogist of California, Mr. J. J. Crawford, has introduced the practice of publishing special memoirs upon subjects of technical interest; the titles of two that have reached us are given above. They are both of considerable interest, as containing much orginal detail, the result of personal observations by the authors, and therefore of value as supplementing the larger general treatises, which are apt to become a little antiquated as regards newer developments. Mr. Storms' paper on "Mine Timbering" gives numerous illustrations of the heavy system of frame timbers used both in the lode and drift gravel mines of California, and their development from the old post and lintel systems to the square set methods introduced by Deidesheimer in the Comstock mines in 1860. This system, although of great service in its day, is likely to become less useful in future, mainly on account of the difficulty of obtaining timber of sufficient size. Even in a wooded country like Northern California, timbers 24in. by 28in. are becoming scarce. In the future of deep mining we may therefore expect that methods based upon the use of bearing arches of rock and masonry, with waste rock packing, will be likely to take the place of timber in the securing of workings from large deposits.

Mr. Preston's paper, besides containing a description of the construction of stamp mills and their accessories, gives a very convenient compendium of the present practice of gold quartz reduction by stamping and amalgamation as carried out in different parts of California, with ores varying greatly in richness and mineral associations. This is contained in a series of notices of nineteen different mills on pages 64 to 77, each representing some special peculiarity. Particular attention is given to the arrangements for collecting and saving valuable material from tailings. The economic results obtained by these arrangements is in some instances very remarkable, as, for instance, at the Spanish Mine in Nevada Country, where ores yielding about twenty-one grains of gold per ton are mined, and milled in the Huntingdon Mill at a total cost of about 2s. 1d. per ton, leaving a surplus of about 1s. 6d. per ton; and Mr. Crawford has done good service in causing these treatises, which are commendable among other good qualities for their brevity, to be prepared and circulated. In connection with these publications, we notice a curious instance of the desire for local protection which has become so strongly developed in America of late years. Copies of the gold mill paper may be obtained by sending three cents for postage, if the sender is a citizen of the State, but to those living outside the State of California the price is 50 cents; and this discrimination is established not merely against foreigners, but also against the 50 millions or so of Americans who are not Californians. However, even at the higher price the purchaser will get good value for his money.

Vergleichende Versuche über die Feuersicherheit von Speicherstützen. 4to. 84 pp. with 17 plates. Hamburg: Otto Meissner. 1895.

THIS is the report of a Technical Commission appointed by the Senate of Hamburg, after the disastrous fire in April, 1891, when the State Granary on one of the principal quays was destroyed, for the purpose of investigating the fire-resisting powers of iron and metal pillars used in warehouse construction. The plan of experiments was arranged and commenced in August, 1892, when the outbreak of cholera, calling for the services of the members in other directions, led to their suspension for nearly a year; but they were resumed and concluded in the period between July and October, 1893, the final report being dated October, 1894. The objects experimented upon were full-sized examples, 18ft. in length, of the lattice-framed iron pillars used in the Hamburg Harbour Warehouses, which were maintained in a vertical position by hydraulic pressure acting from below against a cross beam overhead, the pressure being regulated to the amount representing that of the fully loaded warehouse floor, or from 115 tons to 180 tons for the iron, and 60 tons for wooden piers. Heat was applied, nearly at mid height, by a closely fitting gas furnace with eight burners, and continued until the bearing power as indicated by the pressure gauge of the hydraulic press was exhausted. The temperature attained was observed by a pyrometer, and the lateral deformation during heating, as well as by one sided cooling, were determined. The metal pillars were tested with the lattice work open and filled with concrete, and also with different kinds of fire-proof casing, including plaster slabs, cork composition, xylolite, Monier concrete, and asbestos cement, and the wooden ones with and without similar protecting casings; and the results obtained are fully described, with numerous illustrations reproduced from photographs. The general conclusions show that malleable iron pillars have very small fire-resisting powers, their stability being entirely destroyed at a temperature of about 600 deg. Cent., and the advantage to be gained by an internal filling of concrete is so small that it cannot be considered to be of any protective value. It is different, however, with external casings of fire-proof or bad conducting materials, which may protect the metal against being dangerously heated for a considerable time, and so afford a notable protection in case of fire. The protective materials that have proved most efficacious are the patent cork composition made by Gunzweig and Hartmann, of Ludwigshafen, and xylolite slabs with an outer casing of sheet iron. This gave off inflammable gases for 2¼ hours, and became completely carbonised, giving a covering that was not affected by the jet from a fire hose. The pillar did not give way until the heat had been applied for four hours, while from seventeen to thirty minutes were sufficient to destroy it when it was without a protective casing. Next in order was a 40-millimetre casing of Monier concrete, which held out for 2½ hours; but other substances, such as ordinary and hard plaster slabs and asbestos cement, proved to be of small value.

The experiments with wooden piers show that, although they ignite at a lower temperature than 600 deg. Cent., they maintain their carrying power longer than unprotected iron ones; but no advantage is gained by casing them with sheet iron. Oak piers seem to be slightly better in fire-resisting power than those of fir.

The report is accompanied by a series of appendices, the most important one being that containing extracts from the records of the observations, with several typical examples given at length. These, together with the accompanying illustrations, give a very clear idea of the character of the evidence upon which the conclusion of the report is founded. The Commission, which was presided over by Mr. F. Andreas Meyer, the chief municipal engineer, point out that their report is necessarily incomplete, many important points of warehouse construction not having entered into the scheme of experiments, which was, no doubt, limited by the funds available, but within these limits they have supplied information of considerable value to architects and engineers, and thanks are due to the Senate of Hamburg for their liberality in publishing and circulating the results.

The Locomotive Engine and its Development; A Popular Treatise on the Gradual Improvements made in Railway Engines between 1803 and 1895. By CLEMENT E. STRETTON, C.E. 4th Edition, revised and enlarged. London: Crosby Lockwood and Co. 1896.

IT is barely a year since we reviewed the third edition of Mr. Stretton's excellent work, and it must be most gratifying to him that a fourth edition is required after so short an interval. Mr. Stretton has responded to this demand by producing what is in a large degree a new work, so greatly is it enlarged and improved in this new fourth edition. In addition to copious revision and supplementing of the original text, the author has added twenty pages of entirely fresh matter, and fourteen new illustrations. The work is brought thoroughly up to date, even the new express engines just brought out by the Manchester, Sheffield, and Lincolnshire Railway Company, Great Western Railway Company, and London, Brighton and South Coast Railway Company, and those now building by the Midland Railway Company receiving due notice. In fact, a very clear and comprehensive account is given of the locomotive development of the year and of the general advance made. It is to be hoped that Mr. Stretton will see his way to bring out a fresh edition annually.

But, further, the author has expanded and improved that most interesting phase of his work, the early history of the locomotive. He gives much valuable information as to several points recently discussed in connection with the early engines of the Great Western line and some capital illustrations, including one of the original engines, Great Western, the first of the famous express engines which were the standard for the broad gauge until its final extinction in 1892, as it appeared after the extra pair of leading wheels had been added, but while it still carried the high-domed "haycock" fire-box. Another noteworthy illustration is that showing the details of construction of the curious 8ft. disc wheels of the engine Ajax, about which there has been so much controversy. There is also a great deal of new matter touching the introduction of bogies and other useful features in railway practice.

Nor does Mr. Stretton confine his attention to Great Britain. He has a large amount of important information to give and illustrate as to locomotive development in the United States of America. There is a good frontispiece view of the celebrated No. 999, and a picture of the new American single, No. 388, with various particulars of work done by various American locomotives. Among the curiosities of the illustrations of British engines may be mentioned one of the Great Western, Leopard, as it appeared after a burst, the boiler having exploded in 1857, owing to a defective safety valve.

One of the author's remarks regarding the mode of expressing gradients we cannot quite follow. He says, "In this country it is still the practice to express gradients in their proportion or ratio to 100"; that is to say, by their percentage. But this has not been usually the case in our experience, the proportion expressed being almost invariably the ratio to unity, or one, *e.g.*, a rise of 1 in 75, 1 in 80, 1 in 150, &c. The percentage method of expressing grades, *i.e.*, as so much per 100, is more used in America than in this country, though, as Mr. Stretton justly says, it is more usual in the States to refer to gradients by giving the rise in feet per mile.

Mr. Stretton's new edition is sure to be in large demand like the predecessors, and even those who possess last year's edition—the third—will find themselves almost obliged to procure the new one if they desire to keep up to date.

SHORT NOTICES.

Transactions of the Royal Scottish Society of Arts. Vol. xiv. Part I. Edinburgh: Printed for the Society by Neill and Co. 1895.—Contains amongst others, papers on a sun-dial protractor, an improved bucket pump, a direct reading micrometer wire gauge, and on the Ferranti electricity meter.

The Indian and Eastern Engineer Diary and Reference Book for 1896. London: 28, Victoria-street.—This is a quarto diary with three and four days on a page, on good paper, and interleaved with blotting paper. The diary is accompanied by eighty-four pages of quarto letterpress relating to trading information useful to those with business relations in India and other eastern countries, and it also contains a well-made selection of facts and formula for the use of the engineer.

The Third Annual Review of the World's Grain Trade, 1895. By Geo. J. S. Broomhall. Being a record of the world's chief cereal crops, prices, imports and exports, stocks, population, &c. &c. Liverpool: Northern Publishing Company, Ld. Price 2s. 6d., post free 2s. 9d.—This relates to cereals and to flour, and opens with an article on the international grain trade, past, present, and prospective. It is accompanied by numerous curves or diagrams showing fluctuations in prices, quantities, freight, of wheat flour and feeding stuffs generally. The article on international grain trade contains information of great interest in connection with the steamship transport of wheat and other grain.

The Export Merchant Shippers' Directory for 1896. Thirty-first year of publication. London: Dean and Son, Ld. Price 15s.—With this issue of the "Export Merchant and Shippers' Directory," a supplement in the form of a cloth bound itinerary of the City of London is given to every purchaser. It forms a very useful addition to the means of finding out the names of people, what they sell, and what are their markets. It is, of course, more particularly useful to those whose business it is to make calls on importers. The directory is, as usual, printed in clear type and divided into several sections, easily recognised before opening the book. It refers to about a dozen other large trading towns and cities besides London, their trading ports, and the class of goods shipped.

Donaldson's Engineers' Annual and Almanack for the year 1896. *A Record of Progress and Events in connection with Steam Shipping, compiled for the use of Marine Engineers and the Mercantile Marine, with Tide Tables and other References.* Paper. By James Donaldson. London: Norie and Wilson; F. Brett. Price 1s.—Besides the information which the title of this annual conveys or promises, it contains a large number of tables specially devised and arranged for the use of sea-going engineers. The position of engineers in the different navies, and regulations under which they work, are set forth, and our Board of Trade regulations for engineer examinations are given. The usual collection of tables of weights, materials, and measures, is followed by short articles on record passages, tales of the sea, harbour matters, and various things that will make the annual an engine-room companion.

BOOKS RECEIVED.

Annuaire pour l'An 1896. *Publie par le Bureau des Longitudes. Avec des Notices Scientifiques.* Prix 1f. 50c. Paris: Gauthier-Villars et Fils, Quai des Grands-Augustins, 55.

Dynamo-electric Machinery. A Manual for Students of Electrotechnics. By Silvanus P. Thompson, D.Sc., B.A., F.R.S. Fifth edition, revised. London: E. and F. N. Spon. 1896.

The Journal of the Royal Agricultural Society of England. Third Series. Volume vi. Part IV. No. 24. December 31st, 1895. To be continued quarterly. London: John Murray. Price 3s. 6d.

Elementary Treatise on Electricity and Magnetism founded on Joubert's "Traité Elémentaire d'Electricité." By G. C. Foster, F.R.S., and E. Atkinson, Ph.D. London: Longmans, Green, and Co. 1896. Price 7s. 6d.

Discoveries and Inventions of the Nineteenth Century. By G. Routledge, B.Sc., F.C.S. Eleventh edition. Revised and partly re-written, with additions. Containing 450 illustrations. London: George Routledge and Sons, Ld.

Lockwood's Builders', Architects', Contractors', and Engineers' Price Book for 1896. *A Comprehensive Handbook of the Latest Prices of Every Kind of Material and Labour in the Trades connected with Building, including many useful Memoranda and Tables.* Edited by Francis T. W. Miller. With a supplement containing the London Building Act, 1894, &c. &c. London: Crosby Lockwood and Son. 1896.

ALMANACKS AND CALENDARS FOR 1896.

A LARGE monthly tear-off almanack, mounted on an attractive and large background, has been sent out by the Rugby Portland Cement Company, additional interest being given to the almanack by a view of their works and a geological section of the country across England from Holyhead to Dover.

Messrs. W. H. Willcox and Co. also send a monthly calendar arranged so that the sheet giving each month may be turned back and leave the present month visible, the back months being retained for reference. The background of the calendar varies for each month with illustrations of the many forms of engineering requirements which Messrs. Willcox display.

The Magnolia Anti-Friction Metal Company have also sent a calendar with removable cards, making it, with a supply of three for each year, a perpetual calendar. The letters of the day and month are very clear, and the figure for each day of large size.

Messrs. Sankey and Son, of Canning Town, send a large monthly tear-off almanack, the background of which is illustrated by their various kinds of sanitary stoneware.

Messrs. Peckett and Sons, locomotive engine builders, send a nicely got-up monthly tear-off almanack, with an almanack for the year and various postal and other information printed on the back of the card carrying it.

Mr. John M. Henderson, stone-working tool and machinery maker, Aberdeen, sends a monthly tear-off almanack, and another is sent by the Sun Insurance Company.

The Hardy Patent Pick Company, Sheffield, also sends a very clear monthly tear-off almanack with white letters on blue background. The illuminated card to which this is attached contains a calendar for the year, a view of the company's now very large works, and references to their specialities in disintegrating, grinding, and screening machinery, mining tools, colliery vibromotor screens, and coal-washing, coking, and briquette plant.

INLAND NAVIGATION AND FOREIGN GOING STEAMERS.

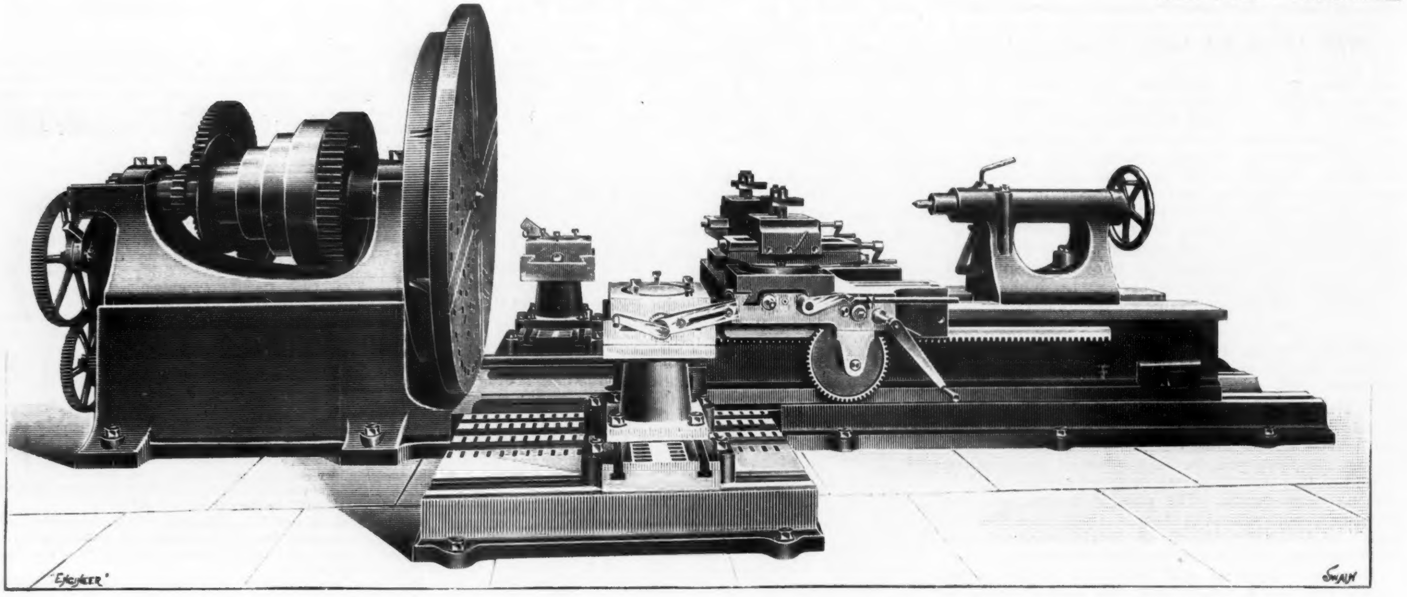
WITH the advent of the New Year an additional trading steamer, built for the purpose, has been added to the line plying between Manchester, Liverpool, Rouen, and Paris. The St. George, which is typical of the fleet, was built at Sunderland, is 600 tons burden, and supplied with engines of 650-horse power indicated. The masts and funnels can be lowered to the level of the upper deck. The traffic commenced eighteen months ago as an experiment with the s.s. Kenilworth, subsequently the s.s. St. Denis was built expressly for the service, and has been running six months. It is intended to add another steamer of the same capacity and build as the St. George shortly. This shows that the Seine and Mersey Steamship Company is satisfied with the present and hopeful for the future. Sea-going steamers ply regularly between London and Paris. Owing to the fixed bridges over the Seine, funnels and masts have to be movable, and even then the headway is much less than is desirable. The three lowest bridges are:—The Sevres Bridge, headway 22ft. 6in. above low summer level; the Conflans Bridge, headway 20ft. 6in. above low summer level; the St. Pierre d'Andé Bridge, headway 20ft. 1in. above low summer level. On the canalised Seine there is a traffic of 4,000,000 tons; 1,250,000 tons of this arises at Rouen. The whole is subject to railway competition, and is handicapped by distance, as between Rouen and Paris it is 137 miles by the river, which has an extremely tortuous course.

There is a minimum depth of 10ft. 5in.; in fact, the navigation is practically on a par as regards draught of water with the Weaver Navigation to Northwich and the Severn to Worcester. The Westgate Bridge over the Severn at Gloucester, however, provides a headway of only 18ft., 2ft. 1in. lower than the lowest of the bridges over the Seine, but this should not be a bar to sea-going steamers penetrating to Worcester, and thus getting within thirty-seven miles of Birmingham by canal. Moreover, there is always the hope that this bridge will be improved in the interest of the navigation. Since the navigable depth has been increased to 10ft. the reasons for altering the Westgate Bridge are much more cogent than before. To Northwich there is 60ft. clear headway over the Weaver, and space for transhipping cargoes into narrow boats, which can proceed thence by canal to the Potteries, about twenty-five miles away. At present the large traffic using the canal route is transhipped on the Mersey at Runcorn, Weston Point, or Ellesmere Port. Corn, however, is carried in barges of 200 to 300 tons from Liverpool to Northwich and sent inland by canal.

MARINE ENGINEERING DESIGN.—The Council of the Institution of Junior Engineers announce that arrangements have been completed for a course of six lectures on the above subject, to be given by a gentleman of long experience on the north-east coast, and now occupying the first position in the designing department of one of the leading London marine engineiring works. The lectures will be specially prepared to be of practical benefit to those attending them, the great importance of economical, as well as efficient design being kept in view throughout; and as there will be many questions considered affecting steam engine design generally, they will be of interest and value to engineers not exclusively engaged in marine engine work. The following are the dates of delivery:—From 7.30 to 9.30 p.m. on Monday evenings, 3rd and 17th February; 2nd, 16th, 30th March; and 13th April, at the Westminster Palace Hotel. Fee for course, 12s. Syllabus:—Lecture 1: Cylinders and Cylinder Fittings. Pistons and Piston-rods. Connecting-rods.—Lecture 2: Crank-shafts and Shafting. Main Bearings and their Frames. Thrust Blocks. Stern Tubes. Propellers.—Lecture 3: Condensers. Air Pumps. Circulating Pumps. Feed Pumps. Bilge Pumps. Pump Levers. Links, &c.—Lecture 4: Slide Valves and Rods. Valve Gears. Reversing Gears. Turning Gears.—Lecture 5: Engine Framings. Pipes and Pipe Arrangements. Stop Valves. Safety Valves. Expansion Joints, &c. Sea Valves.—Lecture 6: Boilers. Furnace Gear. Smoke-boxes and Uptakes. Chimneys. Lagging. Engine and Boiler Seatings.

SLIDING AND SURFACING BREAK LATHE

MR. W. ASQUITH, HIGHROAD WELL WORKS, HALIFAX, ENGINEER

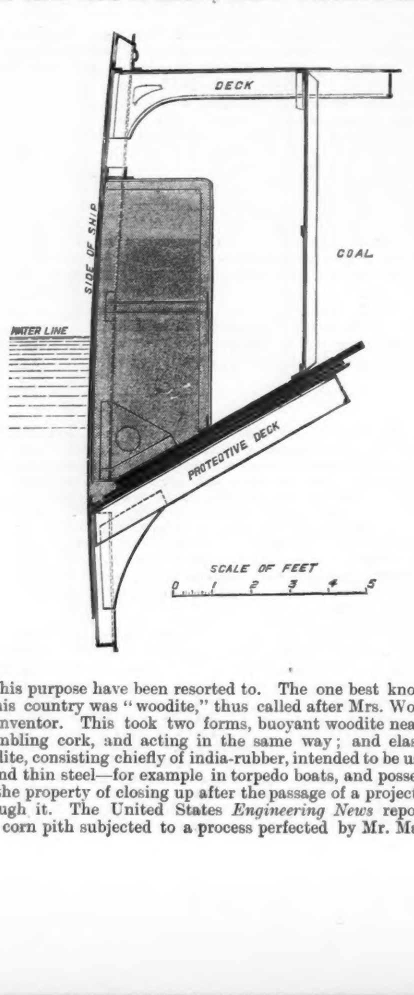


SLIDING AND SURFACING BREAK LATHE.

THE illustration represents an extra strong and powerful treble geared, 18in. centres, self-acting sliding and surfacing break lathe. The gearing in the fast headstock is machine cut, and so arranged as to give twenty-four changes of cutting speed, and the cone is suitable for a 5in. belt. The loose headstock is of strong construction, can be easily adjusted longitudinally along the bed by a carriage as shown, and has suitable provision for securely fixing it. The bed is of improved construction, the guiding slides being right angular, the carriage being fitted with loose gibbed strips, ensuring accurate adjustment and working with less friction and torsion than with the ordinary form of guiding surfaces. The carriage is fitted with two strong portable slide rests for general turning, the front rest being arranged with an improved self-acting motion for turning internal and external tapers. The improved self-acting sliding feed motion is positive, and can be stopped and started instantly by a lever on the front of the carriage. The bed is arranged to slide on the continuous bed-plate by power motion to form the break, and will admit 6ft. 6in. diameter by 4ft. 6in. wide in the break, on each side of which are foundation plates, carrying two saddles and pillars for receiving slide rests from the carriage. The lathe is of extra strong construction and great power, intended to do the heaviest cutting to advantage, and is capable of taking finishing cuts at the rate of 1in. traverse per revolution of spindle. The weight of the tool as illustrated is about 17 tons.

CORN PITH CELLULOSE FOR WARSHIPS.

FIVE years ago the question of packing the sides of warships with raft material was prominent, that is to say, the system of filling spaces with very light material, which would preserve floating power, inasmuch as there was no hollow space which could be filled by water. Curious substances for this purpose have been resorted to. The one best known in this country was "woodite," thus called after Mrs. Wood, its inventor. This took two forms, buoyant woodite nearly resembling cork, and acting in the same way; and elastic woodite, consisting chiefly of india-rubber, intended to be used behind thin steel—for example in torpedo boats, and possessing the property of closing up after the passage of a projectile through it. The United States *Engineering News* reports that corn pith subjected to a process perfected by Mr. Mark Marden has recently given capital results, acting in both ways to a certain extent, its weight when pressed as used being 6·5 lb. per cubic foot. This was compared with cocoa fibre cellulose weighing 7·7 lb. per cubic foot. The trial took place on June 10th last in the presence of Secretary Herbert. Two steel cofferdams 6ft. by 6ft. by 3ft. were used, the front plating was $\frac{3}{8}$in., and the back $\frac{3}{16}$in. thick. One was fitted with cocoa cellulose and the other with corn pith cellulose pressed in tight by screw jacks. A 6in. shot weighing 100 lb. was then fired through both, with a velocity of 1000 foot-seconds, after which each material appeared to close up the hole, water was then brought up over the holes. In about 10¼ minutes a drop of water found its way through the cocoa, and the water then flowed at the rate of nearly a half gallon per minute. The corn pith was subjected to the action of water rising to the top of the dam, perhaps 5ft. above the hole for 1½ hours; no water, however, made its way through.



An 8in. shot weighing 250 lb. was next fired through each cofferdam. On water being applied it began to get through the cocoa cellulose in 25 seconds, and then gradually attained a flow of 1½ gallons per minute, but failed to get through the corn pith for 45 minutes, when the test was discontinued.

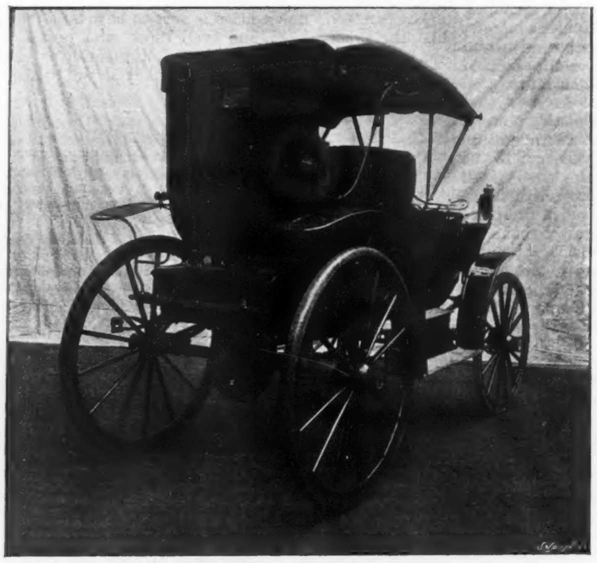
The combustible qualities of each packing were then tried by exploding a 3 lb. shell in an iron chest containing cellulose. The cocoa burned, but the corn pith was only charred.

On the faith of these trials, Secretary Herbert ordered corn cellulose to be used on the two warships "No. 4" and "No. 5." The figure herewith shows the manner of application to war vessels. Coals, are of course, often used in a similar way, and have the advantage of adding nothing to the weight of the ship, supposing the coals to be part of the supply carried for fuel, and coals have greater stopping power, we suppose. They have, however, the disadvantage of not closing up the shot hole.

EASTBOURNE WATER SUPPLY.—The Eastbourne Town Council recently decided to promote a Bill in Parliament to acquire the water supply, which is now in the hands of a private company. Opposition was raised by a number of ratepayers on the grounds of economy, and a poll was demanded. The result, which has just been made known, is as follows:—For the Corporation, 3527; against the Corporation, 3752; majority against, 225. There were 563 unmarked papers, many not voting because the ballot was not secret.

AMERICAN MOTOR CARRIAGES.

WE have received from our American correspondent the following particulars of the Benton-Harbour Motor Carriage Company's carriage, referred to, but not illustrated, in our last issue. It is a two-seated carriage for four persons, and has heavy rubber tires on the wheels. It is of a common and attractive design, fitted with a "hydrocarbon" engine of 7½-horse power, giving a maximum speed of 23 miles per hour on a good and level road. The motors are placed under the rear seat, and have no exposed chains or gearing, the driving gear being enclosed, as shown in the engraving. There are only two running gears, one of which is of raw hide to prevent noise; and only ten bearings in the entire carriage, all of which are fitted with $\frac{5}{16}$in. hardened steel balls running on tempered and ground steel cones, so that the friction is reduced to a minimum. A single horizontal handle pivoted to a shaft in front of the dashboard controls the brake, the change of speed, and the stopping, starting and reversing of the motor. The carriage weighs, complete, about 1050 lb. The inventor of this carriage has been experimenting with motor carriages since 1886. He first tried steam, and then electricity, perfecting a fairly practical storage battery carriage in 1893, but then turned his attention to the hydrocarbon engine, with still more satisfactory results. The company has a factory fitted up for the manufacture of these carriages.



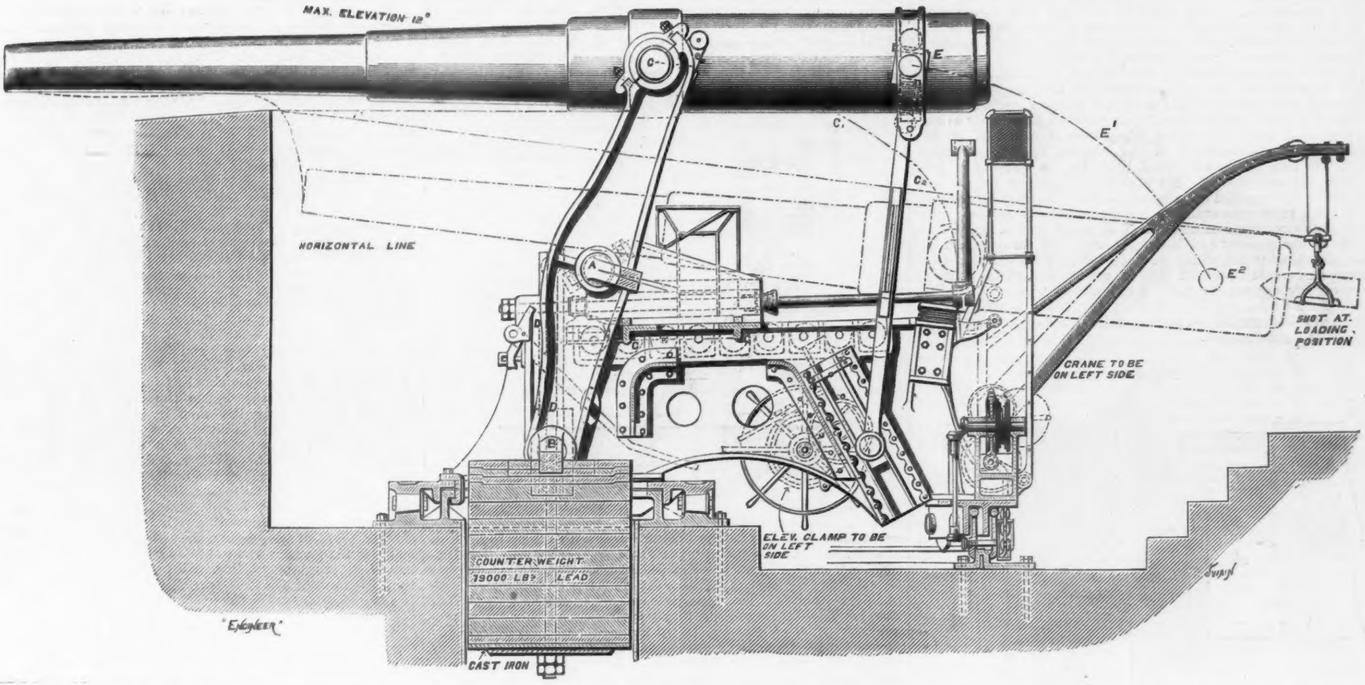
BENTON HARBOUR MOTOR COMPANY'S CARRIAGE

As regards the "Morris and Salom Motor Carriage," we may add that the carriage shown in our illustration last week was the one which made the run on November 28th, and it was awarded a gold medal "for best showing made in official tests, for safety, ease of control, absence of noise, vibration, heat or odour, cleanliness, and general excellence of design and workmanship." It carries forty-eight accumulators manufactured by the Electric Storage Battery Company, these being of 50 ampère hours capacity each, the electrical capacity of the battery being 5-horse power hours at the maximum discharge rate. The total weight is 1650 lb., of which the batteries make 664 lb. The maximum mileage on one charge is 25 miles—at 12 miles per hour—and the maximum speed is 20 miles per hour.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Chief engineers: George Ramsay, to the Vivid, additional, for the Blanche, from the day on which the Blanche pays off; George R. Taylor, to the Pembroke, additional, for the Alarm; and Samuel A. Screech, to the Swallow. Engineers: Edward A. E. Crowley, to the Tamar, additional, for Hong Kong Yard; and George W. Murray, to the Humber.

THE NATIONAL SKATING PALACE.—Hengler's Circus, Argyll-street, Regent-street, has been converted into a spacious and luxurious skating rink. The floor of real ice is made on a system hitherto untried on a large scale for this purpose. Messrs. Tyler and Ellis and Messrs. J. and E. Hall are the patentees of the system adopted, and the refrigerating machinery is that using carbonic anhydride. Over the floor are two galleries, the first being fitted up as a promenade, and the other as a restaurant. The whole of the interior has been decorated, and electric light is used throughout. Special interest in the success of the enterprise is taken by the National Skating Association of Great Britain, who have made the rink their headquarters. The building will be opened to the public in a day or two. Two sets of Hall's tandem compound engines with jet condensers and compression pumps are installed, one set easily doing the work. Shallow steel tanks are used for the ice floor, instead of other forms used elsewhere. For the water supply Messrs. Tilley and Son have sunk a well nearly 400ft. into the chalk. Three nominal 40-horse power locomotive boilers by Messrs. Davy, Paxman and Co. are employed, or will be when the large cold storage warehouses now under construction are completed. The work has been designed and carried out under Messrs. A. H. Tyler and J. S. E. de Vesian, Assoc. M. Inst. C.E. Mr. Cooper being resident under them.

THE BUFFINGTON CROZIER GUN CARRIAGE



THE BUFFINGTON CROZIER DISAPPEARING GUN CARRIAGE.

A DISAPPEARING carriage on a modification of the Moncrieff system has been designed by Colonel Buffington and Captain Crozier, of the United States Ordnance Department, and taken up by the Bethlehem Company, which has met a need and been adopted by the United States Government. It is shown in the accompanying illustration. The gun's trunnions rest in the upper ends of two long levers, one only of which, C A B, can be shown in the figure; pivoting at the centre A is the top carriage. A heavy counterweight slightly outweighing the piece is hung on a shaft connecting the two lower ends B of the levers. At A also a pivot or axle connects the two levers resting in a trunnion bed across the top carriage. The top carriage runs on rollers G G in the lower carriage or chassis. There are two hydraulic cylinders in the top carriage.

On firing, the top carriage recoils on the rollers, carrying the middle point or shaft of the levers on it. The lower ends of the levers are confined in a vertical groove D D, and as the top carriage runs back, each end B is forced up this groove, the combined action causing the upper end C carrying the gun to follow the curve C C^1 C^2, the breech travelling along E E^1 E^2, and the gun coming down to the position shown in dotted outline under cover of the parapet. This curve is calculated to withdraw the piece and lower it in the most convenient way, first clearing the crest of the parapet by the horizontal withdrawing movement, and then descending rapidly.

The energy of recoil and of the falling gun is partly absorbed by raising the counterweight and partly by the resistance of the liquid in the two hydraulic cylinders in the top carriage. The pistons of these cylinders are stationary, the rods passing through the forward heads, and being attached to two lugs projecting upward from the chassis. The rods are also produced through the cylinder heads, and rest in supports at the rear of the chassis. By thus producing the rods through the rear heads, an equal volume is drawn into the cylinder during recoil to compensate for the portion of the rods drawn out through the front ends; and the volume of the cylinder which is devoted to the liquid remains constant, the cylinders thus remaining always entirely full, with no danger of the leakage into them of air to mix with the liquid and reduce its specific gravity and resistance. The orifices for the flow of the liquid past the pistons are so graduated in size as to produce a constant resistance during the recoil.

To raise the piece to the firing position after loading, the pawls at the forward end of the chassis which retain the counterweight are tipped by means of handspikes, which are passed through two screw eyes serving as fulcra, and bear against the lower ends of the pawls. The greater preponderance of the counterweight causes it to fall, raising the piece and drawing forward the top carriage. The forward end of the chassis rests upon a ring of conical rollers whose centre is on the axis of the counterweight. The rear end rests through four wheels upon a traverse circle or racer track, the wheels being mounted in roller bearings to diminish friction. Traversing is effected by handles at the sides of the chassis acting on a worm gearing, drawing over a spocket wheel and chain, which lies around the near end of the traverse circle, and is fastened at the front, somewhat resembling the Cunningham gear known many years ago in this country. Pointing is performed with hand wheels acting on spur gearing and toothed racks, &c. Designs embodying the principle of centre pivoting are now completed.

The advantages claimed for this system of mounting are mainly economy and simplicity, combined with the protection of disappearance. Our English experiment with the Hercules attack of a disappearing gun is quoted, also the firing of an exposed gun charge at Shoeburyness and Eastbourne with small projectiles. Sir George Clarke's expression of opinion on the advantage of disappearing mountings is quoted, and it is urged that for this kind of mounting the design in question has great advantages over the Moncrieff carriages. It is claimed that the features of complexity of construction and delicacy of mechanism have entirely been got rid of—that the carriage is as simple as an ordinary barbette or broadside carriage. An 8in. gun carriage fired 47 rounds on trial without any injury. The hole for the descent of the counterweight might be diminished if the latter were made of lead instead of iron. The system gave very little trouble with reduced charges. The official report states that ten rounds were fired in 14 min. 42 sec. by a detachment of eleven men and one non-commissioned officer.

MEGASS AND REFUSE FURNACES.

By WILLIAM PRICE ABELL, Assoc. M. Inst. C.E.

THE use of megass as fuel in the manufacture of cane sugar has, during the past few years, largely owing to the increased cost of coal, become more general, and on many estates in the West Indies it has entirely replaced coal, of which 25 cwt. were formerly required for the production of one ton of sugar. During the years 1890-94, 520 furnaces were rebuilt in British Guiana, at a cost of about £50,000, the annual saving thus effected amounting to more than £100,000.

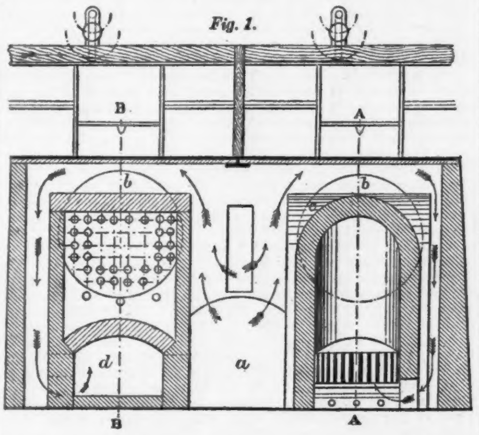
On the assumption that sugar-cane contains 12·5 per cent. of woody fibre, and the juice 16 per cent. of sugar, Mr. Nevile Lubbock states, as the result of many trials, that double crushing extracts 72 per cent., and single crushing 66 per cent. of the juice, leaving the green megass, composed in each case of woody fibre, water, and sugar in the following proportions:—

	Double crushed. Per cent.	Single crushed. Per cent.
Woody fibre	45	37
Water	46	53
Sugar	9	10
	100	100

Exhausted diffusion chips reach the furnace composed of 60 per cent. of water, 0·44 per cent. of sugar, and 39·6 per cent. of woody fibre.

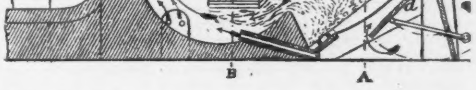
In the old furnaces, which do not utilise the oxygen and hydrogen in the water of the megass for combustion, it is calculated that 4·83 lb. of double-crushed megass and 5·98 lb. of single-crushed megass are required to give the same amount of available heat as 1 lb. of Scotch coal. Sir Frederick Bramwell and Dr. Letheby, in their report on the sugar manufactories belonging to the Khedive of Egypt, state that 2·09 lb. of sun-dried megass are equivalent to 1 lb. of Welsh coal.[1] From 100 tons of single-crushed cane are obtained 34 tons of megass, sugar, and water combined as fuel, 8½ tons of sugar, and 57½ tons of water to be evaporated out of the juice; and from 100 tons of double-crushed cane there result 28 tons of megass, sugar, and water as fuel, 9½ tons of sugar and 62½ tons of water to be evaporated out of the juice. With single-crushing, therefore, for every ton of sugar manufactured, 4 tons of refuse or megass, of which 53 per cent. is water, and, with double-crushing, 3 tons of megass, of which 46 per cent. is water, are obtained. This fuel, in modern though still imperfect furnaces, will evaporate 57½ tons to 62½ tons of water from the juice of 100 tons of cane, besides generating all the mechanical work involved in crushing the canes and manufacturing the sugar. A surplus of megass should be stored while the mills are working, so that it may be possible to manufacture with it the offal products after the grinding ceases.

Fig. 1.



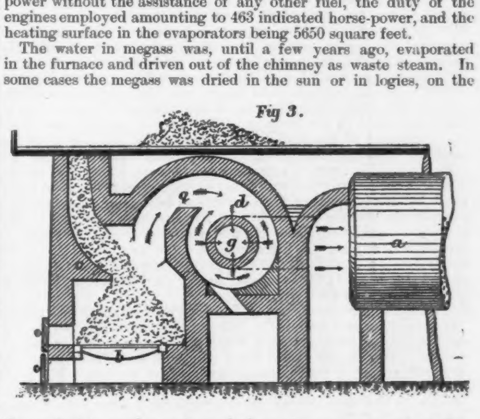
The results of long grinding at a factory producing 1¼ tons of sugar per hour show that the amount of megass available per hour is 3·75 tons, consisting of 2·03 tons of fibre and 1·72 tons of water. This is burnt in five furnaces, of which two are of the type shown in Figs. 1 and 2, and three are of the type shown in Fig. 3, 4·24 cubic feet of megass being thus available for each furnace per minute; but sufficient steam is maintained with 3 cubic feet per minute. Each furnace has a grate area of 20 square feet, and each supplies heat to a multitubular boiler containing 1300 square feet of heating surface. The chimney draught, as shown by a Bailey draught gauge, is 40ft. per second; the flue temperature, as shown by a Bailey pyrometer, is 500 deg. Fah.; and the furnace temperature is such as to melt copper and partially melt cast iron about 2000 deg. Fah. The steam obtained from these five boilers and furnaces concentrates and purifies 9·45 tons of juice into 1¼ tons of pure yellow sugar per hour. The boiler pressure is 75 lb. per square inch, and the cane is crushed at the rate of 13·2 tons hourly, 3·75 tons of megass and 9·45 tons of juice being produced—the latter consisting of 1·25 tons of sugar, and 8·20 tons of water and offal. In addition to extracting juice from the canes with a pressure of 250 tons on each of the top rolls, the water is evaporated, the sugar is cured, and the molass is converted into rum and second sugar. The 3·75 tons of megass develope the requisite power without the assistance of any other fuel, the duty of the engines employed amounting to 463 indicated horse-power, and the heating surface in the evaporators being 5650 square feet.

Fig. 2.



The water in megass was, until a few years ago, evaporated in the furnace and driven out of the chimney as waste steam. In some cases the megass was dried in the sun or in logies, on the theory that to employ water as fuel was to use more energy than could be realised from the combustion of the oxygen and hydrogen obtained from its decomposition. Ordinary megass, if burnt in the usual way, scarcely produces heat enough to promote its own combustion. The result of the improvements in furnaces has been that condensed steam or white smoke is seldom seen issuing from megass chimneys. Green megass may be taken to consist of 50 per cent. of fibre and 50 per cent. of free water, the small quantity of sugar and ash present being negligible. The chemical analysis of the substance is:—

Fig 3.



	Per cent.		Per cent.
Carbon	25·00	Woody fibre	50
Hydrogen	2·78		
Oxygen	22·22		
Hydrogen	5·56	Free water	50
Oxygen	44·44		

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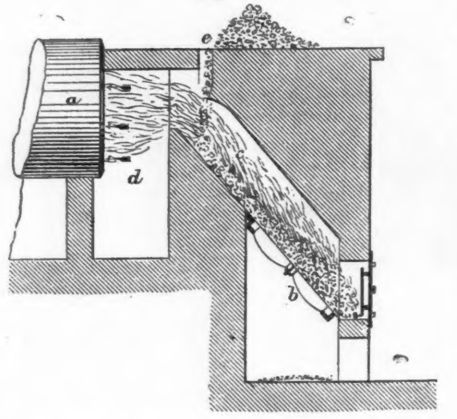
[1] See also "Minutes of Proceedings," Inst. C.E., vol. xlviii., p. 87.

Megass thus contains exactly the amount of oxygen necessary or the complete combustion of its carbon.

When hydrogen and oxygen exist in a compound in the prope ratio to form water, its constituents have no effect on the total heat of combustion. This would be the case with woody fibre in megass under ordinary circumstances, when burnt in the older type of furnace. On the other hand, in a properly designed green-megass furnace, when thoroughly heated, the water, in the form of aqueous vapour, is decomposed in passing over the highly incandescent and porous carbon of the megass; oxygen is liberated and combines with the carbon to form carbonic acid; and the hydrogen passes off partly uncombined, and partly as carburetted hydrogen. The latter, in presence of sufficient oxygen and at the high temperature of the furnace, undergoes further combustion and yields additional heat by its conversion into carbonic acid and water. This is shown in practice by the fact that little air is required for a furnace after it is properly started. If the pores of megass could be impregnated with air and saturated to the required extent, each atom of carbon being contiguous to the necessary air before the fuel was thrown upon the grate, the result would differ from the ordinary smouldering combustion, and would approach that of gunpowder, which contains the necessary oxygen for perfect combustion without air. The fuel should first be gasified and then burnt, the moisture being split up and the oxygen and hydrogen used for the combustion of the carbon in the megass.

Fig. 4.



In an efficient megass furnace perfect combustion of the gases and carbon flecks should be produced, the gas being first liberated and then consumed, so that no white vapour escapes from the chimney. It should require no increase of chimney height, and should work without forced draught. The temperature in the combustion chamber should be sufficiently high for the production of water-gas. Ample provision should be made for expansion through large and varying ranges of temperature. Furnaces have been constructed in which the waste heat from the chimney is utilised for drying the fuel on its way to the fire-box. Experiments made by the author in 1887, however, showed that with a flue temperature of 550 deg. Fah., a layer of megass 3in. thick took forty-five minutes to dry.

In Fig. 4 is shown the Alfred Fryer furnace, introduced in 1883 by Mr. Maurice Costa, and adopted with success in British Guiana. The grate *b* is inclined with the lowest part at the furnace front, and the green megass is introduced between the bars and boilers *a*, so that all the flames pass through and over the green fuel on its way down the drying plane *c*. The megass is introduced at the opening *e*, and, falling on the inclined drying plane, it gravitates downwards on the fire-bars, as that below it is burnt. The whole of the products of combustion pass up over this drying plane and there evaporate, taking up much of the moisture of the megass. The flames then pass the feed-mouth into the combustion chamber *d*, and finally into the boiler. No air was observed to be drawn in at the feed-mouth, although the stream of flame was always plainly visible passing this opening, which measured 10in. by 5ft.

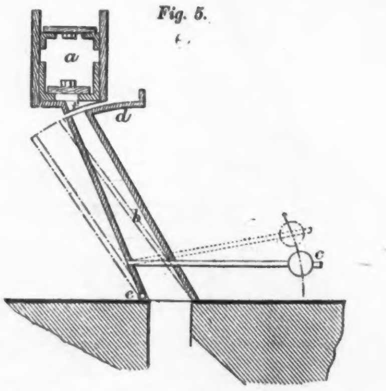
In 1890 the furnaces shown in Figs. 1 and 2 were introduced by the author. They are arranged in pairs, the air for combustion being drawn between the two furnaces at *a*, over the boiler tops *b*, and finally over the reverberatory arches $c\ c^1$ into the ashpit. The air is caused to pass the hottest or lower part of the fire-bars by the deflecting plate *d*, reaching the top end of the fire-bars and entering the megass at a temperature of 300 deg. Fah. The check wall or plate *e* regulates the thickness of megass on the fire-bars. In order to still further heat the air and facilitate the complete combustion of the gases and carbon flecks, a similar furnace, but possessing an additional combustion chamber, was introduced and gave highly satisfactory results. In 1892 the automatic feeding arrangements were added, with a view to reduce labour on megass platforms, to dispense with the gearing hitherto used in mechanical firing, and to give a constant and regular feed of fuel. They have proved so sensitive in practice that without any assistance they can supply one furnace with the exact quantity of megass, passing the surplus on to the next. The megass is carried the whole length of the platform by the usual rake carrier, connected with each furnace by enclosing hoppers. Down these the megass falls direct into the furnaces until the hopper is sufficiently full to cause the megass in the carrier to pass over that in the hopper. The surplus megass can either be discharged at the carrier end or be stored between each furnace by opening intermediate doors under the control of the attendant. No firemen are required, except when the megass furnaces are not stopped owing to the mills ceasing work, in which case, by simply opening the door at the bottom of each enclosing hopper, the furnace can be fed by hand in the usual way. The attendant simply regulates the flue dampers to give the necessary steam, and adjusts the intermediate doors to prevent too much megass from accumulating at one place. He also sees, by means of the peepholes in the hoppers, that each furnace is taking its proper amount of fuel.

The apparatus shown in Fig. 5 utilises the weight of the megass to regulate its own feed. The hopper is hinged at *e*, *f* being an opening in the cross carrier, *d* a damper or sluice, and *c* a balance weight. The megass passes down the shoot *b* to the furnace until it is full, and then the weight of the megass, accumulating in the hopper, causes it to descend about the hinge into the position shown by the dotted lines, at the same time raising the balance weight and sliding the sluice or plate over the opening *f*, thus causing the megass to pass on to the next furnace.

In 1893 a furnace was tried by the author in which the fuel was passed through an open-ended retort projecting vertically into the combustion chamber. The flames of combustion heated this retort, and thereby heated, dried, and distilled the gases out of the megass ready for combustion so soon as they reached the combustion chamber, and solid partly dried fuel falling upon a hearth surrounded by four pigeon-holed walls. It was found advantageous to block up the pigeon-holes until only 7 square feet of grate area were allowed for burning 7 cubic feet of megass. The ratio was thus 1 square foot of grate area per cubic foot of megass, whereas it had previously been 6 square feet of grate area per cubic foot of megass burnt per minute. In other words, with a boiler having 1300 square feet of heating surface, the furnace having one-third the usual grate area, the amount of steam obtained from double the quantity of megass was three times that derived from similar boilers with ordinary furnaces in the same battery, and this with a natural chimney draught of 40ft. per second. The construction of the furnaces required only about half the number of bricks of ordinary furnaces.

The loss of megass, and particularly of diffusion chips when charred and partly burnt, is considerable, on account of the unburnt carbon flecks. These are similar in appearance to the end of a charred match, and are carried through the furnace and up the chimney unburnt in such quantities that on a still morning the ground round a sugar factory becomes strewn with them to a depth of some inches. To prevent the waste from this cause, a centrifugal combustion chamber—Fig. 3—has been successfully adopted for retaining the carbon flecks until they are distilled and completely consumed. The megass enters at *e* and falls to the fire bars *b*. The flames are led into the combustion chamber *d*, tangentially at *g*, so that the heavy unburnt particles are speedily separated from the light gases by centrifugal force—the heavy sparks and carbon flecks flying off to the circumference, and the light flames of combustion finding their way through the centre *g*, up the flue into the boiler *a*. The same arrangement has been applied with success to the retort type of furnace, wherein the combustion or whirling chamber is arranged above the hearth, around which are fixed tangential tuyeres supplied with air, preferably under pressure, from the chamber. The air enters the tuyeres and produces a whirling motion which causes the heavier unburnt particles of megass or chips to remain in the chamber, which is of large diameter, in virtue of their weight, whilst the lighter products of combustion pass up the deflector.

Fig. 5.



The economy of megass furnaces is still susceptible of great improvement, by the adjustment of the proportions in which the several constituents are consumed rather than by the introduction of new principles of construction or operation.

The paper is accompanied by several tracings, lithographs, and photographs, from a selection of which the figures in the text have been prepared.

THE ENGINEER IN NAVAL WARFARE.

WE give Lieutenant Edwards's second lecture. The *World*, commenting on it, says:—

The first lecture dealt with the work of the engineers in preparing the vessels for an active campaign. The second lecture tells of the actual combat as Mr. Edwards knows it might have been. Neither Mr. Edwards, when he delivered the lectures, nor Secretary Herbert, when, after long deliberation, he gave permission for their publication in the *World*, dreamed that the lessons which they taught might so soon be in danger of needing practical application. Of all the 70,000,000 people in this country and the 30,000,000 in England, not a baker's dozen had the vaguest idea that there was the faintest shadow of war between the two countries. Within a day the cloud burst, and as this second lecture of the series is going to press not only the 100,000,000 people of England and America, but a large proportion of the other civilised people in the world, are talking of nothing but the possibility of war between Great Britain and the United States. There will be a keener interest, therefore, in Mr. Edwards's lecture, which follows:—

"On the night of May 29th, the steam yacht Now Then, one of the mosquito fleet, steamed into the harbour of Vineyard Sound. She reported that one of the enemy's battleships and one of the heavy cruisers had been seen moving slowly to the eastward, accompanied by a torpedo boat, a steam collier, and one of the floating workshops. The two large vessels appeared to be in distress, for the torpedo boat moved constantly from the workshop to the war vessels. The Now Then had watched these vessels until dusk. She had to keep too far away from them to gather any definite information, but the ensign in command felt convinced that the enemy's vessels were bound either for Halifax or some point to the eastward, where important repairs were contemplated. This news was communicated to the Commander-in-Chief, who immediately congratulated the little scout on her pluck and good luck. The Chief-of-Staff was ordered to have the fleet leave harbour before midnight. The Admiral's face brightened as the Captain of the flagship pleasantly remarked that the little scout had a very suggestive name for a time of battle.

Condition of our fleet.—Our ships were in a high state of efficiency. They not only had clean hulls but full crews. The bunkers nearest the fire rooms were filled with selected coal; and to save the men from overwork this coal had been placed aboard and stowed by shore people. The several departments of every ship had a full supply of stores, sufficient not only for ordinary cruising, but for unusual emergencies. The crews were in excellent health, having had considerable rest, although standing watch and watch everywhere, except in the engine and fire-rooms. Under the peaceful shelter of the harbour highlands there had been no fear at night of torpedo attack. The men were therefore free of that intense strain under which the sailors of the blockading fleet were supposed to labour. There were no sick aboard, and as an almost perfect commissary system had been established, the crews were prepared for protracted and severe work. Dark clouds gathered on the horizon on the early morning of Decoration Day. While our sorrowful people were preparing garlands and tokens, to honour the heroic dead who had fallen in battle in the Wilderness, or on some such field as the bloody angle at Spottsylvania, the crews of the defence fleet were called to quarters and told to prepare for action.

Condition of the sea.—With the early dawn the wind and sea increased. It was particularly noticeable to the commanding officers that our men were somewhat superstitious concerning the result of a conflict on Memorial Day. The Admiral had anticipated this action, and in a general order had reminded our crews that grief was the forerunner of glory, and that if all did their duty Memorial Day would hereafter be associated in America with the greatest naval victory of the century. Early in the forenoon watch, the enemy's fleet was sighted to the northward, and appeared to be in readiness for action. Their numerous scouts and torpedo boats instantly steamed towards the shelter of the heavy battleship. The fleet of the enemy steamed to the south-east, and it was evident that if they accepted battle, it would take place some distance from shore. At this time there was quite a rough sea, and considerable wind, which materially checked the speed of the smaller boats.

Comparison of old-time frigates and modern battleships.—As our vessels approached the enemy and saw their powerful battleships, the old sailors were impressed with this fact, as expressed by a correspondent from Kiel, 'That modern navies cannot reproduce the glories of the ships of the line and old-fashioned frigates of Nelson's time. An old-time man-of-war, with her seas of snowy canvas, was a thrilling sight. A fleet of such vessels with sailors swarming in the rigging was a spectacle for gods and men. The modern battleship, with all its defensive armour and tremendous batteries, cannot be dressed for a holiday like one of the heavily rigged frigates of former days. It is a clumsy fortress in the water, without adequate facilities for decorative effect. It is an engine of war, a fighting machine, a marvel of engineering science, but with all the potency of its armaments it has not the same power of arousing enthusiasm which the old line ships have exercised in the past. And a modern fleet with its destructive engines and defensive resources lacks capacity for lighting up imagination. It is an immense combination of smoke-stacks, machine shops, engine houses, and ordnance factories, tricked out with occasional bunting, but deficient in spectacular charm and fascination.'

Preparations for action.—The crews had no need to be told that for the first time in the world's history there was now about to be waged a battle of machines; and that victory would come to that nation whose crews could handle and control the various engines of war with the greatest skill and for the longest period. A few weeks previous to the battle the engineers had been given absolute charge over the men in their department, but the demoralising work and influence of a decade of a faulty organisation could not be wiped out in a day. The fire-room watch repaired to their stations below, and soon the clicking of metal warned them that some of the hatches were being battened down by the carpenter and his mates. The Admiral in command realised that his success that day depended upon the efficiency of the machinery, and to prevent anything from falling among the moving parts of the engines the hatches were closed. Perchance many of the firemen who went down that day in their ships of war had some presentment that their coffins were being sealed when they saw some of the deck openings thus being closed. The ring of many a hammer was the death knell of some brave fireman and coal passer.

Appearance and condition of engineers' force.—The engineers' force presented a particularly fine appearance. Strong men, with intelligent faces indicative of character and loyalty, comprised this assemblage of mechanics and firemen. Always the neatest and best-dressed division of a war vessel, they realised the worth and importance of their own services in the impending battle. Many were continuous service men, and although they had the unqualified respect of their engineer officers, but few good conduct badges adorned their breasts. An inexcusable system whereby it was not the province of the chief engineer to recommend worthy men to his commanding officer for this honour had deprived these firemen of these desirable badges. Their commanders had respected them, too, but in the midst of the multiplicity of papers they had forgotten to reward the men working below. Coxwains-of-boats and captains-of-tops who were under the immediate observation of the executive officer, never failed to receive such recognition when deserved. With his quick eye and wonderful judgment the Admiral realised the condition of affairs, and then he spoke words of encouragement to these men. Machinists, firemen, and coal passers knew that this brave man regretted his neglect of previous years, and that at last the time had come when their work was appreciated. A cheer of joy and gratitude went out from the hearts of these firemen, and when it was taken up by the crew the Admiral was visibly affected.

Council of War assembled on all the ships.—The Admiral of the defence fleet had given orders that the executive officer, the chief engineer, the navigator, and the officers of the gun divisions, should, in council of war, be notified by the commanding officer of each ship of the plan and details of the proposed fight, as far as the movements and actions of each ship were concerned, so that, in the very likely case of the destruction of the interier communications, each of these officers could still act intelligently and in accordance with the prearranged plan. On this subject, it may be interesting to note the observations of the Commission of Inquiry on the French battleship Magenta. "Enclosed in the conning tower, assisted by a few picked men, the Captain's whole care will be the manœuvring of the vessel; he cannot see his crew nor cheer them by his presence and example, and can communicate his orders to them only by means of wires and pipes, the destruction of which, on their long circuit around the vessel, is open to many chances. If he has not, long before, given precise instruction to his officers; if these officers are not fully conversant with his ideas; if they have not, in their turn, instructed the crew in this respect; and if, finally, each man does not understand the details and importance of the part he is to fill, there will be, at the moment of combat, no assured communication with the Captain, and each party, shut up in a compartment of the vessel, will anxiously inquire what is taking place in the adjoining ones."—*Marine Française*, May 25th, 1895, 741.

Final inspection of the engineers' department.—The chief engineer and his assistants made a final inspection of the fire and engine-rooms. Provision had been made for getting the best work out of every machine, and they were in a most excellent state of efficiency. The men were kindly greeted and encouraged, and the example of their officers in going about their duties so quietly and unconcernedly inspired great confidence in the engineers' force. There was no piping of whistles and blatting of orders to men within speaking distance. The men were thoroughly posted in regard to their duties, and the watch bill had been so laid out that each man knew the extra duties he was expected to perform in case any should fall or become prostrated from the heat or overwork. Some spare tools had been placed within reach of the machinists, and all necessary stores were in accessible positions. The emergency watch made the rounds of the vessel and adjusted things where necessary. A final consultation was held with the commander of each vessel. It was recognised by the several captains that the man aboard ship who had to be resourceful, ready to assume responsibility, and peculiarly fitted for his task, should be the chief engineer. In this hour of danger he was not told that he was an idler and that 'aboard ship he was a non-combatant.' But he was reminded of the fact that his post was one of danger, and that upon the efficiency of his department would depend the result of the conflict. For speed is now a weapon in naval warfare, and he who controls it can look for victory. The chief engineer had no need to be told that when the fight was over and the crews mustered, it would be found that a greater percentage of the firemen than of the seamen would rest that night under the surging waves of the Atlantic.

Opening of the battle.—Gradually our fleet overtook that of the enemy. A flash of fire, a puff of smoke, the whizzing in the rigging of a projectile, and then commenced the historic battle of Chatham. From the time the first short was fired, the enemy made every effort to render the vessels of our squadron unmanageable. Shell were fired at the water line aft, with the hope that some fragment would strike a vital part of the rudder and screws, or some one of their attachments. To the great dismay of our Admiral, the Brooklyn was partially disabled in this way. It was found necessary to steer the vessel by means of her screws. Some of the hatches had been battened down, and the temperature of the engine-room had risen to 150 deg. within a half hour from the time daylight was shut out. The annunciator signals worked rapidly. Midway between the high-pressure cylinder and some auxiliary machines, the machinists stood at their posts working the engines to bell signal. The inspiration and encouragement given the firemen and coal passers by the officers in their tours of observation had much to do with the cheerfulness of the men.

They were not cheered by an occasional shout of victory which broke forth when one of the enemy's vessels seem to waver under some disablement, or when our Admiral complimented an occasional ship for her superb work. These brave artificers performed their duties with zeal and intelligence, but the strain upon them was intense. At times the seaman at the engine-room telegraph in the conning tower pulled the lever a trifle hard, and the index pointed to the line separating two different signals. The man on watch would have to decide quickly to which order he would respond. His judgment and common sense came into play, but it required great concentration of thought and immediate decision. Breathing an atmosphere partly saturated with steam—for the drain and relief valves had to be opened occasionally to the bilge under such circumstances—these men by their devotion to duty saved the ship. Before the fight was over one of the engineer officers fell in an apoplectic fit. And after the battle, when the excitement was over, one machinist and two oilers collapsed from the result of their terrible strain in manipulating the engines for nearly five hours. Within three months these men passed away, but their work on the day of battle had been glorified by a crown of martyrdom.

Disablement of the Massachusetts.—The enemy seemed to concentrate their fire on the battleship Massachusetts, that name recalling to the mind of their admiral the great part that Massachusetts had played in the history of our country. For a time it seemed as if this vessel had to contend against a division of our opponents' fleet. The skill and courage of the commander saved her more than once from being rammed and sunk. Two of our battleships and several cruisers were sent to her assistance, and relief was thus given her, but just before the enemy's squadron had been made to retire the Massachusetts sent up a signal of distress. The continuous shower of shell upon her armour, combined with the recoil of her own guns, had started the main stop valve joint on the starboard boiler of the after compartment. The escaping steam had driven the men from the fire room. One of the water tenders who had been fitting a new gauge glass near this valve chamber had been killed by inhaling the steam, and a part of the fire room force who had entered the bunker were missing. An engineer officer who had tried to prevail upon the men to remain in the fire room had been partially blinded, having groped his way midst the escaping steam to locate the impairment. Until he had found the cause it had been believed that an auxiliary steam pipe had burst. This officer had been pulled out of the fire room by a machinist, whose accurate knowledge of the fire room passage had made it possible for him to reach the water-tight door leading into the engine-room. The men from the other fire room in this compartment had been compelled to leave their station, the leak from the joint continually increasing. Communication with the other boilers had been cut off, but not until the pressure in the boilers of the other compartments had fallen. Brave men finally raised the safety valves and eventually from deck stop valves were closed. A good percentage of the men treated that day by the surgeons of the Massachusetts were found in the watch that had this casualty to battle with. The frightful roar of steam through the escape pipes disheartened the ships of our squadron, and once again the Massachusetts was made the centre of attack. Her gallant captain fell at his post, but the story of his fight is known to every schoolboy in the land. Like the Constitution and the Hartford, the Massachusetts will ever be regarded as one of our historic ships for the work she did that day.

Effect of the heavy sea upon the small boats.—There being considerable sea, the speed of the smaller vessels of both squadrons was materially reduced. The enemy, by having blockading work to do, had quite a number of transports, which at this time hampered them. Many of these boats put to sea. Followed by the Olympia, with her large boiler power, quite a number of these small craft were totally disabled. The heavy sea did not affect the speed of the large cruisers to the extent that it did the smaller craft. And our vessels, with their great boiler power, were not affected to the extent that the enemy was.

Efficient work of the emergency watch.—The picked men who formed the emergency division did excellent work on all the ships. Comprised, as this body was, of men who were resourceful and inventive, they were constantly in demand. The dexterity and skill shown by some of the boiler-makers in the use of hand tools astonished and delighted the commanders, and the jamming of the forward turret of the flagship was overcome by the rapidity with which the obstruction was cut out of the gearing. More than one disabled fireman was temporarily repaired by fitting straps over the defective part. By quickly fitting an alligator wrench to the spindle of its training gear, one of the large guns of the Indiana was again made to do service. The after smoke pipe of the New York was kept in place by the ingenuity with which eye bolts were secured to the rim of the upper section. The official reports of the several chief engineers and executive officers tell in detail of the incessant calls made upon this division, and the readiness of resource with which this picked body performed the many services required of them.

Efficiency of the triple-screw vessels.—The Columbia and Minneapolis with their great speed distinguished themselves that day, and forever silenced their critics. The numerous torpedo boats and torpedo chasers were gradually sunk by the shell of their rapid-fire guns. The result of this battle showed that vessels of 7000 tons, installed as the Minneapolis is, with a boiler power of 20,000 horses, in a rough sea will make quick work of a nest of small craft, and that the pirate type will play a specially important part in a battle between fleets. One of the nautical guerillas, in the shape of a torpedo boat chaser, disabled the starboard screw of the Minneapolis. With the two remaining screws this vessel made over 20 knots at intervals; she was easily steered, for there was comparatively little helm angle, and, disabled as she was, in connection with the Olympia and Columbia, she did magnificent work, chasing and overhauling the transports of the enemy after the battle. All during the fight the strain upon the chief engineers of the respective ships was beyond description. For years these officers had no power to reward or punish their firemen. The unmanly of the fire-room force soon found out that their comfort and convenience could best be secured by winning the favour of the executive officer, rather than by doing their duty at their stations. The duties of the firemen "were of the most arduous and disagreeable nature, very trying to health, temper, and discipline. Their management by the engineer officers was often a difficult task even in times of peace.

Insubordination in the fire-room.—When the stokeholds were closed on one of our ships, and the firemen realised that if any of the crew were to go down in their vessels there was no hope of escape for them, they insisted upon leaving some doors open, so that there might be some hopes of reaching the deck before the vessel foundered. The engineer officers had the doors closed, but not before shooting the ringleaders of the mutineers. These men apparently could not understand that an engineer must have absolute control over his men in action, and that isolated as he is, he must be ready to assume great responsibilities. The insubordination on this vessel in the fire-room, resulting from a vicious system, was the greatest stain upon that ship's good name and fame, and her sinking must be attributed to the demoralisation in the fire-room, for if that force had been effective she would not have been rammed.

Condition of the enemy.—From one of the engineer officers who was attached to the enemy's flagship, the following facts were gathered concerning the work of their corps of naval engineers: Even before they left Halifax, trouble had been found aboard two battleships and one of their fastest cruisers with their hydraulic piping. Night and day the mechanics had been at work overhauling the joints. The flanges had been smoothed, and where necessary caulking of the seams had been carefully done. The entire line had been repeatedly disconnected, and whenever possible easier bends had been substituted. Vegetable packings woven in a variety of forms had been tried, as well as the cup leather and metallic types. Incessant leaks had occurred, and up to the day the fleet had occupied Province-town, it had been impossible to move one of the turrets on the speediest battleships; for in repeatedly overhauling this vessel, several of the flanges had been cracked. No one in the fleet had been able to repair the damage, for the flanges had been secured in a special way which required the use of particular machine tools. Several of our own ships had some of the flanges of the hydraulic piping fitted in ways equally hard to repair, but fortunately our ships had been within a few hours' reach of repair establishments where a speciality was made of this kind of work. These ships had crossed the Atlantic just in time to encounter the equinoxial gales. From the day they took their departure from the Western Islands until they reached the American coast they had met continuous bad weather, and it is possible that the turrets and hydraulic outfit had in some way been impaired at the time. Several pinholes in the pipes had made their appearance, but this weakness had been overcome by fitting eye straps over the defects. Under a pressure of 600 lb., a stream would issue from one of the holes which had velocity enough to cut a person standing in front of it. A single hole was sufficient to imperil the system. Exceeding care had been taken with the cotton rubber packing of the joints, but it was found that from atmospheric or chemical causes, the material had lacked some of the advantages which it possessed when the plant was installed. It was impossible to prevent the joints from leaking a short time after pressure had been applied. Some trouble had been anticipated with this piping, for about ten years ago one of the enemy's most powerful vessels had met with a similar disablement in the Far East. Had not the enemy this difficulty to overcome in two of their battleships, the Massachusetts would probably have been sunk after the accident to her stop valve chamber. Our admiral was not altogether surprised at the news, for he well knew that it had been found necessary to renew the piping of the Monterey, and that experts had to be sent from the Washington gun foundry to overhaul the joints of the Amphitrite's hydraulic gun gear after she had been months in commission.

Impairment of the fans.—On one of the ships having a closed fire-room, serious results occurred from the stoppage of the fans. The fine dust from the floor plates was carried into the bearings and crank pins of the blower engine, and at one time three-fourths of the fans were not in use. The repeated bell signals from deck compelled the artificers to give their attention to the working of the main engines. The overhauling of blower engines had, therefore, to be done very hurriedly. Orders having been received to force the fires, the blowers were speeded up again. Water having been carried over, the result was a breaking down of the plant. It was not long before the vessel's speed was reduced, and this magnificent ship, from which so much was expected, cut a sorry figure in the fight. Better luck was had on those ships having the 'closed ash-pit system.' The experience acquired in this battle showed that the blower engines should not be made so light that they will not stand hard usage and slight neglect.

Very inefficient firemen in enemy's transport service.—The enemy laboured under the great disadvantage of not being able to maintain a sufficient and trained fire-room force. Their stokeholds were filled with firemen and coal passers who were inefficient by reason of their age and inexperience. They were practically boys who had been recruited from a class which had never worked in vitiated atmospheres, and when compelled to do duty in a stokehold heated to a high temperature they soon collapsed. These youths could not do the work that had been performed by the Chinamen who had formerly done the stoking. Our ministers at Peking and Tokio had urged the respective Governments of China and Japan to forbid their citizens entering the service of the enemy, and this request had been complied with. This seriously crippled their transport service, and materially lessened the efficiency of their merchant marine. The Engineer-in-Chief of the enemy's service had pleaded almost to desperation that the declaration of war be delayed until at least partly trained firemen could be secured for the transports. It was absolutely impossible for him to reason with the incompetent officials of the Admiralty. They thought that they knew more about firemen than he did. They told him that by his very nature, training, and education he was incapable of looking at matters beyond his department. He was also told that his efficiency, if necessary, must be subordinated to the good of the service. This platitude and truism had no application to his request, but in connection with the slur upon his profession it was expected to silence him. It was a costly error to that great nation to rebuke this able man, for if his advice had been taken the result might have been different. This man knew the bulk of the great carrying trade of the world had been done in vessels with Chinese firemen, and that if they were suddenly removed there would be no trained substitutes available. Of all the steamship companies that enter the ports of the Far East, only three have European firemen, and even these companies have Coolies assisting the white stokers. There are over sixty lines of vessels trading with these ports, so that it may be said that in one hemisphere there are practically no ships with a European fire-room force. Five-sixths of these lines have Chinese firemen, and some of the stokeholds are so hot that white men cannot work in them. For years the weakness of our enemy in this respect had been known to marine engineers, but their warning had been ignored. The study of the tactics of preceding centuries had a greater charm than the solution of an important engineering question. 'Remove the Chinese from the stokeholds of our vessels and the carrying trade of the Far East passes from our control forever,' said an European marine superintendent, who had lived over a score of years in China. This man knew that it would take them five years at least, and probably ten, to supplant the Chinese stokers by a trained force of competent firemen. There are men who believe that the task would be impossible, for the Chinese stokers live in heated stokeholds where Europeans would collapse. The firemen of the Transatlantic greyhounds are compelled to lay off at least every third trip; and to keep them up to their work they are supplied with a most nourishing diet, as well as commodious quarters. These Chinamen had simply to be prevented from entering the merchant-marine service of the enemy, and their commerce received a blow which was more than serious. The Japanese have a full realisation of the aid rendered England by the stokers of the Middle Kingdom, and one of the ways the Asiatics are going to secure the commerce of the China sea is by cutting off this supply. A distinguished Russian officer told me that in case they ever had trouble with Great Britain, one of the first things to be done would be to drive the Chinese out of the English fire-rooms. If no other method could be found they would declare such men pirates, and hang them upon capture. In this way, he said, we will cripple their transport service, and drive much of their commerce from the ocean. I was also told by an able English editor that the removal of the firemen would so impair the speed of their boats that the insurance rates would run up so high that a good percentage of the ships would have to tie to their docks. This fire-room question was a momentous one to our enemy working far from their military base.

Shore firemen inefficient at sea.—The most skilled firemen had been sent to the war vessels, and this left a comparatively untrained force for the transports. It was noticed that the firemen who had previously worked around boilers in shore establishments were not efficient men at sea. They were good water tenders and possessed some skill in firing, but the great heat and limited room for working the furnaces seemed to unnerve them. It was almost impossible to make them stand up to their work. On shore the boiler houses were large, and there was room for all manner of appliances which somewhat lightened their work. The older the shore firemen the more unsuited they seemed for the work required of them aboard ship. The experience of the blockading fleet, and particularly the work on the transports, showed the necessity of having some training school for firemen. Halifax not being a commercial centre, it was found difficult to secure men to replace any vacancies in the fire-rooms of the several vessels.

Condition of the enemy's firemen.—From the time our fleet had been sighted, the Admiral of the blockading squadron had hesitated in regard to engaging in battle. There was not a ship in his fleet which had a full fire-room force. There is not a modern man-of-war afloat which can do blockading duty for a month without a good percentage of the firemen breaking down. The men had given way under the intense strain of continuous work and the fear of torpedo attack. Boilers under steam for weeks, and worked irregularly, are bound to leak; and to keep up an engineer's department under such circumstances requires incessant work. It is true that these men had been assisted by mechanics from the repair ships, but the number of men that can be accommodated on such vessels must necessarily be limited. With each succeeding day the strength of the engineers' force decreased so far as numbers were concerned, and it was only because the blockade had to be maintained, and that time was diminishing the efficiency of the firemen, that the Admiral of the enemy's fleet consented to meet a squadron which was superior to his own only so far as the health and completeness of the ship's crews were concerned. One of the fire-rooms, aboard a certain class of vessel in the enemy's service, is known to their stokers as the "slaughter house." If it is so baneful under easy cruising, what will such a stokehole bring in time of war? In one of our types of vessels we have a fire-room which is not much better. How can the men be made to work in such a place? It is said that aboard the Yangwei at the naval fight of Yalu, "down in the boiler-room naked coolies shovelled coal for dear life, gin was as free as water to them, and whenever a man lagged he was urged on with blows from a thick club made of rubber belting. The draught was so intense that a continuous sheet of flame poured forth from the funnel." We can't drive our men in this way, but how are we to make them stand up to work that seems beyond their endurance? Here is the way Admiral Reveillere, of the French navy, would overcome this difficulty: "Let not the deck officers scorn to go below in the fire-room when the machinery is going at full speed. In time of war, when the engineer officers will be overworked and the firemen exhausted, it will be necessary to order below in front of the fires our strongest apprentices, in order to be able to give chase or to run. The young officers or midshipmen ought to be able to lead them there. There, where there is danger and fatigue, is the post of duty for the officer. Formerly we did not disdain to go out on a yard arm in bad weather. We should now be able to go in front of the fires when it becomes necessary to push the pressure above the limits of the boiler, either to capture or escape from an enemy. Let everybody on board be trained to fire regularly, and every one knows how much coal each furnace will burn at the greatest and at usual speed. The lowest boy used formerly to know how much the ship made by the wind or with the wind astern. Our crews have enough pride to attach the same importance to the speed of the engines, and not one of them will therefore dislike going below before the fires on the day of a fight, to take the place of the sick or the cripple." This reads beautifully, but the enemy with the best fire-room force in the world could not put such desirable recommendations into practice. A fireman is a skilled worker, not a strong labourer, and cannot be replaced so easily.

Weakness of the enemy's transport service when far from its base.—Heretofore the enemy had been regarded as a nation which had an unrivalled transport service, and one which was supposed to be sufficient for every emergency. Operating three thousand miles from home, and with an alert and aggressive opponent, was a condition quite different from that which had confronted them in previous years. The Columbia, Olympia and Minneapolis had captured so many of these boats that the protection of the transports was a matter of great concern to the commander of the enemy's fleet. It was recalled to mind that the Japanese required eighty transports to carry the same number of men that our enemy had. But the transports of Dai Nipon worked only 400 miles from their base, and were practically unmolested in their service. The ships of the Japanese were also coaled by people from shore. The enemy operating off the New England coast had to coal at sea. The Japanese practically did no blockading. The firemen of many transports broke down under the severe work exacted of them. With crowded decks they neither had the privileges nor the comforts heretofore given them. Our Minneapolis, Columbia and Olympia had no trouble in capturing the fastest of them. The transports not having done the work that was expected of them, the enemy's fleet went into battle with more than one vessel lacking a sufficiency of stores and supplies.

Disablement liable to occur.—During the action the engines of the several ships were used intermittently; not only at full speed, half speed, and at varying speeds of backing, but at progressing and decreasing speeds ahead. The machinery is built for such work, and with care should not suffer when subjected to such strains. But in time of excitement the men on watch will hear the telegraph signal repeated by startling orders from above, and in order to obey quickly valves will be suddenly opened. Starting up quickly will cause the boilers to foam, and if water gets in the auxiliary line of steam piping there is going to be trouble with some of the dependencies of the main engines. Some of our ships have single engines to drive their circulating pumps, and these are liable to become disabled if water is carried over. The same trouble can be expected from the independent air pump. These dependencies must be placed low in the vessel where they can easily be manipulated, and as separators, traps, and such contrivances are at times unreliable, their working will be seriously impaired when water reaches the pipes. There is another class of accidents which may happen for which the machinery should not be held responsible. I now refer to accidents caused by shot and shell, by torpedoes and by ramming. A shot or shell in the machinery space, a torpedo under the ship, or a good blow from a ram would probably disable the ship, and in most cases the only thing to do would be to get out. There are other incidents which may arise from shell bursting over battle gratings. Suppose a shell were to burst in the armoured portion of the smoke pipe, or just over the grating; the concussion or force of the blast might easily tear away some of the uptake and interfere seriously with the draught. Again, should a shell burst over some of the other hatches which must be open for ventilation, splinters from the shell would come through the gratings and might cut some of the steam pipes, filling the compartment with steam, and disabling a part of the machinery which was supplied by that pipe. It would not require much of a splinter to pierce the main steam pipe. This would disable, or rather might disable, the main engines, depending on whether there was more than one steam pipe and on how serious the accident was. These splinters might do other damage, but I do not think they would be likely to do much harm to the larger parts of the machinery.

Effort to disable our propellers.—The position of the propeller renders it liable to accident, and more than one ship was disabled that day from injury to the screw. Floating objects will break the blades and shafts of the propellers, and the machinery when subjected to unusual shock or strain may bring about the same result. Our enemy's commander-in-chief expended at least one fast torpedo boat in the effort to disable a screw of the Iowa's propeller. A bold attempt was also made, under cover of the smoke, to carry on the bows of a swift boat a wire netting which it was believed could be entangled in a wing screw of one of our large ships. All through the fight the disabling of a propeller of our battleships was a feature of the enemy's strategy. The Admiral believed that any battleship, with one of her two sets of engines disabled, and carrying a helm angle that materially interfered with her manœuvring powers, was little better than a cripple so far as offensive work was concerned. Our commanders, with their intimate knowledge of the currents off the New England coast, were able to manœuvre the vessels in such a way that, except in the case of the Minneapolis, their propellers were not disabled by the maritime pests in the shape of rapid small craft. The breaking of a propeller blade in itself may not be a serious casualty. If it is followed by irregular working of the engines and subjecting the machinery to shock, a broken thrust shaft may be the consequence. Losing a blade throws the engine out of balance, and machinery is then subjected to irregular strains. With a heavy sea prevailing and a propeller in this condition a fracture of the thrust shaft need not be surprising. Partly submerged objects in a narrow channel may do great damage to the propellers of war vessels by breaking off the ends of their blades. Our admiral had carefully warned the several commanders to look out for floating objects, and that the protection of the propellers was a matter of serious importance.

Mistake in having dynamos far removed from mechanics.—That policy of ours which placed the dynamo rooms as far as possible from the boilers brought distress to more than one of our vessels. The insulation of the wires has not been impaired on other ships by placing the plant within the engine or boiler compartments; and as we use the best insulated wire that can be purchased, it is fair to presume that we can do as well as other people in this respect. Our ships went into the fight with a long line of piping between the boilers and dynamo engines. That mysterious force which can be so well understood by the pupils of our naval engineers, but by some wonderful paradox is beyond the comprehension of the teacher, has its generator in a part of the vessel where the engine force cannot assist in its maintenance, and where skilled mechanics cannot put it in order when disabled. We paid dearly for this work in this battle. Very early in the fight two of the battleships had metal splinters disable the steam pipes of the dynamo plant. The concussion started the joints on another ship on the long line of piping on the berth deck, and in general we repeated the performance that took place at the Yalu, where every electrical device was out of order when the contest was over. The enemy had better luck with their electrical plant, for their dynamos and attachments were better protected and nearer the boilers. Their skilled artificers of the engine force supervised and directed the running of their dynamos, as the engines were within reach. Our machinists being in another compartment, could not assist when called upon for aid. The emergency watch, however, made temporary repairs whenever it was possible to do so.

Result of the battle.—This lecture simply tells of the responsibilities and duties of the Corps of Naval Engineers. It is not an account of that great naval conflict which was fought off the bold coast of New England, and wherein we gained that great victory which placed the laurel crown upon the brow of the greatest admiral that America ever produced. Our enemy was vanquished. From Bar Harbour to Block Island the coast was safe. When the story was told across the water, our enemy soon realised that with the best engineer force of any nation in the world, their steam department had brought their ships to grief. The disadvantages under which the engineers and firemen of the blockading fleet laboured, compared with those of our defence fleet, were too great to be overcome. There were no immediate reliefs to take the place of the sick and exhausted. There were no auxiliary repair stations to overcome casualties. There were not thousands of labourers ready to coal the ships. There were no peaceful harbours to anchor in during the fury of the gale, or when great repairs were needed. There was a vigilant and aggressive fleet for our enemy to watch, and the defence fleet had at its command within a few hours the resources of the best machine shops in the world. As the battle of the Chatham had been a contest of machines, it was not surprising that we won. Their engineers and firemen—and there were none better afloat—had simply been used up by the fewness of numbers, the inexperience of many of the firemen, and by excessive work before the battle began. That mighty nation then looked for the cause of the collapse in the motive department of their vessels of war. It was found in a vicious organisation, which had not done justice to the engineer and his force of men. Then a structure fell, whose foundation stones were tradition and conservatism; and ever since in that service the purple stripe between the bands of gold has received the recognition it justly deserves. This battle also aroused our Government to the importance of the engineer force on board ship. Countless facts were then forthcoming of the vital necessity of the naval engineers' work being extended. It was then realised that on the engineers primarily rests the fighting efficiency of every navy. A reorganisation was effected. The superannuated officers of a previous generation, who had been indifferent to the development of machinery in vessels of war, regarded the whole reconstruction as revolution."

POWDERED COAL FIRING.

MESSRS. BRYAN DONKIN AND COMPANY, Bermondsey, London, S.E., are now experimenting with the Wegener system of firing. Small sacks of powdered coal, weighing about half a hundredweight are put into a conical hopper. The powdered coal gradually falls out of the sacks, as required into the hopper, and then on to a sieve about 5½in. diameter, with small openings in it. The powdered coal would not go through this sieve with certainty without continual tapping, and this is done in the following way:—Immediately beneath the hopper, and level with the boiler-house floor, is an air pipe about 20in. diameter, through which nearly all the air for combustion enters. As it enters it is made to pass through the blades of an air-wheel or turbine, and this passage of the air causes the latter to revolve like a smoke-jack. On the axis of this air-wheel there is a little knocker which taps the sieve about 150 or 250 times per minute, causing the powdered coal to descend vertically through the sieve, meeting the air for combustion as it ascends vertically. The powdered coal and air for proper combustion in this way get mixed thoroughly together and pass on into the boiler flue, each particle of coal being surrounded by air. There is no grate and there are no fire doors, and the stoking simply consists of putting a sack of powdered coal from time to time into the top of the hopper and seeing that the right amount of air is going in for combustion. If there is not sufficient air for proper combustion entering through the main opening, as seen by a little smoke, there are two other smaller pipes where additional air can be admitted, each kind of coal requiring a somewhat different amount of air. The only object of the air-wheel revolving, from 50 to 80 revolutions per minute, is to shake the sieve and cause the powdered fuel to go into the furnace in the quantity desired. When more steam and coal are required a greater knock is given to the sieve and more powdered coal is burnt; when less is required a less shake is necessary. A screw adjustment for knocking is provided to regulate the amount of coal entering, which is done by turning with two fingers a half-inch thumb-screw. The only duty of the attendant is to put the sacks of coal into the hopper, and he ascends a short ladder to do this. He also has to regulate the amount of air for combustion, and then there is no smoke. He can therefore attend to several boilers. An alalysis of gases of combustion proves that the combustion is excellent and the amount CO_2 is much higher than with ordinary furnaces.

A GOOD BEARING.—We have received some particulars of an excellent bearing, which deserve publicity. The bearing in question was made by the Phosphor Bronze Company, of Southwark-street. It is a footstep loaded to about 480 lb. on the square inch. It is in use at Messrs. Fry's chocolate and cocoa manufactory, Union-street, Bristol. The upright shaft which rests upon it is 8in. diameter at the bottom end, and together with wheels, &c., fixed to it, weighs between 10 and 11 tons. The revolutions are 65 per minute. During the first two years the bearing was very free from excessive heat, and the wear has been almost imperceptible. Messrs. Fry state that the cost of lubricating the bearing with castor oil is something less than 2d. per week. The footstep was put into use in 1879. The shaft was recently lifted and found in excellent condition. The wear of the footstep was $\frac{1}{32}$in. after sixteen years' work. We shall be glad to publish similar results obtained with other bearings and lubricants if our correspondents can supply particulars. The loads must not be overlooked, however; any material, indeed, will do for a light load.

AUSTRALIAN NOTES.

PRIVATE Bills are now before Parliament for a connection across Sydney Harbour, one for powers to build a high-level bridge, and another for a subaqueous tunnel. From time to time various schemes have been suggested, and the Government strongly urged to provide a better means than water transit for the enormous traffic—both passenger and vehicular—that travel daily between Sydney and North Sydney; but the matter has always been shelved on the question of cost. The only means of conveyance at present is in the hands of one private company, whose monopoly allows it to easily declare an annual dividend of 10 per cent.

It is reported that Mr. J. H. Smith, whose term of office as chairman of the South Australian railways recently expired, has been offered the management of the Cape railways at a salary of £2500 per annum.

The annual report of the Department of Mines and Agriculture, New South Wales, for the year 1894, gives some interesting information, although the report is very late before such information is available. During the year 766 applications to lease Crown lands for mining purposes were dealt with; 586 were for gold-mining leases, comprising an area of 2819 acres, and 180 were for mineral leases, embracing an area of 10,427 acres. The reduction of 633 acres of auriferous land and 4200 acres of mineral land, as compared with that applied for in the previous year, is accounted for as owing to the general depression which has restricted the investment of capital in mining ventures, and to the low price of some of the metals. The total area of Crown lands held under lease in the Colony was 64,975 acres for the year.

The result of the operations effected from the aid of the "Prospecting" vote is regarded as satisfactory, by which means several discoveries are made and mines opened up that would otherwise be abandoned, owing to want of funds. Out of 1068 applications, aid was granted in 397 cases.

One of the best solutions to relieve the unemployed was the suggestion made some time ago by Mr. Harrie Wood, Under-Secretary for Mines, to the effect that free railway passes and a miner's right on credit be granted to the men to enable them to proceed to some of the gold fields of the Colony, where the men thought they would be able to earn a living by "fossicking." This has not only been the means of relieving a large body of men, but has made a decided increase in the quantity and value of gold won in the Colony.

The number of applications received by the Superintendent of the Government Labour Bureau was 9572 during the year.

The aggregate value of the mineral product of the Colony to the end of 1894 amounted to £109,336,847.

The output of coal shows an increase of 393,748 tons to that of the previous year; but with a decrease in value of £16,149, due to the very low price prevailing. The average price of coal for the year, viz., 6s. 5·53d. per ton, is the lowest since the year 1849.

The number of men employed in and about the collieries, raising coal and shale, was 9428.

The approximate number of miners engaged in gold mining is estimated as follows:—Alluvial miners, Europeans, 7982; ditto, Chinese, 760; quartz miners, Europeans, 8465; total, 17,207. The approximate number of men employed for minerals, other than above, is estimated at 6273.

The progress and development of the railways in West Australia is a good index of the prosperity of that colony. The Engineer-in-chief and Acting-General Manager for Railways has furnished a report on the working of the railways for the past four years, bringing the information up to the 30th June last. Owing to a variety of causes, published statements of the working have not been issued for a considerable period, and the information now published will be read with exceptional interest. The return on capital invested for the year ending 30th June last is—with the probable exception of some Indian lines—the highest of any State railway in the world. In the year 1891, the net earnings, after paying working expenses, were only £498, while for the year ending June 30th, 1895, the gross revenue not only met working expenses and total interest on loan expenditure, but also left a surplus of £30,838.

During the year the following lines were opened for traffic:—Northam to Yilgarn, 170 miles; Mullewa Junction to Mullewa, 57 miles; Boyanup to Busselton, 27 miles; making a total mileage of 573.

In addition to the fact of efficient management, two factors are to be taken into consideration in the remarkable results achieved—being the abnormally low cost of construction, the average being only £3804 per mile—and the opening up of the goldfields, causing a great rush of traffic.

The Acting General Manager states, "At the inauguration of responsible government in 1891, an important reason for the non-productiveness of the railways was traced to the existence of the very steep grades on the Eastern Railway, in conjunction with light rails, and, consequently, light locomotives, whereby reasonably heavy trains could not be hauled, and in order to as quickly as possible in some measure attain better results, heavier rails—60 lb. in place of 46 lb. to the yard—were decided to be laid down, and more powerful locomotives obtained. These improvements having, therefore, now been in existence for a considerable time, it is natural to look for some evidence of their effect towards reducing the working expenses—especially of the locomotive branch of the service." The locomotive expenses on the Eastern Railway, as compared with the gross receipts, have been reduced from 62·42 per cent. in 1890, to 27·91 in 1894-5.

Since 1891, £127,438 has been expended in the purchase of additional rolling stock for the use of lines open.

Various improvements have been made in the type of locomotives and rolling stock, thereby reducing the working expenses.

The statistical returns furnished along with the report are very comprehensive, and supply a long-felt want in making comparisons of the Australian colonies.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

THIS has been the week of the January quarterly meetings, the gatherings being held as usual in Wolverhampton yesterday, and in Birmingham to-day — Thursday. But for the unfortunate developments of the last ten days or a fortnight in foreign affairs we might have had a good trade. As matters now stand, however, trade was very much interfered with, and buyers hesitated a good deal about operating. Marked bars were re-declared at the former figure of £7 per ton. Messrs. John Bradley and Co. re-quoted their best bars at £8 per ton, or £1 10s. in advance of any other firm. Their second quality bars were £7 10s. The firm profess that if they were to reduce prices they should have to also reduce quality, and rather than do this they prefer to occupy an independent and exceptional position. The Earl of Dudley's quotation for bars was £7 12s. 6d as a basis. Messrs. Noah Hingley and Sons quoted their prices for the new quarter as follows:—"Lion" bars, ordinary, £7; best, £8 10s.; double best, £9 10s.; and treble best, £10 10s. "Lion" turning bars are £8; rivet iron, £7 to £8 10s. and £9 10s., according to quality; and chain iron, £7 to £8 10s. and on to £10 10s. Messrs. William Barrows and Sons quoted bars, £7; hoops, £7 10s.; and cast chain iron £8 10s.

The Unmarked Bar Association upheld the combination formed just twelve months back. It was at the January meetings of 1895 that the association was first organised. The association started with a membership of sixteen firms, and the minimum was fixed at £5 5s. at works, or £5 7s. 6d. delivered. This—Thursday—afternoon the association was as strong as ever, and the basis price for the new quarter was declared at £5 15s. per ton, makers' works, showing an advance on the twelve months of 10s. per ton. It was announced that most of the forty or fifty common bar firms established in the district were now members of the association, and all the members express themselves strongly opposed to any attempt to reduce prices. Merchant bars on the open market were mostly £6 to £6 10s.

The makers of sheets for consumption by the galvanisers reported themselves still in receipt of a good demand, though it was admitted that orders are less plentiful than a month ago. Confidence is, however, expressed that the demand will again early resume its old proportions if political troubles can be got out of the way. Prices were quoted at £7 2s. 6d. to £7 5s. for doubles; £8 for lattens; and £7 for singles. Galvanised corrugated sheets were quoted £10 7s. 6d. to £10 10s., 24 gauge, f.o.b., common sorts. At the January quarterly meetings last year sheets for galvanising and similar purposes were quoted £6 5s. to £6 7s. 6d. for doubles, and £7 for lattens. Galvanised sheets were £9 7s. 6d. to £9 10s., and £9 12s. 6d. as the minimum for qualities of 24 w.g., bnndled f.o.b. Liverpool. The only doubt in the present state of the sheet iron trade is occasioned by the knowledge of the additional new mills which have recently been re-started. It is not, however, to be assumed that all the mills existing at old works which have recently been re-acquired will immediately be brought into activity again; hence the market is somewhat reassured. Especially does this apply to the Woodford Ironworks, Smethwick, now in the occupation of Messrs. Ash and Lacy, which comprise in all seven mills, and to the Gospel Oak Ironworks, Tipton, which have been acquired by Messrs. Page and Wilkinson, jun., and where some five or more mills are erected.

The advance declared last quarter-day of £2 per ton on large tinned sheets, and £1 per ton on stamping sheets, was upheld to-day by the best—thin—sheet firms, and Messrs. Knight and Crowther quoted coke tinned sheets, singles, £25, and charcoal ditto £27; while Stephen Thompson and Co. quoted tinned sheets £24 singles, and £25 10s. doubles. Black sheets, singles, are quoted by Knight and Crowther £9 for the Dibdale brand, £10 K.B.C. brand, £11 10s. Knight's crown, and £13 Knight's plough. Demand in the pig iron trade was slow, and prices easier. All descriptions of pig metal were three months ago in large call, and makers were very strong, many of them having closed their books. Northampton forge pigs last October were a minimum of 41s. to 42s. 6d.; Derbyshires, 42s. to 43s., less 2½ per cent.; and Lincolns, 44s. to 44s. 6d. net. Local all-mine hot-air pigs were advanced 2s. 6d., making the price 57s. 6d., while cold-air pigs were 87s. 6d. This afternoon Derbyshire and Northampton pigs were easily procurable at 41s. 6d. to 42s. 6d. in actual business, although higher prices were quoted nominally, and Lincolns were also rather easier. Staffordshire cinder pigs were 36s. to 37s. 6d., and North Staffordshire part-mines at 44s. Steel occupies a good position, and prices are well sustained, particularly for constructional and other engineering descriptions.

Satisfaction is occasioned this week by the character of the Board of Trade returns for the month of December and the completed year. Our iron and steel exports during the month amounted in all to 220,579 tons, and their estimated value was £1,774,497. These returns show an improvement of 10 per cent. in quantity and 13 per cent. in value on the corresponding month of last year. For the whole twelve months of 1895 our exports under this heading improved in quantity by a little over 7 per cent., and in value by a little over 5 per cent. They amounted to 2,838,149 tons, compared with 2,649,998 tons in 1894, and 2,856,574 tons in 1893. The corresponding values were in 1895, £19,695,382; in 1894, £18,688,763; and in 1893, £20,592,577. It will thus be seen that the year just closed marks an improvement on its predecessor, but has failed by a rather substantial margin to reach the figures of two years ago. The following are the increases in particular items on the year's trade:—Pig and puddled iron, 8 per cent.; bar, angle, &c., 3 per cent.; railroad material, a fraction; wire, 14 per cent.; cast and wrought iron, 9 per cent.; old iron, 12 per cent.; galvanised sheets, 15 per cent. The articles showing a decrease for the twelve months are:—Telegraphic wire, 43 per cent.; hoops, sheets, &c., 26 per cent.; unwrought steel, 1 per cent.; tin-plates, 2 per cent.; and unwrought tin, 11 per cent. The machinery exports for December were of the value of £1,099,088 against £839,359 in December of last year, showing an improvement of £259,729. For the twelve months the machinery exports were worth £12,428,143, against £11,140,112 in 1894, or the very satisfactory increase of £1,288,031. Steam engines figure this December at £222,850, against £239,939 in the closing month of last year. For the twelve months the figures are: 1895, £2,786,967; 1894, £3,065 103.

It is rumoured this week that the Birmingham Mint, Ltd., have just secured important contracts from the Russian Government for silver and bronze coins. It is stated that the contract will give full employment for upwards of six months. The firm are already engaged on other European orders for coins, and are also well employed in their various metal branches.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The opening of the year has so far been anything but encouraging, but notwithstanding increasing complications abroad, and the threatened further protraction of the dispute in the shipbuilding trade, there is still a very general feeling of confidence in the future, whilst the remarkably steady tone maintained in the market is satisfactory evidence of the sound, healthy condition of trade. The position is naturally not so strong as it was; the uncertainty of the outlook necessarily checks forward buying, and users who have orders to place hold back as much as possible for the chance of lower prices, but as far as the principal brands of iron both raw and manufactured, used in this district, are concerned, makers have not so far given way to any appreciable extent. Where there has been any actual breakdown in prices it has been in some of the purely speculative brands, or with iron in second hands, which has been pushed upon the market by a few nervous holders; and considering the present disturbed situation, the continued generally strong position that is maintained is a most hopeful feature in the market.

There was about a full average attendance on the Manchester Iron Exchange on Tuesday, but only a very slow business doing generally. Pig iron met with but very little inquiry, and for the most part business was only practicable at some concession upon recent quotations. Local and district makers are, however, so well sold for the present that they are under no necessity to seek for new business at lower prices, and although there has been practically nothing doing to really test the market, their quotations may be said to remain unchanged on the basis of 46s., less 2½, for No. 3 foundry Lancashire; 46s. 6d. to 47s. 6d. for No. 3 foundry Derbyshire; and 41s. 6d. for forge to 43s. 6d. for foundry Lincolnshire, net cash, delivered Manchester. With regard to outside brands coming into this market, Middlesbrough is easier, and generally there is a good deal of underselling with second-hand parcels. Delivered equal to Manchester, ordinary foundry Middlesbrough could be bought at about 44s. 10d. net cash, with special brands quoted about 1s. per ton above this figure. For the leading brands of Scotch iron, however, quoted rates scarcely show any very appreciable giving way, 47s. net cash, delivered Lancashire ports, being about the average for Eglinton, with 48s. 6d. asked for Glengarnock.

Finished iron makers report new business coming forward only in very limited quantity, but so far as bars and sheets are concerned, they are well booked over the next two or three months and steady at late rates, except that some Staffordshire bars might be bought for prompt delivery at 2s. 6d. to 5s. per ton under recent full quotations. The general quoted prices remain, however, at £5 10s. as the minimum for Lancashire bars, with Staffordshire makers still quoting £5 15s., and sheets £7 10s. to £7 12s. 6d., delivered here. Hoops are exceedingly quiet, mills not having sufficient work to keep them going half time, but the Association list rates remain unchanged at £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths, delivered Manchester district, and 2s. 6d. less for shipment.

The position in the steel trade remains unsatisfactory, ordinary foundry hematite being in but very slow request, and not averaging more than 55s. 6d. less 2½d., with steel boiler plates obtainable from £6 to £6 5s. per ton, delivered Manchester district.

In the metal market the recent giving way in raw material has been followed by a reduction of ¼d. per lb. upon all descriptions of manufactured goods except yellow metal plates, and for delivery Manchester district list rates are now as under:—Solid drawn brass boiler tubes, 6d.; solid drawn brass surface condenser tubes, 7½d.; solid drawn copper tubes, 7¼d.; brazed copper gas and steam tube, 7d.; brazed brass gas tube, 6d.; brass wire, 5¼d.; copper wire, 6½d.; and rolled brass, 5d. per lb,

The position throughout the engineering industries continues generally satisfactory, establishments for the most part resuming operations after the holidays with a fair weight of orders in hand, sufficient in some branches to keep them well engaged over a considerable portion of the ensuing year. Of course, the disturbed outlook abroad has some effect upon the immediate prospects of the future, but not, so far as I can gather, to any really serious extent, and as an illustration I may mention that even the South African troubles have not checked the placing of orders in this district, one of the leading pump makers having in the last few days booked several separate orders for about a dozen different kinds of pumps, to be sent out to the Transvaal.

Reviewing the position of the Lancashire engineering industries throughout the twelve months just closed, it is satisfactory to note a generally decided improvement as compared with the last three or four years. Although 1895 opened with much the same discouraging outlook that characterised the iron and coal trades of the district, engineering works in nearly all departments being short of orders, and the unemployed list of the trade union societies considerably above the average, prospects began to brighten early on in the year, and an improvement set in which has been well maintained. This improvement, however, did not make itself felt in any very special measure during the first three months, and probably not to the same extent in the Manchester district as in other important engineering centres. The Amalgamated Society of Engineers, which commenced the year with an out-of-work list of from 9 to 10 per cent. of the local membership, did not materially improve upon this unsatisfactory state of affairs until well into the second half of the year, but the Steam Engine Makers' Society was able to record a fairly substantial reduction in the number of out-of-work members, which at the commencement of the year stood at about 5½ per cent., and during the first three months got down to about 4 per cent.

During the first quarter foreign orders of considerable weight were secured by some of the leading firms, whilst there was also a fair amount of new work stirring in connection with railway requirements, and from the commencement of April onwards, the position steadily improved, with only occasional temporary slight fluctuations, all through the remainder of the year. Amongst stationary engine builders a large weight of new work was given out, the principal portion of which was for abroad, in connection with extensive orders for cotton machinery for shipment, and machine tool makers also secured a good deal of new work. This increasing activity was necessarily reflected in the lessened unemployed lists of the trades union societies, the returns of the Amalgamated Society of Engineers in June showing not more than 7½ per cent., and those of the Steam Engine Maker's Society 3 per cent. of the local membership in receipt of unemployed benefit. A still more marked improvement was manifested during the second half of the year, all branches of industry getting busier, cotton machinists booking considerable orders for China and Japan, whilst the shops of both light and heavy stationary engine builders were filled with work for some time ahead, and the out-of-work returns of the trades union societies showed a further substantial reduction, until the Amalgamated Society of Engineers had not more than 5 per cent. and the Steam Engine Maker's Society only about 2½ per cent. of the local membership in receipt of donation benefit.

Towards the end of the year some slackening off in new inquiries became here and there noticeable, the protracted dispute in the shipbuilding industries having no doubt indirectly a depressing tendency. Generally, however, the year closed with the leading engineering industries throughout Lancashire in a sound, healthy position, and mostly well supplied with work, some branches having orders on their books to carry them well over this year. This is especially the case in the stationary engine building trades, both as regards light and heavy departments. Locomotive and railway carriage and wagon builders, who have been but very indifferently off for orders for the last two or three years, have booked a considerable weight of new work, which in some cases will afford pretty full employment over the next six or even twelve months, and there are prospects that the next few months will bring forward a still further important accession of new work. Machine tool makers have opened the year generally well supplied with orders, and most of the cotton machinists are booked for a considerable time ahead.

The boilermaking trade, of which Manchester is perhaps the most important centre in the kingdom, has shown a good deal of fluctuation, but generally establishments have been kept tolerably well engaged; and in general engineering of a constructive character there has been a fair amount of work stirring. The previous protracted period of depression had, of course, so depleted the order books of engineers that, when the improvement set in, the eagerness to secure work prevented any appreciably better prices being obtained, but with engineering establishments now, with comparatively few exceptions, well supplied with orders, a more independent position of affairs has been established, and improvement in the matter of prices is beginning to make itself felt. The trade union organisations closed the year, as regards the employment of their members, in a better position than has been known since 1891, and as compared with 1894, they have scarcely half the number of members on their books in receipt of out-of-work support that they had at the same period of that year.

With regard to shipbuilding, the decline of this branch of industry, so far at least as the Liverpool side of the Mersey is concerned, to which I referred in reviewing the course of trade during 1894, has continued in 1895; but on the Birkenhead side there has been a decided revival of activity, and a greater weight of new work has been secured than for a considerable number of years past. Messrs. Laird Brothers have during the year completed the following vessels:—Salvador Correa, steel screw steamship of 240 tons gross register, 480-horse power, for foreign owners; Queen of the North, steel paddle steamer, 600 tons, 1700-horse power, for British owners; a steel paddle steamer, 111 tons, and 50-horse power, for foreign owners; The Quail, Sparrowhawk, Thrasher, and Virago, twin screw torpedo destroyers, each 320 tons, and 6000 indicated horse-power, for H.M. Navy. The Great Western Railway Company's steamer Pembroke has been converted from paddle to twin screw, with new engines and boilers of 3300-horse power.

In addition to the above work, Messrs. Laird have in hand important home and foreign Government orders for war vessels of various descriptions, including the battleship Mars, which will probably be floated in March, when there are spring tides suitable for the undertaking. This vessel is making rapid progress, and would have been completed sooner but for considerable delay in the delivery of the armour plates. She will be similar to the Magnificent and Majestic, just commissioned, the orders for which were, however, put in hand several months before that for the Mars was placed. The firm has also in hand other important work, including a new lot of 30-knot torpedo destroyers, upon the first of which they expect to have steam very shortly, and four mail steamers for the Holyhead service, the first of which is now plated, and the second one in frame.

On the Liverpool side of the Mersey the shipbuilding industry has practically resolved itself into building small vessels, tugs, barges, &c., and of this kind of work, with repairs, re-boilerings, and conversions, there has been a fair amount. Messrs. John Jones and Sons have built two steel caissons, of a tonnage of 1500, and sixteen small steamers and barges for foreign owners, two being twin-screw, ten sailers, three paddles, and one single-screw, with tonnages of from 450 downwards. Messrs. Clover, Clayton, and Co. have built nothing, with repair work below the average. Messrs. D. Rollo and Sons have re-boilered a number of steamers and done some heavy repair work, whilst they have in hand some small sets of engines, boilers, &c.; and Messrs. H. and C. Grayson have dry-docked about 300 vessels, steam and sail, of all tonnages, and done a considerable amount of repair work to large vessels. Messrs. James Harland and Co. have turned out only one new vessel, the Merlin, a wooden screw steamer of 260 tons, for carrying limestone; and Messrs. James Royden and Co., and Messrs. Gilchrist and Co. have built no vessels, although the last-named firm has in hand three light draught steel screw steamers, to be completed during the present month. The shipbuilding dispute on the Clyde and at Belfast has temporarily interfered with the completion of some of the orders which Liverpool marine engineers have in hand, but of course as soon as the dispute is settled these orders will go on.

The opening of the year has not brought forward any improvement in the coal trade, and although in most cases the holidays at the pits have extended over a longer period than usual, supplies are plentiful, and prices not more than maintained at late rates. The better qualities suitable for house-fire purposes move off only moderately, with quotations unchanged. In the lower descriptions supplies continue largely in excess of requirements for iron making, steam, and general manufacturing purposes, and the competition to clear off surplus output causes excessive cutting in prices, which remain quite as low as at any time during the past twelve months. For inland sales good qualities of steam and forge coals scarcely fetch more than 6s. to 6s. 6d., whilst for shipping orders 5s. 6d. per ton at the pit mouth is being readily taken. The present somewhat restricted output of engine fuel is moving off readily, and prices are steady at late rates, averaging 3s. to 3s. 6d. for common, to 4s. 6d. and 5s. for best qualities of slack at the pit mouth.

Barrow.—There is less life in the hematite trade, and the revival which was expected has not set in. The reason for this to a great extent is to be found in the fact that the engineers' strike is crippling trade and checking the need of deliveries. The complicated state of our foreign relations has also much to do with the depression in the iron market. Prices are at easier rates, but are firm, with warrants at 46s. 4d. net cash sellers, and buyers at 46s. 3½d. The quotation for makers' iron is nominally given at 48s. Stocks have increased this week 4945 tons, and now stand at 298,436 tons. Thirty-six furnaces are in blast, compared with thirty-one in the corresponding week of last year.

Sales of iron ore are few, and the market is flat. Ordinary sorts are at 10s. per ton net at mines. Further supplies of Spanish ore are to hand this week.

The steel trade is brisk in rails, and makers are not only busy, but are well sold forward. Heavy sections are at £4 15s. The plate trade is quiet, because shipbuilders are not in a position to give out specifications owing to the engineers' dispute. Tin bars are also quiet, but billets, blooms, and heavy castings are in demand.

The shipbuilding and engineering trades are very busy, chiefly on Admiralty work, and other orders are expected. The fitting up of H.M.S. Powerful is making much progress, and it is expected she will be ready for delivery soon after midsummer.

The coal and coke trades show a little more life. The demand is improving, and prices are stiffening.

Shipping returns show an improvement. The exports of metal from West Coast ports show during the past week 4726 tons of pig iron and 10,220 tons of steel, compared with 2185 tons of pig iron and 2667 tons of steel in the corresponding week of last year, an increase of 2541 tons of pig iron and 7553 tons of steel. The aggregate shipments of pig iron this year so far have been 7131 tons, and of steel 18,527 tons, compared with 2965 tons of pig iron and 8673 tons of steel in the corresponding period of last year, an increase of 4166 tons of pig iron and 9854 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

DURING the first week in the New Year the pits have been fairly well employed, although the expectation of a large demand, should frosty weather ensue, has not been realised up to now. The settlement of a dispute at a local colliery—Hickleton Main—saw 1895 out without a single strike, with the exception of a slight difference at a South Yorkshire pit. This danger has now happily been averted, and the beginning of 1896 has not so many industrial clouds as the opening of 1895. The demand for household coal is very poor. After the holidays terminated a better tonnage was forwarded to the metropolis and the southern markets generally, although sales of Yorkshire coal are extremely slow, and are made increasingly so by the keen competition of seaborne coal, which has the effect of lessening values in spite of the attempts to keep them up. The business done by coast in this quality of coal is only moderate, and the demand all round is far from active. Quotations remain very much the same as when last reported, with little trade transacted at high rates, while secondary qualities can be purchased at about the same price as ruled during the midsummer of 1895. Silkstone best is at 8s. 6d. to 9s. 6d., with ordinary from 7s. 6d. per ton. Barnsley house can be purchased at 7s. 6d. to 8s. 6d., with secondary sorts at 6s. 9d. per ton. Flockton sells at 6s. 9d. to 7s. 9d. per ton, while thin seam coal is as low as 6s. 3d. per ton.

Steam coal is in fairly good request, considering the season of the year. The Humber ports are naturally taking but a poor tonnage at this time, although a few of the collieries are forwarding a large amount. Railway companies are requiring a full average on contract account, with the additional advantage that the improved condition of the iron and steel trades induces a better request. Prices are extremely unsatisfactory, and supplies can be obtained at very low rates. Barnsley hards, 6s. 6d. to 7s. 3d., with secondary qualities at 6s. 6d. per ton. Gas coal is in better request, and collieries working this class of fuel are fully employed. The bulk of the business is on contract account, and at from 6s. to 7s. per ton. Manufacturing fuel is steadier, with prices low, and stocks accumulating at some of the collieries. Small nuts are at 5s. to 6s. per ton; screened slack, 2s. 9d. to 3s. 9d.; with pit slack, 2s. 3d.; smudge, 1s. Coke is reported better at 8s. to 10s. per ton.

The cheerful anticipations of the latter half of 1895, that a very good year could be looked for in 1896, have been somewhat dashed by the serious political troubles in America and other places. These have weakened confidence and shaken the calculations of business men. There is every hope, however, that the horizon will be cleared, and that 1896 will, after all, prove to be one of the most successful years there has been for some time.

At the beginning of each year there is always a good deal of work left over to be completed, and this has been especially the case in the present year. The armour plate mills and forging presses are extremely well engaged on Government account, with every prospect of large orders from Japan, China, and other foreign countries, as well as further requirements from the Home Government. Makers of engines, carriages, wagons, tires, axles, buffers, and all the necessary parts of railway plant generally, are very well off for work, and next week will be once more in full swing. The Christmas holidays have been considerably curtailed this season, owing to all the departments being full up with orders. Better prospects have to be reported in the engineering trades as well. The opinion generally expressed in this district is that business will continue to improve. The requirements at present placed will keep manufacturers very busy well into 1896. Both Bessemer and Siemens steel are in large demand, and a similar remark may be applied to common and forge iron. The rolling mills started this week, and owners report a sufficient quantity of orders in hand to keep them well employed for some months yet.

In the lighter trades the expectations of a better business are as sanguine as in the heavy industries. Cutlery and plated goods are largely called for, and the same may be reported of ornaments and more costly silver goods. Skate makers do not take quite such a cheerful view, and hardly expect to clear their heavy stocks this season. Many of them, however, anticipate a return of the extraordinary frost of 1895, and if this prove the case, they have still time to dispose of their stocks. Scythe, sickle, machine knives, reaper sections, and other goods are in excellent request for early delivery.

Through the courtesy of the United States Consul at Sheffield—the Hon. B. R. Bedle—we are now able to compare the business done with America in cutlery and steel during last year with 1894. For the quarter ending December 31st, cutlery was sent to the value of £45,483 2s. 9½d., which is a decrease as compared with £49,502 14s. 10d. for the same period of 1894. In steel, however, a large increase is shown. The amount reached was £96,601 12s. 1d. last year, as against £69,670 5s. 8d. in 1894. For the quarter the total amount of exports was £158,755 4s. 6d., and in the corresponding period of 1894 £146,970 10s. 5½d., or an increase of £1784 14s. For the year just closed, the total value in both cutlery and steel sent to the States was £536,243 13s. 9d., as against £386,344 18s. 0½d., or an increase of £149,000.

Our foreign trade in hardware and cutlery for the twelve months amounted to £1,862,858, which is £28,000 better than for the previous year. Taking the month of December, the value was £165,689, as compared with £141,186; so that it will be seen that the improvement in business was distinctly accentuated during the closing period of the year. In steel, unwrought, there was also an advance, the value exported last month having been £183,724, against £171,966 for the corresponding month of 1894.

Sheffield is an important centre of limited liability companies, especially those affecting coal, iron, steel, and allied industries. A tabulated list of leading concerns reflects the significant improvement in trade which has taken place during the year, particularly in the latter half of it. In fifty-three companies, the shares of which are largely held in Sheffield, the called-up capital is £15,378,101, and the market price, as per Stock Exchange quotation, is £13,970,457. This shows a net depreciation of £1,407,644. Several companies have improved their general position very materially, noteworthy amongst these being Vickers, Sons, and Co., who now show an increase of £496,875, against a decrease last year of £9375. The Yorkshire Engine Company has also improved, its capital showing an appreciation over the paid-up amount of £8000. In 1894 the net depreciation in these companies was £2,667,436, and as that was reduced last year to £1,407,644, the improvement in the position of the companies in the Sheffield district is increasingly manifest. There is every expectation locally that this change for the better will be accentuated during the present year.

It was stated some time ago that the steel works at Maryport had been purchased by Mr. James Duffield, manager for Messrs. Charles Cammell and Co., at their Derwent Iron and Steel Works, Workington. These have now become the property of the company, and are to be used for the manufacture of finished steel. With that view the works at Maryport will be dismantled and the plant removed to Workington. It is stated locally that the negotiations for the purchase of the Solway Ironworks at Maryport by Cammell and Co. are almost completed, and that the furnaces will shortly be put in blast.

The Transvaal "surprise" has had some adverse effect on local business, weakening confidence and spreading distrust. Of course the orders from South Africa were on their way before the troubles began, and although none of these have been countermanded, so far as inquiries made to-day—January 8th—can disclose, it is expected that the result of the upheaval will be to stop the brisk call which had begun to set in from the South African markets.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE continuation of the Clyde-Belfast engineering dispute does not, in the presence of unsatisfactory Imperial influences, much affect the market, neither does the somewhat unfavourable annual stock returns which have been issued by the Scotch and Cleveland ironmasters, both of which Associations have to report for last year an excess of production over consumption, and increased stocks. The iron trade in the North of England have added 75,006 tons to the stocks of Cleveland iron alone, though they have added but 17,343 tons to the output, and from this it is apparent that the consumption was not as large last year as it was in 1894. No particulars of the stocks of hematite pig are issued by the Cleveland Ironmasters' Association, but there can be no doubt that they have been largely added to. Still the stock of Cleveland pig iron in the North of England—305,669 tons—is not an excessive one for the early days of a revival, and it is not half of what has been held, seeing that in August, 1886, no less than 728,094 tons were reported—that being the largest quantity ever stored—while the smallest was in August, 1892, when it was but 46,108 tons.

Lower prices have been taken this week for No. 3 Cleveland pig iron, and also for hematite pig iron; otherwise quotations are fairly-well maintained, as producers have good orders booked, the result of the activity of buyers in the last quarter, and they are in no hurry to agree to reduced prices. No. 3 Cleveland G.M.B. pig iron has been generally quoted at 36s. 6d. per ton for prompt f.o.b. delivery; but some business has been done by merchants at 36s. 3d. this week. Buying for forward delivery is practically at a standstill. Cleveland warrants have been weak during the last few days, and on Tuesday buyers would pay no more than 36s. 1½d. cash, for Cleveland warrants, their price on Wednesday being 36s. 2½d. The stock of Cleveland pig iron in Connal's warrant stores on the 8th inst. was 173,759 tons, or 2059 tons increase this month. No. 1 Cleveland pig iron is quoted 38s.: No. 4 foundry, 36s.; grey forge, 35s. 9d.; mottled, 35s. 3d.; and white, 35s. The scarcity of forge qualities is as great as ever. Some thought that over the holidays the blast furnaces would not work so well as usual, and that there would he a large proportion of forge in the output, but such does not appear to be the case, and it is very few firms who can supply any. Mixed numbers of East Coast hematite pig iron have declined in value, and while 45s. 6d. has been generally quoted this week, 45s. has in odd cases been accepted.

The December statistics issued by the Cleveland Ironmasters' Association were unsatisfactory, but the stocks did not show a larger increase than was expected. The production exceeded the consumption by 34,388 tons, makers adding 17,413 tons to their unsold stocks and 183 tons to their stores, while to the public warrant stores 16,792 tons were added. Still the makers have only about three weeks' production unsold, and the total stock is not over ten weeks' output. An increase in the production was reported of 16,359 tons, part of which may be accounted for by the extra day in December over November, and the total make was 261,469 tons, of which 127,148 tons was ordinary Cleveland. Palmer's Shipbuilding and Iron Company have blown in a furnace to make Cleveland iron, and the number now producing that is 49, while 45 produce hematite, &c., there being 94 furnaces at work, of which 72 are within the port of Middlesbrough. The Ironmasters' Association have deleted from their official list the names of three works which have been for years idle, and which it may be inferred will never work again, viz., the Norton, with three furnaces; the Seaham, with two; and the Ferryhill, with three. This leaves 133 built in the North of England, of which 98 are in the Cleveland district. The exports from the Tees were 24,741 tons less than in November, reaching only 55,229 tons, and the quantity for the year was 985,092 tons against 935,211 tons in 1894, and 914,083 tons in 1893.

The annual summary of make and stocks of pig iron in the North of England shows that the stock of Cleveland iron increased 75,006 tons, and that more iron was held than in any year since 1888. The total production was 46,980 tons less than in 1894, which showed the largest make in the history of the trade, but the 1895 return was the second best, the quantity being 2,916,439 tons. The output of hematite, &c., iron was 64,323 tons less than in 1894, but there was an increase of 17,343 tons in the make of Cleveland pig iron. Last year was the third in which the production of Cleveland iron fell short of that of other kinds.

Steel manufacturers are well-off for orders, and keep their mills in full operation, now that the holidays are over, but they find consumers very shy about distributing further orders. Finished iron makers, however, continue badly supplied with contracts, and there is nothing like full employment at some of the works. The Stockton Malleable Iron and Steel Company are erecting additional and larger mills at these works for plate rolling. Their works manager, Mr. Fred G. Mills, is leaving them to undertake an appointment at the Wishaw Works of the Glasgow Iron and Steel Company. He has been seven years with the Stockton Malleable Company. A tin-plate manufactory is to be started in a few days at Birtley. This will be the only one of its kind in the North of England, and the proprietors think there is no reason why tin-plates should not be made as cheaply in the North of England as they are in South Wales or Staffordshire, which monopolise the trade. Considerable quantities of iron and steel are sent from the North of England to Wales for tin-plate making.

Mr. William Henry Mascall, Bishop Auckland, assistant colliery manager under Messrs. Pease and Partners, has been appointed to the charge of the Joanroyd Colliery, Heckmondwike, and is succeeded by Mr. George Wall. The coalowners and others interested in the Blyth, Cramlington, and Hartley district, in Northumberland, have this week presented an address and casket to Mr. M. W. Ridley, son of the Home Secretary, on his attaining his majority.

Mr. R. Saxton White will join Mr. Henry F. Swan in the direction and management of the Walker Shipyard of Sir W. G. Armstrong, Mitchell, and Co. Mr. White filled the position of manager of this yard for several years before taking the management of the shipbuilding department of the Fairfield Shipbuilding and Engineering Company.

The coal trade is very dull, new orders being scarce in all branches, and especially is this felt in the house coal trade, which should be at its best at this time of the year, but actually is very slack now owing to the mild weather. The prices now taken for Northumberland steam coal are the worst that have ruled for the last seven years, and the ascertainment of average realised prices last quarter justifies the masters in claiming a further 2½ per cent. reduction of wages. In Durham the miners have by a large majority voted for the abolition of the Conciliation Board, 14,894 only voting for the continuance of the organisation, and 30,568 against, while 20,000 remained neutral. Mr. Charles Irwin, who has been twenty-one years with the company, has been appointed fitter and secretary to the Cramlington Coal Company, vice Mr. William Mason, who retires.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE issue of the annual statistics of the iron trade has been the most interesting event of the week. There is nothing of the nature of a surprise in the official figures. There has been a large increase in the production of pig iron, which has exceeded that of 1894 by no less than 441,298 tons, and is the largest make of pigs in Scotland since 1889. The consumption has also been large, but notwithstanding this there is a big addition to stocks, both in makers' yards, and in the public warrant stores. The following are the official figures made up by the Pig Iron Trade Association:—

	1895.	1894.	Increase.	Decrease.
Production as per makers' returns	1,096,912	655,614	441,298	—
Consumption—				
In foundries	126,661	125,516	1,145	—
In malleable and steel works	534,430	294,960	239,470	—
	661,091	420,476	240,615	—
Exports—				
Foreign	115,785	122,690	—	6,905
Coastwise	193,648	129,967	63,681	—
Rail to England	4,363	5,672	—	1,309
	313,796	258,329	55,467	—
Total consumption and exports	974,887	678,805	296,082	—
Stocks as on December 31st—				
Connal's stores	346,003	287,886	58,117	—
Makers' yards	134,621	70,713	63,908	—
	480,624	358,599	122,025	—

The average number of furnaces in blast during the year was 74 compared with 45 in the preceding year, and the average make per furnace was 285 tons per week, compared with 280 in 1894. The average price of G.M.B. warrants was 44s. 5d., against 42s. 8d. in the preceding year, the highest price being 49s. 1d. touched in September, and the lowest 41s. 0½d. in January.

The imports of West Coast hematites into Scotland were 88,500 tons against 141,000 in 1894, and the quantity brought in from the East Coast of England, chiefly from Middlesbrough, was 442,000 against 430,000 last year.

The exports of Scotch pig iron abroad were small, and it is apparent that these have been steadily decreasing, while the consumption of pig iron in Scotland is largely on the increase. The following is an approximate statement of the distribution of Scotch pig iron abroad in the last four years:—

	1895.	1894.	1893.	1892.
France	5,831	3,610	4,060	7,500
Germany, Austria, and Holland	21,479	19,556	37,546	47,287
Belgium, Denmark, Sweden, and Norway	6,449	7,786	7,212	11,143
Russia	9,629	6,565	7,470	11,955
Spain and Portugal	3,104	3,327	4,328	4,277
Italy	15,465	17,064	19,653	23,016
United States of America	3,008	1,672	4,615	14,144
British North America	5,456	6,080	14,057	22,913
Australia, East Indies, China, Japan, &c.	32,646	32,892	28,305	30,015

The business this week in the pig iron market has been limited, but prices are again reduced to the extent of about 3d. per ton, Scotch Cleveland and hematite all sharing in the decline.

The prices of Scotch makers' pig iron are as follows:—G.M.B., f.o.b., at Glasgow, Nos. 1, 46s. 6d.; Nos. 3, 45s.; Carnbroe, No. 1, 47s.; No. 3. 45s. 6d.; Clyde, No. 1, 50s.; No. 3. 47s.; Gartsherrie and Calder, Nos. 1, 50s. 6d.; Nos. 3, 47s. 6d.; Summerlee, No. 1, 51s.; No. 3, 47s. 6d.; Coltness, No. 1., 53s.; No. 3, 48s. 6d.; Glengarnock, at Ardrossan, No. 1, 50s. 6d.; No. 3, 46s. 6d.; Eglinton, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Dalmellington, at Ayr, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Shotts, at Leith, No. 1, 52s. 6d.; No. 3, 48s.; Carron, at Grangemouth, No. 1, 53s.; No. 3, 49s.

In the finished iron and steel departments business is quiet, and prices are practically unaltered.

Messrs. Neilson and Co., of Glasgow, have secured an order to construct 75 locomotive engines and tenders for the Midland Railway, and the other orders, in prospect or in hand, make the outlook in the locomotive engineering trade very encouraging.

The coal trade is quiet, the output being large, and prices as low as ever. The coal shipments in the past week were comparatively good.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

LAST week was the final one, in all likelihood, for holiday depression in the coal exports, and belief now is strong that the trade is now in for a vigorous period, unless colliers "sprag" the wheels, as they term it. Work is full on for January, and prices are ruling firmly, with upward tendency. The disquietude in military and naval circles has a tendency to strengthen this, and it may be anticipated that coaling stations will be well looked after. This week large shipments are noticeable from Cardiff, cargoes of 3000 tons numerous, and one of 4000 tons for Iquique, and one of 6000 tons for Bombay. Coalowners and shippers at Swansea have been gratified with an improved coal trade, in which cargoes for San Francisco figure well, and I am glad to note that a steady run has set in for Monmouthshire coal. On Saturday the Exchange report was to the effect that the demand was exceptionally strong.

It will be seen from quotations that figures are improving. On 'Change, Cardiff, mid-week, best steam coal was quoted at 10s. 3d. to 10s. 6d., and seconds were in good repute, best realising 10s., while inferior fetched 9s. 6d.; drys also sold well at 9s. to 9s. 3d.; best Monmouthshire, 8s. 9d.; seconds, 8s. to 8s. 3d.; best small, 5s. to 5s. 3d.; seconds, 4s. 3d. to 4s. 6d.; and drys, 3s. 6d. to 3s. 9d. House coal is in a very weak condition, and the opinion on 'Change is that if frosty weather should set in prices, instead of being simply firm, will go up. Latest Cardiff quotations are:—Best households, 10s. 9d. to 11s.; No. 3 Rhondda, 10s.; brush, 8s.; small, 6s. 6d. to 6s. 9d.; No. 2 Rhondda, 7s. 9d. to 8s.; through, 6s. 3d. to 6s. 6d.; small, 4s. 3d. to 4s. 6d. Swansea prices are:—Best steam, 9s. to 10s.; seconds, 8s. to 9s.; No. 3 Rhondda, 10s. to 10s. 6d.; anthracite, 8s. 9d. to 12s., according to quality; rubbly coke from 3s. 6d. to 3s. 9d., f.o.b., cash thirty days, less 2½.

Patent fuel is in better demand at Swansea. Last week the shipments totalled nearly 10,000 tons, prices 10s. 3d. to 10s. 6d., destination chiefly to France, Spain, Italy, Roumania, and Algeria. Cardiff prices 10s. to 10s. 6d., and a fair trade. Pitwood continues in steady request. Cardiff prices remain at 15s. 9d. to 16s. In coke, brisk sale is going on, both in furnace and foundry qualities. Latest Cardiff prices:—Furnace, 12s. to 14s.; foundry, 15s. 6d. to 16s. 6d.; special, 19s. 6d.

In the iron and steel trades as remarked on 'Change, Cardiff, this week, an easier condition is visible, and the chief features are a moderate demand for steel rails, but a falling one for the chief staple, tin-bar, due to discouraging signs in the tin-plate trade. In some cases I have noted large quantities of pig going into stock, and as showing successful rivalry, special cargoes as regards quantity coming into Newport, Mon., from Millom, Barrow, and Middlesbrough. These facts are grave comments on the agitation sought to be started against the iron and steel sliding scale. It is well known that it is only by rigid economy in wages, raw material, &c., that the Welsh ironmasters can compete with their rivals, and sometimes even this cannot be done. It is fortunate that quality is made to rank as of special importance, and this commands somewhat of a demand.

I heard lately that tin-platers are now so well versed in the character of tin bar, that they readily detect the source of the various brands, and are very rigid in keeping to those they have become accustomed to.

On 'Change, Swansea, mid-week, it was reported that prices, Glasgow pig, continued to fall, and that the reduction in price from last week amounted to 6d. Works are busy on rail contracts and other make, which will take some time to complete, by which time it is hoped others may be placed. Glasgow pig warrants were quoted at 44s. 11d.; Middlesbrough, No. 3, 36s. 1d.; hematite, 44s.; Welsh bars, £5 5s. to £5 7s. 6d.; steel sheets, £6 5s. to £6 10s.; steel rails, heavy sections, £4 10s. to £4 15s.; light, £4 15s. to £5 10s.; Bessemer steel bars, £3 17s. to £4; block tin, £58 10s. to £58 12s. 6d.; market for last-named is weaker.

In tin-plate prices remain unchanged. Shipments have been very quiet, and much below the usual quantity. Makers complain that they have gone through a very bad year, and that prospects are not opening out well. The December shipments from Swansea to the United States were nearly 5000 tons less than in December, 1894. A crisis may be expected by the action of the workmen's union in bringing operations to a standstill at the end of the month. This was expressed by a manifesto, issued by the secretary of the Tin Platers' Union of South Wales, directing them to hand in a month's notice. This has caused, said an authority this week on 'Change, "little or no excitement, for the trade has become unprecedentedly dull." The Old Lodge Works, Llanelly, are idle, but may start next week. At Port Talbot notices have not been given in. The Cwm Vale Works continue idle, but a new mill has been started at Margam. At Taibach Frwydwyllt men are working under weekly contracts. Glanwalie Works and Taibach are re-starting. In the Neath and Briton Ferry districts opinions differ. In the Neath district no notices have been issued. At the Melyn, where 200 men are employed, warehousemen and millmen could not agree, and matters remain in abeyance. At Briton Ferry the Gwalia men have received fourteen days' notice, and at the Villiers day-to-day work is the rule.

In the Monmouthshire district the tin workers of Blaina and Abertillery have been asked by their employers to grant a concession of 20 per cent, and the rejoinder of the Abertillery men was to offer 5 per cent., though it is really a matter of doubt with the proprietors whether a concession of 20 would suffice. Matters evidently, all over the tin-plate area, are in a peculiar state, but we must wait a week or two to see the drift of things. It is evident that, if no improvement sets in, a large number of mills will be permanently laid off. Last week the shipments of tin-plates only amounted to 37,397 boxes, and the quantity received from works was small—48,423 boxes. Present stocks at Swansea amount to 146,543 boxes. Swansea last week imported 483 tons of tin bars.

There is a good deal of ferment in some colliery districts. The Plymouth colliers, who are working under notice, have been holding meetings frequently this week, and so far the men appear bent upon resistance. I hope that wiser advice will prevail. The contention of the manager is, first, that the present rate of wages is in excess of that paid by the neighbouring coalowners; and, secondly, that unless a reduction be conceded, the collieries will not pay to work. Last year a considerable loss was sustained.

The Tyr Edmund Colliery has been stopped, and 150 men thrown out of employment. At a meeting of the Rhondda district of the Monmouthshire and South Wales Miners' Association, on Thursday, regret was expressed that the Bwllfa Proprietary would not concede arbitration.

A movement is on foot at Merthyr to erect a statue in honour of Sir W. T. Lewis, and in testimony to his eminent services to Wales.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

BUSINESS on the iron market has naturally been very quiet during the past week, but a hopeful, confident tone exists in all branches of the trade, and there has been sufficient work secured before the holidays to keep the establishments well engaged for a considerable time ahead.

From Silesia fair accounts are being received with regard to the position of the iron and steel industries, the majority of the works being in regular operation, while the prices quoted show firmness and here and there an upward inclination. Exports have been extremely poor of late, but there will be most likely a revival in February or March.

On the Austro-Hungarian iron market the business in pig iron is but small, but for malleable iron a comparatively good inquiry is reported to be coming in; especially the demand for all sorts of structural iron continues satisfactory, and fair prices are being realised. At the steel works a good activity is expected for the immediate future, as several large orders for railway and engineering requirements will shortly be given out.

No alteration has taken place on the French iron market, demand for most articles remaining quiet. Production is, in almost all departments, considerably higher than consumption, and stocks, consequently, show an increase. In Paris a slow business is done, both in raw and in finished iron, and dealers have in a number of cases been compelled to accept very low prices. Bars, for instance, only fetch 130f. p.t.. In the Department Nord a fair activity is maintained; one works has been fortunate in obtaining a pretty large order for Roumania.

The most limited business only has, naturally, been done on the Belgian iron market during this week and the last. Imports in pig iron have been very large during the last months, showing a considerable increase against previous years; in October, 1895, for instance, 20,000 tons were imported, against 4500 tons for the same month in 1894, and 7200 tons for October, 1893. During the first ten months in 1893 imports in pig iron were 100,000 tons, in 1894 they amounted to 175,000 tons, while in 1895 they rose on 185,000 tons.

In Rheinland-Westphalia the physiognomy of the iron trade continues favourable. At the blast-furnace works there have been plenty of orders booked to secure a good activity for the first quarter, and further contracts are expected to be placed in a week or two, which will reach far into the second quarter. There is only a moderate demand coming in for malleable iron just now, bars being particularly dull; girders, too, are a trifle more languid than before, and the Girder Convention has consequently resolved to desist from a rise in quotations for the present, M. 86 p.t. being considered as list quotations, free at works. Plates and sheets continue well inquired for on the whole. The steel works are likely to be in healthy occupation for some time ahead, the Essen Railway Administration having given out orders for railway material, which amount to several hundred tons.

The number of men employed in the iron industry of Germany and Luxemburg is statistically stated to have been:—

	Iron ore mines.	Blast furnaces.	Foundries, steel works.	Totals.
1873	39,491	28,129	116,254	183,874
1874	31,733	24,342	118,748	174,823
1875	28,138	22,760	114,003	164,901
1876	26,206	18,556	99,668	144,430
1877	25,570	18,188	95,400	139,158
1878	27,745	16,202	92,026	135,973
1879	30,192	17,386	96,956	144,534
1880	35,814	21,117	106,968	163,899
1881	36,891	21,387	114,433	172,711
1882	38,783	23,015	125,769	187,567
1883	30,658	23,515	129,452	192,625
1884	38,914	23,114	132,194	194,222
1885	36,072	22,768	130,755	189,595
1886	32,137	21,470	130,858	184,465
1887	32,969	21,432	130,176	192,577
1888	36,009	23,046	147,361	206,416
1889	37,762	23,985	161,344	223,091
1890	38,837	24,846	170,753	234,436
1891	35,390	24,773	170,268	230,431
1892	36,032	24,325	168,374	228,731
1893	34,845	24,201	169,838	228,884
1894	34,912	24,110	174,354	233,376

French foreign trade in iron and steel was, for 1894, as follows:—Iron ore, import, 1,638,439 t., against 1,630,441 t. in the year before; export, 247,027 t., against 301,731 t. in 1893. Pig iron, import, 54,599 t., against 82,351 t.; export, 117,803 t., against 104,485 t. Manganese iron, import, 4466 t., against 3598 t.; export, 40 t., against 64 t. Blooms, import, 249 t., against 765 t.; export, 325 t., against 225 t. Merchant bars, import, 12,019 t., against 10,525 t.; export, 12,606 t., against 12,021 t. Iron rails, import, 20 t., against 13 t.; export, 3214 t., against 1569 t. Angles, import, 899 t., against 460 t.; export, 1141 t., against 1085 t. Axles and tires in iron, import, 6 t., against 945 t.; export, 421 t., against 262 t. Hoops, import, 170 t., against 325 t.; export, 1295 t., against 2166 t. Plates in iron, import, 2966 t., against 2166 t.; export, 2302 t., against 2444 t. Tin sheets, import, 3698 t., against 3097 t.; export, 338 t., against 452 t. Wire in iron and steel, import, 683 t., against 1203 t.; export, 1277 t., against 1118 t. Billets and ingots, import, 2360 t., against 853 t.; export, 1542 t., against 111 t. Steel rails, import, 332 t., against 219 t.; export, 13,322 t., against 9017 t. Axles and tires in steel, import, 1350 t., against 2614 t.; export, 65 t., against 22 t. Steel plates and sheets, import, 1123 t., against 943 t.; export, 348 t., against 186 t. Steel wire, import, 298 t., against 265 t.; export, 13 t., against 20 t. Cast iron, raw, import, 5171 t., against 3631 t.; export, 10,072 t., against 8946 t. Cast iron, finished, import, 60 t., against 42 t.; export, 430 t., against 420 t. Cast iron, enamelled, import, 418 t., against 476 t., export, 401 t., against 347 t. Tools, import, 1599 t., against 1580 t.; export, 3552 t., against 3286 t. Wire net, import, 61t., against 40 t.; export, 210 t., against 181 t. Needles, import, 85 t., against 89 t.; export, 7 t., against 5 t. Fishing hooks, import, 12 t., against 17 t.; export, 30 t., against 22 t. Steel pens, import, 31 t., against 35 t.; export, 44 t., against 41 t. Cutlery, import, 28 t., against 25 t.; export, 555 t., against 518 t. Locks, &c., import, 151 t., against 153 t.; export, 2004 t., against 2014 t. Anchors, cables, chains, import, 628 t. against 600 t.; export, 1220 t., against 2331 t. Nails, import, 47 t., against 54 t.; export, 1570 t., against 1781 t. Horseshoe nails, import, 1697 t., against 2104 t.; export, 47 t., against 34 t. Wire nails, import, 21 t., against 20 t.; export, 1446 t., against 1436 t. Screws, bolts and nuts, &c., import, 270 t., against 207 t.; export, 2643 t., against 2884 t. Tubes, import, 1423 t., against 1774 t.; export, 666 t., against 791 t. Sundry small articles in iron or steel, import, 2066 t., against 1698 t.; export, 3627 t., against 3348 t. Enamelled hardware, import, 2540 t., against 2326 t.; export, 3081 t., against 3304 t. in the previous year.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

THE attendance on 'Change to-day was not so large as is usually the case, owing to the general quarterly meeting taking place in Birmingham to-morrow. There was a vigorous tone in the steam and house coal markets. A good demand for pitwood prevailed at last week's prices. The coal shipments have not quite reached the large quantity of 70,000 tons sent away last week. The principal shippers, however, have heavy stems on, and doubtless large quantities of coal will be despatched from the port during the coming weeks. The following large steamers are included in the number of vessels expected shortly: Emin, Taragona, Marim, Donator, Les Beaulex, and Joseph Arbib.

An increase has taken place in the importation of iron ore. With other goods a large quantity of grain has been received. As predicted in our last week's report, a perceptible improvement has taken place in the ship repairing trade, nearly all the firms being well employed.

Prices ruling on 'Change to-day were as follows:—Coal, best steam, 8s. 6d. to 8s. 9d.; seconds, 8s. to 8s. 3d.; best house coal, 10s. 6d.; dock screenings, 5s.; colliery, small, 4s. 6d.; smiths' coal, 6s. 6d. Patent fuel, 10s. 6d. Pig iron: Scotch warrants, 44s. 11d.; hematite warrants, 45s. 11d., f.o.b. Cumberland; Middlesbrough, No. 3, 36s. 2d. prompt; Middlesbrough hematite, 44s. 1d. Iron ore: Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel rails: Heavy sections, £4 10s. to £4 15s.; light sections, £4 15s. to £5 5s. f.o.b. Tin-plate bars, £3 17s. 6d. to £4. Siemens tin-plate bars, best £4 5s. to £4 7s. 6d., all delivered in the district, cash, less 2½ per cent. Tin-plates: Bessemer steel coke, 9s. 3d.; Siemens coke finish, 9s. 6d. Ternes, per double box, 28 by 20 c., 21s. to 22s. Pitwood, 16s. to 16s. 3d. London Exchange telegram: Copper, £41 2s. 6d.; Straits tin, £58 17s. 6d. Freights firm.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, January 3rd.

THE latest transactions in steel billets in 1000 ton lots are 19 dols.; wire rods, in small lots, 27 dols.; steel rails are dull, at 28 dols.; beams, 1·70; angles, 1·55; plates, 1·60; refined bars, 1·35; best, No. 1 F, 14 dols. These quotations can be shaded in favour of large buyers. Very few care to act just now. The future of prices is uncertain, although there is very little room for decline. Telegraphic advices to-day from Pittsburgh show more inquiry for billets and slabs. Similar advices from Cleveland say Lake ore prices for 1896 are virtually fixed. There is considerable anxiety among manufacturers owing to the long delay among buyers. Usually large orders are placed in December, but the past month was dull. There is danger of a too sudden expansion of demand, as there was last summer. A great many mills have been improved, new machinery and more heating and rolling capacity has been added. Numerous similar changes have been determined upon this year. The chances are that the year 1896 will be satisfactory to the well-situated mill especially. This year's Lake ore production will reach 13,000,000 tons. There is a rumour that another fleet of steel boats will be contracted for. One of the favourable evidences is the improving demand for steam and hydraulic machinery. Locomotive work has increased. Tools and shop equipments are also wanted. The agricultural interests continue to be cautious buyers. The Government will soon start around the world on a begging tour for £20,000,000. The masses of the people are enraged at the men and measures that force this action. Tariff legislation will be passed in the house, be fought in the Senate, and vetoed by the President, who, by the way, is duck shooting just now.

LAUNCHES AND TRIAL TRIPS.

The s.s. Eastlands recently built by Messrs. Rafiner and Son, of Stockton-on-Tees, for Messrs. J. F. Wilson and Co., West Hartlepool, left the Tees on Monday last for her trial trip, having aboard Mr. J. F. Wilson, the managing owner, Mr. Maddison—under whose supervision the steamer has been built—and a large party of friends; after a very satisfactory run the steamer was taken into West Hartlepool to receive her bunker coal to take her round to Maryport, where she will load for the River Plate.

On Monday, December 30th, 1895, the fine steel screw steamer Sui Sang, built by Sir Raylton Dixon and Co., Cleveland Dockyard, Middlesbrough, for Messrs. the Indo-China Steam Navigation Co., went for her official trial trip in Tees Bay, under the command of Captain Galsworthy. The s.s. Sui Sang is 323ft. long by 41ft. beam by 27ft. 6in. depth moulded, and has been built to the requirements of Lloyd's 100 A1 class, spar deck rules, her deadweight capacity being about 4500 tons. The vessel has been specially designed to meet the requirements of the Indo-China Steam Navigation Company's trade in the eastern seas. Spar deck is of steel sheathed with teak, main deck of steel, and the poop, bridge, and forecastle decks are of teak. Large cargo ports are fitted in 'tween decks opposite each hatch. A handsome saloon with accommodation for ten passengers is elegantly fitted up under bridge deck. The captain is berthed in a large teak house on bridge, and the officers, engineers, &c., on bridge deck. Rooms for compasses are fitted up in poop aft. Engines of the triple-expansion type have been fitted by Messrs. the North-Eastern Marine Engineering Co., having cylinders 23in., 36in., 59in. by 42in. stroke, supplied with steam from two large steel boilers fitted with Howden's forced draught. The vessel has been built under the supervision of Mr. Buchanan and Mr. Duncan. A number of friends, including Mr. Cheyne, secretary to the Indo-China Steam Navigation Company, were on board during the trial trip, which passed off most satisfactorily.

On January 3rd the steamers Penarth and Bertholey had their trial trips in the Bay off Hartlepool. The vessels have been built by Messrs. Wm. Gray and Co., for Messrs. Morel Bros. and Co., of Cardiff, and they are the fifth and sixth ships built and engined at Messrs. Gray's works for the same firm. They are both built to Lloyd's highest class. The dimensions of the Penarth are:—Length over all, 336ft.; breadth, 41ft.; depth, 24ft. 10in.; and of the Bertholey, length, 310ft.; breadth, 43ft.; depth, 22ft. 1½in. The hulls are built with web frames, and there is a double bottom under each hold for water ballast. Tasteful saloons and state rooms, together with captains' and officers' rooms, have been fitted. Triple-expansion engines have been supplied by the Central Marine Engine Works of Wm. Gray and Co.; in the one case of 1200-horse power, and in the other of 1000-horse power. Three large main boilers, built of steel, and working at 160 lb. pressure per square inch, have been supplied, and this ample supply of steam enables the donkey boilers to be dispensed with, as one of the main boilers can be kept under steam for working the winches, windlass, &c. The vessels and their machinery have been built under the superintendence of Mr. W. G. Morel and Mr. F. Good. The vessels left the dock at the same time, the party of inspecting engineers going out by tug, and after completing the trial of one boarding the other. The engines were in each case run full speed ahead for an hour to test their capabilities, and the trials were in every way perfectly satisfactory, reversing from ahead to astern being done in four seconds, as is usual with these engines. The trials were witnessed by Mr. Good, on behalf of the owners; Captain Murrell represented Messrs. Wm. Gray and Co.; Mr. T. Mudd, the engine builders. There were also present Mr. Kish, of Messrs. J. and E. Kish, Sunderland, together with Mr. Metcalfe, their inspecting engineer; Mr. Percy Mudd, and others. The vessels were in command of Captains Morgan and West, and immediately on the conclusions of the trials the steamers left together for South Wales to load their first cargoes—the Penarth for South America, and the Bertholey for the Mediterranean.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When patents have been "communicated" the name and address of the communicating party are printed in italics.

23rd December, 1895.

24,559. Engine Cutters and Tracers, G. Iden, Brighton.

24,560. Exhibiting Pictures by Lanterns, W. J. Spurrier, Birmingham.

24,561. Preparing Warp Yarns, T. Pickles and G. Landless, Manchester.

24,562. Adjustable Music Stools, J. W. Deans and W. D. Foster, Selby.

24,563. Multitubular Boiler Efficiency, J. Scott, Jarrow-on-Tyne.

24,564. Covers for Boilers, W. H. Parry and J. H. Powick, Birmingham.

24,565. Fasteners for Windows, C. H. Jones, Glasgow.

24,566. Noiseless Tires for Wheels, C. Challiner, Manchester.

24,567. Pneumatic Gas Regulator, H. G. Mason, Birmingham.

24,568. New Boiler or Water-heater, S. Naylor, Leeds.

24,569. Expanding Crank for Velocipedes, H. J. Warsop, Nottingham.

24,570. Gas Cooking Apparatus, E. W. T. Richmond, Liverpool.

24,571. Gear Cases for Cycles, E. Powell, Northampton.

24,572. Stoppering Bottles, T. Cooper and R. Potter, Portobello.

24,573. Clover-making Machines, F. S. Cocks, Peterborough.

24,574. Signalling Railway Trains, R. Wilby, Huddersfield.

24,575. Horseshoes, W. W. Barnes, Harrington.

24,576. Brace Fittings, C. N. Eyland, Birmingham.

24,577. Supports for Electric Conductors, T. Laurie, Falkirk.

24,578. Electric Tramways, D. Urquhart and F. Wynne, Westminster.

24,579. Gulleys, J. D. Cook, Sheffield.

24,580. Lock Mechanism for Fire-arms, C. H. Maleham, Sheffield.

24,581. Cardboard Folding Boxes, J. E. Thornton, Altrincham.

24,582. Ash Guard and Cinder Sieve, T. E. Jones, Oldham.

24,583. Tobacco Pipes, W. Leggett, Norwich.

24,584. Potato Paring Machine, W. Paulson and T. Willoughby, Derbyshire.

24,585. Roofing Buildings, W. Schmitt and E. Kauert, Glasgow.

24,586. Textile Fabrics, L. Schniewind and A. Schmidt, Germany.

24,587. Mail Cart or Perambulator, H. V. Lloyd, London.

24,588. Bracket for Holding Brushes, S. H. Bath, London.

24,589. Floors for Ice Skating Rinks, E. Hesketh, London.

24,590. Protector for Book Corners, B. J. Saunders, London.

24,591. Mechanism of Chronometers, F. W. Engelbach, London.

24,592. Counter for Type-writing Machines, R. T. Haines, London.

24,593. Photographic Printing Plates, G. Poore, London.

24,594. Electric Lifts, J. S. Stevens and C. G. Major, London.

24,595. Method of Extinguishing Lamps, W. Vint, Surrey.

24,596. Manufacture of Tiles, &c., R. Thorburn, London.

24,597. Ladies' Dress Skirts, J. W. Roberts, London.

24,598. Feed-water Heaters, W. Goodbrand, Manchester.

24,599. Rubber Tires for Wheels, C. S. Stone, London.

24,600. Circulation of Air, J. A. Dargue and E. Griffiths, Liverpool.

24,601. Window Sashes, J. Butterworth and H. Clementson, London.

24,602. Doors, J. Butterworth and H. Clementson, London.

24,603. Puzzle Game, H. Golding, London.

24,604. Sheep Dipper and Washer, E. Besent, London.

24,605. Letter Boxes, F. E. Wiggens, London.

24,606. Cigar Cutter and Holder, G. C. Bingham, Waterford.

24,607. Projectiles, H. Stanbridge, London.

24,608. Firebacks for Stoves, S. B. Goslin, London.

24,609. Lift Valves, C. D. Abel.—(*G. Sulzer, Switzerland.*)

24,610. Working Armour-plated Turrets, J. A. Deport, London.

24,611. Heating Apparatus, F. Rotter, London.

24,612. Counting the Number of Bell Beats, E. French, London.

24,613. Cover for Jars, Pots, Bottles, &c., A. Stute, London.

24,614. Intaglio Plates, J. W. Swan and J. J. Waddington, London.

24,615. Production of Essences, M. Woolf, London.

24,616. Beer Engines, H. Scott, London.

24,617. Toy Figures such as Toy Soldiers, H. M. Paget, London.

24,618. Telephony, C. Adams-Randall, London.

24,619. Preparation of Lupines, Max, Baron von Maltzan and G. Bocker, London.

24,620. Spring Clips, F. W. Golby.—(*L. Kanderer, Germany.*)

24,621. Tires for Carriage Wheels, J. U. Burt, London.

24,622. Safety Valve, C. Mackintosh, London.

24,623. Tap, G. Barnes, T. B. G. Zwicker, and A. Tod, London.

24,624. Bilge Syphon, N. Power and P. Braender, London.

24,625. Valves, E. J. Preston and A. T. Cornish, London.

24,626. Cool Safes and Cool Storage, J. G. Lamb, London.

24,627. A Cleansable Sink, J. Christie, London.

24,628. Draught and Weather Excluder, F. G. Groenert, London.

24,629. Punching Eyelet-holes, W. Downs and H. J. Scott, London.

24,630. Dynamo-electric Machines, W. H. Tregaskis London.

24,631. Furnaces for Bakers' Ovens, J. Matula, London.

24,632. Engine Governors, A. S. F. Robinson, London.

24,633. Pipe Coupling, A. Spencer, London.

24,634. Tires, G. E. Lyons and A. Melson, London.

24,635. Tobacco Pipes, A. J. Boult.—(*Société Vuillard and Strauss, France.*)

24,636. Preventing Explosions in Boilers, J. E. Greaves, London.

24,637. Granular Surfaced Paper, E. A. Zuber, London.

24,638. Doors of Dwelling House, A. Mosley, London.

24,639. Device for Tapering Ends of Candles, W Vogel, London.

24,640. Driving Gear for Cycles, W. F. Fremersdorf, London.

24,641. Photographic Lenses, T. R. Dallmeyer, London.

24,642. Stud for Gloves, F. Micheland, London.

24,643. Removing Stains, J. Y. Johnson.—(*The Firm of S. Wallach and Co., and E. Schweitzer, Germany.*)

24,644. Boot Jacks, R. Jacks, London.

24,645. Car Couplings, P. R. J. Willis.—(*W. E. Whiteside, United States.*)

24,646. Rubber Cushioned Lined Wheels, H. Carmont, London.

24,647. Sailing Yachts, A. Sharp, London.

24th December, 1895.

24,648. Lace Fastener for Boots, A. J. Moore, Malta.

24,649. Joints in Cycles, W. F. Taylor and P. H. Clarke, Croydon.

24,650. Door Mats, F. Baggaley and W. J. Robinson, Manchester.

24,651. Cutting Rashers of Bacon, F. J. Burrell and E. Maxwell, Bedford.

24,652. Packing Cases for Goods, J. G. Chadwick, Chadderton.

24,653. Candle Bracket for Mirrors, R. J. Smith, Bromsgrove.

24,654. India-rubber Eraser, R. J. Smith, Bromsgrove.

24,655. Attaching Together Gloves, S. H. Crocker, London.

24,656. Compasses, L. Myers, Birmingham.

24,657. Air-tight Cans, L. Myers, Birmingham.

24,658. Wheels for Perambulators, G. Moore, jun., Birmingham.

24,659. Measuring Fluid, &c., D. L. Hutchinson, Glasgow.

24,660. Window Blind, T. H. Gray and W. J. Loon, Birmingham.

24,661. Double Stench Traps, I. Russell, Birmingham.

24,662. Embossing American Cloth, A. Gray, London.

24,663. Fire Lighters, F. G. Eaton, Manchester.

24,664. Regenerative Furnaces, L. Moyes, Glasgow.

24,665. Affixing Adhesive Stamps, A. Lewis, Liverpool.

24,666. Manufacturing Acetylene Gas, T. Holliday and J. H. Exley, Bradford.

24,667. Ladders and Portable Scaffolds, J. H. Heathman, London.

24,668. Tiles, S. H. Leech, London.

24,669. Protecting Bank Cashiers, &c., N. B. Rees, London.

24,670. Portable Fire-escape, F. M. Quinn, London.

24,671. Folding Wheel-barrows and Carts, R. R. Thom, Kilmarnock.

24,672. Reducing Valves, G. and J. Horrocks, Manchester.

24,673. Cellular Lifebuoy, H. Wall, Stockton-on-Tees.

24,674. Fireproof Flooring and Roofing, F. B. Bond, Bristol.

24,675. Cycle Brake Attachments, C. R. Hall, jun., Birmingham.

24,676. Tobacco Pipes, G. Craigen, London.

24,677. Protecting India-rubber Tires, T. Criswick, Bridgend.

24,678. Type-writers, J. C. Fell.—(*Messrs. Wyckoff, Seamans, and Benedict, United States.*)

24,679. Attachment to Wheels and Pulleys, S. H. Farrar, London.

24,680. Electric Lighting of Cycles, P. H. Emanuel and H. G. Baker, Portsea.

24,681. Universal Music Indicator, J. W. King, Liverpool.

24,682. Manufacture of Parallel Vices, W. Dangerfield, Darlaston.

24,683. Pneumatic Tires for Vehicles, E. Tilston, Manchester.

24,684. Rails for Railways, T. Andrews, Manchester.

24,685. Nursing Nipples, R. L. Shute, Glasgow.

24,686. Shirt Collar Bands, P. R. J. Willis.—(*M. Kyle, Canada.*)

24,687. Stove Pipes, G. B. Barclay, London.

24,688. Nosebags for Horses, G. Wickes, London.

24,689. Clothes Brush, C. Rose-Innes, London.

24,690. Pulleys, L. S. Carr, London.

24,691. Chain Pipe-wrenches, G. Sonnenthal and H. Bamford, London.

24,692. Clothes Washing Machine, J. S. Kingston, London.

24,693. Shafts of Golf Clubs, T. W. Goddard, Waltham Cross.

24,694. Counters for Boots and Shoes, T. H. Donovan, London.

24,695. Box and Dies, H. J. Loney and A. J. Jung, London.

24,696. Decorticating Rhea Grass, J. MacDonald, London.

24,697. Feeding Water to Steam Generators, W. Birrell, Glasgow.

24,698. Lamp Shades for Billiard Tables, H. Nelmes, Glasgow.

24,699. Clamp for Pipes and Rods, R. J. Lockhart, London.

24,700. Securing Soap in Washrooms, J. H. and J. E. Welch, London.

24,701. Embroidery Plate, P. Fournier, London.

24,702. Railway Switch, &c., The Westinghouse Brake Company.—(*J. P. Coleman, United States.*)

24,703. Galvanising, R. Heathfield and W. S. Rawson, London.

24,704. Pamphlet Covering Machine, B. S. Lewis and A. H. Smith, London.

24,705. Hand Stamps, J. H. Gressitt and H. W. Fox, London.

24,706. Electric Telegraphy, G. C. Marks.—(*W. H. Cooley, United States.*)

24,707. Buttons, N. D. Ingram, London.

24,708. Separating Oil from Water, H. H. Lake.—(*Maschinen-fabrik Grevenbroich, Germany.*)

24,709. Sterilising Apparatus, J. L. A. Aymard, London.

24,710. Lightning Arresters, J. Devonshire.—(*W. B. Potter, United States.*)

24,711. Electric Brakes, J. Devonshire.—(*W. B. Potter, United States.*)

24,712. Dress Fasteners, E. J. A. Babbage, H. Friendship, and T. W. Hicks, London.

24,713. Ring Spinning Frames, J. H. Bourry, London.

24,714. Treatment of Fatty, &c., Substances, A. E. Morgans, London.

24,715. Sand-blast Apparatus, J. E. Mathewson, London.

24,716. Switch for Tramways, L. Pritzius and F. Straube, London.

24,717. Fire-lighters, H. Minuth, London.

24,718. Self-acting Hair Brushes, B. P. Olsson, London.

24,719. Wheels for Bicycles and Vehicles, G. Hayes, London.

24,720. Letter Files, W. P. Thompson.—(*W. A. Cooke jun., United States.*)

24,721. Folding Boxes, W. P. Thompson.—(*W. A. Cooke, jun., United States.*)

24,722. Pavements and Steps, G. T. Fuery.—(*G. Martenstein, Germany.*)

24,723. Tramcars, C. Bremer, London.

24,724. Water-tube Boilers, W. C. and A. W. N. Burder and J. M. Newton, Manchester.

24,725. Pyrotechnic Compounds, W. Weiffenbach, Liverpool.

24,726. Rests for Use in Billiards, W. H. Edwards, Liverpool.

24,727. Climatium Japonicum, C. W. Hartung, London.

24,728. New Washing Machine, H. Kramer, sen., Liverpool.

24,729. Anti-nicotine Pipe Cleaner, T. F. Bevan, Liverpool.

24,730. Rag Engines, C. Seybold and W. Schmidt, Liverpool.

24,731. Railway Time Tables, C. A. Bird, London.

24,732. Ball Bearings, A. Hansen, London.

24,733. Cycle Propelling Mechanism, A. Patchett, London.

24,734. Drinking Vessels, W. I. Thompson, London.

24,735. Electric Arc Lamps, &c., W. H. Smith, London.

24,736. Box for Holding Toilet Paper, P. Herzberg, London.

24,737. Photographic Apparatus, B. J. B. Mills.—(*A. Tournier, France.*)

24,738. Clothes Peg, T. H. Prosser and M. Young London.

24,739. Non-fillable Bottles, E. Anderson, London.

24,740. Bottles, G. E. M. Carleton, London.

24,741. Puzzles, C. E. Morrison, London.

24,742. Side Bed-pan, S. C. Wolfskill, London.

24,743. Pipes, J. M. Grau, London.

24,744. Puzzles, C. B. de Camp, London.

24,745. Envelopes, J. J. Lussier, London.

24,746. Non-fillable Bottles, J. L. Wolf, London.

24,747. Pins, L. R. Bisbee, London.

24,748. Non-fillable Bottles, D. Hepp, London.

24,749. Driving Mechanism for Gill Boxes, J. V. Sprangh, London.

24,750. Fire Indicating Apparatus, W. H. Trimble, London.

24,751. Steam Engines, J. S. Raworth, London.

24,752. Paper Cutting Machines, T. B. Kendell, London.

24,753. Steam Engines, C. Sheppard, London.

24,754. Panels for Decorating Houses, W. McLaren, London.

24,755. Horticultural Buildings, H. T. Grainger, London.

24,756. Revolution Counters, A. J. B. E. Darras, London.

24,757. Tobacco Pipe, E. Ropp, London.

24,758. Supporting Bicycles, M. P. M. Collier and W. McArthur, London.

24,759. Horseshoes, A. Falstead and D. A. Davidson, London.

24,760. Bee-hives, K. von Nemesszeghy, London.

24,761. Diving Bells, R. Haddan.—(*J. E. Whiting, India.*)

24,762. Inclinometer and Level, F. Wetzelsberger, London.

24,763. Horseshoe Pads, W. E. Jennings, London.

24,764. Vehicle Wheels, C. Lofmark, London.

27th December, 1895.

24,765. Trammel Compass, R. L. Donkin, Pocklington, Yorks.

24,766. Perfection Skirt and Belt Holder, L. Taylor, London.

24,767. Candlestick, H. N. Shore, Clevedon, Somerset.

24,768. Umbrella and Camp Stool, P. and P. J Weston, Bristol.

24,769. Apparatus for Cleansing Streets, D. Mackie, London.

24,770. Underground Chambers, C. M. Sansom and F. I. Spinks, London.

24,771. Tea Packing Cases, G. F. Dewdney, Cardiff.

24,772. Printing on Underclothing, R. Greenhalgh, London.

24,773. Flat and Tubular Articles, J. T. Pearson, Burnley.

24,774. Condenser Carding Engines, J. D. Tomlinson, Manchester.

24,775. Steam Generators, W. Munro, Newcastle-on-Tyne.

24,776. Cutting Tapered Slots, W. Lister and J. Cardwell, Newcastle-on-Tyne.

24,777. Roofing Tiles, F. A. Krause, Manchester.

24,778. Fishing Reel, J. W. Young, Redditch.

24,779. Colouring Matters, I. Levinstein and Levinstein, Ld., Manchester.

24,780. Pulley Racks for Roller Blinds, G. Hayes, Southampton.

24,781. Weaving Looms, R. L. Hattersley and S. Jackson, Bradford.

24,782. Head Lock for Bicycles, C. W. Burrows, Birmingham.

24,783. Treatment of Spent Oxide, J. H. Paul, London.

24,784. Heel and Toe Tips for Boots, D. A. Berry, Manchester.

24,785. Book Sewing Machines, H. Liebert, Manchester.

24,786. Capstan Lathes, H. Liebert, Manchester.

24,787. Recovering Oil from Waste, G. E. Wright and W. Monk, Manchester.

24,788. Brake Appliances for Carriages, J. J. Broadbridge, Manchester.

24,789. Printing Woven Fabrics, S. Schwabe and Co. and J. Gilbertson, Manchester.

24,790. Mental Telepathic Assistant, E. Mulliner, Southport.

24,791. Cinder Sifter, F. W. Lewis and J. W. Paulton, Wolverhampton.

24,792. Gas and Explosive Vapour Engines, J. E. Rogers, Birmingham.

24,793. Door Bolt, E. G. Hentsch, Sunderland.

24,794. Removable Coal Catcher, P. Jay, London.

24,795. Supplying Water to Spinning Frames, J. Cleland, Down.

24,796. Valve for Pneumatic Vehicle Tires, E. B. Raper, York.

24,797. Machines for Topping Turnips, J. Munro, Glasgow.

24,798. Handle-bar for Cycles, &c., A. W. McMurdo Glasgow.

24,799. Spirit-Vapour or Gas Engine, W. Hewitt, Ayrshire.

24,800. Electric Light Adapters, J. B. Meiklejohn, Glasgow.

24,801. Fire-arms, W. H. Dorman, Stafford.

24,802. Girths for Horses, A. Pottie and J. McCreery, Glasgow.

24,803. Obtaining Metals from Ores, L. Pelatan and F. Clerici, London.

24,804. Rail-aided Cycle, H. J. S. Winslow, London.

24,805. Mangling Machines, W. B. Mair and J. Lindsay, Glasgow.

24,806. Preventing Pocket Picking, B. Strobal and R. Singer, Glasgow.

24,807. Mariners' Compass, H. Florian and H. Schoklitsch, Glasgow.

24,808. Binding Hats, Bradbury and Co. and C. Shaw, Manchester.

24,809. Metallic Bedsteads, T. M. Hewitson, Acocks Green, Worcester.

24,810. Water Heating Apparatus, J. Jameson, Newcastle-on-Tyne.

24,811. Cycle Seats, P. A. L. Pryor and N. G. Thompson, London.

24,812. Metallic Breakwater or Wave Breaker, G. Defosse, Brussels.

24,813. Drop-down Guns and Rifles, J. W. Smallman, Nuneaton.

24,814. Drop-down Guns and Rifles, J. W. Smallman, Nuneaton.

24,815. Bolt-making Machinery, P., S., and J. McFarlane, Glasgow.

24,816. Metallic and Composite Boxes, P. S. Brown, Glasgow.

24,817. Mills, H. Mecke and The Eisenwerk (vorm. Nagel and Kaemp), A. G., London.

24,818. Machine for Measuring Flour, W. R. Clarke, London.

24,819. Baths, A. E. Browning, Birmingham

24,820. Securing Watches, F. W. Hince, Birmingham.

24,821. Finishing Felt Hats, H. H., A., and A. Turner, Manchester.

24,822. Construction of Waistcoats, M. S. Forster, London.

24,823. Coke Furnaces, H. Stinnes, Germany.

24,824. Screening Coals or Minerals, F. Berkley, London.

24,825. Book-binding Operations, W. Wilson, London.

24,826. Gas Burners, T. Holliday, London.

24,827. Cauterising Apparatus, W. P. Thompson.—(*The Actien Gesellschaft fur Feinmechanik vormals Jetter and Scheerer, Germany.*)

24,828. Water Gauge Glasses, W. P. Thompson.—(*J. Pissinger, Germany.*)

24,829. Ventilators for Mines, T. Marsden, Liverpool.

24,830. Utilising Tidal Power, W. J. Roberts and J. R Jones, Liverpool.

24,831. Roller Blinds, Shutters, O. Bayer, Liverpool.

24,832. Transit of Fat, W. and W. W. McNaught and Co., Liverpool.

24,833. Kettles, R. B. Arthur, London.

24,834. Electric Accumulators, C. Théryc and A. Oblasser, London.

24,835. Apparatus for Filtering Liquids, W. Raydt, London.

24,836. Electrically Operated Windlasses, G. Asmussen, London.

24,837. Washing Akali-amalgam, P. Jensen.—(*H. C. F. Störmer, Norway.*)

24,838. Mattresses, &c., B. J. B. Mills.—(*O. Paxcal, France.*)

24,839. Atmospheric Gas Burners, J. Moeller, London.

24,840. Apparatus for Making Oil Gas, J. Moeller, London.

24,841. Separable Boats, H. Lefevre, London.

24,842. Colouring Matters, C. D. Abel.—(*The firm of L. Durand, Huguenin and Co., Switzerland.*)

24,843. Portable Advertising Device, D. Foster, London.

24,844. Shells, G. Kynoch and Co., and E. Jones, London.

24,845. Construction of Ceilings, F. Schweitzer, London.

24,846. Cash Registers, A. J. Boult.—(*The Rochester Cash Registry Company, United States.*)

24,847. Explosives, W. Greaves and E. M. Hann, London.

24,848. Fluoride of Antimony, H. H. Lake.—(*O. O. B. Froelich, United States.*)

24,849. Harness Traces, W. and J. W. Pinder, Lancashire.

28th December, 1895.

24,850. Tires for Cycles and other Vehicles, J. S. Martin, Dundee.

24,851. Telephone and Phonograph, J. E. O. Kumberg, London.

24,852. Material for Electrical Purposes, W. P. Adams, London.

24,853. Saddles for Cycles, L. T. Lewis, London.

24,854. Milk Steriliser, W. Robinson, Wolverhampton.

24,855. Apparatus for Heating Water, A. Foster, London.

24,856. Knitting Machines, R. Challands, F. W. Pare, and J. H. Smith, Nottingham.

24,857. Textile Loop, A. and A. E. Walker, Huddersfield.

24,858. Kiln Hook for Pottery, J. Maddock, Staffordshire.

24,859. Pedals of Cycles, &c., H. Lewis, Birmingham.

24,860. Means for Filling Crates, W. L. Pilkington, Liverpool.

24,861. Cutting Coal, F. J. H. Lascelles, Newcastle-on Tyne.

24,862. Construction of Anchors, J. Donald, Barrow-in-Furness.

24,863. Back for Fire-places, A. Macpherson, Edinburgh.

24,864. Fire-lighters, S. Learoyd, Huddersfield.

24,865. Boots and Shoes, &c., S. Learoyd, Huddersfield.

24,866. Spindles, B. A. Dobson.—(*A. Kirschner, France.*)

24,867. Boilers, W. Cuthbertson, Glasgow.

24,868. Recording Instruments, W. Thomson and B. Kelvin, Glasgow.

24,869. Construction of Lining Tunnels, C. Barlow, Glasgow.

24,870. Joint for Pipes, W. J. Given, Glasgow.

24,871. Brakes, W. Fairweather.—(*O. Quadri, Italy.*)

24,872. Metallic and Composite Boxes, P. S. Brown, Glasgow.

24,873. Valve Instruments, W. Harris, Vermont, U.S.A.

24,874. Handle-bar, C. A. Allison.—(*J. C. Jackman, United States.*)

24,875. Designs upon Carpets, R. J. C. Mitchell, Manchester.

24,876. Erasers, P. Pinckney, Portsmouth.

24 877. Machine for Levelling Roads, J. Heuermann, London.

24,878. Drills and Undercutters, J. A. Derham, Preston.

24 879. Apparatus for Testing Drains, W. H. Temple, London.

24,880. Metal Surfaces, J. E. Mathewson, London.

24,881. Bicycle Rim, J. H. Kydd and J. B. Mitchell, Canada.

24,882. Folders of Printing Machines, B. J. J. Goulding, London.

24,883. Letter-files, Indexes, &c., C. F. Lomb, London.

24,884. Automatic Switch, J. W. and G. Ewart, London.

24,885. Controlling the Supply of Gas, J. R. C. Gale, London.

24,886. Photographic Camera, I. de Balás, Birmingham.

24,887. Asbestos Filters, C. D. Abel.—(*B. Blumenfeld, Austria.*)

24,888. Joints for Electrical Purposes, G. W. Goldring, London.

24,889. Cycle, J. Santiquet, London.

24,890. Ladles for Molten Metal, W. Hainsworth, London.

24,891. Gas Engines, E. Gathmann, London.

24,892. Electric Machines, P. R. Jackson and Co., and J. S. Lewis, London.

24,893. Pneumatic Tires, J. Oliver and L. Fletcher, Liverpool.

24,894. Wringing Machines, J. Barnes, R. W., W. H., and A. Kenyon, Manchester.

24,895. Electric Machines, P. R. Jackson and Co., and J. S. Lewis, London.

24,896. Supporting Scaffolds, J. Edwards and The Coalbrookdale Co., Liverpool.

24,897. Separating Water, J. A. Morris and W. T. Hatch, Manchester.

24,898. Manufacture of Cement, &c., M. Nahusen, London.

24,899. Water-tube Boilers, N. Foley, London.

24,900. Confectionery Coating Machines, J. R. van Derveer, London.

24,901. Boots Soles and Heels, R. Poore, London.

24,902. Dust Excluders, W. T. Hall and W. J. Bayliss, London.

24,903. Breech Mechanism of Ordnance, E. Donn, London.

24,904. Back-pressure Valves for Drains, W. Shoosmith, London.

24,905. Telephone Transmitters, T. J. Rorke, London.

24,906. Necktie Retainers, L. W. F. N. and B. I. Sauer, London.

24,907. Kilns for Burning Bricks, J. Phillipps, Ampthill.

24,908. Paper Fasteners and Label Holders, S. Learoyd, London.

24,909. Pneumatic Tires for Cycles, P. Reidel, Berlin.

24,910. Material for Flooring Rooms, P. Reidel, Berlin.

30th December, 1895.

24,911. Hand Carts, J. E. Neal, Derby.

24,912. Wheels for Warehouse Trucks, A. Dugdale, Manchester.

24,913. Weighing Machine, E. C. Lovell and H. Brecknell, Bristol.

24,914. Moistening Yarn, J. T. Pearson, Burnley.

24,915. Sashes and Doors, A. Rhodes and C. Gill, Keighley.

24,916. Steam Generators, J. J. Tinker, Manchester.

24,917. Mariners' Compass, W. D. Whyte, Glasgow.

24 918. Sights for Fowling Pieces, J. E. Martin, Glasgow.

24,919. Lighting Railway Carriages, J. Mulligan, Sheffield.

24,920. Producing Ammonia, &c., A. McDougall, Southport.

24,921. Apparatus for Inserting Papers into the Folds of Textile Piece Goods, F. Riley and E. O'Connor, Manchester.

24,922. Braking Gear of Cycles, A. E. Hopkins, Chesterfield.

24,923. Manual Pumps, W. Ambler, Bradford.

24,924. Cartridges and Firing of Guns, F. Wynne, London.

24,925. Cycles, W. Woodhead, C. Ford, jun., and J. Wood, jun., Rochdale.

24,926. Hydraulic Machinery, F. Bamford and W. Wadsworth, Manchester.

24,927. Engravers' Chucks, G. Christie, Glasgow.

24,928. Modifying the Transparency of Ivory, C. Raspe, Berlin.

24,929. Cycle Wheels, J. Chaffaud and J. H. Konter, Marseilles.

24,930. Lamp Brackets for Bicycles, F. T. Harrop, Birmingham.

24,931. Parlour Game, E. H. Prew and H. F. Boughton, Barnsley.

24,932. Tobacco Pipe Mouthpieces, &c., J. Y. Fulton, Newport, Mon.

24,933. Roofing Tiles, H. A., G., H. St. R., E., K., and M. S. R. Rumbelow, and G. Hall, Worlington, Suffolk.

24,934. Tobacco Pipes, J. Bush and H. J. W. Raphael, London.

24,935. Scholars' "Acme" Companion, G. H. Pilling, Bacup.

24,936. Gloves for Driving and the like, R. M. Hogg, Glasgow.

24,937. Potato Digger and Sorter, A. J. Macarthur, Glasgow.

24,938. Making Golf Balls, R. J. Hatton, North Woolwich.

24,939. Clip for Holding Wooden Brakes, C. F. Hollis, Shanklin, Isle of Wight.

24,940. "Trilby Puzzle," S. Napper and M. B. Tomkins, London.

24,941. Stay or Corset Busks, &c., L. Kumpfmuller, London.

24,942. Leg Coverings, W. J. Ford, London.

24,943. Sewage Filtering Apparatus, T. B. Jones, London.

24,944. Oil Cans, S. S. Bromhead.—(*F. T. Tolley, Australia, and A. J. Tolley, England.*)

24,945. Carbon Holders for Arc Lamps, H. J. Fisher, London.

24,946. Manufacturing Boots and Shoes, D. Hefferon, London.

24,947. Cistern Valves, E. H. Thornett, London.

24,948. Making Heels for Boots and Shoes, W. Prust, London.

24,949. Electric Arc Lamps, S. S. Allin, London.

24,950. Making Leather, A. K. Y. Anderson and J. Mackintosh, London.

24,951. Flexible Shafting, A. Marotte, London.

24,952. Walking-sticks, F. Bigland and J. Chandler, Liverpool.

24,953. Stopping Engines, A. Spelling.—(*J. S. Yabuley, Japan.*)

24,954. Bicycle Locks, S. H. Patterson, London.

24,955. Puzzles, W. E. Sharp, London.

24,956. Sash Balances, J. H. Bane and L. Brodeur, London.

24,957. Advertising Blocks, O. L. Owen, London.

24,958. Steam Rams, J. P. Randerson and J. M. Seward, London.

24,959. Bottles and the like, J. and E. Stretch, London.

24,960. Sea Signalling, G. J. Pieters and I. Selten, London.

24,961. Angle Joint for Revolving Shafts, S. H. Crocker, London.

24,962. Driving Gear, H. H. Lake.—(*J. Pethely and H. F. Hambruch, Germany.*)

24,963. Safety Device for Perambulators, H. Conitzer, London.

24,964. Yarn Chains, A. G. Brookes.—(*H. F. Straw, United States.*)

24,965. Pulleys, J. G. Lorrain.—(*A. D. Thomas, United States.*)

24,966. Cutting Sweetstuff, G. Prokofiew and M. Streimer, London.

24,967. Producing Marble-like Stucco, M. Hoeft, London.

31st December, 1895.

24,968. Tanning, J. B. Scammell and E. A. Muskett, London.

24,969. Cycle Saddles, C. Creyke, London.

24,970. Umbrella and Parasol Device, J. P. Kinsela, Cork.

24,971. Chain for Reducing Friction, E. Hewer, Eastleigh.

24,972. Pendants for Lighting Purposes, E. J. Shaw, Walsall.

24,973. Dabbing Brushes, J. V. Musgrave and F. Scott, Bradford.

24,974. Engine Governors, W. Swindell.—(*E. Woods, South Africa.*)

24,975. Metallic Travelling Sheet, W. Whiteley, Huddersfield.

24,976. Drying Hanks of Yarn, W. Whiteley, Huddersfield.

24,977. Hubs of Cycles and other Vehicles, W. King, jun., London.

24,978. Driving Gear, L. Callender and A. E. Ragg, St. Helier's.

24,979. Pipes, E. M. Anderson, Glasgow.

24,980. Degerming Maize, W. M., J. A. D., and N. MacG. MacKean, Glasgow.

24,981. Measuring Liquids, J. Hare, Manchester.

24,982. Toe Pieces for Horseshoes, B. Watkins, Birmingham.

24,983. Saucepans, L. J. Painter, Glasgow.

24,984. Pipe, W. Place, Southport.

24,985. Clip Brackets, J. R. F. Flemming, London.

24,986. Tobacco Rolling Machines, B. Hammond, London.

24,987. Railway Carriage Windows, R. Denny, jun., Glasgow.

24,988. Holder and Price Indicator, F. E. Salsbury, London.

24,989. Castors, D. E. Hand, Birmingham.

24,990. Applying Manumotive Force, G. Quick, London.

24,991. Holder for Billiard Cues, A. C. Strains, London.

24,992. Ladders, A. G. Perkins, London.

24,993. Calendars, J. T. Hoare, London.

24,994. Speed Gearing for Cycles, W. H. Miller, London.

24,995. Corset Busks, W. Edwards, London.

24,996. Coin-freed Apparatus, R. T. and J. G. Glover, London.

24,997. Covers for Cleaning Eyes of Drains, G. Hyde, London.

24,998. Oil Stoves, H. W. Wright, London.

24,999. Warp Stop Apparatus, A. G. Brookes.—(*W. F. Draper, United States.*)

25,000. Combustion of Fuel, S. Bender and T. Micoch, London.

25,001. Vapour Condensers, S. G. Merrick and H. L. Washburn, London.

25,002. Electrolytical Apparatus, R. Heathfield and W. S. Rawson, London.

25,003. Bottles, J. Boyd, London.

25,004. Ship's Rudder, W. R. Lawson, London.

25,005. Obtaining Gold from Antimony, W. J. Studds, London.

25,006. Perfuming Articles of Dress, H. J. Dunn, London.

25,007. Machines for Making Cigarettes, J. S. Detrick, London.

25,008. Staple Driving Machines, W. S. Ashbey, London.

25,009. Making Oxide of Lead, H. H. Lake.—(*T. Benfield, United States.*)

25,010. Door Securing Devices, H. H. Lake.—(*F. A. Potter, United States.*)

25,011. Control Mechanism, A. J. Boult.—(*— Stanwood, ——.*)

25,012. Wrenches, S. W. Wardwell, jun., London.

25,013. Plastic Composition, W. L. Woods, London.

25,014. Cash Registers, J. B. Benton and E. B. Hess, London.

25,015. Screw Tipping Gear for Wagons, The Bristol Wagon and Carriage Works Company, Ld., and J. Macdonald, Bristol.

25,016. Lamp Globes, G. C. Marks.—(*C. F. Brown, United States.*)

25,017. Marking Tags, W. P. Thompson.—(*C. J. Weinman and E. E. Eschenhofer, United States.*)

25,018. Mortising Machines, W. P. Thompson.—(*C. Cristadoro, United States.*)

25,019. Massage and Electro-massage, G. Rossbach, London.

25,020. Water-closet Seats, W. S. Wallace, Liverpool.

25,021. Filters, M. Hilton, Manchester.

25,022. Self-oiling Bearings, P. R. Jackson and Co., Ld., and J. S. Lewis, London.

25,023. Purifying Red Oxide of Iron, G. H. Smith, Liverpool.

25,024. Engine Stops, J. Livingston, London.

25,025. Mops, C. Newcome and W. R. Popplewell, London.

25,026. Cane Planters, A. M. Rivero, London.

25,027. Music Holding Appliance, J. R. Collings, London

24,028. Securing Wheels to Axles, A. M. Clark.—(*W. F. McQuivey, United States.*)

25,029. Pneumatic Tires for Cycles, A. E. Sayers, London.

25,030. Trapping Animals, G. Andrews, J. W. and H. V. Briginshaw, London.

25,031. Car Wheels, W. J. Taylor, London.

25,032. Preparing Type or Matrices, O. V. Sigurdsson, London.

25,033. Water-tube Steam Generator, F. G. Hampson, London.

26,034. Valance for Bedsteads, &c., M. I. Major, London.

25,035. Door Bell and Gong, A. Latto, London.

25,036. Sleepers, P. R. J. Willis.—(*O. T. Bedell, United States.*)

25,037. Planer, M. J. Campbell, London.

25,038. Lighting Device for Cigars, V. Lalanne, London.

25,039. New Cycle Bell, M. Weatherhead, London.

25,040. Closing of Preserve Bottles, P. C. Borde, London.

25,041. Scissors, T. Slater, London.

25,042. Fire-arms, C. H. R. Clausius, London.

25,043. Printing Machines, W. M. Rockstroh, London.

25,044. Studs or like Fasteners, J. F. Cornish, London.

25,045. Indicating the Weight of Fabrics, M. H. Tomkins, London.

25,046. Carriage Buffer Couplings, S. J. Warsap, London.

25,047. Hoppers for Casks, J. W. Flower and R. J. Cousins, London.

25,048. Punching Bags, E. A. Hawthorne and H. Sheble, London.

25,049. Rotary Calcining Apparatus, D. A. Peniakoff, London.

25,050. Propelling Aerial Vessels, E. J. Pennington, London.

25,051. Water and Steam Valves, W. Thomson, Baron Kelvin, Glasgow.

25,052. A Gilders' Triple Press, F. W. Vickery, London.

25,053. Portable Electric Lamp, R. T. and J. G. Glover, London.

SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

547,414. Gas Engine, *J. J. Bordman, Brooklyn, N.Y. —Filed February 3rd,* 1894.

Claim.—(1) A gas engine having in combination a casing provided with a combustion chamber, extending around it a power wheel within the casing, means for igniting the gas and a water jacket, extending around the inner circumference of the combustion chamber, substantially as specified. (2) In a gas engine. the combination with a casing, having an annular combustion chamber, of a power wheel within the circumference of said chamber and having blade-like spokes forming chambers, and ports leading from the interior of the wheel to the combustion chamber, the openings of said ports within the wheel being arranged in different circles, one relatively to the other, whereby the explosive element will be discharged into the combustion chamber, but once during the revolution of the wheel, substantially as specified.

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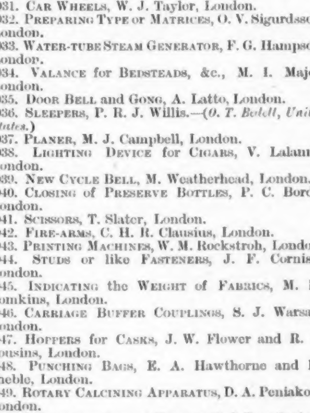
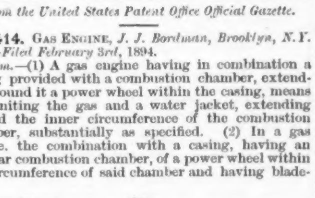


547,441. Electric Bicycle, *H. W. Libbey, Boston, Mass.—Filed October 9th,* 1894.

Claim.—(1) A bicycle consisting of a front driving wheel and a rear double tread steering wheel connected together by a loop frame, an electric battery and an electric motor secured to said frame between the wheels, the motor being under the battery and gears, cranks and connecting-rods to transmit motion to cranks on the axle of the driving wheel, substantially as set forth. (2) In a bicycle the combination with a frame of an electric battery and an electric motor secured to said frame, a longitudinal tube extending from the front to the rear fork and forming a tank to hold exciting fluid for the battery, substantially as set forth. (3) In a bicycle the combination with a frame of an electric battery and an electric motor secured to said frame a longitudinal tube extending from the front to the rear fork for holding the exciting fluid for the battery, an electric controlling device, suitable connections between the battery, motor and controlling device, and suitable mechanism for transmitting motion from the motor to the driving wheel, substantially as set forth.

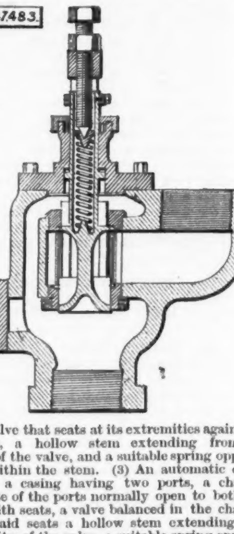
547441.



547,483. Cut-off, *J. H. Dousman, Milwaukee, Wis.—Filed December 19th,* 1894.

Claim.—(1) An automatic cut-off comprising a casing having two ports, a chamber intermediate of the ports normally open to both and provided with seats, a valve balanced in the chamber to oppose said seats but having its extremities of differential area to external fluid pressure, and a suitable spring arranged to exert its power on that extremity of the valve having the least area to said pressure. (2) An automatic cut-off comprising a casing having two ports, a a chamber intermediate of the ports, a cage having one head thereof overlapping the chamber and its other head extended through the same, a clamping ring in screw thread engagement with the latter head of the cage against said chamber, an internally balanced valve that seats at its extremities against the cage heads, a hollow stem extending from one extremity of the valve, and a suitable spring opposing the valve within the stem. (3) An automatic cut-off comprising a casing having two ports, a chamber intermediate of the ports normally open to both and provided with seats, a valve balanced in the chamber to oppose said seats a hollow stem extending from one extremity of the valve, a suitable spring opposing the valve within the stem, and a collar on said stem movable in a recess within the casing.

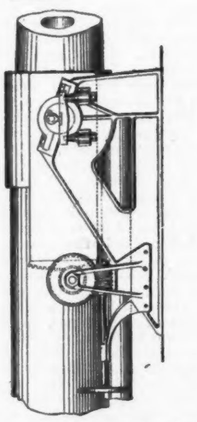
547483.



547,507. Apparatus for Mounting Guns, *J. Strauss, U.S. Navy.—Filed January 4th,* 1895.

Claim.—(1) In a gun mounting, the combination with a gun, and trunnions to stand the shock of recoil, of knife edges secured to said trunnions to sustain the weight of the gun, and supports for said knife edges, substantially as described. (2) In a gun mounting, the combination with a gun, and trunnions adapted to stand the shock of recoil, of knife edges secured to said trunnions, to sustain the weight of the gun, and vertically adjustable supports to said knife edges, substantially as described. (3) In the gun mounting, the combination with a gun, and trunnions to stand the shock of recoil, of knife edges secured to said trunnions, blocks supporting said knife edges, and screws connected to the gun carriage and adjustably supporting said block, substantially as described. (4) In a gun mounting, the combination with a gun, of knife edges which support the same at approximately the point about which the gun is turned for elevating and depressing, and means which limit the longitudinal movement of said knife edges relative to their bearings on the recoil of the gun.

547507



547,524. Broadcast Seeder, *A. King, Hyde Park, Mass.—Filed June 8th,* 1895.

Claim.—In a centrifugal scatterer for seeding machines, a revolving head provided with tubes in combination with adjustable telescoping sections, carrying fan-shaped distributing points, substantially as shown and described

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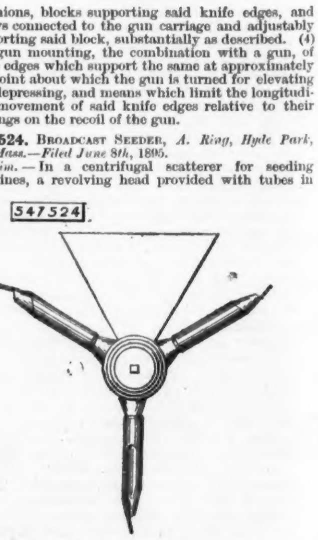


NAVAL ARCHITECTURE.—A FEW PRINCIPLES POPULARLY EXPLAINED.

No. I.—DISPLACEMENT.

FROM time to time numerous inquiries reach us in regard to the meanings of terms employed by naval architects when discussing or describing the qualities of a vessel, and we are often asked to explain how these qualities are determined. For instance, in the answers to correspondents contained in our issue of 11th October last, there will be seen the reply which was given to one of these many inquiries. In this case, as in numerous others, it was impossible to give a complete answer to the question within the limits of space at our disposal for such a purpose. Some of these inquiries relate to abstruse problems in naval science, but the greater number of them are of a simpler character, and admit of a more or less clear explanation in general terms, such as may be understood by the ordinary reader. In view of the demand thus evinced for information of the character we have indicated, it has been thought desirable to present our readers with a few articles devoted to an explanation of some of the common terms employed in naval architectural science, as well as to the methods whereby some of the qualities of a vessel are determined. In seeking to treat these matters popularly we do not, of course, suppose that the articles will be of any service to those already employed in shipbuilding and ship design; but to the apprentice and junior draughtsman they may perhaps serve somewhat to clear the way for further and more exact study. It is, however, for the layman pure and simple, from whom the great bulk of inquiries come, that we intend principally to write.

Let us commence, then, with the question of a vessel's displacement, which was partly answered in THE ENGINEER of 11th October, and discover what further can be said in simple terms in the way of explaining how the displacement is calculated. In our reply to "Shipbuilder"— a *nom de plume*, by the way, adopted by one who never built a ship—we said, "The displacement is obtained by calculating the volume in cubic feet of the immersed body of the vessel, and then dividing the result by 35, which is the number of cubic feet of sea water weighing a ton." Now, if the immersed body were of some regular form, such as a rectangular box or any other figure of which the cubical contents admit of ready and exact computation, the determining the displacement would be a very simple matter indeed. It is because the immersed surface of a ship is not of a regular form, and the volume enclosed by it is not determinable by any of the rules of mensuration, that the task of calculating that volume is so intricate and laborious.

In proceeding to show how the calculation is made, let us begin with a rectangular box—Fig. 1 — floating, with four sides vertical, and therefore with the bottom horizontal and parallel to the plane of the water surface. If this box be 7ft. long, 5ft. broad, and float with a depth of 2ft. immersed, then its displacement will be $7 \times 5 \times 2 = 70$ cubic feet. Suppose it to be floating in sea water, which weighs a ton per 35 cubic feet, then it is evident that the box in question with its contents will weigh $\frac{70}{35} = 2$ tons, and two tons are, therefore, the displacement of the box at a draught of 2ft. This is a very simple case; being simple just because it is so easy to calculate the area of a rectangle, and the volume of a rectangular cube. The only regularity about a ship's form consists in its being symmetrical—or, in other words, both sides being alike. Hence, if we can calculate the immersed volume of one side, we have only to multiply the result by two to get the whole. But that does not help matters much, seeing that the one-half is of so peculiar a form for measuring and calculating.

FIG. 1

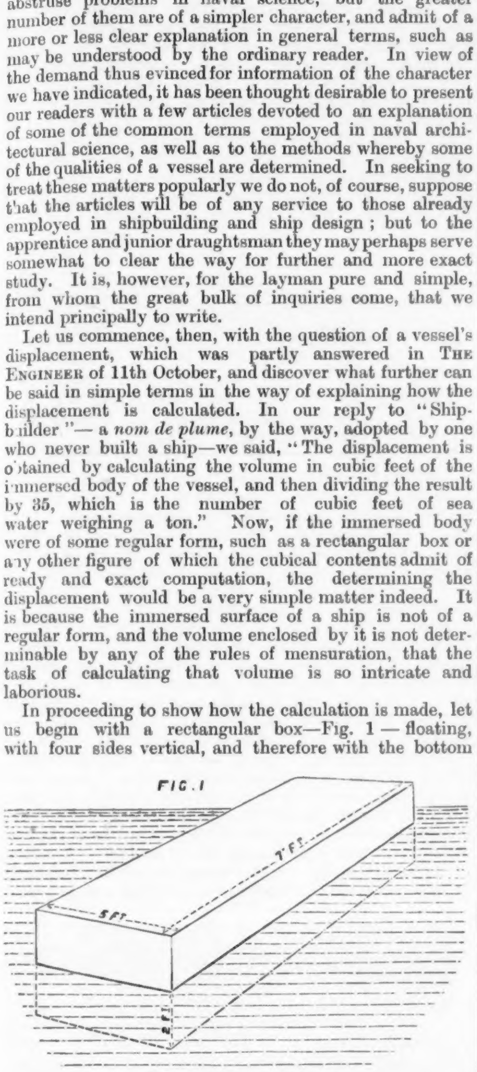


Fig. 2 shows a transverse section of our rectangular box, and within it is the midship section of a ship-shape vessel of the same breadth and depth. The ratio which the area of the vessel's section below water bears to that of the circumscribing rectangle is termed by naval architects the "coefficient of fineness of midship section." That "ratio" or "coefficient" will vary from about ·5 in pleasure craft to about ·9 in cargo carrying tramp steamers. Transverse sections of the vessel and circumscribing box taken at places nearer the bow and stern will show greater differences in the two areas, and, therefore, lesser ratios or coefficients.

FIG 2

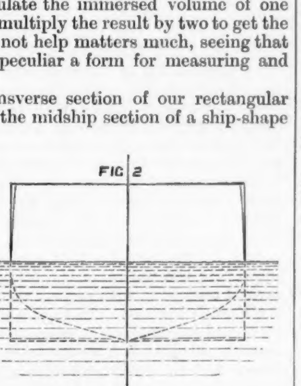


Fig. 3 shows a middle line longitudinal vertical section of vessel and circumscribing box, and there the difference in area between the two below the water surface is very little; but at parallel plane sections further from the middle line the differences become continually greater.

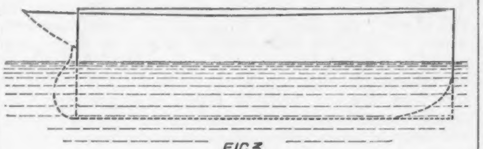


FIG. 3

Fig. 4 shows a horizontal section of vessel and circumscribing box at the water surface, and the ratio between the two is called the "coefficient of fineness of the load water plane." This coefficient will range from about ·85 in a bluff cargo steamer to about ·75 in a steamer of fine form. The parallel sections below the water-line of the vessel, as shown in the figure, become smaller and smaller in area in approaching the keel, and therefore their ratios, or coefficients, diminish in the same way as do the vertical sections towards the bow and stern. The ratio which the volume of the entire body of the vessel below water bears to that of the circumscribing cubical box is called the "coefficient of fineness of displacement," and varies from about ·6 to ·8 in ordinary sea-going steamers. Hence if the coefficient of fineness of a ship-shaped body circumscribed by the box 7ft. by 5ft. by 2ft. be ·75, then 2 tons × ·75 = 1·5 tons, which is the displacement of the ship-shaped body in question, and the fact of floating at a mean draught of 2ft. will show that the weight of the vessel and what she is carrying at that time is 1½ tons.

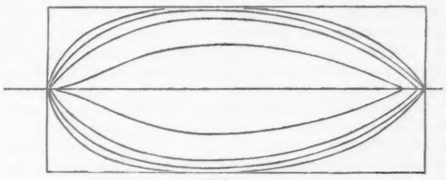


FIG. 4

But the coefficient of fineness cannot be determined until the displacement has been first calculated. Our only reason for referring to it at this stage is to call attention to the fact that a vessel's form, as shown by the three sets of sectional planes, is continuously diminishing towards her extremities in relation to the rectangular outlines of the same plane sections of the circumscribing rectangular box.

Supposing we were to cut up the ship into a great number of thin vertical slices, parallel to the midship slice shown in Fig. 2, making the slices so thin that for all practical purposes their two plane sides would be of equal area. Supposing, also, that we could calculate the area of each such slice. Then in that case the volume of each slice would be obtained by multiplying the area of one of its sides by its thickness, and the volume of the whole immersed body of the vessel would be the sum total of the volume of all the thin slices.

Or, once more, suppose we cut the vessel into a great number of thin horizontal slices parallel to the slices at the water plane shown in Fig. 4. By adding together the volumes of all these horizontal slices we would also get the volume of the entire immersed body of the vessel, and the result would be necessarily the same as was obtained by summing the volumes of the thin vertical slices.

Now this is precisely what the naval architect does in computing the displacement of a vessel; but he goes about it in a way that to the ordinary observer would wholly disguise what he was doing.

Let us see, then, what he does, and why he does it. To do so, we must go back to an elementary curved form, and try to discover a way of getting its area.

Consider the plane surface bounded by the straight line A B, and the curved line A C D E F G B, shown in Fig. 5. This may represent the half water plane of a vessel. Divide A B into an even number of equal lengths—say six—at the points H J K L M, and set up vertical lines or ordinates from these points intersecting the curved line at the points C D E F and G. Join these points by the straight lines AC CD DE EF FG and GB, and it will then be seen that these short lines enclose within them and the line AB a right-lined polygonal figure, the area of which approximates more or less closely to that of the entire figure circumscribing it. Moreover, the greater the number of divisions made in the line AB, and the greater the number of ordinates drawn from the dividing points, the more closely do the two areas approximate.

Let the lengths of the ordinates be represented by the letters *a b c d e f* and *g*, and let the common distance between the ordinates, termed the "abscissa," be represented by x. Then the area of

$$\text{H A C} = \frac{a+b}{2} \times x;$$

$$\text{of C H J D} = \frac{b+c}{2} \times x;$$

$$\text{of D J K E} = \frac{c+d}{2} \times x;$$

$$\text{of E K L F} = \frac{d+e}{2} \times x;$$

$$\text{of F L M G} = \frac{e+f}{2} \times x;$$

$$\text{of G M D} = \frac{f+g}{2} \times x.$$

In Fig. 5, the value of a and g are zero; but in Fig. 6 the end ordinates are shown of a small length. The principles involved, and the methods pursued are, of course, the same in both cases.

Summing these areas we have total area of polygonal figure A C D E F G B

$$= \frac{x}{2}(a + 2b + 2c + 2d + 2e + 2f + g)$$

and this area approximates closer and closer to that of the circumscribing figure bounded by a curved line, just as we increase the number of ordinates and, therefore, diminish the value of x, the common distance between them.

We have thus investigated what is known as the "trapezoidal rule" for the calculation of such figures as that of a vertical or horizontal half-section of a ship; which rule is stated thus:—

Add the end ordinates to the sum of twice the intermediate ordinates, and multiply the result by one half the common distance between the ordinates.

This gives, however, at the best but a rough approximation to the area required, and consequently something closer must be sought. The trapezoidal rule has been stated here because it illustrates the principle underlying the method actually adopted by naval architects, viz., that of close approximation; the result obtained being nearer and nearer the truth, just as the number of ordinates is increased and the length of the common interval between them is diminished.

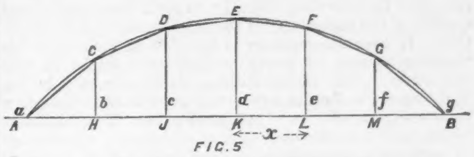


FIG. 5

The properties of the conic sections is a subject too extensive for discussion here; but two statements may be made in regard to it.

In the first place the curved lines of a ship do not depart materially in their character from the curves of the conic sections; and in the second place the areas bounded by curves of the conic sections, and straight lines can be approximated to very closely indeed by the application of a formula or rule, which admits of statement in a manner analogous to that of the "trapezoidal rule." The rule used by naval architects as applied to the case shown by Figs. 5 or 6 is thus expressed:—

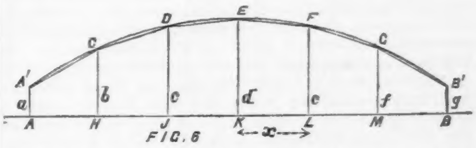


FIG. 6

Area $= \frac{x}{3}(a + 4b + 2c + 4d + 2e + 4f + g)$ and is stated thus:—Divide the base line A B into an even number of equal lengths, from which set up ordinates, which will necessarily be odd in number. Multiply the length of each of the even ordinates by four and that of each of the odd ordinates by two, except the first and last or bounding ordinates, which multiply by unity. The sum of these products multiplied by one-third the common interval between the ordinates will give the area required.

In this way, then, the naval architect calculates the area of each of the equidistant horizontal sections, parallel to the water plane, into which the model or drawing of half the immersed body of the ship is divided. Having found each area separately by this rule, he treats these areas as ordinates and multiplies them by two when even ordinates, by four when odd ordinates, by unity when end ordinates, and finally multiplies their sum by one third the common interval between the water planes and so obtains the entire volume of immersion.

Or, similarly, he may first calculate the area of each of the equidistant sections—see Fig. 7—parallel to the midship section into which the same model or drawing is divided. Taking, for instance, the case of Fig. 7, the common interval between the horizontal planes is y, and the area of the figure A C D E F B is

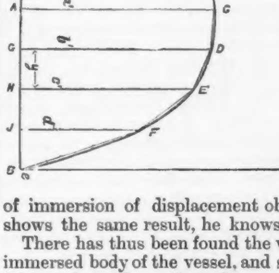
$$\frac{y}{3}(a^1 + 4b^1 + 2c^1 + 4d^1 + e^1).$$

In this instance the value of e is zero.

Having found the area of each vertical section in this way they are treated as ordinates, and the rule applied, as before explained, to determine the whole volume of immersion.

The naval architect calculates that volume in both of these ways, using each as a check upon the other. When the volume of immersion of displacement obtained by each method shows the same result, he knows that it is correct.

FIG 7



There has thus been found the volume of one half of the immersed body of the vessel, and so, on multiplying it by two, we have the entire volume. If the unit of measurement used throughout our calculation has been 1ft., then the result will be in cubic feet, and when the total in cubic feet has been divided by 35, we have the displacement of the vessel in tons. That is to say, we have the weight of a body of sea-water at 35 cubic feet to the ton, equal in volume to that of the immersed portion of the vessel. This is, therefore, the weight of the vessel and all she contains when floating in sea-water at that immersion.

FAILURE OF THE GREAT DAM AT BOUZEY.

The total or partial failure of important hydraulic engineering works of magnitude is fortunately rare, although instances are not wanting, both at home and abroad, which forbid the assumption that they are either unassailable or indestructible. The calamity which so grievously afflicted the inhabitants of the Department of the Vosges in France is a convincing, and, at the same time, a lamentable proof that dams of masonry, as well as those of earthwork, are not exempt from perils of a grave, and sometimes of a disastrous character. Experience has previously demonstrated that the occurrence of a similar catastrophe is not restricted to any particular sphere of action, but constitutes a contingency to which the people of every country in the world are liable. The very possibility of accidents of so terrible a nature, however rare they may be, indicates the urgent necessity for providing liberally, in both the quantity and quality of the materials, for the requirements of construction. If ever an engineer is justified in increasing his working margin of safety beyond what might be considered adequate under ordinary conditions, it is in the building of the dam of a reservoir capable of impounding millions upon millions of gallons of water. English dams, which have hitherto been almost exclusively constructed of earthwork, as a rule have stood well, though a few of the most notable failures, both at home and abroad, will be subsequently referred to. Whether the cause be due to the theoretical or practical conditions—that is, whether to the employment of a better profile, or shape of dam, or to superior workmanship and choice of materials—may be left to experts to decide. The fact remains that the failures of the dams of reservoirs in England have been neither so frequent nor so disastrous in their results as similar accidents in foreign countries.

To find a parallel at home to the destruction of property and the loss of life which was occasioned by the failure of the dam of the reservoir at Bouzey, near Epinal, it will be necessary to go back thirty-one years. A few particulars of this great disaster, in reference to the subject under notice, may not be uninteresting. It was caused by the bursting of the dam of the Bradfield reservoir, in the neighbourhood of Sheffield, on the night of the 11th of March in the year 1864. The suddenly-liberated volume of water swept away with irresistible fury every obstacle and impediment, whether natural or artificial, which opposed its impetuous career, drowned animals in thousands and carried death to 260 human beings. It will be at once apparent that the results of the inundation at Sheffield were precisely the same as those generally described as occurring in the dam near Epinal, but on a scale of greater magnitude. No analogy exists between the two dams themselves, since the one in France was built of masonry, and that at Bradfield was composed of earthwork, with a maximum height of 95ft. At the subsequent inquest held at Sheffield, the evidence of the professional experts, which attributed the failure to the objectionable and unsound practice of laying the naked cast iron outlet pipes through the earthen embankment, was so preponderating as to leave no reasonable doubt on the matter. When pipes are thus laid, the water, in spite of the best puddling and the adoption of all necessary precautions, will "creep" along their outside surfaces, and if the mischief be not checked, which is a very difficult and troublesome operation to effect, the downfall of the dam becomes sooner or later inevitable. *Apropos* to this peculiar "creeping" action of water, an eminent engineer has expressed his belief that where ordinary drainage tiles are laid in a clay, that is, in a puddle subsoil, they drain as much by their external surfaces as by their internal capacity, and that there is a "creep" on every pipe along the outside surface. It is worth mentioning that the result of the inquest led to the general abandonment of the principle of laying naked pipes through an earthen dam. The "Report" of the Commission charged with the duty of investigating the causes which led to the failure of the French dam on 27th April of this year has just come to hand, together with the views of the Department of the Ponts et Chaussées on the whole subject. We shall refer to this Report more in detail presently.

It will be first necessary to recapitulate briefly the principal dimensions of the French dam, not merely for the sake of comparison with other examples, but in order to point out that it was not quite so stupendous a construction as has been assumed. It was designed to form an impounding reservoir, to supply with water the Eastern Canal, and to contain, in round numbers, 7,000,000 tons of water. The length was 1545ft., the height above the bed of the channel 49ft. 3in., and the total height above the foundation 75½ft. At the top the width was 13ft., and at the bottom 39ft., and the façade of the dam was perfectly straight throughout its entire length, or it may be described as straight in plan. The largest dam, or, to speak more correctly, the dam forming the largest reservoir in the world, and thus impounding the largest supply of water, is known as the San Roque dam. It was constructed to furnish a supply of water for the purpose of irrigating the lands in the neighbourhood of the city of Cordoba, in which is situated one of the termini of the Central Argentine Railway. This dam has a height of 115ft., and the water, when it was first constructed, stood at a depth of over 100ft. in it. The reservoir has a storage capacity of 260,000,000 tons, or rather more than thirty-seven times that of the example at Bouzey. As a proof of the comparatively enormous storage capacity of the San Roque reservoir, it may be mentioned that it exceeds by 30,000,000 tons the combined capacity of twenty-four out of the twenty-six largest reservoirs in the world. It should be stated that this dam has not stood as well as it should have done. A year ago very serious defects were discovered in it, and it is not considered safe to allow the water to rise in it higher than 72ft. Even when the water is at this height the reservoir will hold 56,000,000 tons, which is more than double the capacity of any single one of the largest reservoirs either in Europe or in Algeria. As the San Roque dam is situated at no great distance from the city of Cordoba, the bursting of it might lead to an appalling catastrophe, involving the loss of many thousands of lives, and in comparison with which all previous calamities of a similar description would be reduced to very small proportions. It is not at all reassuring—although *absit omen*—for the future of this dam, that one built at Habra in Algeria, and very closely resembling it in height, in shape, bad materials, and inferior construction, collapsed after a brief existence of ten years. A breach in the dam, 330ft. in length by 110ft. in height, was made by the escaping flood, which swept away a large portion of the town of Perregaux, several villages, and destroyed 210 lives. Similar disasters attended the dams at Grand-Cheurfos and Sig, also in Algeria.

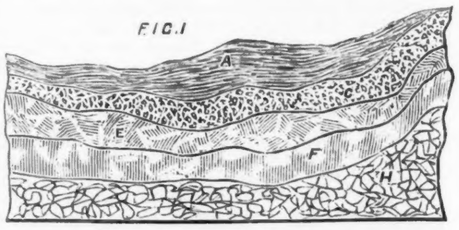
It may be assumed, in the comparison of different dams, that the foundations are adequate in all of them, and therefore the effective relative heights of the dam wall, which will obviously be proportional to the depth of water impounded, constitute the true criterion of this dimension. The effective height of the French dam, judged by this practical standard, is barely 50ft., which is not half that of the similar work at San Roque, which, as will be subsequently shown, is not the highest dam constructed by a good deal. The dam of the Beetaloo Reservoir, built in one of the driest districts in South Australia, has a height of 103ft., and 118ft. was given to the Tansa dam, which impounds 51 million tons of water for the potable and domestic supply of the city of Bombay, and has a length of nearly 9000ft. As an example of the reputed highest dam actually constructed, the Furens dam, situated in the "Gouffre d'Enfer," which supplies St. Etienne with water, may be quoted. It impounds a head, that is, a depth of water, of 164ft., thus completely throwing into the shade not only the dam near Epinal, but all the other examples alluded to. This height, great as it undoubtedly is, will be surpassed by the Quaker Bridge dam across the Croton Valley at New York, to which it is proposed to give a height of 270ft. The stowage capacity of the impounding reservoir formed by it will amount to 31 thousand million gallons.

It should be stated that the French dam was straight, and not curved from end to end, and it has been suggested that the failure might be attributed to this cause. It is, however, a mistake to suppose that the requisite amount of stability and security cannot be given to a straight as well as to a curved or slightly arched dam. It would, perhaps, having regard to the length of the dam at Bouzey, have been advisable to give it a small curvature along the face, and, as nearly all the dams in France are curved, it is not quite apparent why the usual practice should have been departed from. The Tansa dam may be quoted again in support of the statement respecting the security of straight dams, since it is laid out in two straight lines, meeting at a very small angle, nearly at the centre or half way. Each of these separate halves is, therefore, perfectly straight, and the length of each is only a little under three times that of the entire length of the French dam. It is deserving of notice that two of the engineers engaged on the design for the Quaker Bridge dam were strongly against the adoption of the curved form, and recommended a straight line instead. They were opposed by other of their *confrères*, who were equally urgent in their support of a slightly-curved dam. America has not been exempt from failure of works of this character. More than a hundred occurred in a very short period, including those at Danberry, New Redford, Mill River, and Worcester. That at Conemaugh, in May, 1889, about ten miles from Johnstown, in the United States, was a very lamentable affair, closely resembling in its general features the disaster at Sheffield, and the recent failure in France. Probably the most remarkable specimen of construction of the description under consideration is to be found in the Bear Valley dam in California. It is 48ft feet in height above the foundations, only 3ft. thick at top, and 8½ft. at base, and resembles an obelisk far more than a dam. No wonder that an eminent engineer remarked that he would not care to live in any town situated at a lower level in proximity to it.

Nearly all dams are really designed and built on the principles which govern the straight form, and the curvature is added—or "thrown in," as it were—to increase their resistance. There is only one dam in France which acts strictly on the arch or curved principle. It is stated to be 120ft. in height, but of the insignificant length of 200ft. It is called the Zola dam, and was constructed by the father of the present well-known novelist. The Villar dam impounds the water supply for Madrid, and is curved on plan. A terrible catastrophe attended the collapse of the dam of Puentes, early in the present century. It was situated at Sorca, a town on the river Guadalentin, about fifty miles by rail from the seaport of Cartagena, and the bursting of it cost the lives of over 600 of the unfortunate population. The Gileppe in Belgium and the Vyrnwy in England are the first examples of dams constructed of masonry in their respective countries. The Vyrnwy dam is founded on the solid rock, and it has one feature quite unique in such construction, which is that it is the first high dam built to act as a weir. Thus it practically becomes its own weir, and does not require the services of a separate byewash. Both the Belgian and the English dams are generally considered to have an excess of material in them; or, in other words, that they have a superabundant amount of strength. Even so; but, having due regard to the great and important interests involved in the construction and maintenance of these works, and the calamities attending their failure, the right course is to err—if it is erring—on the safe side, and provide *ab origine* for contingent evils, which, should they subsequently occur, are frequently well-nigh irreparable.

Ever since the dam at Bouzey became a *fait accompli* it has not enjoyed a good record. Commenced in 1878, the building of it occupied a couple of years, and during the execution of the works, it was proposed to raise the total height some 6½ft. more than was contemplated in the original design. It should be stated here that the department of the Ponts et Chaussées set its face against this proposition, but it was overruled by the Minister of Public Works, and the alteration was sanctioned. The filling of the reservoir began towards the end of 1881, and even at this incipient stage of future service, springs were discovered on the down stream side of the structure yielding a leakage of 900 gallons per minute. About a year afterwards two fissures made their appearance. From this period until March, 1884, the water was maintained at a height of 2½ft. below what was regarded as its normal safe level. On that date the dam suddenly gave way, and slid on its base horizontally for a distance of 450ft. At the same time the flow from the springs increased to 1700 gallons per minute. Notwithstanding this ominous state of affairs, the water in the reservoir was maintained at the level already mentioned until the following year, when the water was run off, and an investigation into the causes of the slip took place. Before detailing them, we may quote an actual example of the failure of a dam from this very reason. It occurred about two years ago in Texas, when a dam of masonry exceeding 60ft. in height gave way. An inspection of the fractured structure indicated in a manner that left no room for doubt that the water had forced its way through the soft seams of the rock, upon which the dam was founded, and had exerted an upward destructive force that was irresistible. Similarly to the Texas dam, that at Bouzey was not carried down to the solid rock. An examination of the slip of the French dam revealed the existence of a large horizontal fracture extending along a length of 300ft., together with a number of vertical cracks and fissures, and a partial breaking up of the substratum under the foundations to a maximum depth of 10ft.

FIG.1



The accident was due to the fracture of the wall, and the pressure of the water which had found its way underneath. In 1889 the works undertaken to repair and strengthen the dam were concluded, and in so short a period as two months, when the masonry must have been perfectly green, the refilling of the reservoir was commenced, and was carried to a height of 6ft. above the level attained at the time of the slip in 1884, and within 2ft. of the maximum water level possible. The result of this pressure was to cause the down stream face to deflect from the normal straight line to the extent of ⅛in. The circumstances attending the disastrous failure of the dam in last April are well known to our readers. A portion of the central section, 520ft. in length and 35ft. in height, gave way, and in this length was included a large part of the length which succumbed nine years previously. It would appear as if the first accident had established a permanent weak spot in the whole structure. It was also discovered that in those places in which the old stonework had been toothed and racked off, to make a good bond with the new work, there was a considerable amount of disintegration and chipping of the masonry, especially on the down stream face. It appears from the report that the actual pressure per unit of area upon the masonry was considerably less than that obtaining in the dams Gouffre d'Enfer, and in others at Ternay and Chatrain. Two important conclusions were also arrived at. One was that the profile of the dam was so designed that the curve of pressure was not situated in the middle third of the wall, and that the stonework in the up-stream face was subjected to stresses of tension. The report deals lightly with the former consideration, clearly regarding it more as a measure of prudence than an absolute necessity, and there are no doubt numerous retaining walls of many descriptions in which this proviso is either ignored or neglected. There is but one opinion respecting the second point, but it is alleged that in the instance under notice the tensile stresses were so small that they might be neglected with perfect safety.

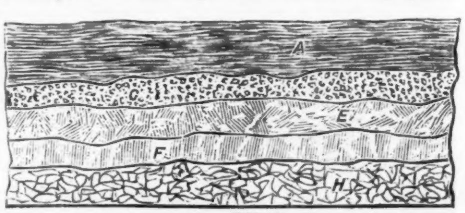


FIG.2

It is a little singular that complete silence is observed respecting the nature of the foundations, the more so as several criticisms with respect to them have appeared in the French journals. In Figs. 1 and 2 are represented a cross and longitudinal section of the valley in which the dam is situated. A peaty layer A forms the top soil. Beneath it lie sandy and alluvial deposits C, and underneath them come the sandstone and schist E. Underlying the last-mentioned is a bed of rough, porous sand and grit stone F, and beneath this a more compact, but by no means a solid stratum of sandstone G, upon which the work is founded. It is not until a depth varying from a minimum of 10ft. to a maximum of 18ft. is attained that the actual solid rock is reached. Under these conditions it is, perhaps, pardonable not to have carried the foundations down to the rock, as the expense would have been excessive. It is certainly a notable feature that the ultimate failure of the structure should have occurred at the exact spot in which was located the previous fracture. The conclusion to which the Commission arrived was the following:—The stonework of the dam was exposed to stresses of tension which exceeded its powers of resistance in consequence of the bad bond made between the old and new masonry work. The same cause gave rise to a long horizontal fissure where the underpinning was executed. The pressures due to the effect of the oblique fissure made at the time of the slip in 1884, and also of the long horizontal fissure, brought about the failure of the dam. The Report concludes with some advice respecting precautions to be taken in similar instances of partial failure, but they are not relevant to the immediate subject before us.

After hearing the opinions of its different members, the Department of the Ponts et Chaussées observes as follows:—It remarks that the raising to a further height of 6¼ft. of the dam and its contents was contrary to the views expressed by the department. It further considers that that circumstance, combined with the influence of the fissures subsequently produced, especially the horizontal fissure arising from the defective bond in the old and new masonry, was one of the principal causes of the catastrophe. The views of some of the members of the department of the Ponts et Chaussées are rather singular. It is put forward by one that the failure of the dam was due to exceptional circumstances which were beyond all human foresight, and that the accident was really owing to a powerful manifestation of that mysterious agent *force majeure*. In addition to the conclusions arrived at, there is very little doubt but that the rapid and decidedly premature filling of the reservoir after the first failure was, at the least, a very injudicious proceeding. As the pressure of water increases, so does the tendency to cause deflection in the face line of the dam, and also to augment the dimensions, the breadth especially, of the fissures. After the French dam was in use, after undergoing repairs, the deflection increased from ⅜in. to ⅞in., and the fissures widened proportionally. One result of deflections in a dam is to cause stresses of tension in the material, and, should they pass certain limits, they may give rise to cracks, or even produce openings at the joints.

Seismic agency, as well as the action of severe frost during the winter preceding the collapse of the French dam, have both been advanced as causes of the collapse. A German scientist suggests that a sudden and exceptionally high tide in the Avière, caused a powerful reflux of a large volume of water into the reservoir, which, conjoined with other causes, might have brought about the failure. It is admitted in the French technical journals that instead of Portland cement, lime mortar, *chaux du Theil*, was used in the actual building of the dam, some parts of the face of which were plastered with the thinnest possible veneer of Portland cement mortar. One French engineer goes so far as to condemn all dams of masonry, and advocates a return to the old method of building them of earthwork, with the orthodox puddle wall in the centre, basing his views upon the success which has attended the general adoption of that material in our own country. Some idea of the extent of the damage and loss caused by the failure of the Bouzey dam may be gained from the fact that £230,000 are needed to replace all that it is possible to replace.

STEAM LOCOMOTIVES ON COMMON ROADS.

By W. FLETCHER.

THE following paper is a sequel to that concluded on page 315 of the last volume of THE ENGINEER:—

In this article separate locomotive engines intended for drawing an omnibus for passengers, and one or more light vans for goods, will be described. I believe there is a great future for this system of road locomotion, to act as feeders to the railways in our Colonies and foreign countries, where no laws are in force such as we have to contend with in England. As soon as these laws are modified, the same means of communication between the village and town, and between the farm-yard and the nearest railway station, will be used in England also. In this place I shall omit all reference to purely historical examples, but shall describe a few road engines and trains that have been put to actual work in comparatively recent times.

A brief description is given of a small road steamer made by Messrs. Perkins and Son, Regent-square, London. This road engine is of very novel design, and possesses several features of interest. From the engraving Fig. 23,[1] it will be seen that the engine, boiler, and driving gear are mounted on a circular frame, above the single driving wheel; this machinery turns with the wheel in the act of steering. It is claimed for this arrangement that the machine pulls in the direction that it is steered. The engine is coupled to a carriage upon which an atmospheric condenser is placed. The condenser is composed of a number of small pipes, through which the exhaust steam is passed as it leaves the engine, the lower part of the wagon being used as a tank for catching the condensed steam. The following are some of the dimensions of the engine and boiler:—Engines are of the double-cylinder compound type; two high-pressure cylinders, 1⅛in. diameter; two low-pressure cylinders, 3⅛in. diameter; stroke of each cylinder, 4½in. Diameter of the driving wheel is 25in., and 12in. on face. Section of india-rubber tire, 10in. by 5in. thick. The vertical boiler is constructed entirely of thick wrought iron tubes, with welded ends, and is perfectly free from any liability to explosion. The boiler is 26in. high, 15⅝in. wide, and 20⅜in. long. Fire grate area ¾ of square foot. The working pressure is 450 lb. per square inch. These engines have been run at a speed of considerably over 1000 revolutions per minute. The engine only weighs 32 cwt.; the condenser, wagon, and passengers, 52 cwt. It runs on the road at eight miles an hour, without emitting any smoke or steam into the atmosphere, and is practically noiseless. The consumption of coal is only 2 lb. per ton per mile. This high-pressure high-speed minature engine developed 20-horse power when running full speed under a load.

Mr. Thompson's road steamers must not detain us, as these were referred to in Mr. Head's paper.[2] The inventions of Mr. Thompson, undoubtedly promoted steam locomotion on common roads. A considerable number of road steamers were made by Messrs. Burrell and Sons, Thetford; Messrs. Ransomes, Sims, and Head, Ipswich; Messrs. Robey and Co., Lincoln, and others. Many of these were shipped to foreign countries for passenger service. Some particulars of four road steamers made by Messrs. Ransomes are given in a paper read in 1879, by Mr. Crompton, on "The Working of Traction Engines in India," before the Institution of Mechanical Engineers.[3]

Soon after Messrs. Burrell took up the manufacture of Mr. Thompson's road steamer, they very wisely discarded the "pot" boiler, because of the trouble it gave; and substituted in its place the more reliable locomotive type of boiler. The engines were entirely rearranged to suit the altered conditions, and numbers of engines of this type were sent to various parts of the world, mostly for running passengers and light goods at fairly high speeds. An engine of this design was made for the Turkish Government, and described by THE ENGINEER as "one of the best designed road locomotives up to that time constructed."

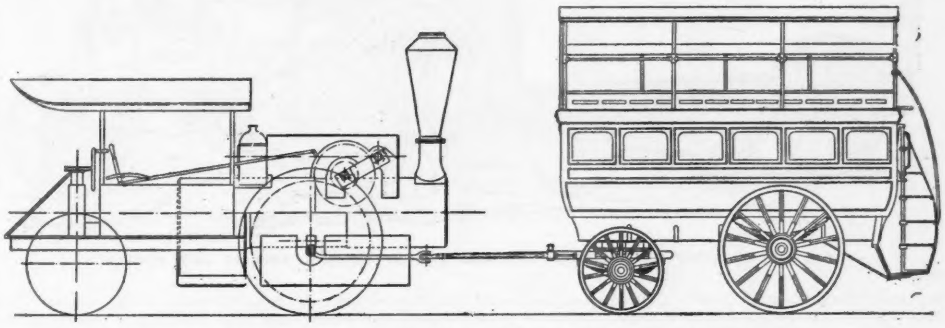


Fig. 24—ROAD STEAMER AND OMNIBUS BY MESSRS. CHAS. BURRELL AND SONS

Fig. 24 shows an outline drawing of a large passenger engine of this class connected to a well constructed omnibus intended for forty passengers. This engine was fully tested in England, and sent to Greece. It will be seen that the engine is mounted on the top of a locomotive multitubular boiler; the cylinders are placed at the fire-box end of the boiler. The coal bunkers, steering column, and boiler are mounted upon a wrought iron frame as shown. This end of the engine leads, the two leading wheels are placed inside the wrought iron frame, and are, like the driving wheels, provided with india-rubber tires properly protected. The driving axle is situated about the middle of the boiler, the chief weight of the engine, boiler, and water tank resting on the driving wheels. Spur driving gearing is employed for transmitting the motion from the countershaft to the wheels. The main axle is fixed, the driving wheels revolve on it, so that no power is transmitted through it. It will be seen that a pinion on each end of the intermediate shaft gears into a spur ring bolted near the periphery of the drivers, by which means the weight of the driving wheels may be reduced. The following are some of the dimensions of this engine:—The two steam cylinders are 7¼in. diameter, and 10in. stroke; the two driving wheels are each 6ft. diameter, and the leading wheels are 4ft. diameter. Two speeds are provided, the ratios arranged for running at four miles or eight miles an hour, according to the nature of the roads. A cab is erected for protecting the driver and steersman from the heat of the sun, or from rain. The engine work is all neatly closed in, so that the working parts are not seen, and are also kept free from dust. The working pressure was 130 lb. per square inch. Several engines of this type were made for quick running; in some instances smaller engines are used, and slight modifications in the arrangement of the parts took place, but in the main the engines were all similarly equipped, and were successful.

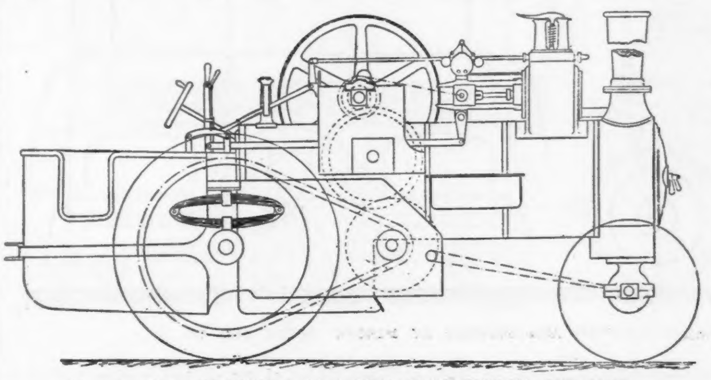


Fig. 25—ROAD LOCOMOTIVE BY MESSRS. CHAS. BURRELL AND SONS

An outline drawing is given of a special road locomotive, recently made by Messrs. Chas. Burrell and Sons. From the illustration, Fig. 25, it will be seen that the countershaft is placed in a line with the main axle, to admit of chain driving, and an efficient method of mounting the heavier part of the engine on laminated springs. The countershaft under the boiler barrel is provided with compensating gear; a chain pinion is attached to each end of this shaft; therefore two driving chains are employed, and the engine answers to the steering wheel, both driving wheels doing an equal share of work when passing along a straight road or when turning sharp corners. This engine was not built for particularly quick travelling, but the silent running driving chains and excellent arrangement of springs render it worthy of note. If a pair of elastic wheels were added, this type of engine would run smoothly on common roads at six miles an hour or more.

The showman finds it to his advantage to adopt a road locomotive for working his steam circus—lighting up the show by electricity, and also as a means of drawing the entire paraphernalia from town to town, the same engine performing the three duties efficiently. Messrs. Chas. Burrell and Sons have constructed some fine compound spring mounted engines for this work, with a dynamo erected over the smokebox. It is well known that the showman has often to cover a good many miles of road during the night and early morning, in order to fulfil his printed engagements. The road locomotives travel well at high rates, irrespective of Acts of Parliament, and do more work than horses could possibly achieve.

Messrs. Aveling and Porter, of Rochester, have manufactured a large number of road locomotives for all manner of purposes. They have been favoured with orders from several European Governments for a number of quick-speed road locomotives for military purposes—the transport of troops and materials. As these road engines and trains are suitable for passenger service, and have been employed in a similar capacity, a few particulars of results achieved may not be without interest. It is twenty-five years since Messrs. Aveling and Porter built the steam sapper No. 1, when a committee of the Royal Engineers made a thorough trial of it. From that time to the present no adverse report has ever been made by the authorities in charge, but an additional engine has been brought every year since the trial took place. Experiments were made during the end of 1893 with some of these steam sappers in Paris, when a speed of twelve miles an hour was reached on ordinary roads.

Lieutenant-Colonel Templer says:—"At present a train of wagons can on the best roads only traverse fifteen to twenty miles a day, while a traction engine would in the same time reel off sixty to seventy-five miles a day."[4] Road locomotives are used in the Italian Army, and by the Swiss Government. In an official report on the employment of road engines in the Russian Army it is stated:—"The road engines, although only a part of them were employed, did not only completely reimburse their purchase money and the cost of maintenance, but brought an actual profit. The road locomotives have received in the military department the right of citizenship, and will, there is no doubt, render great services to that department in future."

"During the Berkshire manœuvres of 1893, eight steam sappers were employed in taking stores and material to Uffington, Idstone, Liddington, and the different rest camps *en route*, being a total tonnage of 356 tons, a distance of 150 miles, and although the engines were of different patterns and age, this service was accomplished without accident and at small cost, which I venture to say fully proves that steam transport by road locomotives for the army and reserve forces would render most valuable service, both in peace and war, and effect an enormous saving to the country." Lieutenant-Colonel Templer goes on to say: "The steam horse consumes only cheap coal or wood, while animal muscles must be renewed with expensive hay and oats. At the halt the engine ceases to require fuel and water, whereas horses require forage and water in the same quantity as when on the march. When the engine does not work it does not eat, and is costing nothing. Again, the horses would be very much harassed with a continuous march, whereas the capabilities of the steam locomotives are at least an average of fifty miles per day, for month after month. The steam sapper Queen came from Chatham to Aldershot—viz., seventy-two miles—in twenty-six hours, and went to its regular work the next morning." It is interesting to note that the modern road locomotive is being advantageously used for many purposes, and are equally successful when applied to the requirements of the army. Some of these road trains are illustrated in Lieutenant-Colonel Templer's pamphlet. A compound traction engine drawing a food van is reproduced by Fig. 26. Messrs. Aveling and Porter's spring arrangement will be illustrated in due course.

Messrs. Robey and Co., of Lincoln, have made a considerable number of road steamers for passenger service in foreign countries. Fig. 27 shows one of these road locomotives, and a two-wheel omnibus. The engine is of the vertical type, as introduced by Mr. Thompson, but Messrs. Robey have carried out many improvements in the details of the engines, suggested by a twenty years' experience. There is certainly something to be said in favour of this type of engine for running light loads at brisk speeds. The chief drawback of the original Thompson road steamer was the "pot" boiler, which was a constant source of annoyance; this has been replaced by Messrs. Robey's patent tubular boiler with satisfactory results. The engine is mounted on three wheels with india-rubber tires 5in. thick, protected by bands of steel plates. Most of the weight is placed over the driving wheels; the single leading wheel is lightly loaded; the engine is steered with ease. An experienced driver can manœuvre these engines with the utmost facility. The engine carries a large water tank. All the working parts are neatly boxed in. A canopy is provided for the driver and steersman. The engines run silently, and very little trouble is experienced in meeting horses on the road when running at eight miles an hour. Messrs. Robey and Co. have supplied some of these engines recently to customers who have had engines of their make in use for nearly twenty years, which is an excellent testimony in their favour.

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[1] THE ENGINEER, 27th September, 1895, p. 315.

[2] "On the Rise and Progress of Steam Locomotion on Common Roads," by Mr. John Head, "Minutes of Proceedings" of Inst. C.E., vol. 36, page 36.

[3] See "Steam Locomotion on Common Roads," E. and F. N. Spon.

[4] "Steam Transport on Roads, by Lieutenant-Colonel Templer.

The india-rubber tires act as an excellent spring, and are placed where the spring should be situated; that is, in the nearest point to the road, thus saving the machinery from a great amount of wear and tear. The enormous cost of the tires is a great drawback; we may, however, be able to scheme a good wheel possessing the advantages of the rubber tires at much less expense.

Messrs. John Fowler and Co., Leeds, have made a large number of road locomotives that are available for a variety of purposes, and a no inconsiderable number of engines have been sent to the Colonies, suitably equipped for making long journeys at high travelling speeds. Much might be said respecting the success of Messrs. Fowler's engines, but I have only space to give a few particulars. Reference must be made to an 8-horse power compound road locomotive in use in Australia; the owner of this engine resides forty miles away from the nearest township, the locomotive hauls wood and other produce across country without any roads whatever. At one time a river was crossed by the engine and its load; the banks were about 50ft. deep. Journeys of 300 miles are accomplished at good speeds. These engines are provided with an extra tank for carrying a good supply of feed-water; a few sacks of coal or wood can always be thrown on the wagons. The engines are mounted on springs, so as to allow of accelerated speeds on indifferent roads. In a previous paragraph reference is made to the employment of the modern road locomotive by the up-to-date showman.

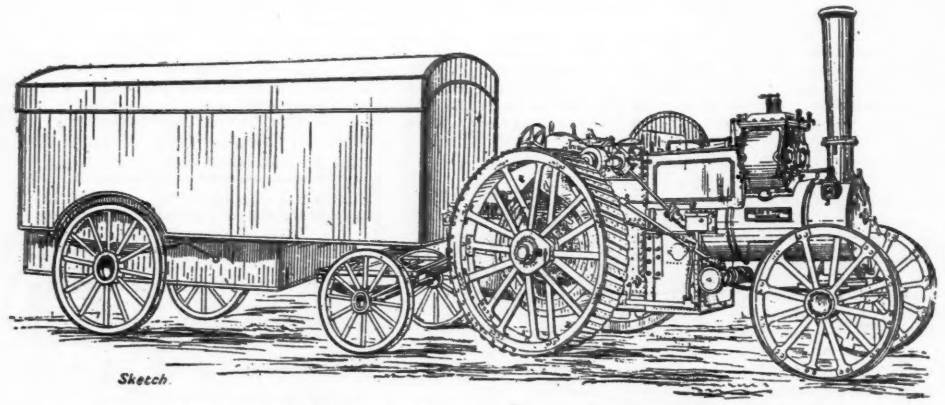


Fig. 26—COMPOUND ROAD LOCOMOTIVE AND VAN BY MESSRS. AVELING AND PORTER

Messrs. Fowler have supplied a large compound road locomotive, which hauls five large vans containing the nameless paraphernalia for a steam circus or roundabout. The engine drives the apparatus during the day time, at night it also keeps the machine in full swing, and drives a dynamo for lighting up the whole show. On the road the engine hauls the five vans and watercart at a good speed up some of the steepest hills in Kent, Surrey, Berks, Bucks, and Oxon. A considerable number of road locomotives are used in many districts for hauling huge boilers, machinery, and other commodities that the railways are unable to carry.

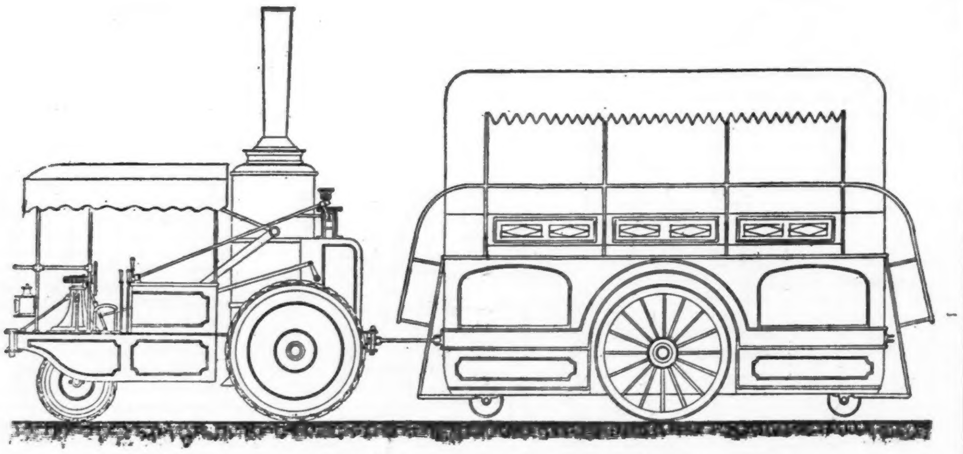


Fig. 27—ROAD STEAMER AND OMNIBUS BY MESSRS. ROBEY AND CO.

By the employment of these road trains some traders are practically independent of the railway companies, and the economy of steam haulage is proved beyond doubt. THE ENGINEER recently remarked:—"Hitherto the transports for the Dover and Canterbury manœuvres have gone by rail; they are now being taken by road by traction engines. It is suggested that traders and farmers might adopt the same system by judicious co-operation. Many classes of merchandise would suffer nothing from the longer time spent in conveyance. The military authorities reckon that they are making a saving of 50 per cent." As an instance of the economy secured by the employment of road locomotives, I may mention the removal of a large boiler which cost £1 15s. If horses had done the work this would have cost over £5, occupying a much longer time and taking up considerable more room. Messrs Fowler's latest form of spring arrangement will be given presently.

Messrs. J. and H. McLaren, of Leeds, have supplied road locomotives and coaches for passenger and light goods service in India, France, &c. In the next article I shall be able to give a side elevation of an engine and train for running a parcel service in France, as described in Mr. John McLaren's paper.[5]

It only remains for me to give some further particulars of the trains, three of which ran regularly between Lyons and Grenoble, which are about seventy miles apart. The parcels were collected and packed into the van during the day; one engine started out of each town in the evening, and delivered its load at the other end the next morning. As the journey has to be made in the night over a very rough and dangerous road, it was important that the engines should be fitted with ample brake-power, a reliable steering gear, and an efficient system of lighting. They were therefore fitted with a steam brake as well as the ordinary hand brake. The steering gear was of the worm-and-rack type. The engines were fitted with an arrangement for burning ordinary gas. One charging of gas was sufficient to give a brilliant head light, and supplied the signal lights for the round trip of 140 miles. These are favourable examples of quick-speed road trains. In addition to the engine of this type, Messrs. McLaren have many other engines doing rather remarkable work.

The Cliffe Hill Granite Company, Leicester, have had two engines at work for several years; these engines make five trips each per day from the quarry to the railway siding, a distance of nearly three miles, carrying 14 tons to 16 tons each trip. They are seldom allowed to stand for half a day. They consider this to be a hard test at continuous working that will be difficult to beat. Another engine at work in Yorkshire on steep hills may be named. The ruling gradients are 1 in 10; one short pinch varies from 1 in 4½ to 1 in 6. The engine takes itself and two empty wagons up this incline easily, and brings down two loaded wagons with 16 tons of stone. It is fitted with an arrangement in the front for raising the smoke-box end of the engine by steam pressure to something like the horizontal position, when descending the hill. It is not only fitted with a powerful brake, but the wagons have double brakes on each set of wheels both back and front. The New Zealand engines for wool-carting continue to give excellent results, but as these engines were dwelt upon in Mr. McLaren's paper, I need not enlarge on this part of the subject. Instances can be given where this maker's engines have more than saved their total cost in one year. In one particular case the use of one of these engines enabled the owners to dispense with fourteen horses. As a rule the use of road locomotives will effect a saving of from 30 per cent. to 70 per cent. as compared with the cost of the same work when horse-power is used. In ordinary circumstances the cost of transport has been reduced to 2d. per ton per mile, and this economy would be still further increased if the engine could be provided with a load both ways.

Enough has been said to show the immense advantage of the employment of the road locomotive for all kinds of work, on all kinds of roads, for slow speeds with heavy loads, or quick speed with lighter roads. Wherever the traction engine has been put to work by competent makers it has always given a good account of itself.

(*To be continued.*)

LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—The annual general meeting of this Association was held on Saturday evening, the 4th inst., at the Cannon-street Hotel, when the balance-sheet was read and approved of, which showed the society to be making continuous steady progress, both in members and funds. The total amount of the funds was stated as £4971, the increase during the past year having been £103. Mr. William Royal was elected president, and Mr. A. K. Douglass vice-president for the present year. The retiring president, Mr. R. J. Cook, gave an address reviewing the proceedings of the past year, and giving some suggestions for future improvements, and a vote of thanks to the retiring officers closed the proceedings.

THE ALBERT RAILWAY BRIDGE AT INDOOROOPILLY, QUEENSLAND.

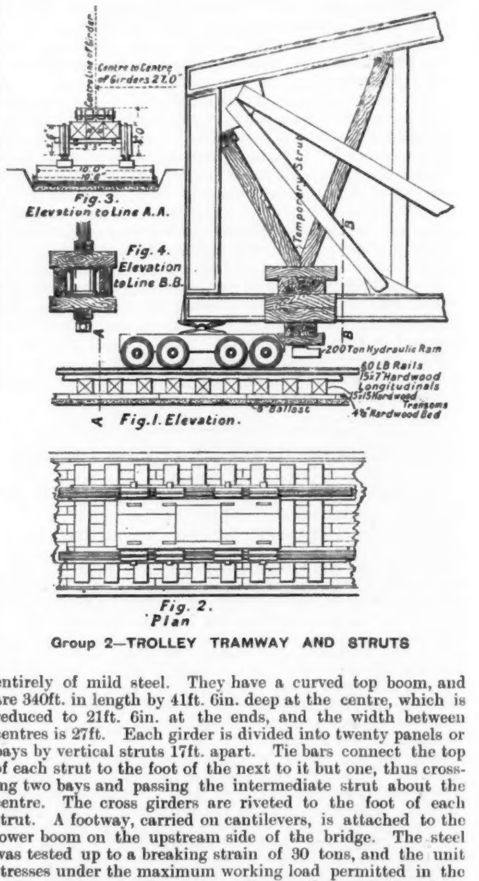
THE Albert Bridge, which we illustrate on page 53 and on page 60, crosses the Brisbane River at Indooroopilly, five miles out of Brisbane City. The river here runs with great force when in flood. In February, 1893, after the phenomenal rains which then fell, all record flood levels were eclipsed, the water covering places which had hitherto been considered well above flood level. Farms, houses, bridges, were all alike swept away before the rushing torrents, and the devastation will long be remembered by the hundreds of ruined inhabitants of Queensland.

Among the many bridges destroyed was the Albert Bridge, and until a new bridge could be built, Brisbane and all the northern parts of the Colony were cut off from direct railway communication with the southern Colonies. The destroyed bridge consisted of eight spans—one of 160ft., six of 80ft., and one of 40ft. The four southern spans were not carried away, although two of the supporting piers collapsed, causing the girders to be balanced on the two remaining piers. Piles were driven to replace the two piers, and this part of the old structure was afterwards used as staging whereon to erect the new southern span.

To cause as little obstruction as possible to the *dèbris* which is down the stream on the flood waters, it was decided that instead of having seven piers in the river as formerly, the new bridge should consists of two spans having only one pier in the river. This pier was built of concrete encased in an iron caisson to low-water mark, then masonry facework with concrete hearting to the bearings of the girders.

The wrought iron caisson was provided to reach the foundation for the centre pier. It was elliptical in shape—see page 53—51ft. across the major axis, and 21ft. 6in. across the minor axis, by 74ft. in height. It has an outer and inner shell of plating 4ft. apart, and well braced together by angle irons. The lower 6ft. of the inner shell was bevelled outwards, meeting the outer shell at the base and thus forming the cutting edge. The space between the two shells was water-tight, and this provided the buoyancy chambers. Concrete was put in these chambers as required to sink the structure. Two cross walls were also provided, which divided the caisson into three wells through which dredging operations were carried on.

The girders for the superstructure—see page 53—are built entirely of mild steel. They have a curved top boom, and are 340ft. in length by 41ft. 6in. deep at the centre, which is reduced to 21ft. 6in. at the ends, and the width between centres is 27ft. Each girder is divided into twenty panels or bays by vertical struts 17ft. apart. Tie bars connect the top of each strut to the foot of the next to it but one, thus crossing two bays and passing the intermediate strut about the centre. The cross girders are riveted to the foot of each strut. A footway, carried on cantilevers, is attached to the lower boom on the upstream side of the bridge. The steel was tested up to a breaking strain of 30 tons, and the unit stresses under the maximum working load permitted in the various members will vary according to the work they have to perform, from 4·5 to 7 tons per square inch.



Group 2—TROLLEY TRAMWAY AND STRUTS

Erection.—Immediately the contract was let the contractors imported new machinery from London, and erected workshops on the river bank, where the whole of the ironwork was manufactured, the raw material only being imported. The first 20ft. of the caisson was built on a slip at the water's edge, from whence it was launched, the remaining portion being built up as the caisson was sunk. Guide piles were driven to keep the structure in its correct position, and so well did they answer their purpose that on completion it was found that the caisson had deviated from the centre line only 2in. From highest flood level the depth of water is 89ft., but at ordinary mean tides it is 42ft. After the caisson was placed between the guides, 33ft. of gravel was dredged out before the rock was touched, and then 3ft. of rock was removed, leaving an even bearing for the caisson. The rock was taken out by divers, the air being supplied by a small compressor. Removing the rock proved a very tedious and hard work, but an excellent foundation was formed. The weight carried on the foundation is between seven and eight tons per square foot.

Launching the girders.—The most important part of the undertaking was the method adopted for building and launching the northern span, as illustrated on pages 60 and 53. It was built partly on shore and partly on piles, see—page 60—it being necessary to build the outer end on piles in order that it might be extended over the water sufficiently to allow the hulk to be floated beneath it. The shore end of the span was carried on two trollies—Group 1, Figs. 1 and 3 of the an-

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[5] "Steam on Common Roads," by John McLaren, excerpt "Minutes of Proceedings" of the Institution of Civil Engineers."

ERECTION OF THE ALBERT BRIDGE, INDOOROOPILLY, QUEENSLAND

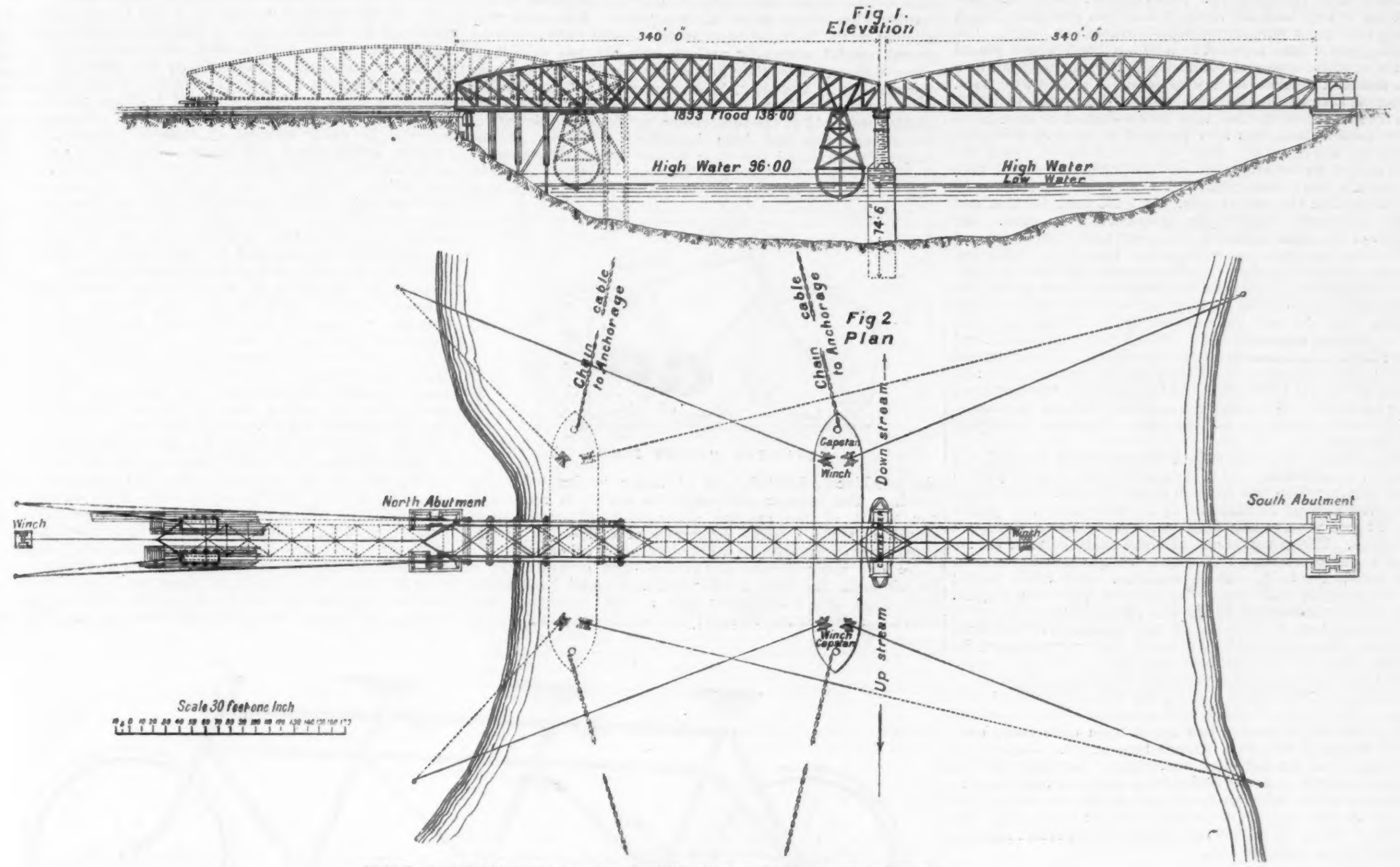
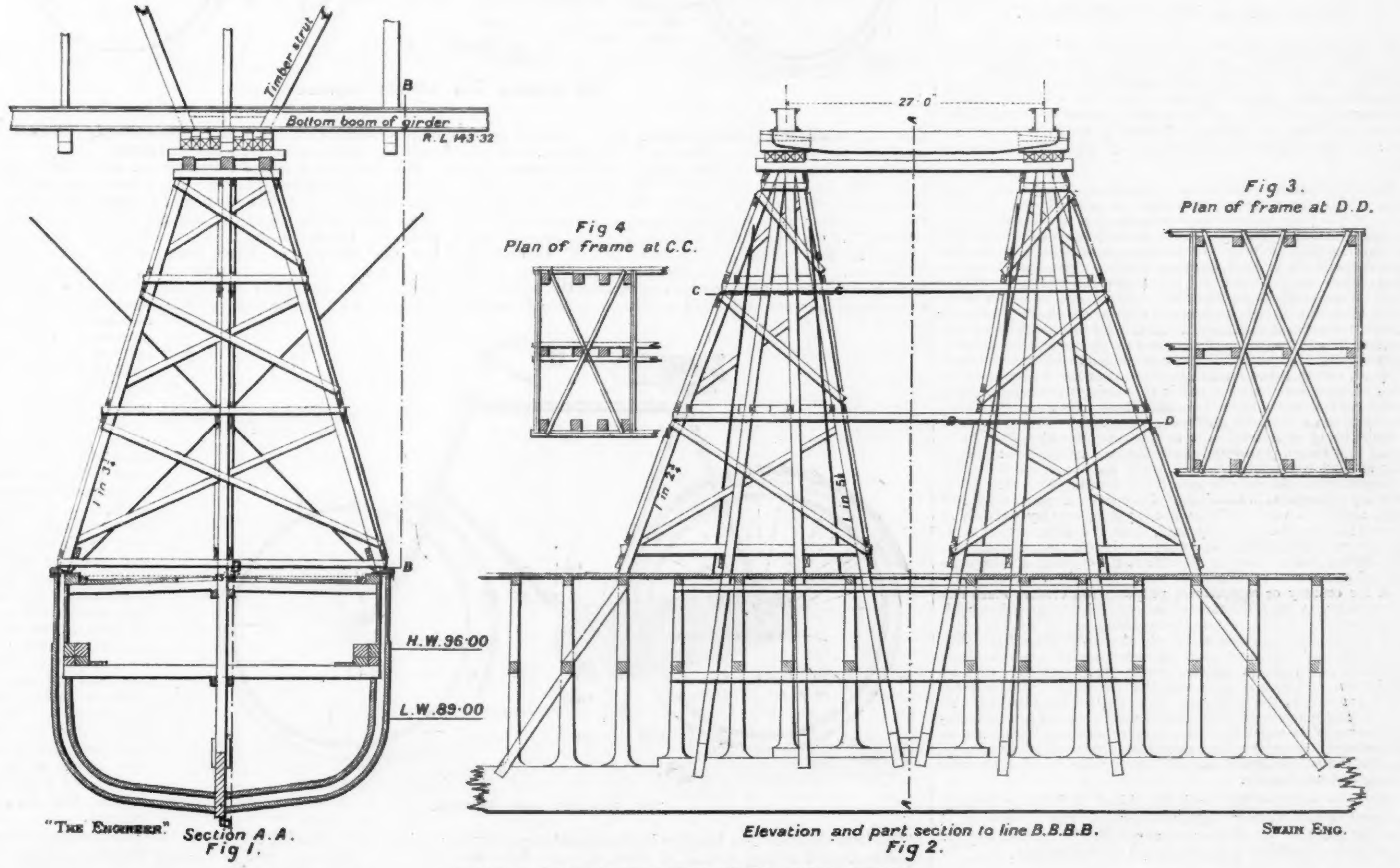


Fig 1.
Elevation
340' 0"
340' 0"
1893 Flood 138·00
High Water 96·00
High Water
Low Water
74·6
Fig 2
Plan
Chain cable to Anchorage
Chain cable to Anchorage
Capstan
Winch
Winch
Capstan
Down stream
Up stream
North Abutment
South Abutment
Winch
Winch
Scale 30 feet-one Inch

GROUP 1—ARRANGEMENTS FOR CONNECTING NORTH SHORE GIRDER


Timber strut
Bottom boom of girder
B
R.L. 143·32
1 in 3¼
B
H.W. 96·00
L.W. 89·00
27' 0"
Fig 4
Plan of frame at C.C.
Fig 3.
Plan of frame at D.D.
C
D
1 in 2¼
1 in 5¼

"THE ENGINEER." Section A.A. Fig 1.

Elevation and part section to line B.B.B.B. Fig 2.

SWAIN ENG.

GROUP 3—STAGING TO CARRY NORTH SHORE GIRDER

nexed engravings—each formed of eight cast iron wheels 2ft. 6in. diameter running loose on 6in. steel axles. The body of each trolley was built with three iron bark timber baulks 18in. × 18in. × 14ft. long, between which were inserted two 18in. × ¾in. wrought iron plates, the whole being securely bolted together and clamped to the axles. These carried the load—140 tons on each trolley—without deflection, and distributed it over 14ft. of the road. On the trollies were placed pivoted bearings for the ends of the girders to rest upon; this allowed for the vertical movement to take place with the rise and fall of the tide. The girders were built high enough to allow the trollies to be placed in position, but as it would be necessary to ease the weight off the trollies to remove them, timber struts—Group 2, Fig. 1—of 20in. diameter iron bark, having their base in front of the trolley, and 8ft. from the end post, were inserted to transmit the load to the various members, and under these struts 200-ton hydraulic jacks were used to free the trollies, and eventually to lower the span the 4ft. necessary to place it on its permanent bearings. The road laid down to carry the trollies—Group 2, Figs. 1, 2, and 3—was over a foundation of clay. It was dug out 10ft. 6in. wide. Six inches of ballast was first laid down, on top of which was laid, breaking joint, sleepers 9in. × 4½in. On the sleepers were 15in. × 15in. transoms 15in. apart, and on the transoms the longitudinal bearers 15in. × 7in. There were two 60 lb. rails on each bearer bolted together, and dogged down every 2ft.

The outer or river end of the span was carried into place on the old barque Jennie Parker, which has a tonnage of 1600 tons, the weight carried by her being about 320 tons, in addition to the weight of the staging and 200 tons of ballast. The ballast was limited to 200 tons on account of the shallow water on the north edge of the river, but to assist in steadying the vessel four booms, weighing ten tons each, and which just floated, were hung to the sides of the ship, and the vessel was braced to the girders by the four steel ropes—1¼in. diam.—as shown, Group 3, Fig. 1. Strong timber towers were built up on the barque, the centre members being carried down to the keelson—Group 1, Fig. 2. The centre of the lifting power was placed under the third strut, or 34ft. from the end of the girders, the thrust being distributed to the second and fourth struts by means of four piles 20in. diameter, and well braced and fixed at the heads similarly to those shown on Group 2, Fig. 2. It was necessary to allow the outer bay to overhang in order that the end pillars would reach their permanent position when the vessel reached the pier. The height of the towers was fixed so that they would reach the under side of the girders at quarter tide. On the day of the launch there was a 4ft. 2in. tide, and when the water had risen 3ft. 6in., it was found that all the temporary packing pieces were free, and that the span was carried on the ship and the trollies only. The outer tiers of piles were thrown over into the river, the operation taking about an hour, and everything was then ready for the span to be moved forward. The barque was moored up and down stream by two cables run out 600ft. and attached to 3-ton anchors, a second cable being run out up stream and attached to two trees, to be available in case of a westerly wind springing up. Four quarter lines were also laid out to help keep the vessel in a correct position. These cables and wires were controlled by winches on board. The hauling power was supplied by a 20-ton hand winch placed on the opposite span and connected to the moving span by a 1in. diameter flexible steel wire rope. A second wire, 1¼in. diameter, attached to the rear end of the girder, to which was rove a six-fold flexible wire tackle hauled by an 8-horse power steam winch, was also provided in case of necessity, but it was not required. The barque was placed under the span at low water 11.30 a.m. on June 29th, and at 4.25 p.m. the launch was commenced, and 90 minutes later the span was landed on the centre pier. At 10.55 p.m. the tide had fallen sufficiently to allow the barque to be removed. The weight of the span as launched was 600 tons.

The southern span was built on the top of the remaining portion of the old bridge, and consequently 5ft. 6in. too high. After completion the chocks were removed except at the two extremities, and the old girders cut away and lowered into punts. The new span was then lowered to its place by means of two 200-ton hydraulic jacks. When the permanent level was reached the span was 5in. too far south. A dozen turned rollers, ¾in. diameter, were then placed between the sole plates of the end pillars, and the bearings and the span were then readily moved forward the required distance by heaving on two 6-ton union screws, the whole operation occupying but 2¼ hours.

The bridge is the largest in Australia which is wholly of colonial manufacture, and it is exceeded only by the Hawkesbury Bridge, which was built in Great Britain. The bridge has given general satisfaction to all concerned, and proves that as good work can be done in Australia as in European countries. The principal quantities of material used are:—Steel in superstructure, 1200 tons; wrought iron in caisson, 250 tons; Portland cement concrete, 3400 cubic yards; masonry, 52,000 cubic feet. The contract price was £66,061. The bridge was designed by Mr. H. C. Stanley, Chief Engineer for Queensland Railways, and the methods of erection, including the launching of the north span, were planned by Messrs. John McCormick and Son, the contractors, under whose personal supervision the entire work was carried out.

On August 17th, before opening the bridge to traffic, it was tested. Each span was built with a camber of 6in. The first test consisted of placing two trains upon each span, each train weighing 260 tons, or 520 tons in all. Under this stationary test the deflection was 1·95in. Secondly, the two trains were run on to the bridge from opposite directions, at a speed of thirty miles an hour, and timed to meet in the centre of the span. Under this test the deflection was 1·68in. When the loads were removed it was found that the deflection was removed also.

MECHANICAL ROAD CARRIAGES.

AMONG the many applications of mechanical road carriages it is expected that the carriage of farm and market garden produce will be one of the most important. and that this is thought probable may be gathered from the article by Mr. F. S. Courtney, M.I.C.E., in the current quarterly journal of the Royal Agricultural Society. Referring to THE ENGINEER offer of prizes and the conditions of trial, Mr. Courtney says:—

> These trials should prove of the utmost interest, as the conditions under which they will be made conform more nearly than those of either of the Paris trials to the requirements of this country. All the most successful petroleum motors in the Paris trials used a light oil with low flashing point. In the above conditions, however, the regulations of the Royal Agricultural Society with regard to petroleum motors are confirmed, and only heavy oils will be permitted. This will necessitate considerable modifications, and it is to be hoped that some of the English manufacturers who have given such attention to working with heavy oil may, before the trials take place succeed in arriving at an efficient and simple combination of carriage and motor. Racing, moreover, is precluded by the regulations as to speed, and this should result in more attention being given to other essential requirements, and in the carriages produced being of a stronger and more useful type than those which might be built merely to run a race over a 200-mile course.
>
> There being no restriction as to the type of motor, it is to be hoped that steam, petroleum, electricity, and compressed air or gas may all find representatives. Though for use in towns, where arrangements might easily be made for re-charging, electricity offers so many advantages in the absolute freedom from smell, noise, and heat, and is so very easily handled, yet in country districts at present it cannot be generally used, since the difficulties as to re-charging would necessitate an excessive weight in the accumulators. This difficulty of re-charging also affects the question of using compressed gas or air in the ordinary way. It would seem, therefore, that for country or agricultural purposes the contest must rest between steam and petroleum, either of which may provide us with a self-propelled vehicle superior to anything yet produced, which shall travel along the roads noiselessly at a speed of not less[*] than ten miles per hour, and shall be under perfect control. Both engineers and carriage builders are busying themselves with its production, and we may be assured that the vehicle will be forthcoming so soon as the restrictions as to its use are removed. To obtain their removal, all interested should be agreed as to the precise nature of the regulations they consider necessary for the reasonable safety of the public, which should, as far as possible, be enforced by the central authority rather than by the various Councils throughout the country.

We may mention that with the object of helping towards a repeal of the existing legal restrictions, the proprietor of the *Autocar* has followed our example and is circulating for signatures a petition to be presented to Parliament.

ELECTRIC LIGHTING BY LOCAL AUTHORITIES IN THE METROPOLIS.—The advisability of the establishment of public electricity supply works in the Metropolitan districts is a question that is now being prominently pressed forward by the various local authorities. Works are in operation at St. Pancras, Hampstead, and Ealing, and the Islington Vestry Works are announced to be ready for opening on March 4th. The latest local authority which has decided to undertake the duty of providing a public supply of electricity for its parishioners is the Battersea Vestry, and they have taken the novel course of offering premiums to consulting engineers and contractors for the best schemes, reports, designs, plans, and estimates, for lighting the parish, the schemes to be submitted to an engineer of eminence for an independent report. In response to the invitation, 21 schemes have been sent in and they are now under the examination of Mr. Robert Hammond, M.I.E.E., of London, who has been appointed the Vestry's electrical adviser on the subject.

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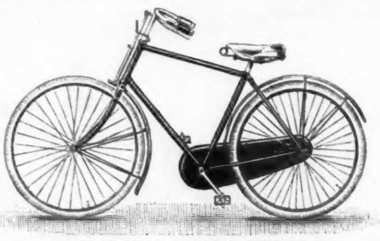
[*] Mr. Courtney probably meant to say at speeds up to ten miles per hour.—[Ed. E.]

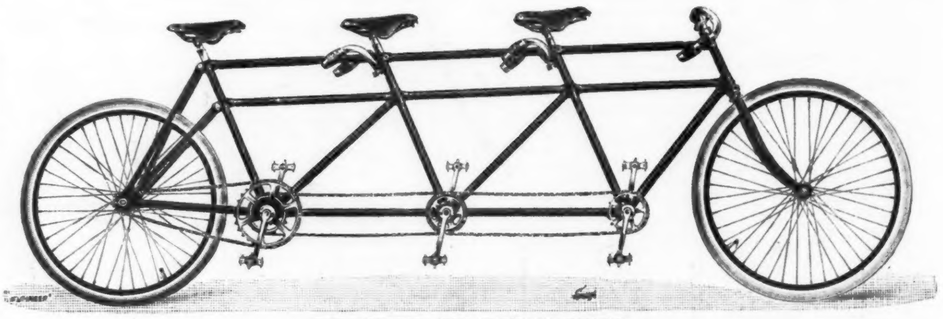
RECENT CYCLE EXHIBITIONS.

IN our impression of the 29th November we mentioned some of the cycles and cycle details as exhibited at the Stanley Club Cycle Show at Islington. This show was followed by the National Show at the Crystal Palace, and by several special shows by makers who did not exhibit at either of these. The latter include the Humber Company, as representing its Coventry, Wolverhampton, and its Beeston Works; and the Coventry Machinist Company, whose exhibition was held at the show rooms in Holborn. Several of the makers who had been important exhibitors at the National were absent this year, either by re-attendance at the Stanley or at the special exhibitions. Visitors looked in vain for any very striking novelties, but a large proportion of the machines exhibited were of better workmanship and finish. The greater uniformity in design is apparently the result of the gradual elimination of unsatisfactory detail, and the general concensus of opinion as to the superiority of the safety form of bicycle over all others.

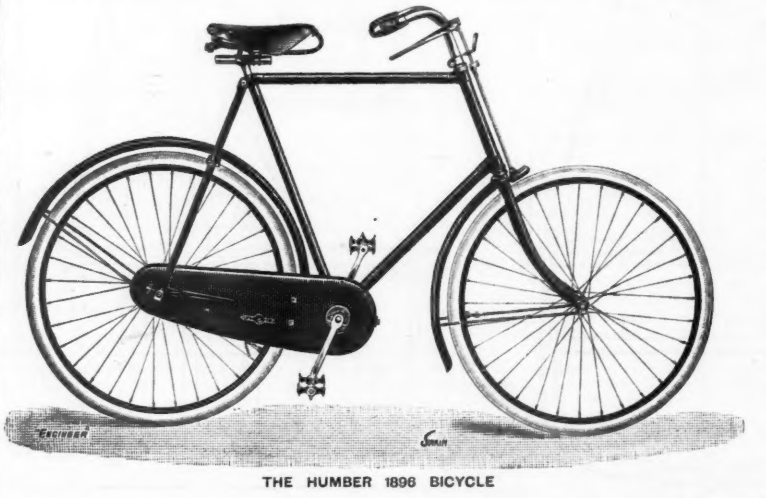


STARLEY'S "ROVER COB"

No one now exhibits any of the once general type of bicycle with the high front wheel and small back wheel, known as the "ordinary," but a few machines were shown of the front driver type, some of them having the very small front geared wheel which is used in the machine known as the "Bantam," all these front gear machines being made by the Crypto Cycle Company, and fitted with the Crypto hub gear. The Safety type, however, originated in its modern form by Messrs. J. R. Starley and Co., who, rather more than ten years ago, brought out the "Rover," is the type which, with, the modified form of frame known as the "Humber" pattern, is the favourite the world over. The Humber machines have in this respect, and in matters of detail, provided the essentials of the best designs now adopted in what one might call the consolidated pattern of the 1896 bicycle. The honours in these matters are pretty equally divided among several of those who are deservedly known as the best makers. Recent modifications do not excite much notice, although on numerous points to which the more intelligent cyclists pay particular attention, much might be said.



THE HUMBER 1896 TRIPLET BICYCLE



THE HUMBER 1896 BICYCLE

In the very large collection of machines lately exhibited one thing was particularly noticeable, the very large number of machines now made for female riders, the main difference between these and the machines for men being the absence of the top bar of the diamond frame; to make up for the absence of this important strut member, various designs of frame are adopted. One of the best patterns for the ladies' machine is that originally brought out as the "Psycho" pattern, but modified and improved in the Coventry make of the Humber machine. In this form one large curved tube forms the nearly vertical portion carrying the seat pillar and the member which grasps the head, this tube being curved downwards and receiving the crank bracket at the lower part of the curved loop. The next most satisfactory pattern is the Humber ladies' machine as made at the Beeston Works. In some of the frames for these machines, the designers' unsuccessful struggle with straight tubes to make a frame which is satisfactory from the mechanical and æsthetic points of view, is amusingly obvious, and there is room yet for improvement in design in this respect.

One of the causes of the success of the Crypto Cycle Company with the Bantam type of machine is the facility with which riders can mount the saddle while one foot still remains on the ground, and correspondingly can touch the ground with the foot when it becomes necessary to stop, this advantage being more particularly prized by those who learn to ride or continue to ride late in life. This advantage may, however, be easily secured by suitable proportion of the ordinary safety frame, and many riders have had frames made with the object of getting a low crank bracket and low seat pillar. Messrs. J. K. Starley and Co. exhibited the machine designed with this object, which we illustrate by the annexed engraving. It is known as the "Rover Cob," and enables those riders who find mounting by the step, or dismounting from it, attended by some risk, to throw the leg easily over the saddle and push off from the ground. In other respects this machine is similar to the usual pattern of "Rover," and no doubt Messrs. J. R. Starley and Co. will find this a favourite machine, more particularly for the elderly riders, so many of whom now have to learn to use a machine so as to accompany their cycle-riding youngsters. Many, however, do not require this excuse, for every year adds many hundreds, and probably many thousands, to those who late in life are finding that the bicycle provides the most enjoyable means of health-giving exercise.

At the special exhibition of cycles at the Aquarium, the Humber Company showed a number of tricycles of the rear driving pattern, and some new patterns of tandem machines, one of them from their Coventry works being an open front tandem bicycle with a ladies' seat in front. They also showed a new type of the tandem machine for three riders, as shown in the annexed engraving, machines of this class being much sought by athletic riders who like to cover great distances in a short time. The wheels of these machines are slightly heavier than those used in the single rider bicycles, and their success, and that of the pneumatic tires on which they run, affords valuable evidence as to loads that can be carried by such very light structures when well made.

The Humber roadster machine of the 1896 type is shown by the engraving below. These machines are remarkable illustrations of the evolution of a successful machine by very minute attention to the dictates of very extensive experience. Great strength is given where this is necessary, but the material is paired down to the last quarter of an ounce, where the purpose can be effected without weight. The Humber Company also exhibited a number of machines with spring frames, but without trial of this type of machine it would be unwise to express an opinion. Spring frame machines with considerable range of spring have in very small numbers been made for years, but most riders find sufficient spring movement in the saddle and pneumatic tires, and do not favour frames which need in their construction several moving parts. All the machines we have illustrated have wheels the spokes of which are of the tangent pattern; in fact, very few makers are now using the direct or radial spoke, experience having shown that the stress upon the spoke is much less severe with the larger hub flange from which the spoke is tangent.

Among the steering locks to which attention may be drawn is a very simple one used in the new Humber machine, consisting of a pin which, when inserted in the lugs on the fork collar and frame head, is fixed there by a small key carried by the user, the pin itself being also carried when the machine is in use, so as to avoid all possibility of the lock accidentally coming into action. The Premier Cycle Company still use the helical tubing for their frames, and the Raleigh Cycle Company has to some extent modified its designs, which are now very similar to those of the Humber Company. Some machines exhibited had wheels the hubs of which were exceedingly narrow between the spoke flanges, a great defect, inasmuch as the wheels either easily buckle or great stresses are thrown on the spokes by comparatively light side stresses at the tire. The Centaur Cycle Company uses for the back wheel a hub which is particularly well designed, with a view to placing the ball races at a maximum distance apart, thus reducing the pressure upon them and the balls under side stresses on the wheels and under the pull of the driving chain.

A very important part of the National Show was that in which the very numerous forms of pneumatic tires were displayed. Amongst those tires which are apparently designed with a view to novelty and freedom from infringement of the two or three leading patterns, and which have some points which recommend, are those known as the Grappler and another named the Humber. In the former the outer cover is provided with closely placed hooks very slightly raised above the surface of the material, and these very easily catch into the inwardly turned over edge of the rim, the rim not being dovetailed in form but a complete hook. The tire named the Humber has within it an aluminium ring which sits upon the edges of the outer cover, and when the inner tube is filled with air it bears upon the aluminium ring and the latter keeps the outer cover in its place.

Several noticeable forms of brakes were exhibited, amongst others of Mr. Terrell, Q.C., in which a segment of several inches in length is brought into action on the hind wheel by hydraulic pressure from a little cylinder on the handle bar, connected to a similar cylinder on the brake by means of an india-rubber tube. Erskine's brake, which acts on the rim of the front wheel and does not touch the tire, was also exhibited, and is very favourably spoken of.

The manufacturers of machine tools used by cycle manufacturers were represented on a large scale, but to these we must refer on a future occasion.

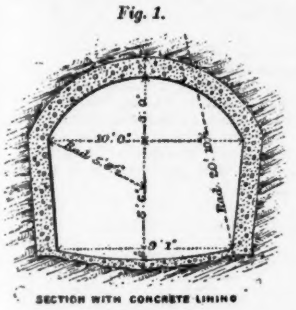
OBSERVATIONS ON THE FLOW OF WATER IN THE NEW AQUEDUCT FROM LOCH KATRINE: GLASGOW CORPORATION WATERWORKS.*

By ALEXANDER FAIRLIE BRUCE, M Inst. C.E.

THE object of the following notes is to give the results of some observations made by the author on the flow of water in the new aqueduct connecting Loch Katrine with Glasgow, with the view of determining the value of the coefficient of friction *n*, in Kutter's formula,[1] for such channels, and of ascertaining the comparative value of velocities obtained by the use of floats.

For about 53 per cent. of its length the aqueduct is lined with concrete—Fig. 1—which was built in the usual way, in 12ft. or 15ft. lengths, generally the former. Open frames of 6in. by 2in. battens were first placed in position, and ¾in. tongued and grooved boards, smeared with soft soap, nailed to them horizontally as the concrete was filled in. Every possible precaution was taken by working with spades, to obtain a good face, and except where some defects showed themselves, no rendering was afterwards necessary. The whole of the invert was concreted, and floated with a steel float, whether lining was required or not, and, as shown in Fig. 2, the unlined portions are made 2ft. wider than where lining is required in order to allow for the additional friction. This increases the available area, when the aqueduct is running full—*i.e.*, a foot above the springing level of the arch—from 64·866 square feet to 78·280 square feet, and the hydraulic mean radius from 2·869 square feet to 3·106 feet; or 21 per cent. and 8·25 per cent. respectively. These increased values were fixed upon by Mr. J. M. Gale, in designing the works, on the basis of the values of *n*, found by him experimentally for the lined and unlined portions of the old Loch Katrine aqueduct, which proved to be 0·0184 and 0·025 respectively. The part of the aqueduct selected for experiment is perfectly straight, extending from the access chamber at High Lettre to that at the Blairgar aqueduct bridge, a distance of 1921 yards. Rather more than half of it is lined, and the gradient is 1 in 5500. The depth of water flowing in the aqueduct was measured on the gauge rods in the chambers, and the true mean velocity was arrived at by dividing the quantity of water measured over the gauge weir at Mugdock reservoir[2] by the area of flow in the aqueduct. The results are given in Table I. in the Appendix.

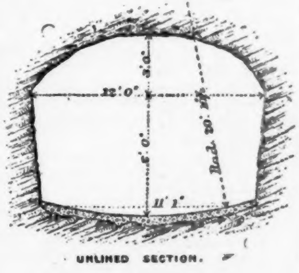
Fig. 1.



SECTION WITH CONCRETE LINING

Scale, ⅛in. to 1ft.

Fig. 2.



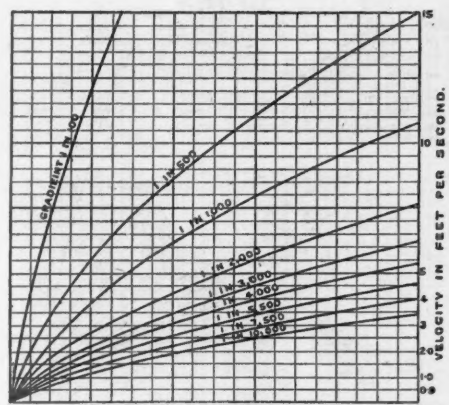
UNLINED SECTION.

Scale, ⅛in. to 1ft.

For comparison with the above experiments surface floats were used, made of circular pieces of wood 1¾in. diameter and ¾in. thick, and rod floats 1in. diameter and 2ft. 2in. long, weighted with lead, so as to be immersed to the extent of 1ft. 9½in., and painted white; hooks were screwed into the top to enable them to be more easily recovered, and each set of floats was numbered from 1 to 10. The floats were placed in the water, at intervals of between 30 seconds and 45 seconds, in the middle of the chamber, and timed as they entered the tunnel. Five or six of each series were usually between one minute and two minutes slower than the mean, owing, probably, to their having been caught and detained in eddies in the unlined portion. These were rejected, and the results given in Table I. are the means of the four or five remaining, which usually came within thirty seconds of each other.

It would appear from these experiments that velocities obtained by the use of the surface floats are, in such cases, unreliable; those in the present instance giving a result, if Darcy's formula[3] be applied to calculate the mean from the surface velocity, about 18 per cent. less than the correct figure. On the other hand, though the velocities obtained by the red floats fluctuated somewhat, they gave a mean result of only about ¾ per cent. less than the true mean, which is a sufficiently close approximation for most purposes.

Fig. 3.



The values deduced for *n* vary between 0·0119 and 0·0129, the mean being 0·0124, except in one or two cases, where, perhaps, there was some slight uncertainty in reading the quantity flowing over the gauge weir, the variation being generally only about 0·0001 on either side. This value is half-way between those given by Kutter, for "unplaned planks," and "ashlar and brickwork," and agrees with Mr. W. J. B. Clerke's figures for the aqueduct in connection with the Tansa Waterworks for the supply of Bombay.[4] The large value obtained by Mr. Gale, in his experiments on the lined portion of the old aqueduct, is no doubt due to its being lined with masonry, the joints of which are very open, all the mortar having been washed out of them. This causes the formation of eddies, thereby greatly increasing the surface friction. The velocities of discharge have been calculated for various values of *m* and *i* when $n = 0·0125$, and the velocity curves—Fig. 3—have been plotted from them.

Some observations on the discharge of the syphon pipes across the Blane Valley are given in Table II. in the Appendix. There are two lines of 48in. pipes, 3557ft. long, which, at the date of the experiments, had been laid between two and three years, and charged with water four months, so that they had been exposed to a certain amount of corrosion. The volume discharged was measured at the gauge basin, as in the case of the aqueduct experiments, and the levels of the water, both at the valve chamber where it enters the pipe, and at the basin where they deliver it again into the aqueduct, were carefully measured. The quantity delivered by the pipes for various hydraulic gradients is given in Table II., and is practically identical with that obtained by calculation, using Professor Unwin's modification of Darcy's formula, for new pipes coated with pitch;[5] viz., $v = 69 \sqrt{di}$, where *v* is the velocity of the water in feet per second, *d* the diameter of the pipe in feet, and *i* the hydraulic gradient.

In conclusion the author desires to express his indebtedness to Mr. Gale, chief engineer to the Glasgow Corporation Waterworks, for the facilities granted him for making the above experiments.

The paper is accompanied by two tracings, from which the figures have been prepared.

APPENDIX.

TABLE I.—*Observations on the Flow of Water in the Aqueduct at Different Levels.*

Depth of water in aqueduct.	Cross-sectional area of stream.	Discharge over gauge weir.	Mean velocity	Hydraulic mean radius, *m*.	Coefficient of discharge, C.	Coefficient of friction, *n*.	Surface velocity by floats.	Mean velocity by weighted rods.
ft. in.	sq. ft.	cu. ft. per sec.	ft. per second.	feet.			ft. per sec.	ft. per sec.
1 8⅝	14·225	26·620	1·8714	1·2273	125·35	0·0123	2·1139	—
2 1⅞	18·299	37·863	2·0691	1·4713	126·58	0·0125	—	—
2 1⅞	18·299	38·567	2·1076	1·4713	128·93	0·0123	—	—
2 2⅜	18·692	41·423	2·2161	1·4896	134·59	0·0119	—	—
2 2½	18·788	39·986	2·1283	1·4982	128·88	0·0124	—	—
2 2⅝	18·888	40·702	2·1549	1·5002	130·41	0·0123	—	—
2 3¾	19·765	42·890	2·1750	1·5469	129·62	0·0124	2·1836	2·1631
2 5	20·774	45·832	2·2062	1·5990	129·33	0·0125	2·2600	2·1986
2 5	20·774	45·832	2·2062	1·5990	129·33	0·0125	2·2554	2·2309
2 5	20·774	45·832	2·2062	1·5990	129·33	0·0125	2·2422	2·2095
2 5	20·774	45·832	2·2062	1·5990	129·33	0·0125	2·2621	2·2020
2 5	20·774	45·832	2·2062	1·5990	129·33	0·0125	—	2·1970
2 5⅛	20·857	46·582	2·2334	1·6071	130·58	0·0125	2·2571	—
2 5¼	20·931	46·582	2·2255	1·6105	130·14	0·0125	2·2340	—
2 5½	21·132	47·335	2·2451	1·6208	130·72	0·0124	2·2275	2·1911
2 5¾	21·330	48·092	2·2547	1·6270	131·02	0·0124	2·2466	2·1680
2 8¾	23·687	53·504	2·2588	1·7403	126·92	0·0129	2·2335	2·2215
2 11¼[6]	25·627	53·504	2·0845	1·8122	135·58	0·0121	2·1271	2·1054

[6] The sluice on one of the Blane syphon pipes was closed, so the water was dammed back to a surface slope of 1 in 7711.

TABLE II.—*Discharge of 48in. Pipes for Varying Hydraulic Gradients.*

Ruling gradient.	Discharge of pipe measured at gauge weir.	Velocity.	Discharge calculated by formula.	Velocity by calculation.
	cu. ft. per sec.	ft. per sec.	cu. ft. per sec.	ft. per sec.
1 in 5928	1352·6	1·798	1347·6	1·787
„ 5081	1487·6	1·908	1455·7	1·930
„ 3785	1628·9	2·161	1686·6	2·237
„ 1423	2750·0	3·649	2750·9	3·648

THE INSTITUTION OF CIVIL ENGINEERS.

THE SANITARY WORKS OF BUENOS AYRES.

AT the ordinary meeting on Tuesday, the 14th January, Sir Benjamin Baker, K.C.M.G., the President, in the chair, the paper read was on "The Sanitary Works of Buenos Ayres; Sewerage, Drainage, and Water Supply," by the Hon R. C. Parsons, M.A., M. Inst. C.E.

The city of Buenos Ayres, situated on the western shore of the Rio de la Plata, where it was 30 miles in width, was described as being built upon a bank rising abruptly to a height of 60ft. above the river. Above and below the city were extensive marshes, the soil of which was composed of running silt, whilst the bank upon which the city was constructed was of hard clay. The annual rainfall averaged 33½in., but the district was subject to violent storms, during which 4in. of rain frequently fell in one hour, the wind attaining a velocity of 100 miles. The water supply for the city, amounting to 20,000,000 gallons per day, and drawn from the river 3½ miles above the city, although very turbid, was found, when filtered, to be in every way suited for domestic purposes. For the intake in the river a shaft was sunk, about 1000 yards from the shore, communicating with a tunnel 3½ miles in length of which the first mile was under the river-bed, and which terminated at a point on the outskirts of the city, where the water was pumped into settling-ponds. These ponds, each intended for the treatment of 4,000,000 gallons per day, consisted of continuous channels, 3100ft. in length, through which the water flowed slowly, depositing during its transit a considerable quantity of the suspended alluvial matter. It then flowed on to sand filters, 2ft. in thickness, and passed downwards into covered storage reservoirs constructed beneath them. Subsequently the filtered water was pumped to a height of 162ft. into a large service reservoir in a central position in the city. This reservoir consisted of a series of wrought iron tanks, supported on cast iron columns above the surface of the ground, the whole being enclosed in a building of elaborate architectural design, faced entirely with terra-cotta manufactured in England. The author gave a detailed description of the construction of this reservoir and of the precautions adopted to prevent damage to the structure arising from the expansion and contraction of the ironwork, due to the great variations in temperature which occurred in Buenos Ayres. The tanks were arranged in three tiers, each tier supplying the corresponding zone of the city, according to their respective levels. The capacity of the entire reservoir was 15,888,000 gallons. In addition to the pressure resulting from the levels of these various tanks, arrangements were made by which the water could be pumped at a higher pressure direct into the mains whenever desirable.

The water was distributed through the city by means of five main pipes, varying between 36in. and 24in. in diameter, from which branch pipes passed to each separate block of houses. A uniform arrangement of piping was repeated throughout the city, and a definite position assigned to each valve and hydrant. The internal services of both water supply and drainage were carried out in such a manner as to fulfil modern sanitary requirements.

The sewering of the town was on the combined principle, the collecting sewers being capable of discharging a rainfall of 1½in. per hour, which had been found amply sufficient to carry away the rain which fell during the heaviest storms. The sewers were ventilated by a pipe carried up the front of each house to a height of 6ft. above the roof. This pipe was connected with the branch sewer immediately outside the syphon-trap which cut off the sewer gas from the house. Air was admitted into the sewers by the gratings of the street manholes. The area of the city was divided into separate drainage districts, in each of which the collecting sewers formed an independent system converging to the lowest point, and there communicating with the intercepting sewers. The capacity of these latter was sufficient to carry off a rainfall of ¼in. in twenty-four hours, the difference between this quantity and that conveyed by the collecting sewers during storms being removed by large conduits discharging directly into the river in front of the city. The sewage passed from the collecting sewers of each district to the intercepting sewer over a trough, the capacity of which was limited to the quantity to be conveyed by the latter, so that any larger quantity was forced to overflow into the storm-water conduits. The capacity of these troughs was regulated by means of a valve, and corresponded in each case with the discharge from the district, so that the quantity of storm-water conveyed to the pumping-station was reduced to a minimum. The conduits were for the most part 14ft. wide by 12ft. high, and the total quantity of water conveyed by them was about 9000 cubic feet per second. Over the greater area of the town the sewage found its way by gravitation into the intercepting sewers, pumping being resorted to only for the low districts near the river. In two of the smaller districts the sewage was lifted by steam pumps; but in the large one lying to the south of the city an entirely different method was adopted, consisting of short pipe sewers, 6in. and 9in. in diameter, laid in shallow trenches, the rain water being entirely excluded from them. Over this area the sewage was raised at seventeen points by means of small pumps actuated by hydraulic motors worked automatically from one central power station. The pressure employed was 750 lb. per square inch in the accumulator, and the pressure water was distributed to the motors through about eight miles of hydraulic-pressure piping varying between 6in. and 3in. in diameter. The pumps, which were in duplicate, were placed in wells sunk beneath the roadway, and were started and stopped automatically by floats actuated by the rise and fall of the sewage. The pressure-water was admitted into a ram placed in the centre of the plunger, the return stroke being performed by two small push-back rams, constantly open to the hydraulic pressure. The pumps were 30in. in diameter, some being of 3ft. and others of 4ft. stroke. The area provided for in this portion of the scheme was about 1600 acres, and the ultimate population 200,000. In this district automatic self-closing manhole covers were adopted to exclude the floods, which frequently inundated it. Self-acting valves were provided for flushing the sewers by water supplied from the mains.

The sewage was discharged into the river twelve miles below the city at a point where no trouble was caused by its being washed back. The outfall conduit on leaving the city passed beneath a tributary of the Rio de la Plata, 200ft. in width, by an inverted syphon, consisting of three tubes of cast iron 5ft. high by 2ft. 3in. wide, embedded in concrete and supported on cylinder foundations sunk into the bed of the river. To avoid obstructing the river during construction, these tubes were put together inside large horizontal cylinders of wrought iron, which, after being built on shore, were floated out and sunk into position. The space between the casing and the tubes was then filled with concrete, in which were embedded strong wrought iron lattice girders with the object of giving sufficient strength to span the intervals of 50ft. separating the cylinder foundations, and thus rendering the tubes independent of any support from the soft mud upon which they rested. The abutments of the syphon were also upon cylinder foundations, the body of the abutment being constructed within an annular cofferdam of 14in. piling. As no solid foundations could be obtained for this work, reliance had to be placed upon the depth to which the cylinder foundations were sunk into the soft material of the river-bed. To secure the fall necessary for discharging the sewage at the outfall, a pumping station was erected on the line of the conduit where the whole sewage was lifted a height of 43ft.

The paper was accompanied by tables of the daily consumption of water for the last twenty-one years, and also of the comparative death-rates for the years preceding and of those following the inauguration of the sewerage works, which afforded conclusive evidence that the annual death-rate of the city had been reduced from 32 to 24 per 1000. Details of the cost of the works were given, and showed that about 2½ millions sterling had been expended on the water supply, and 3 millions sterling on the sewerage and drainage, equivalent to £5 10s. and £6 respectively per head of population served. There was also appended a brief account of the political and financial vicissitudes to which the works had been subject since their inception in 1871, which prevented them from being completed until twenty years after their commencement.

THE objects and work of the Electrical Standardising and Training Institution are explained in the *Faraday House Journal* of this month, which includes articles on bitumen conduits, electric light engines at Newport electric welding, and on a Ferranti slow-speed alternator.

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* "Proceedings," Institution Civil Engineers, vol. cxxiii.

[1] $$C = \frac{41·6 + \frac{1·811}{n} + \frac{0·00281}{i}}{1 + \left(41·6 + \frac{0·00281}{i}\right)\frac{n}{\sqrt{m}}}$$

C = coefficient of discharge.
i = sine of the inclination.
n = coefficient of friction.
m = hydraulic mean radius in feet.

[2] Calculated according to the formula: $Q = 3·421\, l \sqrt{h^3}$; where Q is the quantity of water discharged in cubic feet per second, *l* is the length of the weir in feet, and *h* the head above its lip in feet.

[3] $v_m = v_s - 25·4 \sqrt{m \times i}$.
v_m = mean velocity in feet per second.
v_s = surface „ „

[4] "Minutes of Proceedings" Inst. C.E., vol. cxv., p. 27.

[5] *Encyclopædia Britannica*—"Hydraulics, p. 485.

AMERICAN ARMOUR PLATES

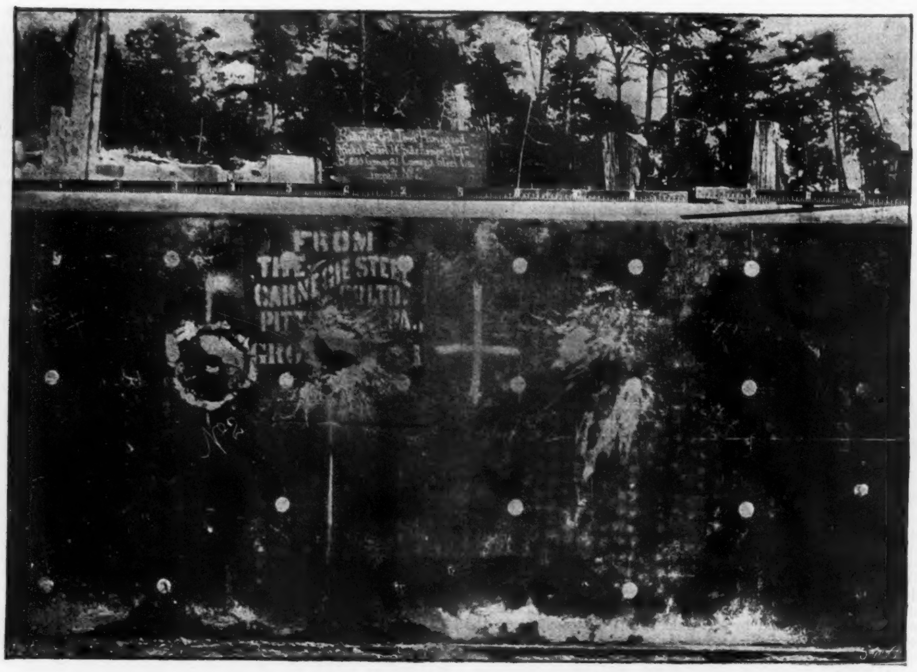


Fig. 1—CARNEGIE DOUBLE FORGED HARVEY 14in. PLATE

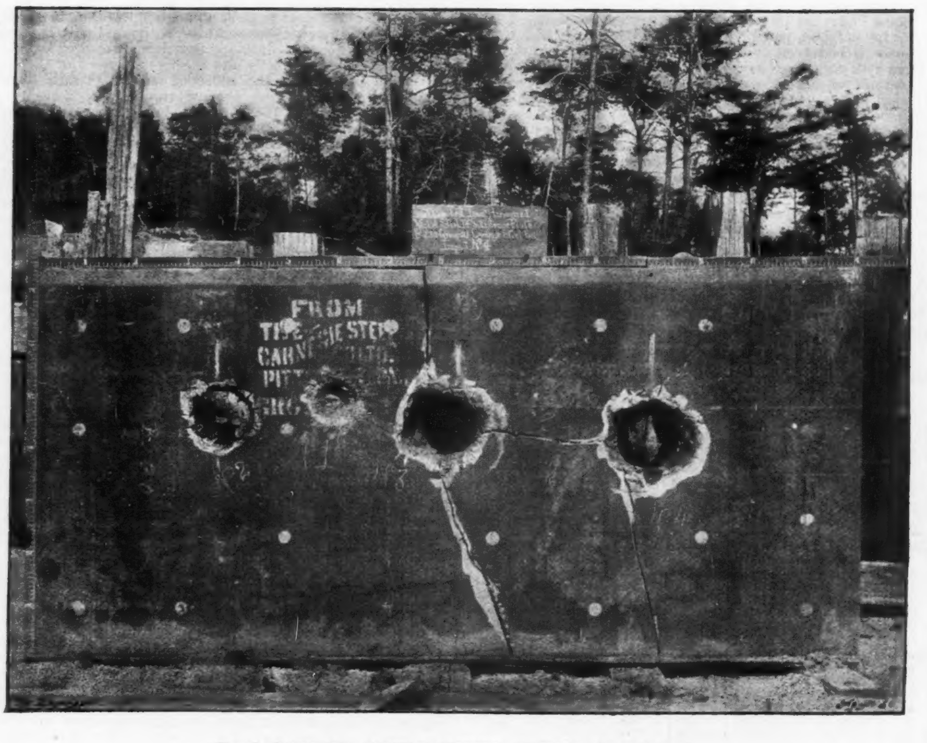


Fig. 2—CARNEGIE DOUBLE FORGED HARVEY 14in. PLATE

DOUBLE FORGED CARNEGIE ARMOUR.

In a paper read before the United Service Institution, Captain Jaques gave the details of a trial of a double forged 14in. plate made by the Carnegie Company. We have now received copies of the four official photographs of this trial. Two of these, however, are sufficient to illustrate the account, one—Fig. 1—being taken before the plate began to crack, and the other—Fig. 2—at the end of the trial. We think it best to give Captain Jaques's account just as it stands, adding a few remarks at the conclusion.

"Ballistic Test of Iowa's Side Armour-Plate.

"On September 4th, 1895, at Indian Head, Md., the Iowa's 14in. side armour ballistic plate was tested. The plate was mounted on backing, and a structure representing a section of the ship's side. The 10in. breech-loading rifle, with Carpenter armour-piercing shell, weighing 500 lb. each were used in the test.

"The left-hand end of the plate as mounted was the bottom end with reference to the ingot. The first point of impact was taken at a point about 10in. above the line of the bevel, and about 2ft. to the left of the middle of the plate. The shots were fired through the screens; the striking velocity as measured was 1482 foot-seconds, the contract velocity being 1472 foot-seconds. The shell broke up on the plate, leaving the point embedded in the face of the plate to a depth of about 3½in.; there were no cracks. The second point of impact was taken about 8in. above the bevel line, and 29in. to the left of the first point of impact. This distance should have been 35in., but as the plate showed no disposition to crack the shot was placed nearer. The velocity on this round was 1856 foot-seconds, the contract velocity being 1859 foot-seconds. The shell broke, leaving the ogival, much distorted, buried to a depth of about 9in. in the plate. There were no cracks. The plate thus passed the contract test with a large margin to spare.

"The third round was fired with the 12in. breech-loading rifle. A Wheeler-Sterling shell, weighing 850 lb., with a striking velocity of 1800 foot-seconds, was used. The point of impact was taken about 30in. to the right of the first point of impact, and about 8in. above the bevel line. The shell broke across the forward part of the body, about two-thirds of the body of the shell being found in one piece in front of the target. The point of the shell penetrated to about the back of the plate, which was cracked across from top to bottom through this impact.

"As the contract velocity for the second shot against a 17in. Harvey plate is 1858 foot-seconds, and as the additional 58ft. would not have caused this shell, although a very good one, to have perforated the plate and backing, it appears that this plate, after having stood the test of a 14in. plate, has passed the test of a 17in. plate. This is a better record than any other thick plate heretofore tested. The 14in. re-forged plate, tested in February last, was perforated by a Wheeler-Sterling shell with 1858 foot-seconds, although it kept out a Carpenter 12in. a.p. shell with the same velocity. This plate, therefore, although a bevelled one, stood a better test than the 14in. experimental re-forged plate of last February.

"A fourth round was fired at this plate later, the point of impact being taken on the right-hand portion. A Wheeler-Sterling 13in. a.p. shell weighing 1100 lb. was fired with a striking velocity of 1800 foot-seconds. The shell perforated the plate, backing, and structure, and was recovered unbroken. The plate was cracked comparatively little."

The excellent resistance of this plate will be better understood if we recall that the second, or higher velocity shot, for an 18in. Harvey plate, with the 13in. gun, requires a velocity of 1810 foot-seconds.

These tests justify the conclusion that the forging after carbonisation, as practised by the Carnegie Company, benefits very materially the body of the plate, while at the same time it does not appear to impair the efficiency of the carbonised surface.

That Captain Jaques' remarks are justified we think the following figures will show. The calculated perforations through iron due to each of these rounds are shown in the table below:—

	Projectile.		Striking velocity.	Perforation.		
				Iron.		Steel.
	Calibre.	Weight.		Maitland or Fairbairn.	Tresidder.	Tresidder.
	inches.	lb.	f.s.	inches.	inches.	inches.
Round 1 ..	10	500	1482	16·0	15·4	12·3
Round 2 ..	10	500	1856	20·4	21·6	17·3
Round 3 ..	12	850	1800	23·5	24·4	19·5
Round 4 ..	13	1100	1800	25·8	26·7	21·4

This 14in. plate then defeated, without cracking, two projectiles, the calculated perforation of the second being 17·3in. of steel untreated. It kept out but broke under the third with 19·5in. calculated perforation. The last round outmatched it. This for a plate of this great thickness is a great feat. We especially lay stress on the thickness, because we have before said thin plates have still greater resisting power, a first-rate 6in. double-forged plate keeping out a 6in. projectile.

The official particulars are as follows:—Fig. 1, official number 424. Ballistic test of Iowa's 14in. double forged face-hardened side armour plate, B-230, group No. 21; the Carnegie Steel Company. Impact No. 2: Striking velocity, 1856 foot-seconds; striking energy, 11,954 foot-tons. Carpenter 10in. A. P. shell, lot No. 11, penetrated about 11in. and broke up; no cracks in plate. Effect on target structure very slight.

Fig. 2, official number 426. Ballistic test of Iowa's 14in. double forged face-hardened side armour plate, B-230, group No. 21; the Carnegie Steel Company; mounted on experimental target structure, representing framing behind the belt armour of the Iowa. Impact No. 4: Wheeler-Sterling 13in. A. P. shell, lot No. 2. Striking velocity, 1800 foot-seconds; striking energy, 24,736 foot-tons; penetration, through plate, backing, framing, target structure, and into sand of butt. Projectile recovered entire.

TEST OF A STEAM ENGINE.

It will be remembered that some time ago we illustrated an engine constructed for Sir Titus Salt, Bart., Sons, and Co., by Messrs. Cole, Marchent, and Morley, Prospect Foundry, Bradford. Since these engines were made the firm have constructed another exactly similar, which has recently been tested by the National Boiler Insurance Company. Below we give the results of the test, which we consider to be very good. Boiler, 30ft. long by 8ft. diameter, having total heating surface of 965 square feet, and a grate surface of 38 square feet; a Green's economiser of 1440 square feet area of heating surface. Engine, high-pressure $15\frac{17}{32}$in., low-pressure $32\frac{3}{32}$in., stroke 3ft. 6in.; cylinder ratio 1 to 4·5. There is a horizontal air pump 11in. diameter of the same stroke as the engine; the ratio of the air pump bucket displacement to low-pressure displacement, 1 to 8·6.

The test was made on November 19th, 1895, with a flying start and a flying finish. The duration of the test was three and a-half hours in the morning and three and a-half hours in the afternoon:—

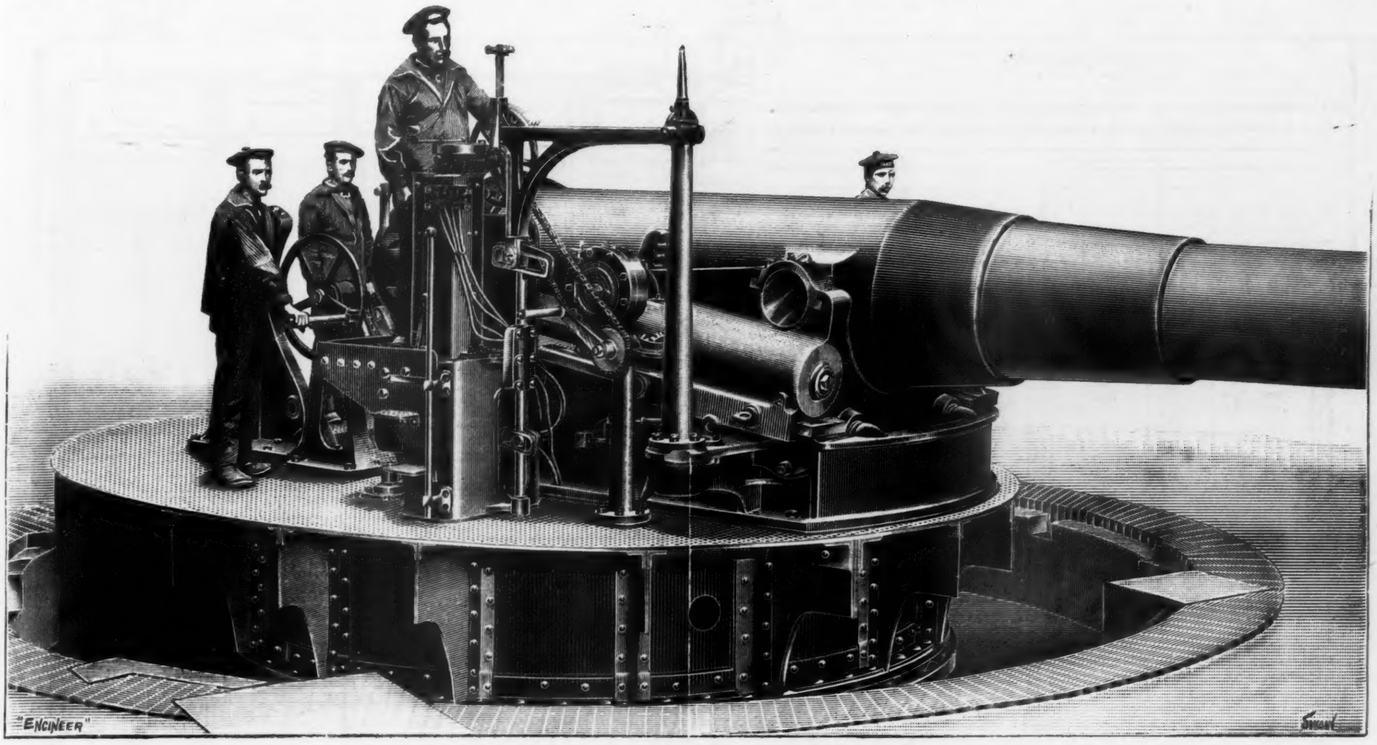
Mean revolutions per minute	83·4
Mean boiler pressure above atmosphere	137
Atmospheric pressure	14·5
Vacuum in condenser, per gauge	12 lb.
Vacuum in low.pressure cylinder, per indicator	10·8 lb.
Mean temperature of injection water	71 deg.
Mean temperature of hot well water	106·5 deg.
Mean temperature of feed to economiser	107 deg.
Mean temperature of feed to boiler	254 deg.
Mean total indicated horse-power	344·6
Mean weight of steam used per indicated horse-power per hour	14·25
Evaporation of water per pound of coal	9·18
Evaporation of water from and at 212 deg.	10·6
Weight of coal per indicated horse-power per hour ..	1·55
Weight of coal per square foot of grate per hour, in lb.	17

The insurance company report as follows:—"Throughout the test the running of the engine was highly satisfactory." The figures given above are the mean of the morning and afternoon test.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—Fleet Engineer: Richard S. Hamm, to the Endymion. Staff Engineer: Richard G. Willby, to the Northampton. Chief Engineer: Edwin C. Carnt, to the President, additional, for service at the Admiralty. Engineers: Wm. H. Wood, to the Victory, additional, as assistant to chief engineer in charge of drawing-office, Portsmouth; Arthur R. Grant, to the Pembroke, and Ernest Haves, to the Victory. Assistant Engineers: Walter Stokes, to the Majestic; Henry M. S. Tuckwell, to the Repulse; and Percival R. T. Brown and William P. C. Spriddle, to the Endymion. Mr. E. Carnt, chief engineer, who has been employed for some time in the chief engineer's office in the dockyard, having been transferred to the Admiralty, his place in the yard has been taken by Mr. Wm. N. Wood, engineer, serving in the Majestic.

Electric Lighting of Stone Quarries.—Electric lighting for outside industrial concerns has not up to the present made any great headway, but a noteworthy application of the modern illuminant is that just carried out at the Ballochmyle Stone Quarries, Ayrshire. Owing to the amount of work on hand, and the large demand for stone which he found himself totally unable to supply during the hours of daylight, the lessee of the above quarries, Mr. Bain, decided to introduce the electric light. The order for plant and machinery was placed with Messrs. Paterson and Cooper, of London and Glasgow, and the installation has been successfully completed under the superintendence of Mr. E. George Tidd, M.I.E.E. The area at present being worked is the largest that has ever been operated upon since these quarries were opened. Five powerful steam cranes are kept constantly at work, raising to the bank large blocks of red sandstone, and, that the work may proceed night and day, six arc lamps, each giving a light equivalent to 2000 candles, have been hung over the workings. The light is thrown down into the farthest depths of the quarries—in some places 200ft.—enabling work to go on uninterruptedly.

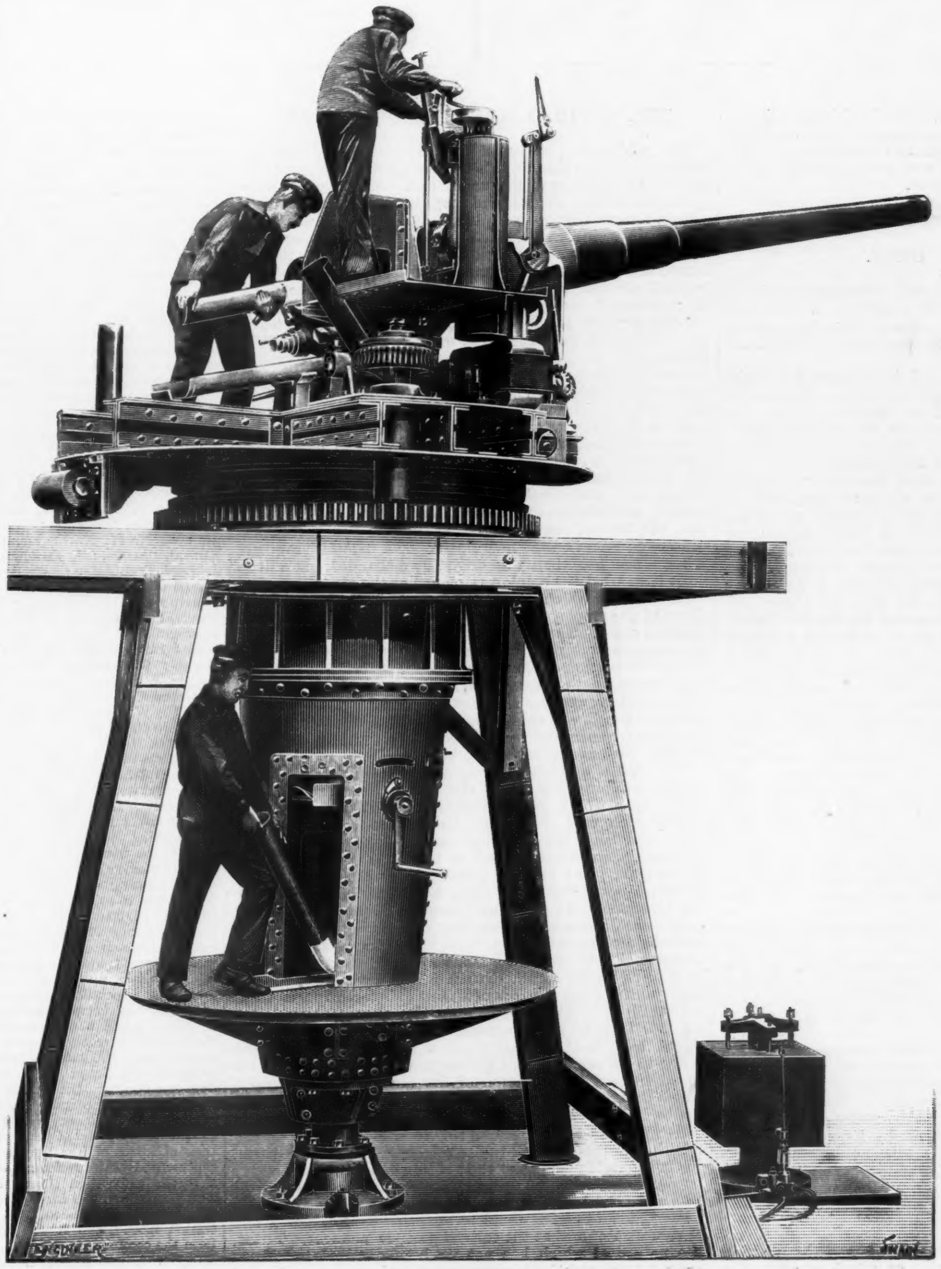
CANET ELECTRIC TURRETS FOR THE DANISH WARSHIP SKJOLD



CANET ELECTRIC TURRETS.

We may say in introducing the following brief description of the newest patterns of Canet electric worked turrets, which we have obtained from the manufacturers, that the general principles said to characterise the working of French turrets are alternative hand gear, the provision of automatic return of all lever handles to their original place directly they are released, by means of counterweights; and the provision of safety gear, so as to guard against all mistakes and accidents as far as possible in action. In the hydraulic working the rotation of the turret is generally effected by a simple application of chains and hydraulic cylinders. It may be seen that the same general principles are kept in view in the electric system of Canet, in which the French Government has taken the lead of England. Our own Powerful and Terrible have barbette mountings for 9·2in. guns worked by electricity, which appear to be excellent, but the ships will not be in commission for some time to come.

The Société des Forges et Chantiers de la Méditerranée have turned out or have now in progress nearly forty turrets worked by electricity for the Latouche-Tréville, the Jaure'-guiberry, the d'Entrecasteaux, the Pothuau, the St. Louis, the Captain Prat, the Skjold, and the Carlos V. Those last completed, which have embodied in them the newest improvements, are for the Danish coast defence ship Skjold. The work supplied includes (1) one Canet turret for a 24 cm. gun, (2) three Canet turrets for 12 cm. guns. These are closed turrets, and, as in all others of the same type, the electric gear is supplemented by alternative hand gear, with provision for instantly changing by means of switches from one system to the other. In the 24 cm. gun turret electric working is applied to laying the gun and also to raising the ammunition. In the 12 cm. turrets it is applied only to laying the gun. In the latter, hand gear provides such efficiency and speed that there is no necessity for having recourse to an electric motor.



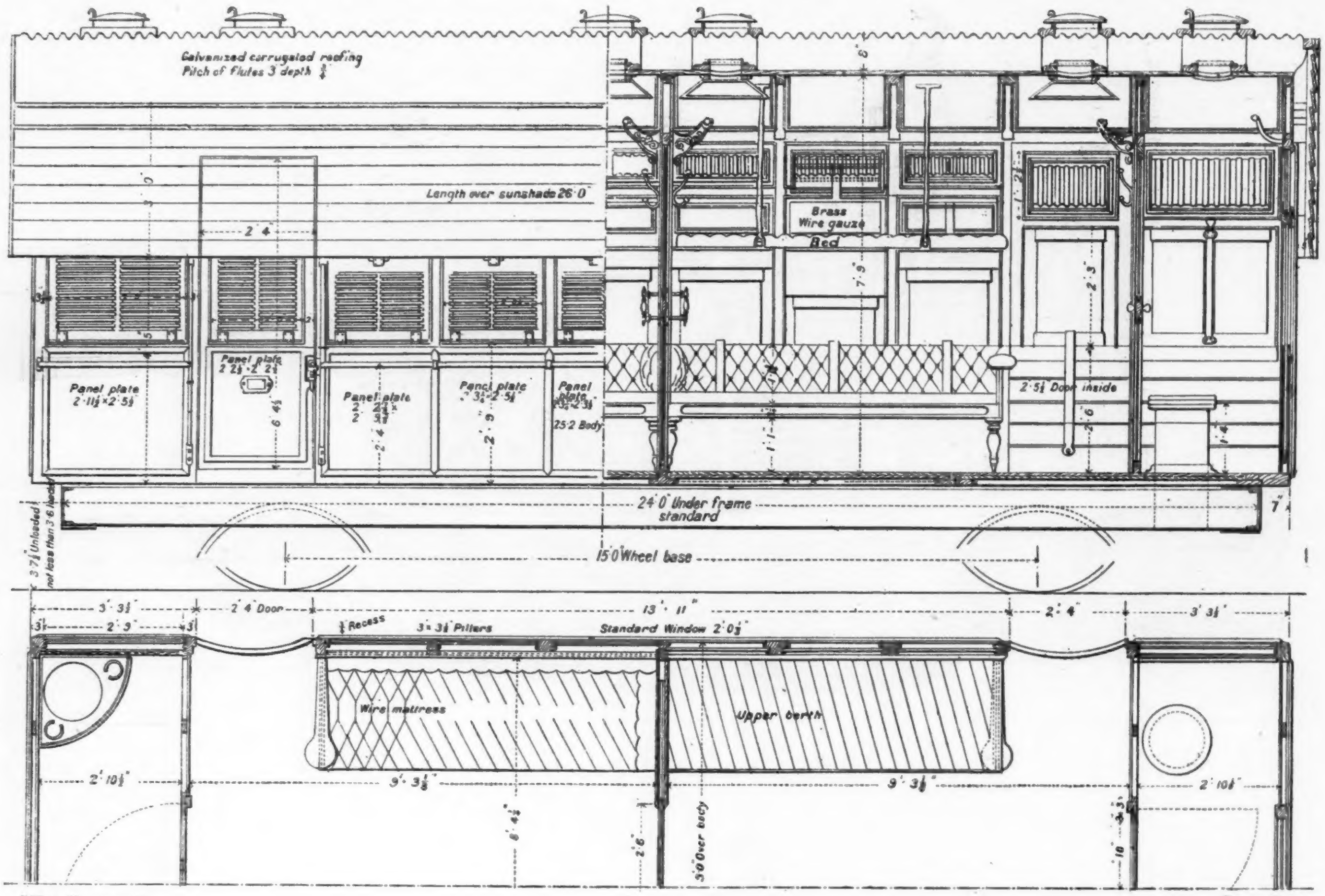
The electric apparatus for laying the gun is of the type known as the "cartouche électrique type." Excellent results, we are told, were obtained with this system on the Latouche-Tréville, and these have been entirely confirmed by trials which took place at Havre in the presence of the Danish Commission, and which have given prominence again to the great accuracy with which laying can be performed by the use of the "cartouche électrique," identified with the names Canet, Hillairet, and Hugnet. Not only has the captain of the gun complete control throughout, whatever may be the velocity of rotation of the turret, so that he can stop it dead, but also in laying he can at will, in either direction, make corrections less than the fortieth of a degree. These trials have been repeated many times before a great number of officers.

Thanks to the special arrangements which characterise the Canet turret system, and to the adjustment of weight, the work necessary to give rotation to the running weight is reduced to a minimum. Thus for the motor for rotation of the turret of the 24 cm. gun, the nominal power is 15-horse power, and hardly two-thirds of this amount is ordinarily required. For the rotation of the turret of the 12 cm. gun a motor of 3-horse power is sufficient.

The ammunition hoist of the 24 cm. gun turret is worked by a motor of 8-horse power. It is controlled by a commutator of a special kind, provided with automatic return to either end of its range, and with special safety arrangements to prevent the possibility of accident.

The engravings show the general arrangements of the turrets. No attempt is here made to give a lengthened description in detail. A report on these turrets has been made at the request of M. Neilson, formerly director of construction, and now director of the dockyards of Bur-

CONTRACTS OPEN—FIRST-CLASS CARRIAGES, OUDE AND ROHILKUND RAILWAY



"THE ENGINEER" SWAIN ENG

meister and Wain at Copenhagen. The Danish Commission entrusted with the testing and acceptance trials at Havre consisted of MM. Schwanenflügel and Rasmutten. The President of the French Republic was present at the trials, and himself worked the 24 cm. turret.

CONTRACTS OPEN.

THE illustration shows the general arrangement of the first-class carriages for which the Secretary of State for India in Council is now—amongst other rolling stock—asking tenders, and are intended to run on the Oudh and Rohilkund Railway.

The carriage is 25ft. 2in. long, and to accommodate eight passengers with a bed each. A partition with a sliding door shuts off one half of the carriage from the other. There is a lavatory and a water-closet at each end, also a looking-glass, 18in. by 18in., set in teak frames. There is a liberal allowance of light, and of hat pegs and light luggage racks. The roof is double, consisting of an inner wooden roof and an outer one of corrugated iron, with an air space of 8in. between the two. There is a wooden sunshade running all round the carriage, extending 3ft. downwards from the corrugated iron roof, thus leaving a free air current space from side to side of the carriage. The top bed frame is made of wrought iron piping, with solid gun-metal corners, brackets, and washers; the ends of the corner pieces turned to fit the piping, and secured by ½in. rivets. All the ironwork for the bed fittings not turned or otherwise fitted must be filed up to a smooth surface, and then black japanned. One side of the bed is attached to the carriage by brass hinges, and the other side, when let down for use, is suspended from the roof by chains encased in leather. The lavatory fittings are to be of the best gun-metal, ground perfectly tight, the ends fitted with union screws. The piping is to be the best wrought iron, with bends and unions to match. The wash basins are of cast iron, with gun-metal union screw and plug with chain. The flanges, top and interior of the basins, and all the front flange or bead, are to be enamelled white with the best glass enamel; the exterior is to be glass enamelled grey. The commodes are to be of wrought iron, No. 14 B.W.G. thick, and provided with a French-polished teak lid, 1in. in thickness. The steel wire mattresses for the carriage seats are to be of the best quality and finish, made by the Longford Wire, Iron and Steel Company.

The roof sheets are to weigh, before galvanising, 1¾ lb. per square foot, and after galvanising 30 oz. per square foot. These sheets are to be corrugated to a pitch of 3in., and ¾in. deep, after they are galvanised. After the sheets are finished they are to be stacked in the contractor's premises for a month before they are inspected; the sheets must also be perfectly free from spangle.

Every delivery is to consist of the ironwork and other materials complete for a given number of vehicles. No delivery of incomplete parts will be accepted. The name of every maker from whom it is proposed to obtain any of the materials to be submitted to the consulting engineer for approval before the work is commenced. Every piece of iron or steel must be interchangeable without dressing of any kind. Tests, specifications, and conditions are all as usual. Tenders to be in by 28th inst.

AT the last meeting of the Civil and Mechanical Engineers' Society, a paper was read on "Lock-nuts and Nut-locking Devices," by Mr. E. H. G. Brewster, A.M.I.C.E.

THE CLYDE ENGINEERING DISPUTE.

THE engineering wages dispute on the Clyde and at Belfast, although thrown into the background somewhat by the "excursions and alarums," and warlike sensations sprung on us from abroad, still drags its weary length, without, on the one side or the other, any definite indications of terminating. Mr. Sellicks, the president of the Associated Society of Engineers, has returned to London, and the informal and private negotiations carried on during his sojourn in the Clyde district have been continued since. The game of "see-saw," however, has been kept up in respect of rumoured "near prospects of a settlement," followed closely by "no progress has been made towards an arrangement of differences." It is at least safe to infer that one result of Mr. Sellick's visit was to show the executive of the men's society the hopelessness of expecting the employers to take the initiative in any proposed modification of their offer made at the Glasgow conference.

Some informal proposals, emanating from the men's side, made since Mr. Sellick's visit, go to show that a disposition has set in amongst them—or has for some time existed, though not openly declared—to fall away from the "no surrender" attitude and spirit so long maintained. Lord Provost Bell, of Glasgow, has been the intermediary in these half-hearted advances on the men's part. The modified overture is for much less than was originally demanded, but a little more than what the employers offered at the conference, and for an advance which should take effect at once. The disposition of the employers on this issue has, so far, been of the negative order. The date fixed by them for the concession of the advance was arranged with a view to the completion of the major portion of the work which had been undertaken at a low contract price, and the intervening period they estimated at eight weeks. This contract work has not since been advanced much, and the employers now are disposed to postpone any advance that may be decided on until the intention of their original stipulation has been met.

This, and a number of other stubborn circumstances, at present combine to persuade the men of the futility of any longer maintaining an uncompromising attitude. It is being clearly recognised that while the apprentices continue at work, and have the assistance of the few men who have returned, the masters will not be forced to concede further. Then, again, great pressure is being put upon the engineers by the shipyard workers to effect a settlement, as otherwise the associated industries must come to a complete standstill very soon. Practical illustrations are not wanting to show that the prolonged deadlock is having injurious effects on the securing of fresh orders. Instances of orders being postponed or of being placed elsewhere than on the Clyde, owing to the uncertainty of delivery, are of almost daily occurrence. Well-known Clyde builders entirely lost the chance of tendering for four torpedo boat destroyers, which but for the strike might have been secured; and a strong fear exists that owing to the same cause, Clyde firms who might be expected to secure a fair proportion of the ten third-class cruisers which the Admiralty has just arranged to contract for, will not be in a position to tender, more particularly as speedy delivery is said to be a leading condition in the tenders.

Although there is still the usual uncertainty about them, the latest statements as to the position of affairs wear a very hopeful aspect. Through their intermediaries, Lord Provost Bell and Lord James, both sides, it is said, are quietly making arrangements to bring about an amicable understanding and have work resumed at the earliest possible moment. Terms, the nature of which has not yet been divulged, have been arranged and practically agreed upon by both employers and employed, though there yet remains some little difference of opinion as to when the advance is to come into force. Matters, apparently, being now so well in train for settlement as regards the amount of the advance, the hope may be expressed that the employers will not insist upon adhering to an uncompromising, though perhaps justifiable, position as regards the date at which such advance shall take effect. Yesterday a joint meeting of the employers on the North-East Coast and those of the Clyde and Belfast was held at Carlisle, but whether the business considered had direct reference to the present position of the dispute or not is uncertain.

THE DELEGATES OF THE IRON AND STEEL TRADES, who, under the auspices of the British Iron Trade Association in the summer visited various German and Belgian works in order to inquire into the subject of foreign competition, have at last agreed upon their report, and this interesting document will be issued in a few days.

ASSOCIATION OF WATERWORKS ENGINEERS.—At the Exchange Hall, Nottingham, on Saturday afternoon, a meeting was held for the purpose of taking into consideration the advisability of forming a British Association of Water Engineers. The chair was taken by Alderman Sands, and on his left the Sheriff—Mr. J. Wright. Those present were Mr. D. M. F. Gaskin, engineer (Nottingham Waterworks); Messrs. R. H. Swindlehurst, Bolton; H. Roberts, Ipswich; T. A. Simpson, Kettering; A. F. Bowker, Mid-Kent; W. G. Pierce, Richmond; A. F. Bryant, *Journal of Gas Lighting*, &c.; S. Moore, Nottingham; C. H. W. Biggs, London; H. J. Kilford, Ilkeston; J. Radcliffe, Todmorden; W. Watts, Oldham; J. Lees, Tonbridge; E. Sandeman, Plymouth; T. W. Dent, *Bradford Observer*; H. Ashton Hill, South Staffordshire; E. A. B. Woodward, Wolverhampton; W. Matthews, Southampton; H. C. Marks, Dewsbury; R. O. Wynne Roberts, Oswestry; E. W. Dixon, Harrogate; E. Sainty, Eton; T. V. Ritson, Kendal; W. Millhouse, Scarborough; J. B. Fenwick, Retford; T. L. Hughes, Wigan; R. Kennedy, Kilmarnock; W. J. Wane, Maidstone; I. Carr, Widnes; T. Raynes, Birmingham; J. Deas, Warrington; A. Graham, Mansfield; C. H. Priestley, Cardiff; H. W. Pearson, Bristol; W. Terrey, Sheffield; W. A. Richardson, Birkenhead. The town clerk, who was unavoidably absent, was represented by Mr. F. B. Harris. In opening the proceedings Alderman Sands said it was singularly appropriate that the first meeting should be held in Nottingham, because the town was the birthplace of one of the first engineers whose attention was directed to waterworks and water undertakings generally, and he might now be looked upon as one of the fathers of works of that nature—Mr. T. Hawksley. Mr. Gaskin, who was received most cordially, remarked that he thought the inauguration of such an institution would benefit not only themselves, but also the consumers and the public generally. As the meeting was aware, they were at present an isolated body—that was to say, as compared with other bodies, such as gas and electrical engineers. He would like to make himself clearly understood that they were not departing from the parent institution in Great George-street. It was one of the finest in the world, but the meeting would know that the association in Great George-street could not take up in detail many questions with which the proposed new association wished to deal. For instance, the diversity of regulations between different towns. He was convinced that combined action would effectually dispose of the inconvenience. He thought a strong argument in favour of the formation of an association of the nature contemplated was the issue, a month or so ago by the Board of Trade, of a circular having reference to domestic boilers. Mr. Gaskin proposed—at the suggestion of Mr. Biggs—that an institution to be called the British Association of Waterworks Engineers should be formed, and the first members should be composed of those present, and those who had signified their attention of becoming active supporters. Those gentlemen represented waterworks all over the country. It was proposed that the association should consist of members and associates. This proposition was carried, and at the suggestion of Mr. Gaskin, Mr. Macintyre, London, was elected provisional secretary. Mr. Gaskin moved, and it was agreed, that the following gentlemen form the committee:—Messrs. J. Parry, A. F. Bowker, N. Ashton Hill, W. A. Richardson, I. Carr, C. H. Priestley, W. Matthews, H. Roberts, E. A. B. Woodward, W. Terrey, W. Watts, and W. Leggatt.

RAILWAY MATTERS.

In addition to orders for locomotives recently announced as having been placed with Glasgow houses, it may be stated that Messrs. Sharp, Stewart, and Co., Atlas Works, Springburn, have secured an order to build seven powerful passenger engines for the Midland Railway.

A tramcar dining car is the latest innovation proposed by an enterprising Brooklyn caterer, who thus proposes to furnish a good breakfast to men going early to business. He would also serve a luncheon to shoppers in the daytime and dinners to theatre parties in the evening.

Some new Post-office cars on the Erie Railway are 65ft. in length, and are carried on two six-wheeled bogies, each with a wheel base of 10ft. 6in. The width of the cars is 9ft. 8⅜in. over the sills. They are lighted by eleven Pintsch gas lamps supplied by four gas reservoirs 8ft. 6in. long, and 20in. diameter.

A colossal group representing engineering, which is to surmount and adorn the central gable of the new Bombay, Baroda and Central India Railway offices in Bombay, now being erected from the designs and under the supervision of Mr. F. W. Stevens, C.I.E., F.R.I.B.A., is the work of Mr. E. Roscoe Mullins, sculptor, of London, who has been commissioned to execute it in Bath stone. The *Indian Engineer* says, Mr. Mullins has also instructions to execute large medallion heads of the late Colonel French and General Kennedy, the pioneers of this railway, to be placed in the circular panels over the outer arches of the central carriage porch of this building.

In mentioning methods of making joints with locomotive fire-box crown stays, the *Railroad Gazette* remarks concerning stays with a washer placed under the head, that when this was first tried copper washers were employed; but this metal has been abandoned, unless the road ordering the locomotive specifies copper washers. The reason for discontinuing the use of copper washers is that they do not last. Either a galvanic action takes place which destroys the washer or they do not stand the heat. In the place of copper charcoal, iron has been substituted, and it is the present practice of the builders to use this style of washer on their latest engines.

Reports from the car building companies of the United States show that car building has taken an upward turn, the output of the contracting shops being 31,893 freight cars. This is in comparison with 17,029 freight cars built in 1894. When we say that car building has taken an upward turn, we limit the phrase to a comparison with the previous year. The total of cars built this year is not a large record by any means, and makes the number built in the years immediately preceding—51,000 in 1893 and 93,000 in 1892—appear extraordinarily large. It seems probable that railroad managers have continued the use of much equipment, not in good condition, and which ordinarily would be replaced. In this fact lies the hope of the car builders.

In addition to the very extensive terminal arrangements for goods and coal already possessed by the Midland Railway Company at St. Pancras, Somer's Town, and Kentish Town, the company now finds it necessary to increase its coal depôt at Somer's Town by about six acres, having more wagon accommodation than at any existing depôt. Already large blocks of once important but recently neglected houses have been removed, and new blocks of model dwellings have been erected to provide for those who will be displaced by the removal of houses to make room for the new depôt. Messrs. Howell and Co., Westminster, are the contractors for the new buildings and depôt works, which will be erected from the plans prepared under the chief engineer of the Midland, Mr. J. A. M. McDonald, M. Inst. C.E.

The Secretary of State for Foreign Affairs has received from her Majesty's Minister at the Hague an extract from the *Staatscourant* of the 4th inst., announcing that the Technical Office of the Colonial Department at The Hague will receive up to noon on the 22nd inst. tenders for 16 bridges and 18 turntables for the State railways in Java, and also for iron plates for the Marine Department of the Netherland Indies. Full particulars can be obtained of Martinus Nijhoff, 18, Nobelstraat, The Hague, on payment of 50 cents (10d.), 1 florin (1s. 8d.), and 50 cents (10d.) respectively. It is also announced that the Intendant of the 1st Division of Infantry will up to noon of the 22nd inst. receive at 106, Breadstraat, The Hague, tenders for 90,000 kilos. of hard wheat, and for 30,000 kilos. of soft wheat. Full particulars may be obtained from Gebroeders van Cleef, The Hague, on payment of 10 cents (2d.).

All of the thirteen locomotive building companies in the United States, except one, built more locometives in 1895 than in 1894, and the total number of engines built foots up 1109, against 695 in the previous year. This is something of an increase, and a very good record so far as it goes, but that it does not represent a normal increase seems evident from the number of engines built in the five previous years, when never less than 2000 locomotives were built in any one year. That this is a safe deduction the large orders for locomotives which have been placed in recent weeks give additional evidence. Two of the companies reporting locomotives built in 1895 did not build any in 1895, and one other company did not report in the latter year. The *Railroad Gazette* says the larger locomotive works seem to have been in a better position to profit by the large increase of orders, and several of such works built more than twice their output in 1894.

The Bengal-Assam Railway Company has addressed the Liners, inviting them to make Chittagong a port of call to pick up tea to be brought direct from Assam, without passing through Calcutta. The proposal represents a scheme that has no doubt long agitated the promoters of this line, to set up a rival port to Calcutta, to which they should have the exclusive privilege of carrying produce. Apart, however, from the additional run that this would involve, and the somewhat important fact that none of the large liners could ever get up the Chittagong river in safety, the proposal is a visionary one, for water carriage for tea is far cheaper than carriage by rail, and the natural route lies *viâ* Chandpore and Goalundo by the Eastern Bengal State Railway to Calcutta. To facilitate carriage, the Indian General Steam Navigation Company have recently started a much improved line of boats from Chandpore to Goalundo, and there is, says the *Indian Engineer*, no reason to suppose that the present current of trade will be changed.

A correspondent writes on the proposed London and South Wales Railway, to the *Times*:—"The promoters have considered it desirable to withdraw this scheme, and an arrangement has been made by them with the Great Western Railway Company. The promoters have been influenced in this matter by the projection of the new lines of the Great Western Railway Company from Wootton Bassett to Patchway and the advantages which South Wales would obtain by their construction. They have also been influenced by the want of support and the threatened opposition on the part of large interests in Cardiff and various landowners and local bodies along the route. They have protected the public interest as far as they can by arranging that the Great Western Railway Company are to maintain all the facilities recently given to South Wales, to use their best endeavours to get their new lines authorised, and vigorously to proceed with the construction of the same; to make Cardiff an open station; on July 1st next to reduce their passenger fares to South Wales, and to run passenger trains on their Ely and Garw Valley branches; to reduce the coal rates to Southampton, and to use their best endeavours to reduce the cost upon South Wales coal sent to London for bunkering purposes."

NOTES AND MEMORANDA.

The gas obtained from cleveite freed from hydrogen by passing it over red hot cupric oxide, and from nitrogen by means of magnesium, has a density of 2·02 as compared with hydrogen.

The pig iron output for the year 1895 in the United States is estimated by the *American Manufacturer* at 9,387,639 gross tons, which exceeds that of 1890, the year which has hitherto held the record for largest production, the output in that year being 9,202,703 tons. The production during the last two months has been at the rate of about 11,000,000 tons per annum.

In a recent paper read before the Academy of Sciences in Paris, on the presence of sodium in aluminium prepared by electrolysis, by M. Henri Moissan, it is shown that electrolytic aluminium contains in general from 0·1 to 0·3 per cent. of sodium, and that the presence of this impurity renders the metal easily attacked by water. Aluminium should always be used alone and pure, as it readily forms electric couples with every other metal, and is then easily attacked by water.

In a paper on the origin of argon and of helium in gases disengaged by certain sulphurous waters, by MM. L. Troost and L. Ouvrard, it is shown that, though argon is generally present in waters, helium is only found in certain mineral waters, and does not probably owe its origin to the atmosphere, but to the rocks through which the waters have percolated. M. Bouchard added some remarks on the therapeutic value of helium and argon, and supported the view that these gases have no action on the economy, but admitted that the metals present in helium containing minerals might have medical action when present in minimal amounts.

Silica volatilises readily in the electric furnace under the influence of the arc from a current of 1000 ampères and 50 volts, and if the action of the arc is stopped before volatilisation is complete, crystals of silicon, like those described by Senarmont, are sometimes found in the lower part of the crucible. M. Moissan finds that when a mixture of rock crystal and carbon is heated in the electric furnace in a carbon tube closed at one end, the open end of the tube becomes full of flocculent volatilised silica, below which are crystals of carbon silicide, whilst still lower in the tube is a ring of crystals of silicon mixed with some carbon silicide. It follows that silica is reduced to silicon by carbon under the influence of the electric arc.

When electric sparks are passed through a mixture of nitrogen and carbon bisulphide vapour at about 20 deg. sulphur and carbon are precipitated, and the nitrogen is slowly absorbed. A small quantity of mercuric thiocyanate is formed, but the greater part of the nitrogen is converted into more highly condensed products. With the silent discharge in place of sparks, there is no precipitation of carbon, and after some time the nitrogen is completely absorbed. There is no fluorescence, such as is observed in the case of argon and benzine. If the product is heated, some carbon bisulphide is regenerated and nitrogen is liberated; but, according to M. Berthelot, the volume of the latter is much smaller than that of the original gas.

According to the discoveries of Zsigmondi, it is possible, says a contemporary, by the addition of small quantities of protoxide of iron to produce glass which possesses sufficient transmission for rays of light, while allowing the passage of a small quantity of heat only. Such glass is especially adapted to the manufacture of protective shades against radiating heat, which would be of great value to many industries as well as to the single lighting bodies. Of similar importance are these discoveries for the production of good window glass, as well known window glass may show a rather strong green colouring without its being noticed much or disagreeably when put in the windows. By using glass containing protoxide of iron it would, therefore, be possible to detain to the greater extent the radiant heat produced in the interior of the room, as well as the caloric rays of the sun falling from the outside upon the windows. This, however, already happens to a very considerable extent with the every-day glass of commerce.

A remarkable discovery in photography has been made by Professor Roentgen, of Wurtemburg, by means of which, with the light from a Crookes tube, some things which absorb the light may be photographed, while others enclosing these things are unnoticed. Thus he is able to obtain pictures on a photographic dry plate which was enclosed in a wooden case. He also varied the experiments, as by enclosing in wooden cases the objects he wanted to be reproduced, or by wrapping them up in other materials. He also photographed the hand and a larger part of the human body than the hand, and according to the Vienna correspondent of the *Standard*, obtained pictures of the bones only, without their fleshy covering. The light from the Crookes' tube is absorbed by metals and bones, but goes through wood and other organic substances, just as ordinary light goes through glass. Aluminium, however, forms an exception to the rule. The rays which produce the effect are not refracted by glass lenses. Professor Roentgen has sent rays of the new chemical light through aluminium plates of 1½cm. in thickness, and they went as clean through as if the substance had been wood. The same was the case with two sets of books, including many volumes. These he placed between the Crookes tube and an ordinary compass; behind them was the wooden case with the dry plate, and the result was as complete a photograph of the compass as possible. It is, perhaps, not strictly a photograph in the ordinary sense, because no lenses are used.

Making a calculation according to the Ihering-Slaby figures to see how the useful effect of the consumption of coal, liquid acetylene and carbide of calcium compare in operating a 1000-horse power ship engine for a period of 600 hours—twenty-five days—the following figures are obtained:—*a*. Coal. For 600,000-horse power hours are required, at 0·7 kilos. each, 420,000 kilos. = 420 tons of coal, which well packed would occupy a space of 420—430 cubic metres. *b*. Liquid acetylene. According to the concurring statements of Ihering and Slaby 0·18 kilos. per horse-power hour are necessary for large engines, or for 600,000-horse power hours 108,000 kilos. = 108 tons, for which—spec. gravity at 0 deg. = 0·451, at 35·8 deg. = 0·364. In view of the higher temperature of the hold, vessels of at least 270—300 cubic metres volume would have to be provided, which would afford absolute safety at a pressure of fifty atmospheres or more. *c*. Carbide of calcium. To produce 0·18 kilos. of acetylene required for 1-horse power hour from 90 p.c. carbide of calcium, 492 grammes or about 0·5 kilos. of carbide are required, or for 600,000-horse power hours 300,000 kilos. = 300 tons, which with a specific gravity of 2·22 require a space of about 131 cubic metres, which by adding the sheet covering above referred to would not be increased to more than 150 cubic metres. The material necessary then to supply a 1000-horse power engine for twenty-five days would be in case of first coal 420 tons net, requiring a space of 420 cubic metres; in case of compressed (liquid) acetylene 108 tons net, requiring a space of 280 cubic metres, excluding vessels, and in case of carbide of calcium 300 tons net, requiring a space of 135 cubic metres. In making this comparison it must be considered that the operation with steam engines requires a large and expensive boiler arrangement, and that for liquid acetylene two large storage vessels are necessary, while by using carbide of calcium but a few simple and light apparatuses would be needed. Dr. Adolph Frank, of Charlottenburg, writing on this in the *Journ. f. Gasbel and Wasservers*, says: "Such projects, as well as others connected with the production of acetylene, may, as the *American Manufacturer* remarks, appear to some like phantastical music of the future, but they can gain importance very quickly, as soon as the next problem, the cheap production of carbide of calcium on a large scale, is once solved."

MISCELLANEA.

At the Home-office on Tuesday, Mr. Jesse Collings, M.P., presided at the eighth meeting of the committee of inspectors and manufacturers appointed at the conference held in the council chamber, Birmingham, to devise means to remove the anomalies existing under the Weights and Measures Acts.

Mr. A. Cooper, of the North-Eastern Steel Works, and the Acklam Ironworks, Middlesbrough, has been elected President of the Cleveland Ironmasters' Association for the year, vice Mr. F. A. E. Samuelson, of the Newport Ironworks. Mr. George Ainsworth, of the Consett Ironworks, has been elected vice-president.

We have received from Mr. W. S. Hipkins, of Coseley, Bilston, some samples of hammer handles, including a handle of 38½in. length for a flogging hammer, and one of 16½in. for a bench hammer. They are made of excellent straight-grained tough ash not too close-grained. They have defied our attempts to break them; they will take a bend but will not break, and would evidently stand a lot of the jarring of hammer handle work.

Mr. Alfred E. Beach, editor of the *Scientific American*, died in New York on Janvary 1st. He was a man of remarkable energy, and excelled in ideas for improvements in engineering and mechanical arts. Among his inventions were a typewriter and schemes of pneumatic mail transmission, and a pneumatic railway. In the construction of a short section of this road in New York city, use was made of a hydraulic shield for excavating without disturbance of the street surface.

The Cunard steamer Cephalonia, which went on the rocks near South Stack Lighthouse on New Year's morning, and was afterwards grounded in Holyhead Harbour, was successfully floated on Saturday night. The operations have been conducted under the supervision of Captain Watson, marine superintendent of the Cunard Company. Three tugs lay alongside taking off the cargo, while powerful pumps were brought from Cardiff and other ports. The Cephalonia will be temporarily fitted up, and will proceed to Liverpool in about a week.

An American inventor who advocates the use of electricity for propulsion of ocean-going steamers is, it is said, about to equip a steamboat on the following lines:—He will put in his boat a powerful engine of the slow-speed type, connected to a multipolar generator transmitting current to electric motors attached directly to the propeller shafts. The motion of the motors being rotary, a very high speed could be attained with comparatively little vibration, while the reciprocating part of the propelling machine—the engine—could be run at a comparatively slow speed. The further advantage of better regulation in rough weather, when the propellers lift, would be secured.

An important scheme is in progress for further developing the Warwickshire coalfield. A company is being formed with a capital of £150,000 for developing and working the minerals under the estate of Mr. F. A. Newdegate, M.P., at Astley, and other adjoining properties, containing an area of between 2000 and 3000 acres. The valuable coal seams of the district have been proved to exist on the north-east and south sides, and a borehole has lately been put down near the centre of the estate, proving the principal seams of coal to be over 20ft. thick at a depth of nearly 500 yards. The estate is in close proximity to the London and North-Western and Midland Railways, and is likely to prove of much importance as being the nearest coalfield to the London market.

A new lamp, the invention of Mr. Ludwig Durr, of Bremen, is being tried by our military authorities. "The light is originated by evaporation and superheating of the vapours from ordinary petroleum. Air is drawn into the lamp between the gasifier and an external cylinder, and a smokeless flame of great brilliance is produced. In short, vapours are produced by intense heat and converted into gas, which, upon being burned, yields a light ranging from 3500 to 14,000-candle power. The apparatus is self-acting and does not necessitate the employment of compressed air. It is so constructed that a lamp and reservoir capable of holding 10 litres of petroleum, and supplying a 3500-candle power light, can be strapped on to the knapsack of a soldier. The lamps can be carried about when burning or may be fixed in any position."

The application of machinery to glass bottle manufacture has formed the subject of a correspondence between the Duke of Devonshire and Mr. A. Greenwood on behalf of the glass bottle manufacturers. Speaking on technical education in Birmingham last month, his Grace, quoting from the prospectus of a company to be formed for making glass bottles by machinery, spoke of the machine as "producing bottles at 3d. a gross against 3s. 6d. by the hand-blowing process, and its producing eighty gross a day by boys without men, and a saving of 33 per cent. waste," &c. Mr. Greenwood has written to the Duke to state that "up to the present time the invention referred to has never been taken up by a single glass bottle manufacturing company in the United Kingdom, except the original one, which collapsed, and that not a single machine is now in operation in the kingdom." The Duke of Devonshire, in acknowledging the communication, states that his remarks had references to the advantages claimed at the time for an invention, among others, which illustrated the application of science to industry, but his Grace's information did not then show that the particular process had proved unsuccessful.

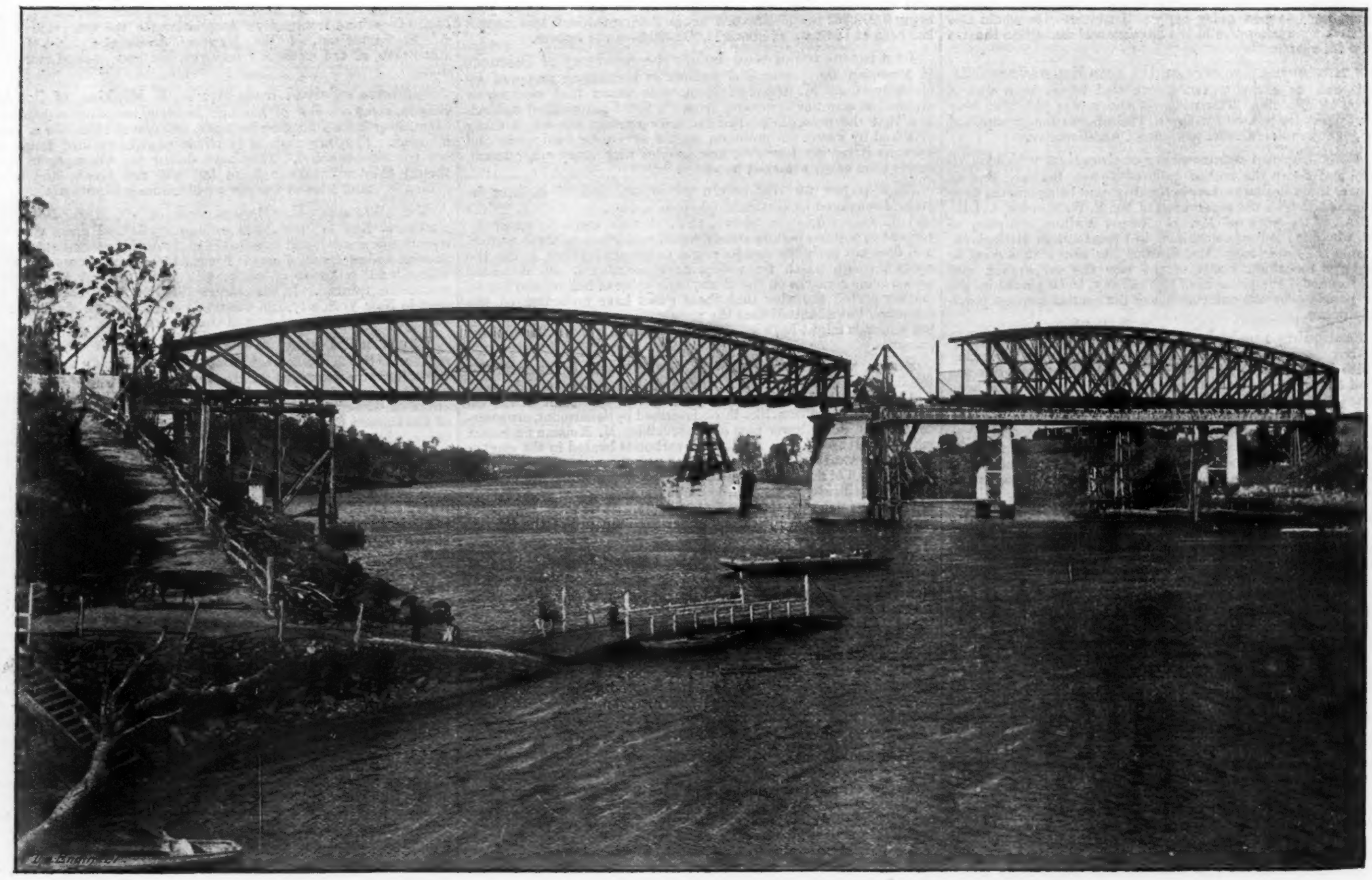
The report of the Yorkshire coal trade with Hull, issued by the Hull Chamber of Commerce and Shipping, shows a very large increase in the business done during the month, and a decrease on the twelve months. There were sent to Hull last year 2,190,016 tons, as compared with 2,256,824 tons in 1894, or a decrease of 66,808 tons. The amount forwarded in December reached 184,496 tons, as against 159,128 tons in the same month of 1894, an increase of 25,368 tons. Denaby Main again heads the list with 25,368 tons, as compared with 31,480 tons in December of 1894. The same colliery occupies the lead for the year with 328,888 tons, as against 256,968 tons, or an increase of 71,920 tons. Manvers Main comes second, Carlton Main third, and Aldwarke Main fourth. Sixteen South Yorkshire pits sent to Hull last month 110,760 tons, as compared with 41,248 tons from the same number of West Yorkshire collieries. In the exports to foreign countries, Sweden and Norway are again at the top of the list with 22,944 tons in December; 297,661 tons in the twelve months. North Russia comes second with 192,648 tons on the year, and 3117 tons on the month. Germany took 12,899 tons last month, and 134,728 tons during the year.

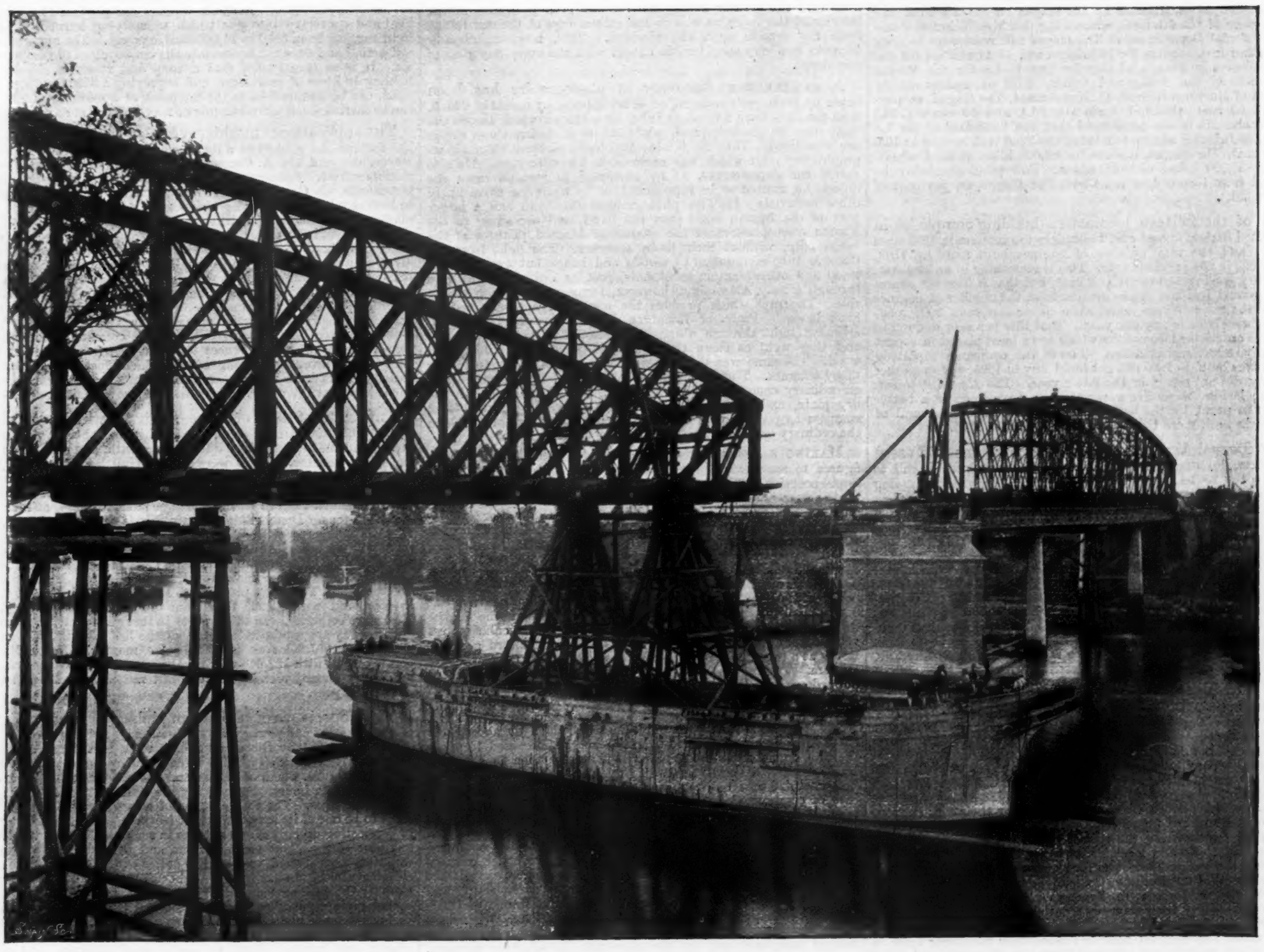
The importance of safe steam piping in central stations of electric light and power plants is again, says a recent *Engineering News*, illustrated by the accident last week in a Brush arc light station in New York city. The bursting of an 8in. cast iron elbow ruined 3000 dols. worth of belting and put the station out of service for twenty-four hours. Fortunately the station attendants escaped with their lives. The steam piping of a large central station has come to be one of its most important features, owing to the practice of connecting up boilers and engines in such a manner as to permit any part of the plant to be cut out, and the attempt to provide duplicate pipe systems to a greater or less extent. It is worth considering whether better results might not be secured by striving to simplify the pipe systems so far as possible, and instead of duplicating piping, putting sufficient additional expense into the single line of piping to make it absolutely safe. In many cases it is likely that the expenditure of more intelligence in the design of the piping and greater efforts to secure good drainage, and avoid strains due to expansion and contraction, would result in great improvement. It should be understood by the builders of such stations that the design of the steam piping is too important a matter to be left in the sole charge of an ordinary steam-fitter.

THE ALBERT BRIDGE, INDOOROOPILLY, QUEENSLAND

MR. H. C. STANLEY, M. INST. C.E., ENGINEER; MESSRS. J. McCORMICK AND SON, CONTRACTORS

(*For description see page* 52)





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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, January 21st, at 8 p.m. Paper to be discussed: "The Sanitary Works of Buenos Ayres: Sewerage, Drainage, and Water Supply," by the Hon. R. C. Parsons, M.A., M. Inst. C.E.

ROYAL INSTITUTION OF GREAT BRITAIN.—Tuesday, January 21st, at 3 p.m. Lecture: "The External Covering of Plants and Animals: Its Structure and Functions," by Professor Charles Stewart, M.R.C.S., F.L.S. Thursday, January 23rd, at 3 p.m. Lecture: "Dante," by Philip H. Wicksteed, Esq., M.A. Friday, January 24th, at 9 p.m. Discourse: "Ludwig and Vitalism," by Professor Burdon Sanderson, M.D., D.C.L., LL.D., F.R.S. Saturday, January 25th, at 3 p.m. Lecture: "The Valley of Kashmir," by Walter R. Lawrence, Esq., I.C.S., C.I.E.

SOCIETY OF ARTS.—Monday, January 20th, at 8 p.m. Cantor Lecture: "Alternate Current Transformers," by Dr. J. A. Fleming, F.R.S. Wednesday, January 22nd, at 8 p.m. Paper: "Supply of Sea Water to London," by Frank W. Grierson.

DEATHS.

On the 9th inst., suddenly, at Upper Norwood, HUMPHREY CHAMBERLAIN, M.I.C.E., late of Montevideo, eldest son of the late Humphrey Chamberlain, Barnsley, Yorkshire. Friends kindly accept this, the only, intimation.

THE ENGINEER.

JANUARY 17, 1896.

THE MINERS' CONFERENCE.

AMID the troubles which perplex English people abroad, we must not lose sight of a gathering which may mean an industrial conflict at home. At the annual conference of the Miners' Federation of Great Britain, held at Birmingham this week, there were delegates from Yorkshire, Lancashire, Midland Federation, Derbyshire, Notts, Leicester, South Derbyshire, North Wales, Cleveland, South-Western Section, and the Scottish Federation—in all forty-one delegates, representing 159,331 persons in different unions, out of a total of 298,269 miners employed in the districts covered. It will be noted that several important localities are here unrepresented, viz.:—Northumberland, Durham, and South Wales. Interest mainly turned upon the address of the President, Mr. Picard, who, when he rises, rises like the Nile and spreads himself over pages of space. His presidential address on this occasion, as reported in the Yorkshire papers, extends to over four columns. At the point where the public look for information and guidance they will find it hard to discover any. The Rosebery arrangement terminates in June, and the question which everybody is asking is this—Is that arrangement to be continued, or are we to have another coal war on its expiration? Some months ago Mr. Pickard was asked for an answer to this inquiry, and his reply was:—"Wait till the Miners' Conference in January." The Miners' Conference has been held, and the public is no wiser. We gather, however, from the drift of Mr. Pickard's speech, that in spite of the downward trend of coal values, the increasing difficulty of working any but the large mines, and the gradual absorption of the coal workings by huge concerns, there are to be no concessions whatever from colliers. There is something plausible in what Mr. Pickard puts down as the miners' watchword for the future, "Men must live by their labour, and a living wage must be paid where coal is got." There is no desire to dispute the right of the miners to a living wage; the only point is whether Mr. Pickard and his Federation are going the right way to get it. He and his colleagues have laboured during the reign of the Rosebery Agreement to reverse the economic law that values govern wages. They have sought to establish during that time the theory that coal values need not fall if coalowners make up their minds that they shall not fall, and that whether they fall or not a certain wage must be paid to the coal getter. This theory, of course, is against all well-established economic principles; and although the wages have been paid, the values of coal have not been maintained. The result, as we have said, has simply been that the smaller collieries have gone to the wall, while business has accumulated in the hands of the larger coalowners, with every prospect that this tendency will be acutely accentuated in the future. Mr. Pickard himself expects that the collieries in course of being opened out will produce, when in full play, an additional output of about one-third. He must know that that production will be in the hands of the great colliery undertakings, and that as no concession is to be had in regard to wages, increasing efforts will be made to obtain an enormous output at proportionately less price per ton in the getting. We say nothing at present as to the points emphasised by Mr. Emerson Bainbridge in regard to existing Continental competition, which is already cutting off some of our northern markets, and the almost certain development of the coal fields in the Far East. The first is already an ascertained fact, and it is coupled with eqully certain data, which prove that the Continental miner—in Germany, Austria, Belgium, and France—works for nearly one-half, and in some instances quite one-half, less wages than the British miner. These are facts which cannot be talked away, and it is no answer to say that "the British coal producers can more than compete with any nation in the world, even in their own markets." It is simply shutting our eyes to an immediate danger to say, as Mr. Pickard says:—"All the information we possess in regard to the exportation of coal from this country leads us to infer that British coal fears no competition with foreign markets, and it is quite clear that those who sell the coal to the foreigner know well that it pays, otherwise they would not go on exporting it to the extent they do." Every person conversant with coal mining knows that contracts must be taken to keep the pits going a certain number of days per week. It is not always possible to get a paying price, but many a coalowner takes less than he would like to have, so that when the opportunity offers for more favourable prices, he may be able to take advantage of it to spread the cost of production over a greater output. That is not, we admit, the most desirable condition of affairs, but it is inevitable, and as a fact must be fairly faced. Mr. Pickard alludes to collieries which, he says, have made handsome fortunes for their owners. No one denies that money has been made out of coal, but why not put the debit as well as the credit side of the account? For every colliery which, during the last half dozen years, has made a huge profit, there could be named half-a-dozen which have made none at all, and many worked at a loss are now completely laid aside. No one denies the right of the collier to a living wage. Everyone wishes he may get it and a good one. But is there no such thing as the right of a living dividend? A large portion of the colliery undertakings of the country are now in the hands of limited companies. Limited companies are composed of shareholders, many of whom are dependent upon their dividends for their existence, quite as much as the collier is upon his wage at the week's end. Have those who advance the money which keeps collieries going and find colliers work, no claim whatever to a reasonable return upon their capital? Mr. Pickard makes no mention of them. He talks wildly of a "millennium of greed," about workmen being "fair game for the heartless speculators," whom he describes afterwards as "greedy horse leeches." The hardship, however, is not with the speculator but with the *bonâ fide* owner, who has put his money down a pit and expects a return for his capital on quite as honest grounds as the collier expects his wages for his work. The public, too, have surely some right to be considered. If protection spelt with a big "P" is to be resolutely maintained in the coalfield with a view to making the public pay more for the coal than it is worth in a fair market, why are these very Miners' Societies opposed to protection in other industries? The argument is that they must draw a ring fence around coal, otherwise the getting of it will not pay the getter. But has not this been the case for a long time in agriculture? Farmers have found it impossible to farm at a profit; farm labourers have been dismissed in thousands, and land, miles upon miles of it, in every agricultural county, has gone derelict. Yet Mr. Pickard and his people do not propose a living wage for the agricultural labourer, or seek to secure it by giving him the protection which they demand for the collier. Were he but to think a bit he could have a convincing argument in favour of ranking farm labourers in the favourable industrial treatment which he claims for the collier, for when the farm servant leaves the land where does he go? He goes straight down the pit, where he competes with the collier, and tends to make that over-abundance of labour which is the chief cause of there being more workers than work in the coalfields of England. The farm servant's presence there is not only diametrically opposed to the wage interests of the miner, but is in a measure a menace to his safety at work, for he is not, and he cannot be expected to be, so thoroughly acquainted with the conditions of coal seams, fiery and otherwise, as the man who has spent his life from a boy upwards in the bowels of the earth.

It has been suggested to Mr. Pickard that one of the first steps to "steady" wages at home would be to utilise some of these International Miners' Congresses to "level up" the Continental miner to something like the British standard. That would cut off one form of keen competition. But he cannot see his way to a crusade of this sort, and, meanwhile, there are grave inequalities at home by which one coalfield, by cheaper labour, is able to undersell another. That is not the fault of the employers, and it proves that, after all, the Miners' Federation, though powerful enough as was painfully proved by the last coal war, cannot even command uniformity in wages throughout the coalfield at home. So long as one district is able to bring its product to bank under wage conditions 10 to 15 per cent. lower than another, there must be a loss of trade to the handicapped localities, which, by the way, are those in which Mr. Pickard himself, from the labour standpoint, is the most potent factor.

ADMIRALTY CONTRACTS.

OUT of evil good may be wrought by those who know how to profit by opportunity; and the difficulties and alarms which disturb the nation may suffice to silence for a time, if not for all time, those who preach economy in naval expenditure, who tell us that ships of war represent waste, and that all the rest of the world is full of peace and charity and the other gentle virtues. We do not doubt that large additions will be made to our naval strength. Indeed, it is not only possible, but right and proper, that our shipbuilding programme for the next half-dozen years should represent a very large expenditure, and the occasion seems to us fit and suitable for the discussion of the system on which we obtain our warships, and the relations prevailing between the Admiralty and the great shipbuilding and engineering firms of this country. It may be said, perhaps, that the moment is not opportune for criticising Admiralty policy; we hold, however, a contrary view. Nothing that we are about to say can in any way hamper those in authority at Whitehall, and it is of extreme importance that at the conclusion of one programme and the beginning of another, the system, or want of system, adopted in spending very large sums of money should be criticised, that the facts should be made known, and desirable changes effected.

For a long time past the relations of the Admiralty and contractors have been strained. Complaints reach us from many different directions. In some cases they refer to very large matters indeed, in others to comparative trifles; but great or small, they all tend to prove that between the Admiralty and contractors there is friction, and this friction is not for the good of the country, and might be easily avoided by the exercise of tact, and a recognition of the truth that "red tape" may be a very objectionable thing. Let us consider what the system is. If a new vessel is required, certain firms on the Admiralty list are asked to tender, and tenders are sent in. This is all straightforward, and as it should be; but, instead of the Admiralty accepting or declining particular tenders with an evident intelligent perception of what the tenders mean, a system of bargaining commences. "A's" tender is used as a lever to reduce "B's" tender, and the result again is used to cut down "C's" prices. All this is very undignified in a great public department. It may be urged, however, that as the Admiralty have to spend national funds, of which they are in a sense trustees, no other course is open than to try to buy as cheaply as possible. To this we reply that the duty of the Admiralty is to obtain the best possible ships, engines, guns, &c., that can be had; and that those who have to consider the tenders ought to know when a tender is too high or too low. In a word, they ought to know the value of what they propose to buy. Whether the knowledge does or does not exist in the Controller's department, we are unable to say; apparently it does not. The actual method of obtaining ships is strictly analogous to that adopted by a man who, totally ignorant of what a dwelling-house ought to cost, first gets drawings from an architect, and then advertises for tenders. Having obtained them, he proceeds to pit the tenderers against each other, assuming that in this way he will get the best value for his money. The mere mention of this method of doing business will be enough to condemn it in the eyes of our readers. But there is ample evidence available that the Whitehall people do not know what is the proper price to pay for work or materials, and to this ignorance on the one hand, and on the other to a fear of being cheated based on that ignorance, is no doubt due the bargaining and bartering which during the last few years have gone on at Whitehall, and have at last become so vexatious that it is matter of common talk among those firms who have laid themselves out to execute Admiralty orders. The following little incident may be cited as an example of what we mean. The sums concerned are insignificant; the lesson taught is no less suggestive and important. Messrs. Yarrow and Company provided certain additional parts in one of their vessels, and made a charge for them as an extra of £20. Whether this was a fair amount or not we have no means of judging. The Admiralty offered the firm £7 10s. This was refused. Then the Admiralty offered £10. This was declined, and the firm wrote to say that having made a proper charge in the first instance, they could not accept less, but that, as the Admiralty thought differently, they would make a present to the country of the additions; thereupon the Admiralty sent the full amount claimed. Now, if the work was really only worth £7 10s. the authorities certainly did not do their duty when they offered £10, and still less did they do it when they paid £20. If, on the other hand, £20 was the proper price, why in the name of honesty did they offer the contractors £7 10s.? In another case, with a different firm, certain work was, we are informed, passed by an inspector. Subsequently this work was condemned by another inspector—not, be it observed, because the contractors were held to be in fault—and constructive changes were introduced representing an outlay of some thousands of pounds. When the bill was sent in the Admiralty offered half the sum demanded, and then went on offering more and more, and finally, we believe, the whole question was referred to arbitration. We could cite many instances of the same kind. A policy and a system lending itself to such transactions cannot but be bad for the country. The general result is that contractors accept what the Admiralty offer, and are now protecting themselves by asking a great deal more than they expect to get. In some cases this is done directly; in others it is done indirectly by allowing in the terms of the tender a larger margin for contingencies than would otherwise be needed.

It must not be forgotten that there is a clause in the Admiralty contracts to the effect that in case of dispute the sole arbiter is the Controller of the Navy. A little reflection will show that although in the old days of sailing ships such a function might be properly discharged by a seaman, an admiral is not the right man in the present day. To the ordinary business mind it appears that the proper person to arrive at a decision on vexed points would be one having some personal knowledge of work — the time it represents, the value of labour, &c. &c. Now, the Controller of the Navy is an admiral, and never, of course, received any training in his life of the kind needed. He cannot possibly of his own knowledge say whether a charge is or is not too high, and he must place himself in the hands of subordinates. It follows, therefore, that the Controller is only the mouthpiece of departmental officials, and that in so far as this question of the cost of work is concerned, the theory that a very high and impartial official will weigh the interests of the contractor on one hand, and those of the nation on the other, has no foundation in fact. But it may be conceded at once that the Controller of the Navy ought to be an admiral. It follows, therefore, that on some one else should devolve the duties of arbiter—on whom we shall not attempt to determine, but obviously one who by his training and experience possesses the necessary qualifications. It is, we may add here, a noteworthy fact that neither the Assistant Controller and Director, nor the Engineer-in-Chief of the Navy, has anything to do with this question of prices, all the financial work connected with contracts devolving on another department. The functions of the Controller as an arbiter are quite subordinate to those of another kind for which a seaman's knowledge is indispensable, and we have no doubt that he would gladly be relieved of a troublesome duty. But waiving for the moment this aspect of the question, we come to another of perhaps greater importance,

It ought to be clear that the relations prevailing between the Admiralty and the shipbuilding and engineering firms of this country ought to be of the most cordial description. If we trace the history of the progress of the Navy, it will be seen that it has been the result of the labours of the great engineers and shipbuilders of the nation, and not of the Lords of the Admiralty. On the contrary, it is not too much to say that up to a very recent period successive Boards of Admiralty did all that in them lay to retard progress, and we cannot call to mind a single instance in which they originated anything. A Board of Admiralty opposed tooth and nail the use of steam, another Board opposed the screw propeller. It was only with the greatest difficulty that the compound engine was forced on a reluctant body of sailors by the efforts of chief constructors and engineers-in-chief. Armour was opposed. In short it is matter of common knowledge that the Navy as we have it has been built up to its present perfection in spite of Whitehall. But the proper policy for the nation to pursue is to encourage those who, not content with what they have done, continue to do better and better. Instead of this, the Admiralty policy has been mean to the last degree. It is a fact which admits of easy proof that it is dangerous to the interests of a contractor to devise an improvement. Here is an instance: the Russian torpedo destroyer Sokol was the first vessel of its type built in Great Britain of nickel steel; she was to a large extent experimental, and her builders accepted the risk. The Sokol has been a great success. The Admiralty will ask for nickel steel in future, but they will be very unwilling to pay an extra price for it. If Messrs. Thornycroft build for a foreign Government a boat faster than ever was built before, the Admiralty will insist on having equally fast boats, but they will higgle over the price, and obtain tenders from other firms who can profit by the experience of those who have done all the experimental work. Nor is it to be supposed that one firm is better treated than another. The Admiralty are always prepared to utilise the information supplied by one firm to cut down the tenders of another. Statements such as these ought to be substantiated, and there is no difficulty in doing this. Sometime since we had occasion to allude in very strong terms to the action of the Admiralty in distributing Messrs. Yarrow's detailed working drawings of the machinery of the Havock among a large number of firms who were, for the first time, attempting the construction of this kind of vessel, and this was done without first consulting or gaining the sanction of the firm whose designs were thus dealt with—designs, as is well known. arrived at by long experiment in this special class of machinery. A more unfair proceeding it is impossible to imagine. The injustice of making use of the Yarrow designs in the manner described was strongly condemned by some influential Members of Parliament at the time, and it led to a statement in the House by the Secretary of the Navy, which although probably considered by the outside world as a compliment to the Poplar firm, was practically a public apology on the part of the Whitehall authorities for the wrong they had done. But this is not all. On examining the last published Navy Estimates, we find that the average price paid for the destroyers built in the North was several thousand pounds more than that paid to the London builders for the first vessels of this type, in spite of the fact that many of the firms in the North had Messrs. Yarrow's designs furnished them as a guide. In the Navy Estimates the Havock and Hornet are put down as costing £33,174 each, while the vessels ordered from three of the firms on the East Coast, at Newcastle and Sunderland, averaged between £37,000 and £38,000 each.

It must not be assumed that we wish to convey the impression that Messrs. Yarrow have been treated with exceptional injustice. The Admiralty seems to be ubiquitous in doing just that which ought not to be done, and doing it with a very high hand. It may be admitted that the Controller's department has difficult cards to play, but the difficulty is not by any means insurmountable, and is augmented by the department. But there is a higher interest at stake than that of the engineers or shipbuilders of Great Britain. It is the welfare of Great Britain herself. Foreign Governments compete with our own for the work of such firms as Thornycroft and Yarrow, Armstrong and Humphreys, and they get it. Ask where we will, in what port we may, alike on the Thames and the Clyde, the Tyne or the Mersey, we get the one answer: "It is better to deal with a foreign Government than with the Admiralty." This should not be. Instead of building for foreigners, our private yards should be full of work for England. Orders for 30-knot destroyers have recently been placed. It is worth comment that none will be built at Poplar—why, we may perhaps explain at another time; but Messrs. Yarrow, although they have not taken orders from our own Admiralty, are building for foreign Governments. Comment on such a fact, at such a time, is needless. We have said enough, we think, to show that some change for the better in the Admiralty contract system is imperative; and we trust that the attention of Parliament will be directed to the subject soon after it meets.

A writer obviously well informed, in the pages of one of our daily contemporaries, commenting on Admiralty policy, says:—"It is nothing but a breach of trust, and is resulting in what any one with any forethought would have expected, namely, in the disgust of firms of contractors who have in past times been the best friends of the naval authorities, and of the Navy, and in their no longer caring for British Government work, and laying themselves out to supply foreigners, and to send their best productions abroad." We cannot think that the public will regard with favour a policy that permits England to be outbidden for the fastest craft in the world, or makes it better worth the while of Armstrong or Laird to build for a foreign Government than for England. We do not advocate waste; we have no desire to see private firms paid exorbitant prices, nor, it is fair to say, do they want them. What we urge is that the Admiralty is not quite in the position of a limited company. There are national interests to be considered. The building of warships for ourselves should be encouraged. The building of warships for other nations should be discouraged. The relations of employer and employed would be improved, both at Whitehall and outside it, and the chance of the occurrence of labour troubles would be diminished by the display of a little more liberality on the part of the Admiralty. There is such a thing as being penny wise and pound foolish. We have no desire to attack anyone. We express the opinion of all the important shipbuilding and engineering firms in the kingdom, when we say that the existing Admiralty contract system is faulty, and that reform is urgently needed. In what that reform shall consist it is for Government, which is superior to the Admiralty, to decide. To us it appears that nothing more is needed than the adoption of broader and sounder views as to the relations which should exist between the State and engineers and shipbuilders.

A QUESTION OF TRAIN RESISTANCE.

IN this country, when an individual or a newspaper makes a statement which is contrary to or beyond experience, it is customary to regard the statement with doubt, and to ask for a proof of the matter. Nor is offence taken. The maker of the statement understands that being outside experience, and in a manner quite new, it will have to be substantiated by evidence which must be the more exact, complete, and trustworthy, as the statement to be confirmed is more difficult of general or special acceptance. In nothing is this proposition more true than in technical or scientific affairs. In the United States, however, they manage matters differently, and we are bound to accept every statement made, or run the risk of being considered impertinent and offensive. The latest example is supplied by an editorial article in the *Railroad Gazette* of December 6th, 1895. The point at issue is one of sufficient importance to justify reference to it here at some length.

It will be recollected, perhaps, that in our issue of November 15th we criticised what purported to be an official statement, to the effect that a locomotive very similar to an English six-coupled goods engine took a train weighing about 224 tons, including engine and tender, at the average speed of 72·91 miles an hour on the Lake Shore and Michigan Southern Railway, and this not for a mile but for a run of eighty-six miles. The engine has 5ft. 8in. driving wheels and a bogie, and cylinders 17in. by 24in. We had not the least hesitation in saying that such a performance was outside all our English experience. We may say further now that it is outside all American experience as well, and we have asked, and now ask again, for further and detailed information, which we may add has never been published. Analysing the performance, we showed that the boiler could not be expected to produce more than about 700-horse power of steam, and that in that case we must believe that a bulky train, weighing 224 tons, could be propelled at 73 miles an hour by a tractive effort representing about 15 lb. per ton. Our contemporary quarrels with us, and, accepting these figures as perfectly true, goes on to mix up two things which are quite distinct, namely, the internal friction of a locomotive regarded as a steam engine, and the specific resistance opposed by the track to the locomotive regarded as a vehicle. Now it so happens that some few years ago another journal, the *American Engineering News*, took up this question, and, having quoted certain experiments which proved that the pull on the draw-bar between the engine and the train represented less than half the indicated power, proceeded to advance certain views, and generally accepted as sound the explanation of the fact which we gave. To this we shall refer in a moment, but we must first point out that the *Railroad Gazette*, after combating our statement about the boiler power of the engine, subsequently adopts as correct our estimate of 700-horse power, and then says plainly that the resistance of the train at seventy-three miles an hour was but 15 lb. per ton. Now, as regards the internal friction of the engine, we need not concern ourselves. No doubt the internal resistance of a six-coupled engine is greater than that of one with single drivers. What we have to do with is the resistance of such an engine as a vehicle, and in saying that it is much greater than that of any other vehicle in the train, ton for ton, we only assert what is well known to every railway man. Our contemporary, feeling that we have some grounds for our argument, says:—"Of all the fallacies that have ever been published about locomotive performance 'in the States,' one of the most unwarranted is the statement which THE ENGINEER has remembered, that 'not more than about one-half the horse-power of a locomotive is available for hauling the train.' The statement was made by an irresponsible publication, and we are surprised that any one should have taken it seriously. It carries the presumption that the engine in itself, without regard to its weight, absorbs one-half of the power which it generates. This is a simple case of distorted facts."

Now, so far as we can see, the *Engineering News*, far from being an irresponsible journal, is as well conducted and as influential as the *Railroad Gazette*. They are both responsible and respected on this side of the Atlantic. We learn, then, from the pages of the latter that everything that appears about railway matters in the American technical press is not necessarily true. A similar statement is the head and front of our offending. As our contemporary puts it, the proposition we have quoted is simply a case of distorted facts, and he has himself distorted them. There can be no doubt whatever that the draw-bar pull of a locomotive is not nearly the equivalent of the horse-power exerted; and we have explained this fact on the ground that the leading wheels of the locomotive are always running up hill, because of the deflection of the rail under their tread. Everything has to be brought down to its bearings by the engine. It is the yielding of the road that is accountable for a very large percentage indeed of train resistance, and it is by no means impossible that the resistance at very high speed is comparatively small, because the inertia of the road prevents it from sinking as much as it would sink under the longer continued pressure proper to smaller velocities. This is a point, however, on which we do not dogmatise; we are content to suggest. Struggle with the facts as he may, however, it is indisputable that the resistance of the vehicles of the train behind the locomotive must have been much less than 15 lb. per ton, if the power exerted by the locomotive was but 700-horse power and the speed 73 miles an hour. This proposition makes an extraordinary demand on our faith. Our contemporary, instead of supplying us with aids to belief, draws yet further on our powers. For he says: "It has been shown in these columns that the entire train resistance taken from the power of the cylinders, and *pro rata* over the whole train, without making allowance for the internal friction of the engine, has been in some cases only about 12 lb. per ton at about 90 miles per hour." Nothing of the kind has been proved either by the *Railroad Gazette* or any other journal, or individual, for the simple reason that no locomotive hauling a train has ever attained a speed of 90 miles an hour on a level. If that velocity has been got at all, it has been got down hill, and for so short a time that the relation between the indicated power and the resistance could only be estimated. Our contemporary ought to understand that this question of train resistance has an importance quite outside the pale of newspaper controversy. The proper way to treat the matter is that which we have already indicated in the concluding sentences of the article which has stirred up the wrath of our contemporary against us. We wrote: "It is not for us to say that official figures lie; but it is open to us to say that if the speed said to have been attained on the line on the day named was really attained, then it is certain that there is some peculiarity about American track and American rolling stock that is not found elsewhere in the world; and we advise all railway men in the country to hasten to ascertain what it is. Ostensibly the performance was almost impossible on a level, or compensating track." We have nothing to withdraw. We do not say for a moment that 86 miles were not run at nearly 73 miles an hour. But it remains for our contemporary now to show how a result which has never been got in this country has been got.

We have in England roads which it is impossible to excel. The Great Northern, the London and North-Western, and the Midland track is at least as good as anything on the Lake Shore and Michigan route. The mere rolling resistance cannot be greater on one of these roads than it is on another, save to a degree represented by a most insignificant percentage. There is not one scrap of evidence available, however, to prove that on our roads the recorded resistance in any experiment with a train was as low as 15 lb. per ton at 73 miles an hour. We have no records indeed of any experiments at this speed, for the simple reason that it has never been attained save for very brief periods, even by trains which were not fitted with recording apparatus. The *Railroad Gazette* speaks airily of train resistance, as though its amount at high velocities was a matter of common knowledge. We are quite willing to confess that we know next to nothing about it. We challenge our contemporary to advance evidence at once trustworthy and detailed to prove that he is in a better plight. Finally, we come down to minutiæ. Our contemporary has in a manner pinned his reputation on the accuracy of the report which we have criticised. We have asked for further information. We have, perhaps, been misunderstood. We explain. We want to know the gradients of the specific section of the Lake Shore and Michigan Southern line, between Erie and Buffalo Creek. We want to know how the maximum speed attained, stated to be 92·3 miles an hour, was recorded? We want to know what the axle-boxes were like, and the method of lubrication. We want to know what the weather was; in one word, we want to know what were all the conditions under which the most extraordinary bit of travelling in the history of the world was done; and we want all this information, not for the purpose of winning a dialectical argument over our contemporary, but in order to place the facts before the railway world at this side of the Atlantic, so that here in Great Britain we too may be able to run a train weighing 244 tons, with a six-coupled goods engine, at 73 miles an hour from this to York, or Leicester, or Bristol, or Birmingham. If that can be done with a goods engine, what may not be possible say, with one of Mr. Aspinall's flyers on the Lancashire and Yorkshire Railway, or one of Mr. Stirling's big singles on the Great Northern?

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ENGLISH ENGINEERS AND FOREIGN MARKETS.

AN analysis of the annual statistics relating to our machinery exports, of which last week only the bare totals were given, shows that, compared with 1894, the value of the 1895 machinery shipments, excluding steam engines, was an improvement of 11 per cent. This satisfactory state of affairs is due mainly to greatly increased orders for mining machinery, and also for textile machinery, English engineers having, compared with 1894, received more money from abroad for the former class of goods by 86 per cent., and for the latter by about 20 per cent. It is to the enormous activity in South African mining that the credit of the larger increase is chiefly due. This market during 1895 has absorbed about two-thirds of the aggregate trade done with all countries in mining machinery, and so gigantic have been the strides which it has made during the twelve months just passed that the value of the machinery sent there has a good deal more than doubled compared with 1894, having increased from £237,484 to £487,610. Such a showing will increase among English engineers and machinists their regret that the Transvaal difficulty should have arisen, and their satisfaction that a settlement is being arrived at. Another very pleasing feature of the annual mining machinery statistics is the advance made by Australia, which has been so rapid as to suggest the leaps and bounds of her emblematical kangaroo. The figures last week available show indeed that the trade of 1894 has actually been multiplied more than seven times over, for it has risen from £12,270 to £86,265. We are accustomed to fluctuations in the mining machinery returns, but those to which attention has been called probably "beat record," and should have the effect of making British mining engineers particularly keen upon African and Australian trade in 1896. Textile machinists have done a trade during the year amounting to the handsome total of more than six millions sterling, and absorbing about half of the aggregate trade in machinery of all kinds (exclusive of engines). European business has brought in about two-thirds of their income, having been augmented during the year by some 9 per cent., and standing now at not far short of four millions. Second place is taken by India with £827,150, or an 8 per cent. improvement. Business with the United States has more than doubled, having risen from £233,470 to £478,989. With nearly all markets we have done better than a year ago in miscellaneous machinery. The net drop of 9 per cent. in steam engines of all kinds has been due to agricultural and miscellaneous sorts, and has not affected locomotives, which have progressed in value from £749,586 to £799,597, the chief contributory advances being India 50 per cent. (from £204,091 to £305,327), and South America over 7 per cent.

LITERATURE.

Coal Pits and Pit Men. By R. NELSON BOYD, Mem. I.C.E., Second Edition. Revised and enlarged. Crown 8vo., pp. 356, with 36 illustrations. London: Whitaker and Co. 1895.

WE are glad to see that this book has been so well received, that a new edition has been asked for in what, considering the special nature of the subject, must be called the short time of three years. In the new volume, without departing from his original plan of describing the changes that have been made in the legislation affecting the working of coal mines in continuous chronological order, the author has taken the opportunity of adding a preliminary chapter, taking a general survey of the whole subject; and a full digest of the Report of the Royal Commission on Accidents in Coal Mines, which was only briefly noticed in the first edition, has been added. The history of the coal trade has also been continued to the end of 1894, bringing in an account of the great strike in the Midland districts in 1893, and there is a notice of the Report of the Royal Commission on the Aged Poor. The technical part has also been enlarged both in the text and illustrations, the latter including several good figures of hauling and other engines, and reproductions of some of Mr. Arthur Sopwirth's excellent photographs taken underground by magnesium light. These additions, while increasing the size of the volume by nearly one-half, have considerably improved it, making it a useful, if somewhat one-sided, contribution to economic history which, from its popular style, is likely to be of interest to many readers in addition to those technically familiar with the subject. We fear, however, that the author's sympathies with the working classes lead him at times to overstate his case, as, for instance, when he assumes, in the absence of statistics, "that the number of men injured in and about coal mines cannot be much less than 100,000 per annum, and a large proportion of these would be sufficiently injured to weaken even a robust constitution." This appears to give one non-fatal accident for every 1800 or 1900 tons of coal raised; while in the Kingdom of Saxony, where statistical returns under the Compulsory Accidental Insurance scheme are available, the proportion of injuries involving total, partial, and temporary disablement in 1894 corresponded to one in 22,300 tons. Now, as we can scarcely imagine that coal mining is twelve times as dangerous, or that miners are twelve times as careless in England as they are in Saxony, we cannot accept the author's 100,000, except as a symbol for a large number. We are also in doubt as to his scheme for establishing pensions for miners, based upon voluntary savings effected on the security of the State, with a provision that the money paid in should be returned on demand, and the pension, with an equitable addition by the State, claimable at a reasonable age, say, fifty years. This, no doubt, would, in the author's words, be a "most popular scheme," and we hope, therefore, that he may soon have the opportunity in a new edition of showing us how to make it a workable one.

The Colliery Manager's Handbook. By CALEB PAMELY. Third Edition. Medium 8vo, pp. 848, with 648 illustrations. London: Crosby Lockwood and Co., 1896.

IN its new form this work has been enlarged by about two hundred pages, considerable additions having been made to the chapters on shaft-sinking, surface railways, surveying and planning, and safety lamps. In the chapter on coal mine gases and ventilation, the introductory part dealing with the chemical and physical properties of gases has been greatly improved, it having been re-written by Dr. Frank Clowes, of University College, Nottingham, and the geological part has been revised by Mr. F. W. Riedler, who has replaced the diagrams in the earlier pages of the former edition by new ones. The result of the co-operation in these two instances has been so satisfactory as to lead to the wish that the same principle of expert assistance had been followed in other sections of the volume. As it is, the additions seem to have been made with the principal purpose of increasing the size of the volume, when judicious concentration would have been more valuable. What may be considered to be the principal section—namely, that on coal working—seems to be reproduced without alteration, and there is substantially nothing given about the use of compressed air or other methods of transferring power from the surface to underground workings. The chapter on safety lamps has been extended to ninety-five pages, or rather more than a tenth part of the whole book, which seems excessive, considering that the whole of the mechanical details of centrifugal fans are compressed into about thirty lines, and no space has been found for such important subjects as screening and coal washing. In the preface the author calls attention to the account of the Gobert modification of the Poetsch process of sinking through watery ground by freezing the strata, which is now published for the first time in England. This differs from the original method in dispensing with the use of calcium chloride solution as an intermediate agent, the freezing being done direct by allowing liquefied ammonia from the condenser to evaporate in the circulating tubes around the site of the pit. This account is extremely interesting and well illustrated, but no details are given of the practical results obtained by the method. There might be a better utilisation of the heat expended by doing away with the intermediate fluid, but in the absence of evidence to the contrary, it may be doubted whether the work of freezing would go on as regularly. The main point to be regarded is regularity in working the compressor, and this is more likely to be attained when it draws its supply from an evaporator near at hand than when it has to depend upon evaporation going on at a number of different points in a circuit of pipes, which may, as in a recently described case, be more than two miles long. In the case in question, the sinking of the Vicq pits at Anzin, the primary cooling was done with about 14 cwt. of ammonia, which was evaporated, compressed, and liquefied once in every twenty-five minutes, with a range in temperature of 62 deg. Fah., while the freezing employed 77 tons of brine, containing 25 tons of calcium chloride, whose temperature in making the round from the refrigerator through the freezing tubes and back was only raised about 4·7 deg. The parts played by the two fluids are so dissimilar that it is difficult to see how in such a case the brine could be safely discarded. We should, however, be glad to have more information on this point.

Weather and Disease; A Curve History of their Variations in Recent Years. By ALEX. B. MACDOWALL, M.A., F.R. Met. S. London: The Graphotone Company, 1, Maclean's-buildings, E.C. Price 2s. 6d. 1895.

THE relation that subsists between variation in health and variation in weather is probably not personally ascertained by more than a very few, if any, people living. That changes of considerable magnitude in the weather are accompanied by effects more or less notable, though not always the same in the health of most people, is, perhaps, undoubted, and some attempts have been made to trace relation between meteorology and zymotic disease; but this relation is chiefly followed in connection with large numbers of people and death rates. The comparison of these death-rate fluctuations, and variations in rainfall and temperature, involve a good deal of trouble, or, at all events, of care, and the interpretation of the meaning of the variations and their co-relation is at any time a mental exercise, which is greatly simplified by the graphic method adopted by Mr. MacDowall in this little book, and also in a book previously published by him, showing by curves the changes in the history of certain parts of the History of Ireland. In the book before us there are thirty-six diagrams giving the fluctuations over greater or less periods in the temperature, rainfall, dryness, frosts, spells of hot and cold weather, sun spots and thunderstorms, early and late seasons.

Sixteen of the diagrams show the rise and fall of the most prevalent diseases, the rise of some and the decadence of others. The curves include the whole variation through short periods within each of a number of years, and a heavier line curve shows the mean variation, so that the effect over long periods is shown at a glance. In the short discussion which accompanies each curve, in several cases connecting the disease curves with the meteorological curves, Mr. MacDowall's book will be found of interest to a great many readers, and an extension of it or his curves might usefully be made in which the relation between both sets of observations might be graphically shown. The abscissæ might be easily co-related, and the ordinates might be arranged so that the curve relations might be read off by means of two or more ordinate scales.

SHORT NOTICE.

Practical Hydraulics for the use of Waterworks, Sanitary, Agricultural, Drainage, Irrigation, Inland Navigation, Mining, Railway, Harbour, and River Engineers. Part No. I. Kutter's Formula Simplified, for the Easy and Rapid Calculations of the Discharge of Rivers, Canals, Channels, Drains, Culverts, Sewers, and Pipes. By J. W. H. Hullet, C.E., Adelaide. Hussey and Gillingham. 1896. Price 5s.—This is a once-folded card carrying the several expressions of Kutter's formulæ for velocity, discharge, and diameter or dimensions, with tables of coefficients for different surfaces. Kutter's formulæ are given as slightly modified, and with modified coefficients giving correct results where Kutter's are correct, and slightly simpler formulæ for use when a maximum error of 2 per cent. is unimportant. The collection of formulæ, examples, and coefficients is a useful one, and the author, who is in the department of the engineer-in-chief of the Government of South Australia, gives formulæ for irregular channels, and intends to supplement the card now published by another giving special formulæ for different branches of hydraulics.

BOOKS RECEIVED.

British Industries and Foreign Competition. By A. Williamson. London: Simpkin, Marshall, Hamilton, Kent, and Co., Ld. 1894.

A New View of the Origin of Dalton's Atomic Theory. A Contribution to Chemical History. By Henry E. Roscoe and Arthur Horten. London: Macmillan and Co. 1896. Price 6s. net.

The Local Government Annual. An Official Directory. 1896. Edited by S. Edgecumbe-Rogers. Fifth year of publication. Price 1s. 6d. London: *The Local Government Journal* Office.

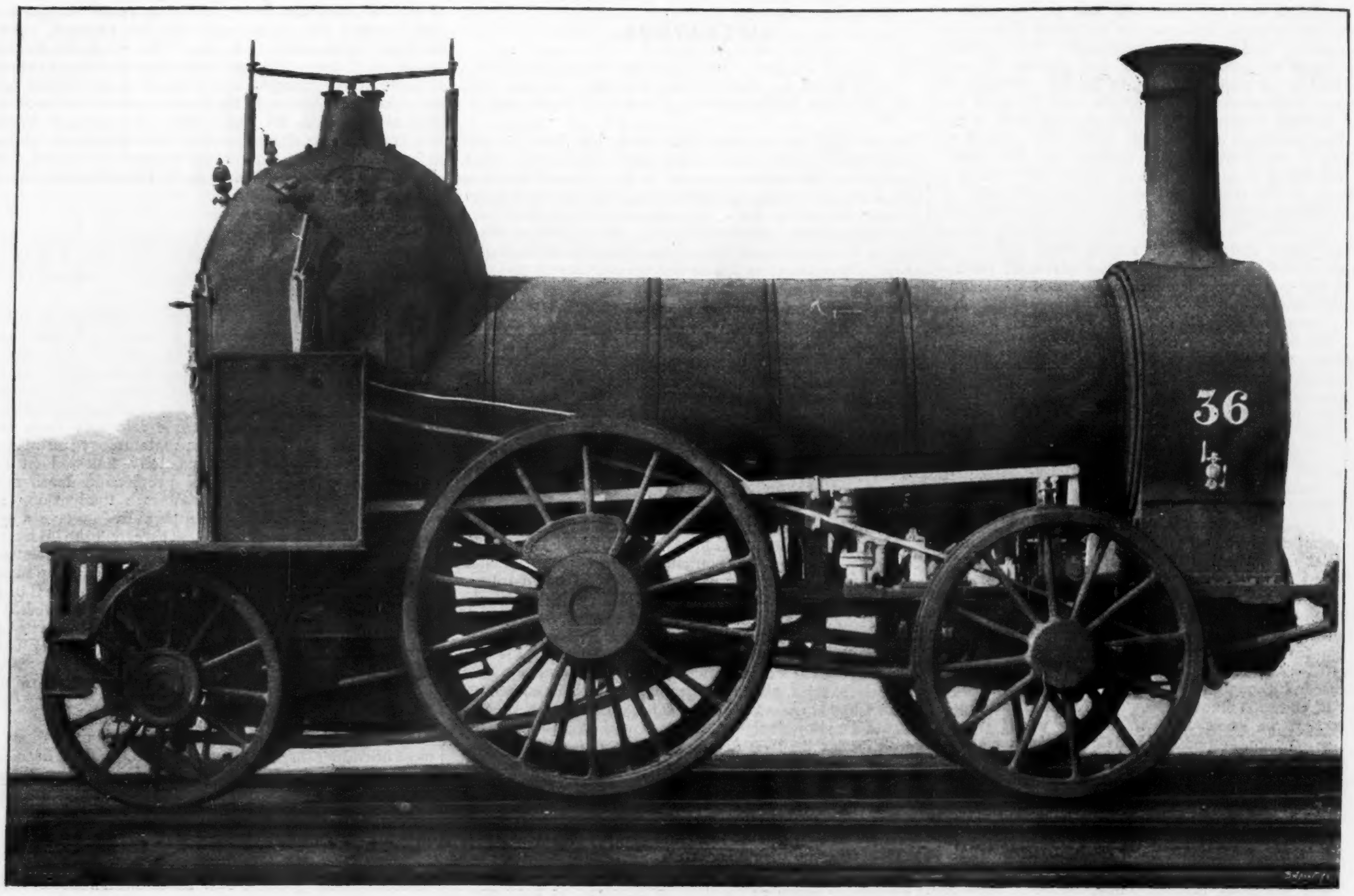
The Local Government (England and Wales) Bill, 1893. *Abstract of Clauses of the Bill, with Full Index.* Reprinted from the *Local Government Journal.* London: S. Edgecumbe-Rogers, the *Local Government Journal* Office. Price 1d.

The Steam Engine considered as a Thermo-dynamic Machine. A Treatise on the Thermo-dynamic Efficiency of Steam Engines. Illustrated by diagrams, tables, and examples from practice. By James H. Cotterill, M.A., F.R.S. Third edition. Revised. London: E. and F. N. Spon. 1896.

DEATH OF MR. THOMAS GALLOW, MECHANICAL ENGINEER AND INVENTOR.—In the death of Mr. Thomas Gallow, 13, Lilly Hill-terrace, Edinburgh, the mechanical world has lost one of its sons of inventive genius. He died on New Year's Day, at the age of fifty-nine, after an illness of some months of great pain and suffering. He was buried on Saturday, the 4th, in Rosebank Cemetery. His body was followed to his last resting-place by many friends and admirers of his genius. Mr. Gallow was the patentee of several useful mechanical inventions, which brought him little monetary reward. For the long period of twenty-eight years he occupied the responsible position of mechanical engineer to the Commissioners for the Harbour and Docks of Leith. In this capacity he made many valuable additions and improvements to the dock machinery. With Mr. Chapman, of Messrs. Hawthorne and Co., of Leith, he was joint patentee of a simple form of hydraulic capstan, used instead of horses for the haulage of coal to the hydraulic hoists. This form of hydraulic capstan has been in use at the docks for several years, and has proved an entire success.

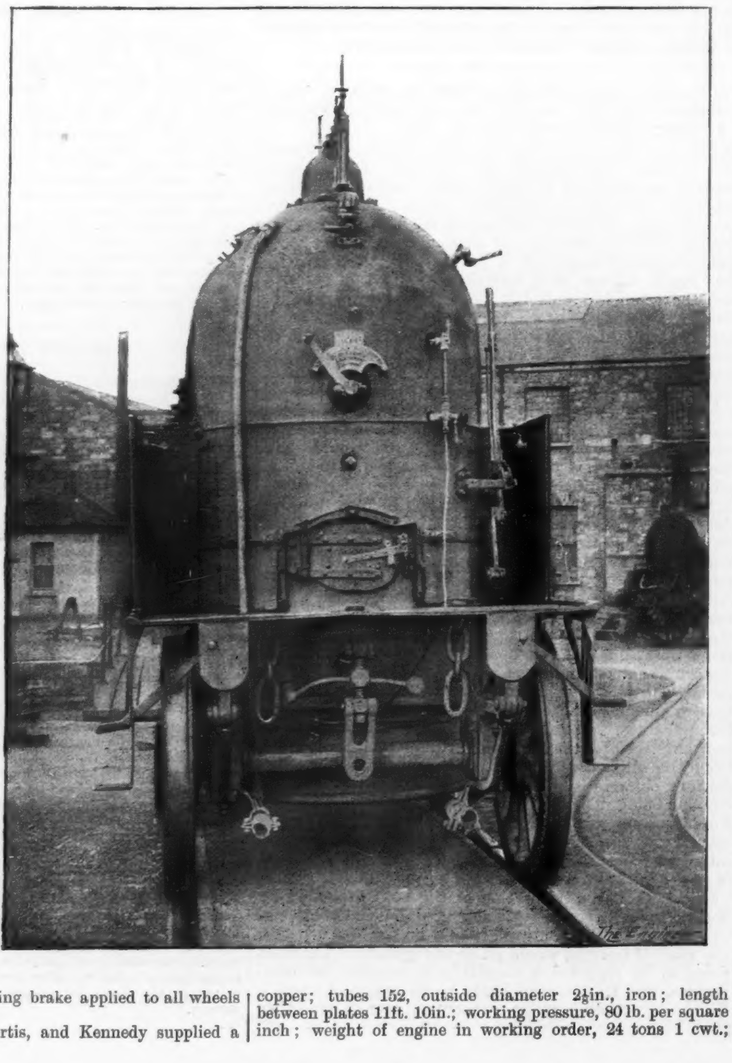
PASSENGER LOCOMOTIVE—GREAT SOUTHERN AND WESTERN RAILWAY, 1847

MESSRS. BURY, CURTIS, AND KENNEDY, ENGINEERS



PASSENGER ENGINE, GREAT SOUTHERN AND WESTERN RAILWAY, 1847.

In our last impression we illustrated the Jenny Lind, and now, through the courtesy of Mr. Ivatt, we are enabled to illustrate one of the best engines ever built by Messrs. Bury, Curtis, and Kennedy. The photograph was taken nearly ten years ago, after the engine had fallen into decrepitude, and gives no adequate idea of its finish and excellence of workmanship when new. The engines on the Great Southern and Western Railway were always very well kept, and the copper dome and brass-work were polished, and the paint and varnish excellent.



Unfortunately there is no complete drawing of the engine in existence. That which we have reproduced is much dilapidated, but enough remains to show the bar frame. The engine was put on the line in 1847 and worked up to 1872, running 345,163 miles in that time, or 13,800 miles per annum. The permanent way consisted of flange ⊓ rails weighing 90 lb. to the yard.

The engine was No. 36, and its dimensions as follows:—Wheels, six, single, diameter leading 4ft. 2in., driving 5ft. 8in., trailing 3ft. 8in.; wheel base, front 6ft. 11in., hind 6ft. 2in., total, 13ft. 1½in.; axle-box bearings inside; inside cylinders, 14in. by 20in.; copper fire-box, length 3ft. 3in.—inside—breadth 4ft., height above grate 4ft. 3in.; iron tubes, 119 outside diameter 2⅛in., length between plates 10ft. 8½in. tires, steel, made at Leeds; weight of engine in working order, 19 tons 10 cwt. Tender: Capacity of tank 1344 gallons; number of wheels, four; hanging brake applied to all wheels both sides; tires iron.

In 1848 Messrs. Bury, Curtis, and Kennedy supplied a goods engine, No. 105, of the following dimensions:—Wheels, six four-coupled; diameter of wheels, driving and leading 5ft., trailing wheel 3ft.; distance of centres, front 8ft., hind 6ft. 8in.; axle bearings inside; cylinders 16 by 24—inside—fire-box, length 4ft. 3in., breadth 4ft. 4in., height 4ft. 7in., copper; tubes 152, outside diameter 2¼in., iron; length between plates 11ft. 10in.; working pressure, 80 lb. per square inch; weight of engine in working order, 24 tons 1 cwt.; tires, iron. Tender: Capacity of tank, 1344 gallons; number of wheels, four; brake applied to all wheels both sides; iron tires.

On page 66 we give detailed drawings of the crank axle and driving-wheels. The hubs were of cast iron, the forged centre with split spoke ends being put in the mould and the cast iron run round it. These wheels were very successful, and it is worth notice that balance weights were used as far back as 1847, and probably long before that date, by Bury.

THE MANCHESTER SHIP CANAL TRAFFIC.

Tables showing approximately the traffic over the Ship Canal for 1895 have been issued, and although the statement does not come up to the expectations of the most sanguine of its advocates, still the amount is substantial, and gives good hope of continued improvement. At length the great waterway is becoming equipped in various ways to conduct traffic in a manner to satisfy the needs of shipowners and others. The connection with the London and North-Western Railway Company is made by the branch railway from Eccles, and in addition to the transit sheds on the quays, large warehouses are provided for the storage of goods. The Manchester Corporation have their cold air stores in active use.

During 1895 and 1894 the traffic and receipts are given as follows:—

	1895. Tons.	1894. Tons.	Increase. Tons.
Seagoing traffic	1,087,443	686,158	401,285
Barge traffic	271,432	239,501	31,931
Total	1,358,875	925,659	433,216
	Receipts.		
	£	£	£
Seagoing traffic	120,586	76,969	43,617
Barge traffic	5,073	3,636	1,437
Passengers	1,750	6,865	* 5,115
Rents and sundries ..	9,350	7,186	2,164
Total	136,759	94,656	42,103

* Decrease.

As compared with the early days of the Suez Canal the increase is not discouraging. In 1870 the gross tonnage by way of Suez was 1,142,200 tons; in 1869, 654,915 tons; increase, 487,285 tons.

Royal School of Mines.—The twenty-third annual dinner of the Old Students of the Royal School of Mines will take place at seven o'clock on Friday, January 24th, 1896, at the Criterion Restaurant. The chair will be taken by Mr. A. G. Charleton, Assoc. R.S.M., Member of the Council of the Institute of Mining and Metallurgy.

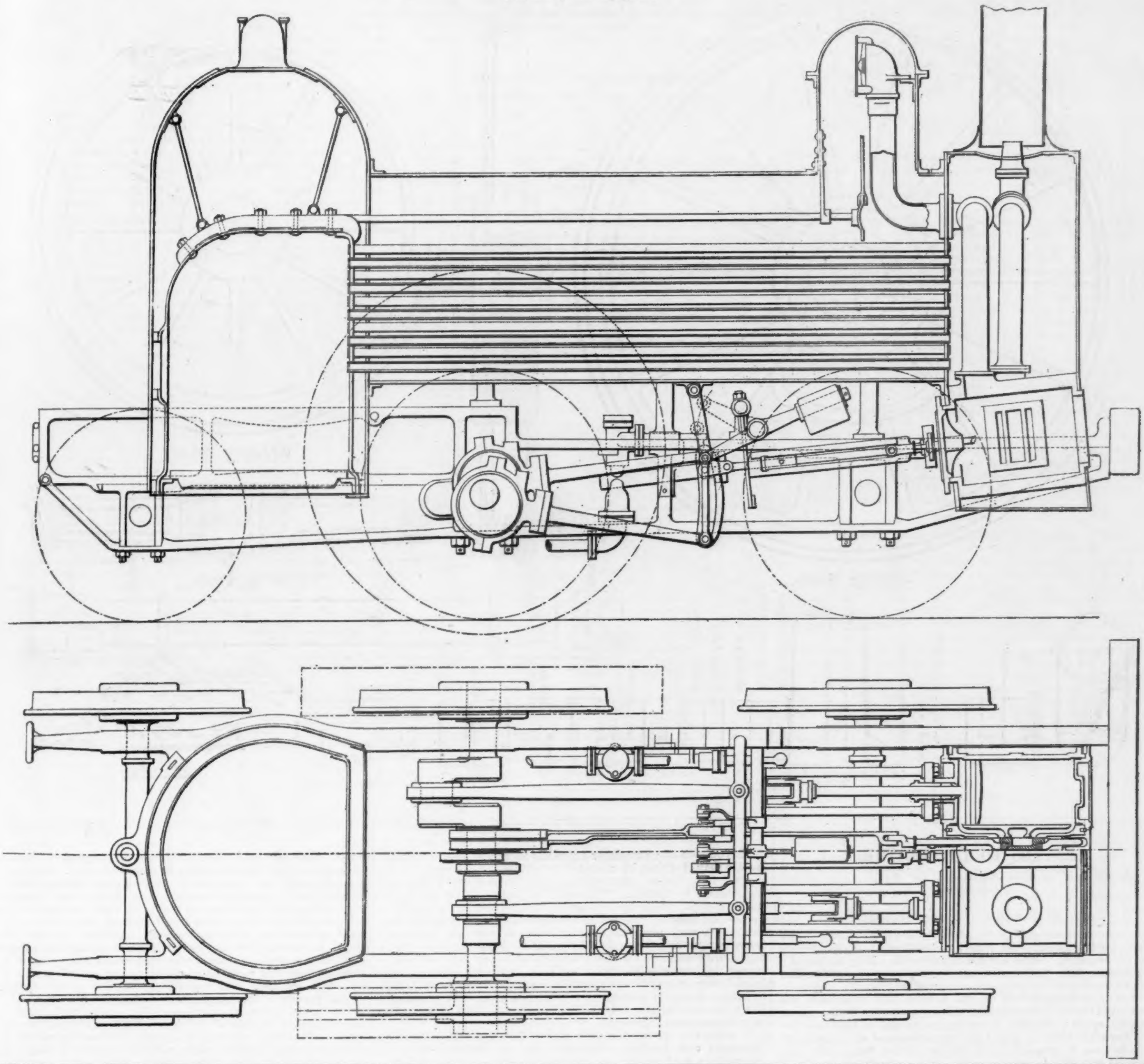
Rope Traction.—The particulars of the London Tramway Company's Brixton-hill rope will be read with interest by those who have the adoption of the rope system of haulage under consideration:—

Length	30,000ft
Size when new	3⅝in. cir. full
Worn down to	3¼in. cir.
Put to work	July 9th, 1893
Taken off	November 9th, 1895,
Worked	853 days
Speed	8 miles per hour
Time	18 hours per day
Total rope miles	123,120
Total car miles	1,791,293
Cost per car mile	·1608 pence
Total passengers carried	24,232,699
Cost per passenger	·001188 pence

This rope was made of Cradock's improved patent crucible stee. Lang's patent lay.

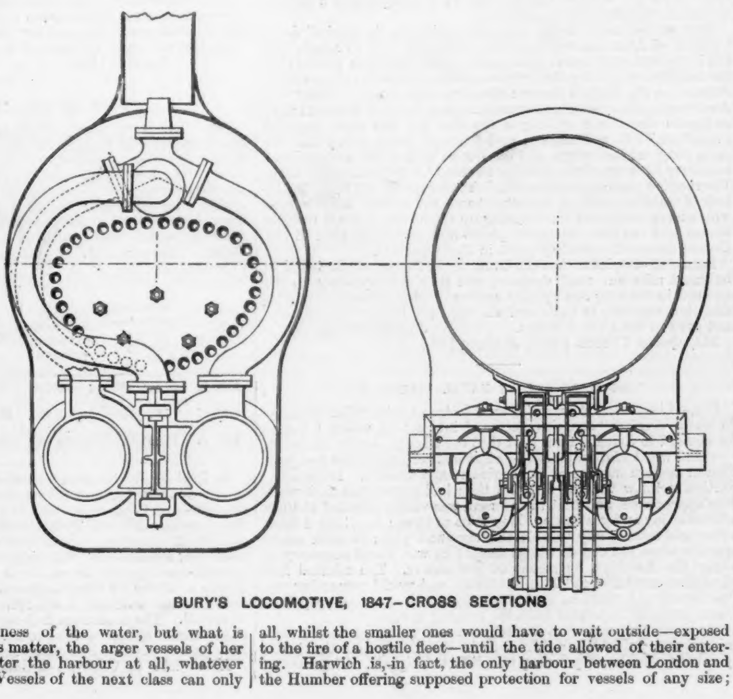
PASSENGER ENGINE, GREAT SOUTHERN AND WESTERN RAILWAY, 1847

(*For description see page* 64)



THE DEEPENING OF HARWICH HARBOUR.

THE condition of Harwich Harbour has been the subject of frequent complaints to the Harwich Conservancy Board, and has also been repeatedly brought under the notice of the directors of the Great Eastern Railway, who are interested in the subject on account of their services from that port to the Hook of Holland and Antwerp. It seems that on the "Gristle" shoal, lying between the Guard and North Shelf Buoys, there is as little as 14ft. at low water ordinary spring tides, and on the "Glutton" shoal, extending from the North Shelf Buoy to the North Cliff Buoy, there are several patches on which there is but the same depth of water; but when, at spring tides there is a continuation of south-westerly winds, the water falls more than a foot below the figures shown on the Admiralty charts. It is true there is a narrow channel between the "Gristle" and the "Guard" shoals with 20ft. water, and also a channel between the "Glutton" shoal and Felixstowe beach with 19ft. at low water; but this is only narrow, and there are no lights to lead vessels through. This channel, therefore, cannot be used at night, nor can it often be used by day, as it is almost invariably blocked up with vessels at anchor, so that it is impossible to get into the deep water. The result of all this is that not only do the four Great Eastern vessels of the new type, which draw about 15ft. 6in., frequently touch the ground at low tide, owing to the shallowness of the water, but what is regarded as a much more serious matter, the larger vessels of her Majesty's Navy cannot now enter the harbour at all, whatever may be the state of the tide. Vessels of the next class can only enter or leave the harbour at the time of high water, and the present guardship, the Mersey, which may be included in the third-class, with a draught of about 19ft. 6in., can enter or leave the harbour only at half tide. Should, therefore, one or more of our ironclads sustain any serious damage in time of war, and try to make the harbour, the larger type would not be able to enter at all, whilst the smaller ones would have to wait outside—exposed to the fire of a hostile fleet—until the tide allowed of their entering. Harwich is, in fact, the only harbour between London and the Humber offering supposed protection for vessels of any size; but although during the last twenty-five or thirty years the military authorities have spent thousands of pounds on Harwich and neighbourhood, and although the harbour itself is now strongly guarded by forts and batteries mounted with heavy guns, and garrisoned by detachments of artillery and marine-artillery, nothing has been spent during the whole of this time in rendering the harbour itself more accessible to her Majesty's ships.

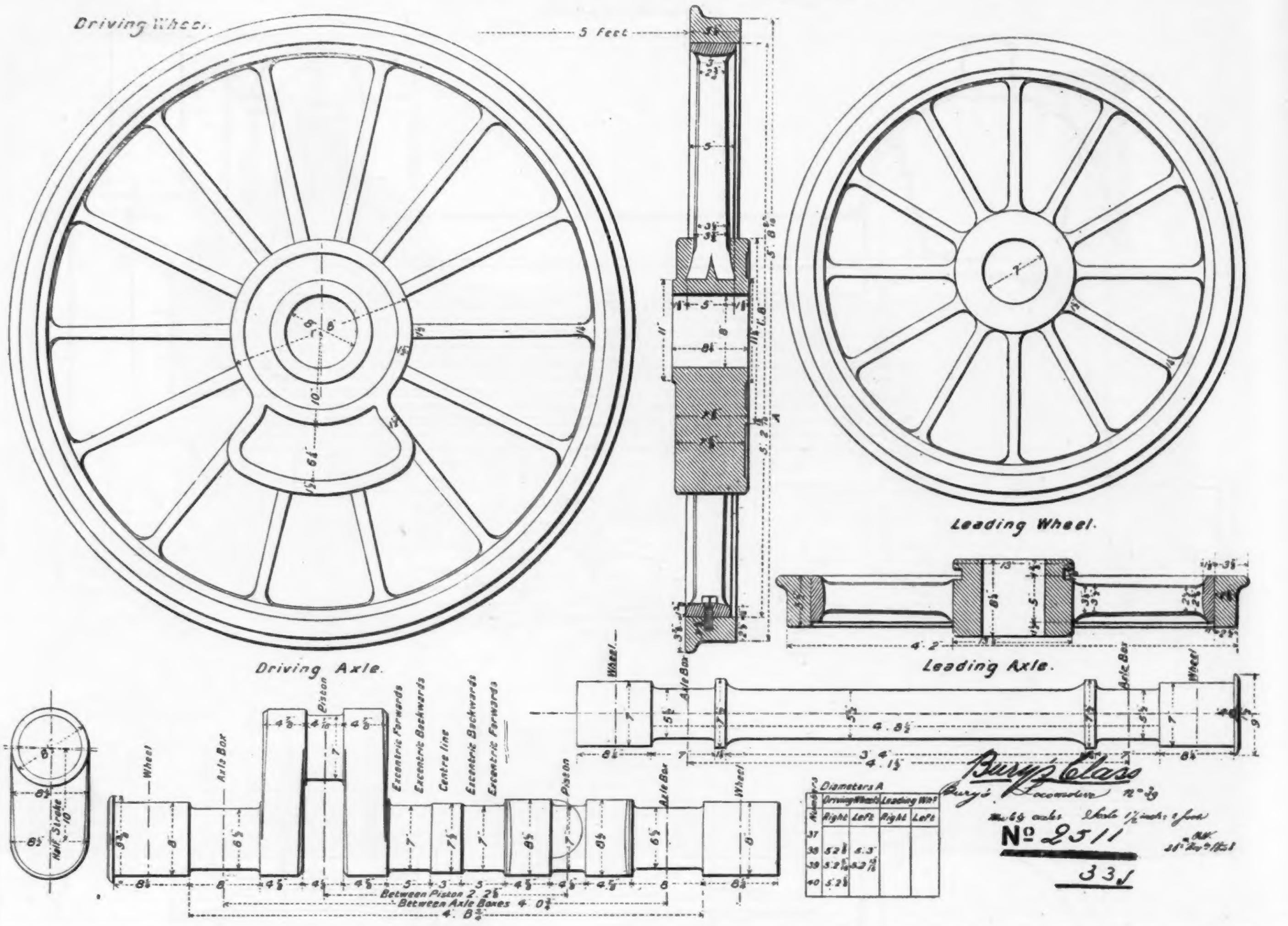


BURY'S LOCOMOTIVE, 1847—CROSS SECTIONS

The attention of the Admiralty has been called to the matter, and a reply has been received stating that: "Sounding has been carried out at Harwich at frequent intervals during the last ten years, and the variations discovered last spring were much less than usual. So far as the soundings made at the request of the Board of Trade are concerned, there is no ground for apprehension that the harbour is 'silting up.'" It is, however, urged that the real question at issue is not whether the harbour is becoming still shallower, but whether it should not be dredged sufficiently deep to allow not only of passenger ships navigating it without touching the ground, but also of the large vessels of our Navy being able to enter in case of need. This latter point, it is contended, says the *Times*, should be regarded as having an important bearing on the question of national defence.

THE INDEX MAP OF THE GEOLOGICAL SURVEY.—A new departure has recently been made by the Government with a view to popularising the work of the Geological Survey, by supplementing the maps which have hitherto been published on the scale of 1in., and in part on that of 6in. to a mile, with a smaller one on ¼in. to the mile scale, containing as much of the detail of the 1in. map as is likely to be generally useful to travellers and tourists. Several sheets of this map have been prepared and coloured by hand, according to the system adopted for the larger scales; but this, no doubt the best method, is practically prohibitory as regards price. The cost of colouring a double-elephant sheet with an average amount of detail, would make it necessary to charge 10s. 6d. to avoid loss. An experiment has therefore been made by the Stationery-office of printing in colours one of the sheets—No. 12, including the South-East of England, south of Cambridge and Orfordness down to Battle, and westward to Blisworth and Petersfield—which can be sold for 2s. 6d. a copy. The colour-printing has been done by Messrs. Wyman and Co. and is extremely good, leaving little to be desired when compared with the hand-coloured copies. The sheet selected is well adapted to test the capabilities of the method, as it contains no less than nineteen different formations, from the lias upwards to the Suffolk, all of which are indicated by flat tints without dots or cross-hatchings, the general scheme of colour being similar to that of the larger maps. Should the experimental map be successful, the Stationery-office propose to produce the other sheets of the series in the same manner, so that we hope that it may meet with a ready sale.

BURY'S PASSENGER ENGINE, 1847—DETAILS OF DRIVING AXLE AND WHEELS



LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BULLHEAD RAILS AND FLANGE RAILS.

SIR,—In your issue of 27th ult., Mr. Tratman, in a latter on this subject, further defends the American preference for the flanged section. He says, "Rails are intended for the rolling surface of a track construction, and should not be considered as independent structures acting as bridge spans supported on piers."

I have never suggested that a rail is to be thus considered, nor even that it should be compared with a continuous bridge girder of several spans; and such a comparison would be fallacious, because the alterations of levels due to subsidence of sleepers are altogether out of proportion—in relation to the spans—with any variations met with in bridge piers. But, curiously enough, as it seems to me, some such assumption must be involved before we could regard the provision of a "rolling surface" as the main purpose of a rail.

If the supports were absolutely fixed in level, we might, by reducing their distances, increase the effective strength and stiffness of the rail indefinitely; so that, if the sleepers were placed close together, the rail would not require any appreciable stiffness, and need only be a wear-resisting strip. That such reasoning would be quite inapplicable to a railway, is sufficiently evident from practice in the United States, where experience has dictated the use of the heaviest rails yet made, although they rest on sleepers spaced more closely than usual in any other country. My contention has been that stiffness for the purpose of distributing a concentrated load over a considerable length of track, and reducing vertical curvature, is one of the most essential functions of a rail. Deficiency in rail stiffness cannot be compensated by close sleepering, and this, I think, is shown in American practice by an unnecessary expenditure of material, owing to the section of rail adopted.

Of course, stiffness is a quality distinct from strength under static stress; the one depending upon the moment of inertia, and the other upon the moment of resistance of the section; and it is quite possible that with two rails of the same weight, one may have less strength but greater stiffness than the other. Under fast traffic, I suggest that with two rails of equal static resistance, the stiffer one would be effectively stronger owing to its greater radius of curvature under the advancing load, and that therefore, important as adequate stiffness is in all cases, increasing speeds render it more especially so at the present time for the sake of both road and rolling stock.

A bullhead can always be made stiffer than a flange rail of the same weight without altering the head or decreasing the strength, and, as far as I have been able to find, the only argument in favour of the latter now is saving in initial cost of track. As regards that point I am enabled, by the courtesy of Mr. Tratman in a personal communication, to quote Mr. Sandberg's opinion as follows:—"It would, therefore, be better to give up the plan of laying the rail flange direct on the tie, and to adopt a steel tie-plate of sufficient surface, or equal to that of the cast iron chair, nearly 100 square inches, say 12in. by 8in. and ½in. thick, so as not to bend it, and fasten the same to the tie with three fang-bolts, wood screws or spikes, using clips and steel keys for fixing the rail to the base plate." That rather suggests an emergency expedient, but to continue quotations: "By this means it might be possible to obtain an equally good and safe track with flange rails as with the English bullhead type of rail, and at somewhat less cost. . . . As it would be useless to try and introduce the English type of track in those countries where flange rails are already adopted, the only way to obtain an equally safe and strong road for heavy traffic as on the English lines seems to be to strengthen those by the adoption of the Goliath rail with steel tie-plates, but to let everyone keep to his section of rail."

This opinion of an engineer especially identified with the flange section may, I think, be accepted as strong confirmation of the views I have before expressed in your columns, but it goes one important step further. "It would be useless to try and introduce" a type, which by implication is admitted to be superior, because an inferior type was adopted at the outset. I submit that this has a very practical bearing in relation to Mr. Tratman's remarks regarding Colonial development by cheap railways. When the future welfare of a growing country is kept in view, much may be said in favour of "building for posterity" as contrasted with hand-to-mouth expediency; and the engineer to whose lot it falls to initiate a type of permanent way which is likely to be permanent has in his control more far-reaching power for good or evil than may be generally supposed.

It is not the rail section only that is involved. In comparing American and English permanent way, the different types of locomotives used in the two countries should not be overlooked. With smaller wheels and shorter distances between their axles, an American locomotive is statically easier on the road, weight for weight, than an English one; the frame and springs serving to perform part of the duty thrown upon the rail here. This suggests the following rather curious coincidence. We find in the United States extremely heavy rails, sleepers placed at very short intervals, and locomotives with very short distances between their axles; and a possible cause for each one of these peculiarities might, by *a priori* reasoning, be found in the adoption of a form of rail inherently deficient in stiffness.

That we owe much to the experience gained in the gradual development of American railways I should be the first to admit, and the introduction of cars of American type on our roads proves that the Britisher is not hopelessly conservative, but such cars are more at home on the English than on the American track. That "the American track is probably more stable than the best English track, owing to the closer spacing of the ties and the more frequent fastenings," I do not believe, and I should prefer to say that the more frequent fastenings, and the ties to hold them, are rendered necessary by want of the stability afforded by the chairs used here. The running performances on English railways do not indicate any lack of stability, and, on the other hand, the various contrivances which have been tried for strutting up the heads of flange rails on curves, and the more recent tie plates and fang bolts used in the United States, do certainly point in that direction.

I am still of opinion that the track of the future will be found in bullhead rails on steel sleepers, and that the economy to be secured in the long run by that system must eventually secure its adoption, not only in India and the Colonies, but in this country, and even in the United States. JAMES WHITESTONE.

113, Queen Victoria-street, January 13th.

THE ENGINEER IN NAVAL WARFARE.

SIR,—Lieutenant Edwards' second lecture on the "The Engineer in Naval Warfare" contains matter of interest on which I beg to be allowed to touch. I am glad that the admiral—with his quick eye and wonderful judgment—had at last recognised the real position in modern warfare of the engineers and firemen. It is a satisfaction to know that at last the time had come when their work was appreciated, and that the admiral was visibly affected at their cheers of joy and gratitude. May it be so in our case! As I have often said before, why trouble the wires and pipes in such emergencies when you can do things direct? It was found necessary to steer the Brooklyn by means of her screws. The admiral had doubtless carefully read THE ENGINEER, and would remember my last letter, and what he could have done had reversing propellers been available, operated from the conning tower.

At times the seaman at the engine-room telegraph in the conning-tower pulled the lever a trifle too hard, and the index pointed to the line separating two different signals. The man on watch—with *his* quick eye and wonderful judgment—would have to decide quickly to which order he would respond. Just so! Before the fight was over one of the engineer officers fell in an apoplectic fit. And no wonder. Any doctor who understood engineering would say that the real cause of his death—he passed away in three months, glorified by a crown of martyrdom—was the want of means for direct action on the screws by *the* brain of the ship. In an action of this sort had the engineer not enough to look after in such a place under such conditions, without being troubled with this uncertain manipulation at second hand? Why, the waste of time and uncertainty of the present system at critical periods is enough to give the admiral "fits," too.

During the action the engines of the several ships were used intermittently not only at full speed, half speed, and at varying speeds of backing, but at progressing and decreasing speeds ahead. In order to obey quickly, valves will be suddenly opened. Starting up quickly will cause the boilers to foam, and if water gets in the line of steam piping there is going to be trouble. Why not avoid all this by means I have so frequently pointed out in your esteemed journal?

I pause for a reply from the men of "quick eye and wonderful judgment," especially as I have just received reports from the manufacturers, of the continued excellent working of reversing propellers, to the satisfaction of every owner of every installation. One of fairly large diameter has now been out two winters in one of the roughest seas round our coasts; and everywhere they have proved themselves trustworthy. This aid to easy manipulation and safety of the great ships of war ought to be used in our Navy.

39, Dagnall Park, Selhurst, S.E., ROBT. MCGLASSON,
January 11th. Hon. M.I.M.E.

FREE TRADE AND NO TRADE.

SIR,—The more deeply we study the course of prices, and the effects on our food supplies caused by the Repeal of the Corn-laws, the greater is our amazement at the extraordinary delusions which have so long existed in regard to what was in reality the most disastrous measure ever passed by the Legislature of this country. To enable your readers to see at a glance what were the results so directly the reverse of the promises held out, I have compiled the following table. The figures of home production are taken from Messrs. Lawes and J. H. Gilbert's table in the *Field*, 12th February, 1887:—

Years.	Average yearly imports of wheat and flour, qrs.	Average yearly home production, quarters.	Total quarters.	Per head of population, lb.	Average yearly prices per quarter.
1852-59	4,767,803	14,435,799	19,203,582	326	57s.
1860-67	7,977,632	13,300,296	21,286,879	347	50s. 7d.
1868-75	10,801,453	12,684,765	23,486,219	357	53s. 11d.

In 1842 Sir Robert Peel estimated the annual home production of wheat at twenty-two million quarters—see *Annual Register*, 1842, page 38—and Cobden, in 1843, at twenty millions. It will be seen that between 1852 and 1859 it had fallen to 14,435,779, a decline of 7,564,221 quarters. From 1842-46 the import averaged, yearly, 1,647,688, against 4,767,803, an increase of 3,120,115 quarters; or, notwithstanding the increase in population—1,014,823—a less supply available for consumption of 4,444,106 quarters, and if we take Cobden's estimate, 2,444,106. Such were the blessed results of repeal. The consumers had to pay 57s., or about £7,000,000 more than as shown by the prices ruling before repeal, they would have had to pay had Protection not been withdrawn.

If we add to Cobden's estimate of 20 millions, the 982,287 quarters we imported in 1843, we get 370 lb. per head, or 27 lb. more than the average of the 24 years, 1852-75. During 1843-45, when wheat was subject to a duty of 20s. per quarter, the price averaged 50s. 8d., or actually 6s. 4d. less than from 1852-59. From 1833-37, when the duty was 34s. 8d., the price averaged 48s. 5d., or 8s. 7d. less. These figures, which any one can verify for himself by referring to the "statistical abstracts," simply tear into shreds the fictions about the miseries inflicted on the people by the corn duties, so industriously circulated for political purposes, and incontestably prove, that not only were these duties not paid by the people, but that, had they never existed, bread would have been dearer.

And there are actually people among us, thanks to Cobden Club misrepresentations, who still cling to the belief that our prosperity after 1850 was caused by the abolition of the Corn Laws in 1849, for achieving which Richard Cobden has been elevated to the position of a demi-god; a man, as Mr. Morley says, "who had found out a momentous secret," and for which he was presented with a national testimonial of £75,000! And in the face of our greatest industry ruined, and the others having to struggle for their very existence against this cruel foreign competition, through his instrumentality, the Cobden Club has actually deemed the present a fitting time to publish and circulate gratuitously throughout the country a short memoir of their false prophet, which, for a travesty of truth, could hardly be excelled.

I should have thought the lesson these figures teach would have been sufficient for all time, but, as if the nation had not yet had enough of the squandering of its revenue, Mr. Gladstone's Government in 1869 must needs lay its hands on the "last rag of Protection" left to the unfortunate British farmer—the shilling registration fee on corn. No one complained of it, not even Cobden. It then yielded a revenue of £900,000 per annum. Since its abolition we have to end of 1895 imported 799,614,154 quarters of grain, which would have given £39,980,707 to the Exchequer, or if we add compound interest at 3 per cent.—which I have taken the trouble to calculate — no less a sum than £56,609,940! Here again the consumer did not benefit, for the price, which between 1863 and 1869 averaged 50s. 6d., actually averaged during 1870-76 52s. 4d. Who then benefited? If not the foreigner, perhaps the Cobden Club will tell us who did. Let it be borne in mind that this revenue, so recklessly thrown away, was not a remission of, but inasmuch as it had to be made good from other sources, which the foreigner wholly escaped, an addition to taxation. Mr. Morley in his life of Cobden says:—"History shows that Cobden was amply justified in laying down the principle that the affairs of a nation come under the same laws of common sense and homely wisdom which govern the prosperity of a private concern."

Will Mr. Morley, or indeed any one out of Bedlam contend that the abolition of that shilling fee was an act of common sense or homely wisdom? If such were the principles on which Cobden conducted his business of calico printing, little wonder he succeeded in landing it in such a state of insolvency; it had, after a short career of six years, to be finally wound up, and that thereafter he confined himself to the more profitable occupation of agitation. The following table shows how rapid has been the decline of wheat cultivation, and the increase on the imports of wheat and flour since 1870:—

Years.	Average yearly supplies of wheat and flour. Quadrennial periods.			Per head.	Prices.	
	Imports.	Home production.	Total.			
	quar.	quar.	quar.	lb.	s.	d.
1871—74	11,253,192	11,800,831	23,054,523	346	57	0
1875—78	13,686,966	10,842,287	24,529,253	356	42	7
1879—82	17,113,197	8,566,227	25,679,424	355	44	8
1883—86	17,504,607	9,402,287	26,906,894	358	35	3
1887—90	18,780,418	9,456,111	28,236,529	365	31	6
1891—94	22,008,346	7,459,712	29,468,058	369	28	4
1895	23,360,952	4,700,000	28,060,952	344	23	1

Past experience, at least prior to 1876, has shown that when the supply was 350 lb. per head the price was, as nearly as possible, 50s. Yet, with only 344 lb. available for 1895, it is only 23s. 1d., or 52 per cent. less. How is this possibly to be accounted for, save by the enormous gambling going on in wheat "futures"? If the high price of 57s. from 1871-4 does not seem to agree with the price having ruled about 50s. when the supply was 350 lb., we must bear in mind that in those years we exported considerable quantities to France, which, the exports of wheat and flour being as a rule trifling, I have not deducted. It is very significant that these gambling systems in wheat, cotton, wool, silver, &c., first began in the United States in 1876, and not in this country and Europe till 1883.

There was one lesson taught us by Cobden, of which we might with advantage avail ourselves, and until we do so I fear there is little hope of fiscal reform—that is the formation of a great league to demand protection for British industries. Why our agriculturists, manufacturers, and others whom it so deeply concerns, should sit calmly contemplating the ruin so rapidly approaching of their country's great industries is inexplicable, when they have the remedy in their own hands, namely—a return to Protection. When the working classes realise the great fact, that in the last twenty-one years—1875-95—our imports have amounted to £7904 millions, a half of which, if produced at home, would have added £1387 millions to their wages fund, instead of having been paid to foreign labour; while if only 10 per cent. of duties had been levied on the other half, our revenue would have benefited to the extent of £395 millions, they will make short work of a system by which they have been so enormously defrauded. A. WILLIAMSON.

15, Moray-place, Edinburgh,
January 14th.

STOREY'S DEAD WEIGHT SAFETY VALVES.

SIR,—The correction of Messrs. Isaac Storey and Sons in your issue of January 3rd as to the design of the arrangements of dead weight safety valves for kitchen boilers, illustrated in your article, might with advantage have gone a little further. As a matter of fact, neither of the safety valves illustrated in the article which appeared in THE ENGINEER for December 27th, page 646, is the design of Mr. Lavington E. Fletcher. The open dead weight safety valve—shown in Fig. 1 in your article—was designed and patented more than thirty years ago by Mr. Cowburn, of Manchester, and is commonly known as the Cowburn dead weight safety valve.

I am sending you by this post a small treatise on "Household Boiler Explosions," by a former engineer of the Manchester Steam Users' Association, in which full credit is given to the Association for its experiments on the effect of admission of water in red-hot boilers, and on page 24 of this book will be found an illustration in section of the valve, and the following paragraph, which accurately describes it:—"An adaptation of what is known as the 'Cowburn' Dead Weight Safety Valve has been very generally adapted for this purpose, and is probably the best that could be devised, as there are no spindles, levers, or joints to become deranged."

Mr. Fletcher first suggested the attachment of safety valves to kitchen boilers in his monthly report for January, 1865, and in his report for January and February, 1867, he gives an illustration of the Cowburn valve, and describes it as "a miniature adaptation of a valve in very satisfactory use on many of the large steam boilers under the inspection of the association." The open safety valve, as stated in your article, required the building in the chimney breast of a cast iron box, fitted with a door to protect it from the dirt, soot, &c. Mr. Hiller in his design of enclosed safety valve—patented on behalf of the National Boiler Insurance Company—makes use also of the Cowburn valve; but his design has the merit of covering up the valve itself and protecting it from damage, as well as providing a means of testing the valve, and allowing the water to be conducted away without nuisance, the whole being self-contained and merely requiring screwing all together in one fixing to the top of the boiler, &c.

Mr. Fletcher, I think, cannot have seen your article attributing the design of both valves to him, as one would think a gentleman of his position and standing would be the last to appropriate credit to himself to which he is not legitimately entitled.

January 14th. HONOUR TO WHOM HONOUR IS DUE.

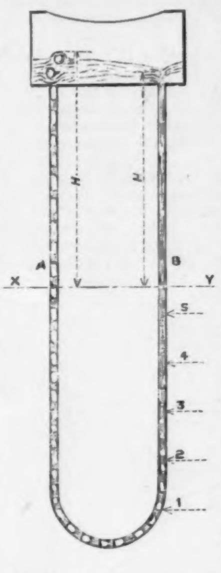
CIRCULATION IN WATER-TUBE BOILERS.

SIR,—The experiments of Mr. Yarrow related in your last week's issue are of the highest interest. But the deductions which can be drawn from the observed effects, without fully investigating their causes, will just throw a little more trouble on the controversy of circulation in water-tube boilers.

The most striking of the experiments carried out is the one numbered 7 in Mr. Yarrow's paper. Circulation maintained downwards in the return pipe, notwithstanding the whole of the heat being applied to it.

The photograph of the apparatus—Fig. 9, page 29—shows that in these extreme conditions heat only impinges on the lower half of the tube. The enclosed sketch represents how heads of water stand in this case. The upper half of the downcomer b is filled with a continuous liquid column, whilst the corresponding half of the branch a is filled with bubbles of steam alternating with water pistons. Motion is maintained by the difference of the heads h h.

This phenomenon can be produced, but with the peculiar conditions in arrangement of apparatus and starting of circulation realised by Mr. Yarrow. The downward flow in branch b will reverse if one or more burners be brought above line x y. The fact stated by Mr. Yarrow in his paper that such extreme conditions cannot be realised at atmospheric pressure is due to the different way in which the return tube was heated—as per Fig. 3, page 28. In experiment No. 6 the same phenomenon was produced at atmospheric pressure with air and cold water, and Fig. 8, page 29, shows that here inlet of air was applied to the lower part of the return branch.



Turning again to experiment No. 7, I will add that the slightest cause diminishing the volume of steam generated in the lower part of the downcomer will stop the flow and reverse circulation. Feed-water, colder and heavier, will immediately rush into the branch, stop ebullition, and when set up again the motion will be upward. It is even possible that the removal of the lagging which protects the small receiver on x—Fig. 9—would be sufficient to upset matters.

The conception and realisation of such an experiment is a most ingenious and skilful *tour de force*; but it has no analogy with what takes place in boilers where tubes are heated on their whole length, and where feed-water, or the inrush of cold air when firing troubles at any moment the thermic conditions of the steam generator.

As regards experiment No. 1, I often heated both branches of a U tube, with quite different results; decrease in circulation, and geyser action in both legs when equally heated. I tried yesterday to carry out Mr. Yarrow's experiment, but failed to maintain circulation. Probably this is due to the different mode of heating; my burners are not so wide apart, and I cannot light them at intervals one after the other. I am having my apparatus altered accordingly, in order to investigate the cause of this discrepancy. But whatever be the special conditions under which these experiments can be carried out, they clearly demonstrate one very important point: steam bubbles always follow the stream of water in which they are generated, whatever be its direction; they do not possess any entraining power, and by the sole fact of their presence cannot set an upward motion in surrounding water. For this demonstration the engineering world is greatly indebted to Mr. Yarrow. CH. BELLENS.

Paris, January 13th.

THE LINDE OXYGEN PROCESS.

SIR,—It is remarkable, I think, that up to the present no one has commented on the singular method of producing cheap oxygen devised by Dr. Linde, and described in your issue of October 4th. It is probable that in the first instance the scientific world received the announcement with incredulity. As, however, Professor Dewar has shown the Linde process at the Royal Institution, there is, of course, no room for doubt.

There is, however, much room for discussion as to the nature of the phenomena, and I hope that Col. Basevi, or someone else who has studied the motion of gases, will throw some much needed light on what takes place. First, we have what is known as "Joule's effect;" the cooling of an imperfect gas by passing forcibly through an orifice. Why is it cooled? The answer, that heat takes another form of energy, is only to substitute one puzzle for another. What other form of energy? Again, according to Lord Kelvin, hydrogen is heated not cooled. Why is hydrogen an exception to the general rule? But, in any case, the cooling produced is very small. I have seen no demonstration, mathematical or otherwise, of the relation between the cooling and total loss of heat. Is the Joule's effect necessary to the success of the operation? I think not. We are told that much of the success of the process is due to the first cooled air circulating round the pipe containing the second incoming quantity and reducing its temperature, but this can only be done by raising the temperature of the air just cooled. Of course the work can be done with a given volume of air, without any subsequent additions. Let us suppose that this air is divided into two portions, A and B. We are told that first A is cooled, then it cools B, then B cools A again, and then A cools B, and so on until liquid air is produced; but this is much the same as saying that a man standing in a bucket can lift himself.

I have been at some trouble to make calculations on the basis of the figures given in your impression for October 4th, and on no possible received thermodynamical hypothesis can I make the process work. I assume that the pressures and temperatures are not those which are really used. Is it too much to ask Dr. Linde for some further information? I presume that the discovery or invention has been fully protected by patents by this time, so that there is no longer need for reticence concerning a most valuable and interesting process. M. A.

Woodstock, January 13th.

EARLY LOCOMOTIVES.

SIR,—Mr. John Wilson, page 11, and Mr. G. A. Sekon, page 35, are both very much in error with reference to Mather, Dixon, and Co., and the Bath-street Works. I have sent to Liverpool to have the matter investigated, with the result that it is found that "Mather, Dixon, and Co. first appeared in the Liverpool directory for the year 1827, at their works, 23, Bath-street. They remained there till 1839, when they removed to Williams-street, Regents-road, Bootle, to the works known as Union Foundry. In 1843 the firm became Mather, Dixon, and Grantham, and ceased to exist at the close of 1844."

I have some of the old Mather Dixon drawings, dated Bath-street Works, 1838. It will therefore be seen that although Mr. Wilson may have a good memory, it is useless to rely on memory when it does not agree with official documents.

I am quite aware that Mr. Sekon, in his "History of the G.W.R.," has stated that "Some of those early engines were provided with a projector in front." But that does not alter the fact that no engine was ever built for the Great Western Railway with such a projector.

Full details have been given in THE ENGINEER, and also in my locomotive book, relating to the whole of the first twenty engines—Nos. 1 to 20—and the reason why no mention is made of the projector engines is simply because they were never built. Of course there may have been many designs, but that is not the point in question. CLEMENT E. STRETTON.

Leicester, January 13th.

SIR,—I find in my letter of the 6th inst., 9th line, an error. It should read, "I would not like to say that there was not a 10ft. spokeless locomotive driving wheel ever made."

The late discussion was on engines on rails, and it was proved that the Great Western Railway only had one 10ft. engine. There were many designs laid before the locomotive committee and Mr. Brunel. Steamboats on wheels was an old idea then, for in 1804 there was an "Eructor Amphibolis" built at Philadelphia for land and water, and it is recorded that it did actually work on both.

Has Mr. Sekon ever seen the books and papers of Messrs. Mather, Dixon, and Co., or has he seen the Liverpool Directories of 1827 to 1844? By the latter books, Messrs. Mather, Dixon, and Co. appear to have been at Bath-street from 1827 to 1839, when their address was altered to Williams-street, Regent-road, Bootle, namely, North Foundry. About 1843 the firm became known as Messrs. Mather, Dixon, and Grantham, which firm ceased to exist about 1845.

John Jones commenced business as a locomotive builder at Newton under the title of Jones and Potts, after the firm of Mather, Dixon, and Grantham broke up, where he was manager. I do certainly deny that there was any "steamboat" locomotives on the Great Western Railway. HENRY GREENLY.

Queen's Park, W. January 13th.

SIR,—In your interesting article on the Jenny Lind, passing reference is made to one of Bodmer's reciprocating locomotives. It has always appeared strange to me that none of the present—so-called—locomotive historians make mention of these curious engines. The South-Eastern Railway took over one when the joint committee was dissolved. This had 16in. cylinders and 30in. stroke; driving wheels 5ft. 6in. diameter; heating surface of fire-box 73 square feet; tubes 769 square feet; weight about 17½ tons. This engine was No. 123, and on its trial trip broke down and killed one of the attendants. This can hardly be the mishap to which you refer, as Lewes is not on the South-Eastern Railway. Another of these engines was constructed by Sharp Bros. and Co., in 1844, for the Sheffield and Manchester Railway. This had cylinders 14in. diameter, 20in stroke; driving wheels 5ft. diameter. A third—possibly the one that came to grief at Lewes—had outside cylinders 22in. diameter, 24in. stroke, 7ft. driving wheels, steam pressure 90 lb. to 100 lb. The real stroke was only half the above dimensions in each case. Bodmer was also famous for his method of working the steam expansively, about which little is said or perhaps known. G. A. SEKON.

January 13th.

PERMANENT WAY.

SIR,—The letter of "Sextus" states admirably the case against the American system of flanged rails; and all engineers who are acquainted with the English methods, and who have also watched the recent developments of American practice, must agree that the tendency is towards the use of chairs. But, curiously enough, "Sextus," while criticising Mr. Tratman's views, does not notice how that gentleman gives himself away in the latter part of his letter in THE ENGINEER of December 27th, where he describes a first-class track as composed of "flange rails of 80 lb. to 100 lb. per yard resting on steel plates on sixteen ties to eighteen ties per rail length of 30ft." The steel plate is the embryo chair, and suggests the adoption of the latter in due course. RAILBED.

Leeds, January 13th.

SLIDE VALVE FRICTION.

SIR,—Some years ago I carried out a series of experiments with a small double cylinder horizontal engine, working at 120 lb. pressure. It gave on the brake 28-horse power.

The slide valves were so made that they were relieved on the back of nearly all pressure, or worked like ordinary valves. The change could be very easily made in a few minutes.

I ran this engine several times under both conditions, taking indicator diagrams, the speed, load, &c., remaining always the same. The broad result was that about ·6 of a horse-power was required to work the unbalanced slide valves.

Lubrication was effected by a drop sight feed lubricator. The results obtained were exceedingly uniform. I arrived at the conclusion that about 5 per cent. of the indicated power of the engine was absorbed in working the slide valves. The engine made 180 revolutions per minute. The valves were large enough for cylinders another inch in diameter.

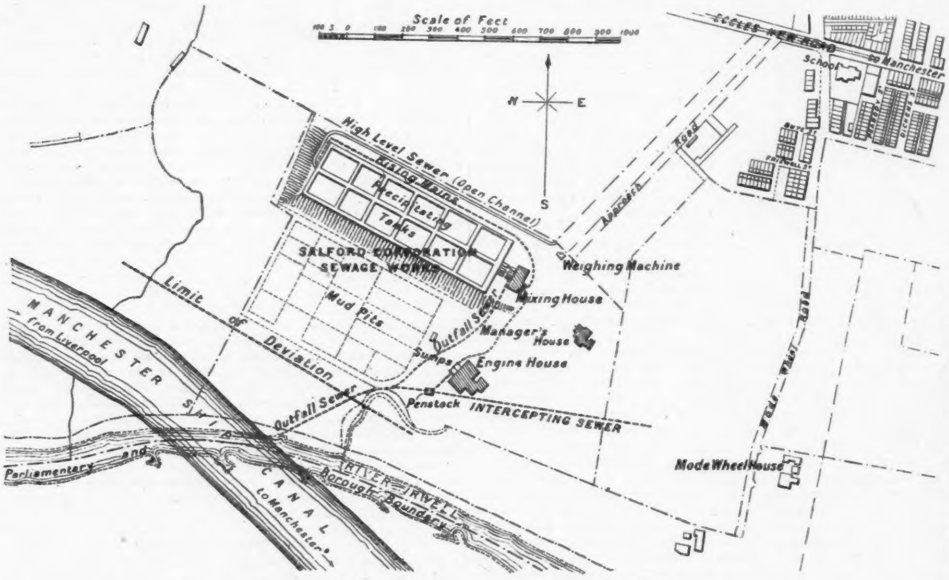
Paris, January 13th. FROTTOIR.

SHREWSBURY MAIN DRAINAGE.—On Tuesday, the 7th inst., an inquiry was held at the Town Hall, Shrewsbury, by Colonel Ducat, R.E., into the proposal of the Corporation to borrow the sum of £70,000 for the purpose of carrying out a main drainage scheme. The Town Clerk, Mr. Henry Clarke, appeared on behalf of the Corporation, and stated that the sewage of the borough now entered the river Severn at various points, and that the object of the scheme was to intercept the sewage from the river and to purify it. He also stated that the Corporation had had various schemes under their consideration during the past thirty years, and that an abortive attempt to carry out works had been made twenty-seven years ago, which works failed by reason of the extremely difficult nature of the ground met with. The scheme now before the Inspector had been prepared by Messrs. Taylor, Sons, and Crimp, of Great George-street, Westminster, with regard to which Mr. Santo Crimp and Mr. G. M. Taylor gave evidence to the effect that it was intended to construct intercepting sewers of a total length of about eleven miles, consisting mainly of brickwork and large cast iron pipes. As it was important to keep the sewers above the summer level of the Severn and to pump the sewage to the purification works, the site for the pumping station had been found in a central position in the town, to which the intercepting sewers gravitated from all directions. Here it was proposed to erect a pair of compound beam pumping engines to indicate 56-horse power, and to pump the sewage through a cast iron main, 21in. in diameter, to the head of the gravitation sewer, which is to have a carrying capacity of 7 million gallons a day. This outfall sewer, which is about 1½ miles in length, will discharge into settling tanks at the proposed farm. The tanks are to hold 600,000 gallons; and after the sewage has been chemically treated the clarified effluent is to be applied to land, of which 150 acres are available. The sludge is to be filter-pressed, and the works generally are designed in accordance with the most modern ideas. The scheme is intended for a population of about 40,000 persons, and is estimated to cost £70,000.

SEWAGE DISPOSAL AT SALFORD.

Salford has for the last twenty years at least been very much troubled on the question of sewage treatment and disposal. As conservator of the watershed of the river Irwell, she early set a good example to her neighbours and rivals in the valleys of South-East Lancashire by constructing, at great cost, very extensive plant for the pumping and chemical treatment of something like nine million gallons of sewage per diem. These works, including a duplicate range of large concrete tanks, were carried out by the late Mr. Arthur Jacob, who was at that time the borough engineer and surveyor, and were formally opened in the summer of 1881. Up to that time the lime precipitant was looked upon as the acme of perfection in all such cases, and the Salford works were accordingly laid out for this process; though Mr. Jacob, with true intuition, constructed his tanks at such a level as to command the ordinary ground level for subsequent filtration by gravitation if found desirable. If our more advanced knowledge and more scientific schemes of to-day lead us to modify these works, let us not condemn those who designed and authorised the erection of the existing works, but rather admire the public spirit which prompted them to undertake so heavy a duty, and practically without guide to attempt a solution of a question which many public authorities have persistently shirked even down to the present moment. There is no doubt that Salford has done far more towards the ultimate purification of the Irwell waters than is generally realised. At the same time it must frankly be admitted that the works, as originally designed, were not a success, according to modern requirements, and did not yield an effluent which could with satisfaction be discharged into the Ship Canal.

For the last six years the engineer and the responsible committee of the Corporation have been conducting a series of large scale experiments; and here again we note the public spirit of the Royal Borough, for these trials have been watched with keen interest by the whole of the municipal engineers of the kingdom. In all some thirty different schemes have been tested and watched at Mode Wheel, and the results of these have been carefully noted from time to time. Of these thirty, two were singled out as being the most satisfactory, and in 1892 tenders were received from these respective patentees or promoters. Either company was prepared to treat the whole flow of sewage, as delivered from the Corporation pumping station, for a sum of £12,000 per annum, on condition that the Corporation would purchase their plant at the expiration of twenty years. These offers, however, fell through, and the present borough engineer—Mr. Joseph Corbett—now reports to his committee that by an expenditure of £50,718 on alterations and extensions to the works, he can efficiently treat the whole flow at a cost of £6870 a year—this, of course, in addition to the cost of pumping the crude sewage, and carrying the sludge to sea by steamers, as at present.



SKETCH PLAN OF THE SALFORD SEWAGE WORKS

We give above a sketch plan of the existing works, so that our readers may more readily follow Mr. Corbett's proposals. From this report we gather that it is proposed to alter the existing tanks by lowering the cross walls and practically to have only two long parallel tanks with dwarf cross walls. It appears, too, that the Council have already accepted the principle of filtration of the effluent from the precipitation tanks, and have at the present time contracts in hand for plant for loading the sludge steamer. The structural requirements for the complete treatment of the sewage are thus narrowed down to three items, viz.:—(1) The removal of sludge from the precipitation tanks without in any way interfering with the continuous use of the tanks. (2) The provision of "roughing filters" for straining out the particles of solid matter from the tank effluent. (3) The final filtration of the clarified effluent. The average daily flow is on the increase, so in all the following estimates a bulk of twelve millions of gallons per twenty-four hours is allowed for.

Sludge.—A scheme for the removal of the liquid sludge is already under consideration by the Council. This consists of a travelling scoop, carried by a pontoon fitted with traversing gear, and flexible pipes for conveying the sludge to the iron pipes and open channel leading to the new sludge tanks. The estimated cost of removing the "slurry" by the above apparatus is set down at 1s. 8d. per million gallons of crude sewage passing through the tanks; and it is claimed that there would be no necessity to check the continuous flow through the tanks.

Roughing filters.—Long-continued tests with filters working at the rate of 12,000 gallons per square yard per diem, and cleansed by upward washing and surface raking, have completely satisfied the surveyor. It has even been found practicable—he writes—to work 40,000 gallons per square yard per day through a 3ft. filter of sand, with only 2ft. head of water, but here it is admitted the efficiency was reduced. "In the scheme now submitted an area of about 2040 square yards of roughing filters is provided by forming six separate filters in two easterly tanks of the existing twelve precipitation tanks. The cleansing of these filters by upward flow and surface raking, and occasionally by a thorough turning over and washing of their sand, would only occupy a small portion of the time for each filter; but even allowing for one filter being out of use and only five at work, when dealing with 12 millions of gallons of sewage per day, the average flow would be only 7048 gallons per square yard per day, so these filters could readily treat an increased flow during rainy weather up to three or fourfold the ordinary flow." Provision is for the mechanical cleansing of the filters by sand-washing machinery travelling on rails laid on the side walls of the beds, and it is estimated that about £4820 will cover the cost of construction of filters, channels, valves, &c., including the sand-washing engine. The cost of working is put down at 2s. 11d. per million gallons of effluent passed through the filters. We are told that the action of these beds would be similar to that of the coke breeze filters at Glasgow Sewage Works, or the "clarifier" of the "International" process. They could quickly be constructed, and would remove all serious ground of complaint, pending the full completion of the works. The borough analyst—Mr. Carter Bell—reports that repeated samples of effluent from the experimental filter show an almost complete removal of all matters in suspension, and a slight reduction in the albumenoid ammonia.

Final filtration.—Mr. Corbett, writing at great length on this head, proves himself no friend to the modern patentee of filtering "media." Indeed, if his contention proves in the result to be well founded, it seems to strike a veritable death blow at all such materials as polarite, magnetic carbide, magnetite, and the like. Arguing from the experience of the several London Water Companies, the Wakefield Corporation, and the recent experiments at Laurence, Mass, U.S.A., the surveyor deducts that ordinary sand filters, "duly aërated by intervals of rest and drainage, will *permanently* purify sewage." (The italics are ours.) This *permanent* efficiency he indicates is due to the intermittent action of the filter "by inducing a growth of air-breathing bacteria which transform the offensive sewage effluent into harmless products. Careful experiments," he continues, "with special patented materials proved definitely that these high-priced filtering substances are no better than, if as good as, so much clean sharp sand. Somewhat similar experiments in the filtration of clarified sewage, carried on for about three years past by the London County Council with filters of burnt ballast, of sand, of coke breeze, and of sand with a layer of special material, proved that there was no decided difference between these filters, and that the one of coke breeze was slightly the best of the four. The mass of information obtained from these numerous investigations all indicates that the essentials of an efficient sewage filter are—(1) A hard, granular, durable material free from very fine particles, such as sharp sand with the finest grains riddled out, or coke breeze, or cinders, or crushed brick with the fine dust riddled out. (2) Arrangements for intermittent use, with thorough drainage and aëration in the intervals of rest, at least once a day, and preferably many times a day. (3) A flow of not more than 1000 gallons per square yard per day while in use, with 5ft. dep thof filtering materials. On these principles the Salford proposed aërated filters have been designed. The clarified effluent from the roughing filters would be carried by three separate main pipes to the aërated filters, each pipe having a controlling valve, so that one-third or two-thirds of the area can be shut off for aëration while the remaining part is in use, and thus each third of the area would be aërated once a day, or oftener. The filters are arranged in three sections, about 44 yards clear width, and averaging 164 yards in length, a total area of 20,640 square yards, providing for the filtration of twelve million gallons per day, at the rate of 582 gallons per yard of total filter area. The filters are spaced into breadths of eleven yards by lines of tram-rails and gangway planks, supported on cast iron pillars, which also form conduit pipes leading up to the distributing pipes presently described. The filtering material would be sand, coke breeze, cinders, brick dust, crushed stone, or any other hard, granular, durable material of 5ft. depth, but with height of walls, &c., ready for adding material to 8ft. depth if required. The clarified sewage would be distributed over the surface of the filters by a network of iron pipes with spray jets, and the filtered effluent would be collected into a 4ft. culvert, under a road alongside the southern boundary fence. This culvert would discharge into a small fishpond, where the pure quality of the effluent would be always visible, and from thence it would pass over a long weir on one side of the intercepting sewer outfall culvert, and so into the Ship Canal. A sand-washing engine, similar to that to be used on the roughing filters, would be in constant use on these aërated filters, washing and opening up the sand so as to continually renovate the filters by removing the insoluble particles and glutinous matter, which tend to choke any filter which is not periodically opened up and cleansed throughout. It is estimated that it will be necessary to wash the top layer of filtering sand every six months, the next layer every twelve months, and the bottom layer every two years, and the sand-washing engine proposed is quite capable of doing this work during ordinary working hours."

Cost.—The same report, dealing with the question of cost of the above scheme, sets down £19,390 to cover the construction of the 20,640 square yards of aërating filters, complete with all their pipes, valves, culverts, pond, &c. "The filtering material would cost about £6900, and the sand-washing engine £600, a total of £26,890. The annual cost of working and of interest, sinking fund, &c., would be about £2423, equal to 11s. 1d. per million gallons filtered."

Chemicals.—Mr. Corbett finds that there are "so many chemical systems, any of which might serve," that he does not attempt to select one at the moment. He, however, assures his committee that "it will be practicable when the roughing filters are at work to considerably reduce the quantity of chemicals used," because he is satisfied "that roughing filters alone, without any tanks or chemicals, can remove 50 or 60 per cent. of the impurities of sewage. It will also be practicable," the report states, "by substituting simple lifting and mixing machinery for the excessive amount of hand labour now employed to effect further economies, so that the total cost of chemicals, machinery, and labour for the precipitation process would not exceed 15s. per million gallons, say thus:—5 cwt. sulphate of iron at 1s., 10 cwt. lime at 8d., and 3s. 4d. by 12 equals 40s. per day for wages of ten men. The total annual expenditure on sewage treatment, apart from sewage pumping, and sewage disposal by steamer, is estimated at £6870, equal to 31s. 5d. per million gallons of sewage treated. "This," we are told in conclusion, "is the practical outcome of Salford's long-continued experiments."

We are free to admit that it may possibly be an economical policy to avoid "any handing over of the sewage works to patentees or speculators," but at the same time we shall await with keen interest the reception which the above scheme will meet at the hands of the Local Government Board.

Since the above was written a special meeting of the Salford Council has been held, at which Mr. Corbett's scheme and report were discussed at great length. In the end the following amendment was passed unanimously:—"That the scheme as submitted be adopted, with the exception of the provision of 12,360 square yards of aërating filters at a cost of £15,700, and that the height of the walls of the filter beds be reduced from 8ft., as proposed by the borough engineer, to 5ft. 6in., or 6in. above the level of the filter bed, and that the committee have discretionary power to increase the size of the aërating filters by 4000 square yards." In other words, it is decided to reduce the area of filters from 33,000 square yards, as contemplated by the committee, to the original 20,640 square yards referred to in the surveyor's report, with the discretionary addition of a possible 4000 square yards. This will reduce the total estimate from £50,718 to £35,018, to which must be added the extra cost of the 4000 square yards of filter if constructed; but against this possible cost must be set the saving effected by reducing the depth of all the walls from 8ft. to 5ft. 6in. throughout.

On Friday last this question came before his honour Judge Parry, sitting in the Manchester County Court, when counsel for the Corporation applied for a further extension of time. Mr. Rycroft, for the Corporation, explained that application was already being made to the Local Government Board for borrowing powers to the extent of £40,000; and in the end the Mersey and Irwell Joint Committee, while not entirely approving the scheme above detailed, agreed to an adjournment of the proceedings for three months. The hearing will therefore be resumed on April 20th, at the Salford County Court.

The Institution of Junior Engineers.—At a meeting of this Institution, held at the Westminster Palace Hotel, Victoria-street, London, on Friday evening, January 10th, Mr. H. J. Young in the chair a lecture on "Problems connected with the Theory, Working and Testing of Gas Engines and Hot-air Motors," was delivered by one of the honorary members, Professor T. Hudson Beare, B.Sc., M. Inst. C.E. There was a very large attendance. The lecturer began by giving a short account of the early forms of hot-air motors, describing the Cayley, Stirling, and Ericsson motors, as representatives of the three classes into which he divided these engines. He gave a *résumé* of the long discussions at the Institution of Civil Engineers on the value of the regenerator, which led to a paper by Sir Wm.—then Mr.—Siemens, entitled "The Conversion of Heat into Mechanical Effect;" this was the first time the then novel mechanical theory of heat had been brought before engineers. A short description of the early gas engines, Lenoir, Otto, and Langen, and other forms was then given. Dealing next with the possible cycles which can be adopted for hot-air motors, the lecturer gave first a brief summary of the general principles of all heat motors. For each type certain temperature limits had been chosen, and the maximum possible efficiencies and the actual possible efficiencies of each were worked out, and shown in a table exhibited to the meeting. The cards for each cycle had also been prepared, and diagrams illustrating an engine of each class, the table and diagrams showing very clearly the large amount of power absorbed by the pumps in most of the large engines, to which circumstance was due their low mechanical efficiency. It was also pointed out how poor the average effective mean pressure obtainable was. The actual efficiencies reached in practice were then given, and the reasons, both thermo-dynamical and practical, why these motors failed so to reach their possible efficiencies were discussed. Professor Beare then proceeded to consider the gas engine. After indicating the advantages of the de Roche cycle, he contrasted the small amount of work spent in the pumping stroke in the gas engine as compared with the large amount it became in hot air motors. The question of the value of a regenerator in a gas engine was investigated, and the points illustrated by two fully worked-out examples; it was shown that the possible efficiency could be increased by its use, but probably at the expense of making the engine bulkier for a given power by reducing its effective mean pressure during the working stroke. The testing of gas engines was lastly dealt with, all the observations needed being fully treated; the difficulties in carrying them out, and the best means for ensuring accuracy of results were mentioned. The lecturer explained how it was possible to work out a complete heat balance for any gas engine, without directly measuring either the quantity of air used or the temperature of the exhaust. It was necessary to assume the temperature of the charge just when compression was about to begin, and it was shown that this must be about that of the jacket water. This was the only assumption to be made. Some interesting observations on the lecture were at its conclusion made by Mr. Henry Davey, M. Inst. C.E., Mr. G. Burls, Mr. W. J. Tennant, and Mr. H. G. Christ; and a vote of thanks was passed to the lecturer.

THE ENGINEER IN NAVAL WARFARE.

WE publish here the third and concluding lecture delivered by Lieut. Edwards at the U.S. Naval War College. The *World* says:

"The first lecture dealt with the work of the engineers in preparing the vessels for an active campaign. The second lecture told of the actual combat as Lieut. Edwards knows it might have been. To-day Lieut. Edwards, supposing that the United States fleet has won a victory, tells how repairs must be made to render the warships efficient again, and makes a strong plea for simpler and uniform construction in our war vessels. There is a mine of suggestion to cool the blood of over-heated jingoes in his words":—

"*After the battle.*—'Rejoin my flagship in three weeks,' signalled Vice-Admiral Ito to the commander of the Matsu-Shima as she steamed for Japan after the battle of the Yalu. With moderate steaming this vessel ought to have reached a dockyard in two days. Allowing three days for docking—which is more than the average time taken in Japan when no repairs are made to the hull or propeller—and at least two weeks were given for repairs. The only impairment which seriously interfered with her efficiency as a fighting machine was the disabling of the controlling valve of her 65-ton gun. The other repairs were scattered, and admitted of a large force to work upon them. The Matsu-Shima will ever be regarded by the Japanese as the historic ship of the Yalu, and Admiral Ito had a special love for this vessel, for upon her decks he had won his great victory. It was upon the military mast of this vessel that the kite flew which brought so much happiness to the sailors of Dai Nipon's fleet, and which was regarded as the harbinger of success. There were other good reasons why the Admiral was anxious to have the vessel join him at a very early day, and in giving three weeks for repairs it is fair to presume that they could not have been done in less time. This will give some idea of the delay experienced in making repairs to a modern cruiser. The workmanship of the several parts is of the highest order, and unusual care is taken in assembling them together. To withstand the pressure and strain which the parts are subjected to the best of material must be used, and the design must have much to commend it. Too many people have written of the strategy and tactics of a fleet in the piping times of peace and fair-weather cruising. In one of the publications of the United States Naval Institute, Fleet Engineer George Quick, of the Royal Navy, writes of 'The Organisation of the Naval Engineer Forces.' He particularly dwells upon their duties 'in the hour of battle and the week afterwards.' This earnest and talented officer has contributed one of the best and most important monographs that has ever been issued by a service journal. And yet his article stands out almost alone in that periodical as the one contribution which has been unnoticed and not deemed worthy of discussion. His views are sound, even though his words fall upon unwelcome ears. Our great land will yet profit by his warning, for he tells us things we should all know. He writes with an earnest affection for our navy, although in a service which may one day meet us in battle. But he assails too strongly, although very kindly, the traditions of the past, and therefore his able article has been unnoticed.

Where disability threatens.—In speaking of the impairment aboard war vessels he says:—'Let me give one small example of those things which are occurring every day in all navies. On July 13th, 1891, during target practice on board H.M.S. Trafalgar, the locking bolt of the after turret was broken, and the turret was practically useless for three days, although the ship's artificers worked night and day at the repairs. Here we see one-half of the fighting power of a ship of 11,940 tons and 12,000-horse power disabled for three days by the breaking of a single bolt. But if the breaking of a single locking bolt disables the half of the fighting power of a 12,000-ton ironclad, and the repairs of that defect require the labour of the whole ship's artificers for three days and nights, what may we expect when a ship has been engaged for an hour with an enemy of equal fighting power? How many mechanics will be required to repair damages after one heavy shell has exploded inboard? This question is easy to ask, but not so easy to answer.' With such facts before us it must be recognised that the breakdown of the engineering department during action means the total loss of the ship or its usefulness for offensive work completely destroyed. If any part of a shackle is defective, the result may be as serious as the breaking of the strongest link in the chain. The failure of a piston-rod to have a well-rounded fillet on its shoulder may cause the same wrecking of cylinders that occurred on the Ericsson. The blowing out of a single tube may disable a boiler and interfere with the efficient working of others.

Reliable machinery.—The distinguished naval architect, Sir W. H. White, in a paper read before the Royal Society, expressed the opinion 'that modern ships will not stand more than one well-contested engagement, and many naval officers share this view.' Thus declared the *Army and Navy Gazette* less than a year ago and after the battle of the Yalu. To prepare for such a day, our vessels should be designed accordingly. There should be no stinting of weights in the engine-room. Rather than do this, decrease the width of the armour belt and cut down the bunker supply. A leaky boiler and a poor condenser on a cruiser will reduce the steaming radius more than the removal of a hundred tons of coal. The engineer-in-chief of the Navy, in his uncompromising struggle against the reduction of machinery weights, is fighting the battle of our commanding officers rather than that of the chief engineer.

Providing for repairs.—Naval experts have now commenced to realise the necessity of making provision for executing repairs more promptly. The equipment of floating workshops is an outcome of the repeated breakdowns on war vessels, due to crowded machinery with excessively light parts. That inexcusable fad to make lighter machinery than one's neighbour is now going out of fashion, although we can rejoice in the fact that the custom did not have a strong foothold in America. It is no longer good form to be an advocate of a half-dozen kinds of motors aboard a single ship, for immense repair bills and disabled machines are the sequence of having steam, anhydrous ammonia, compressed air, hydraulic accumulators, and dynamos aboard the same vessel. The full measure of the specialist has been taken, and most of his projected machines now do not get beyond the designing-room, for the tendency is to simplify the auxiliaries and give each one more room and increased weight for its installation. This makes the several parts more accessible for overhauling, and decreases their liability to become impaired. In designing machinery for war vessels facility for examination and repairs is going to be considered a greater factor than it has been heretofore. That vessel is no longer regarded as useful which is constantly under repairs. In order to prepare for battle and to quickly recover from its effects, war vessels must be constructed for continuous service and not for trial trips. In building the several types the machinery should be made sufficiently strong, and more room should be given for its installation, which space could be found by taking part of the quarters of the officers. If this were done the vessels would be more serviceable in action, and there would be fewer repairs to make after battle was over. In the upbuilding of a navy, therefore, types and classes of vessels should be constructed. There should not be an aggregation of individual ships which embody the ideas of earnest specialists, but which have no relation to a comprehensive plan, and which require months to repair when disabled. There are many strategic reasons why there should be such classes, but from an engineer's standpoint the following are sufficient:—'Defects of design in the machinery would sooner be discovered and overcome. With men thoroughly acquainted with the fitting of several ships, it would be possible to make several changes in the *personnel* by which the engineer's force could quickly be re-organised after battle. The best method of maintaining the efficiency of the department, making necessary repairs, and doing the general overhauling, could be developed. From several permanently disabled vessels all but one might be rendered serviceable after battle if the impairment was in the machinery. Fleet drills and manœuvres could be carried on with more efficiency. Reliable uniform speeds could be secured more easily and rapidly. And the Admiral in command could get better work from his fleet, for his strategy and tactics could more easily be carried out.' It is true that the individual commander, by his skill, courage, and strategy, may render great service to the State and bring glory and renown to his career. The destiny of nations, however, will be decided by battles between fleets, and not engagements between ships.

Where repairs should be made.—To return to the narrative. A few days before the enemy had been attacked, the question of where and how the repairs could be made had been carefully considered by the Engineer-in-Chief, the Admiral in command of the Defence Fleet, and the Secretary of the Navy. Should the vessels be sent to a Navy-yard? How should they be repaired? These important questions were carefully inquired into. Except the vessels which required docking, it was determined not to send them to a Navy-yard for the following reasons:—Time was of the utmost importance in getting the fleet ready for sea again, and the history of the Navy-yards in previous emergencies showed that work could not be expedited there. Industrial engineering methods are incompatible with official routine, and the vessel, once within the grasp of a military clerical system, had to submit to vexatious delays. Until the conflict was finished it would be impossible to tell how extensive the repairs might be, and it was almost a certainty that private firms would be called upon for assistance. These establishments could not work in co-operation with naval plants. Their methods were altogether different, and there could not be harmony and efficient commingling of their forces. This was unhesitatingly told the Secretary of the Navy. Another fact which influenced the decision was the time that it had taken the North Atlantic Fleet the previous year to overhaul at the Navy-yard and the fraction of that time which it had taken sister ships on other stations to do the same general work. The Engineer-in-Chief showed so conclusively that the repairs could be made more promptly in Narragansett Bay, that his recommendation was endorsed by the Admiral of the Fleet. Considerable preparation had therefore been made for the reception of the vessels, and a strong corps of naval engineers and scientific mechanical experts had organised the various auxiliary repair stations and machine shops into one great plant, where all worked harmoniously in common. Except the vessels which required repairs to their hulls and propellers, our victorious fleet steamed to Narragansett Bay, and the several ships immediately commenced making repairs. Nearly every town and city on Narragansett Bay is within two hours of Boston or Worcester by rail. Within three hours nearly every manufacturing city in the Blackstone and Connecticut Valleys can be reached. The forts at Newport would deny an enemy entrance to the bay, and innumerable small boats could communicate between the fleet and Providence with impunity. Within two weeks a solid built-up crank shaft could be constructed in Providence for a small cruiser. Time will not permit me to tell of the advantages this bay would have for repairing the machinery and fittings of a fleet.

Director-General of Repairs.—From the auxiliary naval repair stations, from the manufacturing cities and towns along the Blackstone and Connecticut rivers, and from New York and its environs thousands of the best mechanics were sent to the vessels. Engineer-in-Chief Melville, by order of the President, was made the Director-General of Repairs. This appointment was received with unusual favour by the country, for one of the enemy's greatest engineering authorities had declared that Engineer-in-Chief Melville was the ablest chief of any manufacturing or constructing bureau that America ever had in her naval department. Our people remembered that even as a boy he had been a leader, for before he was eighteen years of age he had designed and constructed a breech-loading gun, during the civil war he had rendered important service, for he had originated the idea of a protected deck; that he had been particularly commended for his skill, ability, and readiness of resource on board the ill-fated Jeanette; that he had shown himself great in the unparalleled search for De Leng in the Lena Delta; that he had been greater still in the rehabilitation of the navy as Chief of the Bureau of Steam Engineering and as Engineer-in-Chief of the Navy. And the nation believed that his highest greatness could be reached in having his energy and matchless engineering talents directed to the restoration of a crippled fleet and the captured cruisers and battleships.

How the repairs were made.—The repair ships Fulton and Corliss within a few hours reached the fleet. Additional telegraph and telephone lines had been established within a day, the military telegraph engineers having put lines in a manner that had astonished even the officials of the Western Union Telegraph Company. Directed by the genius of able electricians, who had volunteered their services, there had been established in an incredibly short space of time, as a gift from the great electrical combine, a great electric light plant, which permitted the prosecution of the work at night. From all along the coast the scouts and Sound steamers brought tools and supplies. Under the inspiration of several fleet engineers and such men as D. H. Thompson and Gardner Sims, of Providence; S. B. Whiting and Asa Mattice, of Boston; Francis A. Pratt, of Hartford; C. W. Moore and Horace Lee, of New York; D. H. Tompkins, of Charlotte, N.C.; John Fritz, of Bethlehem; Coleman Sellers and J. J. de Kinder, of Philadelphia; and George W. Dickie, of San Francisco, Engineer-in-Chief Melville soon brought order out of chaos. There was not a machine shop in New England whose proprietor was not willing to turn his establishment into a naval repair station. Providence and Pawtucket, with their thousands of skilled mechanics, did the bulk of the work. Every small order was duplicated at different shops, and this was found an excellent method of pushing work. Many of the torpedo boats were repaired at Bristol, the genius of a Herreshoff personally superintending the direction and scope of the work.

No naval constructor in the battle.—During the progress of the repairs it was greatly regretted that not a single naval constructor had been aboard any of our vessels participating in the battle. The executive officer who was in charge of the construction department had important duties to perform in assisting the captain to fight the ship. Many questions relating to the principles of naval architecture had therefore to remain unanswered at the time. The enemy, however, had naval constructors aboard several of their large ships, and they furnished valuable information to their naval authorities, which would have been of inestimable benefit to the Engineer-in-Chief, could it have been secured during the few days following the battle. The mistake in not sending the constructors to sea having been recognised, one was ordered to each of the large vessels. The same success which had attended the detaching of the ordnance and engineer designer to sea-going ships was afterwards found in the case of the constructors. Particular improvements were noticed in the ventilating arrangements, in the improved facilities for coaling ships, hoisting boats, cleaning bilges, rigging gangway ladders, and in the location of cargo ports. Not having seen anything of the fight, many questions relating to the repairs which should have come within the province of the constructor had to be solved by the naval engineer, whose experience in the battle made him competent to decide intelligently.

Special work of the engineers.—The great work of the chief engineer and the assistants of the several ships was to overlook the repairs and suggest remedies and improvements. Their services at such a time were too valuable to give their attention to any single impairment. The limited room for working and the many local difficulties to be overcome in making repairs and doing general overhauling astonished the mechanical engineers from shore. They realised then more fully than ever before the responsibility connected with the efficient maintenance of the motive department of a war vessel. Vice benches, drilling and punching machines, anvils, and forges made a sad plight of what had once been snowy decks. No injury was done to them, however, as they had been covered by light flooring. To see the work done on these decks with hand tools reminded many of the time when there were but few machine tools, and when it was said that such firms as Fletcher, Harrison, and Co. had built the machinery of the North River steamboats on the sidewalks of New York. Bed plates and valve seats were faced in those days by experts with hand chisels, and equally as good work was done on many of the ships of the fleet. Loyally and patiently the shore mechanics worked. Within the cramped quarters of the back connections the boilermakers fitted patches. For hours the machinists strained themselves in scraping the linings of valve chests. The fitters, at the peril of their lives, removed and replaced overhead piping. Conscientious men crawled under cylinders and boilers to clean bilges and keep the boiler shells in a state of efficiency.

Excellent work of the triple-screw ships.—For three days after the battle, and while the other vessels of the fleet were being repaired, the triple-screw ships Columbia and Minneapolis were cruising off the New England coast, capturing transports and scouts which had been sent from Halifax and which had no knowledge of the battle. Even with her disabled starboard crews, the Minneapolis did brilliant work. From the time a prize was sighted until its capture the Columbia had no difficulty in steaming 21·5 knots; the Minneapolis with her two engines maintained a speed of nearly nineteen knots. The remarks of Admiral Fournier before the French Special Parliamentary Commission of Inquiry, undoubtedly reflect the views of our people in regard to these triple-screw vessels. The Admiral is thus officially reported: 'Wisdom should order us to abandon as soon as possible the construction of these ruinous mastodon battleships. The type of war vessel most useful is that of the triple-screw vessel Dupuy de Lôme.' He also said: 'The naval battle of the Yalu proved the truth of the following conclusions:—(1) The capital advantage of speed. (2) The superiority of rapid-fire guns over heavy guns. (3) The uselessness of heavy armour. We should insist upon speed, which is the weapon *par excellence* of modern warships.'

French praise for the cruiser.—The most glowing, and at the same time the most interested, praise of the Columbia was published in *La Patrie*, of Paris, on July 12th, under the signature of its editor-in-chief, M. Lucien Millevoye. He said:—'The fêtes at Kiel will have, perhaps, as an unexpected consequence a renovation of the French Navy. Do you know what our sailors have admired especially in the German waters? It was not the pomp displayed by William II. to dazzle them; it was neither the golden eagle of the Imperial helmet nor the theatrical show of German power. What has struck France and all Europe with surprise mixed with fright, is the speed of one of the vessels of the American fleet. The cruiser Columbia has manœuvred before all the congregated squadrons with marvellous agility. This is, indeed, the great war instrument of the naval fights of the future. What a strength in the hands of the hardy captains of the sea! Maritime war will be greatly changed by it. That vessel, the Columbia, will be able to accept or refuse combat, according to its wishes. It will thunder forth shot and shell or run away at will. It can with impunity cover the surface of the ocean with ruins and wrecks, or laugh at the avengers sent to pursue it. The European nation, which would have the foresight to create a large number of those terrible cruisers would be unassailable, invulnerable, and invincible.'

An even keel.—One of the lessons impressively taught during the progress of the battle, and which caused certain work to be done during the course of the repairs, was this: That keeping ships on an even keel may have an important bearing upon the efficiency of a vessel in action. There are several causes which may list a ship quickly, and unless special provision is made to overcome such accidents, it may be a question of hours before the vessel can be put on an even keel. A list of 10 deg. would expose the plates below the armour, and in this way a battleship might be sunk by the rapid-fire gun of a torpedo chaser or a gunboat. Anything happening to either boilers or bunkers on one side might cause the list. There are several causes which might make it impossible to use coal equally from both sides of a vessel. Leaky tubes, the blowing out of a rivet, the breaking of some attachment to the shell, may all cause the water to run out of a boiler. The impact of the heaviest shell upon the side armour may start the joint and may rupture the steam and water piping; and boilers will undoubtedly be disabled in this way. Trimming tanks being a necessity, they were so placed that they were under the control of the chief engineer. They were connected to the main circulating and other pumps, so that they could be quickly emptied or filled. Every longitudinal bulkhead had some contrivance, whereby communication could be instantly established between the compartments which they separated.

Torpedo boats after battle.—An examination of the captured torpedo boats showed that the boilers and engines had been forced to their utmost. A few of the grate bars had been melted down and the tubes leaked considerably from the forcing which they had been subjected to. In the effort of the boats to escape, the working pressure had been exceeded and the blowers had been run at an excessive speed. Driving these small boats into a heavy sea had subjected the engines to shock. The anti-attrition metal had run out of one of the crank-pins and several bearings. Some of the discharge valves of the air pump had been carried away, which had greatly impaired the efficiency of the condensers. The condition of the engine and fire-room force was pitiable. For nearly a month these men had been under a great strain, both physical and mental. The long trip from Halifax had severely taxed them, and after reaching the Massachusetts coast their work was not lessened, for the boats were kept on the go constantly in doing messenger service. The character of the work performed in the engine and fire-room of such boats has been told by Mr. John I. Thornycroft, who is the peer of any builder in the world of any such craft. Personal and financial reasons would prompt him to declare that this work was within the ability of the average man, but Mr. Thornycroft speaks plainly to those purchasing boats from him.

Work on torpedo boats.—In a recently delivered lecture on torpedo boat destroyers, in which he referred to the excessive work performed in the engine-room, Mr. Thornycroft says—Lieut. Edwards quoted from THE ENGINEER:—Speaking of the firing, he said the stokers have to exert themselves much more than when firing the ordinary slow-working boiler, for when the boat is running at full speed, if the crew are divided in two watches, it would mean that each man must stoke about 600 indicated horse-power of boiler, which is many times the ordinary rate of working, and necessarily requires very good men. Again, as it is important to run the engines very fast, it may be interesting to consider how the artificers in charge of them are taxed by this necessity and compare the running of torpedo boat engines with the engines that were used in the first steam vessels, which made few revolutions in a minute, examples of which are still to be found in tug boats, for which they are suitable. If we turn from the comfortable-working heavy engine of the tug or river boats to the high-speed torpedo boat engine working at its highest power, we then note that the sound in the engine-room is confused by the addition of a number of auxiliary engines, each adding its own peculiar series of sounds to the noise of at least three cylinders of the main engine; and all these engines making a confusion which is further complicated by the fact that the auxiliary engines in their rate of working keep no constant ratio to each other or the main engines; they may be considered as part of an orchestra having a separate conductor for each instrument. Now take the next important sense for the engine-driver—feeling. The engines are revolving, say, 400 revolutions in a minute, and the important moving parts must be touched by the fingers and any change of temperature detected promptly. If this is not done, heating may ensue, which may oblige the engines to be stopped. In this rapid working the eye is even put to a great disadvantage. The motion is so rapid that no particular position of any working part can be assigned to it, while a spray of water and oil is thrown in the eyes and the vision temporarily impaired. However, this description only applies to running at the highest speed. At full power the firing scarcely ever ceases, and the forced draught gives such a high temperature in the furnaces as to render the light blinding and painful to the eyes, making the use of coloured glass necessary to protect the eyes when examining the furnace to see in what part the fuel is most required. The space for stoking is limited, and the coal bunkers, being small, cannot afford convenient room for the coal being rapidly trimmed from them. The very large amount of air passing through the stokehold causes coal dust to be carried about so as to be most unpleasant. In all this dust and hurry the water level and steam pressure must be attentively watched, and we owe much to our stokers for performing these duties, which are of the first importance for the speed and safety of the boat.

Changes made in torpedo boats.—In writing unofficially the naval engineer inspector of the Ericsson made some excellent suggestions in regard to the design and construction of torpedo boats and their machinery. In view of the fact that something sad is always happening to such boats of every nation, his views were carried out in repairing the boats which took part in the battle. His ideas upon the subject were as follows:—'In designing torpedo boat machinery, the great risk to men below should be uppermost in mind. The great watchword should be, the least possible number of pipes. It would be better to dispense with pipes that could only be used in a remote contingency. No piping should be installed which does not directly influence the speed. In short, one pipe for many services, not many pipes for one service. The pass-over steam pipe on the Ericsson had never been used during the twelve trial trips. On the steam pipes from the boilers, on the engine-room side of each fire-room bulkhead, there should be fitted a butterfly valve to be worked from deck; a man to be on watch with orders to throw down the lever on the instant of an explosion. No time was lost in shutting the Ericsson's valves, yet the time consumed in doing so was appreciable. The necessity of an open hatch over the whole length of the engine-room should be appreciated and provided for. The structural strength necessary should be given by cross beams; a cover, to be fitted when necessary, could always be carried and the hatch made strong enough to withstand the shock from any sea. The constructors would object, but the lives of men must be of more consideration than inexcusable precedent. A plate at the forward end of the engine-room was off; size, 2ft. 10in. by 4ft. 6in. The course of the steam was directly up and forward and much came through this opening. Had this plate been on, matters would have been worse. Had there been a complete open hatch matters would have been much better. The great danger from explosion, besides scalding, is the inhalation of steam. The old-time rule in case of an explosion is to get flat down and grope out. Hence air passages or holes should be provided for, by which, in case of an explosion, they could be immediately opened from deck and the whole volume of air from the fire-room blowers should be sent along the engine-room floor-plates. The broken pipe will always be high up, and the great volume of air suddenly thrown in at the bottom of the engine-room would unquestionably be of benefit to men fighting for their lives. This idea in connection with the open hatch must appeal to everybody. The form of ladders and their location in the boat should be a subject of great thought and care. They should be fitted in the most available space for reaching the deck.'

Work after battle.—In addition to the repairs on the machinery and boilers of the disabled vessels, there were other important things to be considered in getting the vessels ready for sea. The experience acquired during the conflict caused many changes to be made in the design of minor parts, and the working out of the details was no easy task. The new men had to be instructed in the performance of their duties. When it was remembered that the Texas has over seven hundred valves and twenty-five miles of piping, one can get a faint idea of the intelligence and ability of the machinists who are expected to successfully operate the many contrivances. Even before the fleet started for Narragansett Bay an additional force of firemen and machinists from the other vessels had been placed on board the Columbia and Minneapolis in order to help bring home the prizes which should fall within their grasp. It was night and day work with the engine-room force. Men who are working out important applications of mechanical principles cannot lay down their work and peacefully fall to sleep; but restlessly the brain continues to work out the solution even after the eyelids close.

Uselessness of repair vessels to a defence fleet.—This month's experience proved that repair ships for a fleet operating in home waters and in close proximity to the great manufacturing establishments were of little use. If they carried machinery they crowded out the men. The routine work of the ship had to be carried on, and she had to steam at a fair speed from place to place. There were numberless things which could be secured on shore to hasten repairs which could not be obtained on the repair ships. The number of fittings connected with a vessel like the New York, with her one hundred steam cylinders of various machines, runs up in the thousands, and at times it must be necessary to secure special parts from the manufacturers to make repairs. Skilled mechanics, who were experts in the management of machine tools, were useless in the fire-room, and in their ignorance of man-of-war rules they were constantly violating regulations. Vexatious delays occurred in securing and handling material and altogether the experience with the floating workshop was not a success. It was afterwards said that our enemy found them very useful in their fleet operations under conditions where time was not a factor in the matter. The repair ship was designed at a time when it was believed that vessels could be self-sustaining in regard to repairs. Time was not regarded as such a supreme factor as it is now known to be. They may be useful for a blockading fleet; as storeships they are valuable even to a defence fleet.

Reorganising the engineer's force.—One of the most important questions that arose after the battle was the reorganisation of the engine and fire-room watches. There is not a steamer afloat in which there is not some specially troublesome machine or valve, either in the engine or fire-room, and which requires special skill or knowledge on the part of some one to overcome its weakness. The failure of this auxiliary to work may have an important effect upon the efficiency of the main engines. There are some things which cannot be told; they must be acquired gradually by experience. If all our commanding officers realised how skilful, resourceful, and patient a good water tender should be, these men would receive more consideration than is now accorded them. If it should be our policy to use water-tube boilers, then the duties of the water tender will require an even more efficient man for this work than in the past. From the deck force men may be found to relieve the second-class firemen and coal passers; but the machinists, boiler-makers, coppersmiths, oilers, water tenders, and first-class firemen cannot be secured from the seaman contingent. That day has passed when the average oiler could relieve a machinist. On a modern war vessel a boilermaker might make a cruise without doing any work in the engine-room. So long as we act upon the defensive and are within a day's reach of New York, deficiencies in the engineer's force may be made up.

Insufficient engineer force.—The error of that policy which has permitted the best machinery in the world to be neglected by having an inadequate force of naval engineers was soon evident. The percentage of engineers who had become incapacitated, or had gone down in their ships, was greater than that in any other corps. The intense heat of the department, the strain of controlling and directing men who were worn out with toil, the shattering of their constitutions by the impact of shell upon the side armour, and the concentration of thought in overcoming impairments and casualties, had played havoc with the commissioned officers of the engineer's force. The few engineers that had been on duty on shore to supervise important work, were sent to the fleet as the reliefs of those who had been exhausted. Exceeding difficulty was found in making up the engineer's complement. It was only done after the passage of special laws, which permitted the engineer to give the full measure of his services to the Government. The number of engineer officers has been cut down very low in the British Navy, and still lower in the United States Navy. I say they have been cut down dangerously low, because in war time a very slight accident may disable the two or three engineer officers, and leave the engineer department entirely headless.

Vital necessity of repairing quickly.—It is impossible to overestimate the importance of the speedy repair of the machinery of ships of war after an action, for the gaining of only a few hours in effecting repairs after battle may decide most important naval operations following upon either a slight or severe engagement. It is not a good argument to say that our ships will carry as many artificers or mechanics as foreign ships, and that consequently there is no need to increase the staff of mechanics on board our ships. For if two similar ships engage, and each receives similar injuries so that they are compelled to cease fighting and withdraw for repairs, then if one of those ships carries, say, only thirty skilled mechanics for effecting repairs, while the other carries sixty mechanics, the latter ought surely to be in fighting condition first, and must assuredly capture or destroy the fomer. The sting of a defeat might be removed by a defence fleet which made speedy repairs, for with the aid of workmen from shore, the ships might be put in readiness so quickly that the blockading ships could again be attacked before repairs could be effected by the limited number of overworked machinists on board those vessels. The New England coast, although it would be a rich prize for a hostile fleet, has elements of strength in its manufacturing establishments which may play an important part in a naval conflict.

An engineer's warship.—And when the rewards were distributed to those who had rendered service to the fleet, a strong public sentiment demanded that the Director-General of Repairs and the Fleet Engineer be signally honoured. These men then said that as a grateful country had recognised their knowledge of the requirements of a modern war vessel and fleet, they be permitted to build what should be known to all the world as an engineer's ideal ship of war. It would be one that would do the work which was expected of her. Upon this subject the greatest engineering paper in the world has thus spoken: 'Miles of letterpress have been printed and published and read and discussed concerning the construction and qualities of ships of war. We cannot call to mind that any of these disquisiuions, or treatises, or papers, or books have emanated exclusively from the brains of engineers. Of course, without the aid of the engineer the modern warship could have no existence. But hitherto he has always taken a second place. He has been told to do this, that, and the other thing, and he has gone and done it; but little deference has been paid to any of his rare expressions of opinion. He has been told that naval matters are too hard for him, and that his true function consists in accomplishing the tasks set for him, and asking no questions. He is shown, for example, a very limited space on certain plans, and told to put engines and boilers into it which shall develope 10,000-horse power, or some other trifle of that nature; but he is not allowed to suggest that if he had a freer hand he could produce a better speed result, let us say, for less power. He is told that a gun is to be worked in a particular way, and that he must have the machinery for so working it; but he is not permitted to point out that the thing permits of being done in another way. He is not snubbed exactly, but he has been taught to keep his own place, and stand, hat in hand, when the naval architect, the artillerist, and the sailor pass by. Considering how very important is the part played in a compulsory, disjointed fashion by the engineer, we venture to think that he has not been treated quite in the way that he deserves, and we go so far as to ask, Is it not about time that the engineer took the initiative, and, reversing the normal practice employed the naval architect and the artillerist to carry out his designs? We hold that there can be but one sound answer to this question, and it may not be unprofitable to consider what way the engineer would probably go to work. It goes without saying that he would come to the task of designing a fighting ship with a very fair knowledge of what has already been done, and with a mind quite free from prejudice. His first endeavour would be to produce an honest ship, a vessel quite free from shams of all kinds. He will be moderate in his promises, but then they will certainly be kept. As to the shape of the hull, and the lines, these must be settled by the naval architect, acting under the general instructions of the engineer. It would be clearly understood that the speed settled upon would be the true sea speed of the ship, and not a fancy result got on a four hours' run with picked coal and selected stokers. There would always be precisely similar vessels cruising in company. They would be as much alike as three Martini-Henry rifles. Every part of each would be interchangeable with any other of the three, and as the sea speeds of all would be the same, there would be no waiting for the slowest, and they could always keep in company, save in the wildest weather. In one word, the engineer's warship would be less of a scientific museum and more of a floating gun-carriage. Her claims would be modest, but what she promised to do she could do. The story told by past naval manœuvres goes to show that the promises of the modern warship are seldom kept; and this simply because more is attempted than the wit of man can carry out.'

What it could do.—When the engineer's ship of war was finished, it was observed that she could be coaled quickly, and steered more readily and reliably. She could steam faster for a protracted period because sufficient weight had been allowed to instal reliable auxiliaries. Her bilges were accessible for cleaning. Considerable judgment had been exercised in providing for a system of ventilating the compartments. The fire main was a reliable one, and it was not impaired by numerous sharp angles and bends. The quarters of the officers were cut down, but the crew was more comfortable and contented. In case it was found necessary to abandon the ship, there were enough boats to carry the entire ship's company, and these boats were of such a character that they could live in a seaway. There was something else than an obsolete and ill-continued system of ladders and approaches to the hatches. A simple and efficient way of battening down had been fitted. The electric light plant was installed near the boilers, and where it could receive the care and supervision of capable mechanics. It was the production of a sea-going expert, not the creation of a theoretical scientist."

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

A DECIDED improvement has taken place in the trade of the port during the past week. A large number of vessels has arrived in both the Alexandra and Old Docks. In fact, both docks may be safely described as being crowded. In confirmation of this we may state that several steamers have been at the buoys waiting berths for a considerable number of hours. The price of steam coal has also advanced. Stems are well filled up all round, and there can be no doubt about it that shipping will be in a state of great activity for some time to come. A good demand for pitwood prevails at last week's prices. The ship-repairing trade has been brisk, all firms having been well employed.

Prices ruling on 'Change to-day was as follows:—Coal, best steam, 8s. 6d. to 9s.; seconds, 8s. to 8s. 3d.; best house coal, 10s. 6d.; dock screenings, 5s.; colliery, small, 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 6d. Pig iron: Scotch warrants, 46s. 1½d.; hematite warrants, 47s. 3d. f.o.b. Cumberland; Middlesbrough No. 3, 37s. 3d. prompt; Middlesbrough hematite, 45s. 3d. Iron ore: Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel: Rails, heavy sections, £4 10s. to £4 15s.; light ditto, £4 15s. to £5; tin-plate bars, £3 17s. 6d. to £4; Siemens tin-plate bars, best, £4, all delivered in the district cash less 2½ per cent. Tin-plates: Bessemer steel coke, 9s. 3d.; Siemens coke, finish, 9s. 6d.; ternes, per double box, 28 by 20c., 21s. to 22s. Pitwood, 16s. to 16s. 3d. London Exchange telegram: Copper, £41 5s.; Straits tin, £59 2s.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

AN improvement is noticeable in the iron trade this week on the tone manifested at the quarterly meetings, the result of the less threatening attitude of continental and South African diplomacy, and of the stronger character of the Cleveland and Barrow markets. Less indisposition is shown by consumers to operate, and the excessive caution of last week is subsiding. Marked bars keep at £7, merchant sorts £6 to £6 10s., and common £5 10s. Merchants quote a minimum of £10s. 7s. 6d. for galvanised corrugated sheets, but makers mostly require £10 10s. to £10 12s. 6d., and for best brands £11 10s., f.o.b. at outports. Mail advices from Australia bring news of a better demand for galvanised sheets at Sydney, and of an advance of 10s. per ton in some of the leading brands.

The remarkable manner in which the export demand for galvanised iron keeps up is matter of much gratifying comment. The completed shipments for last year have beaten all previous records, and surpassed even the greatest expectations of local makers, who were reckoning on a total shipment of 200,000 tons at most. Instead the figures come out 204,200 tons. For 1894 the total was 169,500 tons, and for 1893, 166,660 tons, so that last year has exceeded 1894 by 34,700 tons and 1893 by 37,600 tons. This is a marvellous performance for this class of iron. The largest customer on the year has been Australia, with 40,780 tons, an amount 500 tons in excess of two years ago, and only 1000 tons less than in 1894. India, which has been rapidly improving for twelve months past, takes second place with 38,800 tons, an advance on 1894 of no less than 11,000 tons and on 1893 of 10,300 tons. South Africa, which has advanced as remarkably as India, has been the third largest buyer, having purchased 33,500 tons, against 20,600 a year ago, and 20,300 tons two years ago, showing in each case an advance of 10,000 tons. The Argentine Republic is fourth with 19,600 tons, against 18,300 tons in 1894 and 16,000 tons in 1893, thus showing an increase of 1300 tons on a year and 3600 tons on two years ago. "Other countries" unenumerated appear for 20,600 tons, an increase of 2300 tons on 1894 and 4000 tons on 1893; and Chili has taken 10,800 tons, compared with 8500 tons in 1894 and 9700 tons in 1893. Never before have such returns been presented by the galvanised sheet iron trade, and their condition affords the liveliest prospects for the year that has now been entered upon.

In the pig iron trade stocks at the furnaces have accumulated somewhat during December and the holidays period; but makers are resisting the temptation to put all the iron on the market at once, believing that patience will be rewarded by better values. Derbyshire forge pigs are stronger this week and are quoted at 42s., and Northamptons 41s. to 41s. 6d. Foundry pigs are 45s. to 46s. for Derbyshires, and 44s. to 45s. for good Northamptons. Staffordshire cinder pigs are quoted 37s. for forge, and 38s. 9d. to £2 for common foundry iron. Staffordshire part-mines to compete with imported Midland pigs are quoted 42s. 6d. forge, and 47s. 6d. to 48s. for foundry, and occasionally on to 50s. nominal. Staffordshire mine iron—best forge—is quoted 44s., and foundry 55s. per ton.

The following figures show the number of furnaces built and in blast respectively at the opening of 1896:—Staffordshire South, 69 and 22; Staffordshire North, 38 and 14; Shropshire, 10 and 6; Nottinghamshire, 26 and 14; Lincolnshire, 21 and 14; Leicestershire, 4 and 3; Derbyshire, 52 and 30. The following are the increases in the number of furnaces in blast at the opening of 1896 compared with three months previously:—Staffordshire South, 1; Staffordshire North, 1; Derbyshire, 1; Leicestershire, none; Lincolnshire, none; Northamptonshire, none; Nottinghamshire, none; Shropshire, none. In the cases were no progress has been made, the number of furnaces now blowing is the same as a quarter ago.

Steel is still in large sale, and prices are maintained better than for iron. Bessemer basic angles of local manufacture are quoted £5 5s. for railway wagon building and engineering purposes; bridge plates and tees and channels, £5 10s.; boiler plates, £6; bars (flats), £5 10s.; and large shafting bars, £5 15s. to £6. Current prices are 5s. to 10s. per ton higher than this time last year.

Another meeting of the new combination in the Birmingham metal trade has been held, at which it was reported that there were now very few firms standing out from the movement, while more than two-thirds of the trade had given it their active support. Mr. E. J. Smith, of Birmingham, the well-known promoter of these new form trade combinations, was appointed chairman, and he was instructed to confer with the workmen on the subject of a proposed alliance between employers and employed.

Birmingham manufacturers view with much satisfaction this week the more pacifie aspect of Transvaal affairs. A large business is done between Birmingham and the Transvaal in engines, machinery, tubes, galvanised corrugated sheets, tools, and a great variety of miscellaneous metal goods. Several large Birmingham merchants have depôts of their own at Cape Town, Durban, Port Elizabeth, and other recognised trading centres. A few of the larger Birmingham manufacturing firms also are directly represented, not only in the South African ports, but in the Transvaal itself. Tangyes, Limited, for instance, have a large establishment in Johannesburg, and in pumping and mining plant and machinery they probably do the largest trade on the Rand. Another Birmingham manufacturing firm that is directly represented in Johannesburg is that of Lloyd and Lloyd, there being a great demand out there for iron and steel tubes of all descriptions. The stamping machinery, and other apparatus for dealing with the auriferous material when it is brought to the surface, is supplied, as far as this country is concerned, by London and other firms outside the Midlands, and is largely of American invention. The engines, however, and the engineering and winding appliances, are sent out, to a predominating extent, from Birmingham and the Black Country. One of the biggest orders now, and for some years back, in the trade with the Transvaal, and, indeed, with South Africa generally, has been in corrugated sheets and other galvanised goods. Dudley and the Walsall district, with Birmingham, share largely in the trade in gas and water pipes necessitated by the rapid commercial and municipal developments. For mining and cultivating tools of all kinds there has been a considerable demand from this district.

This week the Miners' Federation of Great Britain have been holding their annual conference in Birmingham. The proceedings opened on Tuesday with a luminous address by Mr. B. Pickard, M.P., President, dealing with the Employers' Liability and Eight Hours questions, internal competition among coalowners and low prices in the coal trade, a minimum wage for miners, and other subjects. On Wednesday a resolution was passed by the Conference declaring that no Employers' Liability Bill would be satisfactory which contains a contracting-out clause, and another resolution instructing the Executive of the Federation to press forward the Eight Hours Bill in the next session of Parliament. Other business was transacted on the remaining days of the sitting From the character of the President's address, and the general temper of the Conference, it seems entirely unlikely that the Federation will consent to any reduction of wages this year, but will stipulate for a continuance of the existing scale.

Mr. J. Robson, late manager of the steel mills at the Shelton Bar Iron and Steel Company's Works, Hanley, was on Saturday evening entertained to dinner, and presented with a gold watch, chain, and pendant, by a number of the mill employés, on the occasion of his leaving the company. Mr. W. Grey, in making the presentation, said that Mr. Robson had been their manager for about three years. They had learned to respect and esteem him, and had made that presentation because they had learned to regard him as a sincere friend. Mr. Robson, in replying, said that he should never forget the men who had worked under him at the Shelton Bar Mills. Mrs. Robson also was presented with a bread tray and knife with electro mounts.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—During the past week a decided change for the better has come over the iron trade here. The brightening foreign outlook, and the more hopeful prospects which are now entertained in well-informed quarters of some early settlement of the shipbuilding dispute, have both tended to dispel the depression which overclouded the opening of the year, and there is returning confidence in the market, the first evidence of which is the strong upward move in warrants during the past few days, and the lessened disposition to undersell on the part of speculative operators, whilst buyers who have been holding back in the expectation of lower prices, are now coming forward with their orders. The recent disturbance of the market, as I have previously reported, has been all along regarded as not more than temporary, and the quick recovery in prices only affords additional proof of the healthy condition of trade, and the general feeling of confidence as to the future. The opinion everywhere expressed has been that the upset of the market would soon pass over, and that with the large weight of work ahead already known as coming forward, the prospects of trade for the ensuing year were more satisfactory than they had been for a very long time past.

The Manchester Iron Exchange on Tuesday was well attended, and there was a better tone generally throughout the market, with more inquiries stirring. Although there is still not more than a moderate weight of actual business doing, buyers who have been holding back are showing more disposition to place orders at prices which a week or so back they were not willing to give, whilst some of the outside brands of pig iron could scarcely be brought within 6d. to 9d. per ton of the figures which sellers in some cases would have readily accepted quite recently. There is still a good deal of pressure on the part of users of pig iron to get down prices, but local and district makers who have not been in any way sensibly affected by the fluctuations in warrants, remain firm at their quoted list rates—the only exception being that Derbyshire foundry brands, which of late have been quoted at somewhat prohibitive prices, are not quite maintaining these, and are getting back to a more reasonable selling basis. For Lancashire foundry pig iron, makers still quote 46s., less 2½, whilst Lincolnshire makers remain in the position that they are mostly so heavily sold as to be indifferent about quoting at all, and their prices remain firm at 41s. 6d. for forge to 43s. 6d. for foundry, net cash, as the minimum for delivery equal to Manchester. Derbyshire foundry, which has lately been quoted as high as 48s., might, however, now be bought, according to brand, from about 45s. 6d. and 46s. up to 47s. net cash, delivered here. One or two fairly good orders have been put through in outside brands at improved prices, 45s. 4d. to 45s. 10d. net cash, being now the minimum for Middlesbrough, delivered Manchester, whilst in Scotch iron business has been done at 47s. 3d. to 47s. 6d. for Eglinton, and 48s. 3d. for Glengarnock, net prompt cash, delivered Lancashire ports.

A steady tone is generally reported in the finished iron trade, makers booking sufficient new business to keep them fully going, and they are firm at the recent quoted rates of £5 10s. for Lancashire, to £5 15s. for North Staffords ire bars; £7 10s. to £7 12s. 6d. for sheets; and £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths of hoops, delivered Manchester district, and 2s. 6d. less for shipment.

No very material improvement can be reported in the steel trade, ordinary foundry hematites being still obtainable at about 55s. 6d., less 2½, delivered Manchester, and steel boiler plates at from £6 to £6 5s. per ton, but rather better prices have been got for steel bars.

The position throughout the engineering industries continues generally satisfactory, most branches being fairly well supplied with work, whilst in some departments the leading firms have orders on their books which will keep them fully engaged for well over the remainder of the year, this applying especially to stationary engine builders, one or two of the locomotive builders, and machinists, whilst boiler-makers are also better off for orders than they have been recently, and machine tool makers generally are all well engaged and report new work coming forward satisfactorily.

The employment returns of the trades union societies are also a further satisfactory indication of the improved condition of trade. The continued dispute in the shipbuilding industry necessarily keeps up the general percentage of out-of-work members at a comparatively high figure, the Amalgamated Society of Engineers having about 8 per cent. of the total membership in receipt of out-of-work support; but, notwithstanding this, the returns compare favourably with those for the same period of last year. In this immediate district there is a continued steady decrease in the unemployed list, which now represents about 4 per cent. of the local membership in receipt of out-of-work benefit; and this probably may be taken to represent something like what the position would be throughout the society, but for the large number on the books, in connection with the disputes at Belfast and on the Clyde. The reports received from the various branches in this immediate district also show a decided revival in some branches which have been but moderately employed, and perhaps the most conclusive evidence of this increasing activity is a pressing demand for pattern-makers and smiths, which, I understand, the local secretary of the Amalgamated Society of Engineers now finds some difficulty in meeting.

Mr. Joseph Nasmith, the new President of the Manchester Association of Engineers, delivered his inaugural address to the members of the Society at their meeting on Saturday. It was, he said, not an easy task to select a subject for an address of that kind, but it was following a good precedent to deal with that side of engineering with which the president for the time being was most familiar, and he had taken as his subject the inventive epoch in the cotton trade, which would perhaps possess some features of novelty to many members. The president then, after an interesting historical survey of the growth of the textile art, the origin of which was, he said, completely lost in antiquity, dealt at length with the development of modern inventive skill as applied to the cotton manufacturing industry, accompanying his remarks with numerous illustrations of machinery and appliances, as typical of the progressive stages in attaining the present, if not absolutely perfect, still remarkably high position of efficiency. In conclusion, he said it was impossible to close without a word on a side of the question which was of deep interest. One of the first results of the invention of the various machines to which he had referred was the destruction of the old system of working, and the substitution of a new one. The household industries had been gradually proving inadequate for the needs of the nation, and when the adoption of the fly-shuttle led to an enormous increase in the demand for yarn, it could only be met with the new frames. The development of the steam engine released manufacturers from the necessity of depending upon water power, and speedily led to an increase in the size of the machines, until in 1812 mules of 700 to 800 spindles were in extensive use. To employ these it was necessary to collect under one roof the whole of the machinery necessary for preparation, and the independent spinner and weaver became transformed into the factory hand, and the system of organised industry arose. From this system had arisen by slow degrees that extension of popular liberties which had rendered this country the finest, and on the whole the most prosperous which the world had ever seen. The efforts of our machinists and engineers had also been directed to the improvement of the instruments of production, and these had in turn led to enormous improvements in the structures used to contain the machines, until working conditions were approaching the ideal. There was further a marked improvement within the last generation in the physique of cotton operatives, as it was proved beyond doubt that the industrial victory rested with the population which was best fed and best paid. On the motion of Mr. Ashbury, seconded by Mr. T. Daniels, a vote of thanks was unanimously passed to the president for his valuable address, and Mr. Nasmith in responding, incidentally observed that notwithstanding what the Americans might say as to the mule being a "doomed instrument," there was no sign of any extensive change from it as yet.

There is still no improvement in the coal trade; although in most cases pits continue working about five days per week, supplies, now that the extra pressure following immediately on the resumption of work after the holidays has disappeared, are excessive, and prices, if anything, easier. The better qualities of round coal suitable for house fire purposes move off slowly for the season of the year, with no quotable change in list rates, which, however, are barely being maintained. Common round coals continue in but very indifferent request, with excessively low prices ruling, 6s. to 6s. 6d. being the full average prices for good ordinary qualities at the pit mouth. Engine fuel meets with a moderate demand, but supplies are ample, and prices are not more than steady at late quotations, common slack being readily obtainable at 3s. to 3s. 6d., and better qualities 4s. 6d. to 5s. per ton at the pit mouth.

Only a very limited weight of business comes forward in the shipping trade, with very low prices accepted to get hold of business, ordinary steam coal not fetching more than 7s., except in very special cases; whilst as low as 4s. 6d. per ton has been taken on sales of good rough slack, delivered Mersey ports.

Barrow.—There is a much healthier feeling in the hematite trade this week, and not only has the sale increased locally, but there is evidence of further improvement all round. Prices accordingly are stiffening. Warrant holders ask 47s., net cash, and buyers 1s. less. Makers quote 48s. to 49s. per ton, net, f.o.b., for mixed Bessemer numbers.

Stocks of hematite iron have been reduced during the week to the extent of 560 tons. They now represnt 297,876 tons, being an increase of 8701 tons since the 22nd of December last. There are thirty-five furnaces in blast, compared with thirty in the corresponding week of last year.

Iron ore is only a poor trade, as although the consumption is heavier, foreign cargoes are being brought in. Average native qualities are at 10s. per ton, net, at mines.

The steel trade is busier than it has been for some time. Indeed, all departments are now at work at Barrow. The plate mills, which have been idle for six months, are again in full swing, and orders are fairly well held, and the demand is good and likely to be better. The rail mills are still busy, and orders are reported good, while prices are up at £4 15s. per ton for heavy sections, net, f.o.b. Billets, hoops, and castings are all good trades, and the year's prospects are all round brighter.

In the shipbuilding trade there is plenty of activity, and the work in hand is being pushed forward very satisfactorily. New orders are expected.

In the coal and coke trades there is more firmness, and a better demand is springing up on manufacturing account.

Shipments have been rather fuller this week. The exports of pig iron from West Coast ports during last week were 6865 tous, and of steel 4621 tons, as compared with 2248 tons of pig iron and 6931 tons of steel, an increase of 4617 tons of pig iron and a decrease of 2310 tons of steel. The total shipments since Dec. 21st last have been 13,996 tons of pig iron and 23,148 tons of steel, as compared with 5213 tons of pig iron and 15,604 tons of steel in the corresponding period of last year, an increase of 8783 tons of pig iron and of 7544 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE pits are now fairly well employed, and a better business is looked for in the near future. The production has been about an average one during the past week, the present unseasonable weather greatly affecting the demand for household qualities of fuel. The London and southern markets have taken only a moderate amount, while a similar remark applies to the eastern and other markets. No improvement will be reported in this business until a spell of cold weather comes. Competition is very keen, and the small tonnage in demand gives seaborne coal a considerable advantage. Quotations are said to be higher, although in many cases buyers can obtain concessions. Silkstone coal is at 9s. to 9s. 6d. for the best, and 7s. 6d. to 8s. for the secondary sorts. Flockton coal, which is only produced in about five local pits, is sold at 8s. 3d. to 8s. 6d., with best classes of thin seam at 6s. 3d. to 6s. 6d. Barnsley house coal of good quality can be disposed of at 8s. to 8s. 6d. per ton. Notwithstanding the lateness of the season, there is a good tonnage of coal being sent to the Humber ports. Stocks are accumulating, however, owing to owners having to raise both seams of coal at the same time. The business done with Hull is about the same as is usual during the first month of the year. Prices are as follows:—Barnsley hards, 6s. 6d. to 7s. 3d. for the best, and 6s. to 6s. 3d. for secondary qualities, a quotation which is a little lower than when last reported. Gas coal continues in good request, while 6s. 6d. to 7s. is all that can be obtained for supplies. Local pits are doing an active trade with Yorkshire manufacturing districts in engine fuel and slack. Nuts make from 5s. 6d. to 6s., and Barnsley pit slack 3s. to 3s. 9d., with screened ordinary pit slack at 2s. 3d. to 2s. 6d. per ton. Smudge is again plentiful at cheap rates. The coke trade is rather more active. North Lincolnshire is doing a larger business, and an increase in the number of blast furnaces, which is expected soon, will materially add to the consumption. Derbyshire, on the other hand, is transacting but a poor trade, smelters not ordering so freely as usual.

The trouble in the Transvaal has not had such an adverse effect on the Sheffield heavy industries as was anticipated when war broke out. Firms engaged in the production of miners' shovels, picks, machine stamps, crucible steel for drills, and similar goods, report a large number of orders, which have been received from their London agents and direct from South Africa. None of these have been cancelled by telegram, but this dispute will lessen the number of requirements following those at present on their way to this country. Railway material manufacturers report an excellent business doing in tires, axles, springs, buffers, and other locomotive parts. In view of these facts it is expected that these departments will be well employed for some months to come. Quotations remain about the same as when last reported. Bessemer billets are at from £5 12s. 6d. to £6, with bar iron at £5 10s. at makers' works. Hematites are quoted at 57s. 6d. to 60s. Marine material is in poor request, owing mainly to the strikes on the Clyde and at Belfast, which are unfortunately still continuing. These decreased requirements are also due to the small number of new ships now being ordered, in consequence of the lowness of freights, there being hardly sufficient employment for the ships at present floating. Messrs. Charles Cammell and Co., Messrs. John Brown and Co., and Messrs. Vickers, Sons, and Co. are well employed on armour plates for the British Admiralty, and it is anticipated that the latest political trouble will bring about an entirely new naval programme.

In the lighter trades the New Year appears to be opening very well. Sheffield is undoubtedly making satisfactory progress in electro-plate and silver manufactures, in spite not only of home opposition, but of the keen competition of Germany. Troubles in South Africa, it is expected, will tell against the demand which has so readily risen in that region for the best classes of silver goods. So far, however, we do not hear that any of the indents have been countermanded, but there is little doubt that the next mail from the South African markets will be a small one, and manufacturers at present have not been pushing forward shipments until affairs have settled down. South Africa is taking a large value of goods in machine stamps, crucible cast steel for drills, disintegrators, and all the varied appliances required in the mining industry, while mining shovels, of a special pattern, are also freely ordered. At home there is a capital demand for contractors' tools, spades, shovels, hammers, axes, and similar goods, in which manufacturers have been well employed all the year, and 1896 promises to be quite as fertile in work. Houses which produce hand-cut files, as well as those which adopt file-cutting machines, are very busy. Best cutlery has been in good demand, a noteworthy tendency of trade having been the call for articles displaying artistic taste at a moderate price. Several of our manufacturers are at length taking a leaf out of the foreigner's book and offering attractive productions at low figures. It is high time this step was taken, as the tendency towards cheaper goods becomes more and more manifest every day.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

A VERY decided change for the better has set in this week in nearly all departments of the iron and steel industries, and the tone now is as hopeful as it was despondent last week, while confidence is rapidly returning, and a disposition to buy is becoming very manifest. The reason for the improvement is that the fears that were entertained about the grave political complications have subsided, and it is now generally the opinion that trade will not be hampered by the hostilities that were threatened, but that "peace and plenty" will be the lot of commercial men this year. The unsatisfactory state of political matters has undoubtedly been the main cause of the last 2s. fall in pig iron prices, and now that they are more reassuring, considerable recovery is looked for, even during the winter months, though these are the quietest in the year.

Distinct evidences of revival are everywhere apparent, and must be more so after the termination of the Clyde-Belfast engineering dispute, which has done so much to interfere with trade in this district and Scotland during the last two months or more. The belief that the difficulty would come to an end very shortly has had something to do with the improvement in the market this week, as has also the excellent Board of Trade returns and the good accounts of traffic receipts issued by the railway companies. The feeling generally is now inclined to be optimistic, and thus is the opposite of what it was last week.

Pig iron makers have done a fairly satisfactory business this week, and generally have realised higher prices. No. 3 Cleveland pig iron — the standard quality — has risen 9d. — and thus is back to the figure that ruled a month ago. Consumers, influenced by the general improvement, are becoming anxious to buy for forward delivery, but they find it difficult to induce either makers or merchants to sell for other than prompt delivery at present. Last week No. 3 could have been bought at 36s. 3d. per ton; this week there are plenty of consumers willing to purchase at 36s. 9d., but they now have to pay at least 37s., and most of the producers have put up their quotation to 37s. 3d. Cleveland warrants on Tuesday went up to 37s. 1d., cash, which was 11½d. advance on the previous Tuesday's rate, but on Wednesday 37s. 5½d. was the rate.

It is satisfactory to see that the stock of Cleveland pig iron in the public warrant stores is not increasing so rapidly as it did in December, owing doubtless to better shipments. The stock held by Messrs. Connal and Co. on Wednesday night was 176,063 tons, or 4363 tons increase this month. The pig iron exports from the Cleveland district this month have been 32,296 tons, as compared with 24,616 tons last month, and 18,664 tons in the corresponding month of last year to the 15th. No. 1 Cleveland pig iron is at 38s. 3d.; No. 4 foundry at 36s. 6d.; grey forge at 35s. 9d.; and white at 35s.

The market for East Coast hematite pig iron is dull and weak, notwithstanding the activity in the steel trade, and the price has not moved up in sympathy with that of Cleveland iron. Probably the low price of Middlesbrough hematite warrants induces people to hold off, but there is good reason to believe that the prices quoted on the warrant market for these warrants are fictitious, for brokers find it impossible to execute orders at any such prices, and directly an offer to buy is sent in, the price is run up at once. The quotation for mixed numbers of East Coast hematite pig iron is 45s. 6d., which is not an advance on last week. Rubio ore is firm at 12s. 6d. per ton delivered Tees, though rates of freight have dropped. Cleveland No. 3 basic pig iron is steady at 39s. 6d., but there is not much on sale.

The realised price of No. 3 Cleveland pig iron during the past quarter has, by the official accountants, been certified to be 36s. 5·06d., as compared with 35s. 1·51d., increase 1s. 3·55d., but the wages of the blast furnacemen are to be reduced this quarter by 2 per cent. The reason for this is that in October the men were given a special advance of 3¾ per cent., but the return just received proves that the condition of prices did not justify the payment of so much, and accordingly the wages have been reduced to the rates that the sliding scale gives. The cost of the carriage of iron-making materials will, however, be raised 10 per cent., as the railway rates for these are regulated by sliding scale based upon the realised price for No. 3 Cleveland pig iron. The average realised price for the year 1895 was 35s. 2·94d.

An extraordinary instance of the success of Belgian competition in this district is reported. Sir B. Samuelson and Co., at the Newport Ironworks, Middlesbrough, are adopting what is in this country a new plan for the manufacture of coke for their blast furnaces. Instead of having the coal converted into coke at the colliery, they are to have the raw coal carried to the ironworks and there converted. This plan is said to have been tried in Germany, and answers admirably, as a drier, harder, and better coke can be put into the furnace, and it has not to be handled so often. At Newport Ironworks, therefore, a large number of coke ovens are being erected for the firm by Mr. H. Simon, of Manchester, the patentee of the Simon-Carves, ovens, and, requiring a number of girders in the work, Mr. Simon has bought them in Belgium, though close to the Newport Works, and within half a mile of where the girders are used are the well-known mills of Messrs. Dorman, Long, and Co., who make the manufacture of builders' girders one of their specialities. This is competing with our own manufacturers even at their very doors.

The steel rail trade is very active; local works are fully employed with the exception of the Darlington, which are closed, and the large number of inquiries that are received justify the expectation that the activity will be continued. Orders on Indian account are numerous. Quotations for 17,000 tons for one of the Indian lines are asked; also for 17,000 tons for Mexico. A large quantity of steel sleepers have been recently sent to Mexico from the Tees. Railmakers maintain their quotation of £4 15s. net at works for heavy steel rails. Chair founders are doing better, but the improvement with them has not been anything like so pronounced as it is with the rail manufacturers, and instead of prices being put up 25s., as in the case of rails, the chair makers have to be content with 2s. 6d. advance, and find it difficult to get even that. The great activity in the rail trade has led to the circulation of various rumours about the re-opening of the Darlington Steel and Ironworks and their acquirement by other owners; but there appears to be no foundation for these reports.

The steel plate trade is improving as far as regards demand, but some makers have this week accepted reduced prices, for ship plates could be got at £4 17s. 6d., less 2½ per cent., at works, and there was a little businee done at £4 16s. 3d. Steel ship angles are now offered at £4 15s., less 2½ per cent., and iron angles at £4 12s. 6d., also less 2½ per cent. Some of the producers of common iron bars have been more successful in booking orders than they were in the last quarter, and generally the manufacturers speak more hopefully. The price of common bars is £4 17s. 6d., less 2½ per cent., at works, but orders might be placed at less.

The engineers find work more plentiful, and they expect a good year, but as yet they have been able to do little in the way of raising prices. This is especially the case with marine engineers. Locomotive engineers report more work, both on home account and for export. Wagon builders are also reporting more favourably of their position and prospects. The directors of the North-Eastern Railway are about to increase their wagon building operations at Shildon to more than double the present output. Inquiries for pipes are numerous, but competition is still too keen to permit of any substantial advance in the prices.

The coal trade is showing no improvement, and especially is the steam coal branch depressed. So unsatisfactory have been the prices during the last quarter that at a meeting of the Conciliation Board held at Newcastle, the umpire decided the wages were to be reduced 1½ per cent. for the present quarter. Best Northumberland steam coal can now be got at 7s. 9d. per ton f.o.b. The Durham coal trade is not quite so slack, but still is poor on the whole, partly because of the mildness of the weather. At Dunston-on-Tyne a few years ago the North-Eastern Railway Company constructed coal shipping staiths for the accommodation of the collieries in the north-west of Durham, and such has been the support accorded to them that the present accommodation is inadequate, and a deputation of the Coal Trade Association and other bodies concerned proposes to wait upon the railway directors to get them to enlarge the shipping facilities there. Last year's coal and coke exports from Tyne Dock amounted to 5,429,586 tons, as compared with 5,569,513 tons—a larger quantity, it is claimed, than has been shipped from any other dock in existence. Coke for blast furnace purposes is firm at 13s. per ton delivered at urnaces on Teesside or 14s. 6d. f.o.b.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has been a better feeling in the iron market this week. A large quantity of Scotch warrants changed hands at improving rates, the price advancing about 1s. per ton above the rates current last week. For Cleveland pig iron warrants there was but a poor demand in this market, but the prices rose in sympathy with Scotch iron. A moderate business took place in Cumberland hematite warrants, which also improved in price.

At Gartsherrie Ironworks there are 7 furnaces making hematite and 4 ordinary; Coltness, 8 and 1 respectively; Summerlee, 6 on ordinary; Calder, 4 on hematite and 1 ordinary; Shotts, 1 hematite and 3 ordinary; Carnbroe, 4 ordinary; Govan, 1 hematite and 5 ordinary; Clyde, 4 ordinary; Wishaw, 3 hematite and 1 ordinary; Glengarnock, 2 hematite, 4 basic, and 3 ordinary; Dalmellington, 1 hematite and 4 ordinary; Eglinton, 2 ordinary; Muirkirk, 3 ordinary; Lugar, 3 hematite and 2 ordinary; Carron, 2 ordinary. There are thus at the beginning of the year 30 furnaces making hematite, 4 basic, and 45 ordinary pig iron, the total number in blast being 79, and there are altogether 29 out of blast.

Although constant additions have been made to stocks in the last few months, they amount to not very much over one-third of the quantity in store half-a-dozen years ago. With moderate wages and cheap fuel, the ironmasters appear quite justified in turning out iron at the present rate of production.

There is a hardening tendency in the prices of the special brands of makers' iron which are improving a little in sympathy with warrants. When warrants receded badly, however, makers' iron ore fell away to a small extent, so that it may be expected warrants will recover further before there be much addition to the prices of the special brands. Govan and Monkland, Nos. 1, are quoted f.o.b. at Glasgow, 46s. 6d.; No. 3, 45s.; Coltness, Nor 1, 53s.; No. 3, 48s. 6d.; Summerlee, Calder, and Gartsherrie, No. 1, 50s. 6d.; No. 3, 47s. 6d.; Clyde, No. 1, 50s.; No. 3, 47s.; Carnbroe, No. 1, 47s.; No. 3, 45s. 6d; M. and C., No. 3, 43s. 6d.; Glengarnock, at Ardrossan, No. 1, 50s.; No. 3, 46s.; Eglinton, No. 1, 47s.; No. 3, 45s.; Dalmellington, at Ayr, No. 1, 47s.; No. 3, 45s.; Shotts, at Leith, No. 1, 52s. 6d.; No. 3, 48s.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 48s. 6d.

The pig iron shipments in the past week were small, being 5395 tons, against 3704 in the corresponding week of 1895. There was dispatched to India, 112 tons; Italy, 150; United States, 10; South America, 25; Australia, 10; France. 15; Germany, 30; Holland, 30; Belgium, 40; Spain and Portugal, 30; China and Japan, 500; other countries, 52; the coastwise shipments being 4391, compared with 2902 in the corresponding week.

The market for finished iron is quiet. Business has scarcely yet had time to assume normal proportions since the holidays. In the steel trade there is a fair promise of good employment if only labour disputes could be warded off, and that which now exists in the shipbuilding industry brought to a satisfactory conclusion. Prices of manufactured iron and steel have not changed materially since last week.

Several fresh shipbuilding contracts have been booked by Clyde builders in the last few days.

The coal trade is in a rather languid state, the past week's coal shipments from Scotch ports amounted to 92,953 tons, compared with 95,940 tons in the preceding week, and 101,197 tons in the corresponding week of last year. There has been a heavy falling off in the East Coast shipments, those from the Clyde showing a considerable increase. All classes of coal are at present slow of sale on Glasgow Exchange. The prices at the ship's side in Glasgow Harbour are for main coal 5s. 10d., splint 6s, 6d., ell 6s. 9d., and steam 7s. 6d. per ton.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE coal trade may fairly be described as satisfactory, and yet there are several districts that are in anything but a prosperous condition. The Plymouth colliers continue irresolute, and though meetings amongst them are frequent, it is quite possible that the end of the month will see a complete stoppage. In the Aberdare and Hirwain districts one firm employing 1100 men suspended operations lately. Ycyborwen Colliery, one of the oldest in the valley, is also closed, though it is stated that sixty acres remain unworked; this will put aside a number of men. The new drift at Dythus is being worked vigorously in that neighbourhood, and this will absorb some men- These partial upsets must be expected in an increased ratio as time goes on, old properties failing to pay, especially when in rivalry with new collieries, which can be more cheaply worked.

The total exports from Cardiff last week were satisfactory, 285,000 tons. Newport report was 40,064 tons foreign, and 20,515 coastwise. Swansea total was below the average, only 27,833 tons. At Cardiff a brisk business was reported this week, and the maintenance of good prices. On Saturday 10s. 6d. was firmly quoted for best steam coal. Early in the week the gratifying news was discussed on 'Change, Cardiff, that an extension of Government coal contracts in Wales was certain, to the substantial figure of 100,000 tons, so as to provide for all contingencies. Coal prospects are, then, tolerably good for some time to come. Most of the Welsh industries have suffered from the strained character of our foreign relations, but coal generally thrives in a war atmosphere. Cardiff prices mid-week were as follows:—Best steam coal, 10s. 6d.; seconds, 9s. 6d. to 10s.; drys, 9s. 6d. to 9s. 9d.; best Monmouthshire, 8s. 6d. to 8s. 9d.; seconds, 8s. to 8s. 3d.; best small, 5s. to 5s. 3d.; seconds, 4s. 3d. to 4s. 6d.; drys, 3s. 9d. to 4s.

The mildness of the weather of late has evidently told a little upon the house coal trade. As a rule, in the early part of the year, there is a greater amount of buoyancy about house coal than steam, but this year it is *vice versâ*, and for the last few days a degree of flatness has characterised most house qualities. Prices are much about the same, best being quoted at 10s. 6d. to 11s.; seconds, 10s.; No. 3, Rhondda, 9s. 9d. to 10s.; brush, 8s.; small, 6s. 3d. to 6s. 6d.; No. 2, Rhondda, 7s. 9d. to 8s.; through, 6s. 3d. to 6s. 6d.; small, 4s. 3d. to 4s. 6d. Swansea prices are: Best steam, 9s. 6d. to 10s. 6d.; second quality, 8s. 6d. to 9s. 3d.; small, 4s. 3d. to 4s. 9d.; No. 3, Rhondda, 10s. to 10s. 6d.; No. 2, Rhondda, 8s. 9d. to 9s. 6d.; Anthracite, from 8s. 9d. to 12s.

The patent fuel trade is moderately good at the various ports, Cardiff, Swansea, and Newport. Prices remain ranging from 10s. to 10s. 6d. Coke prices are unaltered. Pitwood at Cardiff this week realised from 16s. to 16s. 3d.; Swansea, 17s. 9d. to 18s. into truck. Iron ore at the same place is being quoted at 11s. 7½d. to 12s. A novel mixed cargo figured amongst the imports to Cardiff for Dowlais this week—"iron ore and salt," from Bilbao. Substantial consignments continue to arrive this open weather. One from Castro, for Ebbw Vale, 1680 tons, 1530 tons from Bilbao for La Société Commerciale, and several large cargoes for the Dowlais Iron Company.

There is not much of an encouraging nature to report in connection with the iron and steel trade. The condition of the tin-plate trade has told seriously upon the tin bar trade, and prospects ahead in that branch are rather gloomy, though not quite so bad as some have stated. Swansea Exchange reports this week indicated a fair degree of trade in steel rails, but a small one in steel bars. Quotations are as follows:—Steel rails, heavy, £4 10s. to £4 15s.; light, £4 15s. to £5 10s.; Welsh bars, £5 5s. to £5 7s. 6d.; steel and iron sheets, £6 5s. to £6 10s., with the usual extras for higher gauges. Bessemer steel, tin-plate bars, £3 17s. 6d. to £4; Siemens not quoted. Cardiff quotations are, Bessemer, £3 17s. 6d. to £4; and Siemens, £4 to £4 2s. 6d.

Swansea imports continue to be suggestive. Last week they included 862 tons pig iron; scrap iron, 150 tons; tin-plate bars, 400 tons; steel rails, 347 tons. Tin-plate exports were depressing to a degree. The quantity shipped was only 20,647 boxes, while 37,637 boxes came up for the works. In reviewing the December trade, the falling off in exports of tin-plates is very striking. To the United States the quantity sent in December, 1894, was 15,910 tons, and to Russia 3163 tons. December, 1895, the figures respectively were 10,635 tons and 2687 tons. The collective totals to Germany, France, Italy, Portugal, and Austria, shows also a serious decline.

I regret to announce the death of Captain Pomeroy, chief docks harbour master at Cardiff. He has been felicitously described as Sir. W. T. Lewis' right-hand man, and there is no doubt he was one of the ablest of his agents, not only in conducting the duties of his post, but in the getting up of dock extension plans and changes. He was an excellent witness on Parliamentary Committees. He was only in his fifty-second year. Speculation is rife as to the appointment of his successor. The vacancy is expected to be filled from without. Sir W. T. Lewis, Bart., is still absent in South Afrfca, and nothing will be done until his return.

Llanelly shipping indicates an increase. During December the exports amounted to 12,848 tons, as compared with 12,420 tons in November; this was exclusive of tin-plates. Imports 6566 tons, an increase of 655 tons over non-imports.

I have now the official totals of coal, and iron, and steel shipments from the leading Welsh ports for 1895; Cardiff during the year despatched 12,793,381 tons of coal, 43,824 tons of iron and steel, 81,941 tons of coke, and 388,995 tons of patent fuel. Newport, Mon., 3,412,854 tons coal, 18,140 tons iron and steel, 4717 tons of coke, and 55,531 tons patent fuel. Swansea, 1,794,481 coal, 1954 iron, 10,576 coke, and 297,320 patent fuel. Llanelly, 250,011 coal, 12 iron. As anticipated in my previous notice, there is a decrease in coal shipments. The total from Welsh ports in 1894 was 18,567,017 tons. The total in 1895 was 18,150,727 tons.

I am glad to hear that the well-known Abertillery seam of coal has been struck. It is understood that the London and South Wales Railway Bill has been withdrawn, certain concessions having been given by the Great Western Railway in the form of reduced fares, and railway improvements. The engineer's estimates respecting the Rhymney Bill in carrying out the construction of lines, &c., if sanctioned, is £97,597. Those of the South Wales and Bristol Direct Railway totals are £1,116,348. This scheme for shortening the route from Wales to London is estimated by local authorities to amount to £31,500 per mile.

With reference to the condition of the tin-plate trade, it was announced mid-week by Mr. W. Mann, of Morriston, that there was no immediate prospect of a restart at the Worcester Works, but if orders could be obtained, four mills might be set going at Upper Forest Works, the work at which might be shared by the employed.

At Gwendraeth, Kidwelly, it has been intimated that, owing to depressed state of the tin-plate trade, the works could not be kept going, unless the men conceded 15 per cent. and seven sheets per box, which would be equivalent to 25 per cent. reduction. So far the men appear resolute not to give way. In most quarters the outlook is bad. Thus, at the Villiers, Briton Ferry, only three mills worked last week. This meant half-time for the men. Mills at Earlswood were restarted Wednesday week. Vernon mills were all at work, but a notice is posted that will expire in three weeks. Last week three mills were at work at Raglan Bay, and three at the Gwalia. At Briton Ferry and at the Albion there was an average make of steel bars and a good demand.

At the last Birmingham quarterly meeting there was no improvement recorded in the tin-plate trade, but prices were advanced from the old selling prices of 9s. and 9s. 1½d. per box to 10s. and 11s. per box.

The South Wales Works, Llanelly, which employ 1000 hands, are in steady operation.

The extension of the Prince of Wales Dock, Swansea, has been decided upon—£100,000 to be borrowed. This and the threefold scheme—electric light, tramways, &c.—now before the Corporation, indicate that the port is going to open the year with vigour.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THIS week again only a moderate business has been transacted on the iron market, for, apart from the quietness that is always noticeable immediately after the holidays, there has been a slightly weakening tone perceptible in some branches, and the tendency of prices is not so firm as could be desired.

With regard to the iron trade in Silesia, a fair employment is on the whole maintained at the blast furnace works, and in the malleable iron department there has also been pretty much life stirring. Some of the larger ironworks, Borsig, for instance, Huldschinsky and Fulva Works, contemplate the extension of their establishments in spring. Tenders for the supply of a further large quantity of structural iron have lately been invited by the Breslau Railway Administration, and the orders will probably be secured by Breslau dealers. Compared to this time last year, prices for bars and structural iron are on an average M. 1·90 per 100 kgr. higher.

In Austria-Hungary the year has begun with a slight improvement in the quotations for some articles, the Convention of the Bohemian and Moravian rolling mills having resolved to raise bars and sectional iron 25 to 50 cr. per 100 kgr. This upward movement, which is due to the continuing favourable condition of the German iron market, will most likely lead to a general rise in quotations before long On the whole, there is very little doing in the pig iron trade, and few orders are holding out, but for manufactured iron a lively demand is experienced, and the steel trade is in healthy occupation, owing to the numerous contracts that have of late been placed by the Railway Administrations. The locomotive and wagon shops are reported to be in exceptionally good employment, the Kaiser-Ferdinand North Railway having ordered 100 passenger and freight cars, while two other railway companies have invited tenders for the supply of several hundred coal wagons and 2000 passenger and freight cars. The following figures, which have recently been published, show that consumption of coal in Hungary, which was extremely limited till 1867, has since then considerably increased. From 1867 to 1876 consumption was, in 100 kgr., 15 millions per annum; in 1880 it amounted to 20 millions; and in 1883 it rose to 27 millions. Since 1890 consumption of coal in Hungary was as under:—

	Pit coal.	Brown coal 100 kgr.	Totals.
1890	16,076,807	22,701,539	38,778,346
1891	18,318,050	24,504,790	42,822,840
1892	18,616,708	25,734,992	44,351,700
1893	20,018,767	29,409,818	49,428,585
1894	20,357,926	34,763,837	55,121,763

Compared to this, consumption in Austria was—for 1886, in 100 kgr., 160 millions; 1887, 175; 1888, 184; 1889, 190; 1890, 205 millions. And

	Pit coal.	Brown coal. 100 kgr.	Totals.
1893	119,060,223	100,497,977	219,558,200
1894	125,878,041	105,379,232	231,257,273

During the period from 1867 to 1876 the average output of coal in Hungary was, in 100 kgr., 13 millions; for 1877 production was 16 millions; 1878, 18; 1879, 16; 1884, 25; 1885, 25; 1886, 24; 1887, 25 millions. Import in coal also shows a considerable increase, having been, for 1883, in 100 kgr., 4 millions, which is exactly double the quantity that was imported in 1873. Since 1890 Hungarian business in coal was as follows:—

	Pit coal.	Brown coal. 100 kgr.	Totals.
1890.			
Production ..	9,948,117	22,504,462	32,452,579
Import	6,170,425	982,638	7,153,063
	16,118,542	23,487,100	39,605,642
Export	41,755	785,561	827,316
	16,976,787	22,701,539	38,778,326
1891.			
Production ..	10,193,522	24,279,263	34,472,785
Import	8,161,764	1,084,694	9,246,458
	18,355,286	25,363,957	43,719,243
Export . ..	37,236	859,167	869,403
	18,318,050	24,504,790	42,822,840
1892.			
Production ..	10,522,136	25,543,646	36,065,782
Import	8,153,078	998,263	9,151,341
	18,675,214	26,541,909	45,217,123
Export	58,506	806,917	865,423
	18,616,708	25,734,992	44,351,700
1893.			
Production ..	9,827,982	29,178,991	39,006,973
Import	10,287,312	1,006,850	11,294,162
	20,115,294	30,185,841	50,301,135
Export	96,527	776,023	872,550
	20,018,767	29,409,818	49,428,585
1894.			
Production ..	10,000,000	34,000,000	44,000,000
Import	10,431,099	1,599,510	12,030,609
	20,431,099	35,599,510	56,030,609
Export	73,173	835,673	908,846
	20,357,926	34,763,837	55,721,763

The trade done on the French iron and steel market is, on the whole, but limited. Here and there rather more business is reported to be stirring in the manufactured iron department, but generally there is not much animation noticeable. Prices, though not showing the slightest inclination to rise, are tolerably firm.

The same may be told with regard to the Belgian iron industry, which has been dull during this week and the last, the mills and foundries being, on the whole, irregularly occupied, while the prices for most articles continue quite as low as ever.

Since beginning of December last year no change, either in prices or demand, can be noticed in the pig iron trade; for most sorts a good demand continues to be reported, and quotations exhibit considerable firmness. Spiegeleisen, 10 to 12 p.c. grade is quoted M. 53 p.t.; forge pig, No. 1, M. 48 to 49 p.t.; No. 3, M. 42 p.t.; hematite, M. 65 p.t.; foundry pig No. 1, M. 65 p.t.; No. 3, M. 56 p.t.; basic, M. 50 p.t.; Luxemburg forge pig, M. 45 p.t.

On the malleable iron market the tendency is firm, and even rising. Bars for home consumption are in fair request, considering the time of the year, and even from abroad rather more inquiries have been coming in lately. With regard to girders, only small purchases are being made just at present. At a recent meeting of the Rhenish-Westphalian rolling-mills, a rise of M. 2 p.t. for bars and girders has been resolved upon.

The position of the plate business is not very satisfactory. It is true there has been an increase in demand since October last year, but only the most favourably situated establishments can work with a profit, while the majority of the mills justly complain of the low, unremunerative prices they are still compelled to accept. In sheets demand has improved rather than otherwise. The wire and rivet business is quiet, but steady. At the machine and wagon factories a fair activity is going on, but the foundries are, on the whole, weakly engaged, and seem to be anxious to secure more contracts. At a late tendering for fish-plates, M. 120 p.t. was the lowest offer, others ranging between M. 121 and M. 142·40 p.t.

The following are the latest list quotations, per ton at works:—Good merchant bars, M. 108 to 110; angles, M. 118; girders, M. 84; hoops, M. 112 to 117; billets in basic and Bessemer, M. 80 to 83; heavy plates, for boiler-making purposes, M. 160; tank ditto, M. 135 to 140; steel plates, M. 125; tank ditto, M. 110 to 113; sheets, M. 135 to 145; iron wire rods, common quality, M. 118 and higher; drawn wire in iron or steel, M. 120 to 138; wire nails, M. 127 to 130; rivet iron, M. 130; rivets, M. 150 to 155; complete sets of wheels and axles, M. 270 to 280; axles, M. 200; steel tires, M. 195 to 200; steel rails, M. 108 to 110; steel sleepers, M. 106; fish-plates, M. 112 to 120; light section rails, M. 95.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, January 8th.

THE anticipated replenishment of the Federal Treasury, through in part popular subscriptions, has already exercised a favourable influence on business. The prompt action of the House in passing a measure to increase Government income is helpful in another direction. The enormous gold production and the encouraging possibilities of the Western gold field, are producing a good effect. The increasing evidences of an overwhelming Republican sentiment throughout the country is having a good effect in industrial directions. There has been a slight decline in iron and steel production. Prices have receded a little more. Large buyers are awaiting developments. Lake ores are out of reach, and coke must come down. The Pittsburgh iron region is overcrowded with work excepting in steel billets, and large buyers refuse to pay current rates. Sheet and plate mills are quite busy. All the cast iron pipe mills are full of orders. Rail orders come in slowly. Last year was the worst railroad year we ever had. There is much projected railroad building in the States and Mexico, and only favourable conditions are needed to stimulate construction. The standing drawback is that all our international obligations are payable in gold, and our creditors know we will never have gold enough to pay the principal. There is an encouraging increase in industrial activity throughout the Southern States.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

⁂ When patents have been "communicated" the name and address of the communicating party are printed in italics.

1st January, 1896.

1. Hydraulic Hoisting Apparatus, F. Eastmead, London.
2. Revolving Pumping Apparatus, F. W. Brewster, London.
3. Keel for Pleasure Sailing Vessels, T. O. Smith, Oxford.
4. "Drip" for Railway Carriages, &c., D. Tilsley, Limerick.
5. Treating Linseed Oil, J. E. and C. S. Bedford, Leeds.
6. Partitioned Box or Crate for Bottles, J. Brooks, Sheffield.
7. Oil Lamps, E. F. Hulse, Manchester.
8. Metallic Packing for Pistons, &c., W. Harbinger, South Shields.
9. Making Ammonium Compound of Casein, W. Majert, Manchester.
10. Shuttle Smash Preventer, P. J., A., and E. B. Evans and J. H. Clissold, Stroud.
11. Pneumatic-tired Wheels for Vehicles, J. Ralph, Wolverhampton.
12. Medicated Fruit Syrup, J. H. Dalwood and Co., Sherborne.
13. Stopping Leaks, J. C. Sellars, Liverpool.
14. Gas or Oil Motors, H. S. Booth, Manchester.
15. Mechanism for Branding Articles, R. Gibson, Dundee.
16. Moulding Pipes, H., J., and A. Coulthurst, Manchester.
17. Cycles, J. Robson, Birmingham.
18. Beetling Machinery, J. Downham, Manchester.
19. Patent Wood Block Flooring, J. W. Musselwhite, Basingstoke.
20. Gutta-percha Balls, R. Ramsbottom and H. J. Rofe, Manchester.
21. Making Vanillin, W. Majert, Manchester.
22. Driving Gear for Cycles, T. Lambert, Plymouth.
23. Safety Bolt Fastener, M. Rohleder, Cologne.
24. Ventilating and Air-moistening Apparatus, C. Buchmuller, Cologne.
25. Tear-off Calendar, E. H. Janssen, Cologne.
26. Cruet, Camera, Flower, &c., Stands, H. Moreton, Birmingham.
27. Construction of Casement Windows, C. Ower, Dundee.
28. Combined Window Sill and Flower Box, J. Paton, Glasgow.
29. Cycles, J. Casey, London.
30. Artificial Flowers, T. M. Cockroft, Leeds.
31. Polish for Stained Floors and Harness, H. Dell, Brighton.
32. Horse Collars, H. Collings, Tonbridge.
33. Trouser Stretchers and the like, R. O. Rowland, London.
34. Device for Attachment to Lathes, J. H. Mayer, Birmingham.
35. Bathing Carriage, W. R. Lane, London.
36. Lasts for Repairing Boots and Shoes, J. Clegg, London.
37. Vegetable Slicer, W. Stabb and F. J. J. Bagley, London.
38. Stop and Draw Cock, W. G. Kershaw and J. W. Cowling, London.
39. Making Large Globes and Maps, T. R. Johnston, London.
40. Silver Alloy, S. Callow, London.
41. Attaching Tire Covers to Wheels, J. A. Score, London.
42. Button-hole Sewing Machines, J. Gutmann, London.
43. Water-closet, J. Duckett and Son and J. Duckett, London.
44. Tobacco Pipes, S. Aldwinckle, London.
45. Self-releasing Stirrup Bar, G. de Goldschmidt, London.
46. Making Articles of Glass, A. Kopp's Sohn, London.
47. Preventing the Refilling of Bottles, J. G. Clemmer, London.
48. Anti-incrustation Fluid, C. B. Moore and F. Turner, London.
49. Cycle Saddles, W. Grotefend, Aix-la-Chapelle, Germany.
50. Working the Breast Roller of Gigs, J. Bailey, Dewsbury.
51. Bath Brush, C. W. Phillips, London.
52. Fire-places of Puddling Furnaces, W. Roberts, London.
53. Preparing Barley, M. Lawes, Croydon.
54. Cycle Driving Mechanism, F. W. Golby.—(*A. J. Bureau, Belgium.*)
55. Lighting Tobacco Pipes, W. Carter and J. H. Prall, London.
56. Outdoor Lamps, &c., W. Carter and J. H. Prall, London.
57. Match Boxes, &c., W. Carter and J. H. Prall, London.
58. Preventing the Abstraction of Bottle Contents, H. E. Haines, London.
59. Chamber Utensils, C. Andrews, London.
60. Tie Clip, E. Scantlebury, London.
61. Bottles, D. McIntyre, London.
62. Grip or Holder for Blind Cords, W. T. Nicholls, London.
63. Appliance for Sharpening Pencils, W. Peck, London.
64. Electric Tramways or Railways, F. Krizik, London.
65. Covers for Hermetically Sealed Vessels, J. J. Stone, London.
66. Combined Oil Feeder and Lamp, J. R. Watson, London.
67. Plate Holder for Carrier for Cameras, R. Krugener, London.
68. Apparatus for Burning Chalk, &c., W. R. Taylor, London.
69. Prolonging the Life of Railway Rails, J. E. Stead, London.
70. Keys, W. Wrentmore, London.
71. Trousers' Shield for Bicyclists, E. L. O'Brien, London.
72. Table Supports, H. E. Peltzer and B. Doll, London.
73. Machines for Filling Sacks, W. Fredenhagen, London.
74. Bedding, A. H. Smith, London.
75. Gas Generators, W. W. R. Warn and L. F. King, London.
76. Saw Blade Tangs, J. Heyn, London.
77. Range Finders, A. G. Hadcock and R. T. Brankston, London.
78. Coats, J. Bedford, London.
79. Musical Instruments, H. H. Leigh.—(*Messrs. Guiterman, Rosenfeld and Co., United States.*)

2nd January, 1896.

80. Head Coverings, &c., W. L. L. Bell, London.
81. Jacquards of Looms for Weaving, T. Allen, Halifax.
82. Clinograph for Indicating Angles, B. H. Mounsey, Halifax.
83. Spinning and Twisting Frames, J. Barbour, Belfast.
84. The "Defiance" Clothes Peg, J. E. Cornford, Chatham.
85. Fog Signals, H. Hutchinson and J. W. Green, Manchester.
86. Reversible Fastener for Cuffs, J. F. Kendal, London.
87. Portable Cooking Apparatus, G. Fowler, Maidstone.
88. Tobacco Pipes, J. S. Hodgson, Manchester.
89. Medicated Tubes for Smokers, D. Rylands, Barnsley.
90. Pneumatic Mesh Vests, &c., A. H. Valda, Twickenham.
91. Shuttle Threader, J. Walsh, Patricroft, near Manchester.
92. Hub for Cycle Wheels, J. and J. Ellwood, Carlisle.
93. Method of Mounting Photographs, J. Joly, Dublin.
94. Regulating Electric Lamps, H. S. Jacques, Cheltenham.
95. Combined Bag, Pillow, Seat, &c., J. Fanstone, Brighton.
96. Non-refilling Valve for a Bottle, J. T. Ford, London.
97. Generation of Steam, L. W. Williams, Glasgow.
98. Rams, W. Evans and A. Hopwood, Wolverhampton.
99. Railway Coupling, H. Waltz, London.
100. Feed-water Superheater, A. D. Curling, Canterbury.
101. Waist belts, &c., A. M. Lermit, Birmingham.
102. Means for Preventing Incrustation, G. Bailey, Keighley.
103. Cyclist's Trouser Clips, &c., W. Pearce, Birmingham.
104. Sale or Hire Machine, E. A. Pallister and J. Hall, Leeds.
105. Oil Stoves, F. S. Rippingille, London.
106. Wood Screws for Fastenings, W. J. Critchlow, London.
107. The Health Grease Trap, E. Margrett, London.
108. Pneumatic Tires for Vehicles, R. J. Adcock, Dublin.
109. Apparatus for Adjusting Pictures, S. Barnett, Swansea.
110. Means for Producing Rain, D. Cook, London.
111. Adjustable Cellar-flap Roller, R. Worth, London.
112. Method of Fastening Envelopes, R. Hirsch, London.
113. Machine for Opening Skins, P. Young, London.
114. Guns, J. Robertson, London.
115. Gas or Motive Power Engines, C. E. Hearson, London.
116. Producing Pictures, O. Imray.—(*E. Nister, Germany.*)
117. Apparatus for Grain-drying, T. G. Frost, London.
118. Coring Machine for Fruit, T. R. Watson, London.
119. Cutter for Fruit, Vegetables, &c., T. R. Watson, London.
120. Nose Bags, A. W. Tooley, London.
121. Steel Horseshoes and Plates, W. J. Kent, London.
122. Bell Mechanism, E. D. Rockwell, London.
123. Furnaces for the Manufacture of Steel, J. Gjers, London.
124. Coffins made of Sheet Metal, H. Diekmann, London.
125. Driving Gear for Cycles, J. Wirnitzer, London.
126. Mechanical Reproduction of Oil, G. Mora, London.
127. Skirt Suspender, H. J. Haddan.—(*M. Rothenbucher and C. Winckler, Germany.*)
128. Extracting Metals from Solutions, H. F. Julian, Liverpool.
129. Playing Cards, J. M. Hawkins, Liverpool.
130. Electric Accumulators, R. J. Gulcher, Liverpool.
131. Bicycles of the Rover Type, F. Lorthiois-Six, London.
132. Growth of Plants and Destruction of Microbes, J. Fuchs, London.
133. Plungers in Connection with Pumps, J. Reisinger, London.
134. Medical Appliance, A. O. P. Gordon and E. Spencer-Mason, London.
135. Carbons of Electric Arc Lamps, V. Fabris, London.
136. Chaff-cutters, F. K. Woodroffe, London.
137. Holders or Clips for Wire, J. G. Flint, London.
138. Automatic Extinguishing Candlestick, B. L. Latham, London.
139. Vegetable Fibre, H. H. Lake.—(*T. Villamor, Mexico.*)
140. Feed-boxes, H. H. Lake.—(*National Feed Box Company, United States.*)
141. Pencils, J. Y. Johnson.—(*The Eagle Pencil Company, United States.*)
142. Joints and Packing for Steam Pipes, J. Lee, London.
143. Drilling Implement, J. Y. Johnson.—(*Pracisions Werkzeuge Fabrik Gunther and Co., Germany.*)
144. Ball-bearing Axles, G. H. Harrison, Birmingham.
145. Hand-spats, E. Metcalfe, London.

3rd January, 1896.

146. Paper and Letter and Hat Racks, G. G. Tucker, Ramsgate.
147. Loop Pile, G. Allen, Kidderminster.
148. Incandescent Mantles for Gas, W. G. Potter, London.
149. Receptacles for Conveying Food, W. F. Down, London.
150. Dippers for Photographic Plates, W. Tylar, Birmingham.
151. Lining for Boots and Shoes, &c., E. Booth, Halifax.
152. Latches and Rim Locks, G. Spencer, Staffordshire.
153. Yarn Delivery Motions for Mules, J. Lord, Manchester.
154. Stays for Casements, F. W. Cope and H. S. Owens, Birmingham.
155. Burning Lighting Gas, C. M. Stead and J. E. Brooke, Leeds.
156. Regulating the Supply of Gas, H. T. Proctor and R. E. Gill, Glasgow.
157. Hot-water Boot Drier or Tree, R. L. Bennet, Glasgow.
158. Shelling Liberian Coffee-fruit, T. F. Doijer, London.
159. School Seats and Desks, F. E. Morgan, Oldbury.
160. Vessels, R. Scott, Newcastle-on-Tyne.
161. Self-balancing Toe-clip, E. A. Patterson, Staffordshire.
162. Stencil Machine, D. Taylor, Chatham.
163. Stoneware House Drain Trap, J. W. Mearns, Sunderland.
164. Means for Construction of Yachts, J. W. Petavel, London.
165. Drying Machine, J. Brearley.—(*F. Brearley, Germany.*)
166. Connecting Tubes or Pipes, W. E. C. Pinchbeck, London.
167. Apparatus for Propelling Ships, J. B. Hirschman, Glasgow.
168. Locks, W. Fairweather.—(*G. R. Hillhouse, United States.*)
169. Child's Hoop, J. Clarke, London.
170. Corking Bottles, G. W. Browne and R. Bayley, London.
171. Driving Gear for Cycles, L. N. Dyhrberg, London.
172. Pneumatic Tires for Cycles, J. W. Smallman, Camp Hill Grange, near Nuneaton.
173. Shortening the Legs of Garments, T. A. Venimore and E. H. Hobling, London.
174. Filters, E. Lund, Manchester.
175. Means for Connecting Pipes, J. J. Mann, Manchester.
176. Apparatus for Grinding Cards, J. and F. Rothwell, Manchester.
177. Pottery, The Worcester Royal Porcelain Co., E. P. Evans and C. F. Binns, London.
178. Manufacture or Production of Toys, G. Hewett, London.
179. Spirit and Perfume Stands, W. Candland, London.
180. Turbines Driven by Steam, L. Bollman and S. Kohnberger, Vienna.
181. Obtaining Motive Power, H. Coombs, London.
182. Joint Fastenings for Railways, J. L. Hopwood, London.
183. Hansom Cabs, W. F. Pickles and A. Sugden, London.
184. Projectiles for Ordnance, D. M. Mefford, London.
185. Ointment or Healing Salve, C. M. Hornibrook, London.
186. Bridges of Violins, W. S. Simpson, London.
187. Packing for Pistons, J. Airey, London.
188. Apparatus for Fog Signal, E. R. Starmer, London.
189. Incandescent Gas Burners, P. C. Chaux, London.
190. Hasps, E. Lamprell, London.
191. Post Office Pillar Boxes, J. Kantorowich, London.
192. Cycling Habit for Ladies' Wear, P. Nilsson, London.
193. Purifiers for Middlings, H. Simon, London.
194. Socket Pipes, &c., E. W. and T. M. M. Johns, London.
195. Device for Raising Ships, J. D. Cooper, London.
196. Construction of Yachts, &c., F. J. Sweeting, London.
197. Suspenders for Attaching to Glass, H. Thacker, London.
198. Cigarette Machines, J. A. Bonsack, London.
199. Cigarette Machines, H. Bilgram, London.
200. Securing and Closing Apparatus, F. Gladwin, London.
201. Machinery for Working Stone, F. Trier, London.
202. Treatment of Metals, E. Placet, London.
203. Treatment of Iron and Steel, E. Placet, London.
204. Carriage Lamps, W. T. Webber, Birmingham.
205. Apparatus for Looping Wire Strings, A. O. Windsor, Birmingham.
206. Sinking Shafts, W. P. Thompson.—(*R. P. Rothwell, United States.*)
207. Arc Lamps, W. P. Thompson.—(*The Electric Arc Light Company, United States.*)
208. Covering of Ships' Bottoms, J. H. Neave, Manchester.
209. Boots and Shoes, R. H. D. Johnson, Liverpool.
210. Paper Pulp, H. H. Lake.—(*E. Berland and J. Girard, France.*)
211. Closing Cans, H. H. Lake.—(*D. Elmer, United States.*)
212. Appliances for Displaying Dresses, T. Griffiths, London.
213. Self Application of Rubbing, V. de C. Andrade, London.
214. Screw Propellers, G. Azzeroni, London.
215. New Washing Stand, A. J. Allen, London.
216. Ratchet Braces, D. Roberts, London.
217. Endorsing or Dating Stamp, E. M. Richford, London.
218. A Substitute Busk for Corsets, C. Halfhide, London.
219. Bottles, L. J. Nolan, London.
220. Anderson's Boot Fastener, J. R. Anderson, London.
221. Billiard Cues, S. P. Davis, London.
222. Propelling Devices, E. S. Wheeler, London.
223. Shells, &c., S. Lacavalerie and V. Benedetti, London.
224. Watch Makers' Instruments, H. W. Johnson, London.
225. Cheese Cutters, E. G. Bennett and S. A. Freeman, London.
226. Mucilage Bottles, D. T. Ellis, London.
227. Dish Washers, J. H. Starrett, London.
228. Mucilage Bottles, N. L. Stewart, London.
229. Kicking Strap, C. Wood, London.
230. Locomotive Boiler Furnaces, L. Hainzl, London.
231. Magazine Hand Camera, H. Pradeau, London.
232. Feed-water Filter, J. H. Palmer, South Shields.
233. Apparatus for the Treatment of Smoke, R. Moodie, London.
234. Cycles, R. A. Marples, Bromley.

4th January, 1896.

235. Preparation of Lentils, M. Lawes, Croydon.
236. Preparation of Peas, M. Lawes, Croydon.
237. Typewriting Machines, R. Harrington and T. G. Gatis, Wolverhampton.
238. Shuttle Sewing Machine, A. Greenwood, Preston, Lancs.
239. Extinction of Fire, J. H. R. Dinsmore, Liverpool.
240. Washing Wool, G. E. Wright and W. Monk, Manchester.
241. Brims of Felt Hats, H. Bruckshaw, Manchester.
242. Rubber Tired Wheels, G. W. Lomas, Manchester,
243. Cardboard Boxes, B. Romer and R. Porstmann, Manchester.
244. Tempering Furnaces, F. T. Franke, Manchester.
245. Syringes, H. Stone and H. G. Atkinson, Birmingham.
246. Attachments for Neckties, T. W. Meanley, Birmingham.
247. Water Sprinkling Appliance, A. J. Hember, Bristol.
248. Straightening Top Wire, J. Tovey, Birmingham.
249. Metallic Spring Bedsteads, H. Lewis, Birmingham.
250. Billiard Tables, M. Haley, Halifax.
251. Leer for Annealing Glass, D. Moore, Newcastle-on-Tyne.
252. Air Suction Valve, H. J. and W. A. Harris, Gloucester.
253. Form of Golfing Tee, W. Kirkwood, London.
254. Door Furniture, W. H. Aston, Worcester.
255. Cycle Frame, H. Leeming, Manchester.
256. Cycle Support, J. Clegg, London.
257. Tires for Cycles, H. D. Pearsall, London.
258. Frames for Cycles, H. D. Pearsall, London.
259. Panels for Furniture, The Greenock Cabinet Making Company, and V. Bremner, Glasgow.
260. Ferrules for Billiard Cues, H. Nutter, Keighley.
261. Weighing Machines, K. Scutte and W. Poppe, Glasgow.
262. Wringing and Mangling Machines, M. Stocks, London.
263. Steam Generators, R. H. Radford, Sheffield.
264. Boot Polishing Machines, R. L. Tapscott, Liverpool.
265. Reflector for Electric Lamps, H. N. Bickerton, Manchester.
266. Street Lamps, Sir A. J. Loftus and E. Rowlands, London.
267. Lamps for Attachment to Cycles, Sir A. J. Loftus, London.
268. Propelling Gear for Cycles, R. Belling, London.
269. Billiard Tables, F. Wigglesworth, Bradford.
270. Incandescent Electric Lighting, S. H. Heywood, Manchester.
271. Cream Separating Machine, F. G. Jones and H. Brecknell, Bristol.
272. Lamp Shades, E. Fletcher, Birmingham.
273. Securing Cakes of Soap, S. J. Wiseman and W. B. Hill, Southampton.
274. Poker, W. Place, Southport.
275. Cigar Holders, J. Edgar, Glasgow.
276. Fittings and Gearing for Cycles, D. Sinclair, Herts.
277. Bedsteads, H. J. Ney, London.
278. Machines for Making Cigarettes, E. R. Colgin, London.
279. Manufacture of Advertising Cards, W. A. Sleigh, London.
280. Typewriting Machines, P. R. J. Willis.—(*D. Briggs, United States.*)
281. Purse, P. R. J. Willis.—(*L. Cano and H. Guggenheimer, United States.*)
282. Lamps, R. H. Courtenay, London.
283. Apparatus for Nailing Clogs, &c., E. Lee, London.
284. Means for Shoeing Horses, A. Juillard, London.
285. Cycle Tracks, M. M. Dessau, London.
286. Pneumatic Tires, H. W. Bruning, London.
287. Manufacturing Tubes and Machinery, J. H. Ball, London.
288. Seltzogenes, H. J. Nicole, London.
289. Rendering Waste Leather Soluble, J. Hudson, London.
290. Locust Beans, W. Garner, W. B. Dell, and J. F. Stewart, London.
291. Practice with Heavy Ordnance, H. W. Blundell, London.
292. Connecting Link or Shackle, H. Rongier, London.
293. Socks, A. Gomess, London.
294. Cigar or Cigarette Case, L. H. Wahltuch, London.
295. Heating and Keeping Hot Bottles, S. G. Edmonds, Liverpool.
296. Spraying Medicated Liquids, T. Woodruff, Manchester.
297. Taps for Beer Barrels, W. H. Brooke, Birmingham.
298. Show Cards, Tickets, &c., W. and J. W. Devitt, Manchester.
299. Toy, C. Hamblin, London.
300. Mud Guards for Cycles, S. H. Burchell, London.
301. Registering Device for Billiards, S. Lloyd, London.
302. Controlling Apparatus, E. C. Haines and F. B. Mills, London.
303. Smelting Ores, C. C. Longridge and G. T. Holloway, London.
304. Billiard Cues, C. H. M. Lyte, London.
305. Driving Chains for Bicycles, F. Ellis, London.
306. Electrical Apparatus for Cooking, J. Chambers, London.
307. Range-finder, G. Legh, London.
308. Electric Switches, C. S. Newman, London.
309. Brakes, K. Storey, London.
310. Scaffolding, F. G. Knopfe and H. A. Roder, London.
311. Driving Gear, F. P. Gautier, London.
312. Game, O. Sterkel, London.
313. Petroleum Motors, F. P. Gautier, London.

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314. Writing-desks, W. T. J. Parkes, London.
315. Soft Soldering Aluminium, W. H. Bennett, London.
316. Securing Card Clothing on the Flats of Carding Engines, G. P. Appleyard, Halifax.
317. Apparatus Applicable to Coke Ovens, G. Love, Durham.
318. Cylinder for Kilning Malt, W. Adlam and A. Wilson, Bristol.
319. Handles for Cycles, &c., S. Muir, Birmingham.
320. Plug for Closing Shot Holes, E. T. Whitelow, Manchester.
321. Bodkin, J. T. Williams, Swansea.
322. Purifying Acetylene Gas, J. C. Bayley, Bournemouth.
323. Portable Work Benches, E. Arnold, Bournemouth.
324. Window Fasteners, T. Franke, Manchester.
325. Tobacco Pipes, J. Jackson and A. White, Coventry.
326. Measuring Instrument for Tailors, D. Ritchie, Glasgow.
327. Attachment for Sewing-machines, W. H. Inslee, Glasgow.
328. Self-adjusting Horseshoe Rougher, E. W. Walker, Rugby.
329. Combination Hospital Locker, R. Cross, Blackburn.
330. Construction of Stretching Machines S Walker, Radcliffe.
331. Ships, I. Spy, Liverpool.
332. Car Coupling, J. Wagner and F. Jordan, Germany.
333. Clarifying Vegetable Juices, E. and C. Muller, Berlin.
334. Removal of Keyboard of Pianos, R. Mitchell-Bent, London.
335. Manufacture of Caustic Soda, H. R. Angel, London.
336. Toy Puzzle, W. J. Case, London.
337. Boilers for Hot-water Supply, R. P. Fisher, Sheffield.
338. Stoppers, J. Creasy, London.
339. Attachment to Perambulators, R. B. Fuller, London.
340. Cloths, G. Smith, London.
341. Engraving Machines, A. A, and L. Crossland and Co., Manchester.
342. Portable Electric Light, J. R. Welland, London.
343. Wheel Skates for Road Travelling, P. E. Masey, London.
344. Cigarette-paper Case, W. Bowden.—(*W. Bowden, Jamaica.*)
345. Inkstands and Inkwells, C. A. Maynard, London.
346. Boots, F. M. Boschet, London,
347. Switch for Electrical Purposes, C. B. Wood, London.
348. Holder for Use in Sharpening Tools, E. E. Harington, London.
349. Receptacle for Use of Sick Persons, H. J. Hyde, London.
350. Brakes for Cycles, &c., J. McVitty, London.
351. Building Construction, D. Johnston, London.
352. Photographic Printing, E. D. Percival, London.
353. Preventing Pipes Bursting, J. G. Jones, London.
354. Shower-bath Apparatus, &c., C. Carazetti, London.
355. Electric Regulator for Arc Lamps, A. L. Davis, London.
356. Drying of Goods, G. Seagrave and S. B. Bevington, London.
357. Dress Figures for Garments, O. Selleck, London.
358. Rotary Planing Machines, W. W. Hulse, London.
359. Phantoscopes, T. Armat, London.
360. Mechanism for Transmitting Motion, J. Paquet, London.
361. Separating Compounds from Gas, H. Bower, London.
362. Sheet Metal Pulleys, O. W. Ketchum, London.
363. Time Checking Apparatus, A. J. Boult.—(*V Chiron, France.*)
364. Hinges, C. Adamy and R. Tausk, London.
365. Guiding Devices for Lamps, A. J. Boult.—(*G. Wouters, Belgium.*)
366. Electrical Attachment to Valves, J. C. Berry, London.
367. Baby Carriages and like Vehicles, H. Noelte, London.
368. Organ Pipes, G. W. Scribner, and W. and J. A. McIntosh, London.
369. Cycles, A. Bugnon, London.
370. Cycles, H. C. Field and A W. Storey, London.
371. Photographic Developers, A. M. Clark.—(*Lembach and Schleicher, Germany.*)
372. Dyeing, A. M. Clark.—(*C. H. Boehringer Sohn, Germany.*)
373. Apparatus for Ventilating, &c., J. Cinnamon London.

374. Screw Socket Box Fixing Axle, W. S. Roberts, London.
375. Carts, R., J., and H. Wildor, London.
376. Bonnet Pins, Hair Pins, &c., H. F. L. Aumont, London.
377. Star Maps, G. Castleden, London.
378. Rulers, C. F. England, London.
379. Chain Driven Cycles, J. B. Paton, London.
380. Furnace Grates for Marine Boilers, C. Ware, London.
381. Harvesting Machines, J. Macphail, Chicago. U.S.A.
382. Manufacture of Cycles, &c., W. F. Taylor, Croydon.
383. Cycles, H. R. Yeo, Plymouth.

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384. Reducing Condensed Steam, &c., F. Levett, London.
385. Cure of Smoky Chimneys, E. H. R. D'Eye, Woodbridge.
386. Tennis Racquets, Racquet Bats, &c., H. C. Crawford, London.
387. Water-closets, T. Holt, jun., and S. Holt, Liverpool.
388. Semi-rotary Pump, W. Wheeler, Langley Green.
389. Gas Cooking Stoves, H. J. Yates, Birmingham.
390. Electrical Switches, J. T. Leroux, Birmingham.
391. Adjustable Wheels, W. T. Faizey, Astley Abbots.
392. Driving Bands, F. Smith and J. Ratcliffe, Keighley.
393. Axles, S. G. Whitehouse, London.
394. Oil Lamps, J. Simpson and J. MacGregor, Newcastle-on-Tyne.
395. Manufacture of Acetylene Gas, A. Garton, Huddersfield.
396. Armour for Warships, Forts, &c., T. Andrews, Manchester.
397. Construction of Razor Strops, W. Harrison, Sheffield.
398. Inhalers, T. B. and H. Wilcox, Manchester.
399. Glass Oil Vessels, J. Grime and P. Isherwood, Darwen.
400. Steam Generators, J. J. Tinker, Manchester.
401. Semi-metallic Packing, J. Kirkman, Chorley, Lancs.
402. Cycle Tires, J. Jack, Glasgow.
403. A Safety Clothes Pocket, J. Symington, Glasgow.
404. Type Writer, R. J. W. Down, Bristol.
405. Sluice Valves, J. Barr, Glasgow.
406. Wheel for Carriages, W. Campbell, Newcastle-on-Tyne.
407. Fixing and Adjusting Scythes, H. Newton, near Frome.
408. Stang Planimeter, E. Scott, Wolverhampton.
409. Device for Attaching Labels, &c., A. Barr, Glasgow.
410. Grippers for Printing Presses, J. Watson, Glasgow.
411. Tires for Road Vehicle Wheels, J. Pinch, London.
412. Sewing Machines, W. H. Inslee.—(*The Singer Manufacturing Company, United States.*)
413. Tables, W. H. Inslee.—(*The Singer Manufacturing Company, United States.*)
414. Screw Stocks and Dies, S. Saunders, Manchester.
415. Portable Balances, F. P. Bolshaw, Liverpool.
416. Cigar Cases, G. Nathan and R. Hayes, Birmingham.
417. Underclothing, W. H. Cunningham and W. M. Middlemass, Edinburgh.
418. Fish Plates for Railways, J. Quertier, Bournemouth.
419. Clips for Cuff Holders, C. F. Mackness, Forfarshire.
420. Dental Hand Pieces, J. T. Pedersen, London.
421. Apparatus for Sharpening Band Knives, W. Beecroft, London.
422. Lasting Boots and Shoes, A. E. Stickler, London.
423. Apparatus for Driving Tacks, A. E. Strickler, London.
424. Cooling and Heating Air, G. E. Sherwin, Birmingham.
425. Smoke Cleansing Apparatus, J. Nemecek and F. W. Keitsch, London.
426. Type Writer, G. Royle, London.
427. Cycles, J. G. Hudson, London
428. Breech-loading Fire-arms, J. W. A. Rule, London.
429. Method of Constructing Metal Boxes, H. Piquet, London.
430. Window Sash Locks, P. S. Riddelle, London.
431. Revolvinq Window Sashes, P. S. Riddelle, London.
432. Pistols for Shooting Marbles, W. E. Everitt, London.
433. Locks, R. Muller and A. Muller, London.
434. Phase Completing Device, T. McKenna.—(*Electric Selector and Signal Company, United States.*)
435. Timing Horses, H. A. Lugrin and M. D. Fielding, London.
436. Sealing Jars, H. Birkbeck.—(*J. Boyle, United States.*)
437. Stopping Runaway Horses, W. Crawford, London.
438. A Safety Valve for Boilers, T. Potterton, London.
439. Shirts, F. W. Hamlin, London.
440. Construction of Bedsteads, A. Wainwright, London.
441. Reels of Cotton, C. Syrett and J. W. Rowe, London.
442. Umbrellas, L. Grouard and O. Levilly, London.
443. Polishing Material, O. Imray.—(*M. M. Kann, United States.*)
444. Boots and Shoes, K. F. Jekeli, London.
445. Pneumatic Knife-cleaning Machine, F. Bramley, London.
446. Controlling Gas Supply, H. L. Leslie, Birmingham.
447. Trawling, W. Jackson, London.
448. Air Pumps, C. E. Hearson, London.
449. Compass for Heavy Rain Signal, A. M. Gallett, London.
450. Photography, G. J. Bull and B. F. C. Costelloe, London.
451. Wood-cutting Machines, H. H. Lake.—(*W. F. Hutchinson and E. Gould, United States.*)
452. Electric Motors, H. H. Lake.—(*B. A. Fiske, United States.*)
453. Bush Hammers, G. Main, London.
454. Receipt Blanks, H. H. Lake.—(*D. P. Fackler, United States.*)
455. Spinning Machines, J. A. Miller, London.
456. Musical Instruments, H. H. Lake.—(*The Aeolian Company, United States.*)
457. Harvesting Machines, J. F. Appleby, London.
458. Tables for Bookbinding Machines, H. H. Lake. —(*A. G. Mackay, United States.*)
459. Light Ports for Marine Vessels, W. K. Mackenzie and C. Chamberlain, London.
460. Elastic Tires for Velocipedes, N. Wahl, London.
461. Toys, W. A. Hunter, Liverpool.
462. Dramatic Appliances or Clothing, W. G. Hurst, Liverpool.
463. Extensible or Leaf Tables, W. Edwards, Liverpool.
464. Wrapper Case for Music, E. E. Smith, Liverpool.
465. Machine for Sweeping Streets, D. E. Hipwell, London.
466. Perforators, H. P. Lavender, London.
467. Ships and other Vessels, W. L. Phillips and A. Gluck, London.
468. Drop Keels for Sailing Vessels, C. G. Dixon-Johnson, London.
69. Separating Substances of Different Sizes, J. U. Askham, London.
470. Fire-grates, J. D. Hannah, London.
471. Coin-freed Apparatus, E. Hollanders, C. J. Leather, and T. Taylor, London.
472. Manufacture of Transfer Sheets, G. Grossheim, London.
473. Friction Clutch for Vehicles, W. C. Bersey, London.
474. Turning Plate for Vehicles, W. C. Bersey, London.
475. Electric Accumulators, W. C. Bersey, London.
476. Combination Tools, O. E. Morse and E. H. Brundage, London.
477. Electrical Storage Accumulators, C. N. Stewart, London.
478. Rotary Engines, O. E. Morse, London.
479. Burner or Wick Cap for Liquid Fuel, C. Bourbott, London.
480. Street-car Brakes, R. Haddan.—(*L. S. Fish, United States.*)
481. Diving Bell for Great Depths, J. P. Rossander, London.
482. Bottling Liquids, F. M. Lyte and C. H. M. Lyte, London.
483. Socket for Wire Rope Ends, W. H. Becker, London.
484. Rein Grips, E. Wright, London.
485. Fastening Doors, Windows, &c., G. Inman, London.
486. Washing Machines, H. J. Heinze, London.
487. Cycle Wheels E. J. Spence, London.

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488. Ventilating Workshops, &c., F. Pilkington, London.
489. Sinker for Use in Fishing, S. Allcock, Redditch.
490. Protectors for Horseshoes, R. Abell, Derby.
491. Candlesticks, H. H. Kirby and W. B. Ward, Birmingham.
492. Finishing Woollen Fabrics, J. and G. A. Baxter, and W. H. Hare, Bradford.
493. Cycle Driving Gear, R. Stark, Glasgow.
494. A Mechanical Cue, T. W. Vipond, Newcastle-on-Tyne.
495. Self-registering Lineal Measure, B. Vallance, London.
496. Pneumatic Tire Valves, G. C. Mesuard and G. G. Scurfield, Sunderland.
497. Cuff Suspender, J. M. L. Whitfield, near Huddersfield.
498. Grain Cleaning Machines, W. W. Willis, Ipswich.
499. Cuff and Shirt Ironing Machines, W. E. Baker, Aldershot.
500. Apparatus for Making Cheese, J. Helder, London.
501. Baby Chairs, W. S. McLennan, Glasgow.
502. Cycles of the Chain Driven Type, J. Cuncliffe, Manchester.
503. A Puzzle, A. W. and W. A. Turner, Birmingham.
504. Moving Grain, E. Banks and R. J. Miller, Liverpool.
505. Apparatus for Holding Coins, H. H. Hanmer, Liverpool.
506. Steering Cycles, A. Hamilton, London.
507. Screens for Photography, J. B. Findlay, London.
508. Reducing Collision, J. Thomas, Newcastle-on-Tyne.
509. Manufacture of Chimney Pots, S. S. Hazeland, Penzance.
510. Rudder Straps and Rods, L. J. Franklin, Isle of Wight.
511. A Horse Ball Instrument, T. Shell, Northumberland.
512. Driving Gear for Cycles, C. B. Lawson, Glasgow.
513. Attaching Wagons in Rope Haulage, R. B. Dick, Glasgow.
514. Apparatus for Drying Tea Leaves, J. A. Main, Glasgow.
515. Paper Files, R. Waldschmidt, London.
516. Using Lenses, G. J. Bull and B. F. C. Costelloe, London.
517. Pokerettes, T. R. Voce and B. Drysdale, Birmingham.
518. Washing Machines, J. W. Boot, London.
519. Fluid Meters, E. Hollanders, C. J. Leather, and T. Taylor, London.
520. Top Notches of Umbrellas, F. W. Chambers, London.
521. Cutting-out Garments, O. Stiassny and L. Lobl, London.
522. Bicycles and Tricycles, E. Eite and A. Todd, London.
523. Capstans, Davis and Co., Ld., and W. R. G. Hay, London.
524. Car Couplings, W. Silver, London.
525. Maid Servants' Caps, &c., A. T. Umfreville, London.
526. Gas Lamp Columns, J. H. Stevens and J. Tourtel, London.
527. Consuming Smoke, W. Smith and T. Lockwood, London.
528. Game, H. Fletcher, London.
529. Preparation of Artificial Musk, C. J. Caspers, London.
530. Seamless Metallic Tubes, W. Pilkington, C. T. Bishop, A. Brownsword, and A. Pilkington, Birmingham.
531. Tires for Carriage, &c., Wheels, C. Schwanitz, London.
532. Tires for Carriage, &c., Wheels, C. Schwanitz, London.
533. Telegraph Apparatus, Siemens Brothers and Co.—(*Siemens and Halske, Germany.*)
534. Shuttle Action for Looms, T. A. B. Carver, London.
535. Primary and Secondary Batteries, H. W. Headland, London.
536. Embroidery Frame, W. P. Thompson.—(*H. Rötter, Germany.*)
537. Cycle, &c., Wheels, E. C. Martin and A. Turrall, Liverpool.
538. Couches and Sofas, G. M. Weatherly, London.
539. Beer Engines, G. Watson and A. J. Foley, London.
540. Apparatus for Sewing Machines, F. Wilkinson, London.
541. Hydrocarbon Burners, L. E. Fraipont, London.
542. Treating Yarn, A. Monforts and A. Buckmann, London.
543. Alternating Current Apparatus, G. Hummel, London.
544. Tires, A. Steiner, London.
545. Speed Indicator for Locomotives, A. L. Pouget, London.
546. Electric Incandescent Lamps, &c., R. J. Bott, London.
547. Devices for Joining Cables, &c., H. Edmunds, London.
548. Lamps for Burning Liquid Hydrocarbons, The Lee Lamp (Parent) Company and J. C. C. Read, London.
549. Treating Gold or Silver Ores, W. Blackmore, Sheffield.
550. Quadrant Levels for Heavy Guns, A. Schriever, London.
551. Dynamo-electric Machines, L. B. Atkinson, London.
552. Water-bars for Casements, W. Youlten, London.
553. Casements, W. Youlten, London.
554. Attachment for Glasses, M. Foran, London.
555. Fire-places, E. P. How and G. H. Martyn, London.
556. Lamp Bracket, C. H. Ritchie, London.
557. Electric Batteries, R. Collins and F. Cogan, London.
558. Incandescent Mantles for Gas Lamps, J. H. H. Duncan, London.
559. Pillarless or Cantilever Cranes, J. R. Beaver, London.
560. Oil Engines, H. C. Bergemann, London.
561. Apparatus for Winding Cops, J. R. Leeson, London.
562. Gear Cases for Cycles, J. R. Trigwell and The Aluminium Cycle Fittings Company, Limited, London.
563. Tires, W. H. Jones, London.
564. Cocks and Valves, E. Z. y Guilirarti, London.
565. Transforming Continuous Electric Currents, H. H. Lake.—(*Cie de l'Industrie Electrique, Switzerland.*)
566. Applying Side Pressure to Ball Bearings, W. R. Smith, London.
567. Sight Testing Appliances, A. F. Schoerle, London.

9th January, 1896.

568. Game called "Salisbury Bat-catch," J. Samuel, Epsom.
569. Apparatus for Copying Tracings, B. J. Hall, London.
570. Composite Sash Weight, M. H., J. H., and W. F. Golightly, Hartlepool.
571. Bearings, J. Dewrance, London.
572. Prepayment Gas Meter Mechanism, D. B. Peebles, Glasgow.
573. Trapping and Killing Rabbits, J. H. Richards, Barnstaple.
574. Straining Pulp, D. N. Bertram and J. Blaine, Glasgow.
575. Air Rubber (Rupture) Truss, W. Graham, Enfield.
576. Locomotive, G. Bagnall and E. E. Baguley, Stafford.
577. Anti-ballooning Devices, J. Vaughan, Manchester.
578. Oil Engine, M. H. Hurrell and H. Jasper, Gillingham.
579. Manufacturing Chlorine Gas, J. B. Hilliard, Glasgow.
580. Seats, H. H. Farrell, Liverpool.
581. Latches, M. Sibbring, Liverpool.
582. Packing Blocks, H. F. Massey, Manchester.
583. Metallic Flasks, W. B. Challen and Taylor and Challen, Ld., London.
584. Tilting Saddle Bar for Velocipedes, C. Wooster, Glasgow.
585. Foot Cycle or Road Skate, R. and G. Anderson, Glasgow.
586. Rack for Golf Clubs, C. King, Glasgow.
587. Feed Bags, J. C. Meyers, Dublin.
588. Locking Apparatus for Gas Jets, T. A. Skelton, Southampton.
589. Finishing Woollen or Worsted Fabrics, W. H. Hare, Bradford.
590. Nuts, J. Whitehead W. Drysdale and M. Stoddart, Glasgow.
591. Tilting Barrels, G. Birkbeck and W. W. L. Lewis, Birmingham.
592. Safety Letter Delivery Apparatus, A. Powles, London.
593. Piano Stools, D. Anderson, Glasgow.
594. Fixing Ladies' Dress Guards, L. Lenton, Coventry.
595. Preparing Railway Guides, H. V. Vernon, London.

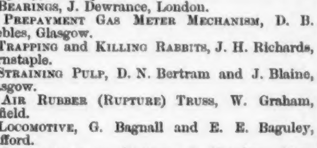
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

547,523. Cycle Wheel Adjustment, *A. Perkins, Chicopee, Mass.—Filed December 22nd*, 1893.

Claim.—The combination with the plates having the rearwardly open axle-receiving slots and the racks at their lower sides, of the threaded transverse axle, a stop upon said axle, the plate, upon the opposite side of the axle-receiving plate, bearing the worm gears engaging the racks respectively, and nuts upon the outer ends of the axle clamping the plates between the nuts and said stops.

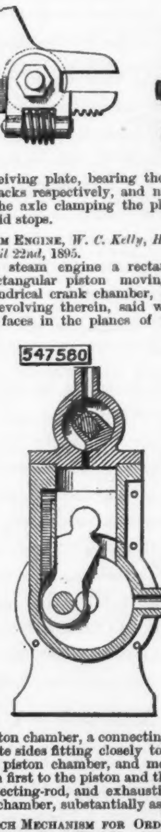
547523



547,580. Steam Engine, *W. C. Kelly, Hastings, Mich. —Filed April 22nd*, 1895.

Claim.—In a steam engine a rectangular piston chamber, a rectangular piston moving therein, a transverse cylindrical crank chamber, a crank and crank wheels revolving therein, said wheels having their opposing faces in the planes of the opposing walls of said piston chamber, a connecting-rod, having flattened opposite sides fitting closely to said wheels and walls of the piston chamber, and mechanism for admitting steam first to the piston and thence to one side of the connecting-rod, and exhausting the same from the crank chamber, substantially as described.

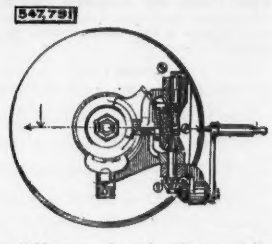
547580



547,791. Breech Mechanism for Ordnance, *O. F. Leibert, Bethlehem, Pa.—Filed May 19th*, 1894.

Claim.—(1) In a breech mechanism for guns, a breech block provided with a recess in its side, and a rack arranged in one side of said recess, in combination with a pinion entering the recess in the block and engaging the rack therein, substantially as described. (2) In a breech mechanism for guns, the combination with a breech block provided with a segmental rack and with a recess in its side having the rack arranged in one side of said recess, of a segmental gear engaging the segmental rack, and a pinion entering the recess and engaging the rack therein, substantially as described. (3) The combination with a breech-piece provided with a segmental rack and with a longitudinal rack, of a shaft having rigidly secured thereto a segmental gear and a pinion respectively engaging the segmental and longitudinal racks of the breech-piece, one of the teeth of the respective segmental gears being cut away, one of the teeth of the pinion being elongated, and the longitudinal rack being provided with a deep recess whereby the said gear and pinion may engage and disengage the said segmental and longitudinal racks at the beginning and end of their movements, and at the same time operate with freedom and be made strong, substantially as described. (4) The combination with a breech block having suitable gears, of a yoke piece supporting the tray to receive the block, a shaft carrying gears engaging the gears of the breech block mounted in the yoke and moving therewith, and operating mechanism for said gears, the arrangement being such that the block is rotated in and withdrawn from the breech on to the tray and swings with the yoke and tray while the operating mechanism is continuously moved in one direction, substantially as described.

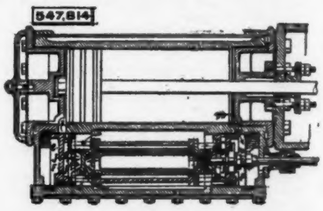
547,791



547,814. Valve for Steam Engines, *E. F. Spaulding, Bound Brook, N.J.—Filed August 17th*, 1894.

Claim.—(1) In a steam engine, the reciprocating valve, combined with the cylindrical cut-off valve carried thereby and having a movement independent thereof and reciprocating valve rod I connecting said reciprocating and cut-off valves, and adapted to turn axially and operate the latter, substantially as and for the purposes set forth. (2) In a steam engine, the reciprocating valve having the spaces *e* and longitudinal ports *h*, combined with the cylindrical cut-off valve seated within said reciprocating valve and having the longitudinal ports *j* and the reciprocating valve rod I connecting said reciprocating and cut-off valves, and adapted to turn axially and operate the latter, substantially as set forth. (3) In a steam engine, the reciprocating valve having the heads F, F, and cylindrical intermediate section, said heads having the spaces *e* and inner cylindrical portions provided with longitudinal ports, combined with the inner cylindrical cut-off valve having closed heads and beyond these the longitudinal ports, and the reciprocating valve rod I, connecting said valves and adapted to turn with the inner valve, substantially as set forth. (4) In a steam engine, the reciprocating valve having the longitudinal ports *h* and spaces *e*, combined with the inner cylindrical cut-off valve having the closed heads *i* and beyond these the longitudinal ports *j* and radial flanges H, substantially as and for the purposes set forth.

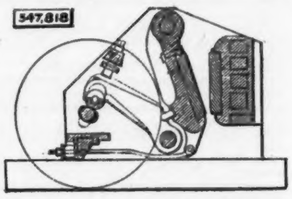
547,814



547,818. Rock-crushing Machine, *G. W. Taft, Kennett-square, Pa.—Filed April 15th*, 1895.

Claim.—(1) In a rock-crushing machine of the character described, the combination, substantially as described, with the movable or swinging jaw, and a vibrating jaw-actuating lever pivoted near said jaw, and connected therewith by a suitable bearing joint or toggle, the cam shaft, and cam engaging a roller at the free end of said jaw-actuating lever, of a non-movable support near the back of said lever, and a bump spring between said jaw-actuating lever and support disposed in disconnected relation to the surface against which it impinges, and adapted for contact, and action in opposition to the throw of the cam, by the lever movement, when at the outer limit of its vibration, for the purposes set forth. (2) In a rock-crushing machine the bump spring composed of india-rubber or elastic gum, the spring carrier having a flanged ring embracing said gum spring, and a supporting column threaded into the frame transom disposed at the back of the jaw-actuating lever, in combination with the jaw-actuating lever, the lever-operating cam, the movable crusher jaw, and means for retracting the crusher jaw, substantially as set forth.

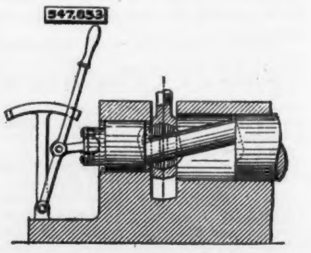
547,818



547,853. Adjustable Stroke Crank, *J. P. Johansson, Enkjöping, Sweden.—Filed June 21st*, 1895.

Claim.—(1) An improved means for varying the length of stroke of reciprocating parts of machinery, consisting of the combination of the following devices, namely, a shaft-box, a driving shaft free to be shifted lengthwise, a crank-pin at one end of such shaft and placed at an incline relatively to the axis of the shaft, a ball gudgeon in which this pin can be shifted longitudinally, a connecting-rod for the reciprocating part of a machine and having an end socket in which the ball gudgeon fits, said shaft-box having a guide recess to prevent shifting of this connecting-rod in the direction of the axis of the shaft, the combination being and operating substantially as and for the purposes set forth. (2) In combination, the shaft *a*, its shaft-box in which it may be shifted endwise and having a recess *e*, oblique pin *b*, gudgeon *c*, rod *d*, and pin *g*, all substantially as and for the purposes set forth.

547,853



THE WORLD'S PRINCIPAL WAR FLEETS.

THE excitement occasioned by the warlike message recently sent to Congress by President Cleveland in relation to the boundary question between Venezuela and ourselves, followed so closely as it was by a suggestion of German interference with our South African affairs, has necessarily directed the public mind to a consideration of our fitness to enter upon a war with any other great Power; and, as the chief source of Britain's strength must always be looked for upon the seas, attention has been chiefly centred upon the relative strengths of the world's principal war fleets.

In this connection it has been thought that the occasion is appropriate for a consideration, not only of what the war fleets of 1896 consist, but also of the development of vessels of war from the earliest time to the present day.

Unfortunately, very little is known regarding the war shipping of the early nations of the world. The first naval engagements of which history affords any detailed or trustworthy records were those between the Romans and Carthaginians, which resulted in the destruction of the Phœnician Colony on the African coast of the Mediterranean. Their war vessels were galleys propelled by one or more banks of rowers, the largest, or "quinquiremes," having five banks of oars on each side. In addition to the rowers, each galley carried a large number of soldiers, who fought their enemies in the opposing fleet with arrows, spears, and darts. The bows of some of the galleys were provided with beaks or rams, and in such cases they frequently attacked the ships of their opponents by ramming—a form of naval tactics which has been revived in modern days. Sailing ships were employed in the naval wars between the Romans and Venetians, but galleys were to be found in the European navies so recently as the seventeenth century. The Mediterranean Sea was the birth-place of naval enterprise, and continued to be the chief scene of naval exploit for more than a thousand years after the Christian era.

The Scandinavian nations were, however, from an early period noted for their maritime prowess; but their activity on the seas was in most cases of a predatory character. The British Isles were the scene of their ravages during the ninth century, and it was with a view to repel their frequent attacks on our shores that King Alfred collected the first English fleet. To check the same marauding foe William I. established the Cinque Ports, granting them certain privileges upon the condition that they furnished fifty-two ships, each with twenty-four men, for a period of fifteen days' service in the event of an attack from these northern raiders. From that time until the seventeenth century the sovereigns of England continued to make levies of ships and men from the mercantile marine to assist in the defence of the kingdom, and a similar practice prevailed in other European countries. A fleet of Edward the Confessor in 1049 is said to have consisted partly of "King's ships" and partly of "people's ships." It is recorded of Edward III. that he blockaded Calais with 730 sail, having on board 14,956 mariners, of which fleet only 25 ships, with 419 mariners, belonged to the Royal Navy. Under Henry IV. and Henry V., the strength of the national fleet was much increased, and the latter monarch is reported to have embarked an army of 25,000 men at Dover on board 1500 sail of ships.

In the early English fleets there were numerous classes of ships, the largest of which, known as "cogs," were of only 250 tons, but each carried 130 seamen, besides archers and soldiers. Of the other classes there were "barges," "balingers," "caraks," "crayers," "doggers," "fluves," "galleys," "galliots," "pinnaces," &c. In the reign of Henry VIII. great improvements were made in the construction of warships, and the Great Harry, built in this reign, is the first recorded ship of war which deserved that name. Her cost was £14,000, which at that period represented a very large sum of money. England's Royal Navy first assumed considerable proportions under the same monarch, and in the thirteenth year of his reign it contained the following ships, besides eleven others of lesser size:—Henri Grace à Dieu, of 1500 tons; Gabriel Royal, of 650 tons; Mary Rose, of 600 tons; Sovereign, of 800 tons; and Great Galley, of 800 tons. The total tonnage of the Royal Navy at that time was 72,600 tons.

The recorded details of the Henri Grace à Dieu are of interest at this time. She was built at Erith in 1512, carried 14 guns on the lower deck, 12 on main deck, 18 on quarter deck and poop, 18 on a lofty forecastle, and 10 in stern ports; or 72 in all. Her complement was 349 soldiers, 301 seamen, and 50 gunners; or 700 men in all. War vessels of this period, as represented in contemporary paintings, were of cumbrous and towering proportions. Their lofty forecastles, poops, and quarter decks must have seriously impeded both speed and manœuvring under sail, and their general appearance was not unlike that of the modern Chinese war junk. The Royal Dockyards at Deptford, Woolwich, and Portsmouth date from this time, and Henry VIII. also founded the Trinity House. At the death of that king the Royal Navy of England consisted of 50 ships and vessels, the largest being of 1000 tons.

The first claim to our naval supremacy was made in the reign of Mary, whose Lord High Admiral insisted upon the fleet of Philip of Spain, consisting of 150 sail, striking their colours and lowering their topsails to the English flag before he would permit his squadron to salute the Spaniards. The defeat of the Spanish Armada in the following reign contributed materially to enhance our naval prestige, and to develope the ardour and enterprise of our seamen. The Spanish Navy was superior to our own in numbers, and in the size of its ships; but their top hamper interfered with their management, and so they became an easy prey to the smaller ships of the English fleet, which cut off individual vessels in the Armada, and destroyed or captured them singly. Moreover, the same defects in their construction will account for so many of the Spanish ships being wrecked through the storms which they encountered in sailing round the British Islands. Such defects were, however, characteristic of the war shipping of the time, and it was not until the reign of James I. that these towering outworks were reduced in the vessels of our own Navy. It is to Phineas Pett, a naval constructor of that time, we owe the first essential improvement in the form and construction of our war shipping. In 1610 Pett laid down the Prince Royal, of 1400 tons, which was 114ft. in length of keel and carried sixty-four guns, "being in all respects," says Stowe, "the greatest and goodliest ship that was ever built in England." Pepys says that in 1618 there were thirty-nine ships in the Royal Navy of 14,700 tons, and six years later the Navy consisted of 33 ships of 19,400 tons, showing that the average tonnage of war shipping was increasing. Charles I. added upwards of 20 ships to the Royal Navy, and Pett built for him the Sovereign of the Seas, of 1637 tons, at Woolwich in the year 1637. Her length of keel was 128ft.; length over all, 232ft.; and breadth of beam, 48ft. She had three decks, forecastle, half deck, quarter deck, and round house; from which data and her great length over all it will appear that the projecting head and lofty poop had not wholly disappeared in warships. Upon comparing an existing painting of this ship with a drawing of the Henri Grace a Dieu in the Pepysian collection, the great improvement in naval design which had been effected during a century is clearly apparent. The Sovereign of the Seas carried 98 guns on her broadsides, besides 20 bow and stern chasers, and smaller ordnance for sweeping her decks of boarders.

During the Commonwealth England was for five years at war with Holland, which at that time was the greatest European Naval Power. Our fleet was increased to 150 ships, many of which were captured from the Dutch, and the Royal Navy then contained 20,000 seamen, so that our naval strength was greater then than it had ever been before. The type of warship known as a "frigate" was added to the fleet by Cromwell; the first, named the Constant Warwick, built by Peter Pett—a son of Phineas —in 1640, being copied from a French frigate which visited the Thames. The French supplied us with models for our ships during more than a century after that time. Indeed, the courage and skill of our seamen contributed much more towards establishing our naval supremacy than the scientific ability of our shipbuilders.

In the early part of the reign of Charles II. the Navy continued to increase, and in 1679 it contained 76 ships of the line in good condition, and at one time there were 30 new ships building. Sir Anthony Deane was placed at the head of our naval construction in 1686, but that eminent naval architect thought it desirable to imitate the best French models, such as the well-known Superbe, of 74 guns. In 1688, when William of Orange landed in this country, the Navy consisted of 173 sail, amounting to 101,892 tons, carrying 6930 guns, and with a complement of 42,000 seamen. William founded the civil government of the Navy, and so augmented our naval strength that at his death it consisted of 272 ships of 159,020 tons. At that time we had 130 ships of the line, and this force was maintained until the middle of the eighteenth century.

At the death of Queen Anne the Royal Navy consisted of 247 ships of 167,219 tons, showing that the average size of our warships continued to increase. George I. left the Navy nearly as he found it, viz., 233 ships of 170,862 tons. In 1739, when George II. was at war with Spain, it was ordered that ships of the line should be enlarged in size, and on the restoration of peace in 1748 it was found that 35 of the enemy's ships of the line had been captured, with a very trifling loss to ourselves. At the king's death in 1760, the Navy consisted of 412 ships of 321,104 tons. Upon the conclusion of the American war in 1783, the naval force of the country amounted to 617 sail, measuring 500,000 tons, and at the peace of Amiens the Navy consisted of 700 ships, of which 144 were of the line. The number taken from the enemy amounted to 600, of which 90 were of the line and upwards of 200 were frigates. Our loss during the war was 60, of which 6 were of the line and 12 were frigates.

From 1808 to 1813 there were seldom less than 100 to 106 sail of the line in commission, 130 to 160 frigates, and numerous smaller vessels; our total naval strength being about 800,000 tons.

A printed return, dated January 1st, 1821, shows that the Navy then consisted of 609 sail of the line and vessels, as under:—

	Number.
First rate, from 120 to 100 guns	23
Second rate, from 86 to 80 guns	16
Third rate, from 78 to 74 guns	90
Fourth rate, from 60 to 50 guns	20
Fifth rate, from 48 to 22 guns	107
Sixth rate, from 34 to 24 guns	40
Sloops, from 12 to 10 guns	136
	432

to which were added 177 vessels, consisting of gun brigs, cutters, sloops, tenders, &c.

In 1836 the total number of our ships of war was 560, of which 95 were ships of the line in good sea-going condition. In 1846 it had reached 671 ships, and in 1857, 735 ships.

Of the war fleet of the United Kingdom in 1859, 110 were ships of the line ranging from 131 guns to 84 guns, and 124 were frigates of from 50 to 36 guns. Sixty-four of the line-of-battle ships and 98 of the frigates were propelled by steam power. Fifty-seven of the line-of-battle ships and 31 of the frigates were in commission. In addition to the foregoing, there were 64 paddle frigates and sloops of from 22 to 3 guns each, and of these 46 were in commission. Many of the ships which were on the Navy List in 1857 had by this time been struck off in consequence of their age and defects.

This brings us down to what may be termed the modern era of war shipping, for from about that time dates the introduction of armour plating, and the commencement of that rapid series of naval developments which result in a warship being obsolete almost before she is completed for sea.

The following is a statement of the strength of the world's principal war fleets in the year 1859:—

	Ships
United Kingdom	711
France	448
Russia	164
Sweden (principally small vessels)	311
Norway	143
Denmark	120
United States	79
Holland	139
Belgium	7
Spain	82
The Two Sicilies	121
Austria	135
Portugal	37
Sardinia	28
Prussia	55
Greece	26
Turkey	49
Brazil	27
Peru	15
Chili	5
Mexico	9

Before considering that series of changes in naval design, and the long list of ships which have been built for the world's war fleets during the past thirty-five or forty years, it is desirable that something should be said regarding the ordnance that was carried by European war shipping from the time of the invention of cannon to that of the Crimean war.

Warships were first armed with cannon so early as the year 1338, and about the year 1372 guns and gunpowder were in common use for war purposes. The armament of the Christopher of the Tower, in 1338, included three iron cannon, of which each had five chambers, and that of the Mary of the Tower included one iron cannon with two chambers, and a brass cannon with one chamber. The weight and calibre of these pieces of ordnance is not recorded, but the projectiles fired from those with more than one chamber were doubtless of small size. At the latter part of the fourteenth century naval ordnance consisted of cannon, which are supposed to have been 60-pounders; demi cannon, 32-pounders; culvers, 18-pounders; falcons, 2-pounders; mynions, 4-pounders; and sakers, 5-pounders.

At the battle of Chioggia in the year 1380, fought between the Venetians and Genoese, guns named "bombards" were employed, which were formed iron rods bound together with hoops of the same material, and the spherical projectiles fired from these were of stone, weighing from 140 lb. to 195 lb. Stone shot of even larger size were used by the Turks in the defence of the Dardanelles early in the present century, and the celebrated Mons Meg, which is still preserved at Edinburgh Castle, is a specimen of large ordnance built with wrought iron bars and hoops, in the manner adopted in the fourteenth century. A similar gun is in Ghent.

The armament of a Maltese galley of about the beginning of the fifteenth century consisted of one 36-pounder, two 24-pounders, and twelve 6-pounders. A Swedish ship, named the Makalos, which was burnt in an action with the Danes in 1564, mounted 173 guns, 67 of which were cannon, and the remainder were small swivel guns; but the weight of their projectiles is not known. It seems, however, that 68-pounders were the heaviest guns in ordinary use on shipboard until comparatively recent times, the great bulk of the ordnance consisting of 32-pounders, 20-pounders, and smaller guns. Indeed, so recently as the year 1857, an eminent naval authority in this country reported his opinion that "our 95 cwt. 68-pounder is probably as heavy a gun as can be worked with facility on board of a ship." Certain it is that Nelson fought his battles with guns of much smaller size, the 32-pounders being considered heavy ordnance in his time, and up to the year 1860 the cast iron 95 cwt. 68-pounder smooth bore gun was the largest ordnance carried in the Royal Navy. Most of the guns captured from the Russians in the Crimean war were 32-pounders, or thereabout.

It was shortly before the war with Russia that explosive projectiles were introduced, and our experience of their effects dates from that time. The use of shell led to the adoption of armour-plate protection, and the floating batteries which were built by England and France during that campaign were the parents of the world's armour-clad fleets.

In what has been said regarding the world's war navies up to the year 1860 attention has been directed almost wholly to the fleet of Great Britain. It is to be regretted that complete statistics are not at hand showing the gradual growth of the naval Powers of Spain, Holland, France, and other countries during the time that the United Kingdom was winning her way to that proud position of maritime supremacy which she attained rather more than a century ago.

Under the Duke of Burgundy in the fifteenth century, the Netherlands—which until then were scarcely known—became the most formidable naval Power in the north of Europe. "His navy was so mighty and strong," says Philip de Commines, "that no man durst stir in the narrow seas for fear of it—being stronger than that of France and England together." Venice in 1420 supported 3000 merchant ships, on board of which were 17,000 seamen. She employed 300 sail of superior force, manned by 8000 seamen; had 45 carracks, with 11,000 men to navigate them, and her arsenals employed 16,000 carpenters.

After the Portuguese had pushed their discoveries around the Cape of Good Hope to India, and Spain had discovered the continent of America, these two Powers made rapid strides in naval construction, building ships of much larger size than before, in order to meet the requirements of their distant voyages. The Spaniards were the first to build a warship mounting three tiers of guns, and thereby laid upon the English Government the necessity of constructing larger and more powerful ships than had hitherto been built for our Navy. During the early part of the seventeenth century the Dutch navy increased rapidly in importance, and they succeeded in wresting a share of both the Portuguese and Spanish commerce. In 1650 their fleet was in all respects the most efficient in Europe.

The navy of France in 1661 consisted of only four or five vessels, yet Louis XIV. and his minister Colbert, in little more than ten years created a Navy which baffled the combined fleets of Spain and Holland, and claimed the mastery of the Mediterranean. In 1681 the French navy consisted of 115 line-of-battle ships, manned by 36,440 seamen, besides 179 smaller vessels; while in 1690 a French fleet of 84 vessels of war, of which 3 were of 100 guns and upwards, and 10 others each above 84 guns, with 22 fire ships, was cruising in British waters. But although the struggle was a severe one the Navy of Britain succeeded in triumphantly asserting its superiority. The French were, however, able naval constructors, and the successes of the British Navy were due rather to our seamen than to our ships. Throughout the wars of the time of George III. our ships were inferior in sailing qualities to those of France and Spain. It was not, indeed, until the commencement of the present century that the British Admiralty called to its aid the same scientific skill as had hitherto been devoted to naval construction on the Continent.

Although the possibilities of steam navigation had been demonstrated for some time previously, it was not until the year 1843 that steam machinery was fitted in ships of large size in the Royal Navy. In that year the frigate Penelope of 46 guns was cut down, lengthened, and supplied with engines of 650-horse power; and in 1846 two screw frigates — the Arrogant and Dauntless — were built in the Royal Dockyards. By the year 1859 a large part of the Royal Navy was propelled by steam power, as shown by the foregoing abstract of that date. Shortly before the Crimean war, and for several years after the conclusion of hostilities with Russia, all the wood vessels built for the principal European navies were designed with a view to screw propulsion; but many of the later constructed screw vessels of the Royal Navy were never commenced nor even rigged for sea, in consequence of the introduction of armour-clads, which speedily rendered obsolete all former types of ships for line-of-battle service. The necessity for this means of protection against shell fire has already been alluded to, as well as the means adopted by England and France in the form of iron-plated floating batteries for resisting the fire from the Russian forts. The floating batteries were speedily found insufficient to meet the wants of the case, and the ironclad frigate La Gloire, commenced by the French Government in 1858, was the first armour-clad ship fit for seagoing purposes. The construction of the sister vessels, Invincible and Normandie, was at once commenced, and they were quickly followed by the Couronne. The British Admiralty found itself compelled to follow in the same direction, and shortly before La Gloire was launched the Warrior was laid down at Blackwall. But while the French armour-clads were constructed of wood, the Warrior, on the contrary, was built of iron, and in that and many other most essential particulars she was more truly the progenitor of the world's armoured fleets than the French vessel; for, except in so far as their rigging was concerned, these latter were no great step in advance of the original floating batteries. The Black Prince, a sister to the Warrior, speedily followed, and soon after them the Defence and Resistance—all of iron—were laid down. In 1861 the British Admiralty decided to cut down to frigates and to armour plate several of the wood line-of-battle-ships then upon the stocks and in a state of great advancement; also to build the Achilles, Minotaur, Agincourt, Northumberland, Hector, and Valiant of iron. During this time the French had built the Solferino and Magenta, and in 1862 they laid down ten frigates of the Gloire type, but with thicker armour.

It will thus be seen that at the commencement of the sixth decade of the century there occurred a remarkable revolution in naval construction, accompanied by great activity at the dockyards of the two principal naval Powers in the world, so that in a brief space of time the pre-existing enormous navies of both Powers were rendered practically obsolete. From that time until now the ingenuity of naval architects has been continually directed towards the attainment of an ideal "ship of the future," which shall occupy the same position in future war fleets as was occupied for about two centuries by the wooden line-of-battleship and frigate.

The simultaneous development of naval ordnance, the introduction of ramming tactics, the invention of the torpedo, and other similar offensive weapons, has, however, made impossible the attainment of finality in naval design. When the French built the Gloire and we laid down the Warrior, it was generally supposed that the 95 cwt. 68-pounder gun was the most formidable weapon that fleets would have to cope with, and the thickness of armour plating adopted in the earliest ironclads—viz., 4in. to 5in.—was considered sufficient to resist the projectiles from that gun, and so secure immunity against the much dreaded shell. But when the armour-plate was found capable of resisting existing guns, ordnance manufacturers set to work to construct more powerful ordnance. To trace the successive steps by which the 95 cwt., 68-pounder, cast iron, smooth bore, muzzle-loading gun has been succeeded by the wrought iron 80-ton muzzle-loading rifled gun of the Inflexible, and the 111-ton gun of the Benbow, to say nothing of the 13½in. 67-ton breech-loaders of the Ramillies, and the 12in. 45-ton guns of the Jupiter, would occupy more space than is at our dispoal. It must be sufficient to say that, thanks to the skill of Armstrong, Lord Rendell, Sir J. Whitworth, the Government staff at Woolwich Arsenal, Colonel Palisser, and others in this country, together with that of Krupp and others on the Continent, the progress of ordnance manufacture has been most rapid, and the results stand in marked contrast with what had been done during several preceding centuries. In the Royal Navy at the present day a gun of 9 tons is considered small; those of 12½ and 18 tons are quite common, while the most formidable of our armour-clads are armed with ordnance of 29, 38, 45, 67, 80, and even 111 tons.

As the gun had increased in size and power, naval architects have sought to clothe ships with armour capable of resisting it. The earliest ironclads, as already stated, were plated with 4½in. to 5in. armour. In 1862 the last named thickness had not been exceeded; but in 1863 the Bellerophon was designed by Sir E. Reed to carry 6in. armour upon 14in. teak backing. The Hercules, laid down by the same eminent constructor in 1867, had 9in. armour plates upon her sides. The year 1872 saw 14in. armour plates being fitted to ships of war, and two years later the Inflexible was designed to carry 80-ton guns, and be plated with 24in. of iron armour. Later on, guns were increased to 100 tons, and an equivalent of 18in. of compound iron and steel armour substituted for the 24in. of iron. During recent years our naval constructors have contented themselves with less heavy ordnance than formerly; but, by reason of the superior strength of the modern steel guns, their penetrative efficiency is fully equal to that of the heavier wrought iron ordnance so much in vogue about ten years ago. Just now another important advance is being made in the manufacture of armour plates from nickel steel, and in the application of the Harvey process for hardening the face of the armour for some distance from its surface. "Harveyed" steel armour of 14in. in thickness is found to offer an equal resistance to penetration by chilled projectiles as that of armour of 18in. to 21in. in thickness which has not been so treated. The 24in. armour of the Inflexible seems to have reached the limit set by the buoyancy of ships of ordinary size, and the requirements in regard to the extent of surface which should be protected.

While the growths in naval construction already referred to were taking place in the British Navy, other nations were not inactive, nor did they at all times permit us to take the lead in the inventive skill brought to bear upon the subject. For a long time the French continued to build armour-clads of wood, but, finding that they rapidly decayed, it was ultimately decided by them to resort to iron and steel. In the year 1874 the last-named material was being largely used in the French dockyards, notwithstanding that failure had in most cases attended our efforts up to that time in the employment of steel both at our royal and private shipyards. Encouraged by the partial success of the French workmen, our naval constructors appealed to steel manufacturers for a more trustworthy steel for ships' construction than had hitherto been supplied, and in response to that appeal the material known as "mild steel" was produced. The committee of Lloyd's Register of Shipping made numerous experiments upon the new material, and very speedily it was accepted by them and the Admiralty. From the year 1875 dates the construction of the steel fleet of steam and sailing vessels of the mercantile marine, and the adoption of the same material for all parts of a warship.

The first ironclads were ordinary broadside frigates, having their sides protected by comparatively thin armour-plates to a few feet below the water-line. The increase in the thickness of armour which soon followed rendered it necessary to limit the area covered by that protection. No sooner was the application of armour limited to certain parts of the vessel than at once there arose a great variety of conflicting views regarding the best possible use which could be made of it. It is scarcely possible to better classify and describe the several systems of armour protection which have been adopted in the world's war fleets than in the language of Sir Nathaniel Barnaby, who preceded Sir William White as Director of Naval Construction at the Admiralty. Sir Nathaniel says:—"Of protected ships there are many varieties. (1) The ships of the Comus class, *i.e.*, corvettes of 2300 tons displacement. They have an under-water steel deck wrought over the engines, boilers, and magazines, with a raft body above it. . . . . . (2) The ships of the Warrior type. These are divided into three parts longitudinally. There is a middle division, varying between one-half and three-fifths of the whole length of the water-line, which has a belt of armour on the sides and ends, and there are two end divisions protected by an under-water deck, as in the Comus, but without a raft body. . . These ships then have, as above stated, three divisions, viz., side armoured middles and protected ends. (3) There is the ship protected by side armour throughout the water-line, associated with a short or with a long and conterminous armoured battery overhead. In the latter case the ship is said to be completely protected, in the former only belted; but in neither of these cases is there a protecting under-water deck. This class includes nearly all the completed ironclads of all navies, and all the protected ships designed in England between 1861 and 1873. (4) There is the ship protected by side armour on a middle division of the ship, associated with protected ends and raft bodies. In this division is included the Inflexible, Ajax, Agamemnon, Nelson, and Northampton, the Duilio, Dandolo, and the German ships—five in number—of the Sachsen type. (5) There is the ship with protected deck and raft bodies from end to end, without side armour, but with armoured batteries, to which it has been understood that the Italia and Lepanto are to belong, but of which there is no actual representation at present."

Since Sir N. Barnaby wrote this classification of the world's armoured shipping, many advances have been made. The torpedo has now a more active existence than in those days, and the quick-firing machine gun has become one of the most important elements in the armament of both armoured and unarmoured ships. Take, for example, the case of the Ramillies recently built on the Clyde. This powerful battleship is of 14,150 tons displacement, she has 18in. and 14in. compound armour on her sides, 17in. compound armour on her barbette towers, and 3in. protective deck armour. Her armament consists of four 13½in. 67-ton breech-loading steel guns, ten 6in. guns, twenty-eight quick-quiring 6-pounders and 3-pounders, eight Maxim guns, and seven tubes for discharging torpedoes.

The Jupiter, now in course of completion, has a displacement of 14,900 tons, Harveyed armour fully equal to the compound armour of the Ramillies, four 12in. breech-loading rifled guns, twelve 6in. guns, sixteen 12-pounder quick-firing guns, twelve 3-pounder quick-firing guns, and five torpedo tubes. These figures will serve to show that in the modern battleship something more is provided for than the pounding of an enemy's armoured sides, all important as that function undoubtedly is. Regarding the unarmoured ships of the British and other navies, it is impossible to give a detailed account in consequence of the great number and the diversity of their types. Some are for cruising, some for dispatch carrying purposes, and others for ordinary service upon distant stations, while others, again, are designed wholly with a view to being employed in torpedo attack. In all these types and classes steel is the material now used, and the improvements effected in recent years with the marine engine and boiler have resulted in far higher speeds and greater coal endurance than was found possible at an earlier date.

An exact comparison of the strength of the world's principal war navies is not possible from a mere statement of the number of battleships, or first or second-class cruisers, &c., &c., in each, for authorities do not agree in regard to the specific value which should be assigned to each of the several functions of a warship. The basis of displacement does, however, afford a rough means of comparing war vessels of the same type, for it is on their buoyant capabilities that the maximum weight of their armour, guns, machinery, coals, ammunition, stores, &c. depend. At the same time, it must be remembered that designers of different skill and experience will appropriate the displacement at their disposal in very different ways. The earlier armour-clads are, ton for ton of displacemant, much less efficient than those of more recent date.

Using the displacement in tons as a basis of comparison, it appears that the relative extent to which Great Britain, France, Italy, Germany, Russia, and the United States have provided themselves with the several powerful classes of warships is as follows:—

Details of the World's Principal War Fleets.

	Seagoing armour-clads and belted cruisers.		Coast defence armour-clads.		Protected cruisers.		Torpedo vessels.		Torpedo boats.		Other unprotected vessels.	
	Ships.	Tons displacement.	Ships.	Tons displacement.	Ships.	Tons displacement.	Ships.	Tons displacement.	Ships.	Tons displacement.	Ships.	Tons displacement.
Great Britain ...	70	676,800	16	61,710	87	390,535	89	71,560	165	7923	156	160,314
France	49	409,400	18	53,775	28	106,035	58	32,356	206	8434	118	193,562
Italy	17	161,880	5	22,860	22	76,885	20	11,639	151	9877	53	69,259
Germany	14	113,557	21	41,840	4	18,850	21	17,450	144	9043	39	63,824
Russia	31	259,540	24	55,800	2	8,150	13	5,544	178	4283	64	59,015
United States ...	8	72,100	21	56,830	16	64,860	4	1,067	4	40	23	29,450

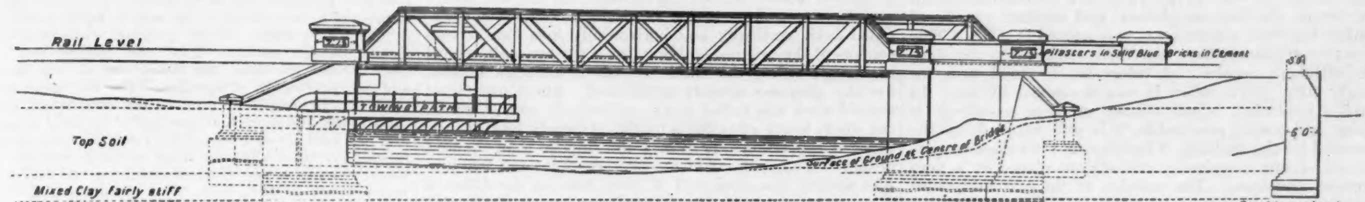
It must not be supposed that the displacement criterion is sufficiently accurate to enable an exact comparison to be made by means of the foregoing table between the strengths of the several fleets named upon it. For instance, of the 21 coast defence armour-clads credited to the United States, 13 date back to the close of their civil war, and are obsolete; and of the 49 seagoing armour-clads in the French Navy, 12 ships of 80,740 tons are built with wooden hulls. Then, again, although we have fewer torpedo boats than France or Russia, and with a relatively less displacement than Italy or Germany, yet it must be remembered that our enormous fleet of torpedo vessels, including the "destroyers" of the Hart and Handy class, serves all the purpose of torpedo boats, and in far more efficient manner. Thanks to the vigorous action of recent administrations—both Radical and Unionist—our fleet is at present stronger in relation to the navies of other Powers than it has been at any time during fifty years before. The efficiency of our Admiralty and Dockyard organisation, and the preparedness of our ships, are evidenced by the promptitude with which the most powerful flying squadron that ever left our shores has been collected and equipped for sea.

THE Lake Erie Ship Canal plans and estimates have been submitted to the consulting engineers, General H. L. Abbott, Major N. H. Hulton, and Professor L. M. Haupt. While no formal report has been made as yet, the Pittsburg *Dispatch* says the following conclusions have been practically arrived at: A 15ft. canal with 340ft. locks would accommodate the bulk of the vessels now engaged in lake traffic; the summit-level water supply, even during drought, is sufficient for a canal with a freight capacity of 13,000,000 tons annually, and this capacity can be increased if the canal is deepened. The railway-bridge crossing question is still in the hands of the engineers; the preliminary estimate of £5,400,000 to £6,000,000 is not far from the expected cost. A canal of 8ft. or 10ft. is impracticable, according to General Abbott, because it would have to be deepened in a few years.

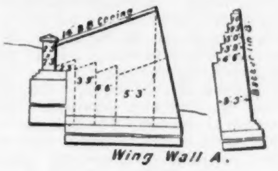
BRIDGE OVER THE OUSE AT ELY—GREAT EASTERN RAILWAY

MR. JOHN WILSON, M. INST. C.E., ENGINEER

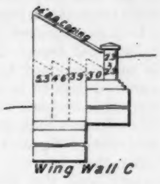
(For description see page 78


Rail Level
Top Soil
Mixed Clay fairly stiff
Stiff Blue Clay
Towing Path
Surface of Ground at Centre of Bridge
Pilasters in Solid Blue Bricks in Cement
Section thro' Abutment.

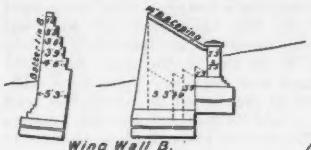
— Elevation. —


14 B.B. Coping

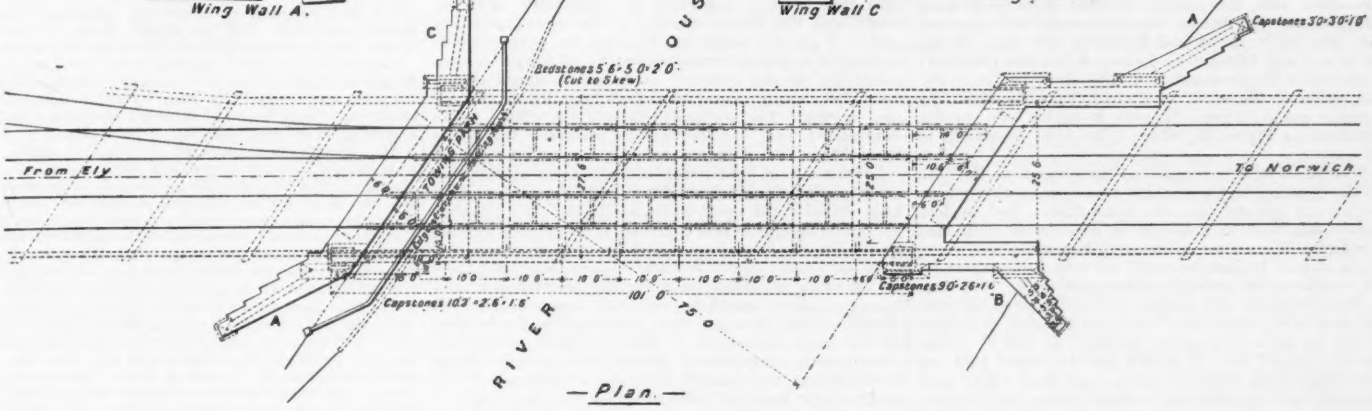
Wing Wall A.



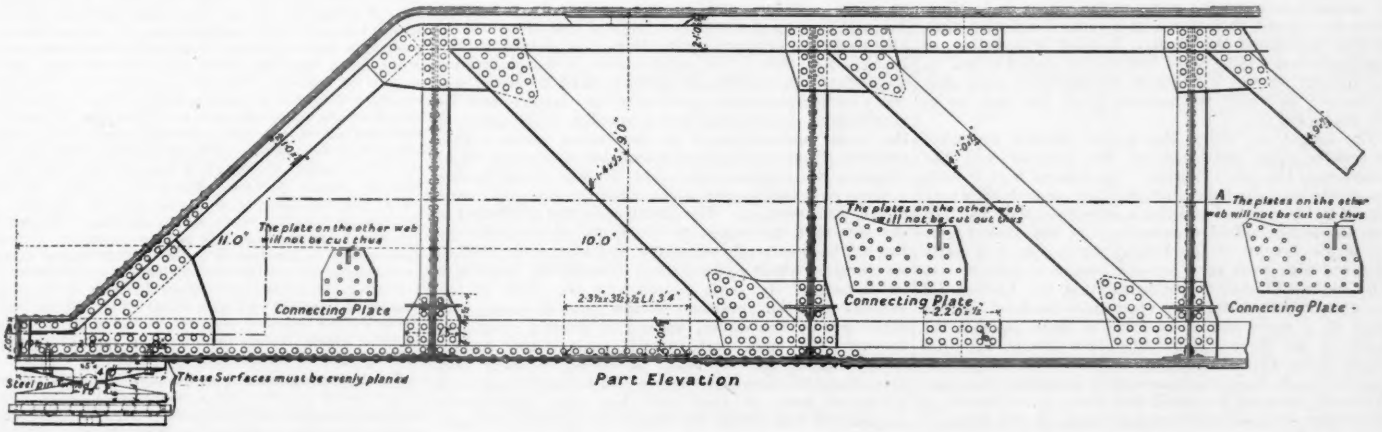
Wing Wall C



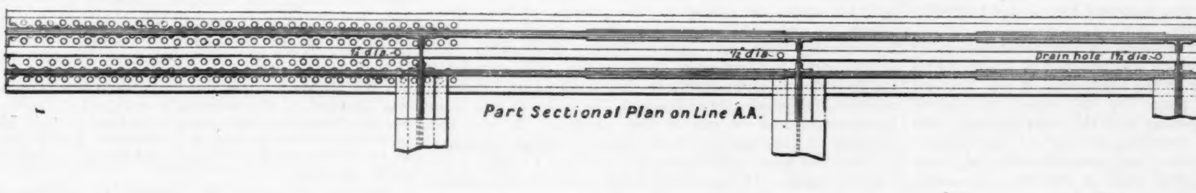
Wing Wall B.


RIVER
OUSE
C
A
B
Bedstones 5'6 × 5'0 × 2'0
(Cut to Skew)
Capstones 3'0 × 3'0 × 1'6
From Ely
To Norwich
Towing Path
Capstones 10'3 × 2'6 × 1'6
Capstones 9'0 × 2'6 × 1'6
101' 0
75' 0
25' 0
25' 6

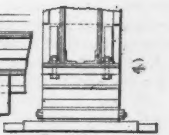
— Plan. —


11.0"
10.0"
The plate on the other web will not be cut thus
Connecting Plate
The plates on the other web will not be cut out thus
Connecting Plate
A
The plates on the other web will not be cut out thus
Connecting Plate
Steel pin
These Surfaces must be evenly planed

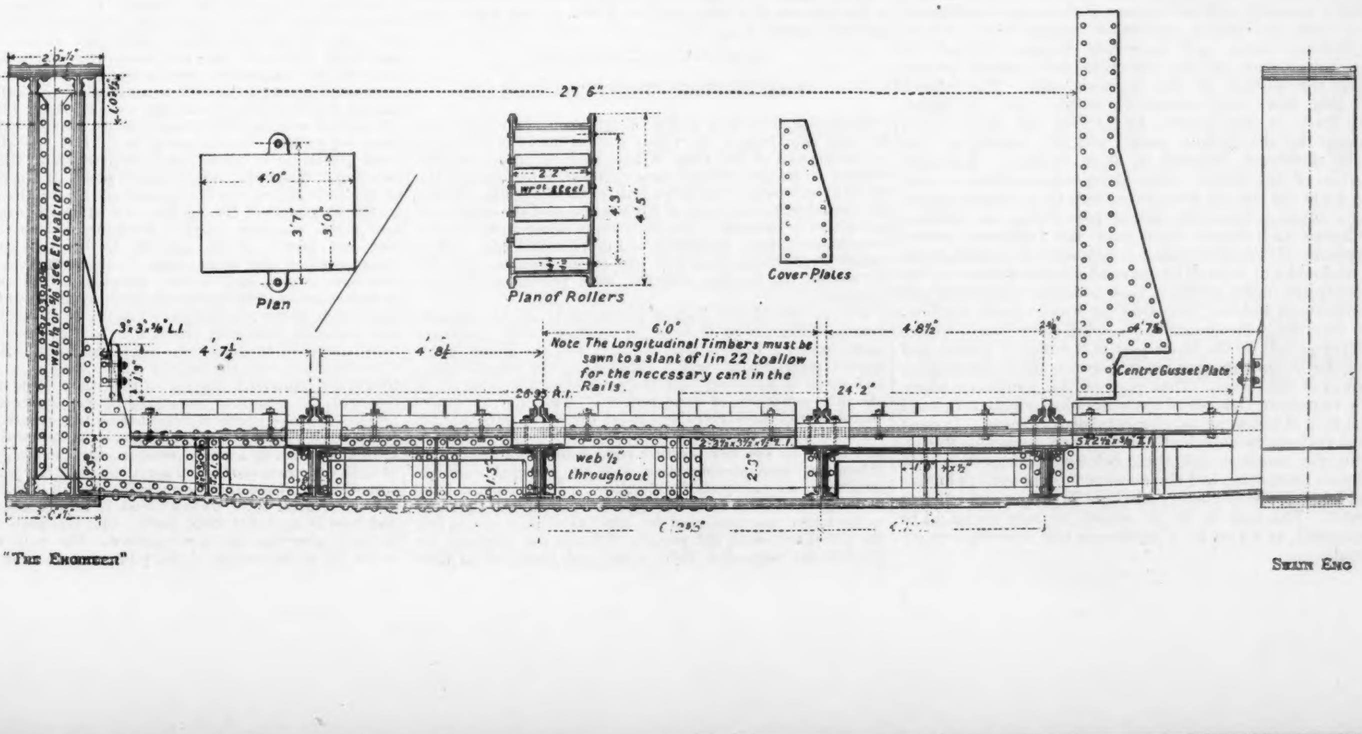
Part Elevation


Drain hole 1½ dia.

Part Sectional Plan on Line A.A.



End View.


27' 6"
Plan
4' 0"
3' 7"
3' 0"
Plan of Rollers
wrᵗ steel
4' 3"
4' 5"
Cover Plates
Centre Gusset Plate
web ½ or ⁹⁄₁₆ see Elevation
3 × 3 × ⅜ L.I.
4' 7¼"
4' 8½"
6' 0"
4' 8½"
Note The Longitudinal Timbers must be sawn to a slant of 1 in 22 to allow for the necessary cant in the Rails.
24' 2"
web ½" throughout

CONSTRUCTION OF MODERN LIGHTHOUSES.

TIMBER, stone, iron, both cast and wrought, and steel have all been employed in the construction of lighthouses. The first of these materials needs no further consideration, although it may be mentioned that exactly two hundred years ago the first Eddystone Lighthouse was built of it. It was swept away in a tremendous storm four years after its completion, and another, chiefly of timber, but with a stone base, was erected in 1708. This structure appears to have been fairly equal to the occasion, for, although repaired at intervals, it stood firm for nearly fifty years, when it was destroyed by fire. In foreign countries, where timber of large scantlings is cheap and readily procurable, it is still adopted as the material for the building of lighthouses; but the examples are not of any magnitude, and seldom placed in a very exposed situation. The erection of the new Eddystone Lighthouse in 1882, and the building of the new Putney Bridge, both of stone, are proofs that iron and steel, however much they may have trenched upon the ground originally occupied by the older material, have not succeeded, and probably never will, in superseding entirely the employment of it in two of the most important works of the architect and engineer. Numerous additional instances could be mentioned in which the solid stone has successfully held its own, but the two modern ones quoted will suffice for our present illustration. In connection with this subject, it must be borne in mind that Smeaton's lighthouse—the predecessor of the present one—was stable, sound, and durable to the last. It was not in any way damaged or destroyed, but was purposely taken down in consequence of the slow but sure disintegration of the rock upon which it was founded. As a monument to its great designer, it can be seen on the esplanade at Plymouth, where it has been re-erected to his honour.

Whether it be true or not that Smeaton took the idea for the contours or form of his tower from that of an elegant and graceful tree, the fact remains that modern stone lighthouses are not built in accordance with that standard. We are not asserting that Smeaton was wrong in his views. In fact, we could not with a due regard for the excellence and stability of his great work. But since his time different, and perhaps more advanced, opinions are now held, which have led to the adoption of another profile for these life-saving beacons, as will be subsequently pointed out. It should also be stated that our knowledge of the action of waves, and their effect upon obstacles and impediments to their motion and violence, has been enormously augmented since the days of the first Eddystone, properly so called. By selecting the tree-form for his tower, the designer probably intended, not so much to resist the action of the waves as to allow them to expend their force in a vertical direction after striking the base of the shaft. Instead of resisting or repelling them, they were induced or coaxed to run up the smooth, sloping exterior of the structure, and, after exhausting their fury, fall harmlessly on the rock or in the waters below.

The height to which the waves reached depended principally upon the state of the weather and the condition of the tide. Waves "mountains high" have frequently been alluded to, but, however strongly they may appeal to the poetical and the imaginative, they will not bear the test of actual experience. At the Wolf Lighthouse the height of the loftiest waves was frequently observed with great accuracy and precision, and it was fully and incontestably established that the highest did not rise more than thirty-two feet above sea level. As the ridge of a wave above sea level is about equal to the depth of the furrow below the same datum, the total height of the wave of maximum altitude in the neighbourhood of Land's End would amount to some sixty-five feet. It should, however, be stated that there is no reason to doubt that the assertion that the waves at the Bishop's Rock Lighthouse have on rare occasions reached a maximum elevation of one hundred feet is not perfectly accurate and trustworthy.

One of the first improvements in the construction of modern lighthouses of stone was adopted in the building of the present structure at the Eddystone Rock. Instead of offering a sloping plane for the waves to run up directly they came in contact with the solid masonry, and ultimately temporarily obscuring the rays of the lantern, they were fairly encountered and resisted at the very base of the edifice. The original form of Smeaton was completely changed, and the contour of the base or pediment was built on vertical instead of inclined lines. Up to high-water mark, and a certain distance beyond it, the lower part of the structure was erected plumb from the surface of the natural rock. The object of this new and improved design was to break the force of the waves, to receive and resist their impact by the weight, mass, and *vis inertiæ* of the solid stonework opposed to their violence. A certain portion of the waves, when there was a violent sea on, no doubt did run up the tower, but to a comparatively very small extent, the larger part being, as it were, reflected and thrown back into the turbulent waters beneath. If this principleof constructionbe adopted, as it no doubt will be in all future solid stone structures of the description under notice, it is an example of meeting and overcoming violence, or action, by simple equal reaction. In describing the structure as solid stone work, we are referring only to the lower part of it which is within, and also for obvious reasons some distance above the striking power of the waves. That part of the lighthouse above the impactive violence of the waters has only to withstand the fury of the wind and elemental disturbances It must also perforce be sufficiently hollow and capacious to contain the inmates and their belongings, together with stores, provisions, and the necessary tools and appliances for keeping the machinery and light in proper and efficient order. This task is by no means so easy as might be imagined, as a visit to a lighthouse will speedily demonstrate.

The older and the more modern contours adopted for the designs of stone lighthouses differed briefly in the fact that the former had no vertical base, which was subsequently bestowed upon the latter. There is a close resemblance between the modern form or profile adopted in the recently built Eddystone Lighthouse and that erected in 1887 at the Bell Rock. This structure was not altogether a new one, but was an improved form, embodying an outer wall or casing of stone, dowelled and dovetailed both vertically and horizontally into the granite courses of the original building, from the foundation level to a height where the shaft necessarily becomes hollow, for the purposes already mentioned. Above this level the old work was pulled down and entirely reconstructed, the whole tower attaining a height of nearly 150ft. to the focus of the lantern, or nearly 40ft. higher than the first design. A comparison of the two principles and two profiles already described will at once indicate the different manner in which the force of the waves is dealt with in the two structures, and also the superior advantages with respect to greater stability, permanence, and security which is endorsed by the adoption of the larger vertical cylindrical base. It is this part of the building that is most exposed to the greatest violence of the waves and requires to be the strongest. The vertical base not only throws back the billows, but widens out the foundations from which the tower springs, and, moreover, lowers the centre of gravity of the whole mass. This last consideration is very important in connection with the safety and the future stability of the tower, as a low centre of gravity tends to diminish the propensity to rocking in a gale of wind, shared by all lofty and comparatively slender edifices. It is not at all uncommon for a high chimney stack to deflect laterally at the top 8in. or 9in. The motion, although not visible to an unpractised eye, can be readily perceived through a theodolite or transit instrument, and measured if required.

In imitation of lighthouses built of stonework, iron has been employed with brick lining, but the more modern type includes the open or braced form. The principle governing designs of this character is essentially distinct from that we have described in the present article, but they have many special features which recommend them for adoption in situations where the erection of a lighthouse of stone would be well-nigh impracticable. It should, in fact, be stated that, previously to the building of the stone lighthouse at Bishop's Rock, which was subsequently strengthened, altered, and partially rebuilt to constitute the present structure, a lighthouse of cast and wrought iron had been put up on the same site. It consisted of a hollow central column, flanked by six smaller on the outside, so as to form a regular hexagon on plan. The six columns were secured to the central or main columns and to one another by the usual diagonal bracing of struts and ties. From the level of high water at ordinary spring tides, the height to the lantern was 96ft. The construction, although tedious and difficult, proceeded satisfactorily until the tower was ready for the placing in position of the lantern and its accessories. In this condition it was left to the mercy of the winds and waves of the impending winter. Fortunately no one was deputed to inhabit it, for one night a furious storm arose, and swept it clean away, leaving nothing of it visible next morning but the stumps of some of the iron columns. The catastrophe was attributed to the fact that the height to which the waves might rise had not been correctly estimated, and that they reached an elevation which enabled them to strike the large area or surface of the shaft intended for the abode of the keepers and the reception of the general stores. In other words, the waves, instead of passing under and through the open part, struck against the sheeted sides higher up. It must be borne in mind that this disaster occurred nearly fifty years ago, and engineers were at that time but very indifferently acquainted with either the theory or practice of open-sided structures of any description. This failure must not, therefore, according to the maxim *ab uno disce omnes*, be regarded as condemnatory of all open-sided lighthouses built on similar lines. Experience has abundantly demonstrated their value and suitability for their duties, and notably in situations where for many reasons, independently of the cost, the erection of a stone lighthouse would be out of the question. A very fine example of the open cast iron columnar design, octagonal in plan, has been recently erected at Cape Charles in the United States. It has a total height from the foundation to the lantern of 176ft., and of 200ft. to the top of the lightning conductor.

THE CUTTER BRIDGE AT ELY.

IN pursuance of their policy of substituting wrought iron for cast iron bridges, the Great Eastern Railway Company, in the persons of Mr. John Wilson, their engineer, and Mr. Charles L. Morgan, the assistant engineer, superintended the removal on Sunday, November 24th, of the old bridge crossing the Ouse just to the north of Ely Station, and the erection of a new one in its place. The contractors engaged on the work were Messrs. Head, Wrightson and Co., Limited, and on their behalf Mr. William Anderson, one of the directors, and Mr. S. Young, the London manager, were present at the proceedings.

Ely is one of the busiest points of the Great Eastern system, inasmuch as there is, in addition to the passenger traffic between London and Norwich and the North, a still heavier goods traffic, which claimed serious consideration, and made it necessary that the work should be done in an absolute minimum of time possible. The original idea of engineers and contractors was to get the whole work through—that is to say, the work as regards taking out the old bridge and fixing in the new—within eight hours; but unexpected difficulties arose in connection with the removal of the old structure—as unexpected difficulties, indeed, have a habit of doing—and three more hours were required. All the same, as the traffic was conducted for some time on a single line, the period for which the passing of trains was rendered impossible was reduced to eight hours, and inasmuch as there were no trains at all due on the Sunday afteroon for half of that period, the actual obstruction of traffic amounted to only four hours. Considering the exceptional difficulties encountered, it was a remarkable performance, and highly creditable to everyone concerned.

The chief trouble consisted in the removal of the old bridge, which, built in 1845, was a nine-span timber-pile structure, three of which supported cast iron girders as superstructure, the remainder being timber, and offering any possible number of uncertainties in the way of bolts, fastenings, and so on, which might impede progress when everything appeared straightforward. Thus the matter was a much more serious one than the lifting out of one iron bridge and the putting in of another. The old structure had a total length over all of 220ft. in the nine spans, but six of these spans, and more than one-half of the total length, stood over the land on each side of the river, the open spaces there making provision alike for flood openings and for allowing local residents to pass from the fields on one side of the railway to those on the other. But these openings have now been closed up, and in their place are embankments terminating in brick abutments, on which the new bridge rests. Thus the new bridge is substantially shorter than the old one. It forms a single span of 75ft. on the square and 91ft. on the skew, with a length over all the girders of 101ft., the superstructure consisting of two main outside girders of wrought iron open lattice construction, 27in. 6in. apart from centre to centre, and 9ft. effective depth, resting on the brick abutments, and provided with expansion roller bearings with rocker and pin at one end. The rails are supported by cross girders 10ft. apart, centre to centre, with rail bearers, upon which the longitudinal timbers are bolted and the usual chaired road used. The net weight of the ironwork was 98 tons, but the timber and rails raised the total to 120 tons.

Such was the structure that was to be moved into position. It had been put together on temporary staging erected over the river, and alongside the older bridge, as near to it as the conditions of work would allow, and it stood ready, on trolleys and rails, for the final operation of traversing.

The uncertainties presented by the old timber bridge have already been mentioned, but there was a still further complication arising from the fact that the river crosses under the line at a very acute angle, so that the two powerful locomotive steam cranes employed—one raising ten tons and the other five tons—were of but little use for the removal of the down line of the old bridge when the up line had been taken away. Had the river been running at right angles with the railway matters would have been much simplified.

The time fixed for commencing the work of removing the old bridge was a quarter of an hour past midnight, but the last down mail train was late, and there were also important goods trains to be got rid of, so that it was after one when operations—facilitated by the use of Wells' lights—really began, though even then there were constant interruptions owing to the necessity of removing the locomotive cranes from the down line, which was to remain open until midday. From this line the cranes lifted, one by one, the six girders and their timbers, which formed the three remaining spans of the up line over the old bridge, the first of them being lifted and taken away within twenty minutes of the passing of the last train. Each girder was raised and carried off by the two cranes to a point lower down the line, where they were at once placed on wagons for removal. This part of the work went off quite easily, no difficulty presenting itself. The old girders having thus been got rid of, the crowns of the piles on which they had been placed were sawn through, where that process had not already been done, and these in their turn were carried off by the cranes, so as to allow the new bridge to be traversed into its proper position. The lower portions of the piles were left standing in the river bed for the time being. Everything was thus ready for the moving of the new bridge into the position which had been occupied by the up line, and as close as practicable to the still remaining down line, or about one-half of the total distance it would have to travel towards its final destination from that part of the temporary staging on which it had been constructed. To facilitate this operation the complete structure of the bridge stood on four trolleys, which in their turn were on rails along the heavy staging running parallel with the river.

The traversing was accomplished by means of two winches which stood on the bridge, and were supplied with ropes passing from them and under the bridge to some timbering on the other side to which they were attached. The distance which the bridge had to travel bodily on this occasion was 15ft., and the time occupied in the operation was altogether thirty-five minutes, great care having naturally to be taken to ensure that the two sides moved at the same rate. The trolleys worked admirably, and the operation went off without the slightest hitch, proving a complete success. This was the end of the morning's work, which, leaving out of account detentions amounting to at least an hour and a-half on account of the passing of goods trains, had occupied three and a-half hours, thus bringing the workers up to six o'clock in the morning.

Between this hour and midday the ordinary Sunday morning traffic, both up and down, was conducted over the down line of the old bridge, which had, so far, not been interfered with, and this was done with but little delay. At noon the contractors' men re-appeared on the scene of operations, hoping to be able to accomplish the feat of completing the work by about four o'clock, which would have left enough margin of time to do the permanent way connections before the next train was due. But the afternoon's work proved to be much more difficult than that of the morning. When the steam cranes stood on the down line of the old bridge it was a very easy matter for them to pull up the six girders of the up line, one after the other. But now there was only one line available, and as the cranes had not length of jib enough to lift the girders, in consequence of the acute angle of the bridge, an entirely different course had to be adopted. The idea was to first raise out of its bed on the piles, by means of hydraulic jacks, each of the two complete lengths of old girders, rails, and timbering stretching across the river to form the down line; and then to draw these complete lengths bodily, one after the other, with the help of winches, along a continuation of the temporary staging, so that they would not interfere with the complete traversing of the new bridge; the massive beams—which represented each a length of about 100ft. and a weight of 35 or 40 tons—being left on the staging to be dealt with on a future occasion. But the bridge-builders of forty-five years ago had done their work so well that it seemed at one time almost impossible to pull it to pieces, and it was not until three o'clock—that is to say, after the men had been at work for three hours—that this particular item in the programme was accomplished. The next thing was to get rid of the crowns of the piles, and as these immense blocks of timber, with their iron bed-plates on which the girders had rested, could not be reached by the cranes, they were unceremoniously tumbled into the river, where they disappeared with a tremendous splash, which was especially appreciated by the local residents assembled on the towing-path.

After this came the final stage in the traversing of the new bridge, so as to bring the rails with which it had already been provided in line with those on the permanent way on either side. This required only another half-hour, the massive structure gliding along the rails with a perfect smoothness. Thus the total time taken in moving along a distance of 30ft. the whole mass of the new bridge—complete as it was constructed, and weighing 120 tons—had been just one hour.

Now came the task of raising the bridge off the trolleys, so that these could be removed, and the bridge then be lowered into position on the bed-plates and abutments. The raising was accomplished by means of hydraulic jacks at each corner, and the expansion rolling bearings, with rocker and pin, having been fixed at one end, the bridge was finally lowered into position, and declared duly fixed, by a quarter to eight in the evening. In the meantime the platelayers had been putting down the rails to join those of the permanent way with those already fixed on the bridge, and the up line at least was perfect by eight o'clock, when the Norwich express—fortunately somewhat late—steamed slowly but safely across the new bridge on its way to London. Thus the actual working time spent in removing the old bridge and putting the new one in its place, available for the resumption of traffic, was only a little over eleven hours.

THE PROPOSED LONDON AND SOUTH WALES RAILWAY.

(*From a Correspondent.*)

THE abrupt abandonment of the projected railway from London through Oxford to South Wales has caused no little surprise and a good deal of disappointment in the district, where for two or three years past an agitation in favour of an independent line to the metropolis has been maintained by the whole mining industry and nearly every representative public body. It was not a case of withdrawing a tentative scheme, hastily prepared, in order that it might be formulated anew in a more complete manner for presentation to Parliament another year. Here surveys had been made, plans prepared, the Bill drafted and deposited, the first directors of the new company nominated, and actually a secretary appointed in the person of Mr. Connacher. All seemed to be going well, when suddenly came the announcement that the promoters, after a conference with the Great Western Railway directors, had determined not to proceed with the undertaking,

The promoters, as specified in the deposited Bill, were the directors and leading shareholders of the Barry Railway, and it was between their representatives and a committee of the Great Western directors that the conference took place. We reproduced last week some of the terms on which it is said that the understanding to abandon the Bill was arrived at; but it requires no special power of divination to discover that the conditions therein mentioned cannot exactly consist of *the* terms, or all the terms, on which the Barry Company consented to sacrifice its elaborate and long-maturing project. For example, the new line of the Great Western Company from Patchway to Wootton Bassett, which would leave Bristol to the south, and shorten the distance to London by twelve miles, was contemplated, as our columns will show, long before the London and South Wales Railway was definitely described in a Parliamentary notice. The extension and "opening" of Cardiff station, and the doubling of the road between that town and Newport, are works which have been proceeding for months past, and for which the money was voted a year ago.

The only concessions that appear to be new, and that are mentioned in the semi-official explanation of the Barry Company, ara a reduction of the coal rate to Southampton by 6d. per ton—undoubtedly a great boon to Welsh coalowners; a promise that very effort shall be made to reduce the rate for bunker coal to London, though on this point the Great Western at present finds its hands tied by agreements with other main lines; and an infinitesimal benefit to passengers by equalising the first and second-class fares between Paddington and South Wales with those charged on other portions of the Great Western system. These matters have long been the subject of discussion between the Great Western and the Chambers of Commerce and local authorities of the South Wales ports; and under the more liberal policy Lord Emlyn has introduced into the Great Western administration there was good reason to believe that the reforms would have been carried out in due course. There is, at all events, some justice in the complaint, raised alike in railway circles and in the industrial districts of South Wales, that if this is all that the Barry Railway has secured as its part of the bargain, it is not sufficient to justify the disturbance its scheme has caused to Great Western shareholders, whose property it threatened, or to the colliery and trading interests, whose hopes it had fired only to quench them in a douche bath of a disagreeably unexpected character.

It is quite intelligible that the coalowners and others—and probably not a few engineers as well—who placed their trust in the good faith of the promoters, should express an honest scepticism as to whether the items already mentioned represent the whole of the conditions on which the Bill was withdrawn, and whether they do not omit some very material advantages which the Barry Railway Company has secured for its system and its shareholders. In the nature of things a railway company does not usually play the part of philanthropist at large, and still less is it to be presumed that a character for universal benevolence would naturally attach itself to a young railway company which was established as an aggressive power, and owes its 10 per cent. prosperity to its legitimately enterprising aggressiveness. The two daily journals in Cardiff, which do not often agree in discussing Barry affairs, are for once of opinion that the Barry directors have been too modest in setting forth their own share of the benefits that are to accrue from the arrangement which has been made with the Great Western Company.

The Barry Railway, as everyone knows, has been making efforts to get access to the Monmouthshire coal valleys. That was the object of the East Glamorganshire Railway, which it twice unsuccessfully tried to carry through Parliament. That is the purpose of the proposal, in its present Bill, to construct a short line between its own railways to a junction with the Rhymney Railway at Walnut Tree Bridge. It is now stated that a part of the compromise with the Great Western Company is that Barry Dock is to be grouped with the Cardiff and Penarth Dock, in regard to the rates from Newport, for all coals brought down from the Monmouthshire coalfield, in which case Barry, with its lower dock dues, and more favourable position, would challenge the Newport trade and become a more formidable rival of Cardiff than it is to-day.

A more important statement in the *Western Mail* is that the withdrawal of the Bill was but one plank in a programme which includes the ultimate absorption of the Barry Railway and Dock in the Great Western system. It looks at first sight improbable, but it is not intrinsically so. The Great Western Company wants a dock in the centre of the Welsh coalfield. It has dock interests at Swansea, larger interests at Llanelly, and it is an open secret that the late Sir George Elliott did not despair of concluding negotiations whereby the Newport Alexandra Dock would have passed to the Great Western Company. The acquisition of the Barry Company's property would involve also that of the Barry adjunct or "feeder," the Vale of Glamorgan, and thus the Great Western Railway would gain a second route for its already congested mineral traffic between the coal valleys converging at Bridgend and the ports upon its main line.

CASTING PUMP PIPES.

THE following paper from the pen of a foreman moulder will be found instructive, we believe, by many of our readers. It describes Scotch foundry practice, which differs in some respects from that of English foundries:—

The writer in introducing this subject will endeavour, as far as possible, to do without the aid of drawings, and the sketches employed are not drawn to scale. At Fig. 1, in cross section form, is the box with the pattern rammed. As there is nothing of special importance in so far as the ramming up of a pump pipe is concerned, it would only be waste of time to dwell on this point, as the sketch should make itself sufficiently clear.

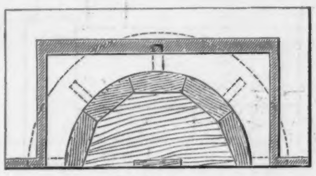


FIG. 1

Fig. 2, a longitudinal section, shows the core bar perforated with holes, to allow the gas which forms in casting to find its way of escape. The core is composed of straw rope and loam. To make a good core suitable in every way, about 2in. should be allowed for the thickness of the straw and loam. The first coat should have one course of straw rope about 1in. thick, rubbed up with black loam while revolving on the core tressels. In callipering, leave about ¾in. for the second coat, which is the finished size of the core, whatever that may be. The loams are generally known as black and red; to the writer's mind the terms are misnomers. He prefers to call them first and second coat loam. The first may be made of any old black sand, providing it is given sufficient plasticity through the addition of the requisite amount of earthy clay. It matters little though the core should be cracked, so long as the loam keeps firm to the straw ropes. Second coat loam is made from river sand. This sand has generally sufficient cohesiveness and porousness, If it is wanting in either it is easily toned by adding clay to bring up the required cohesion. On the other hand, should it have an over abundance of clay, it can be reduced to a proper consistency by the addition of sea sand. Some foundries through force of circumstances are compelled to use sea sand, with clay added, for this sort of loam. This must be a disadvantage, as sea sand has none of the properties that go to make a good loam; in consequence of it being small in grain it is bad for venting, and likewise it is altogether free of plasticity, which is an absolute necessity in second coat loam. If the core after being coated and dried, when taken from the stove should show itself too severely cracked and somewhat glazed on the surface, it may be regarded as a doubtful core.

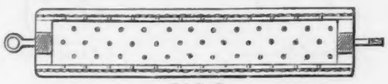


FIG. 2

To avoid possible blistering of the casting, all apparent glaze should be removed by carding before blackwashing. The cracks and hard glaze are the result of too much clay in the loam; that being so, it is easily rectified by a judicious application of sea sand. Any other substitute entirely free from plastic matter, such as sawdust, will also improve its porousness for venting. Finishing and drying the mould may be passed by, as the knowledge how to do it can only be acquired through long and continued practice. The longitudinal section—Fig. 3—shows everything in position previous to casting. In this section is seen the mould finished, cored, closed, and ready for casting. The sand of which the mould is composed is known as rock sand, a rotten sandstone unsuitable for builders. The more rotten it is the better suited it is for moulding purposes. It must have porousness for easy venting, combined with cohesiveness to keep it well in form, to enable it to make a sufficiently strong mould. A, Fig. 3, shows the flow gates.

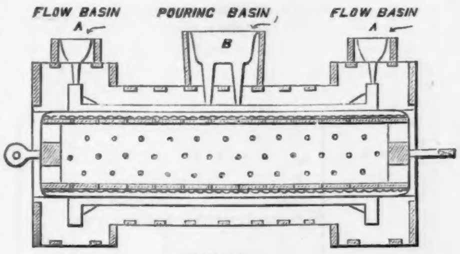


FIG 3

The flow gates are employed for the specific purpose of brightening up the flanges. Without their use the impurities floating on the surface of the metal would find their way to this, the highest part of the mould, and, along with the dullest of the metal, which is always in front, would thus spoil the casting. B, in Fig. 3, shows the pouring gate with its basin. It is necessary that the basin should be sufficiently large to enable all scum which may be floating on the metal still to keep floating in the basin. It is for want of this provision being made that many good moulds are lost, through the metal dropping direct from the ladle to the mould. This is a most important matter in every form of casting. Having thus far shown the various stages in moulding a pump pipe, the writer will next show the three positions of casting, and give their consequent results—(1) Horizontal position; (2) "on the bank," or, as may be more technically put, at 45 deg.; (3) the vertical position. (1) Fig. 4, showing the horizontal position with gates on the top side of the casting, will assist in conveying to the reader how oxide is formed and destroyed, as is also shown in cross section at Fig. 5. The reader must fancy the molten metal striking the top side of the core and finding its way rapidly to the bottom. The moment it reaches the bottom of the mould oxide begins to form, and increases in quantity until the mould is half filled. In cross section at arrows 1 and 2 will likewise be observed the molten metal, shown in bulby form. This is the form it takes when its surface is heavily laden with oxide.

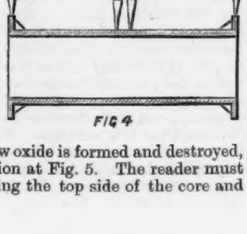


FIG 4

From this point it must be apparent, as the metal with its oxide rises to arrow No. 3, it is seized by the hot metal coming from the pouring gates, which destroys all oxide and passes into combination with all other impurities akin to cast iron. This running of the mould from the highest part of the body in a great measure removes the danger of blistering and cold shot, which is common to horizontal pipe casting. (2) Fig. 6, "on the bank," or at the angle of 45 deg. position, may be said to be *the* position for casting pump pipes. The arrow shown in sketch, with the aid of the bulb as representing oxide of iron, shows the most defective part when cast in this position. This oxide, which is the parent stage of cold shot, is formed through the long run the metal has from its entering the basin, passing down through the gates, then running to the extreme bottom of the mould, and rising up over the back of core, as shown by the arrow. Should the metal when casting be of a pale cherry red, and not milky-white colour, oxide is greatly intensified. Be it observed, this the bottom end is the most defective part, notwithstanding its greater compression when casting; and the only way to avert this possible danger is to cast at a milky-white heat, though it should be at the expense of a rough casting, for if once this oxide bulb be formed, there is no compression capable of destroying it. This oxide bulb is commonly called cold shot. Cold shot may be said to be analogous to a knot in wood, the surface appearing sound and perfect, and the defective part or parts only revealing themselves when under pressure of steam or water.

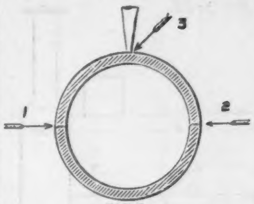


FIG 5

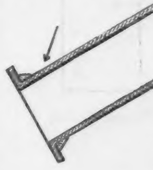


FIG. 6.

Fig. 7 at top end, flaked and dotted, shows the only defective part or parts possible when a pipe is cast on end. In this position there are no such defects as cold shot, blistering, or unequal thicknesses possible, providing ordinary care be exercised by the moulder. The defects as shown in Fig. 7 are caused through the molten metal having such a lengthy drop to the bottom of mould. It is almost impossible for it to strike the bottom without creating more or less dust, should nothing worse happen. This dust accumulates when the mould is in the act of filling, and along with what oxide it gathers can only produce results as shown in sketch. Were one to analyse the contents of the top end of the casting it could only prove to be metal of a very doubtful character. Again, there are other troubles to contend with in this position, viz., vacuum holes created through "draw," "setting down," or solidification. These all concentrate themselves in the top end. Thus it will be seen, although this position is highly favoured in many points, the good is more than counterbalanced in the other ways enumerated. Therefore, unless it be to secure a proper "bore," such as is necessary in a working barrel or cylinder, vertical casting is not commendable. In short, were this a casting 15ft. to 20ft. long, it would take no small amount of trimming before satisfaction could be attained under a hydraulic test. To show how in a great measure one can obviate the ills that accompany vertical casting, the writer gives, Fig. 8, the arrow 1 pointing to a dead head, to be subsequently cut off. There is a provision made in the mould to receive the impurities that are floating on the metal while the mould is in the act of filling. But this dead head is not always satisfactory. If we can imagine the metal rising up past the flange at the arrow 2, it will be seen how impurities on the surface are partially trapped, and in consequence never reach the sinking head at all, the casting showing an imperfect face when the sinking head is cut off. The best part of it will be right round the core, that part having an uninterrupted rise to the highest part of the mould.

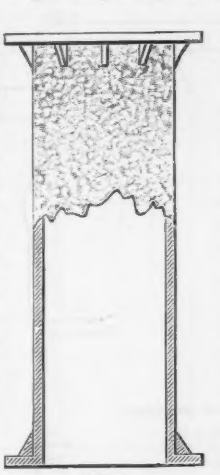


FIG. 7.

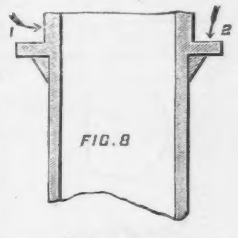
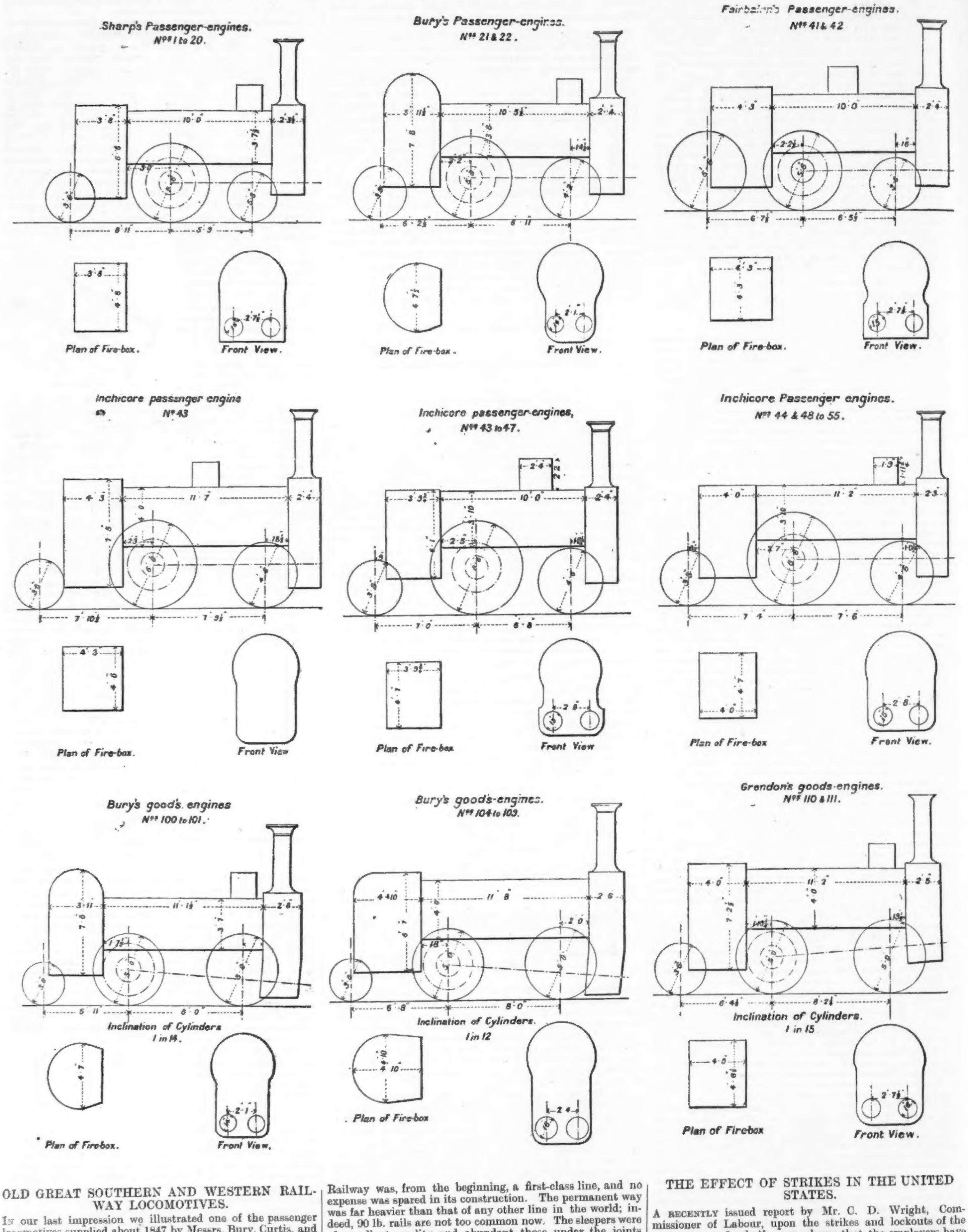


FIG. 8

Regarding the length of the sinking head, the longer the better; but if it be the first part of the casting to "set down," or solidify, it is entirely useless. The point to observe is to make it so heavy that it will be the last part to set, as it is from this reserve the natural demands of the casting are supplied, viz., feeding to solidify the entire casting during the process of cooling.

THE SUNFISH TRIALS.—The average of three hours trials of the torpedo boat Sunfish recently gave 27·581 knots per hour. The mean speed for six runs over the measured mile on the Maplin was 28·082 knots. Going with wind and tide, she performed knot after knot under two minutes. The mean steam pressure in the boilers was 188 lb. per square inch, and the mean revolutions were 351·2 per minute. The average indicated horse-power developed by the engines during the trials was 4174.

EARLY LOCOMOTIVES, GREAT SOUTHERN AND WESTERN RAILWAY, IRELAND


Sharp's Passenger-engines.
Nos 1 to 20.
Plan of Fire-box.
Front View.
Bury's Passenger-engines.
Nos 21 & 22.
Plan of Fire-box.
Front View.
Fairbairn's Passenger-engines.
Nos 41 & 42
Plan of Fire-box.
Front View.
Inchicore passenger engine
No 43
Plan of Fire-box.
Front View
Inchicore passenger-engines,
Nos 43 to 47.
Plan of Fire-box
Front View
Inchicore Passenger engines.
Nos 44 & 48 to 55.
Plan of Fire-box
Front View.
Bury's goods engines
Nos 100 to 101.
Inclination of Cylinders
1 in 14.
Plan of Firebox.
Front View.
Bury's goods-engines.
Nos 104 to 109.
Inclination of Cylinders.
1 in 12
Plan of Fire-box
Grendon's goods-engines.
Nos 110 & 111.
Inclination of Cylinders.
1 in 15
Plan of Firebox
Front View.

OLD GREAT SOUTHERN AND WESTERN RAILWAY LOCOMOTIVES.

In our last impression we illustrated one of the passenger locomotives supplied about 1847 by Messrs. Bury, Curtis, and Kennedy, to the Great Southern and Western Railway of Ireland.

Through the kindness of Mr. Ivatt we now give a number of diagrams supplying the leading particulars of the early locomotives on that line. It will be seen that there was no standard. For the most part the line is level; the only really heavy bank on it being that from the Kingsbridge terminus in Dublin to Inchicore. The conditions are wonderfully like those of the London and North-Western between Euston and Chalk Farm. In the early days tickets were collected at Inchicore, and then the engine was detached, the train running down to the terminus by gravity. We are unable to add any information to the diagrams. There is no date on the chart, but it is probably 32 years old, and the ink has in many places faded. The Great Southern and Western Railway was, from the beginning, a first-class line, and no expense was spared in its construction. The permanent way was far heavier than that of any other line in the world; indeed, 90 lb. rails are not too common now. The sleepers were of excellent quality and abundant, those under the joints were 18in. to 24in. wide; in many cases slabs of beech; the flanged rails were secured by hooked spikes. But for lack of money the renewals and repairs were few, and twenty years ago the line was, perhaps, the worst in the world. The iron rails had become crystalline, and broke with great ease. On the branches lengths of six or seven feet, and not infrequently lengths of but three feet were abundant. But the reconstruction of the permanent way has been energetically carried on, steel rails in chairs have been laid, and now the main line is excellent, and little fault is to be found with the branches. No doubt the bad condition of the rails was very trying to the locomotives, and the performance mentioned in our last impression bears the fuller testimony to the excellence of the engines made by Messrs. Bury, Curtis, and Kennedy.

THE EFFECT OF STRIKES IN THE UNITED STATES.

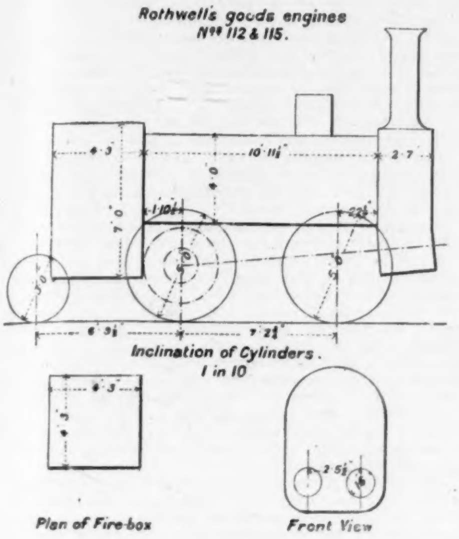
A recently issued report by Mr. C. D. Wright, Commissioner of Labour, upon the strikes and lockouts of the past seven and a-half years, shows that the employers have lost 29,000,000 dols. and the men 35,000,000 dols. During this period the State of Illinois had the largest number of establishments affected, both by strikes and lockouts, there having been 10,060 of the former and 1193 of the latter. New York came second on the list, with 9540 establishments involved in strikes and 723 in lockouts, and Pennsylvania third, with 8219 strikes and 490 lockouts.

The industries most affected by strikes were the building trades, with 20,785 establishments involved; coal and coke, with 5958; clothing, with 3041; tobacco, with 2506; food preparations, with 2398; stone quarries and cutting, with 1993; metals and metallic goods, with 1834; transportation, with 1327; printing and publishing, with 608; boots and shoes, with 607; furniture, with 459; wooden goods, with 409;

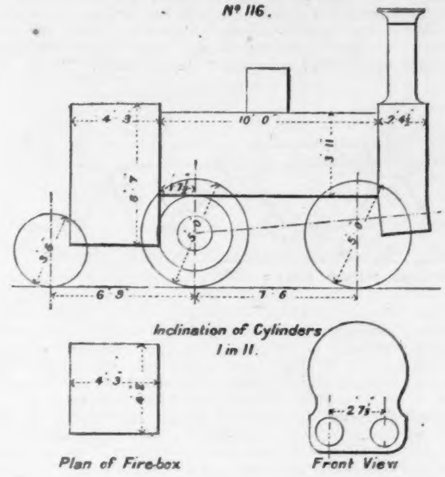
EARLY LOCOMOTIVES, GREAT SOUTHERN AND WESTERN RAILWAY, IRELAND

(*For description see page 80*)

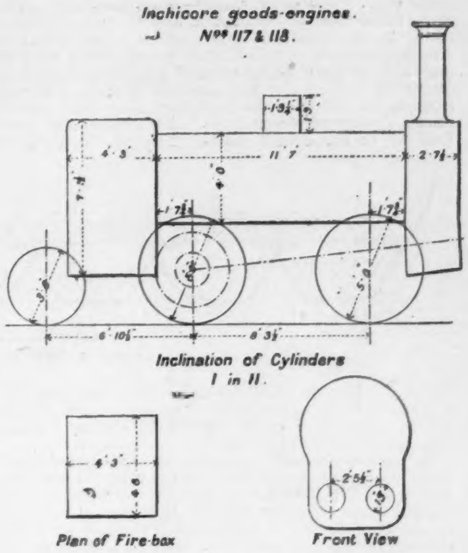
Rothwell's goods engines
Nos 112 & 115.


4·3
10·11½
2·7
4·0
7·0
1·10½
2·2½
3·0
5·0
5·0
6·3½
7·2½
Inclination of Cylinders.
1 in 10
4·3
Plan of Fire-box
2·5½
Front View

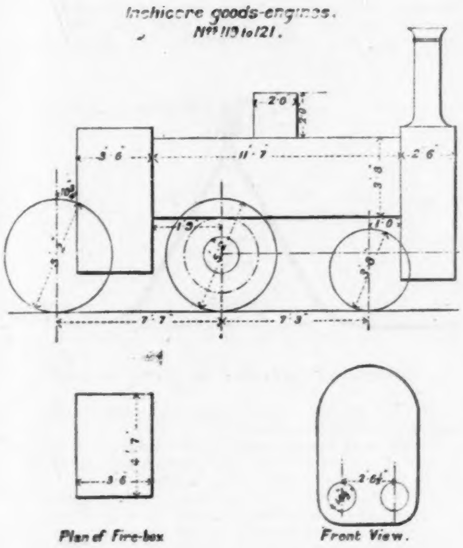
Fairbain's goods engine.
No 116.


4·3
10·0
2·4½
3·11
6·7
1·7½
3·6
5·0
5·0
6·3
7·6
Inclination of Cylinders
1 in 11.
4·3
Plan of Fire-box
2·7½
Front View

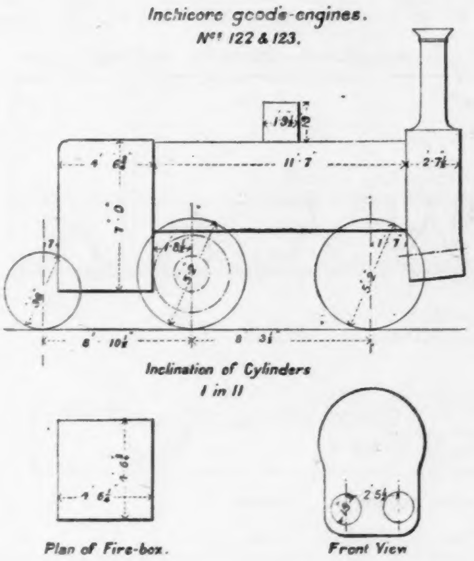
Inchicore goods-engines.
Nos 117 & 118.


1·3½
4·3
11·7
2·7½
4·0
7·8
1·7½
1·7½
3·6
5·0
5·0
6·10½
8·3½
Inclination of Cylinders
1 in 11.
4·3
4·6
Plan of Fire-box
2·5½
Front View

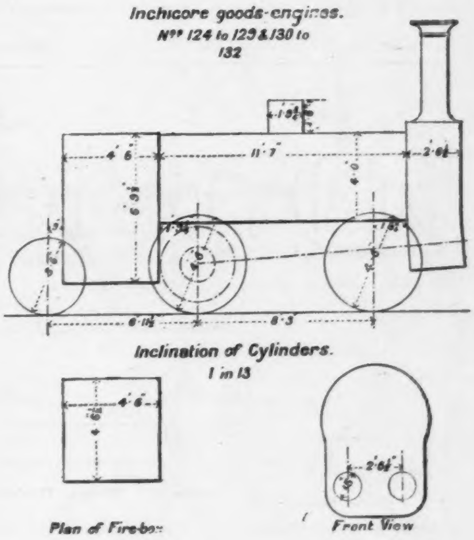
Inchicore goods-engines.
Nos 113 to 121.


2·0
2·0
3·6
11·7
2·6
3·8
1·5
1·0
3·3
3·0
7·7
7·3
4·7
3·6
Plan of Fire-box
2·6½
Front View.

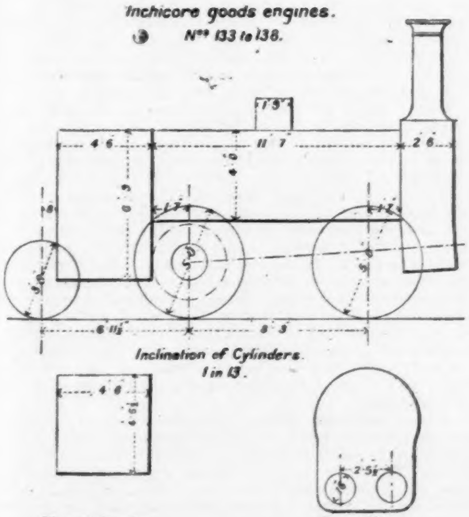
Inchicore goods-engines.
Nos 122 & 123.


1·3½
2
4·6½
11·7
2·7½
7·0
1·8½
1·7
5·2
6·10½
8·3½
Inclination of Cylinders
1 in 11
4·6½
4·6½
Plan of Fire-box.
2·5½
Front View

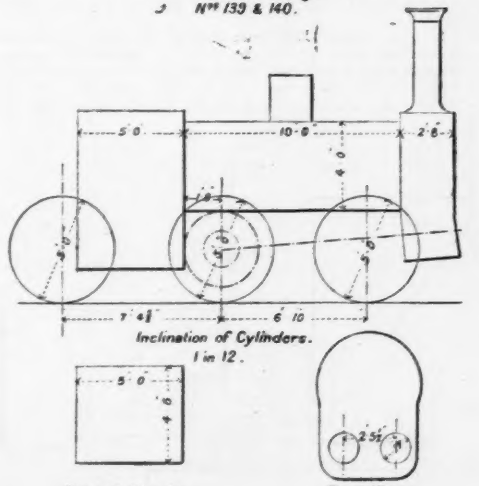
Inchicore goods-engines.
Nos 124 to 129 & 130 to
132


1·3½
4·6
11·7
2·6½
4·0
6·9½
1·3½
1·8½
6·11½
8·3
Inclination of Cylinders.
1 in 13
4·6
4·6½
Plan of Fire-box
2·6½
Front View

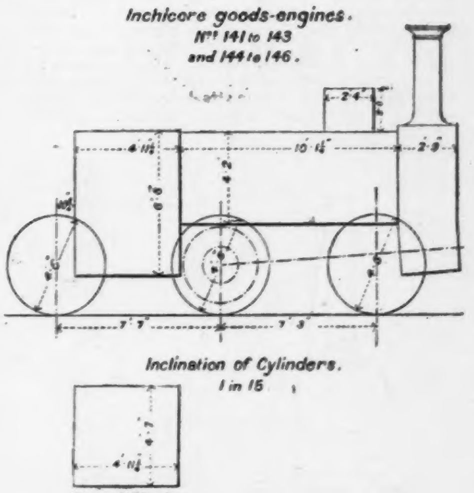
Inchicore goods engines.
Nos 133 to 138.


1·3
4·6
11·7
2·6
4·0
6·9
1·7
1·7
5·0
5·0
6·11½
8·3
Inclination of Cylinders.
1 in 13.
4·6
4·6½
Plan of Fire-box
2·5½
Front View.

Inchicore good's engines.
Nos 139 & 140.


5·0
10·6
2·8
4·0
1·6
5·0
5·0
5·0
7·4½
6·10
Inclination of Cylinders.
1 in 12.
5·0
4·6
Plan of Fire-box
2·5½
Front View

Inchicore goods-engines.
Nos 141 to 143
and 144 to 146.


2·4
4·11½
10·1½
2·9
4·2
6·8
10½
7·7
7·3
Inclination of Cylinders.
1 in 15
4·7
4·11½
Plan of Firebox

and brick, with 406 establishments. Those most affected by lockouts were the building trades, with 1900; stone quarrying and cutting, with 489; clothing, with 431; brewing, with 150; boots and shoes, with 130; metals and metallic goods, with 128; and transportation, with 112 establishments involved. The total number of employés involved or thrown out of employment during the period covered by the report was 2,391,203.

The States in which the majority of the strikes and lockouts were located were five in number, and were respectively Illinois, Massachusetts, New York, Ohio, and Pennsylvania. The strikes in this quintet of commonwealths were about 70 per cent. of the whole number of establishments in the United States affected by strikes, while the lockouts were about 76 per cent. of all those throughout the country. The report shows that these five States contained 51 per cent. of all the manufacturing establishments, and employed 56 per cent. of the capital invested in the mechanical industries of the country, taking the census of 1890 as the basis of computation.

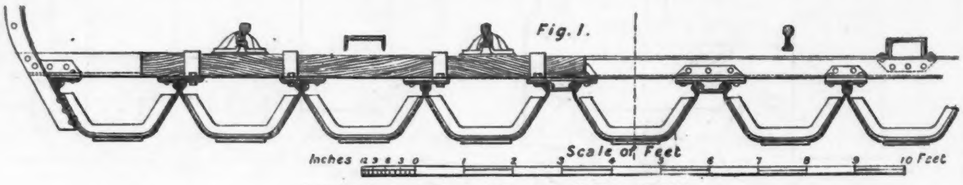
In New York City the wage loss of employés was nearly 6,500,000 dols., exclusive of 792,000 dols. contributed to them by other labour organisations, while the loss of employers was a little more than 3,500,000 dols. The number of strikes in Boston was 257, with a loss to the employés of 800,000dols., as agains 589,000 dols. for the employers. The total number of strikes in Allegheny and Pittsburg was 251, but the loss of wages was 7,379,765 dols., while the loss to employers was 2,600,000 dols. In Chicago, where the strikes aggregated 528, the loss to employés reached nearly 9,000,000 dols., while that of the employers was nearly 14,500,000 dols. In Paterson, N.J., where the number of strikes was only 47, the loss to employés was more than 1,000,000 dols., as against half that sum for the employers. The total wage loss to the employés in twenty-six leading manufacturing cities was in round numbers 35,000,000 dols., while the loss to employers was something less than 29,000,000 dols.

The number of lockouts as compared with the strikes for the same period was small in the aggregate, but the losses incurred were enormously increased. The total was 244 lockouts, with a loss of wages to the employés of 12,000,000 dols., while the loss of employers was nearly half that sum.

For the period covered by the report, out of the 46,863 establishments affected by strikes, success in their demands was gained by the employés in 20,397; partial success was gained in 4775 establishments, and failure followed in 21,687 establishments. Out of the 3853 establishments having lockouts, 1883 succeeded in gaining their demands; 391 partially succeeded, and 1558 failed. The leading cause of strikes was for an increase of wages, and these represent 25 per cent. of the whole number. 13 per cent. were for reduction of hours; 8 per cent. were against reduction of wages; 7 per cent. were sympathetic; 6 per cent. were for increase of wages and reduction of hours; 4 per cent. were against employment of non-union men, and 3 per cent. for a recognition of the union. The remainder of the strikes are attributed to a number of other causes of no especial general interest.

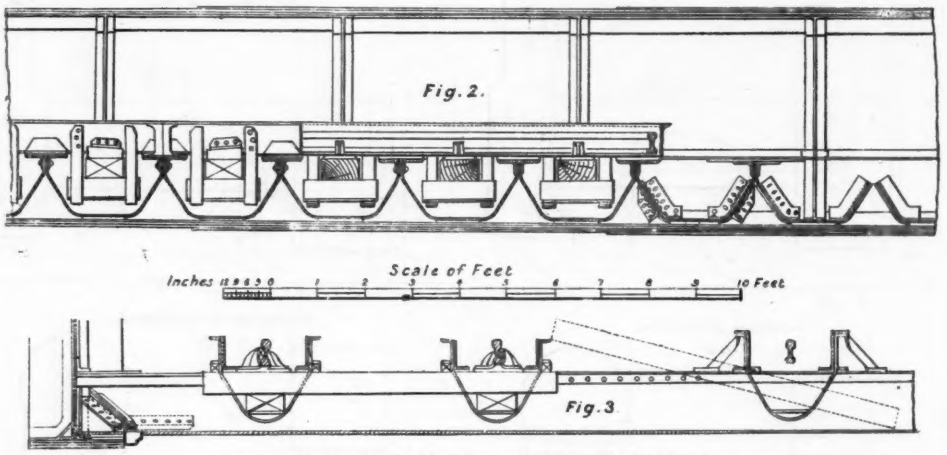
BARKER'S BRIDGE FLOORING.

RAILWAY engineers in this country have employed various corrugated floorings in their bridge work for a number of years. So far back as 26th October, 1865—thirty years ago—the late Mr. Thomas Russell Crampton applied for a patent for corrugated floorings, built up of sections of convenient size, stamped, pressed, or rolled from plates. Since that time quite a number of "improvements" have been devised, and corrugated floorings are often now used in bridge work where cross girders with flat or buckled floor plates used to be the rule. Corrugated floorings are also undoubtedly making headway in the United States. They are in use on the Illinois Central Railroad, the Lake Shore and Rock Island Elevated Railway, and elsewhere. They are also to be employed in the construction of the New York Central four-track viaduct over the Harlem River.

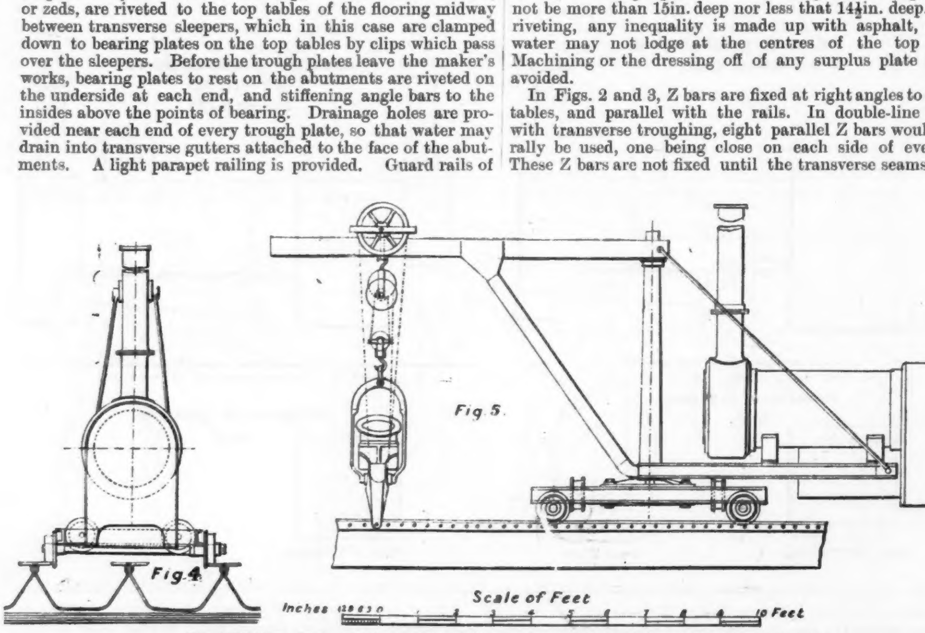


BARKER'S BRIDGE FLOOR FOR SHORT SPANS

We recently illustrated a number of the most used forms of bridge floor—THE ENGINEER, 18th and 25th October, 1895—and we now illustrate a new steel flooring which has been brought to our notice by Mr. Gerald Barker, of 1, Victoria-street, Westminster. It will be seen to possess novel features, although, in common with other systems, it is largely composed of bent plates, which in this case form troughs. The trough plates are placed side by side. A stiff angle bar is attached to each side of the ridge formed by the abutting sides of adjacent trough plates. Fig. 1 shows these plates laid longitudinally in the case of short spans. Transverse Z irons, or zeds, are riveted to the top tables of the flooring midway between transverse sleepers, which in this case are clamped down to bearing plates on the top tables by clips which pass over the sleepers. Before the trough plates leave the maker's works, bearing plates to rest on the abutments are riveted on the underside at each end, and stiffening angle bars to the insides above the points of bearing. Drainage holes are provided near each end of every trough plate, so that water may drain into transverse gutters attached to the face of the abutments. A light parapet railing is provided. Guard rails of inverted channel section are riveted to the transverse zed irons in the centre of each four-foot way.

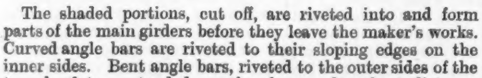


BARKER'S BRIDGE FLOORS WITH TRANSVERSE TROUGHS



DE BERGUE AND CO.'S STEAM RIVETTING PLANT FOR BARKER'S FLOORS

Figs. 2 and 3 show a plate girder bridge in longitudinal and transverse sections. In this case the trough plates are laid transversely, and the ends of the trough plates are cut on a slope, thus—



The shaded portions, cut off, are riveted into and form parts of the main girders before they leave the maker's works. Curved angle bars are riveted to their sloping edges on the inner sides. Bent angle bars, riveted to the outer sides of the trough plates, extend down the slope and a short distance along the sides of the trough plates near the bottom. Short lengths of flat bar are fixed across the cut sloping ends of the trough plates, and riveted to the outside bent angle bars before erection. The width of these flat bars is equal to the width of the outside angles + the thickness of the trough plate + the width of the inside angles. When the trough plates are in position the inner halves of these flat bars become interposed between the curved angle bars on the insides of the trough plates and those on the insides of the short lengths of trough plate which had previously been riveted to the main girders. The rivets to be put in after erection pass through the inside angles of trough plates, the flat bars, and the angles riveted to short lengths of trough plate. A riveting machine with a very small gap can do this work, and all riveting through main girder webs at the site is avoided.

The pairs of angle bars which form the top tables of the flooring extend from web to web of main girders. Horizontal gusset plates may be used, as shown, to connect the top tables of the flooring to angle bars, which run between the stiffeners of the main girder webs. The web stiffeners on each side of the main girders extend from flange to flange. Longitudinal guttering is attached to the inside edge of the bottom flange of each main girder. Both long and short lengths of trough plate drain into these gutters. Down spouts are provided at the four corners of the bridge.

It will be noticed that the edges of all the trough plates are shown to fall short of the level of the top tables of the flooring, the reason being that half an inch allowance is here made for inequalities in the edges of the plates. In other words, the trough plates for a flooring of 15in. depth must not be more than 15in. deep nor less that 14½in. deep. After riveting, any inequality is made up with asphalt, so that water may not lodge at the centres of the top tables. Machining or the dressing off of any surplus plate is thus avoided.

In Figs. 2 and 3, Z bars are fixed at right angles to the top tables, and parallel with the rails. In double-line bridges with transverse troughing, eight parallel Z bars would generally be used, one being close on each side of every rail. These Z bars are not fixed until the transverse seams of the flooring have been riveted. The Z bars are then laid level, or parallel to the gradient of the railway. Packing plates, about 11in. by 7in., and of varying thickness, are inserted between the undersides of the Z bars and the top tables of the flooring. When a bridge is temporarily erected in the maker's works, these packings may then be adjusted and attached to the Z bars by a couple of extra rivets, countersunk on the underside. This would reduce the number of loose parts to be conveyed to the site, and would save considerable time in erection. These eight Z bars give great lateral support to the top tables, and divide their lengths into nine bays, the longest of which is about 4ft.

In all cases cross sleepers may be used with this flooring. In Figs. 2 and 3 they are supported on longitudinal timber packings of the same scantling as the sleepers—10in. by 5in.—and about 1ft. 9in. long. These packings rest on either wrought or cast iron bearing plates suspended in a pair of transverse loops or stirrups composed of flat or angle bars. The ends of these loops or stirrups are riveted to the webs of the pairs of longitudinal Z bars. As the stirrups are short a large factor of safety may be allowed without extravagance. The rivets are merely subjected to shearing stress, and there are no sharp bends in the stirrup loops. The sleepers are shown to be held down on their respective packings by hard wood keys or wedges driven between the tops of the sleepers, and inclined angle iron chubs riveted to the webs of the longitudinal Z bars. The use of bolts is thus avoided, but, of course, there are other methods of securing the sleepers. Junctions, crossings, and turn-outs are not often met with on bridges; but where they do occur special arrangements of Z bars and sleepers are provided.

This form of flooring is not limited in its application to plate girders or lattice girders of multiple triangulation. The trough plates are not cut obliquely, as in Figs. 2 and 3, but are each in one piece, from girder to girder. The horizontal rivets through end angles of trough plates and sides of main girder booms have only shearing stress to resist all pull upon them, through deflection of the flooring, being obviated by horizontal ties across the main girder booms. These ties extend some little distance along the top tables of the flooring. Diaphragm plates, about 5ft. apart, are fixed in the girder booms; or, with a slight alteration in the web members, short lengths of trough plate may be fixed in the booms with short top table angles attached. Cover strips may then be used at every top table. The material required for this flooring consists of ordinary trade sections, and the plates are of dimensions easily obtained and bent to the required shape. The rest is merely a matter of drilling or punching, and riveting. All parts are made interchangeable.

The heaviest pieces of this flooring weigh about 15 cwt. each, and as there are plenty of holes along the upper edges of the troughs, there should be no difficulty in attaching lifting tackle. The trough plates only require to be "landed" in position; no "threading-in" is needed, and being somewhat of wedge shape, the last plate makes a place for itself. The pairs of angle bars which form the top tables of the floor may be fixed after all the trough plates are in position, or may be attached concurrently with the fixing of the plates. The riveting of the seams immediately under the top tables is then proceeded with.

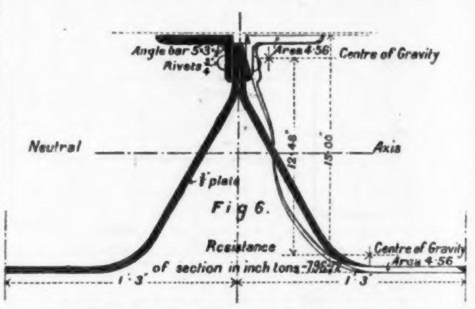


DIAGRAM OF STRESSES IN FLOOR TROUGHS

The whole of the operations of erecting and riveting can be carried out without any scaffolding alongside or underneath the bridge. There is, therefore, no possibility of timber, tools, or rivets falling below. This is undoubtedly an advantage when a bridge is being constructed over traffic of any kind. Men engaged on the work are also saved considerable risk of accident. Every rivet can be put in by machine, a portion at the maker's works, the remainder after erection. Machine riveting is decidedly preferable to handwork. No better proof of this can be given than when hand and machine rivets require to be cut out. When the head has been cut off the former, it can generally be driven out, but it is often necessary to drill out the machine rivet, as it completely fills every irregularity in the holes.

Figs. 4 and 5 illustrate a portable steam riveting plant specially designed by Messrs. De Bergue and Co., Limited, of Manchester, for the riveting of this flooring. It will be seen to consist of a rolling carriage traversing the top tables of the flooring. A small jib crane swivels on a centre standard bolted to this carriage. One of Allen's patent riveting machines is suspended from a roller which can be run in or out along the horizontal jib by means of an endless chain. A horizontal boiler, working at a pressure of 70 lb. per square inch, is carried at the tail end of the crane. The riveter may be either of horseshoe or clipper type. These machines are so generally used by bridge builders in conjunction with an air compressor and receiver, that we need not describe them in detail. Illustrations of Messrs. De Bergue's portable pneumatic plant appeared in THE ENGINEER, vol. lxxv., pages 71, 73, and 75. In this case, however, steam is conveyed from the boiler to the valve chest of the riveting machine by flexible hose.

Messrs. De Bergue's steam riveting plant dispenses with the air compressor and receiver of their pneumatic plant, or the pumps and accumulator of portable hydraulic riveting plant. While the riveter is working, steam must be kept up to ensure uniform quality of work. A 10in. cylinder is sufficient for 1in. rivets. A rivet-heating furnace can also be provided on the rolling carriage. A second set of wheels is fitted at right angles to the other set, and at a higher level. When the machine has riveted the seams within its reach, the carriage is jacked up, a pair of rails laid across the top tables of the flooring, and the crane carriage conveying the complete riveting plant runs on the second set of wheels to the next lot of seams which require its attention, and is there lowered once more on to the top tables.

The trough plates may be closely and firmly clamped together over the whole of their abutting surfaces, if machine riveting is employed. The friction between surfaces so clamped together is undoubtedly of great value.

No ballast is used with this flooring. Ballast on an iron floor is objectionable, as it produces oxidation and shortens the life of a floor. It also adds to the weight of a bridge, and increases the cost of flooring and main girders. Mr. Barker's flooring is designed to be water-tight. It will be observed that water falling upon it drains to gutters below each end of every trough, which are so placed that they prevent water reaching the connection of the flooring to the main girders, which is often a very leaky place.

In Fig. 1 each cross sleeper equally divides its load between four top tables, and brings four complete sections of the flooring into action. In Figs. 2 and 3 it will be seen that—without making any allowance for the distributive qualities of the longitudinal zeds, to which the live load and the weight of the permanent way are applied before reaching the top tables—the load on any sleeper is equally divided between eight points on the two adjacent top tables. But the longitudinal zeds do undoubtedly carry portions of the loading to the top tables 3ft. 9in. distant from the centre of the sleeper, and even to the tables beyond, with but slight deflection in the troughing. It is generally admitted that a shallow floor distributes the loading better than a deep floor, but that the deep floor is stiffer. Excessive deflections tend to loosen the riveted connections.

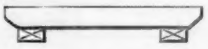
In determining the proportions of a corrugated flooring, it is generally assumed that the load on a pair of wheels of a locomotive is spread over a length of about 7ft. of railway. Now it is claimed that in the flooring under notice the four longitudinal zeds—8in. deep—to each line of rails distribute the concentrated sleeper load almost equally over sixteen points on four top tables, and with very slight deflection call upon four complete sections to sustain that load.

If we take 18 tons as the maximum sleeper load, and 90in. as the distance from bearing on main girder to centre of gravity of the two driving wheels of the engine, we get a bending moment, $M = 18 \times 90 = 1620$ inch-tons. In Fig. 6, the effective area of a single section of Barker's flooring is graphically shown by the white spaces on the right-hand side of the section. The effective area of the complete section is 9·12 square inches, the effective depth is 12·48in. Taking 7 tons per sq. in. as safe working stress, we have the resistance of this flooring, $R = A \times D \times 7 = 9{\cdot}12 \times 12{\cdot}48 \times 7 = 796{\cdot}72$ inch-tons. The gross depth of this flooring, as shown in these drawings, is 15in. Its weight, including everything except rails, sleepers and fastenings, is 55 lb. per square foot covered.

If we leave the safe working stress out of the question, we have a moment of resistance in this flooring of $A \times D = 9{\cdot}12 \times 12{\cdot}48 = 113{\cdot}8$. If we assume that the sleeper load of 18 tons is only divided over two sections of this flooring, and that the longitudinal zeds have no distributive powers whatever, then we have a bending moment of $\frac{1620}{2}$ on each section. The maximum stress on the flooring would, even under these conditions, only amount to $\frac{810}{113{\cdot}8} = 7{\cdot}1$ tons per square inch of section. If three sections equally share the load, the stress is 4·7 tons per square inch.

As it appears, however, with slight deflection, that four sections will share the load, there seems to be no question as to the strength of this flooring. The zeds give great lateral support to the top tables, and enable them to resist heavy compressive stress. By reason of these distributing girders the seams are not liable to have their rivets loosened by deflection waves in the floor. Excessive local deflection cannot occur.

Every portion of this flooring is accessible for inspection and painting. With this flooring the ordinary rails, sleepers, and fastenings are used as on other portions of the railway. Any sleeper may be readily removed, without interrupting the traffic, by first packing up the rails from adjacent top tables and drawing the four wedges. The sleeper is then drawn a couple of feet towards the main girder. The packing in the pair of stirrups next six-foot way is removed, and the sleeper drawn back towards the six-foot way and bodily removed, as shown in dotted outline—Fig. 3. On single-line bridges the sleeper ends are cut thus,



to allow of their being drawn out in the four-foot way. No timber comes in contact with the trough flooring. In some iron bridges plates and bars have been seriously corroded and eaten away by contact with wood containing acids.

When the trough plates are laid transversely between main girders, as in Figs. 2 and 3, there is a vertical depth of 10in. of timber between the undersides of the chairs and the tops of the bearing plates in the stirrups. This should afford a good cushion between the rails and the steel work of the bridge. In these cases also the depth from top of rail to underside of floor is less than 2ft. in double-line bridges without centre girders. The top of rail is about 7½in. above floor surface. In Fig. 1 there is a practically continuous floor for a derailed locomotive to run on, the gaps between sleepers and transverse zeds being only about 8in. The tops of the sleepers may with advantage be kept a little above the zeds, as wheel flanges would cut into the former. The inverted channel guard rail is provided to keep derailed vehicles within the width of the sleeper track. When the troughing is laid transversely, as in Figs. 2 and 3, an even more continuous floor is provided, there being only 4½in. gaps between sleepers and top tables. The longitudinal zeds form efficient "guard baulks" on each side of every rail. These zeds also acting as distance pieces between top tables, check vibration and lessen the humming noise noticeable in some curved plate floors.

In conclusion, we would just point out that longitudinal timber sleepers or "way beams" are very troublesome either on flat plate or corrugated floorings, as, by reason of the longitudinal camber in the main girders, and the transverse camber in the flooring—to say nothing of local inaccuracies, cover strips and rivet heads—they have to be adzed and fitted to the ironwork. They conceal a considerable portion of the surface and render it inaccessible for inspection and painting. As the sleepers usually "break-joint" with the rails, it is necessary to take out two rails before one sleeper can be removed. Longitudinal sleepers afford little protection to a floor in case of derailment, but, on the other hand, increase the risk by raising the rail further above floor level.

As already mentioned, cross sleepers may be used with the flooring described. When the longitudinal zeds have once been fixed level or parallel to the gradient, the cross sleepers require no adjustment, as all the stirrup loops are of one depth. Cross sleepers afford considerable protection to a trough flooring, as they assist in receiving and bearing the brunt of the shock in the case of a derailed locomotive, carriage, or truck.

THE total approximate cost of the work executed in connection with the construction of the Blackwall Tunnel up to the end of December last is £573,560, of which £10,096 represents the value of the work done on the raised approach road. The cost of the operations during the past year was £106,703. On the south side of the river the cut and cover work was completed; and on the north side, out of a total length of 436ft., 398ft. had been executed. The caissons—see THE ENGINEER of 27th December last—for all the shafts are now sunk to their final level.

A NEW INTEGRATOR.

By A. RUSSELL, M.A., and H. H. P. POWLES, A.M.I.C.E.

MANY ingenious and practical forms of integrators have been devised,* but any integrator other than Amsler's is seldom met with outside the laboratory of a technical college, although Coffin's averager, as made by the Globe Engineering Company, Manchester, for indicator diagram work, is a good deal used. The great obstacle to their more general employment is their initial cost, an investment, by the way, that is very often justified, as Amsler's planimeter can be applied to perform almost any integration if we make some necessary graphical constructions first, which are in general very simple. In working out several forms of integrators depending on various mechanical considerations, we were forcibly impressed that nearly all of them to be really useful must be very well made, and therefore very costly. The beautiful simplicity and finished workmanship shown even in a cheap planimeter sets a very high standard for makers of integrating machines. The following integrator, however, is not only an exceedingly accurate instrument, but requires no special skill to construct. If an Amsler's planimeter is available, so that the rolling wheel and gear can be temporarily joined on to the simple wooden framework, then the necessary expense is only a few pence.

The object of the instrument is to measure for a point o $\Sigma\, r\, d\, \phi$, where r is the distance of o from a point on a curve, and ϕ is the angle r makes with a fixed line. All that is necessary, therefore, is to have a wheel rolling on the paper with its axis making a constant angle with r, and its distance from the fixed point always in a constant ratio to r. The length moved round by a point on the circumference of the wheel will then be proportional to $\Sigma\, r\, d\, \phi$.

The instrument shown in Fig. 1, taken from a photograph, is made of parallel pieces of wood, the joint pins being ordinary screws. The centre bar from A to C is double, and the pointer B is carried on a block of wood which slides between the two pieces forming the centre bar. At A the wheel from an Amsler's planimeter is connected by pushing it on to a square piece of wood fixed between the two sides of the centre bar. The anchor point C is fitted to a block of wood which slides freely between the two sides of the centre bar. The sliding blocks to which B and C are attached move quite freely between the bars, and simply keep the axle of the rotating wheel always in the same straight line with the points B and C. The whole arrangement of links and bars can easily be made by anyone who can use ordinary carpenters' tools.

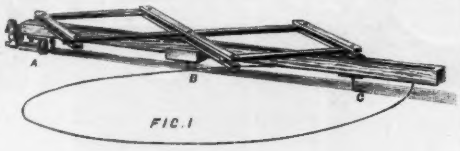


FIG. 1

The best way to calibrate the instrument is to move the pointer round a semicircle of radius r. Suppose the difference between the two readings of the wheel to be A, then the constant of the instrument is $\frac{\pi\, r}{A} = k$. Hence, if we move the pointer over a portion of a curve, and the difference between the readings on the wheel be A^1, then for that portion of the curve $\Sigma\, r\, d\, \phi = k\, A^1$.

The following are a few of the uses to which we have applied this form of integrator, and we have found that errors made in solving problems in this way are generally due to defective drawing, an error of one in a thousand due to reading the instrument being a rare occurrence.

(1) To calculate the elliptic integral, $\int_o^\phi \left\{ 1 - k^2 \sin^2 \theta \right\}^{\frac{1}{2}} d\, \theta$.

With centre A, Fig. 2, and radius A B = R describe a circle B C E. Make A O = k R, and make the angle B O C = ϕ. Let L be the reading of the instrument when the anchor is placed at O and the pointer is moved over B C. Then it is very easy to show that—

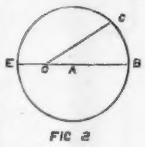


FIG 2

$$\int_o^\phi \left\{ 1 - k^2 \sin^2 \theta \right\}^{\frac{1}{2}} d\, \theta = \frac{L - a \sin \phi}{R}.$$

This integral, which represents the length of the arc of an ellipse, is denoted by E (k, ϕ); k being called the modulus and ϕ the amplitude. It occurs in problems in dynamics, and in many electrical problems.

(2) To calculate the elliptic integral F (k, ϕ)

$$\int_o^\phi \frac{d\, \theta}{\sqrt{1 - k^2 \sin^2 \theta}} = F\, (k, \phi).$$

Describe by any of the ordinary methods an ellipse whose excentricity is k.

Then, Fig. 3, O B being the semi-minor axis, make the angle P O B = ϕ.

Placing the anchor at O, move the pointer over the arc B P, and let the reading of the instrument be L, then

$$F\, (k, \phi) = \frac{L}{O\, B}.$$

This very important integral occurs in the formula for the time of swing of a simple pendulum and in the solution of many other problems in applied mathematics.

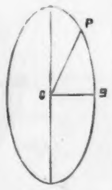


FIG 3

(3) To calculate the magnetic force at any point due to an electric current:

Let A B be the wire, Fig. 4, and let there be A ampères flowing in it, and suppose we wish to find the magnetic force at a point O due to this current.

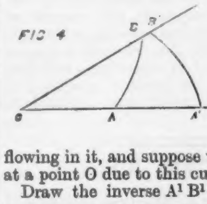


FIG 4

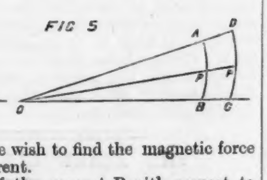


FIG 5

Draw the inverse $A^1\, B^1$ of the curve A B with respect to the point O by means of a Peaucellier linkage or otherwise.

$$\text{Then the magnetic force at O} = \frac{A}{10} \int \frac{d\, \theta}{r} \text{ C. G. S. units.}$$

$$= \frac{A}{10\, k^2} \int r^1\, d\, \theta \quad ,,$$

$$= \frac{A\, L}{10\, k^2} \quad ,,$$

Where L is the reading of the integrator when O is the fixed point, and the pointer is moved over, $A^1\, B^1$ and k^2 is the constant of inversion.

This integrator can also be used for solving many other problems, but the type of problem illustrated is the one which it solves most readily and accurately. One of us formerly used Amsler's planimeter to find $\Sigma\, r\, d\, \phi$ in the following manner:

Let A B be the curve, Fig. 5, and O the pole. Produce O P to p and make P p = k. Construct C D, the curve locus of p, so that A D = P p = B C = k.

Then since

$$\tfrac{1}{2} \int_o^\phi (r + k)^2\, d\, \theta - \tfrac{1}{2} \int_o^\phi r^2\, d\, \theta = k \int_o^\phi r\, d\, \theta + \frac{k^2\, \phi}{2}$$

$$\therefore \quad \int_o^\phi r\, d\, \theta = \frac{\text{area A B C D} - \frac{1}{2} k^2\, \phi}{k}.$$

Hence, the planimeter can be applied to find this integral, and therefore can solve the preceding problems. It is obvious, however, that for accuracy and rapidity an instrument of the form we have described is far preferable.

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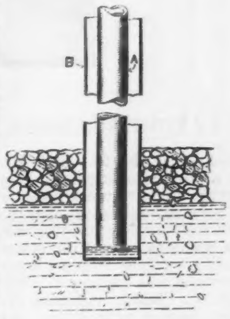
* See "Les Intégraphes, by Professor Abdank-Abakanowicz. Gauthier-Villars, Paris, 1886.

RAISING WATER BY AN AIR PUMP.

IN reporting upon an exhibition in the States, the American *Engineer and Railway Journal* of December says:—"There is one exhibit illustrating the increasing range in the use of compressed air that is made in connection with the Bacon system of increasing the flow of artesian wells by the Knowles Steam Pump Works. The apparatus on the ground is pumping water from a cistern 50ft. below the level of the floor. An air compressor supplies air at a pressure of 10 lb. per square inch, and the delivery is 250 gallons per minute. With a pressure of 35 lb. per square inch, 100 gallons per minute can be raised from a well 250ft. deep. The water is literally blown up, and in order to explain the operation we refer the reader to the accompanying diagram. A is the water pipe, and outside it the casing B is sunk so that the lower end of the latter is a trifle below that of the former. In the water-bearing strata the water level is supposed to stand at C, and it will have a constant tendency to rise about the bottoms of the pipes and enter them. The compressed air that is forced down between the casing and the water pipe drives the water before it, and, as it turns at the bottom to enter the inner pipe, it catches the water at that point and carries it with it in its rush to the surface. The system has been extensively introduced in the South for increasing the flow of artesian wells."



MAIL RECORDS OF TRANSATLANTIC STEAMERS.

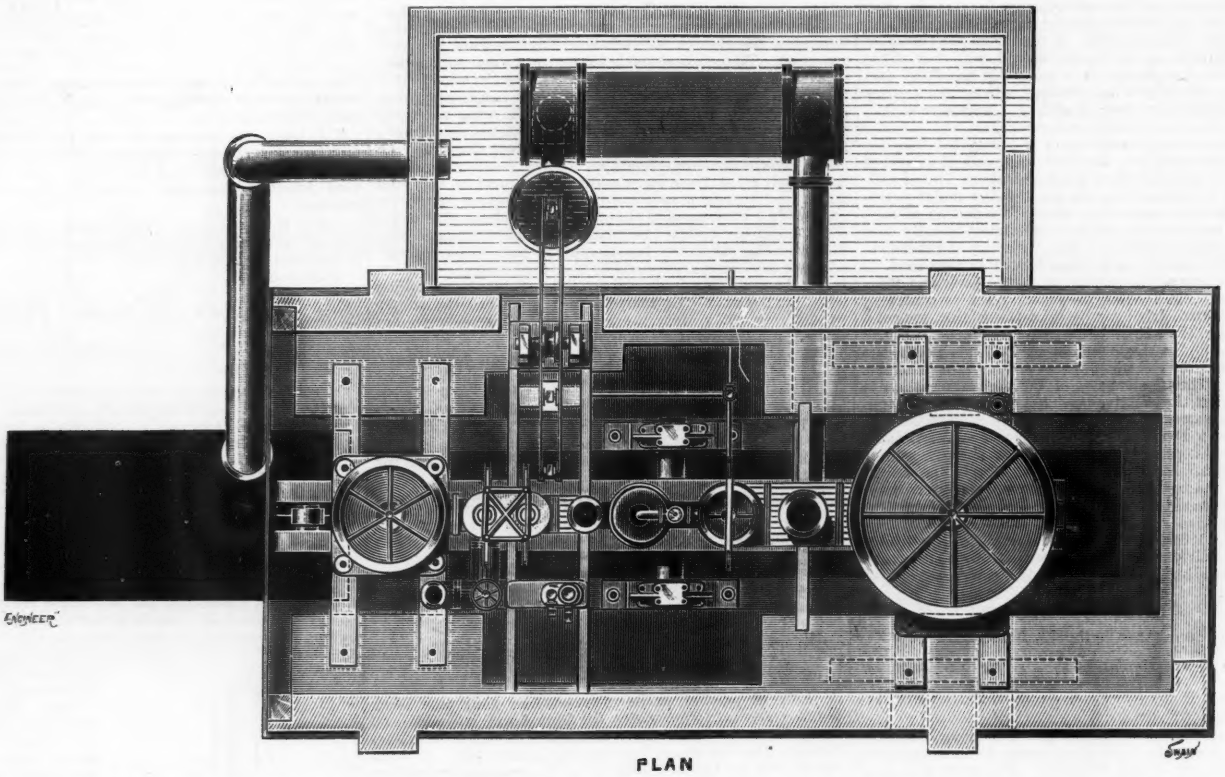
A REPORT prepared by Captain N. M. Brooks, United States Superintendent of the Foreign Mail Service, gives the following tabular statement regarding the mail service of the several transatlantic lines during the year ending June 30th, 1895:—

Cunard (New York to London viâ Queenstown).

Steamer.	No. of trips.	Average time per trip, hours.	Quickest trip, hours.
Campania	9	162·5	157·4
Lucania	11	163·0	156·7
Etruria	12	178·8	172·3
Umbria	12	183·6	170·9
Servia	2	208·1	206·8
Aurania	8	208·5	199·5
Hamburg-American (New York to London viâ Southampton).			
Fuerst Bismarck	7	178·6	167·1
Normannia	8	178·3	170·2
Columbia	7	179·1	174·3
Augusta Victoria	5	185·9	185·0
White Star (New York to London viâ Queenstown).			
Teutonic	12	174·8	168·4
Majestic	13	177·1	168·5
Germanic	7	211·2	200·3
Britannic	13	218·0	207·2
Adriatic	7	233·0	215·2
American (New York to London viâ Queenstown and viâ Southampton).			
New York	14	176·7	167·8
Paris	15	183·4	176·3
St. Louis	2	184·0	177·5
Berlin	13	229·4	219·1
Chester	3	242·0	233·2
North German Lloyd (New York to London viâ Southampton).			
Havel	9	189·1	185·5
Lahn	12	191·9	182·7
Spree	6	198·7	191·7
Aller	5	199·7	195·4
Trave	9	205·9	198·7
Ems	9	205·6	196·9
Saale	11	205·9	199·9
Fulda	4	212·3	210·5
Elbe	7	219·0	214·2
Kaiser Wilhelm II.	2	222·2	221·5
German Transatlantic (New York to Paris viâ Havre).			
La Touraine	8	198·2	185·9
La Bourgogne	10	206·5	198·6
La Champagne	12	206·6	200·1
La Bretagne	7	207·8	198·6
La Gascogne	5	210·6	194·9
La Normandie	10	216·6	204·6
La Navarre	1	235·4	235·4

COMPOUND CORNISH PUMPING ENGINE

MESSRS. HATHORN, DAVEY, & CO., LEEDS, ENGINEERS

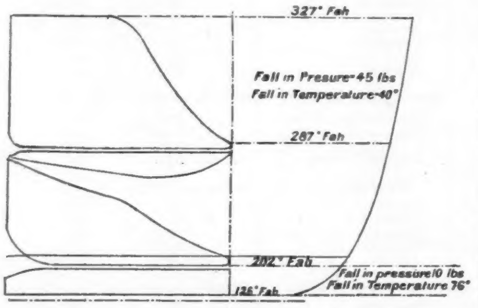


PLAN

COMPOUND CORNISH CYCLE PUMPING ENGINE.

In our annual article we mentioned the fact that Mr. Henry Davey was bringing out a compound engine working on the Cornish cycle. That engine we have much pleasure in illustrating this week. It may be well to say, for the benefit of those not familiar with the Cornish cycle, that one paramount advantage which it possesses is that the steam side of the piston and corresponding cylinder cover are never exposed to the frigorific influence of the condenser. The engine we illustrate consists of two Cornish cylinders, the high-pressure supplying the low-pressure with steam. An important factor is the feed-water heater. If exhaust steam be used to raise the temperature of the feed, not much gain is to be had because the exhaust steam has only a temperature proper to the condenser pressure, say, 110 deg. or less. But Mr. Davey uses the equilibrium steam, passing from one side of the piston to the other, which may have a temperature of 210 deg., or even more, to heat the feed-water. It matters, of course, nothing that condensation takes place, because the steam finds its way the moment the out-door stroke is completed to the condenser.

We illustrate on page 88 a large Davey engine now being made by Messrs. Hathorn, Davey, and Co., of Leeds. It has cylinders 45in. and 90in. diameter by 8ft. stroke, and is provided with 19in. plunger pumps, and also a sinking pump, for a total depth of 1000ft. The steam pressure will be 100 lb. per square inch. The distribution of steam is that of the Cornish cycle in both cylinders. The feed-water is heated to a temperature of 180 deg. to 200 deg. Fah. by means of a patented compound heater. Through one section of the heater the exhaust steam from the low-pressure cylinder passes on its way to the condenser, thus heating the feed-water to about 100 deg. Fah. The water is further heated in the second section of the heater, as explained above, by steam which passes from one side of the piston to the other during the equilibrium stroke.



The distribution of steam is illustrated by the preceding diagram:—On the right-hand side is plotted a curve of temperatures with horizontal ordinates corresponding to the pressures on the vertical line, from which the temperatures in the various points in the cycle can be ascertained, and which shows at a glance the importance of the Cornish cycle in reducing the variation in temperature in the low-pressure cylinder. In the final stage a fall of pressure of 10 lb. causes a variation in temperature of 76 deg. Fah., whilst in the first stage of the cycle a fall of pressure of 45 lb. causes a variation in temperature of 40 deg. Fah. only.

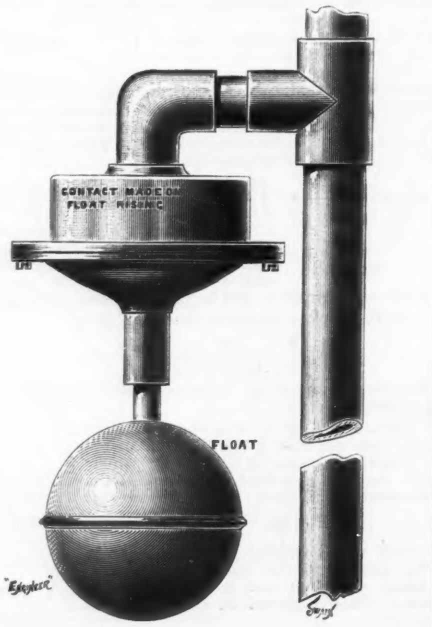
The engine is for working the Cornish system of pitwork, viz., that of a single spear rod, and is particularly suitable for draining metallifferous mines, where the working of the mine is generally contemporaneous with the sinking of the shaft, and therefore the Cornish system or stage pumping is the most suitable. Sinking is performed with a bucket pump to a depth of 200ft., when a plunger pump is put in, and the sinking is continued with the bucket pump, thus there is provided a plunger pump every 200ft. in depth. The engine valves are actuated by Davey's well-known differential gear.

AN ELECTRIC LOW-WATER ALARM.

A simple apparatus applicable to a number of purposes has just been brought out by Messrs. J. Davis and Son, of Derby and London, who have applied for letters patent.

The apparatus consists of a water—or other liquid level—alarum. The rise and fall of the liquid is caused to make or break an electric connection which rings a bell or drops a shutter, or both. The contacts are contained in water-tight metal boxes, having on the lower side a stuffing-box, through which works a plunger rod terminating in a float; the whole thing thus becomes a plunger key in a water-tight case, the motive power being the liquid acting on the float.

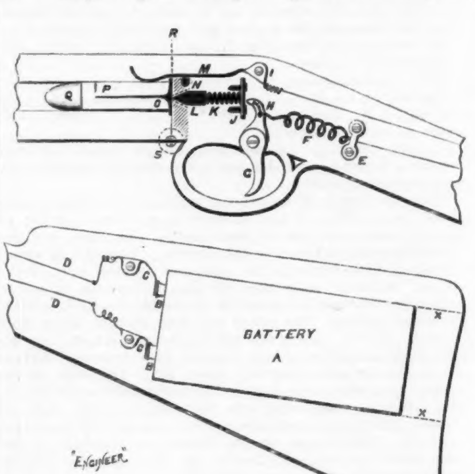
The illustration shows this apparatus arranged for high and low levels, the upper contact being made when the liquid rises and the lower when it falls. Intermediate points may be made to sound the alarum both on the rise and fall, so that it can be seen by a glance at the indicator board whether the liquid is on the rise or fall.



One feature which adds greatly to the simplicity of the apparatus is, as shown by the illustration, the manner of mounting the contact boxes, namely, on a metal pipe through which the electric wires are carried; the required distances for the alarums being thus obtained to a nicety, in addition to which all the contacts can be removed readily and simultaneously for examination or repairs and replaced in their original positions.

THE BLAKE ELECTRIC RIFLE.

The practice of firing big guns by electricity is already well established, but hitherto no practical attempt has been made to explode the shells of small arms electrically. An electric rifle has recently been designed by J. F. Blake, of New Haven, Conn., in which it is sought to carry out this principle. The source of the current is a battery A, which is fitted into the stock either from the side or from the ends. The holes B B are connected to springs C C, from which the wires D D run respectively to a spring M, bolted at I to the lock plate, and to the insulated hammer H, fixed on the upper part of the trigger G. Q is the shell containing an insulated pin, the head of which, O, projects beyond the base of the shell. If necessary, two pins can be placed parallel with each other and insulated until their points nearly meet. Between the base of the cartridge and the hammer is a pin K, encircled by a spring, and riveted into a cross plate J at one end, the other end being fitted into an insulated thimble L, the point of which nearly touches the shell pin head O. When the cartridge has been inserted and the gun closed, the spring M rests on the metal base of the cartridge.



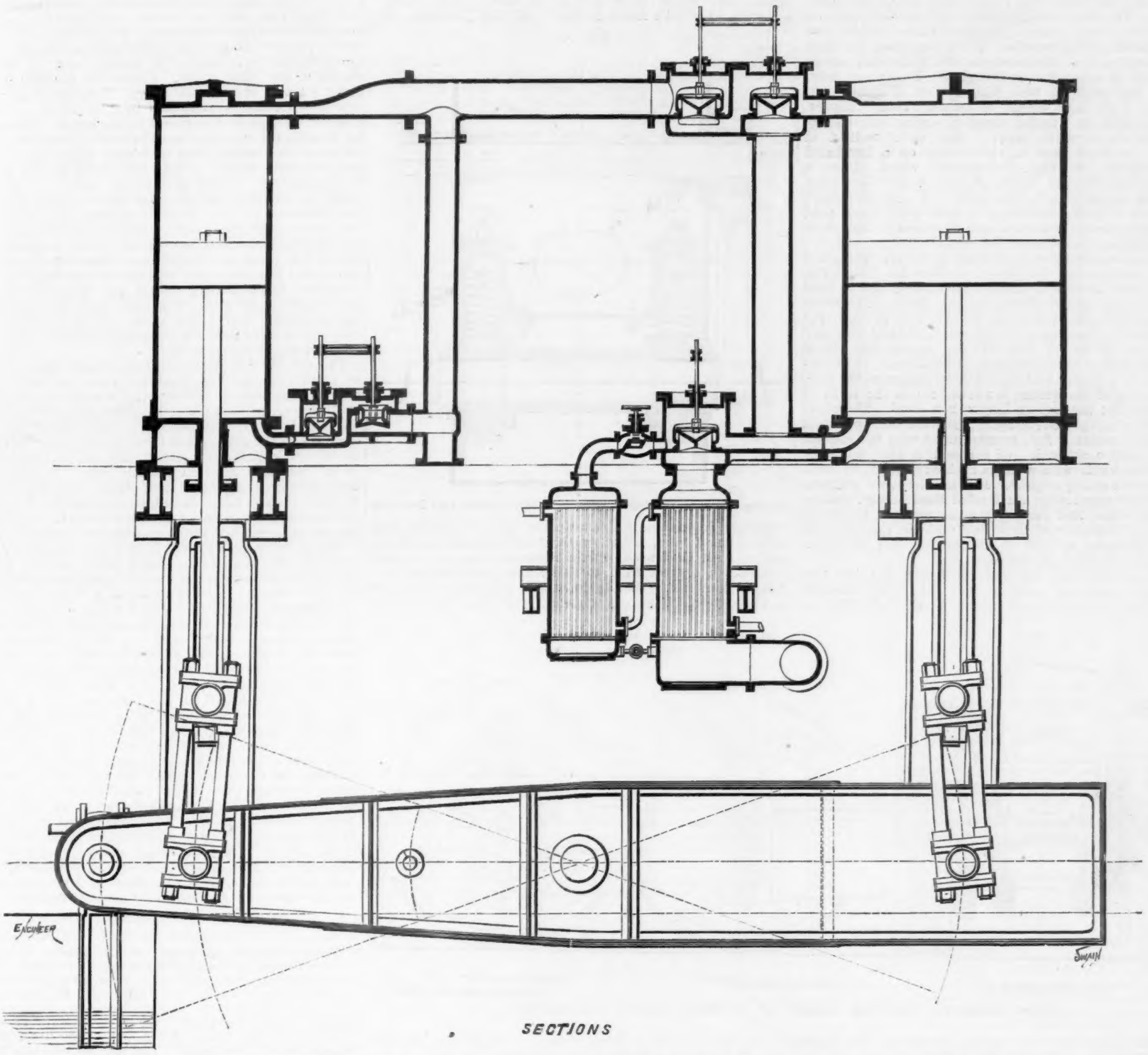
As the trigger is pulled the hammer strikes the plate J, forcing the point of the thimble L into contact with the projecting end O of the cartridge pin. An arc is established at P O, which, the *Electrical Engineer* says, explodes the contents of the cartridge.

The point of the firing pin P can be placed anywhere within the explosive powder of the cartridge, but by extending it near the bullet, as shown in the illustration, a more effective explosion of the powder is secured.

Calcutta is upon the eve, according to the last received number of the *Indian Engineer*, of a dearth of kerosine oil. "The stock on 1st December was eighteen lakhs of cases, and five lakhs only are expected between now and the 1st April. On the other hand, the consumption may be put down at four lakhs monthly or twenty lakhs in the four months, so that by the 1st April practically the whole available stock will have been exhausted. The Russian oil line from Baku to Batoum has broken down, and the European market is too bare to relieve the pressure, while only between three and four lakhs of cases can be expected from America between April and August. After that date, no doubt, the difficulty will right itself, but in the meantime the deficiency will be very considerable."

COMPOUND CORNISH PUMPING ENGINE

(For description see page 84)



SECTIONS

STEAM LOCOMOTIVES ON COMMON ROADS.

By W. Fletcher.

(Continued from page 52.)

Messrs. J. and H. McLaren's compound road locomotive and van for French parcel service is shown by Fig. 28, as described in the last article, on page 52.

Road locomotives mounted on springs—One of the most difficult problems connected with spur-geared road locomotives is the effective mounting of the engine on springs. Many of the plans introduced for this purpose have been much too complicated to be of any real service. Provisions must be made in the arrangement of the details, so that the up-and-down movement of the main axle when passing along a rough road at a fair speed shall not affect the pitch circles of any of the spur driving gear, or interfere with the proper action of the compensating apparatus. It is equally important that the springs should be free to act without being influenced by the transmission of the power through the gearing. In addition to these essential requirements, some traction engine makers insist on the axle being suspended in such a manner that one end of the axle may be higher or lower than the other without affecting the proper working of the engine. It will be seen that to successfully overcome these mechanical difficulties is no easy matter. In passing, we may remark that the mounting of chain-driven road locomotives on springs is very easily accomplished. Fig. 25 in the last article on page 51 shows how this can be done.

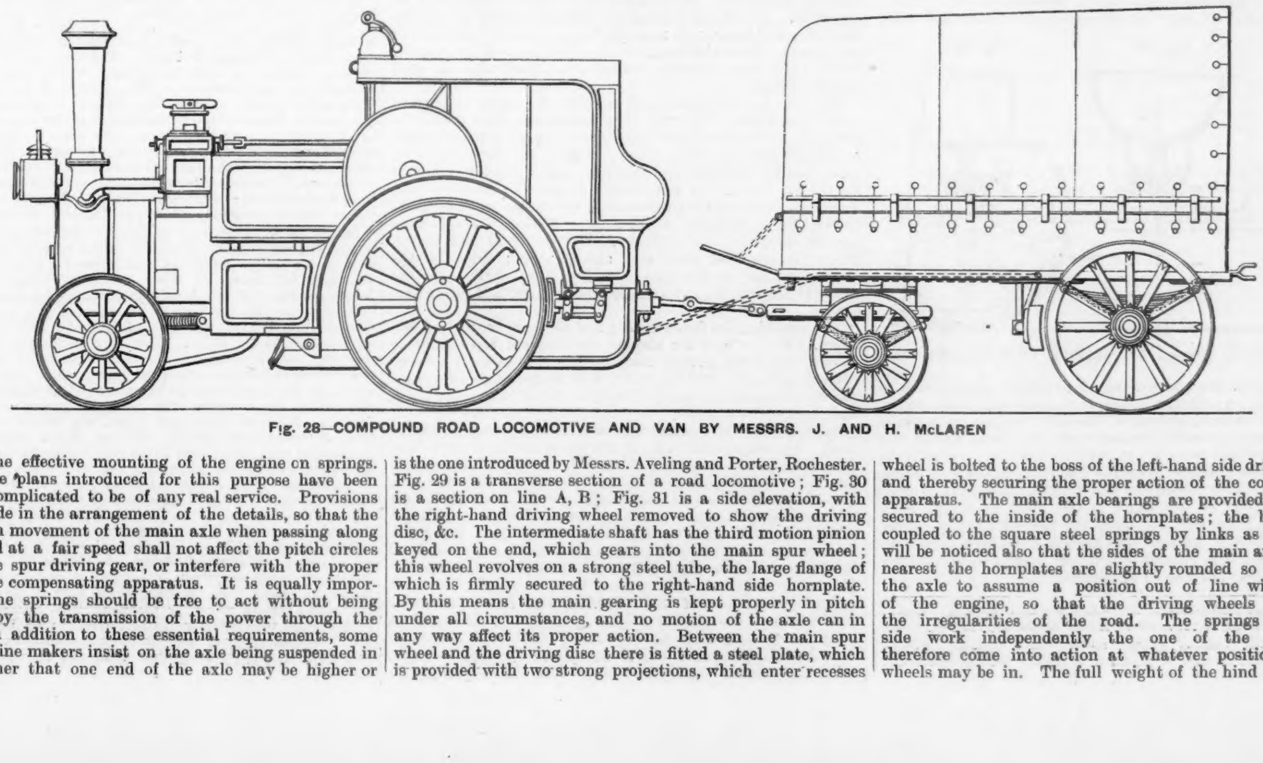


Fig. 28—COMPOUND ROAD LOCOMOTIVE AND VAN BY MESSRS. J. AND H. McLAREN

I will now proceed to describe some of the methods recently introduced for successfully mounting spur-geared road engines on springs. The latest arrangement for effecting this purpose is the one introduced by Messrs. Aveling and Porter, Rochester. Fig. 29 is a transverse section of a road locomotive; Fig. 30 is a section on line A, B; Fig. 31 is a side elevation, with the right-hand driving wheel removed to show the driving disc, &c. The intermediate shaft has the third motion pinion keyed on the end, which gears into the main spur wheel; this wheel revolves on a strong steel tube, the large flange of which is firmly secured to the right-hand side hornplate. By this means the main gearing is kept properly in pitch under all circumstances, and no motion of the axle can in any way affect its proper action. Between the main spur wheel and the driving disc there is fitted a steel plate, which is provided with two strong projections, which enter recesses in the spur wheel; while two more projections at right angles with the above enter the driving disc. This arrangement transmits the power from the spur wheel to the driving disc independent of the position of the axle. It will be seen from Fig. 29 that the driving disc is keyed to a long cannon, which forms the boss of the compensating gear centre, thereby passing the power from one side of the axle to the other. The right-hand side driving wheel and right-hand side bevel wheel are both keyed to the main axle; the left-hand bevel wheel is bolted to the boss of the left-hand side driving wheel, and thereby securing the proper action of the compensating apparatus. The main axle bearings are provided with slides secured to the inside of the hornplates; the bearings are coupled to the square steel springs by links as shown. It will be noticed also that the sides of the main axle bearings nearest the hornplates are slightly rounded so as to allow the axle to assume a position out of line with the rest of the engine, so that the driving wheels can follow the irregularities of the road. The springs on either side work independently the one of the other, and therefore come into action at whatever position the road wheels may be in. The full weight of the hind part of the engine rests evenly on the springs in the usual manner, but the details are worked out in the stiffest possible way. It will be seen that a wrought iron plate fits in between the hornplates and beneath the flanges of the axle slides. The brake rim is cast on the main spur wheel. The hornplates are stiffened by an angle iron frame fitted above the main axle slides. The whole arrangement is well worked out, and will undoubtedly be a success. Messrs. Charles Burrell and Sons' patented arrangement of spring mounting for their road locomotives was illustrated in Mr. McLaren's paper,[5] so it need not be referred to in this place. I may say, however, that engines fitted with their system of springs run smoothly at fairly high speeds on ordinary roads. Messrs. John Fowler and Co.'s spring traction engine has recently been described in these pages. But their method of mounting the front part of the engine on a laminated spring is shown by Figs. 32 and 33, which allows a free movement of the front wheels in all directions to suit the inequalities of the road. Messrs. McLaren's arrangement of spring mounting of their quick-speed road locomotives is clearly illustrated and described in Mr. John McLaren's paper,[6] so this need not be described.

Another spring arrangement is made by Messrs. Wallis and Steevens, Basingstoke. In the plans thus far dealt with, provisions have been made whereby the motion of the hind axle, due to the action of the springs, shall not interfere with the pitch circle of the spur driving gear between the intermediate shaft and axle. In Messrs. Wallis and Steevens' arrangement, shown by Fig. 34, two springs are placed between the load of the engine and the hind axle. The intermediate shaft is fixed. The up-and-down motion of the axle, due to the play of the springs, is allowed for in the teeth of the spur gearing; the cogs are longer than usual. The wheel has two pitch lines placed ⅜in. apart; between these two lines the cogs are practically flat, corresponding with the amount of vertical motion allowed. Of course this plan would be quite impracticable with a range such as is given by some makers to their spring engines. It is said by some practical men that "too much range is a decided disadvantage, making the engine dance, and causing a great wash of the water in the boiler." A range of about half an inch, they say, will be found sufficient to take off all the jar, and cause the engine to run smoothly on common roads.

It will be seen from the illustration that the two axle bearings are connected together by a very strong distance piece, so that the axle must always be parallel with the intermediate shaft when the springs are acting. The spring boxes are provided with set screws and nuts let into the castings, so that the amount of play allowed to the springs can be regulated. When the driving wheels are subjected to an exceptional shock, the axle bearings come into contact with suitable stops, so as to prevent the cogs of the spur wheel and pinion entering too deeply into gear with each other. It must be admitted that this spring engine is the simplest one in the market, but some engineers will possibly take exception to the arrangement. It is said, however, that the up-and-down motion of the axle, causing the teeth of the gearing to ride in and out to the extent of such motion, works very well in practice, and the life of the gearing is not materially shortened by this sliding process.

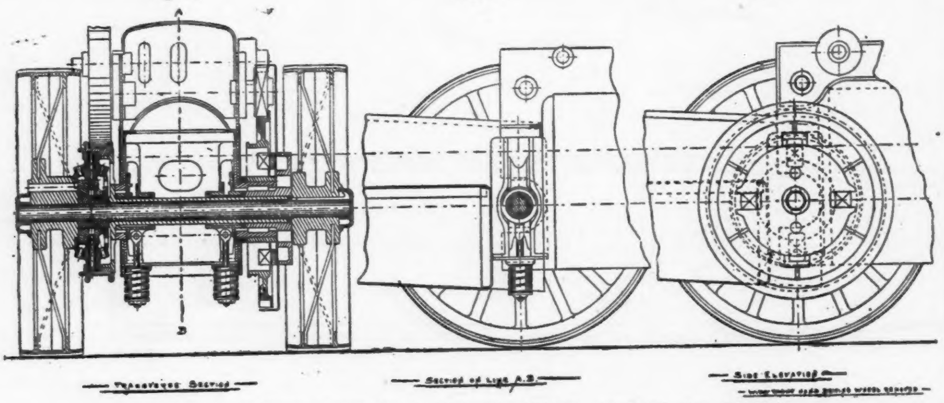


Fig. 29 Fig. 30 Fig. 31

SPRING MOUNTED TRACTION ENGINE BY MESSRS. AVELING AND PORTER

I have described some of the trains that have been used successfully for the conveyance of passengers and parcels at quick speeds on ordinary roads, and dealt with some recent methods of mounting geared traction engines on springs, without which no road locomotive can be run at a good rate with comfort and economy of repairs. It only remains for me to describe the type of engine I should propose for running light carriages for passengers and wagons for market produce at a good speed of, say, eight to ten miles an hour. Some hard things have been said about the modern traction engine, and very often by persons who have had the least experience with them. The present engine as made by the leading makers is the "survival of the fittest."

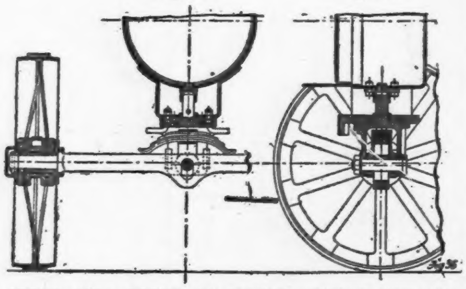


Fig. 32 Fig. 33

FRONT AXLE SPRING BY MESSRS. FOWLER AND CO.

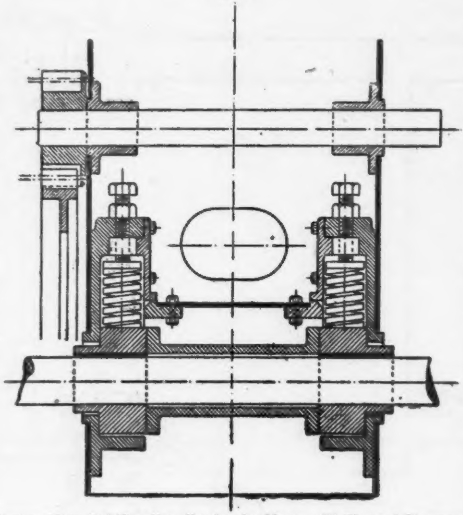


Fig. 34

Spring Mounted Traction Engine by Messrs. Wallis and Steevens

We have in the past seen some curious specimens that were to eclipse all other engines—some arranged vertically in the smoke-box, some placed on the tender, others fixed beneath the boiler barrel, and several types with all the wheels coupled. Road locomotive makers have often been urged to adopt the railway locomotive as a model, thus several attempts have been made to carry out this proposal. It would be interesting to name other types of engines and boilers, but I must not allow these curiosities to detain the reader. All that need be said respecting coupled engines, underneath engines fixed to side frames, and others of a similar character, is that as a rule only one engine was made to the pattern. These experimental types have given place to the modern road locomotive that we now possess, and there can be no question that the best remains.

The engine I should propose for passenger service would follow the lines of the modern road locomotive, with modifications in construction to make it suitable for its special work. It must have no experimental details in its construction, all the vital parts must be of the well-tried patterns. The engine would be mounted on the top of the boiler, in the usual fashion, the cylinder occupying the position of the boiler barrel near the smoke-box. At the fire-box end the various shafts are carried by the hornplates, stiffened by transverse plates forming the box brackets. In this box the first motion gearing is placed, with the clutch lever for altering the speed. The working parts of the engine will be closed in. Every detail must be carefully studied as regards efficiency and wear, and no superfluous material retained in any detail. Wrought iron and steel will be used frequently, so as to give the necessary strength, combined with the least possible weight.

The first consideration, and possibly the most important one, is the boiler. The well-tried locomotive type should be adopted. With fairly good water and careful attention, this boiler will give very little trouble. Steel has for some years been used for the shell, and this material is gaining in favour for the fire-boxes. At one time Lowmoor or Bowling iron was used. The working pressure is 150 lb. per square inch; the test pressure under water will be 240 lb. The following are the thickness of the plates:—Fire-box shell and barrel, ⅜in.; fire-box end plate and saddle, $\frac{7}{16}$in.; sides of the fire-box carried up for supporting the crank shaft, ⅝in.; the internal fire-box, ⅜in.; the fire-box and smoke-box tube plates are ⅝in.

The stays for the fire-box sides and roof will be pitched 4in. apart. Bridge bars for staying the fire-box top cannot be recommended for several reasons, but the vertical screwed stays from the fire-box top to the arch plate, as used for some railway locomotives, are preferable. These stays are light, and the fire-box crown can be kept free from scale.

Solid iron fire-box foundation and fire-door rings should be used. The water space around the fire-box should not be less than 2½in. at the bottom and 4in. at the top; the fire-hole ring is 2in. square, the fire-box front plate being dished to suit. The longitudinal seams are double riveted, and so is the circumferential seam connecting the saddle plate with the barrel. Some makers use 2in. tubes, others 2¼in.: the spaces between the tubes should not be less than 1in.; both ends of the tubes should be expanded in the tube plates and beaded. The boiler barrel must be made as short as possible, so as to reduce the amount of water carried, and the mean water level will be less affected by the gradients of the road. A good fitting ashpan is an important item, with a damper door back and front; a swivel damper in the chimney box, below the exhaust nozzle, is useful. The chimney must be provided with a hinge, and facilities for lowering and raising it when low bridges have to be encountered. No sparks must be emitted, an effective spark catcher must be fitted, and the smoke-box door must be provided with a central handle that will pull the door tightly up to the smoke-box front. As far as possible the engine must be smokeless, coke must be mixed with good coal, and the damper arrangements such as to prevent the emittance of smoke. The fire-door will be of the sliding pattern. A good set of fire-bars are essential, the air spaces should be as narrow as possible, and all the spaces should be the same width. Unless the fire-bars are nicely made a waste of coal will ensue, I should prefer wrought iron deep fire-bars securely held in their places. A manhole properly strengthened is placed in the barrel. The facilities for clearing out the boiler must be carefully studied; in some instances the saddle plate is flanged under the hydraulic press to a large radius, so that two mudholes can be placed in the corners. Every part of the boiler will be riveted under the machine, and the very best workmanship must be bestowed upon it. For a single cylinder 9in. diameter, and 12in. stroke, 160 square feet of heating surface, and 6 square feet of grate area would be required. For a compound engine with a high-pressure cylinder 6½in. diameter, a low-pressure cylinder of 10in. diameter, both the pistons with 12in. stroke, 145 square feet of heating surface and 5½ square feet of grate area should be allowed. The noise from the exhaust must be suppressed. Two water gauge fittings are essential, and they should be of such a safe character that the steam is shut off the moment a glass breaks.

The fire-box side plates are carried upward and backward so as to form the box brackets; there are two transverse plates firmly riveted between the side plates, and held by angle iron to the arch plate. Another plate will be placed at the top for further stiffening the whole structure; this top plate covers the gearing and forms a neat tray. The carriages for the crank shaft, two countershafts, and the main axle must be let into bored holes in the side plates, the rivets merely keeping the bearings up to their places. The carriages should be made of steel so as to reduce the weight. The plates of the box brackets must be machine riveted. If the engine is mounted on springs, the above description must be modified.

The cylinder will be made in two parts, the shell or casing will be in one casting; the liner is made of hard metal and forced into the casing, the annular space around the liner is of ample capacity, in order to act as a steam dome and prevent priming. The jacket steam supply and drainage must be so carried out that the circulation of the steam in the annular space is maintained. At the highest part of this dome the stop valve should draw its supply of steam for the working cylinder. All the passages for the steam should be of sufficient area to admit of a high piston speed. The cylinder will be placed on the boiler as near to the smoke-box tube-plate as possible, and be provided with a strong flange all round the base, the bolts in which will be arranged about 4in. pitch; a sufficient amount of surface must be allowed so as to make a reliable joint between the foot of the cylinder and the boiler barrel; this will prevent any springing of the barrel plate. It is usual to make the steam enter the cylinder as near to the smoke-box as possible. A double spring Ramsbottom safety value is mounted on the top cover of the cylinder. The proper lubrication of the piston and the slide valve is a very important matter, and must be well attended to. The greater part of the cylinder will be carefully lagged and covered with sheet steel. A single cylinder of 9in. diameter and 12in. stroke may be adopted.

(To be continued.)

Street Subways for Pipes.—At the meeting of the London County Council on Tuesday it was moved, "That it be referred to the Highways Committee to consider and report without delay on the expediency of the Council applying to Parliament for power for the Council and the local authorities to construct subways under the streets of London, for the reception of the tubes and wires of the gas, water, electric, and other companies, and to charge rents for the same." This was seconded and agreed to, with the addition of a reference to the Parliamentary Committee.

Institution of Mechanical Engineers. — The forty-ninth annual general meeting of this Institution will be held on Thursday evening, January 30th, and Friday evening, January 31st, at 25, Great George-street, Westminster. The chair will be taken by the President at half-past seven p.m. on each evening. The annual report of the Council will be presented to the meeting on Thursday. The following resolution will be moved from the chair: "That in accordance with No. 31 of the Articles of Association, the Council be hereby authorised to borrow moneys for the purposes of the Institution on the security of the property of the Institution, or otherwise at their discretion." The annual election of the president, vice-president, and members of the Council, and the ordinary election of new members, will take place at the meeting on Thursday. The retiring President, Professor Alexander B. W. Kennedy, LL.D., F.R.S., will induct into the chair the president elect, Mr. E. Windsor Richards. The appointment of a professional accountant, to audit the accounts of the present year, will be made by the members on Thursday, and his remuneration fixed. The present auditor, Mr. Robert A. McLean, chartered accountant, offers himself for re-election at the same remuneration as at present, namely, 25 guineas. The following papers will then be read and discussed, as far as time permits:—"Telemeters and Range Finders for Naval and other Purposes," by Professors Barr and Stroud." "Calculation of Horse-Power for Marine Propulsion," by Lieutenant-Colonel Thomas English, Thursday. "Notes on Steam Superheating," by Mr. W. H. Patchell, of London, Friday.

Death of an American Engineer.—Mr Alfred E. Beach, for nearly fifty years one of the editors of the *Scientific American*, died at his home in New York City on January 1st, aged seventy years. Mr. Beach was the son of Moses Y. Beach, who established the New York *Sun*, but outside of a short time in his father's office, his entire business life had been as a member of the patent soliciting firm of Munn and Co., which he established in 1846 with his former schoolmate, A. D. Munn. The firm purchased the *Scientific American*, and its editorship was undertaken by Mr. Beach, and he has been its responsible editor all these years. But neither that work, nor the direction of the extensive patent business of the firm absorbed all his energies. The list of his inventions is an important one, and would alone have given him distinction. He was a man of remarkable energy, with an active mind, of natural mechanical bent, which well fitted him for his business. As early as 1852 he exhibited a typewriting machine, which received a gold medal at the Crystal Palace exhibition in New York as one of the most important and ingenious inventions exhibited. It had practically all the devices of the present typewriting machines. He devised a pneumatic tube system for carrying mails, and a pneumatic railroad, of which an experimental section—elevated—was put in operation. The Beach Pneumatic Transit Co., of which Mr. Beach was president, built a section of underground road in Broadway, New York, in 1869, being part of an underground pneumatic system which he planned. This section of road was built without interfering with street traffic, by the Beach hydraulic shield, similar ot those used at the St. Clair tunnel, on the City and South London underground road and elsewhere.—*Railroad Gazette.*

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[5] "Steam on Common Roads," by Mr. John McLaren. Excerpt, "Minutes of the Proceedings" of the Institute of Civil Engineers, vol. ciii., 1890-91.

[6] "Steam on Common Roads," by Mr. John McLaren. Excerpt, "Minutes of Proceedings' of the Institute of Civil Engineers, vol. ciii., 1890-91.

RAILWAY MATTERS.

Though the railroad system of the United States increased from a total length of 114,712 miles in 1882 to 178,709 miles on June 30th, 1894, or 56 per cent., the aggregate sum paid in dividends during the latter year was only 95,575,976 dols., being 6,455,458 dols., or 6½ per cent., less than during the former.

The Parliamentary plans have been deposited by Sir John Fowler, Bart., C.E., and Mr. James C. Inglis, the engineers to the Great Western Railway Company, for the construction of that company's proposed South Wales and Bristol Direct Railway. The total cost of carrying out this scheme, according to the deposited estimate, is £1,116,348.

Besides the Ahmedabad-Parantij Railway, the Bombay-Baroda and Central Indian Railway Company is now, says *Indian Engineering*, engaged in constructing a railway on the 2ft. 6in. gauge from Ankleswar to Sarsa for the Rajpipla State, and from Vishvamitri to Padra on the same gauge for the Baroda State. Mr. Whately, who was acting as resident engineer in Bombay during the absence of Mr. Wolff, has been placed in charge of these two lines.

Information has been received at the India-office from the Public Works Department of the Government of India that Berhampore-Rambha section of the East Coast State Railway, a length of 29·5 miles, was opened for the public carriage of passengers on October 15th, 1895, and that the Nankan-Mohnyin section and the Katha branch of the Mu Valley State Railway, 73¾ and 15 miles long respectively, were opened for the public carriage of passengers on October 21st, 1895.

The average charge for carrying a ton of freight one mile *via* thirteen of the most important railroads in the United States during 1865 was 3·08 cents; 1870, 1·80; 1875, 1·36; 1880, 1·01; 1885, 0·83; 1890, 0·77; and 1893, 0·76. These railroads performed one-third of the entire freight transportation during 1893, and from the figures given it appears that 76 cents would pay for as much transportation over their lines in 1893 as could have been obtained for 3·08 dols. 28 years earlier.

The method of preventing electric street tramway accidents adopted by the Steinway Electric Railway, of Long Island City, N.Y., is worthy of adoption by overhead and cable car lines in general. In accordance with an agreement made a year ago, *Engineering News* says, prizes of 25 dols. each were paid each motorman and conductor who got through the year without an accident to his car. The full prize was given to 98 men, and lesser prizes were given to 94 men who had served less than a year, over 4000 dols. in all being distributed.

The railway has been opened to Woolgangee, within 40 miles of Coolgardie, but, owing to the increase in the quantity of goods coming forwards, teamsters have announced their intention of adhering to the present rate of freight, which is £12 per ton. Notwithstanding the fact that the railway has advanced 60 miles, carriage is more expensive now than it was last year. The *Railway News* says large quantities of machinery are waiting removal, and more teams are urgently required. Labour of every description is also very scarce, owing to the large number of buildings going up.

The United States Government report of mail car accidents for the year ending June 30th, 1895, records 33 cases in which mail was damaged by oil and three cases in which the subsequent destruction by fire was caused by oil lamps. The use of compressed gas and Pintsch lamps is recommended. The great improvement made in these lamps and the establishment of compressing plants at so many of the principal cities leaves no reasonable excuse for not using gas and taking away this one element of danger to mail clerks and mails. The same is true of passengers and passenger cars, in quantity of light, cleanliness and safety.

During the year 1895, according to the *Philadelphia Record*, the Baldwin Locomotive Works built 401 locomotives. The output is about 28 per cent. in excess of that of the previous year, 1894, when but 313 locomotives were built, and about 52 per cent. of the product of 1893, when 763 locomotives were sent out by the firm. Of the 401 locomotives constructed during the past year, 162 were for export. There are now in hand orders for 90 engines. Of this number 20 constitute the balance of the order placed some months ago by the Russian Government. These 20 engines are rapidly approaching completion, and will be ready for shipment by the latter end of January.

The New Central and Hudson River Railroad Company has increased the scheduled speed of its Empire State express from an average of 51 miles an hour to 53·33 miles an hour between New York and Buffalo. For more than four years this train has made its daily run of 440 miles in 520 minutes, including four stops and 28 slow downs. Its new time of 495 minutes is not that of an experimental run, but is scheduled for daily service between New York and Buffalo until a further reduction becomes practicable. The speed of the best trains of foreign nations is:—England, 51·75 miles an hour; Germany, 51·35; France, 49·88; Belgium, 45·04; Holland, 44·73; Italy, 42·34; Austria-Hungary, 41·75. The *Railroad Gazette* says America now heads the list with 53·33 miles an hour to the credit of the Empire State express.

The French Ministry of Public Works has recently addressed to the various French railroads a circular letter with regard to some of the complications arising from the fact that enginemen are paid premiums for time made up. It is believed that certain dangers follow the custom of giving such premiums, because the enginemen are tempted to run too fast when they have lost time. These dangers are modified, it is true, by the premiums for fuel saving, and by the rules fixing the maximum speeds. It is thought important to avoid excessive speeds, and yet it is no less important to avoid delays, which disarrange the traffic and cause complaints from the public, and which are often the cause of accidents. The railroad companies are requested to make a study and report concerning the systems of premiums, both for time gained and for fuel saved, in their relative effects, and also to consider and report upon the practicability of a general use of registering speed records.

The new railway construction in the United States, in 1894, was reported at 1760 miles, and that seemed to be as low a record as was likely to be again made. But the total for this year is about 300 miles less than that, being 1428 miles. This will, no doubt, be increased by later returns from companies which are still laying track. But it shows that railroad extension is no longer a very important factor in the industrial concern of the nation. That has been true for some years, but there have been so many adverse conditions stopping the expansion of many enterprises just as severely as railroad building could be affected, that there has been a feeling that with more favourable economic conditions, railroad building would again become of great interest and influence. We apparently should have to conclude that railroad extension hereafter will be small, as compared with what has been done in quite recent years. The following shows the new track laid, by different States:—Alabama, 22·5; Arizona, 65·3; Arkansas, 38; California, 65·5; Colorado, 33·9; Florida, 38·5; Georgia, 67·7; Illinois, 41·8; Indiana, 14·9; Ind. Ter., 144; Iowa, 11·1; Kansas, 18; Louisiana, 17; Maine, 82; Maryland, 2; Michigan, 49·5; Minnesota, 23·86; Mississippi, 10; Missouri, 50; Montana, 5·4; New Jersey, 4·6; New York, 61·6; North Carolina, 44·3; Ohio, 72; Oklahoma, 49; Pennsylvania, 83·5; South Carolina, 1; Texas, 186·5; Utah, 4; Virginia, 14; Washington, 2·6; West Virginia, 68·5; Wisconsin, 35·8; total, United States, 1428·4.

NOTES AND MEMORANDA.

The Gas Company of Paris has in its shops at Tory a 5-horse power de Laval steam turbine which holds a high record for endurance. It operates an exhauster 21 hours a day, and has now run for 5300 hours. After 1700 hours it was stopped for a brake test. Since then it has been running 3600 hours continuously. The peripheral speed of the disc being 525ft. per second, 1,900,000 miles in all, or about 78 times the circumference of the globe, have been made since it started, and about 53 times the circumference in 150 days since it has been running without interruption. The result is the more remarkable as the machine is running without attendance. Someone has to fill up an automatic oil feed every twelve hours; that is all the attention it has needed; 120 lb. of oil have been consumed each month

An experiment has been made at Cleveland, Ohio, in the use of trap rock as a paving material, and it promises to result very satisfactorily. A foundation of crushed limestone, 10in. thick, is laid; above this is placed the trap rock, 8in. thick, arranged in three layers—coarse screenings, fine screenings, and dust. The trap is obtained from quarries near St. Joseph's Island, St. Mary's River, at the north of Lake Huron. The rock can be had for little more than the cost of quarrying and transportation, and the pavement as laid down cost 3·10 dols., 3·19 and 3·65 dols., according to grade. Two miles have been laid in Cleveland, and it is said to promise well. Trap is used extensively in Germany for road making. *The Quarry* says, however, that wherever trap rock has been used it has generally been condemned on account of its liability to become slippery by wear, even when broken up and used in small pieces.

Mr. Alexander Kellas and Professor William Ramsay have found a trace of the new gas argon in the combustible gas from the spring known as "Allhusen's Well," Middlesborough. An incombustible gas from another well at the same place, says the *Globe*, was found to contain about ½ per cent. of argon. Moreover, the gas from a boiling spring, near Reykjavik, Iceland, has even a greater proportion of argon than common air, namely, 1·14 per cent. No helium could be detected in the gas. The fact that breathed air contains a slightly higher percentage—1·21—of argon than ordinary air has led Mr. Alexander Kellas to suppose that more argon is emitted by the blood than is absorbed in breathing, or that the air had been confined over water during breathing. In any case it would appear that argon like nitrogen does not play an important part in the animal ecomony, except as a diluent of the oxygen, which is so necessary to sustain life.

In a paper on "Urban Roads and Footways" recently read by Mr. J. Julian, Cambridge, before the Institution of Junior Engineers, the author remarked that in macadamised roads it was more economical to strengthen the foundation than to use a thick layer of other material between foundation and surface. The materials employed for foundation, and, to a somewhat lesser degree, for surface, were shown to be governed by local circumstances. Examples of cost in three localities amounted to practically the same per yard super.—4s. 3d.; but the problem in most places was, perhaps, to produce a road as good as possible for a fixed figure, the various items varying considerably. Details were also given of the total cost per yard super. of pavings on concrete foundations, viz., granite 11s. 9d., hard wood 15s., and asphalte 11s. The limiting gradients in ordinary cases were, asphalte 1 in 60, wood 1 in 25, macadam 1 in 20, and granite 1 in 15; but there were instances of macadam roads as steep as 1 in 6.

Numerous experiments during the last few years relating to the transmission of heat have shown that much of the earlier work on this subject was interpreted too broadly, and even yet there are questions remaining to be solved by experiment. At the last meeting of the British Association a paper was read by Mr. W. G. Walker on "Transfer of Heat through Plates with Differently-arranged Surfaces," as, for instance, in Servé tubes, in tubes with no ribs, with ribs outside, and with ribs inside and outside; but his ribs were soldered on to the tube, and did not form part of the material as in Servé tubes. Lately Mr. Bryan Donkin, in conjunction with Lieutenant-Colonel English, has been making many experiments, which will probably be shortly presented in a paper for reading. A Research Committee was some time ago appointed by the Institution of Mechanical Engineers, for making experiments on a special experimental steam engine. There has also been a Research Committee appointed for investigating the temperatures and pressures in gas engine cylinders. The experiments on the condensation of steam have been going on for some little time at the University College, under the Steam Jacket Research Committee.

A paper on "Solid Carbonic Anhydride" was recently given in the *Comptes Rendus* by Mr. P. Villard and R. Jarry:—Dry carbonic anhydride cooled and solidified in a wide tube melts at −56·7 deg., and its vapour pressure at this temperature is 5·1 atmos.; it resolidifies at the same temperature, and shows the same vapour pressure. The temperature of solid carbonic anhydride under atmospheric pressure is −79 deg. In making this determination, precautions were taken to protect the thermometer from radiation from surrounding objects. Regnault found −78·16 deg., and Pouillet −79 deg.; contrary to the usual statement, the addition of ether does not reduce the temperature, and the minimum of −79 deg. is only obtained when the carbonic anhydride snow is in excess. The heat of dissolution of the solid in the ether is so small that it can only be recognised if the ether has previously been cooled to −79 deg. Methylic chloride behaves differently, and the solid carbonic anhydride at temperatures below −65 deg. dissolves in it without any evolution of gas, and when the liquid is saturated the temperature is −85 deg., a result due to the dissolution of the solid. By passing a current of dry air through the mixture its temperature can be reduced to −90 deg. Under a pressure of 5 mm., the temperature of the solid anhydride is −125 deg., and it evaporates very slowly under these conditions. It follows that it should be possible to liquefy oxygen with carbonic anhydride only as the cooling agent and with ordinary appliances.

Photographs and photographic slides showing objects such as the bones of the hand of a living person were exhibited and explained at the Camera Club on the 16th inst. by Mr. A. A. Campbell Swinton. The source of influence or light used was a Crooke's radiant matter tube. He has some experiments in progress with metal plates of different thickness, by which he hopes to find whether there is any analogy between their relative conducting powers for heat and electricity and their porosity for these radiations. He showed two pictures, or rather shadows, one being taken in a wooden camera back, and the other through an aluminium plate. These included coins, a leather purse, in which the coins were distinct, while their receptacle was all but invisible, and pieces of wood to which had been affixed wafers of tinfoil—the wood being transparent to the radiations and the metallic wafers opaque. He showed prints from the original plates, but he hesitated to use the terms negative and positive, for it was difficult to say if such terms were allowable. He regarded Professor Röntgen's experiments as an amplification of Lennard's, who had experimented some time back with a Crooke's tube, in which was fitted a window of aluminium, and had found that a photographic plate was to some extent sensitive to similar radiations. What these radiations are it is impossible to say. There are two theories, one indicating that they move in waves, and the other that they consist in the projection of particles of matter, and if it be correct the ordinary laws of optics cannot apply. He could not learn that Professor Röntgen employed any special apparatus, but he himself found that no effects were evident when an ordinary induction coil was employed. He happened to have in use a lot of apparatus for high frequency phenomena, and with this his experiments had been brought to a successful issue.

MISCELLANEA.

The Main Drainage Committee of the London County Council reported on Tuesday that the total quantity of sludge sent to sea during the year 1895 from the northern outfall at Barking had been 1,408,000 tons, and from the southern outfall at Crossness 761,000 tons, making a total for both outfalls of 2,169,000 tons, or an average of about 41,712 tons weekly. These figures, compared with those of 1894, showed an increase of 80,000 tons in the quantity removed at the northern outfall, and of 37,000 tons at the southern outfall, or a total increase for the year of 117,000 tons.

The Board of United States ordnance officers appointed to watch the trials of the three 15in. pneumatic guns mounted at the entrance to San Francisco harbour, have reported to General Flagler that the battery has more than fulfilled all requirements. According to the *Army and Navy Gazette*, the trials included traversing, elevating, and firing air charges to test the capacity of the plant, and about 150 dummy projectiles were fired in three hours. Three sub-calibre 8in. shells were thrown to distances of 1500, 2000, and 2500 yards successively, and one charge with 100 lb. of dynamite was thrown upon the rocks two miles across the bay.

Two horses attached to a brougham ran away in New Bond-street on Tuesday afternoon, and just opposite the Albemarle Hotel came into collision with a gas lamp. The driver was thrown from his seat and killed at once, as was also the driver of a hansom which just then collided with the brougham. Three ladies in the carriage were hurt, and one of the horses had to be shot. It is not often that two drivers are killed by one such collision, but the death of one at a time is somewhat frequent. These accidents with horses occasion but passing notice, but if one such accident occurred, or in future occurs, with motor carriages, the cry against them will be loud and long, as it has in the past if an accident happened with a road locomotive.

The fact that calcium carbide is now obtainable commercially has been ingeniously applied by M. G. Trouvé for the purposes of domestic lighting. The principle of his lamp is that of the "Kipp," used in chemical laboratories, in various forms, for the production of hydrogen sulphide and other gases. The mode of arranging the contact of the water and carbide had to be carefully worked out, as an ordinary "Kipp," charged with calcium carbide and water, gives such a vigorous evolution of acetylene as to be unmanageable. An estimate of the working cost of the lamp compared with that of coal gas is favourable, *Nature* says, to the former in Paris, where gas is costly—7s. per 1000ft.—but in London, if the carbide could be obtained at the same price—4½d. per lb.—the cost would still be double that of ordinary lighting gas.

The ambition of the Water Committee of the London County Council is not to be baulked by any considerations of public expense. On Tuesday they submitted a report asking that they shall be requested to go into the whole question of supplying the metropolis by aqueducts from the Welsh lakes. The scheme is, no doubt, imposing. But the question asked the other day has not yet been answered, and we are glad to see that the *St. James's Gazette* is now refusing to adopt the cry for a new source of supply, and asks, "Why should we convey filtered water at the ratepayers' cost just for flushing drains and watering streets? If the amount of pure water now available were reserved for drinking, cooking, and washing, it would more than meet the needs of a population larger than London is likely to contain fifty, even a hundred, years hence."

The official report to the Board of Trade on the working of the Boiler Explosions Acts, 1882 and 1890, during the year ended June 30th last, states that eighty-seven preliminary inquiries and twenty-seven formal investigations were held, forty-three persons having been killed and eighty-five injured by boiler explosions. The total number of cases inquired into showed a small increase upon that of the preceding year, and the number of persons killed, as also the number injured, was larger than in any year since the Act of 1882 came into force. Several exceptionally serious cases were dealt with, and more than half the total number of deaths resulted from four explosions. The year was, moreover, remarkable for a period of unusually severe frost, one result being a large number of explosions of boilers used for heating public buildings and places of business. There did not, however, appear to be any increase in laxity of management or inspection on the part of steam users or boiler insurance companies, and the figures did not show any general increase in the number of serious boiler explosions.

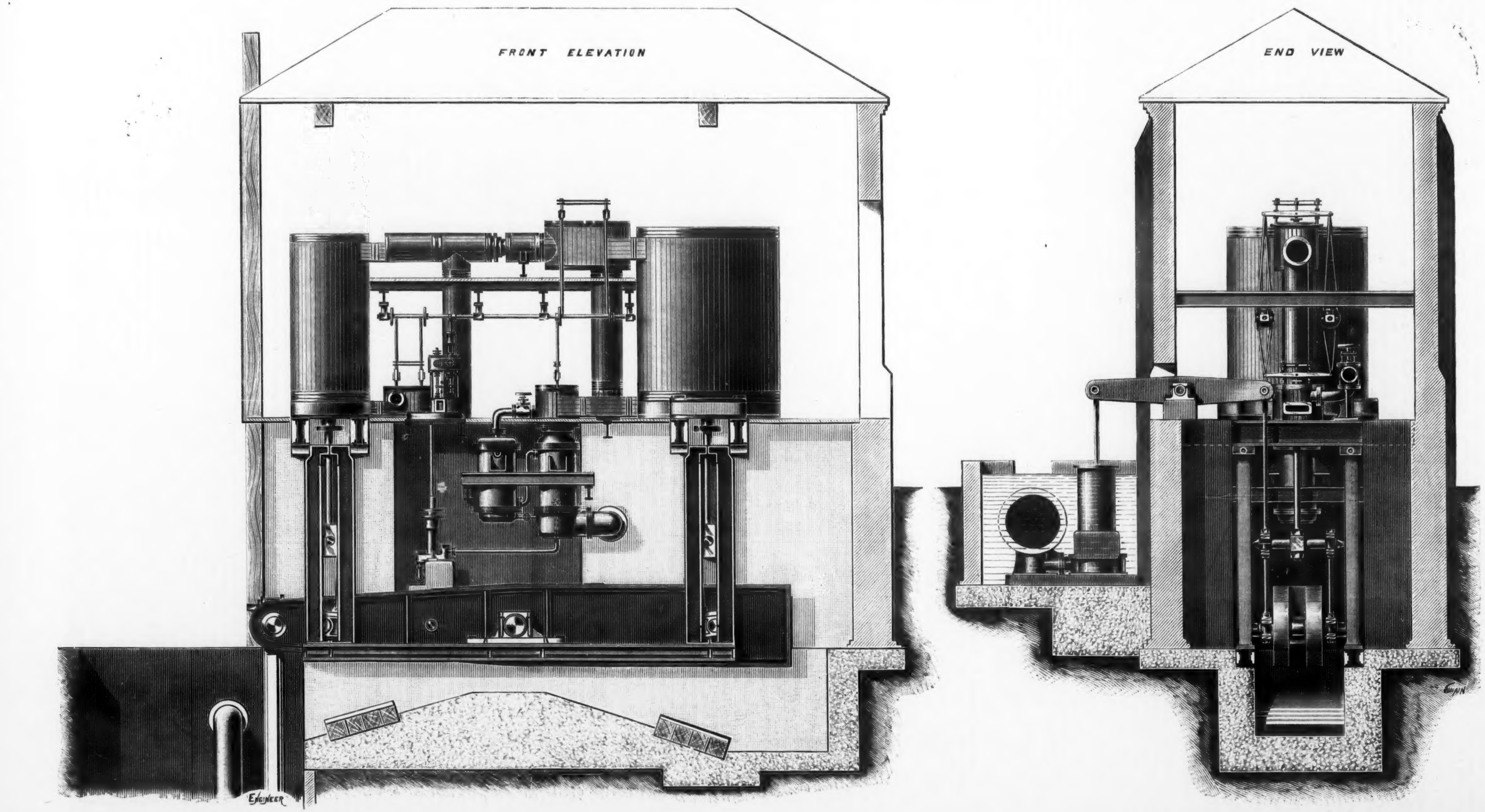
At a meeting of the Society of Arts, on Wednesday evening, a paper was read by Mr. F. Grierson on "The Supply of Sea Water for London." Mr. Grierson described the scheme, which will come before Parliament in the ensuing session, by which it is contemplated to construct conduits for the conveyance of sea water to London from South Lancing, in Sussex. The present intention was to supply nine or ten million gallons a day. One of the main purposes for which sea water could be usefully employed in London was for street-watering. As nearly as could be ascertained, about forty million gallons of fresh filtered water were now daily consumed in London for non-domestic purposes. The cost of the complete carrying-out of the project would be £450,000, and the works could be completed in about two years. There would be less dust and smell, and more cleanliness in the streets; watering would be less frequent and more efficient; the road surface would be more durable; the sewers would be less offensive; the cost to the ratepayers would be less; hospitals and schools would be provided with additional aids to health; every house could be furnished with its own sea bath; the saving of fresh water would be very great, practically adding 25 per cent. to the present supply, and this would make the proposed expenditure on an enormously costly aqueduct system from Wales a more absurdly preposterous scheme than ever.

The new war vessels with which the French Government propose to proceed this year are the Henri IV., ironclad; the Jeanne d'Arc, first-class cruiser; and the Dunois and La Hère, first-class despatch boats. The plans of the Henri IV. are not yet finally approved, but she will have a displacement of 7000 tons, while her length will be 283ft. 4in., her breadth 66ft. 8in., and her draught of water 23ft. 4in. She will be built entirely of steel, her engines will work up to 7000-horse power, and she will be propelled by three screws. Her estimated maximum speed is 15 knots per hour. At 10 knots per hour she will be able to steam 6000 miles. The Henri IV. is to be laid down at Cherbourg in the course of the second half of this year, and she is to be ready for sea by April, 1900. Her estimated cost, including engines and equipment, is £627,163. The Henri IV. has been designed by M. Bertin, who has also prepared the plans for the Jeanne d'Arc. This new cruiser is to have a displacement of 11,000 tons, and she is to be 476ft. 8in. in length by 64ft. 8in. in beam. Her draught of water is to be 27ft. 8in., and her hull is to be wholly steel. She is to be fitted with vertical engines working up to 28,000-horse power. Steam will be supplied by multitubular boilers on the Normand system. The Jeanne d'Arc, which is to be fitted with three screws, is expected to attain a maximum speed of 23 knots per hour. The Jeanne d'Arc is to be laid down at Toulon this month, and she is to be ready for sea by October, 1899. The Spanish Government has ordered two torpedo destroyers in England. They are to steam at the rate of 28 knots per hour. The Brazilian Government has recently placed an order for two ironclads with the La Seyne shipbuilding yards—France. The *Standard* says the Brazilian Government will also shortly place contracts for three 4000 tons, 19½ knots, protected cruisers, ten ordinary torpedo boats, eight torpedo boat destroyers, and five submarine torpedo boats.

COMPOUND CORNISH PUMPING ENGINE

MESSRS. HATHORN, DAVEY, AND CO., LEEDS, ENGINEERS

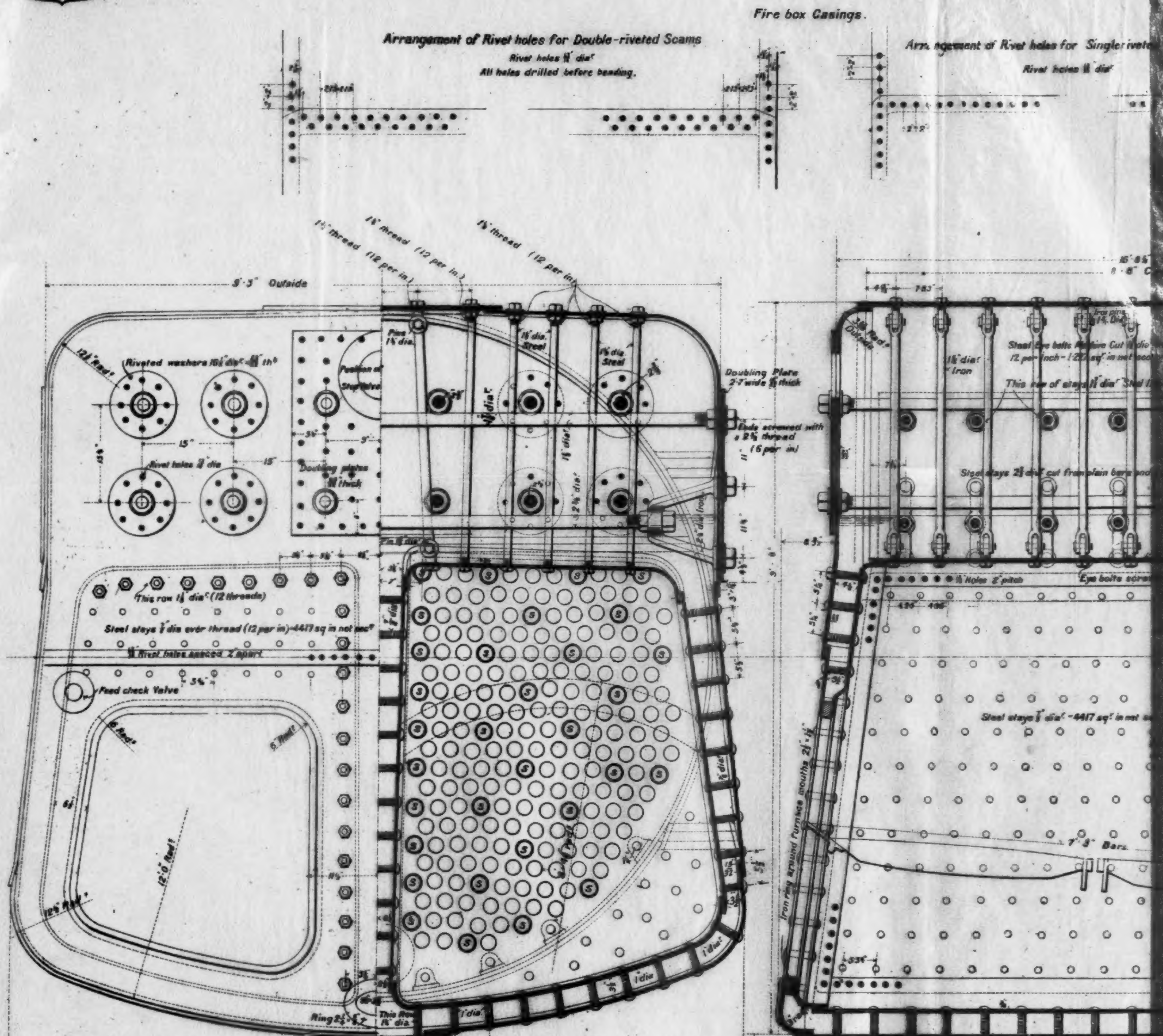
(*For description see page 84*)


FRONT ELEVATION
END VIEW
ENGINEER

LOCOMOTIVE BOILER S.S.

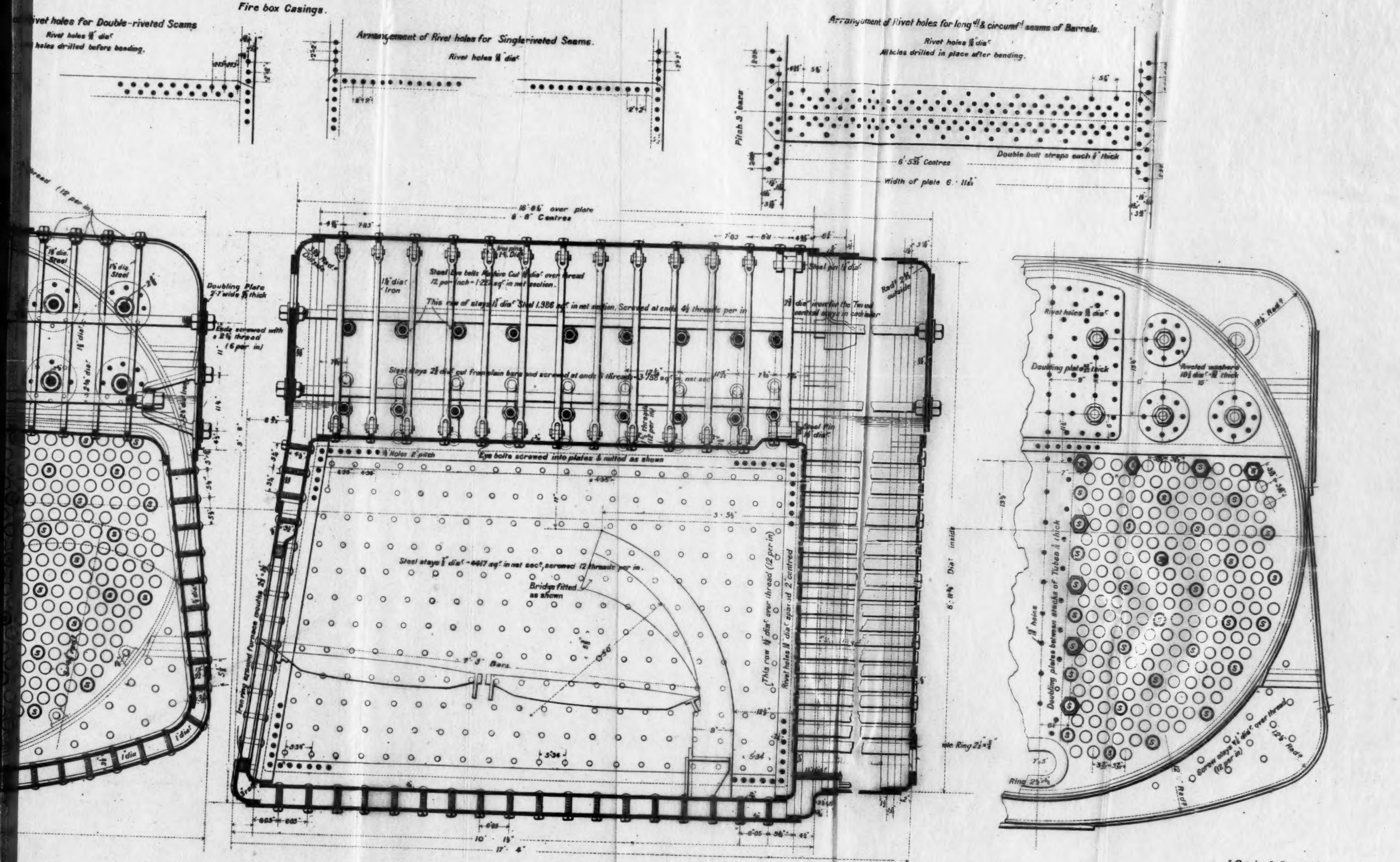
Messrs Laird Bros Birk

PORTFOLIO OF WORKING DRAWINGS
SUPPLEMENT TO THE ENGINEER
NEW SERIES
No 3


Fire box Casings.
Arrangement of Rivet holes for Double-riveted Seams
Rivet holes 15/16" diar
All holes drilled before bending.
Arrangement of Rivet holes for Single riveted
Rivet holes 15/16" diar
1¼" thread (12 per in.)
1⅛" thread (12 per in.)
1⅛" thread (12 per in.)
9' 3" Outside
12¾" Rad.
Riveted washers 10½" diar - 11/16" thk
Position of Stop Valve
Pins 1⅛" dia.
1⅛" dia. Steel
1⅛" dia. Steel
15"
15"
Rivet holes ⅞" dia
Doubling plates ⅞" thick
Doubling Plate 2'-7" wide 11/16" thick
Ends screwed with a 2⅝" thread (6 per in)
2⅝" dia. Iron
This row 1⅛" diar (12 threads)
Steel stays ⅞" dia over thread (12 per in) -.4417 sq in net sectn
⅞" Rivet holes spaced 2" apart
Feed check Valve
18" Rad.
5" Rad.
12' 0" Rad.
12½" Rad.
Ring 3½" × 5"
This Row 1⅛" dia.
1" dia.
10' 0" Outside
16' 8½"
8' 8" C
4⅛"
7.83"
3⅛" Rad. Outside
1⅛" diar Iron
Iron pins 1¼" Dia.
Steel Eye bolts Machine Cut 1⅛" dia
12 per inch - 1.227 sq" in net sectn
This row of stays 1⅛" diar Steel
Steel stays 2⅛" diar cut from plain bars
⅞" Holes 2" pitch
Eye bolts screw
Steel stays ⅞" diar - .4417 sq" in net
Iron ring around furnace mouths 2¼" × 1½"
7' 3" Bars
6.05
10'
17'

OMOTIVE BOILER S.S. QUEEN OF THE NORTH

Messrs. Laird Bros Birkenhead. Engineers.


Fire box Casings.
ivet holes for Double-riveted Seams
Rivet holes 1⅛" diar
holes drilled before bending.
Arrangement of Rivet holes for Singleriveted Seams.
Rivet holes 1⅛" diar
Arrangement of Rivet holes for longdl & circumfl seams of Barrels.
Rivet holes 1⅛" diar
All holes drilled in place after bending.
Pitch 3" bare
Double butt straps each ½" thick
6' 5 3/32" Centres
Width of plate 6' 11 7/32"
16' 6½" over plate
6' 6" Centres
1⅛" dia. Steel
1⅝" dia. Steel
Doubling Plate 2'7" wide ⅝ thick
Ends screwed with 2¼ thread (6 per in)
(12 per in)
3½ Rad. Outside
1⅜" diar Iron
Iron pins 1⅛" Dia
Steel Eye bolts Machine Cut 1⅝" diar over thread 12 per inch = 1.227 sq. in net section.
This row of stays 1⅝" diar Steel 1.386 sq. in net section, Screwed at ends 4½ threads per in
Steel stays 2⅜" diar cut from plain bars and screwed at ends 6 threads = 3.758 sq. in. net sec.
2⅜" diar iron for the Two central stays in each row
Steel pin 1½" diar
Steel Pin 1½" diar
Radl 2⅞" outside
⅞ Holes 2" pitch
Eye bolts screwed into plates & nutted as shown
Steel stays 1" diar = .6417 sq. in net sect, screwed 12 threads per in.
Bridge fitted as shown
7' 3" Bars.
Iron ring around furnace mouths 2½" × ⅞"
This row 1⅛" diar over thread (12 per in)
Rivet holes 1⅛" diar spaced 2" centres
8' 11¾" Diar inside
Ring 2½" × ⅝"
10'
17' 4"
Rivet holes 1⅛" diar
Doubling plate ⅞" thick
Riveted washers 10½" diar ⅞" thick
Doubling plates between stacks of Tubes ⅞ thick
⅞" holes
Screw stays 1½" diar over thread (12 per in)
12½" Radr
12" Radr
Ring 2½" × ⅝"

J. Swain & Son, Litho.

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FRANCE.—BOYVEAU AND CHEVILLET, *Rue de la Banque, Paris.*
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(*To the Editor of The Engineer.*)

SIR,—We will be obliged if you will allow us to ask through your columns for the name of the makers of the new Calyx crown, as we are unable to obtain it out here.

M. AND F.

Johannesburg, December 23rd.

STEEL PEN MAKING MACHINERY.

(*To the Editor of The Engineer.*)

SIR,—We require the name of makers of steel pen machinery, and will be obliged if you will allow us to ask for them in your columns.

St. Petersburg. H. D.

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, January 28th, at 8 p.m. Paper: "Recent Developments in Gas Engines," by Mr. Dugald Clerk, Assoc. M. Inst. C.E. Friday, January 31st, at 8 p.m. Students' meeting. Papers: "Ironfounding in Green Sand," and "Malleable Cast Iron," by Mr. F. A. Lart, Stud. Inst. C.E. Dr. W. Anderson, C.B., F.R.S., Member of Council, will preside.

INSTITUTION OF MECHANICAL ENGINEERS.—Thursday, January 30th, and Friday, January 31st, at 8 p.m., at 25, Great George-street, Westminster, by permission of the Council of the Institution of Civil Engineers. Thursday, January 30th. Papers: "Telemeters and Range Finders for Naval and other Purposes," by Professors Barr and Stroud. "Calculation of Horse-power for Marine Propulsion," by Lt.-Colonel Thomas English. Friday, January 31st. Paper: "Notes on Steam Superheating," by Mr. William H. Patchell, of London.

ROYAL INSTITUTION OF GREAT BRITAIN.—Tuesday, January 28th, at 3 p.m. Lecture: "The External Covering of Plants and Animals: Its Structure and Functions," by Professor Charles Stewart, M.R.C.S., F.L.S. Thursday, January 30th, at 3 p.m. Lecture: "Dante," by Philip H. Wicksteed, Esq., M.A. Friday, January 31st, at 9 p.m. Discourse: "National Biography," by Sidney Lee, Esq. Saturday, February 1st, at 3 p.m. Lecture: "Realism and Idealism in Musical Art, with Musical Illustrations," by Professor C. Hubert H. Parry, D.C.L., Mus. Doc., M.A.

DUNDEE INSTITUTE OF ARCHITECTURE, SCIENCE, AND ART.—Thursday, January 30th, at 8 p.m. Paper: "Locks and Keys, Ancient and Modern: Their Development, Ornamentally and Mechanically," by Harry W. Chubb, Esq., Assoc. Mem. Inst. C.E., London.

SOCIETY OF ARTS.—Monday, January 27th, at 8 p.m. Cantor Lecture: "Alternate Current Transformers," by Dr. J. A. Fleming, F.R.S. Tuesday, January 28th, at 8 p.m. Foreign and Colonial Section. Paper: "Stamboul, Old and New," by Richard Davey. Wednesday, January 29th, at 8 p.m. Paper: "Standards of Light," by W. J. Dibdin, F.C.S. Captain W. de W. Abney, C.B., F.R.S., will preside.

THE ENGINEER.

JANUARY 24, 1896.

FOREIGN COMPETITION IN THE IRON TRADES.

THE investigations which have recently taken place on the Continent, and which were set on foot by the British Iron Trade Association for the purpose of ascertaining how far foreign competition in this industry is affecting the British trade, have now been embodied in a lengthy report, which was drawn up by the delegates, and has now been formally adopted by the Association. The delegation consisted of seven representatives of British masters in the trade and seven representatives of the working men, and their combined efforts have produced a document which is very interesting to the student of international trade matters. No subject is more open to misrepresentation and more persistently misrepresented than that which has to do with industrial problems, whether in their commercial or labour aspects, for there are nearly always two bitterly opposed sides to them, and the statements of both are too often extremely reckless and exaggerated. In the present instance, however, this argument does not hold good, as the joint committee formed of the two contending elements had in view the common and laudable object of ascertaining, as practical men, why it is that continental firms can in many cases undersell the British producer, and of offering suggestions as to how such a state of affairs can be remedied or lessened. In England we have, on the one hand, become so used to the cry, from the masters' point of view, that wages are far too high in comparison with continental standards; while from trade unionists we hear with equal emphasis that the working man is sweated and downtrodden, that it has become very difficult for the most unbiassed and well-meaning individual to strike an accurate mean between the two extremes. It is, therefore, distinctly gratifying to learn that, according to the opinion of the iron trades' representatives, the working man in this country, in these industries at all events, is neither overpaid nor underpaid. His salary is higher than that of his continental brethren, but we are told that the difference between English and German wages is not so great as is generally supposed. Now, it is precisely on this point that statistics would have been extremely valuable, but the report does not give us any figures on the subject.

We are aware that the collection of accurate details as to wages on anything like a comprehensive scale is at once an extremely arduous and delicate undertaking, and that superficial information on the subject would stand a great chance of being rather misleading than otherwise; but it would have been interesting to know in a general way what the difference in wages between us and our neighbours really amounts to. The members of the delegation must have arrived at some basis of their own when they stated that the difference is not so great as is generally supposed. But what is the general impression? We do not know, and we do not believe that any employer in the iron trade has a very accurate knowledge on the subject. This is where the report fails, and leaves matters exactly as they were before as far as real explanations are concerned. It tells us that Belgian wages are lower than German, but this fact has been well known to most iron employers for a long time past. A useful point, however, with regard to the labour question is noted, viz., that the extremes of payment, so noticeable in Great Britain, have no equivalent on the continent. For instance, while in Glasgow engineers are paying their men at least 25 per cent. less than London firms are obliged to pay similar men for similar work, there is no such variable scale of wages among any of our Continental competitors. The logic of so great a variation is by no means apparent, and the Fatherland, whatever else we may have to say about it, is to be congratulated on managing the equalisation of its wages better than we do.

The most instructive and interesting portion of the report, however, is that which deals with the reasons other than labour which tend to lessen the cost of foreign products, and here, at all events, we have some data to go by. The most important of these is the extraordinary difference in the cost of internal transport. In this the Englishman is enormously handicapped, and the report does well to emphasise this fact. From the figures given, it would appear that Belgian producers can send their material by rail to Antwerp, unload it, place it on board ship, bring it to London, and unship it at a much lower cost than is paid by the Englishman to transport his goods from the Midlands to the Metropolis. Another striking illustration of the disadvantage under which we labour is given with regard to "one of the largest works in Germany, whose premises are situated over 150 miles away from any port, but who can send their finished iron and steel through Belgium by rail, and ship it at Antwerp for 3s. 6d. a ton, while the cost of bringing the same class of material from, say, Staffordshire to London, less than 140 miles, would amount to about three times that sum. The delegation have come to the conclusion that were the English railway rates on a par with those on the Continent, we could successfully defy foreign competition in this industry in neutral markets. All round it appears that the railway companies in England charge about twice as much as the continental tariffs. In the face of all these disadvantages, it is satisfactory to learn that the statements with regard to the success achieved by continental firms is habitually exaggerated, and that England, as far as the metal trades are concerned, is not yet "going to the dogs," as pessimists would have us believe, though both Belgium and Germany undoubtedly take many orders which might have been executed in England, were we not so handicapped by external transport.

It is pointed out that Germany goes so far in encouraging its export trade as to have a double price list, charging considerably lower rates for goods destined to be sent abroad. Often this portion of its trade, it appears, is carried on at a loss, the manufacturers relying on the higher prices charged on goods for home consumption to recoup them. It is, of course, Germany's protective tariffs which permit it to charge higher rates on metals and machinery for its own use. After all, perhaps it is not an unmixed blessing to Great Britain that such should be the case, for heavy protective duties on this class of goods, at all events, have been proved to be the most efficient check on progress that a country can have. In England, where we have no protective duties which touch this industry, and where consequently the market is open not only to ourselves, but to Germans, Belgians, and Americans, our three principal competitors, English manufacturers are bound, in order to ensure a market for their goods both at home and abroad, to keep to the front in the way of quality, even when they cannot cut their prices down to those of continental firms; and it is more than probable that were Germany and the other countries to adopt Free Trade, the demand for British machines, large as it is, for use in those countries, would, in spite of their tariffs, be so greatly increased that the local manufacturers would have to bestir themselves to keep pace with us, and thus their competition in outside markets would be much more keenly felt by us than is at present the case. This matter of a double tariff for home and export has long been forcibly illustrated by American machines sent to Europe, as for years past machines manufactured in the United States, after a railway journey at both ends, and the sea voyage, and three loadings and dischargings, have been put on the market in England at a lower price than an American could purchase them for on the manufacturers' premises in his own country. With regard to raw material and coal, we are told, and can readily understand, that we are better off than our neighbours, both as regards quality and price, and all things being considered, it is just as well that such should be the case.

The moral to be drawn from this report is, undoubtedly, that while capital and labour are at continual war with each other in this country, they have overlooked, or at all events neglected, the fact that there are other causes besides the wages question which may tend to drive trade away from the country. The time of both masters and men would often have been much better employed in endeavouring in a peaceful manner to lessen these outside causes which tend to diminish our trade and cut down our profits to so great an extent that generosity on the part of masters in the way of increasing wages becomes an impossibility, even if they were willing to grant concessions. If, as is stated in the report, German and Belgian raw materials and manufactured iron and steel are taken by railway companies at half the price charged in Great Britain, there can be no conceivable reason why concessions should not be demanded from the companies, for our railway system is much more complete than any other in the world, and should be equally effective. It is true that railway dividends are small, but it is not clear that they would be reduced by a revision of tariffs, which would probably be followed by augmented receipts. If the employers' associations and the trade unions would for this purpose co-operate, they could together bring sufficient pressure to bear in the right quarters to effect a great change in transport tariffs. We are by no means advocates of the Government taking over, or having a great deal to do with, our railways and their management, and we consider that, if properly worked, the necessary concessions could be obtained without Government interference; but we would point out that the agitations which have taken place from time to time with regard to railway rates have, as a rule, been ineffective, and even disastrous, mainly because they have not been worked in a right way or by the right people. It will be remembered that when Government took the matter up, and instituted maximum rates for the different classes of goods, some few years ago, the result was the reverse of satisfactory. For the railway companies promptly adopted these maximum rates, which were in many cases considerably in excess of the prices they had hitherto charged, and the public have, as a rule, vainly endeavoured to get these rates reduced. It is, therefore, for master and man, who, after all, are the people who keep the railway companies going, to apply themselves in co-operation to effecting such reductions as will put their produce more on a par in price with that of their foreign competitors. With regard to quality, we have, as a rule, nothing to fear from German or any of our competitors in the engineering or iron industries up to the present.

ACCURACY.

OF the thousands of engineering firms all over the globe, the number which insist on a close approximation to accuracy of work might be expressed in two figures, yet the other firms which are content with less perfect work turn out machinery which performs its duties satisfactorily, and even in certain cases with great efficiency. It is not an uninteresting investigation, then, to look into the conditions which decide the particular degree of excellence which is most desirable in mechanical construction, and to attempt to arrive at a conclusion which may to some extent be capable of general application.

The question has to be viewed from two points, viz., that of the purchaser and that of the manufacturer; for though it may appear at first sight that the maker's most advantageous course is to provide an article which just meets the demand and no more, we think we shall be able to show that in a very great number of cases—we might almost say all cases—it is really to the manufacturer's advantage to maintain a higher standard of work than that upon which his customers insist. At present a higher price is demanded for a first-rate than for a second-rate machine, and this seems natural enough, but we fancy the time is not very far distant when the fact will be recognised that the higher class work, if conducted on the proper lines, is so little more expensive than the inferior quality that the difference should not be taken into consideration. However, the question for us now is to consider the matter as it stands from the two points of view indicated, and with the fact before us that two machines giving results for all practical purposes equally good, may differ from 25 to 30 per cent. in price—the "physical" difference being that the cheaper machine is fitted in the ordinary way, that is to say, no parts have been accurately gauged, but one part has been adjusted to the next, so that they fit with tolerable accuracy, and the whole when completed works with a near approach to smoothness, whilst the other has been made throughout with plus or minus allowances not exceeding a few thousandths of an inch. The most obvious factor in the decision of the purchaser must, of course, be the conditions under which the machinery is to work, and the length of life which is expected of it. No one would think of demanding in an excavator for a Panama Canal the beautiful accuracy and finish of a repeating rifle; not only because the class of work does not require it, but because the machine will only be required to operate for a comparatively short period, and will then disappear into that mysterious limbo whither goes most of the machinery of civil engineering. But when it is desired to keep a machine, be it engine or tool, and particularly the latter, running over an indefinitely extended period, and when repairs and renewals are bound to occur in the course of nature, the purchaser is undoubtedly wise in insisting on thoroughly good and accurate workmanship, for not only will a machine accurately fitted in the first place take much longer to get out of order, but repairs can be executed much more expeditiously, as spare parts ready to go directly into their places can be kept at hand or obtained on very short notice.

The question, then, for the purchaser is sufficiently simple, and in case he feels a difficulty in arriving at a decision from the consideration indicated above, the amount of money he is prepared to spend can generally be used to determine it. But, observe how much more complex is the matter as affecting the manufacturer. Putting aside for the moment the moral effect of the standard of work on his men, he has to take into account (1) The number of similar articles required; (2) the probability of future orders; (3) the cost of the necessary tools, both in outlay and in wear and tear discount; (4) the increase or decrease of highly-skilled labour; (5) the time of manufacture; (6) the increase of price of material, and several other items of a nature affecting his particular case, as shop space, standard of efficiency of his staff, &c. We have put the number of similar articles required and the probability of future orders in the first place, because, provided these be sufficiently high, they overweigh all other considerations. We are well aware that there are still many manufacturers turning out large quantities of machinery identical in all parts, who do not insist on a high standard of excellence. There can be little question that this is false economy. The necessary outlay in tools may mean drawing a considerable sum from the capital; but it will be returned in the increased facility of manufacture. Let us explain this more fully; and, for the sake of example, we will take the case of a large number of small steam engine cylinders all made from the same drawings. The quantity actually on order at any time, it should be observed, does not affect the question if the probability of future similar orders is considerable, or if the price for the first lot is sufficient to partly cover the expense of the tools. The maker who is not prepared to work accurately planes up one cylinder end, bolts the cylinder on to a face plate and bores it out with a simple tool. His lathe probably is not in the best condition, nor by the best maker. Consequently, his cylinder is a little taper and considerably elliptical, perhaps to the amount of several hundredths of an inch. His cylinder covers have in the meantime been turned, and the stuffing-box bored; he prefers probably to leave his piston until he can gauge the cylinder with an indifferent pair of callipers, and turn it to fit the smaller diameter. The holes for the cover studs have been marked off with compasses, or at best with a plate template, and drilled with a shaky drill through the cover. These holes are scribered through on to the cylinder ends, and the tapping holes drilled as accurately as a man can judge by his eye, concentrically with the clearance holes scribered on. They are then tapped by hand. Again, he chips out his ports to scriber lines, and makes his valve in the same way. It is unnecessary to go further. What is the result of all this ramshackle work? The cylinder has to be scraped out true, and the covers adjusted to the position in which the rods work through them best. Some studs are not vertical, and have to be knocked straight; others fit too tight or too loose in their holes; others are not in the right position, and the cover holes have to be filed out to suit. Tedious complications occur with the valve, and so on and so on. How much simpler are the same operations as performed by the best maker? The cylinder is held steady and two cuts taken through with long cutting tools gauged to a thousandth of an inch over the edges, and the ends faced from the boring bar. The stud holes are drilled from cast iron copies through holes bushed with hard steel, and are tapped and studded in a machine that ensures fit and verticality; the ports are milled out to a hard steel copy also. And so with the corresponding parts. What is the result? The engine can be put together, and work without hitch in a fifth the time the other takes. Through all the remaining details the same class of work is carried out. Fitting is reduced to a minimum; it is merely the putting together of parts which are gauge fits. But where fitting has to be done the same accuracy is observed; faces are scraped, not merely filed, and holes made gauge size and drilled through jigs, and all boring and turning done to fixed callipers or bar gauges. It is evident, therefore, that the superior maker can reduce slightly his number of highly skilled hands, though it must be borne in mind that a certain number taken from the fitting shop must be transferred to the tool shop and charged solely with the upkeep of all the accurate tools, templates, jigs, &c. On this point then he does not gain much if at all, and on the original outlay on tools he is considerably the loser. For really accurate work no feature is of nearly so great importance as the condition of the machine tools, and of all the tools, the lathes and milling machines require the greatest perfection and the tenderest care. No one who has not had practical experience of tools of different qualities can fully appreciate the vast difference there is between even a good tool and a perfect one. The manufacturer's outlay on tools must be very high, for he must have the very best tools, keep them in the best condition, and employ good workmen on them. We fancy this is one of the principal obstacles to great accuracy of work in already established firms. They are not prepared to go to the expense of large new plants, and they find they are totally unable to work to a fraction of a thousandth of an inch with their existing tools, so give up trying for "fit" at all, and are content if parts come together within a sixteenth or so. Considerable expense is also involved in the construction of jigs and copies; it not unfrequently occurs that a copy will cost more than the article it is to be used on, so that it is only in quantity that copies pay; but as we have pointed out above, provided the probability of orders is high, the outlay on chucks, jigs, &c., is well worth while, repaying itself over and over again in rapidity and ease of work. The last item we have specified is the increase in price of material, and it is taken on the basis that there must always be a certain percentage of rejection for faulty castings or forgings, and for mistakes in workmanship. If the limit of perfection is very narrow, as in Government specifications, this item may reach from 7 to 10 per cent., but should be a regularly decreasing factor as our knowledge of the whims and vagaries of materials become better understood and dealt with.

This seems a long bill of expenses against the manufacturer, and the only countercharge in his favour is the rate of turnout of work; yet so potent a factor is this that the highest class of work can be made to pay, and by the reputation which it makes, to increase the demand. The proof of this assertion is not far to seek, for the most prosperous firms in this country and abroad are those which have arrived at a high degree of accuracy. And it must be borne in mind that their success is largely due to the fact that by starting in the first place to turn out highly finished work, and having stood the expense of special tools and appliances, they have attracted to themselves extensive orders from all parts for similar articles, so that they have become firmly established in a speciality. No matter where we look, the same observation is true, that the most prosperous manufacturers are those who are able to create and meet a constant demand for some special form of machinery, be it big Corliss, or small high-speed engines, be it sewing machines or quick-fire guns. The power of turning out work rapidly is the cause of a great deal of specialised success, and as, other things being equal, the rate of output varies directly as the accuracy, we may say that in the long run a high degree of accuracy pays well.

But even where special tools cannot be afforded because the demand does not justify the expense, the proper use of standard plain and screw gauges and of rigid callipers should be insisted on, not only because it is expedient from a monetary point of view, but because it is desirable for the general welfare of the nation that its trades and professions should be kept at as high a standard as possible. Such a remote consideration, however, is not likely to affect many persons, and the best plea for good workmanship must be that inaccuracy is nearly as prolific as the greenfly and quite as blighting, whilst the path of accuracy, though it be strait at first, widens in the course of time and leads ultimately to success.

GREAT EASTERN RAILWAY WORKS.

ONE of the earliest of the railway reports to be issued for the past half-year is that of the Great Eastern Railway. The statement of accounts furnishes some facts that are of interest, and that indicate the progress of great works the company has had for some time in hand. In the past six months the Great Eastern has spent the sum of £163,199 on capital account. Out of this sum about £15,957 has been the cost of the purchases of land; and on the widening of lines £27,000 have been spent. The largest work of widening has been that between Bethnal Green and Hackney Downs, on which £8916 was spent in the last six months; and next to that, on the North Woolwich branch, £8643; whilst the remainder was expended on the Whitlingham to Wroxham, Stratford to Ilford, and Rochford to Prittlewell branches. On the electric light works at Liverpool-street, Bishopsgate, &c., the expenditure was £2478. There were additional works at various stations which cost £10,100, and those at Stratford took £9500. Other smaller sums bring up the total to over £103,000. The metropolitan lines have had a further sum of £19,139 spent on them, chiefly in construction of way and stations, &c. On working stock the half-year's expenditure was £39,729, out of which additional carriages took £17,774, and additional wagons £18,452. The capital expenditure on the Great Eastern is now falling off, as with an expenditure, as we have said, of £163,199 for the past half-year, the estimate for the present half-year is only £133,030, two-thirds of which are to be spent on the lines and works open for traffic, and nearly all the remainder is to be spent on additional working stock, so that, compared with the heavy expenditure of three or four years back, there is now a comparatively small sum being spent, and necessarily fewer works of moment are in course of execution. Many of the most important works are becoming productive, and to some of these the great improvement in the suburban traffic of the company is to be in considerable degree attributed, so that in the past six months the passengers on the line have averaged close upon 8,000,000 in each month, whilst the receipts have considerably increased both from ordinary passengers and season tickets. The Great Eastern will now reap the fruits of its recent extensions, and it is to be expected that increasing traffic, both passenger and merchandise, must pave the way for further extensions on a line which is now rapidly becoming one of the leading passenger lines of the country.

LITERATURE.

An Elementary Treatise on Heat and the Steam Engine By the Rev. ISAAC WARREN, M.A. Dublin: Hodges, Figgis and Co. London: Simpkin, Marshall and Co. 1895.

A LITTLE girl walking through a cemetery with her mother, after reading more or less closely a few score of epitaphs, is said to have asked where the bad people were buried? We never see the words "elementary treatise" without feeling disposed to ask where the non-elementary treatise is buried, and what it is like? In our younger days we spoke of treatises not elementary with bated breath, filled with awe. As we have grown older we have by degrees got to the Betsy Prigg frame of mind, and as that lady did not believe in Mrs. Harris, we are incredulous as to the existence of treatises non-elementary. To be more precise, and to apply what we have just written, we maintain that the book before us is very far from being "elementary." On the contrary, it is a very complete and advanced treatise on the steam engine and thermodynamics generally, and the author ought in subsequent editions to leave out the word "elementary" altogether.

Mr. Warren says in his preface that the object which he has "aimed at in this treatise has been to express in intelligible language the main facts of the Science of Heat, together with the Salient Principles which underlie the construction of the Modern Steam Engine." The author has done his work very well; that fact may be admitted at once; but whether the book will take the place of any one of a score of treatises on heat and the steam engine already in use, or at least on the shelves of libraries, is quite another matter. Knowing what we do, if we were buying text books again, we should buy this; but this is not tantamount to saying that those who have already other treatises ought to purchase this. Mr. Warren has succeeded in stating facts very clearly indeed, and the work ought to save much trouble to those who set about the arduous task of teaching themselves, and mathematical formulæ have been reduced to the smallest possible quantity, for which we offer our sincere thanks to the author. We are filled indeed with kindly thoughts concerning him, because he shows that thermodynamics are not after all creations of the mathematical brain, but a real science, the fundamental truths of which can be mastered by anyone possessing sense and fair reasoning power.

Mr. Warren has coined two new contractions, and writes about "Isots" and "Adiabs." These are not lingually æsthetic, but they will commend themselves to the undergraduate, and they lend completeness to the treatise. It may be taken for granted that no author who has any self respect will, in the present day, write a treatise on dynamics or thermodynamics without introducing some new names. We are glad to see that he quotes Lord Kelvin against those who hold that Rumford's experiment on boring cannon was conclusive against the materialistic theory of heat; whereas it was nothing of the kind.

We are not surprised to find that our author goes steadily over the old paths, and does not attempt to take away any of the stones which lie in the way of the thoughtful student. Nothing, perhaps, would be gained if he did under existing conditions. Examiners, for example, are not likely to expect that the student will see that the radiation of heat is an exception to the law that heat cannot pass from a cold body to one hotter than itself. It is open to question whether the production of heat by the resistance of an electric conductor is or is not an irreversible process. The two so-called "laws" of heat are not laws, but arbitrary definitions of certain conditions. The second law, as stated on page 215, is immensely defective. It runs thus: "It is impossible by the unaided action of natural processes to transform any part of the heat of a body into mechanical work, except by allowing heat to pass from that body into another of a lower temperature." Of course, every steam engine gives the lie to this proposition taken in one sense. It is quite different from Kelvin's statement of the second law. The statement on page 231, that the internal energy of a perfect gas depends only on its temperature, is open to question, seeing that hydrogen is raised instead of lowered in temperature by being passed through a porous plug, while the recorded particulars of Dr. Linde's experiments lead to the belief that the theory of gas energy needs some revision. Like almost every other writer on thermodynamics—except, perhaps, Mr. MacFarlane Gray—our author comes to grief over entropy. The following definition leaves the student just where he was:—"The entropy of a substance is a physical property of it which remains constant as long as heat does not enter or leave it *as heat*, *i.e.*, as long as the relation between its volume and pressure per unit area is graphically depicted by an adiabatic line." This reminds us of the celebrated definitions of the function of an archdeacon. It would be improved by the substitution of the word energy for the first "heat." In dealing with our old friend the Carnot cycle, Mr. Warren improves on Clerk-Maxwell, and uses four cylinders instead of three, or rather four positions or states instead of three. It is very difficult, however, to improve on Clerk-Maxwell on any point.

Of the section on the steam engine we can speak very favourably. The illustrations are all new and very effective. Figs. 92 and 95, in which we have combined the position of the crank pin, piston, and slide valve, are both ingenious and highly effective. The explanation of the theory of the injector is novel, although the theory explained is not.

Finally, we may say that while it would be quite easy to find defects in this book, it is far more easy to discover merit, and we take the line of least resistance. Mr. Warren has produced a very good little book, and we think the author deserves the grant which we believe has been made to him by the Board of Trinity College, Dublin, "In consideration of the services rendered to education by the production of the work." The book is a recognised college text-book, therefore, and bears on its title page the arms of the University.

Elements of Geometry. By GEORGE C. EDWARDS, Ph.B. Pages 293. Macmillan and Co. 1895. 7s. 6d.

THIS book is in reality a revision of Euclid's Elements; the cold, cut-and-dried method of the latter, as usually presented to English students, is avoided, and the subject is made interesting and practical. The whole treatment of the matter, and the numerous well-selected examples are justly calculated to appeal directly to the understanding, and thus to be retained in memory without effort, Algebraical expressions are frequently made use of, and aid considerably in simplifying the proof in certain cases; and all the definitions have, as the author states, been so framed that they will not need to be changed when the more advanced portions of the subject are attacked, or when other branches of mathematics are studied. The geometry of solids is dealt with in the same interesting manner, and includes the discussion of spherical arcs and triangles, surfaces and volumes of solids, and the book ends with an introductory chapter on conic sections. The book has been prepared especially for American readers, but, as it will certainly fill a hitherto unsatisfied want here as well as in America, we can heartily recommend it to the notice of English students.

Plane Geometrical Drawings. By ROBERT HARRIS. New Edition, revised and enlarged. London: George Bell and Sons. 1895. 3s. 6d.

THIS is no doubt a very useful book, and one that has been appreciated, or a new edition would not have been called for. It is intended, primarily, to meet the requirements of students preparing for the Woolwich or Sandhurst Army examinations. The problems on plane geometry are arranged and discussed in the usual orthodox manner which the teachers of our youth should know so well; there certainly are a few references to Euclid, but otherwise no elucidation is given as to the why or wherefore. In the graphic arithmetic the author embodies the co-ordinate equations of the line, circle, and parabola; this is a novelty in a book of this class, and should be welcomed. There are also a few useful pages on Graphic Statics and some capital collections of examples, most of which have been abstracted from examination papers. The figures are fair, but no particular care has been taken to have them accurately drawn—see, for instance, Figs. 129 and 138, plane geometry, and Figs. 2, 3, and 4, on cycloidal curves; we also notice that the author uses the term "director" of a parabola—page 108—instead of the classical expression directrix; this, however, may be simply a printer's error, not to be repeated.

SHORT NOTICES.

Tables and Diagrams of Switches and Crossings: A Handy Platelayers' Guide. By Thomas Summerson and Sons, Darlington. Third edition. 1895.—The fact that this little book has reached a third edition is sufficient evidence of its merits. The tables and diagrams are very complete and very clear, and cover gauges from 1ft. 6in. to 5ft. 6in. Simple and satisfactory instructions are given for setting out crossing angles. The type is large and the language simple, but the form of the book is more suitable for an engineer's office than for a foreman platelayer's pocket. It might be worth while to modify the next edition in this respect in a way which will no doubt be obvious to the authors.

The Shipbuilding and Marine Work of the Whole World, and Review of the Leading Trades in Scotland, &c., for 1895; *with Trade Prospects for* 1896. London: Effingham, Wilson, and Co., Royal Exchange; and Glasgow: Proprietors of *The Glasgow Herald.* Second year's issue.—Naval architects and marine engineers will find in this pamphlet a complete *résumé* of the world's progress in shipbuilding and marine engineering for the year 1895. The output is given of all the dockyards, and private yards abroad as well as at home, with plentiful detail and many valuable statistics. Other articles and tables, all on trade generally, such as coal, metals, timber, explosives, &c., more paticularly from a commercial point of view. The whole is in a handy form and is well printed. The publishers are to be congratulated on the second year's issue of so useful a compendium.

Ferguson's Ceylon Handbook and Directory, 1895-96. Kegan Paul, Trubner, and Co.; Street and Co.; John Haddon and Co. Bouverie House, Salisbury-square, E.C.—This latest issue of Messrs. Ferguson's well-known work surpasses in interest and completeness all those that have preceded it. Containing in all more than 1500 pages, more than half of these are filled with valuable and closely printed data and other information connected with the colony. The book is, in fact, a *vade mecum* for research, whether it be by the student of Ceylonese history, of the island topography, or of any other branch of local study. All will find in its pages, and in fullest detail, the information sought for. The work is throughout an admirable specimen of colonial typography, while the copious indexing leaves nothing to be desired by the searcher. We believe this important work of reference not to be even approached in scope and usefulness by any other Colony, save, perhaps, that of Victoria.

Annuaire pour l'an 1896. *Publié par le Bureau des Longitudes.* Small 8vo., pp. 894, with two maps. Paris: Gauthier, Villau and Son, 1896.—This well-known annual appears with the usual regularity at the New Year in the old familiar form of an almanac and ephemiris, accompanied by a large body of information on money, weights, measures, geographical and vital statistics, and physical and chemical contents for the principal natural substances; in fact, the useful knowledge in these fields which is susceptible of reduction to numerical tables. Apart from changes in the astronomical section, that on chronography has been enlarged by an article on the Chinese calendar. M. Moureaux gives a table of the magnetic constants determined by him in 1895, and which now amount to 644 stations, covering the whole of France, and in connection with this subject there is a notice in the literary supplement of a plan of simultaneous magnetic observations by eight groups of French naval officers on different foreign stations, which have been undertaken and in part completed for the purpose of improving the magnetic maps of the world. The newest data in solar and stellar spectroscopy are contained in M. Cornu's notes on these subjects, who also contributes the important literary articles, the first under the title of "Les Forces à Distance et ces Ondulations," being a popular sketch of the history of development in the undulatory theory from the time of Newton and Descartes to the present day, and the second on the optical work of Fresnel, both being papers of enduring value. M. Janssen gives an account of his third ascent of Mont Blanc, in September, 1895, when he stopped for fifty hours at the observatory on the summit, which has only slightly shifted in position during the past year. The air at the summit was extremely dry. With the temperature at the freezing point, and the dew point 32 degrees lower, the lines characteristic of water vapour in the solar spectrum had almost entirely disappeared, thus confirming M. Janssen in his opinion that such lines are entirely due to the terrestrial atmosphere. All the parts of a 12in. equatorial of special construction have been safely carried up to the observatory, but the construction has been deferred to the next season. The biographical notices at the end contain an account of the life and work of Rear-Admiral Fleuriais, a distinguished officer both in the military and hydrographic branches of the service, who died very suddenly in June last while superintending the equipment of the North Atlantic Squadron, which he was appointed to command. He was elected to the Board on the death of Admiral Mouchez in 1893, and contributed a charming article on the history of the mariner's compass to the *Annuaire* for 1894. Another notable loss is M. Emile Brunner, the famous astronomical instrument maker, whose decease leaves the "Artist" class of members unrepresented at the Board.

BOOKS RECEIVED.

A Text-book of Gas Manufacture for Students. By John Hornby, F.I.E. London: George Bell and Sons. 1896. Price 5s.

Forth and Clyde Ship Canal in Relation to the Development of Cemmerce. By J. Law Crawford. Glasgow and London: MacLaren and Sons.

Shipbuilding and Marine Work of the Whole World, and Review of Leading Trades for 1895. London: Effingham, Wilson, and Co. Price 1s. Paper.

A Treatise on Mine Surveying. By Bennett H. Brough. Fifth edition, revised. With numerous diagrams. London: Charles Griffin and Co., Ld. 1896. Price 7s. 6d.

Refrigerating and Ice-making Machinery. A Descriptive Treatise for the use of Persons employing Refrigerating and Ice-making Installations and Others. By A. J. Wallis-Tayler, C.E. London: Crosby Lockwood and Son. 1896.

A Text-book of Marine Engineering for the use of Naval Officers, Marine Engineers, and Students of Marine and Mechanical Engineering. By A. E. Tompkins, Engineer, Royal Navy. With 134 illustrations. Portsmouth: J. Griffin and Co. 1896.

Chemistry for Engineers and Manufacturers. A Practical Text-book. By Bertram Blount and A. G. Bloxam. With illustrations. Volume I.: Chemistry of Engineering, Building, and Metallurgy. London: Charles Griffin and Co., Ld. 1896. Price 10s. 6d.

ALMANACKS AND CALENDARS FOR 1896.

MESSRS. J. ROGERSON AND CO., of the Stanners Close Steel Works, Walsingham, Darlington, send a monthly sheet almanack with the sheets arranged to be turned over and kept for reference. They have good plain figures, and the background is illustrated by engravings of the great variety of steel castings made by the firm from small to very large.

We have received from Messrs. Owen, Brazil, and Co., of the Vulcan Ironworks, Avonside, Bristol, a nice table calendar, with removable and renewable monthly cards printed with clear figures.

Messrs. Ernest Scott and Mountain send a delicately coloured calendar, with monthly tear-off sheets, the background representing some of the firm's specialities in electrical mechanical engineering.

Messrs. Samuelson and Co., of Banbury, send a calendar.

The Columbia Bicycle Company, of Hartford, Connecticut, send a daily tear-off calendar on a metal base. On each day is a suitable remark or *bon mot* relating to cycling or roads and highways, and riding, and a clear space is left for notes concerning coming events or appointments, &c., and as each sheet is held only at one end these sheets are conveniently used for the purpose. The moon's phases are given, but the time for lighting lamps is not, so we may assume the arm of the law is not free in America to stop a cyclist having no light.

THE SHIPBUILDING DISPUTE.

WE are happy to say that it has been officially announced by the secretary of the Amalgamated Society of Engineers that the dispute on the Clyde and in Belfast has been settled. On the Clyde things are quite clear. Belfast was the difficulty, and concerning matters there it was stated yesterday morning that a meeting of the district committee of the Belfast engineers was held at the Engineers' Hall on Wednesday night, and was addressed by Mr. M'Dowell. It is understood that Mr. M'Dowell won over a majority of the committee to the course suggested by the executive. Subsequently Mr. M'Dowell stated, in answer to inquiries, that no ballot meeting of the engineers would take place, but a mass meeting of the men would be held to-day. Mr. M'Dowell intimated that matters stood fairly well for a prompt settlement of the dispute.

REGENERATIVE COLD.

IN our impression for October the 4th we gave a description, condensed from a paper by Herr Schrötter, of the new Linde method of producing cold. We use the word "new," because Dr. Linde has long been known as the discoverer of several admirable methods of constructing refrigerating plant. For reasons not at first sight very obvious, a certain amount of uncertainty and confusion has invested this latest device, and if rumour is to be trusted, some questions connected with it will have to be settled in the law courts. With this matter, however, we have nothing to do. The process is remarkable in many ways. It is remarkable for the fact that it was not used long since; it is remarkable that its nature is not fully understood; and it is doubly remarkable that the facts connected with it have not long since been published. The theory of the Linde process, as we shall call it, admits of being simply stated; we shall so state it, and then deal with the extraneous matters with which the theory has been surrounded.

When a gas is compressed in a non-conducting cylinder its temperature is raised, and the foot-pounds of work done in compressing it are represented by the number of degrees of rise in temperature multiplied by the specific heat of the gas and by 772. When the gas is allowed to expand to its original volume it will fall to its original temperature, provided it is a perfect gas, and will do as much work in expanding as was done upon it during the period of compression. If the gas is not perfect there will be a small loss, and the gas will be a little colder after the operation than it was before. What becomes of the lost energy no one knows. If the gas is perfect there is no loss; if the gas is hydrogen there is a small gain; the temperature being greater after than before compression and expansion. Various explanations have been advanced; we need not concern ourselves with them. In any case the amount of loss or gain is very small. If a gas expands without doing work there is no change of temperature. But there is no known direct means of expanding a gas without overcoming a resistance, and so we have to get at the facts in a roundabout way. Joule took two iron bottles; into one he compressed air to a very heavy pressure, in the other was a vacuum. He coupled the bottles by a pipe and a stop cock, and he put them both in a tank of water at 60 deg. When the temperature was uniform he opened the cock and let the air flow from one bottle to the other. When the temperatures had adjusted themselves it was found that the thermometer stood at very nearly 60 deg.; but during the passage of the air from one bottle to the other the temperature fell in the delivery bottle. Every student of thermodynamics knows why, as far as anyone can be said to know at all. Now, we have here the elements of the cold air refrigerating machine. If it was possible to make a room, compress air into it, and then let the air escape, very intense cold might be produced in the room. This, however, is not a feasible way of working, and so a different method is used. But we may say here that cold air machines have been constructed on the mistaken idea that the air discharged after compression must be cold; the idea being that the receiver bottle in Joule's experiment would be cold, because the delivery one was. Such schemes have, of course, ended in failure. The cold air machine as produced by Giffard, Kirk, Hall, and others works in a different way. Air at, say, 60 deg. is compressed; its temperature is raised during compression according to well-known laws. Thus, by compressing it into one-third of its original space, its temperature would be raised to about 245 deg. Fah. While the air was at 60 deg. no heat could be got out of it by water at 60 deg., but being now raised in temperature, heat can be extracted by passing the air through a surface condenser. We now have the air at a considerable pressure, and at, say, 70 deg. The air is now allowed to expand, and do work in expanding, by driving a piston which helps the compressing engine, and the exhaust air, which has now lost all the heat given up in the condenser, besides that converted into work during expansion, is delivered into the cold room, where the meat to be chilled is kept. So far we have had no occasion to mention Dr. Linde's apparatus, or Regenerative Cold. What we have said was necessary to clear the ground, and make what follows intelligible.

We have said that the air was taken into the refrigerating machine at 60 deg. Now let us suppose that we want to produce a much more intense cold than anything to be had under ordinary conditions. It is obvious that much would be gained in this direction if we supplied the compressing pumps with air drawn from the cold room at, say, – 15 deg. instead of at 60 deg. The late Professor Balfour Stewart, talking of apparatus for producing extreme cold, said that the best effects could be got near the North Pole, where mercury was a solid and strong rum resembled honey in consistency. Again, if we used a third machine and supplied its pumps with air at, say—80 deg., furnished by machine No. 2, we should get a further fall in temperature. We must not forget, however, that apparently water could not be used as the cooling medium, because it would be converted into ice. As a matter of fact, in small apparatus water cannot be so used, and carbonic anhydride liquefied, or some other volatile fluid, is used to carry off the heat. But on a large scale water can be used, and is used by Dr. Linde. No matter how cold air is, it can have its temperature raised to any point we please by compressing it sufficiently. If our readers will now turn to THE ENGINEER for October 4th, they will find an illustration of the apparatus used by Dr. Linde. The compressed air is delivered through a small nozzle above that part of the apparatus in which liquefaction takes place. Now, it is about the functions of this nozzle that confusion exists. To judge from Professor Schrötter, without the nozzle there could be no liquid air. He seems to hold the view that the cooling is a result of what has been erroneously called "Joule's effect." We have said that when an

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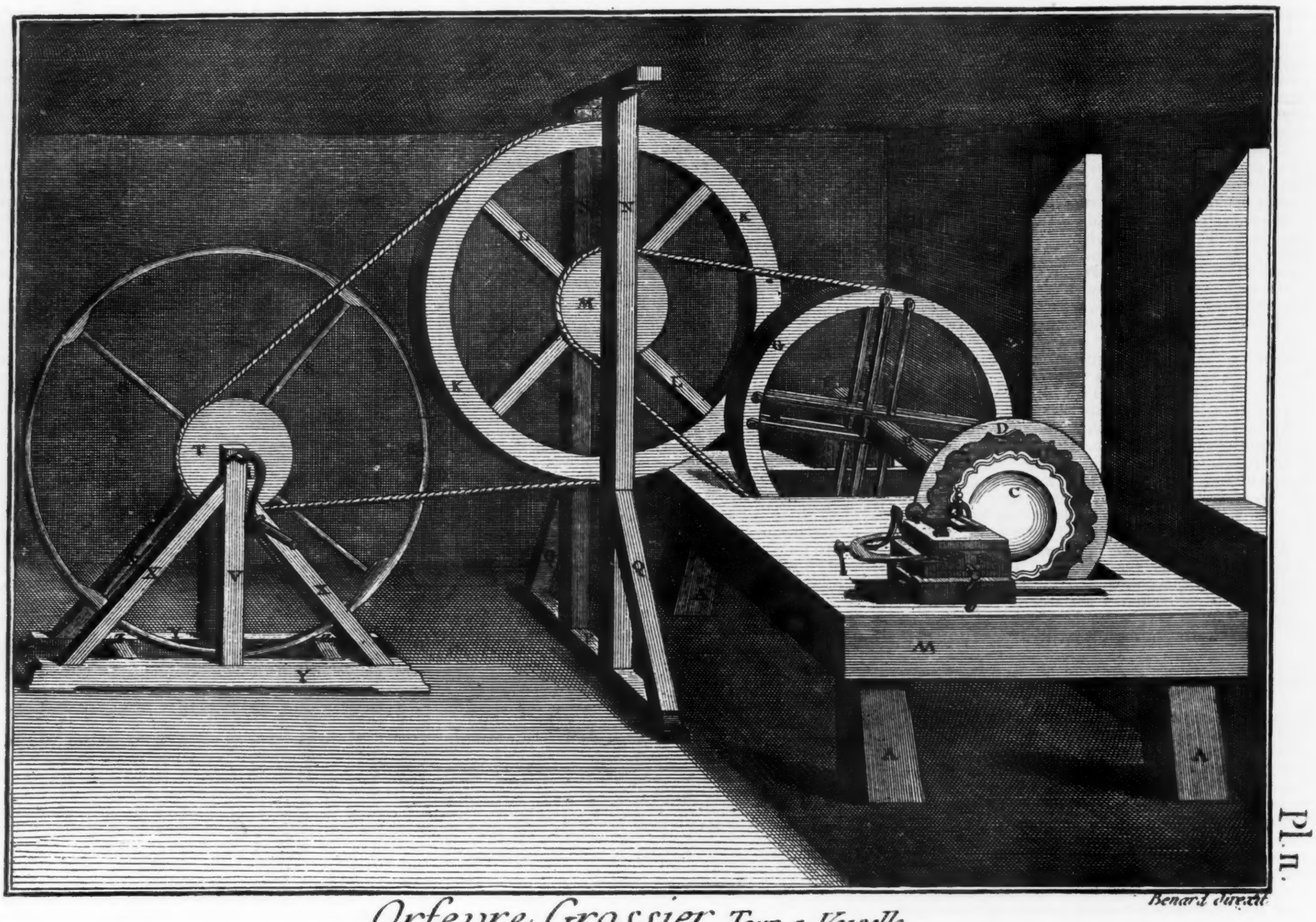
(*For description see page 93*)



Orfevre Grossier, Tour a Vaiselle.

imperfect gas is passed through a porous plug or other small aperture it is cooled. But, as a matter of fact, the apparatus would work with a perfect gas, and is partly independent of Joule's effect. No doubt that effect helps, but it is in no way essential. Let us suppose that a stated quantity of air, say 100 lb., was put into an apparatus surrounded with air at 60 deg. Now, so long as that air was compressed and expanded wholly within the apparatus, and did no external work, there could be no loss of energy unless the temperature was raised, so that heat could escape from the apparatus, or unless it did work on, say, a piston. There is no theory which will lead to the belief that by merely passing the same air over and over again through a small orifice, the air would ultimately lose so much energy that it would liquefy, save one. When steam is permitted to escape through a contracted orifice electricity is produced, and the current carries away some energy. If the same action takes place with compressed air, then energy would be lost and cooling would be accounted for. To assume that the energy in the air would gradually disappear from an apparatus doing no external work, and losing no heat by radiation or conduction, is simply to assume that energy would be annihilated. What does happen is this: The air, cooled by expanding against a resistance, passes away to the compressing pump. In doing so it has its temperature raised by the air flowing down to the nozzle from the cooler. The exchange of heat goes on rapidly through the thin copper pipe, and so by the time the air has reached the compressing pump its temperature has been raised to probably 40 deg., or even more. In the compressing pump, it is, we believe, reduced in volume to one third, not one half as stated by Herr Schrötter. Now the coefficient of temperature for a threefold compression is 1·375. The total heat of air at 40 is $40 + 461 = 501$, and $501 \times 1{\cdot}375 = 688{\cdot}87$. Deducting 461, we have 227·87 deg. Fah. as the temperature at which the air is delivered to the cooler in which water is circulating at 60 deg. It will be seen that it is on the cooler that the whole process depends for success. Energy has to be got out of the air, and the only place where it can be got out is in the cooler. Taking it for granted that no more energy leaves the apparatus through the cooler than the compressing pump engine puts into it, we come to a very important feature of the apparatus. We have said that, in the case of the two Joule's bottles, one was cooled while the other was heated. Now, the speciality of Dr. Linde's apparatus lies in the circumstance that he can have in the same apparatus, and in close proximity to each other, very different temperatures. It will be seen that the temperature of the air leaving the cooler must be over 60 deg., while that of the air which expands in passing through the nozzle is probably —194 deg. It is almost certain that the required result could not be got were it not that the temperature of the air after it has left the cooler is still further reduced by the application of the principle of Regenerative Cold, the effect of which is to localise temperatures. Let us suppose that we have two long pipes, one inside the other, and that we pass two streams of air through these pipes, one of these having a very low and the other a very high temperature, in opposite directions. Let us call these A and B; a transfer of heat will take place so long as there is a difference of temperature, and as A, the hot air, advances and cools, it continually meets with air a little colder still. In the same way, as the cold air advances and becomes heated, it encounters inch after inch air a little hotter than itself. So, in the Linde apparatus, the air coming from the cooler continually meets with colder and colder air, the result being, as we have shown, that the temperature of the air going to the compressing pump is raised, while that going to the expansion nozzle is lowered.

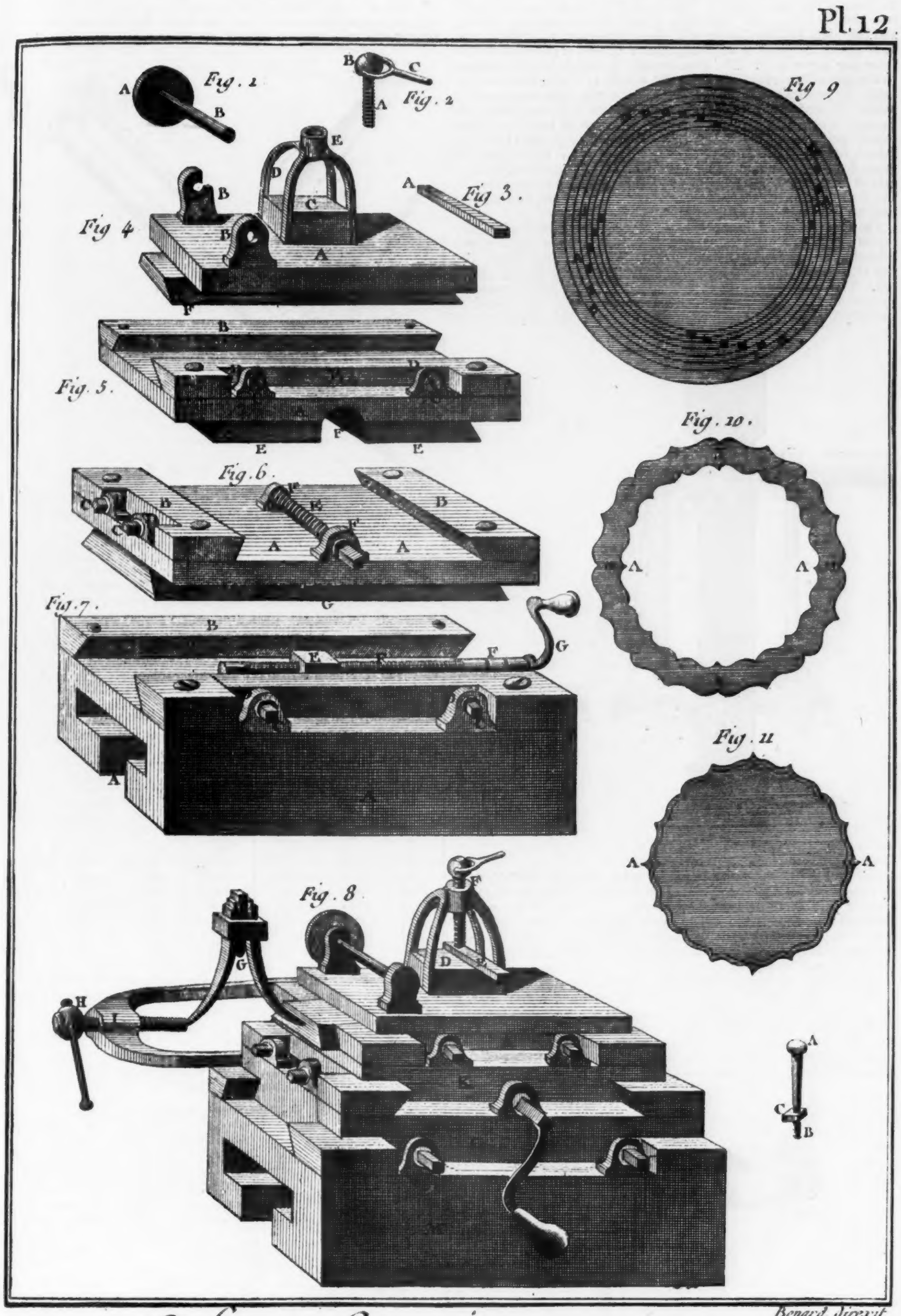
We have used the words "Regenerative Cold," but they are not ours but Professor Dewar's. We have now before us the text of the paper which he read on the 19th December last. We quote the following passage:—"In all continuously working circuits of liquid gases used in refrigerating apparatus the regenerative principle applied to cold first introduced by Siemens, in 1857, and subsequently employed in the freezing machines of Kirk, Coleman, Solvay, Linde, and others, has been adopted." Professor Dewar does not mean that Siemens invented the application of the principle of regeneration to the production of low temperatures, but only that he invented the principle of regeneration; but this is not the fact. In Rankine on "The Steam Engine," page 344, we have under the head "Heat Economiser or Regenerator":—"This difficulty is almost entirely avoided by the following process for producing alternate elevation and depression of temperature with a small expenditure of heat, invented about the year 1816 by the Rev. Dr. Robert Stirling, and subsequently improved and modified by Mr. James Stirling, Captain Ericsson, Mr. Siemens, and others." Rankine then goes on to describe the regenerator. But, as a matter of fact, the method adopted by Linde has next to nothing in common with either Stirling or Siemens. They turned hot air on to wire gratings or bricks, which were raised in temperature by the waste heat. Then a fresh supply of cold air was turned into the heated chamber and warmed. The process is intermittent; the heated bricks in the Siemens regenerator, the hot-plates in Stirling's air engine, or the wire gauze used by Ericsson, acting alternately as recipients and deliverers of heat. In this way Siemens produced the highest temperatures on a large scale known. But it is clear that there is nothing in common between this system and that adopted in the Linde apparatus.

We have already said that the cooling effect which is produced by passing the air through a contracted orifice is very small. We may quote here Professor Dewar as to the reason why the Linde nozzle is more effective than that used by Pictet. "The stopcock that Pictet employed to draw off liquid and produce sudden expansion was in his apparatus placed outside the refrigerator proper, but it is now placed inside, so as to be kept cool by the gases undergoing expansion. This improvement was introduced along with that of isolating the liquid gases by surrounding them with their own vapour in the apparatus made wholly of copper. It is interesting to note in passing that Pictet could get no liquid oxygen jet below 270 atmospheres. This was due to his stop-cock being massive and outside the refrigerator." One point remains for consideration, that is what is known as the cumulative effect. These words are calculated to convey a wrong impression. There is no cumulative effect. The energy contained in the air to be liquefied has to be got out of it, and the only door of exit is the cooler. Work is continuously being done on the air by the circulating engine, which has to raise the pressure from about 350 lb. to about 1000 lb. on the square inch, and the resulting heat must be disposed of. Cold is produced because the air is compressed isothermally and expanded adiabatically. The nozzle is not essential, as would appear from Herr Schrötter's paper, but it is convenient. A fall of twenty atmospheres in pressure would by nozzle action alone only reduce the temperature by about 5 deg. or 6 deg. C. In a word, an ordinary cold air machine, such as Giffard's or Hall's, might be made to produce liquid air by working it at very high pressure, but for the difficulties of lubrication. The fact remains that Dr. Linde has produced an exceedingly beautiful apparatus of extreme simplicity, in the working of which phenomena are manifested of singular interest; but it seems to be clear that the first description of it which appeared in this country, that by Herr Schrötter, conveyed a somewhat erroneous impression, the work of adiabatic expansion being underrated, and that of the nozzle being unduly magnified.

X.

THE record for rapid erection of tall steel buildings has, according to *Engineering News*, been broken by the erection of thirteen and a-half storeys of the ironwork for the Fisher Building, in Chicago, in fourteen days. Previous to this performance, the erection of nine storeys of the Reliance Building, in Chicago, in two weeks was the best record. Both of these buildings were illustrated and described in our issue of October 17th. The Fisher Building is eighteen stories, or 235ft. high, and covers a ground area of 70ft. by 100ft. Work was begun excavating for the foundations July 3rd, and by the last of August they were ready for the ironwork. The first iron arrived October 12th, and work was begun, but it was not until October 19th that the iron could be had as fast as wanted. From October 19th to November 2nd, fourteen days, thirteen and a-half storeys were erected. On November 14th the eighteenth storey was finished, and on November 17th the attic and roof had been completed. From October 12th to November 17th inclusive, there were thirty-seven days, on six of which no work was done, which makes the time thirty-one days for erecting the whole framework for eighteen storeys, attic, and roof. Work is in progress upon the terra-cotta covering, and by December 1st it was expected that the building would be entirely closed in.

AN EARLY COPYING LATHE



Benard Direxit

Orfevre Grossier, Tour à Vaisselle

AN EARLY COPYING LATHE WITH SLIDE REST.

On another page and above we reproduce from the *Encyclopédie des Arts et Metiers*, published at Paris in 1771, two plates representing a curious and early form of the copying lathe adapted for forming the scalloped edge and ornamentation of silver dishes. The text gives no account of the origin of the machine, nor does it mention the name of the inventor, the only particulars furnished consisting of a detailed and minute account of the various parts. The mode of action is, however, perfectly clear. The pattern is fixed upon the face plate D, to which the dish C is also attached. The tool is fixed in a veritable slide rest, identical in its principal details with the slide rest of the present day, and this constitutes another interesting feature of this machine. It is the earliest instance of the appliance which we have met with. As the pattern revolves it causes the rest and tool to move backwards and forwards, the tool being kept to its work by the spring, shown on a larger scale in Fig. 8. One would like very much to know whether this was merely a design or whether the drawing was made from an actual machine.

It will be noticed that the machine as represented is incapable of producing the particular form of scalloped edge depicted, because the friction roller which bears against the pattern could not enter the deep angles of the pattern. The edge actually produced would be of a wavy character, consisting of a series of easy curves. This is, however, in all probability an error of the draughtsman, who thought that an edge with sharp angles would look better. The plates are reproduced not from the original edition of the *Encyclopédie*, but from a subsequent edition in quarto, published in 1781 under the title of *Encyclopédie Methodique*. In almost every detail the plates are identical, though on a somewhat reduced scale. The engravings in the folio edition of 1771 show a wavy edge of easy curves such as a friction roller could readily follow. This explanation seems to be necessary to account for an obvious imperfection in the machine as shown. The plates do not, as might be supposed, belong to the article "Tour" (lathe), but form a portion of the illustrations of "Orfévre Grossier" (gold and silversmith). We have no intention of entering into the vexed question of the invention of the slide rest, but here we undoubtedly have a particular form of slide rest, though not applied to the uses to which it was put by Bramah and Maudslay at a later period. There was an article on this subject on page 391 of the last volume of THE ENGINEER.

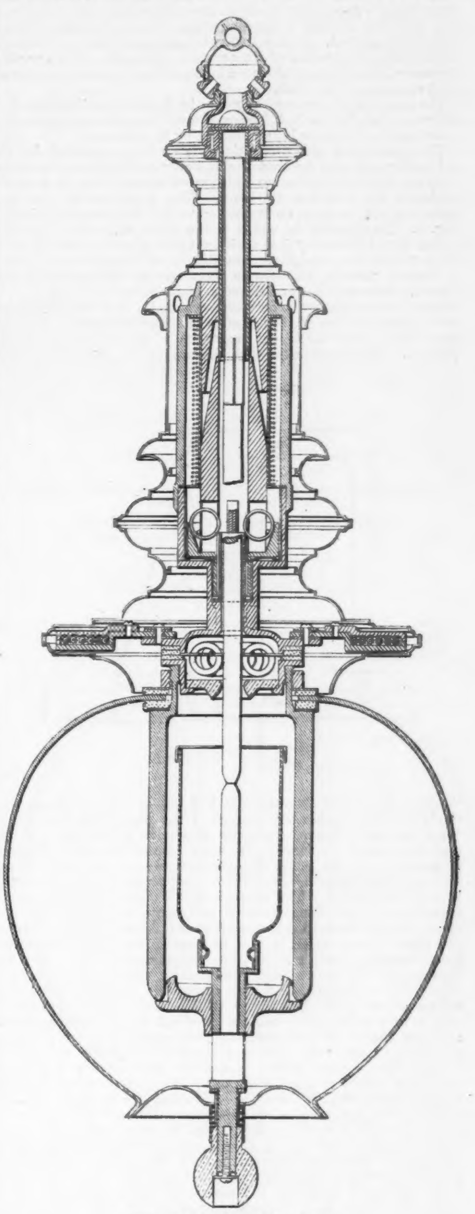
THE JANDUS ARC LAMP.

It is well known that the arc lamp is the most economical instrument for utilising the electric current in the production of light. The drawbacks to the lamp and its defects are equally well known.

Mr. Jandus, an American electrician, has devoted many years to the production of an arc lamp which will be free from that defect, and will be suitable for internal lighting. To this end it is necessary first that the current should be small; secondly, that the carbons should last a long time; and lastly, that the lamps should be simple. We illustrate the lamps as made by Messrs. Johnson and Phillips, of Charlton.

The carbons are carefully selected and of the best quality, and they are "burned" in an atmosphere, self-produced, of carbonic acid. The result is that, instead of wasting at the rate of 1½in. to 2in. per hour for the positive and half that rate for the negative carbon, a positive carbon may last a week, no true combustion taking place at all. It will be seen from our engraving that the carbons are enclosed in a glass jar, open-mouthed, bottomless, and inverted. The top carbon passes, a slack fit, through a hole in a light brass plate, which lies on the bottom of the jar, or rather, as the jar is inverted, on its upper edges. The jar soon becomes filled with carbonic acid, which being heavy, does not tend to escape. But as a further precaution, the outer globe is fitted air-tight at top as shown, at the bottom it is carried on a spun dish plate of brass. The result is that, as we have said, the carbons are surrounded by an atmosphere containing little or no free oxygen, and, as a consequence, they do not burn away.

The feeding mechanism of such a lamp escapes many troubles; under ordinary conditions it is necessary to make the feed as nearly continuous as possible to avoid blinking. In the early days of arc lighting lamps were used which struck the arc by drawing the carbons apart; the light lasted until the carbons had wasted to such an extent that the current could no longer jump across; then the carbons fell together. The current was re-established, the arc re-opened, and things went on as before for five or ten minutes, when the process was repeated. Quick as the fall of the carbon and its rise was, there was a blink quite sensible and annoying to the eye. Now in the Jandus lamp, seeing that the blink does not take place oftener than once in an hour or two, it is of no consequence, and the arc is struck by a coned electro-magnet seen in section in the top of the lamp, in which is a coned armature. The lamps are used in multiple arc, a small resistance being used in the ordinary way to steady them, and consequently no shunt coil is needed. The clutch by which the armature grips the carbon carrier is very ingenious. It will be seen just at the base of the armature, and consists of four milled edge rings, lying inside a conical cup. When the cup rises the rings are forced inward against the carbon holder rod, and gripping it, raises it. It would be very difficult to make the action, which is extremely simple when seen, intelligible to those who have not seen it. In the lower part just above the globe will be seen a number of rings, these take the current into the top carbon. The rings are threaded into notches in the edge of a thin brass diaphragm plate, and they act as guides to the carbon holder. Some of them are certain to be in contact somewhere with the plate, and to carry the current. They take in a very elegant way the place of brushes or springs, and work without friction.



THE JANDUS ARC LAMP

The details of the lamp have been very carefully thought out. The current used is very small, three to five ampères for indoor work, and, hanging in a hall or dining-room, the light, in its silence and steadiness, resembles that of the old-fashioned French "Moderator" more than any other, being quite soft, perfectly silent, and free from sputter or hiss. At long intervals there is a blink, but it is not easy to detect it unless it is watched for. Mr. Jandus has, we think, solved the problem of applying the arc to internal lighting, and we have no hesitation in saying that it is the best lamp of its kind that has yet been produced.

THE INSTITUTION OF CIVIL ENGINEERS: NEWCASTLE-UPON-TYNE ASSOCIATION OF STUDENTS.—The third general meeting of the present session was held in the Durham College of Science, Newcastle-on-Tyne, on Wednesday, 15th January, when Mr. J. D. Wardale, M. Inst. C.E., was in the chair. Mr. C. G. Henzell, Assoc. M. Inst. C.E., read a paper on the Rede pipe line of the Newcastle and Gateshead Water Company.

ON MEASUREMENTS OF SMALL STRAINS IN THE TESTING OF MATERIALS AND STRUCTURES.[*]

By J. A. EWING, M.A., F.R.S., Professor of Mechanism and Applied Mechanics in the University of Cambridge.

MANY forms of "extensometer" have been devised for measuring the small strains of extension or compression which precede yielding in materials subjected to stress by direct pull or push. Such instruments are employed, in the testing of metals, for determining Young's modulus and for observing the behaviour of the material as the limit of elasticity is passed. Apparatus of the same general kind has also been applied to examine the strains produced in the members of bridges and other structures by the application of load to the structure as a whole; the amount of stress in any member being in that case inferred from observation of the strain. Professor Unwin, who has himself designed more than one form of extensometer, has described in his work on the "Testing of Materials of Construction" a number of instruments of this class, and has pointed out that a first condition of accuracy is that the measurements of extension be made on both of two sides of the piece, in such a way that a mean is obtained representing the extension of a central line. In practice, a rod always bends more or less on being pulled. Even when the rod is initially straight the pull is rarely, if ever, so symmetrically applied or the elasticity so uniform as to make the extension equal at all parts of the section. Hence, to avoid errors which would be great relative to the quantity under examination, the extensometer must be arranged in such a fashion that its indications depend only on the change of distance between two points on the axis of the rod, and are independent of those inequalities which are found to exist in the strains as measured on the surface. The condition is met either by taking two separate observations of the strain on two sides of the rod and averaging the two, or by making the extensometer itself indicate a mean strain. Bauschinger's apparatus, in which two mirrors are used to indicate separately the strains on opposite sides of the rod, is an example of the first method. Professor Unwin's extensometer, in which the rod is grasped by a pair of clips at the extremities of two parallel diameters, the change of distance between the clips being measured, is an example of the other.

The object of the present paper is to describe an instrument of the same class, but embodying some novel features, and to mention a few results that have been obtained by its means.

The instrument is self-contained, is entirely supported by the rod under test, and touches the rod only at the points where the clips are attached—a feature which is of advantage in view of the tendency the rod has to bend. The principle of the construction will be seen on referring to the diagrammatic sketch, Fig. 1. To the rod A, which is the piece under test, the two pieces B and C are attached each by a pair of set-screws. Each of these pieces has, separately, one degree of freedom with respect to the rod, namely, freedom to rotate about the axis of its set-screws. Hence, B has two degrees of freedom relatively to C, so long as the two are not otherwise connected. But the piece B has fixed to it an arm B′, which ends in a rounded point P, and this point gears in a V-slot cut transversely across the end of the piece C. The contact of P with the two sides of this slot removes the two degrees of freedom which B would otherwise have relatively to C, and makes the position of the pieces definite. Then, when the rod extends, the point P acts as a fulcrum, and the opposite end of C, namely, Q, moves down through a distance proportional to the mean displacement of the two pairs of set screws. The displacement of Q is a multiple of the strain, in the ratio of P Q to O Q. This displacement is measured by means of a microscope, which hangs from B and sights an object at Q. The strains to be observed are so small that it is easy, without making the piece C inconveniently long, to prevent its angular movement from becoming sufficient to prove troublesome or to affect the accuracy of the indications. The arm B′, which carries the point P, must be so attached to B that, as regards oscillation about the set-screws of B, the two pieces B and B′ move as a rigid whole. But B′ may be flexible in the direction which would give P motion at right angles to the plane of the paper, and by giving it flexibility of this kind—while preserving its rigidity as regards motion in the plane of the paper—the point P may be made to gear in a hole instead of a slot in C. There is a practical advantage in doing this, for if P gears in a slot any unequal extension of the front and back of the specimen makes P work along the slot, and it is difficult to secure that no error will result in consequence of the slot not being perfectly parallel to the axes of the set-screws. This consideration has led the author to adopt the plan of putting a transverse joint between the pieces B and B′, with the object of giving P freedom to adjust itself to a hole—instead of a slot—in C, by movement about this joint in a direction perpendicular to the plane of the sketch. Incidently, such a joint has the further advantage that it allows the whole apparatus to be more conveniently and quickly applied to the rod under examination.

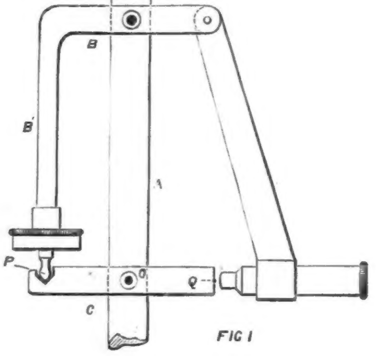


FIG 1

The displacement of Q due to the strain is measured by means of a micrometer in the eye-piece of the microscope. A micrometer scale engraved on glass is convenient for the purpose, and by estimating tenths of a division on such a scale readings are readily taken which correspond to one fifty-thousandth of an inch of extension on the part of the specimen, with an objective which allows the whole of the elastic extension to occur without displacing Q beyond the field of view.

There is a fine screw with a divided head between B′ and the point P. This serves to bring Q into a convenient position for sighting, and also to determine what is the absolute amount of extension corresponding to a division of the eye-piece scale. Should a strain occur exceeding the range of the eye-piece scale, Q is brought back into the field of view by turning P through a distance which is observed by means of a divided head.

Fig. 2 is a view of the complete instrument, taken from a photograph. The clips B and C are in this instance set at 8in. apart, and B is jointed to B′ by a transverse joint, giving P freedom to accommodate itself to a hole in C. The joint between B and B′ consists of two upright pins fixed in B, one of which presses up into a hole and the other into a slot in B′, the line of this hole and slot being perpendicular to the axis of the set-screws by which the clip is attached to the rod under test. Hence, so far as movement about the axis of the set-screws is concerned, B and B′ act as a rigid whole. This movement is prevented by the gearing of P in the hole in the lower clip C. The piece B′ is a frame consisting of two parallel steel rods united by a cross-bar at top and bottom, and carrying, besides the screw P, the microscope, which is hinged to B′ about the point E vertically above Q, and is provided with a focussing screw at F. The counterpoise D, which is also attached to the piece B′, serves to balance the weight of the microscope and make the pressure vertical between P and the hole into which it gears. There is a supplementary counterpoise D′ for adjusting the balance about the axis of the joint between B and B′. These counterpoises are adjusted until when the heavy end Q of C is raised, so that P ceases to be in gear with C, P has no tendency to move in any direction. The excess of weight on the right hand side of C suffices to produce the requisite pressure at the point P. The frame B B′ with the microscope may be lifted off, leaving only the two clips attached to the rod.

The object sighted is one side of a wire stretched horizontally across a hole in a plate at Q, and illuminated by a small mirror behind. The distances O P and O Q are in this instance equal, with the effect that the movement of Q is double the extension of the rod. The eye-piece scale and the length of the microscope are chosen so that the numbers read on the scale correspond to one fifty-thousandth of an inch of extension. This adjustment is tested by turning the screw P, which has a pitch of one-fiftieth of an inch, through one revolution, and observing that the displacement of Q is 500 units of the eye-piece scale. In the instrument illustrated in Fig. 2 the whole scale comprises 1400 units, and calibration tests show that throughout the middle 1200 of them the proportionality of the scale readings with the real movements of Q is practically perfect.

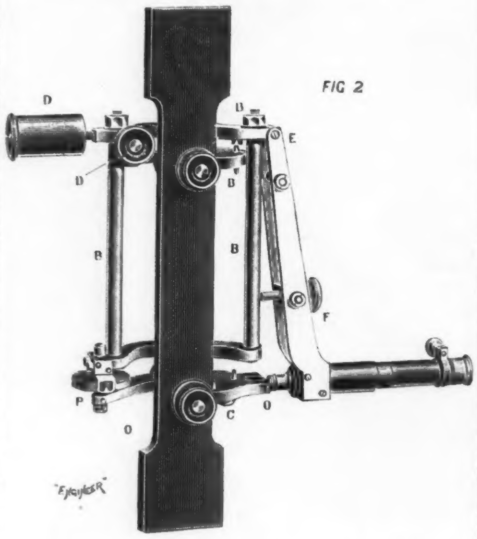


FIG 2

To facilitate the application of the apparatus to any rod, a clamp or distance piece H—Fig. 3—is added, by which the two clips, B and C, may be held at the right distance apart, and with the axes of their set-screws parallel. This makes it in many cases unnecessary to prepare the rod beforehand by punching or drilling holes for points of the set-screws; the clamp is readily held so that the clips stand fairly round the rod; the set-screws are advanced to grip the rod, and the clamp is then removed by releasing the screws G G. The connection of the clamp to each of the clips is by means of three points gearing with a hole, slot, and plane. The clamp is specially convenient when the strain of the specimen has been carried beyond the elastic limit, and it is desired immediately to reset the clips to the standard distance apart after the length between them has been materially changed by the permanent extension of the specimen.

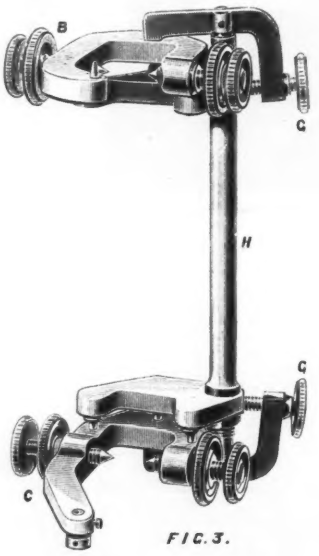


FIG. 3.

Another form of the apparatus designed for use on the members of actual structures is shown in Fig. 4. There are essentially the same parts, but the arrangement is altered in order to make all the apparatus lie on one side of the piece under examination—a desirable and often necessary condition in the application of the instrument to such pieces as the girder flanges. The clips are—as in Professor Unwin's extensometer—adjustable to wide or narrow bars. The pieces B and C engage by means of a screw point in a hole, the necessary pressure being supplied by springs, with the effect that the apparatus can be used in any position, horizontal, vertical, or inclined, as in the figure. The sighted wire Q is on a prolongation of C beyond P, giving a mechanical multiplication of three to one. Between the objective and the eye-piece of the microscope is the box N, containing a series of two totally reflecting prisms, which turn the line of sight through two right angles. This arrangement keeps all parts of the instrument compactly together on one side of the bar or plate under test. A clamp is provided at J, which, by the tightening up of a single nut, disengages P from its hole and fixes the two portions, B and C, in relation to one another, so that the instrument may then be handled as a rigid whole, and be readily applied to the bar which is to be tested, the axes of the clips being then parallel and at the proper distance apart. When the instrument has been put in place, and the clip screws tightened up, the nut J is released, P comes into gear, and things are ready for the observation to be taken,

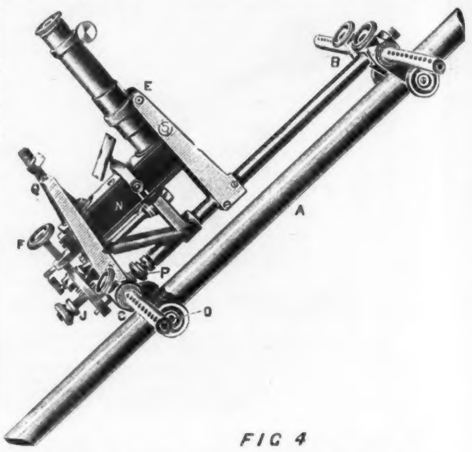


FIG 4

The following are examples of tests made with the author's extensometer in its laboratory form. The pieces were loaded, in tension, by means of the 50-ton Wicksteed single-lever testing machine of the Cambridge Engineering Laboratory. The machine is worked by a hydraulic intensifier, which affords a particularly convenient means of varying the load gradually without shock and without setting the weigh beam into oscillation. Except when otherwise stated, the increments of load were made at intervals of about one minute, that interval sufficing for the adjustment of the load to a new value, and for reading the extensometer. The unit of the extensometer scale readings is in all cases $\frac{1}{50000}$in.

(1) Turned bar of mild steel. Diameter, 1·249in. Length under measurement, 8in. Temperature, 57 deg. Fah. Zero of extensometer set at 400. Results of three successive loadings within the elastic limit:—

Load in tons.	Extensometer readings.			Differences.		
	First loading.	Second loading.	Third loading.	First loading.	Second loading.	Third loading.
0	400	400	400	—	—	—
2½	461	461	461	61	61	61
5	522	522	522	61	61	61
7½	583	583	583	61	61	61
10	645	645	645	62	62	62
12½	707	706	707	62	61	62
15	769	768	768	62	62	61
17½	830	829	830	61	61	62
20	892	891	891	62	62	61
0	400	400	400	492	491	491

Each ton corresponds in this case to a stress of 0·817 ton per square inch. Taking the whole extension due to 20 tons to be 491, or 0·00982in., Young's modulus is

$$E = \frac{8 \times 20 \times 0{\cdot}817}{0{\cdot}00982} = 13{,}310 \text{ tons per square inch.}$$

(2) Turned bar of tool steel. Diameter, 0·706in. Length under measurement, 9in. Temperature, 57 deg. Fah. The bar had not been previously loaded beyond 6 tons.

	Load in tons.	Extensometer readings.	Differences.	
			Per ton.	Per half-ton.
	0	100	—	—
	1	184	84	—
	2	268	84	—
	3	352	84	—
	4	437	85	—
	5	522	85	—
	6	606	85	—
	6½	649	—	43
	7	691	85	42
	7½	733	—	42
	8	776	85	43
	8½	819	—	43
	9	862	86	43
	9½	904	—	42
	10	947	85	43
	10½	990	—	43
	11	1032	85	42
	11½	1075	—	43
	12	1119	87	44
Unload	0	100½	—	—
Reload	12	1119	—	—
	12½	1163	—	44
	13	1206	87	43
	13½	1249	—	43
	14	1292	86	43

The load was then removed, observation being taken at these stages:—

Load.	Extensometer.
10	950
7	693
5	523
0	101½

Here each ton of load corresponds to 2·56 tons per square inch. The mean extension up to 10 tons is 84·7 per ton, and corresponds to a Young's modulus, E, of 13,600 tons per square inch. The extension per ton increases slightly, but perceptibly, with the later loads, although the almost complete absence of set after 12 tons, and even after 14, shows that there was no very clear passing of an elastic limit, even under the greatest strain of 35·8 tons per square inch. There is just a trace of hysteresis in the relation of strain to stress which shows itself in the removal of the load.

These two examples, relating as they do to cases where Hooke's law of the proportionality of strain to stress is very approximately true, may be taken to serve as tests of the sensibility and accuracy of the extensometer.

In the examples which follow, the limits were passed within which Hooke's law applies. In augmenting the stress so as to pass these limits, it very generally happens that one of the first evidences of overstrain is a time effect—a creeping up of the extensometer reading—while the load is kept constant for a few minutes. This creeping, which is a familiar phenomenon in the measurement of strains, can usually be detected a good way before the yield point is reached. It is associated with failure in proportionality of strain to stress, and also with permanent or semi-permanent set. In certain conditions of the material as regards previous treatment, this creeping is far more marked than in other conditions. It shows itself most when the piece has, immediately before the test, been subjected to a load sufficient to cause permanent yielding to occur. But if the same piece is allowed to rest for some days, and is then re-tested, the tendency to creeping is found to have disappeared or to be much reduced in consequence of the hardening and recovery of elasticity which the overstrained material undergoes with the mere lapse of time.

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[*] From the "Proceedings" of the Royal Society, vol. 58.

The following observations were made with a turned rod of common wrought iron, the original diameter of which was 0·697 inch—section 0·381 square inch. Length under measurement, 9in. Each ton of load corresponds to 2·65 tons per square inch. The rod was annealed after being turned. The first loading, after annealing, gave the following results:—

(3A.) *Common iron, annealed.*

	Load in tons.	Extensometer readings.	Differences. Per half-ton.	Differences. Per ton.	
	0	200	—	—	
	½	250	50	—	
	1	299	49	—	
	1½	447	48	—	
	2	395	48	—	
	2½	441	46	—	
	3	488	47	—	
	3½	536	48	—	
	4	582	46	—	
Unload	0	201	—	—	Set = 1
Reload	1	300	—	—	
	2	395	—	95	
	3	490	—	95	
	4	584	—	94	
	4½	632	47	—	
	5	682	51	—	
Unlood	0	208	—	—	Set = 8
Reload	5	682	—	—	
	5·2	702	Creeping to 703 in 1 minute.		
	5·4	721	Creeping to 724 in 1 minute.		
	5·6	749	Creeping to 750 in 10 seconds.		
	5·8	773	Creeping to 774 in 10 seconds.		
	6·0	810	Creeping to 820 in 1 minute.		

With this load of 6 tons the yield point was reached. The creeping under the load was at first slow, then gradually became accelerated, and finally, the sighted wire of the extensometer ran quickly off the scale. At the same time the oxide formed in annealing began to come off in the way characteristic of the yield point. The scaling of the oxide began at one place in the bar and spread gradually in both directions. The load of 6 tons was kept on without alteration for about three minutes while this was happening, and when it was removed there was a permanent extension of 0·10in. on the marked length of 9in.

The extensometer was immediately reset to the normal length of 9in., an operation which occupied two or three minutes more, after which the bar was reloaded as follows:—

(3C.) *Same Piece after Stretching by a Load of 6 Tons.*

	Load in tons.	Extensometer.	Difference per ton.
	0	200	—
	1	297	97
	2	395	98
	3	497	102
	4	600 (Creeping)	—
	—	601 After 1 minute	104
Unload	0	202 (Creeping back)	—
	—	200 After 1 minute	—
Reload	1	297	97
	2	395	98
	3	495	100
	4	598	103
	5	705	—
	—	707 After 20 seconds	109
	5½	767	—
	—	770 After 20 seconds	—
Unload	0	214	—
	—	210 After 3 minutes	—
	—	208 After 45 minutes	—

These figures show how widely different are the elastic qualities of an iron bar in its primitive annealed condition, and in the condition in which it is put by overstrain. In the first condition there is almost no evidence of creeping or "elastische nackwirkung" up to, say, 5 tons of load, and Hooke's law is nearly valid. Immediately after an overstrain there are distinct evidences of creeping at lower loads, and when these lower loads are removed, there is the same kind of thing in the unloaded state, namely, an apparent set which disappears in whole or in part when time is allowed for the creeping to take effect. And further, after the overstrain there is no longer nearly so close an agreement with Hooke's law; a given increment of load produces notably more strain at high loads than at low ones. In loading and unloading there is now much hysteresis in the relation of strain to stress.

In the overstrained state the lowest loads produce not much more strain than they did in the primitive state; the value of Young's modulus so far as very small strains are concerned is scarcely changed. But if the modulus be calculated by reference to the effects of higher loads, it will be much smaller in the overstrained bar. This has been noticed by Bauschiger, who has also observed the tendency, illustrated in tests to be described below, which iron and steel show to recover their elasticity with the lapse of time, after overstrain has taken place.*

On resuming the above experiment, forty-five minutes after the previous load had been removed the influence of the overstrain was still conspicuous.

Load in tons.	Extensometer.	Difference per ton.
0	208	—
1	304	96
2	402	98
3	501	99
4	602	101
5	708	(106)
—	710 After 20 seconds.	108
6	833	—
—	850 After 1 minute.	—
0	244	—
—	240 After 1 minute.	—

The bar was then taken out of the testing machine and left to itself for five days. On the fifth day the following readings were taken; they show in a striking way the effect of this interval of rest:—

(3B.) *Same Piece after Resting for Five Days.*

Load in tons.	Extensometer.	Difference per ton.
0	200	—
1	296	96
2	392	96
3	490	98
4	588	98
5	685	97
6	782	97
0	200	—
6	782	—
0	200	—

The tendency to creep has now practically disappeared so far as this range of load is concerned; the strain is very nearly proportional to the stress, and there is no set. It will be remembered that 6 tons was the greatest load formerly applied, and that it brought the piece to the yield point in the original test. The loading was then resumed, and was carried a stage further to see how far the new yield point would be above the old one.

Load in tons.	Extensometer.	Difference per ton.
0	200	—
1	296	96
2	393	97
3	490	97
4	588	98
5	685	97
6	782	97
6½	832	—
7	908	Creeping, at first slow, then faster, and tending to run off the scale.
0	600	Showing 400 divisions, or 0·008in., of further permanent extension.

The zero of the extensometer was now brought back to 200, and the loading was immediately repeated, to see whether this small amount of further overstrain had undone to any extent the molecular settlement which had been going on during the five days of rest.

Load in tons.	Extensometer.	Difference per ton.
0	200	—
1	297	97
2	395	98
3	492	97
4	591	99
5	692	101
6	793	101
0	204	Creeping back to 202, but not further.

It is clear from these figures that the elasticity has again been to some extent injured by the overstrain at the 7-ton load, small as that was, and one effect is that even a load of 6 tons now produces some persistent set. The following are values of Young's modulus E for this bar calculated from the foregoing experiments—3A, 3B, and 3C:—

Primitive Annealed State (3A).

Mean extension from 1 to 4 tons = 94·5 per ton.
E = 12,500 tons per square inch.

Immediately after passing yield point (3B) the diameter was reduced by the set to 0·693in., and the section to 0·377 square inch.

Extension for first ton = 97; E = 12,310.
Mean extension from 0 to 2 tons = 97·5; E = 12,250.
Mean extension from 0 to 4 tons = 100·2; E = 11,910.
Mean extension from 0 to 5 tons = 101·4; E = 11,770.

After elastic recovery by resting for five days (3C)—

Mean extension from 0 to 6 tons = 97; E = 12,310.

After a small amount of further overstrain—by applying 7 tons—

Extension for first ton = 97; E = 12,310.
Mean extension from 0 to 6 tons = 99; E = 12,060.

Similar results have been obtained in tests of other bars, of mild steel, comparatively hard steel, and Lowmoor iron. In every case overstrain has produced a like fatigue of elasticity, and elastic recovery has followed during an interval of some days or weeks of rest. In several examples the process of passing the yield point has been watched in the extensometer, and has been seen to take place in the same manner as in test (3A). Creeping, which has been slightly visible under lower loads, takes place at first slowly, then it gradually gets faster, though no change is made in the load. This may go on for a minute or two before the crepitation of oxide begins. The following is an instance noticed in testing a bar of mild steel:—The load having been increased a step, and kept constant, there were

3 scale-divisions of creep in the first minute.
9 ,, ,, ,, second ,,
320 ,, ,, ,, third ,,

after which the index of the extensometer raced off the scale. In another case the writer noticed creeping going on quite slowly, when a sound of crepitation was heard. On looking at the bar it was seen that the crepitation had begun near one end, beyond the clips. As soon as it spread far enough to reach the clip there was, of course, a rapid movement of the index.

The following test will suffice in further illustration of the influence of overstrain and subsequent rest. It was made on a turned bar of moderately hard, or semi-mild steel, which had not been previously loaded beyond 6 tons. The diameter was 0·705in., and the section 0·390 square inch. The length under test was 9in.:—

(4A.) *Semi-mild Steel, Primitive State.*

Load in tons.	Extensometer.	Differences. Per ton.	Differences. Per half-ton.
0	200	—	—
1	287	87	—
2	373	86	—
3	459	86	—
4	544	85	—
5	630	86	—
0	200	—	—
5	630	—	—
5½	672	—	42
6	715	—	43
6½	758	—	43
7	800	—	42
7½	843	—	43
8	885	—	42
8½	929	—	44
9	970	—	41
9½	1010	—	40
10	1053	—	43
0	201	—	—
10	1054	—	—
10½	1099	—	45
11	Yield point passed; permanent extension produced = 0·14in. on the 9in. length.		

The load was removed and the extensometer reset to 9in., and the following test was immediately made, beginning ten minutes after the yielding took place:—

(4B.) *Same Piece, after Stretching by a Load of* 11 *tons.*

Load in tons.	Extensometer.	Difference per half-ton.
0	200	—
½	243	43
1	287	44
1½	331	44
2	377	46
2½	422	45
3	469	47
3½	517	48
4	565	48
4½	613	48
5	662	49
0	200	48
5	661	—
5½	710	49
6	760	50
6½	812	52
7	866	54
7½	920	54
8	975	[illegible]
	977 After 30 seconds.	
0	208	—
	203 After 2 minutes.	
8	974	—
	977 After 1 minute.	
0	210	—
	207 After 30 seconds.	
	202 After 3 minutes.	
	200 After 20 minutes.	

As in the example already given, the influence of overstrain is apparent (1) by the presence of creeping or "nachwirkung," and (2) by the progressive growth of the differences as the load increases. The first ton or so produces little more strain than it did before the overstrain took place, but the eighth ton produces a-quarter as much again.

An hour after the yielding had taken place the load was agian re-applied in stages of one ton as follows, and the extensometer readings already show something of elastic recovery through rest. They are given in the following table, along with readings taken on the following day and on subsequent days. It is interesting to notice the rather slow progress of the elastic recovery from day to day. It takes place much less rapidly in this comparatively hard metal than in milder steel or in wrought iron. To facilitate comparison the readings taken immediately after the overstrain are repeated here:—

Successive Loadings of the same Piece, after various Intervals of Time.

Load in tons.	(4B.) Ten minutes after overstrain.		(4C.) One hour after overstrain.		(4D.) One day after overstrain.		(4E.) Two days after overstrain.		(4F.) Three days after overstrain.		(4G.) Five days after overstrain.		(4H.) Twenty-one days after overstrain.	
	Extensometer readings.	Differences.	Extensometer readings.	Differences.	Extensometer readings.	Differences.	Extensometer readings.	Differences.	Extensometer readings.	Differences.	Extensometer readings.	Differences.	Extensometer readings.	Differences.
0	200	—	200	—	200	—	200	—	200	—	200	—	200	—
1	287	87	287	87	286	86	286	86	286	86	286	86	285	85
2	377	90	376	89	373	87	372	86	372	86	372	86	371	86
3	469	92	467	91	463	90	461	89	461	89	460	88	458	87
4	565	96	562	95	559	96	556	95	553	92	550	90	545	87
5	662	97	660	98	658	99	653	97	650	97	643	93	632	87
6	760	98	760	100	758	100	754	101	750	100	741	98	720	88
7	866	106	862	102	860	102	857	103	853	103	844	103	810	90
8	976	110	969	107	963	103	960	103	958	105	950	106	900	90
0	208 to 203	—	206 to 200	—	203 to 200	—	203 to 200	—	203 to 200	—	203 to 200	—	200½ to 200	—

These figures show that even after three weeks the elastic recovery is still somewhat incomplete. This is the more remarkable when it is borne in mind that the testing is done here with a load of 8 tons only, a considerably smaller load than that which had been applied to produce permanent set—namely, 11 tons. The imperfection which the elasticity still shows after three weeks of rest would be more conspicuous if the loading were extended beyond 8 tons.

Throughout this group of tests evidences were seen of much elastic "nachwirkung." If a load exceeding, say, 4 tons, was left on for a few minutes there was continued extension, amounting sometimes to as much as five scale divisions. And when the load of 8 tons was removed there was, as the table indicates, a gradual retraction which in a few minutes destroyed the apparent set observable at the moment of removing the load. In the final observation (4H) this action had almost wholly disappeared, but even then a trace of it could be detected.

As elastic recovery goes on in the days or weeks following overstrain there is a gradual return towards Hooke's law, or as it might be described in other terms, a gradual straightening out of the stress-strain curve. So long as the recovery is incomplete there can scarcely be said to be any elastic limit, in the sense of a point below which there is strict proportionality of strain to stress.

For the Young's modulus of this bar the tests give the following values:—

(4A.) Primitive condition (before overstrain).
Section 0·390 square inch.
Mean extension from 0 to 8 tons = 85·6 divisions per ton.
E = 13,480 tons per square inch.

(4B.) Immediately after stretching past the yield-point by 11 tons.
Section 0·385 square inch.
Extension for the first ton = 87; E = 13,440.
Mean extension from 0 to 8 tons = 97 per ton; E = 12,060.

(4G.) After 5 days' rest.
Extension for the first 2 tons = 86 per ton; E = 13,600.
Mean extension from 0 to 8 tons = 93·7 per ton; E = 12,480.

(4H.) After 21 days' rest.
Extension for the first 2 tons = 85·5 per ton; E = 13,670.
Mean extension from 0 to 8 tons = 87·5 per ton; E = 13,370.

The behaviour of iron or steel when "fatigued" by overstrain, and before recovery of elasticity has taken place through prolonged rest, much resembles that of a brass rod in its normal state. The following is a test of a turned rod of rolled brass with a section of 0·386 square inch. The length under measurement was 9in.

Load.	Extensometer.	Difference per half-ton.
0	200	—
½	281	81
1	362	81
1½	443	81
2	525	82
2½	607	82
3	690	83
3½	772	82
4	856	84
4½	941	85
0	200	—
4½	942	—
5	1031	89
0	202	—
5	1036 to 1037	—
5½	1129 to 1130	93
0	212 to 210	—

Under the higher loads there was a distinct creeping, with a corresponding creeping back after the load was removed.

Taking 163 divisions per ton as the extension under small loads, the value of E is 7160 tons per square inch.

The last test to be cited is that of a "steel" casting of the specially pure kind now extensively used to form the cores of dynamo magnets. The rod was turned from a steel casting by the makers—Messrs. Edgar Allen and Co.—and had been submitted to the writer for a magnetic test, which had shown it to have exceptionally high permeability under strong magnetic forces. It consisted of nearly pure iron. The diameter was 0·753in.

Load.	Extensometer.	Difference per half-ton.	Set.
0	200	—	—
½	237	37	—
1	273	36	—
1½	310	37	—
2	347	37	—
2½	384	37	—
3	423	39	—
0	204	—	4 (apparently persistent)
3	424	—	—
3½	468 to 470	44 to 46	—
4	528 to 540	58 to 70	—
0	249	—	49
4	545 to 550	—	—
4½	670	—	—
	715 after half a minute.		
	758 after two minutes.		
	785 after nine minutes.		
0	447	—	247
4½	798	—	—
5	1200 running slowly off the scale		

The mean extension from 0 to 2½ tons is 73·6 per ton, which makes E = 13,740 tons per square inch.

MR. THOMAS GALLON.—The name of Mr. Thomas Gallon, whose death was announced in our last impression, was incorrectly spelt Gallow. It may be added that his hydraulic capstans were awarded the gold medal at the International and Electrical Exhibition, Edinburgh, 1890.

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* See also a paper by the present writer—"On Certain Effects of Stress," Roy. Soc. Proc., No. 205, 1880—which gives instances of the rise of the yield point with lapse of time, a phenomenon evidently having a close relation to the rise of the modulus.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

EARLY LOCOMOTIVES.

SIR,—Mr. Stretton has given us his opinion concerning the bow-shaped locomotives, viz., "No engine was ever built for the Great Western Railway with such a projector." Here again, unfortunately, Mr. Stretton's opinion is at variance with the actual and indisputable facts. It is well known to students of early Great Western Railway history that Dr. D. Lardner, in the autumn of 1838, for a period of three months, was experimenting with the original broad gauge engines, on behalf of Mr. N. Wood, to enable the latter to prepare his report to the directors of the Great Western Railway. After the report had been published, Dr. Lardner published various magazine articles, &c., giving the results of his experiments. In the *Monthly Chronicle* for 1839, page 191, Dr. Lardner states: "The only expedients which we have seen on that railway"—*i.e.* the Great Western—"are what have been called—from their peculiar shape—the *boat engines*, and these are, or were lately, incapable of working passenger trains, and were used as ballast engines. We have always been informed that the expedients for cutting the air were found—to use a well-known phrase—*not to answer*." Surely Mr. Stretton, in the face of the above statement made by Dr. Lardner, will withdraw his remark "that no engine was ever built for the Great Western Railway with such a projector." Nor is the above the only reference Dr. Lardner makes to these prow-shaped locomotives. At the meeting of the British Association held at Birmingham in 1839, Dr. Lardner read his well-known paper "On Railway Constants and Resistance of Air to Railway Trains." In this we read: "The form of a boat or beak having been given to some of the engines on the Great Western Railway apparently with the view to diminish the effect of the atmospheric resistance, Dr. Lardner determined to ascertain how far such a form would produce any practical effect." Tables 4, 6, and 7 describe these experiments.

Perhaps Mr. Stretton will explain why Dr. Lardner made the eight experiments recorded in the three tables, if the engines did not exist.

I have recently been in communication with a gentleman who represented Mr. Brunel at Dr. Lardner's experiments, but, unfortunately, he is unable to remember anything definite in connection with them.

I have heard from Mr. Wilson that the engine illustrated in THE ENGINEER of 3rd inst. was the "Grasshopper." So it appears that the "Ajax" and "Grasshopper," with 10ft. driving wheels, composed of discs of iron, and with a projecting prow, were found unsuitable for passenger train traffic, and were used for leading ballast trains during the construction of the Great Western Railway.

Mr. Crampton gives the following dimensions of the "Ajax":—Area of fire-grate, 10·22ft.; total heating surface, 474ft.; diameter of driving wheels, 10ft.; diameter of cylinders, 14in.; stroke, 20in.; surface in fire-box, 57·3ft.; cubic contents of both cylinders, 7·09ft.; proportion of capacities of cylinder to the wheel, 1 : 1·41. The "Grasshopper" was apparently of the same dimensions. It will be observed that these dimensions are quite different to those of the "Hurricane," the other 10ft. wheel engine.

January 17th. G. A. SEKON.

MECHANICAL ROAD CARRIAGES AND FEATHERWEIGHT MOTORS.

SIR,—Considerable attention having been drawn to a certain motor on account of its extreme lightness in relation to its power, we should like to be allowed a few criticisms on the subject of very light motors for road carriages. Except for application to cycles, our present opinion is not favourable to extreme lightness of motor for this service. We should give preference to motors of from 1½ cwt. to 3 cwt., of 2-horse power to 4-horse power. In our extensive experience of machine tool making, we have always found, as is generally recognised in all classes of machinery, that, independent of good foundations, perfect balance of moving parts is by no means the only essential to steadiness and to the accuracy and finish of work turned out. The "anvil principle," or the absorption of "trepidation"—we call it vibration—by properly distributed mass is a most important necessity for overcoming objectionable vibration; in the case of carriage motors with the absence of foundation, this principle assumes an even greater importance, and a motor sufficiently heavy to absorb its own vibrations is consequently to be aimed at. What the minimum weight of such a motor should be depends, of course, upon its design, and is a matter of experiment for each type and power of motor employed. Again, the weight of motor and carriage as a whole, and its distribution, should be considered in relation to its power and weight for adhesion. The slipping of some of the wheels on the snowed roads of Chicago was probably due to excess of power over adhesive weight. The relation of these to each other is also a matter of experiment, but a moderate or even a substantial weight is evidently necessary. The tractive force required for a motor of, say, 3 cwt. is so small that the difference between this and one of, say, 20 lb. need not be taken into consideration.

The durability (?) of a motor of 2-horse power, weighing 20 lb., is very speculative. It is said, "The good die young." It is mechanically more satisfactory, however, if the old die good, and the life of a 20 lb. 2-horse power motor, though it may be brilliant, must of necessity be brief.

We hope shortly to furnish you with illustrations of motor vehicles we have now in progress, and to give our experience on some of the above points. In the meantime, we should like, if permitted in a technical letter, to observe that as Britain has recently shown she can hold her own against the world politically, she will also be able to do so mechanically, in the matter of motor vehicles. We intend to be amongst those to prove this, so that anyone who prefers home-made goods to those "made in Germany"—or America—may satisfy their patriotism by placing their orders with firms at home. LISTER AND CO.

Keighley, January 18th.

A QUESTION OF TRAIN RESISTANCE.

SIR,—I think it is possible that I may be able to throw a little light on the question of train resistance, with which you have dealt in your last impression. I assume that you do not doubt that a speed of nearly seventy-three miles an hour was reached on the Lake Shore and Michigan Southern Railway, on the 24th of October, but that you do doubt that the resistance was only 15 lb. per ton. I think it can be shown that the resistance was much higher, and that neither you nor your American critic have done full justice to the locomotive. I have received from a friend in America a species of circular which is being sent out, containing particulars of three runs—that under consideration; one made on the New York Central on the 11th of September; and one on August 22nd and 23rd, during the race to the North, made on the West Coast route. From this circular a few particulars of interest, not previously published, are to be gathered. The circular is, however, silent as to gradients, which is, of course, the important point.

I find that the piston speed of the six-coupled engine was on the average 1484ft. per minute. The united area of the two pistons was 430in., deducting piston rod area, and $\frac{430 \times 1484}{33,000} = 20$-horse power per pound of cylinder pressure effective. The boiler pressure was 180 lb. on the square inch, and I do not think it is too much to assume that the average effective cylinder pressure was about 50 lb.; this gives us 1000-horse power for the engine; it is very probable that it was more. Nor is this remarkable, for although the engine has only 17in. by 24in. cylinders, the boiler is enormous. There are 1700 square feet of heating surface, and what is of yet more importance, 30 square feet of grate. There is no doubt that the engine was provided with the best coal that could be got, and started with the tender tank full of hot water. No device that was known to a fireman was neglected. The engine was run with but one consideration—speed, and no doubt the enormous grate disposed of coal as fast as it could be got through the fire-door under the influence of a powerful draught. The production of steam representing 1000-horse power under such circumstances by a boiler with 1700 square feet of heating surface would not constitute a very remarkable performance. In this country we have had 1000-horse power out of 1400 feet of surface with easy firing.

Now 1000-horse power at 73 miles an hour gives a tractive effort of 5121 lb. That is the total tractive effort of the engine, which was expended partly in propelling itself and the tender, partly in pulling the three cars of which the train consisted. The total weight of the train was 506,500 lb., or 226 English tons, and $\frac{5121}{226} = 22·61$ lb. per ton, which is a far more rational figure than 15 lb.

The engine and tender weighed 202,000 lb. or, say, 90 tons. If we take its resistance, including friction, at 40 lb. per ton, we have 3600 lb. tractive effort, leaving 1521 lb. to haul the cars. They weighed 304,500 lb., or, say, 135 tons, and $\frac{1521}{135} = 11·26$ lb. per ton. All these figures give a very small resistance, and there can be no doubt but that the resistance was very small, but not necessarily anything like so little as 15 lb. per ton for engine and train together.

But the moment we admit that a small tractive effort will give a high speed, the favourable influence of a descending gradient comes out with remarkable prominence. Thus, 15 lb. is very nearly the 150th part of a ton. If, now, the resistance of the American train was but 15 lb. per ton, then it follows that a speed of 73 miles an hour must be attained and maintained for a distance of 86 miles on a down gradient of 1 in 150, engine and all, just sufficient steam being admitted to the engine to prevent pumping action in the cylinders. This seems a very large demand on our faith. I wonder if any of your contemporaries in the United States have looked at the matter from this point of view. But let me push the argument a little farther. Assume that the resistance was nominally, say, 23 lb. per ton for engine and train, but that the train was running down a gradient of 1 in 2240, then the real resistance was 24 lb. per ton. If the gradient was 1 in 1120, then the resistance was 25 lb. per ton; if the gradient was 1 in 500, the resistance would be 27·4 lb. per ton. The only information to be had about the gradients is that from Erie to Harbour Creek the road rose at the rate of 15ft. per mile, up which a speed of 55 miles an hour was maintained.

I think the facts go to show, not that the resistance was very small, but that the power of a big engine run in a very reckless way is great. It must be remembered that the six-coupled engine is half as large again as the most powerful locomotives in this country, measuring the power by the size of the boiler, which is the real test. With a slashing draught such as there must have been when the driving wheels were making 371 revolutions per minute, the huge grate would have got rid of coal in a way to surprise one, and coal means speed and power. I see no reason to doubt that the pressure was maintained all through the run at 170 lb. or thereabouts, and that being so, the average cylinder pressure might have been nearly 70 lb. or 80 lb. As you have said, what is now lacking is more detailed information. Perhaps Mr. Canniff, the general superintendent of the Lake Shore and Michigan Southern Railway Company, will let the railway world have it. SIGNAL POST.

Shrewsbury, January 21st.

SLIDE VALVE FRICTION.

SIR,—I notice a letter from "Frottoir" on the above subject in your issue for this week, in which he states that he had experimented with an engine giving 28 brake horse-power, and found that about 0·6-horse power was required to work the slide valves. I presume this was the difference observed on the brake when the slide valves were balanced, as stated by him, and unbalanced or working as ordinary slide valves. He also states that the conclusion arrived at was that about 5 per cent. of the indicated horse-power was absorbed in working the slide valves. It is with reference to this that I wish to call your attention.

Let x = the percentage of the horse-power absorbed in driving the slide valves, then $\frac{x}{100} = \frac{0·6}{28}$; $\therefore x = \frac{60}{28} = 2·14$ per cent. of the brake horse-power, which will be less than this when compared with the indicated horse-power; thus, let us assume the engine had a mechanical efficiency of 75 per cent., then the relation between the B.H.P. and I.H.P. will be $\frac{\text{B.H.P.}}{\text{I.H.P.}} = 0·75$, and therefore $\text{I.H.P.} = \frac{\text{B.H.P.}}{0·75} = \frac{28}{0·75} = 37·33$ I.H.P. In this case we have $\frac{x}{100} = \frac{0·6}{37·33}$; $\therefore x = \frac{60}{37·33} = 1·6$ per cent. of the I.H.P.; a result which agrees very well with that stated in my letter contained in your issue of the 10th inst. EDWARD J. M. DAVIES.

24, Harrington-square, London, N.W.,
January 18th.

BELGIAN GIRDERS IN MANCHESTER.

SIR,—An enterprising Press Cutting Agency sends me your note, from page 71 of your current issue, about an extraordinary instance of the success of Belgian competition in the Cleveland district, and mentions my name as having bought girders in Belgium. I desire to say that this is inexact. My resident engineer tells me, on inquiry, that he bought some girders from a local English firm, and the iron may have been Belgian, but I did not go out of my way to buy a few paltry girders in Belgium. The whole item does not amount to £50 out of a contract going heavily into five figures.

But why make such a mountain out of a molehill? Are you not aware that every pound—as I have been told by Middlesbrough men—of the iron roof of the large railway station in Middlesbrough is made of Belgian iron? That is a fact worth knowing—not a repetition of the old experience common in almost in every English town, that Belgian girders are used for building purposes. To quote the words from Hamlet—with the necessary alteration—"Something is rotten in—the state of—Middlesbrough," and what that is, is, I am told, sufficiently stated in the interesting report of the British Iron Trade Association on "Continental Competition in the Iron and Steel Trades." Both workmen and employers are at fault, I believe, and the evil, although increasing at present, is, I am sure, still capable of being cured, if the lessons given by facts like the one above, and by the statements of that report, are properly digested by those concerned.

20, Mount-street, Manchester, HENRY SIMON.
January 21st.

ASSOCIATION OF WATERWORKS ENGINEERS.

SIR,—The account which you give in your issue of the 17th inst. of the meeting of waterworks engineers at Nottingham on the 11th inst. is somewhat misleading, and calculated to defeat the objects I and others had in view when urging, and eventually getting the meeting to adopt only resolutions of a tentative character so far as concerns the constitution of the Association in question. The resolution adopted was, "That a Provisional Committee be formed to consider fully the constitution of the Association, the status and qualification of its members, and the necessary rules and regulations, and to report to a meeting of the promoters to be held at as early a date as possible, and that a chairman of such Committee and a Provisional Committee be now elected."

The question of qualification, classes of members, method of election, subscriptions, places and times of meeting, the number, election, and status of the managing Council or Committee, and of the president, secretary, and others, have to be decided by the general body after the Provisional Committee have reported thereon, and it is to be hoped that all who can possibly attend the meeting to consider the Committee's report will do so.

It will depend entirely upon the general character of such report whether or not many waterworks engineers will consent to join the Association, as although in full accord with the generally expressed objects of the same, we feel that there are some points of vital importance to be settled, especially that relating to the qualifications of the members and officials.

WM. MATTHEWS, Mem. Inst. C.E.

Waterworks Engineer's Department,
Southampton, January 23rd.

A PUMPING PROBLEM.

SIR,—I have read the two articles in your issues of the 15th and 22nd November, 1895, under the above heading with great interest, for about two months ago we resumed sinking our main shaft, and after getting down a little distance we found the playing of a quantity of water equal to 3000 gallons per hour, partly from springs in the vein and from surface into the shaft rather unpleasant, and to get over the difficulty I connected it to the suction pipe of the sinking pump, and it has been in it ever since. One point worth noting is that in blasting the pump can continue working on the upper level water when the suction pipe is entirely out of water, either by hauling up the pump or drawing up the telescopic suction.

T. B. FREEMAN LOWE, A.I.M. AND M. AND C.E.

The Wassau (G.C.) Mining Company,
Cape Coast Castle, January 4th.

MOTOR CARRIAGE NOTES.

IF any of those interested in the future of motor carriages on common roads have still any lingering doubts concerning the legality of the use of these vehicles under existing laws, licence or no licence, they may perhaps be dispelled by the latest magisterial decision, a decision given with a full knowledge of the present feeling against the law as it stands. Mr. J. H. Knight, of Farnham, who was fined by the magistrates in November last for using a motor carriage on the highway, applied to the Surrey County Council for permission to use the same under certain restrictions as to speed, and within certain hours, and has received the following reply:—

[COPY.]

Surrey County Council, County Hall,
Kingston-on-Thames, January 16th, 1896.

LOCOMOTIVES ON HIGHWAYS.

Dear Sir,—Your communication of the 6th inst. was read and fully considered by the Highways and Bridges Committee at their last meeting, and in reply I was directed to say that the Committee sympathise with you in your endeavours to secure progress for the movement relaxing the existing restrictions under which locomotives are at present suffered to be used upon highways. But I was also directed to say that they cannot give the permission you ask for—viz., that your locomotive should be used upon the highways in your neighbourhood, although you would undertake not to pass through the town of Farnham in the afternoon, nor to run more than eight miles per hour.

Yours faithfully, R. H. WYATT, Clerk of the Council.

John Henry Knight, Esq., Barfields, Farnham.

A PAPER was read before the Civil and Mechanical Engineers' Society, by Mr. F. R. Simms, C.E., on "Mechanical Locomotion on Common Roads," on January 16th. This subject the author dealt with in an interesting manner, putting before the meeting the salient features of the history of the subject, and drawing attention to the more important points in connection with the matter. The pernicious influence of the Acts relating to mechanical locomotion was distinctly set forth; but, in the author's opinion, these Acts had unintentionally produced good to the community, which might be set, to some extent, against the evil that had arisen from their operation. This good was through the attention to machines capable of being driven otherwise than by mechanical power, resulting in the bicycles and tricycles of to-day.

IN our recent accounts of motor carriage trials in America, the Benz motors and carriages were several times referred to. We may therefore mention that Mr. T. H. Warland informs us that the Acme Oil Motor Carriage Company, of 59, Mark-lane is the sole agent in the United Kingdom for the Benz motor carriages and engines as made at Mannheim. These motors are, it will be remembered, benzoline motors.

THE directors of the Crystal Palace have decided to arrange for an international exhibition of every kind of road vehicle that has ever been used, including private, public, pleasure, military, business, and motor carriages. The exhibition is to take place in May and June or June and July, and an influential committee has been formed to make all the necessary arrangements.

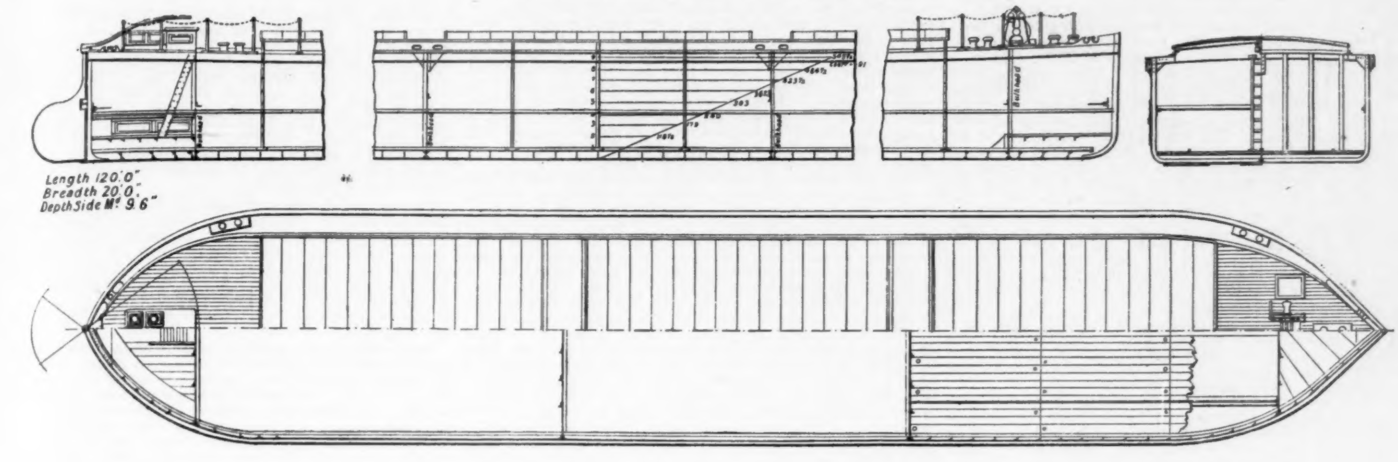
A SPORTS, Games, and Industrial Exhibition is to be opened at Scarborough in May, and remain open until October. Classes 19 and 20 relate to self-propelled conveyances, and to motors for them, and gold and silver medals and prizes in money will be given for them. Mr. Joseph Davis, Piccadilly-mansions, Piccadilly-circus, is the general manager.

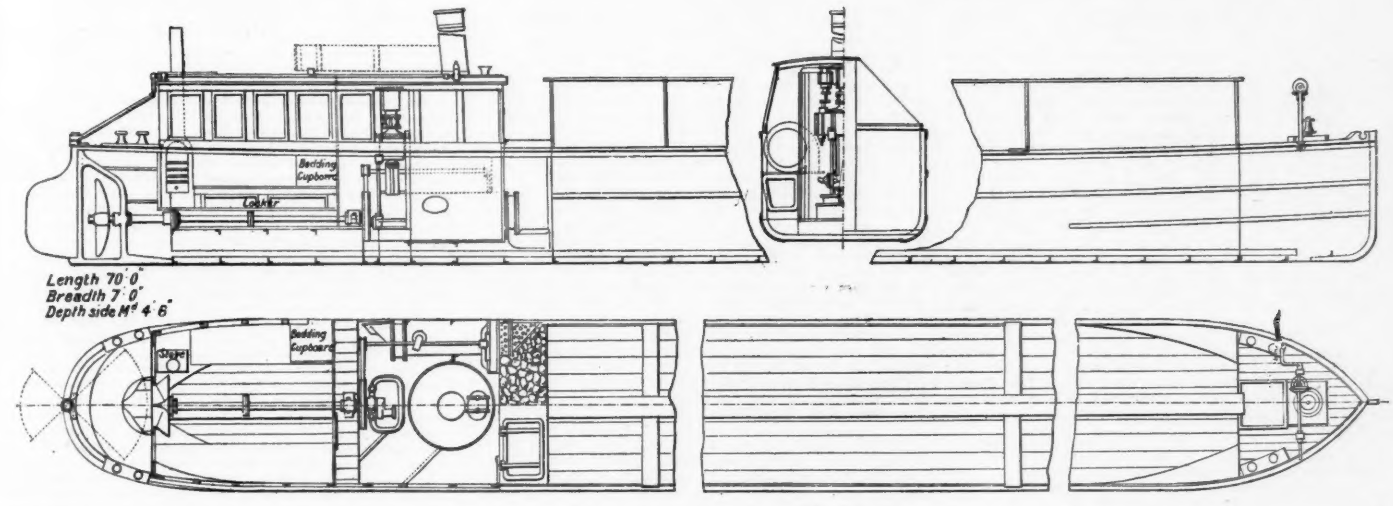
SIR DAVID SALOMONS is having two Serpollet steam carriages built—one as a small omnibus or parcels van, and one a light high-speed vehicle, suitable for military aide-de-camp work.

THE MECHANICS OF HORSE HAULAGE.—A very interesting lecture on "The Principles of Economy in Civil and Military Transport" was given by Mr. T. H. Brigg at Chelsea Barracks on Wednesday evening. Sir Redvers Buller presided, and among those present were Lord Methuen, Major Ross, of Bladensburg, and other officers. Sir Redvers Buller said that Mr. Brigg had given a great deal of time, trouble, and engineering talent to the study of a subject that must be of very great interest to anybody who had anything to do with horses and haulage. He had devoted himself to perfecting a system which eased the labour of a horse, and enabled it to do more work for its employer. He had already passed from theory to practice, and had made an invention which would prove of great practical and economical value. Mr. Brigg then showed, by cleverly devised apparatus, a series of practical experiments, the nature and magnitude of the forces with which horses have to contend, not only in hauling their loads, but in counteracting as far as possible those forces which are introduced by the present arrangements of harnessing and shafts. He showed how it was possible that a vehicle or its load should help to take some load off the horse's feet while on the level, and automatically to change the amount and incidence of the load on his back to help him in getting up hill. He claimed, by automatic arrangements, to increase the life and earning capacity of a horse within a very short time by 50 per cent. He regretted that there was not a single institution in the world where the economy of the application of horse-power was taught, though more millions were invested in horses and carriages than in all the railways. If it was important to economise the force of engines, it was still more so to find out what contributed most to the earning capacity and humane treatment of the horse.

STEAM AND TOWING BARGES—WORCESTER AND BIRMINGHAM CANAL

MR. J. MCGREGOR, M. INST. C.E., ENGINEER



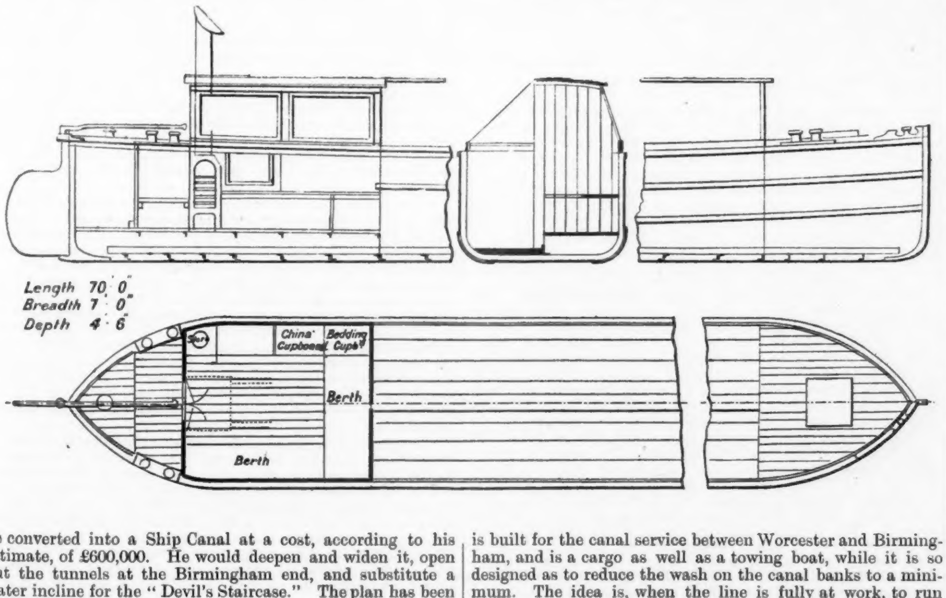


BIRMINGHAM AND THE BRISTOL CHANNEL.

We have already described in general terms the nature of the project for establishing direct water communication between Birmingham, the Midlands, and the port of Cardiff, by way of the Gloucester and Berkeley Canal, the canalised Severn from Gloucester to Worcester, and thence by locking-up to the Worcester and Birmingham Canal. Since Mr. Martin completed with really remarkable economy, the deepening of the Severn to an even 10ft. level, all was fair sailing from tidal water to Worcester. There progress was impeded by the condition of the Birmingham Canal, a narrow and shallow barge navigation, with a series of locks at Tardebigg, which rise nearly 300ft. within four miles. Mr. G. W. Keeling, C.E., has shown that this waterway could be converted into a Ship Canal at a cost, according to his estimate, of £600,000. He would deepen and widen it, open out the tunnels at the Birmingham end, and substitute a water incline for the "Devil's Staircase." The plan has been approved by engineering experts as practicable, and mercantile interests have pronounced it to be most desirable; but it remains at present an unrealised dream.

While this obstruction remained, it was necessary, for through communication between Birmingham and the sea, to construct vessels of a special type, capable of navigating inland waters, and yet seaworthy enough to cross the Channel between Cardiff and Sharpness. Boats answering to these requirements have been designed by Mr. J. McGregor, N.A., M. Inst. C.E., who is now in India, and whose great experience of inland navigation in Indian waters eminently qualified him to devise the class of vessel best suited to the purpose. The scheme of the Water Transport Company, thanks chiefly to the untiring energy of Mr. Robert Johnston, of Cardiff, has now passed beyond the stage of experiment. Boats of three different dimensions have been built, and are described in the subjoined plans. The larger steamerhas already made several trips to and from Cardiff and Worcester, and proved that the Westgate Bridge at Gloucester does not, as it was predicted it would, offer any difficulty in the free navigation of specially-constructed craft on the deepened river. Early in the year, it is expected, the whole of the pioneer fleet will be placed on the service, and it depends upon the extent of the trade thus to be developed or created how far the number of vessels, particularly the smaller craft, may be still further increased.

The large steamboat—it has been named A1—will carry cargo and take a train of barges in tow. The smaller steamer is built for the canal service between Worcester and Birmingham, and is a cargo as well as a towing boat, while it is so designed as to reduce the wash on the canal banks to a minimum. The idea is, when the line is fully at work, to run regular daily trips from Cardiff to Birmingham, dropping a barge here and there as circumstances require, as goods trains drop their wagons at wayside stations; and it is calculated that the journey between the Bristol Channel and the Midland capital will be made in twenty-four hours, after making all allowance for the delay at the Tardebigg chain of locks. The A1 is equally adapted to the coasting trade, or, with slight deck alterations, might voyage to the French and Irish ports. The second-class boats are suited to the navigation of any canal in the kingdom, in that respect fulfilling the description of "amphibious boats" used by our correspondent "Commerce," though they cost much more than the £150 specified by Mr. H. R. de Sales in a recent issue. It would be possible for the new barges to carry cargo to all points on the network of canals of which Birmingham is the centre; to make connection between the Severn Canal system and that of the Mersey, including the Manchester Ship Canal; and either through the Midlands, or by the Thames and Severn Canal, now in course of re-organisation, to open communication between the Bristol Channel and the navigations of the Upper Thames.



Private enterprise has so far found a solution for the problem as to how to utilise our neglected waterways; and that the Severn is a neglected waterway—that is, in relation to its natural advantages and the great opportunities it offers—is proved by the statement of Mr. William Riley, one of the largest timber importers in the country, that not a single extra ton of cargo has been carried on the river since the channel was dredged to a depth of 10ft. summer low level. The commercial benefits of the Cardiff and Birmingham water service are calculated by its promoters—though, of course, they are reckoning on the future—at a very high rate. The railway rates from the Welsh port to the hardware capital are from 5s. to 8s. more than they are from Bristol, because from Bristol there is competition, while from Cardiff there is practically none. Corn, timber, china clay, and flints for the Potteries, the raw materials of manufacture, will be borne inland at charges which it probably would not pay the railway companies to reduce their rates to. Hardware, ironwork, the produce of the innumerable small industries, and, in short, the various products of Birmingham and the Black Country, are regarded as sources of a profitable traffic between the seats of manufacture and the ports.

The success of the undertaking, moreover, would largely revolutionise the trade of Cardiff. Hitherto ships leaving that port have been loaded almost exclusively with coal and rails. A miscellaneous cargo is, we suppose, unrecorded among the clearances. A number of shipowners have undertaken to find accommodation for the miscellaneous goods transported by the new water service from the Midland district. These manufactures have until now been shipped from the Mersey or the Thames, at heavy railway charges to the ports. Freights rule low in the Bristol Channel, as, indeed, they do everywhere just now. But it is claimed that on the average they rule lower at Cardiff than elsewhere. This circumstance, together with the lower cost of water transport, it is anticipated, will divert a good deal of the export trade of the Midland manufacturing region from Liverpool and London to the Welsh port, which, in its turn, hopes by the same means to divert from more remote ports and from the railways a good deal of the oversea traffic consigned to Birmingham and the districts around.

One Way of Making a Speed Record.—Frequent mention has been recently made in the American newspapers of an alleged fast run on the Delaware Lackawanna and Western. It is stated, however, that when Mr. Ely, chief of motive power of the Pennsylvania, wrote to general manager Hallstead, asking for particulars of the dimensions of the engine and other facts which would throw light on the unusual performance, Mr. Hallstead replied: "This railroad company does not pride itself on high-speed performances; we do not have a straight level track, and we do not have four tracks to keep passenger trains away from freight; we do not have any '999' locomotives, and we do not have any 7ft. driving wheels; but we have some of the most accomplished liars east of Chicago, who have supplied the motive power on which the fast run was made."—*Railway News.*

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

Cable incline railway.—The steepest inclined railway in the world is the new—second—cable incline ascending Lookout Mountain, at Chattanooga, and recently opened for traffic. Its total length is 4972ft., in which distance it makes a rise of 1450ft. There is another cable incline, and also an adhesion railway which has a total length of eight miles. The new line is perfectly straight, while the grades range from a minimum of 12 per cent. to a maximum of 68 per cent., or 1 in 1·47. There are two steam engines of 75-horse power driving two main drums 7½ft. diameter by gearing, the spur wheels being 8¾ft. in diameter. There are three boilers, 16ft. long and 5ft. diameter, and a smokestack 42in. diameter and 76ft. high. This hoisting plant is at the top of the incline. Powerful brakes are fitted to the drums and the engine shaft, the brake on the front drum being applied automatically when the car reaches the end of its journey, steam being also shut off automatically in case of any failure on the part of the engineman. There are two 1¼in. steel cables, guaranteed for 104,000 lb., which gives a factor of safety of 7. If either cable should break the motion of the pivoted bar to which they are attached would put in action a jaw brake gripping the heavy timber guard rails. The track is laid with 56 lb. flange rails, and on the steep grades the ties are bolted to longitudinal timbers to prevent creeping. Broken stone ballast is used. There are two rails up to the double-track passing place—which is 300ft. long—and three rails thence to the top. The cars are 32ft. long, with seats as in an ordinary American railway car, seating sixty passengers. There is communication between the conductor and the engineman. Part of the line is on trestle work.

Railway construction in 1895.—The mileage of new railways built, which has been decreasing year by year since the busy year of 1887, reached in 1895 the lowest figure that has been touched for twenty years. One record is about 1500, and another about 1700 miles, and the average of these is probably about right. No very long or important lines were built, most of the work having been in branches and extensions of main lines and small new local lines. The average length was only about ten miles. As so much of the total represents local lines, it is not unlikely that electric railways have had an effect in keeping such construction down to a low figure, although electric railways do not yet affect the construction of lines of any length or general importance. In some circles it is thought that the improvement of business, which is expected during 1896, will lead to a revival in railway construction, especially as labour and materials are cheap, and many good enterprises are waiting. On the other hand, it is thought that railway construction will not feel any great revival, and that no great projects will be undertaken for some years. Most of the work of 1895 was in the Western States, Texas and the Indian Territory being the only cases where the total exceeded 100 miles. The totals for the last ten years have been as follows:—1886, 8500; 1887, 13,000; 1888, 7000; 1889, 5100; 1890, 5800; 1891, 4300; 1892, 4100; 1893, 2600; 1894, 1800; 1895, 1600.

Compound locomotives.—Among the latest compound locomotives are two two-cylinder compound freight engines of the ten-wheel type, having six-coupled driving-wheels and a four-wheel leading truck or bogie. They were built for the Terre Haute and Peoria Railroad by the Pittsburg Locomotive Company, using that company's system of compounding, which is now in use on a number of engines in passenger and freight service, as well as on some tank engines for elevated railways, these latter having four driving-wheels under the boiler and a trailing four-wheel truck or bogie under the tank. The leading dimensions of the two new engines are as follows:—

Fuel	Bituminous coal
Gauge of track	4ft. 9in.
Total weight of engine in working order ..	127,000 lb.
,, on driving-wheels	101,000 lb.
Driving-wheel base of engine	11ft.
Total ,, ,, ...	21ft. 8in.
,, ,, ,, and tender ..	49ft. 9¼in.
Height from rail to top of smokestack	14ft. 7¼in.
Cylinders, high-pressure, diam. and stroke .	19in. by 26in.
,, low-pressure ,, ,, ..	29in. by 26in.
Slide valves	Balanced
Piston-rods, extended through cylinder cover	Steel, 3¼in. diam.
Type of boiler	Extended wagon top
Diameter of boiler at smallest ring	60in.
,, ,, back head	69in.
Crown sheet supported by radial stays.	
Stay-bolts, 1in. hollow stay-bolts	4in. pitch
Number of tubes	256
Diameter of tubes	2in.
Length of tubes over tube sheet	12ft. 5in.
,, fire-box, inside	108in.
Width of ,, ,, ...	32¾in.
Working pressure	180 lb.
Grates	Cast iron, rocking
Grate surface	24·0 sq. ft.
Heating surface in tubes	1653·0 sq. ft.
,, fire-box	152·0 sq. ft.
Total heating surface	1805·0 sq. ft.
Diameter of driving-wheels, outside of tire ..	56in.
,, and length of journals	8in. by 9in.
,, of truck wheels	28in.
,, and length of journals	5in. by 10in.
,, of tender wheels	33in.
Type of tender tank	Level top
Water capacity	4000 U.S. gallons
Fuel capacity	300 cu. ft.
Weight of tender with fuel and water	78,700 lb.
Type of brakes	Westinghouse—American automatic

Mail cars for electric tramways.—One of the principal electric railways of Brooklyn, New York, having about 250 miles of track, has recently put in service five new mail cars, under contract with the United States Post-office Department. They are combination cars, with a passenger compartment and a mail compartment, in which latter the letters are sorted during the trip. They are run according to a regular time-table, and on two routes about six or eight miles long, messengers at different points delivering and taking bags for the several branch post-offices near the route. Each car is 35ft. long over all, and the body is 24ft. long, being divided into two compartments 12ft. long and 7ft. 4in. wide. The platforms are 4ft. 6in. long, with rounded dashboards. The mail compartment, at the forward end of the car, is fitted with the standard mail car fittings, including 200 pigeon-holes, a pouch rack, sorting table, &c. This compartment is entered by side doors only, and there is a small window in the partition through which stamps can be sold to persons in the passenger compartment. A drop box is also provided at each side, so that persons on the street can mail letters. The passenger compartment has accommodation for twenty passengers. There are six cross seats with reversible backs, arranged as in steam cars, and a fixed seat against the partition and the end of the car, the end door opening on to the side of the platform. The seats are covered with spring rattan. The interior finish is of cherry, and in each window post is a push-button to ring the platform gong and signal the conductor to stop. There are ten lights and a central electric heater in the mail compartment, and eight lights and a consolidated electric heater in the passenger compartment. Platform lights and electric headlights are also provided. The cars are mounted on two Brill maximum-traction four-wheel trucks, in which the greater proportion of the weight is carried by the larger wheels, on whose axles the motors are mounted. They ride very easily on the new heavy tracks, laid with 10in. 90 lb. girder rails. The motors were made by the Westinghouse Electric Company, and the controllers by the General Electric Company. Each car is fitted with a Crawford fender and fixed wheel guards. The cars are very handsome, the outside of the body being painted white, picked out in red and gold, and the interior having natural wood finish of light colour and veneer head-lining. They were put in service during the week previous to Christmas, and greatly facilitated the handling of the heavy mails of that season.

Steel centreing for sewers.—In the construction of a large sewer at Denver, steel rings were used for supporting the centreing used by the masons. The ring consisted of two semicircles of steel rails weighing 25 lb. per yard, a section being selected having a height equal to the thickness of the lagging. The lower semicircle has the rail lead outward, the outer radius being that of the invert of the sewer. The upper semicircle has the rail flange outward, and the radius is shortened to allow for the thickness of the lagging. To each end of the lower half is riveted a short piece of the same section of rail, having a hole punched in the flange, a corresponding hole being punched in each end of the upper half of the ring. One of these pieces has its end cut on a slight bevel, corresponding to a similar bevel on the end of the upper semicircle. The two semicircles are connected by two lugs and two bolts at each end. The lagging is 2in. by 4in. in section, dressed with radial joints, and each piece is provided with three small iron clips on the lower side, which fitted over the flange of the ring and held the lagging in place.

New sleeping cars.—A new style of sleeping car, with private rooms opening into a corridor, has movable partitions so arranged that the upper berth is in one room and the lower berth in the next, each passenger having thus a room to himself, although the berths are wide enough for two persons travelling together. The berths are across the car, and by day the upper berths are closed and the lower ones form seats. Each room has a washstand. In another car all partitions fold up by day, forming a drawing-room car, with movable chairs and lounges. The berths and bedding occupy lockers against the side of the car and below the floor.

Magnetic separation of iron ore.—Owing to the recent great depression in iron and to the development of the great Bessemer bed of the Mesabi range, very little has been done to extend the use of magnetic separation, but experiments on a practical scale have been carried on at the Cranberry mines in North Carolina, with encouraging results. At these mines there is an excellent Bessemer ore, non-titaniferous, comparatively cheaply mined, partly in open cut and partly in tunnel, with good transportation facilities, and with a "run-of-mine" averaging about 42 to 43 per cent. of metallic iron. The greater portion of this iron is in magnetic oxide, Fe_3O_4, but from 5 to 11 per cent. is present as FeO in hornblende. Should the total output be crushed and magnetically separated, this FeO would be lost in the tails, and it becomes a question of considerable importance to decide when to save the hornblende and when to sacrifice it. The ore before shipping is passed over bar-screens having 1½in. openings, and what goes through, along with any clay from the open cuts which shows much ore in small pieces, is washed in a log-washer, in which it is freed from clay and very fine rock. A revolving screen on the washer-shaft separates the washed stuff into four sizes, viz.: (1) coarser than 1¾in. round hole, which is hand-picked; (2) between 1¾in. and 1¼in. round; (3) between 1¼in. and $\frac{3}{16}$in. round, which two sizes are treated separately on two Wenström separators; and (4) finer than $\frac{3}{16}$in. round, which is washed by a stream of water to a revolving magnet. The heads from this magnet are again divided by a revolving screen—8 holes per inch, of No. 18 wire—the rejections—"shot"—going to the furnace, and that passing through—"dust"—being sold. As the fines screened from the shipping-ore have not generally furnished enough clean ore to run the furnace, the deficiency is made up by crushing, in a Buchanan crusher, mixed rock and ore thrown out from the shipping-ore and picked out from the old dumps. This material, after crushing, goes through the washer and separators, with the fine from the mines. In one month 920 tons of ore from the crusher and 947 tons of "dirt" from the mine, or a total of 1867 tons, were sent to the washer and separators. From this was recovered 1029 tons of "clean ore," averaging 45 per cent. of metallic iron, 47 tons of "shot," averaging 55 per cent. of metallic iron, and 113 tons of "dust," averaging 63 per cent. of metallic iron; also 271 tons of tails and 406 tons of fines washed away—by difference—averaging together less than 20 per cent. of metallic iron. The conclusions arrived at are as follows:—(1) Emphasis should be laid upon careful washing, screening, and sizing rather than upon fine crushing; and (2) each size of material should be concentrated separately upon suitable magnetic separators, giving as a total result a Bessemer concentrate averaging from 50 to 60 per cent. of iron, and of a size sufficiently coarse for furnace-burden without other mixture.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

THE coal trade during the past week has been in a state of great activity. The shipments exceeded 80,000 tons. Stems are generally well filled, and certainly for the next week or two the briskness will be well maintained. A large amount of tonnage is in both docks. The s.s. Idar commenced loading Monday morning, and sailed this morning with 6190 tons of coal. The s.s. Imaum and several other large steamers are due shortly. The collieries of the district are well employed. The tin-plate market is dull. Pitwood is firm at last week's prices. An improvement has taken place in the quantity of iron ore imported as compared with previous weeks. The activity reported last week in the ship repairing trade is well maintained.

Prices ruling on 'Change to-day were as follows:—Coal, best steam, 8s. 6d. to 9s.; seconds, 8s. to 8s. 3d.; best house coal, 10s. 6d.; dock screenings, 5s. to 5s. 6d.; colliery, small, 4s. 6d. to 4s. 9d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 6d. Pig iron: Scotch warrants, 46s. 7d.; hematite warrants, 47s. 8d. f.o.b. Cumberland; Middlesbrough No. 3, 37s. 7½d. prompt; Middlesbrough hematite, 45s. 8d. Steel: Rails, heavy sections, £4 10s. to £4 15s.; light ditto, £4 15s. to £5 10s.; tin-plate bars, £3 17s. 6d. to £4; Siemens tin-plate bars, best, £4, all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel coke, 9s. 3d.; Siemens coke finish, 9s. 6d.; ternes, per double box, 28 by 20c., 21s. to 22s. Pitwood, 15s. 9d. London Exchange telegram: Copper, £41 6s. 3d.; Straits tin, £59 12s. 6d. Freights firm.

WEATHER AVERAGES.—Some useful modifications have been made by the Meteorological-office in the monthly means of the barometer and temperature which are now given for the twenty-five years, from 1871 to 1895, and the rainfall values for thirty years, from 1866 to 1895. An addition has also been made showing the absolute maximum and minimum temperature recorded during the month, for the twenty-five years, stating the years in which such extremes occurred. The mean number of hours of bright sunshine are also given, for the period of fifteen years, from 1881 to 1895, for the stations in the United Kingdom at which the amount of sunshine is regularly registered. The new values show that in January the average barometer is highest at Jersey, where the mean is 30·01in., and the readings are lowest in the north of Scotland, the mean at Sumburgh Head being 29·68in. This shows very plainly that the prevailing winds in January are westerly. The average highest maximum temperature is 49 deg. at Valentia, while at Spurn Head, where the lowest mean maximum occurs, the reading is only 41 deg. The highest average night minimum occurs at Valentia, where the mean of the lowest readings does not fall below 40 deg., and the place with the lowest average night reading is Cambridge, with 31 deg. The absolute maximum temperatures range between 51 deg. and 59 deg. over the entire area of the British Islands, and they occur in very different years. The highest individual reading is 59 deg., at Nairn and Cambridge. The absolute lowest readings vary to a much greater extent, the lowest being minus 4 deg. at Wick in 1881, and the highest 25 deg. at Scilly in 1894; whilst the lowest reading at many of the Irish stations was 20 deg., which occurred in 1894. The wettest station reporting to the Meteorological-office, for January, is Valentia, where the average rainfall is 6·31in.; and the driest is Spurn Head, where the average is 1·38in. The maximum amount of sunshine is 71 hours at Jersey, the minimum being 26 hours in London.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

A FURTHER advance in the condition of trade is observable, and Messrs. Brown and Freer, of the Leys Ironworks, one of the marked-bar firms, quoted their prices this afternoon:—Round and square rods, ½in. and $\frac{7}{16}$in., £7 for ordinary qualities, £8 for best, and £9 for best best; ⅜in. sizes were £7 10s., £8 10s., and £9 10s., according to quality; $\frac{5}{16}$in., £8, £9, and £10; ¼in., £8 10s. for ordinary, £9 10s. best, and £10 10s. best best. No 4 B.G. were £9 ordinary quality, £10 best, and £11 best best; while No. 5 B.G. was £9 10s., £10 10s., and £11 10s. respectively; and No. 6, £10 £11, and £12. Angle iron the same firm quoted £7 10s. to £8 10s., according to brand; T iron, £8, and half-rounds and ovals £8 to £9, while best rivet iron was £8.

Pig iron exhibits additional improvement on the week, but prices have not yet fully recovered, and some buyers report that they have placed orders at 1s. 6d. and 2s. per ton less than smelters quote. Northampton pigs—forge sorts—are priced at a minimum of 40s. to 41s. as the actual selling figures, but sellers ask 42s. to 42s. 6d. Good foundry iron is 44s. to 45s. Derbyshire forge pigs are 41s. to 42s. in actual business, and foundries 45s. to 46s. Hematites are 56s. 6d. to 57s. 6d. for West Coast forge sorts, and 58s. 6d. to 60s. for foundry.

Much satisfaction is expressed in the Midland district at the probable expenditure of £20,000,000 sterling on British naval requirements, and also at the heavy expenditure intended by Japan under the same head, a great part of which is certain to be allocated to this country. It is stated that orders for the ten men-of-war, by which the Japanese navy is to be increased, will definitely be placed with British shipbuilders, and that four of these battleships are each to have a tonnage of 15,150 tons, which will be 2000 tons in advance of the largest vessels possessed by any other naval Power than our own. The plant and machinery required for the two new Government dockyards to be established in Japan are also, it is rumoured, to be purchased from British engineering shops. Confirmation is also to hand this week of the intention of the Argentine Government to early expend £2,000,000 in this country on arms and ammunition and other war material.

Much discussion took place on Wolverhampton and Birmingham Exchanges this week concerning the report of the continental deputation of the British Iron Trade Association and allied bodies. Complaint was made that it was a colourless document, too much having been made of railway rates and rolling mill equipment, and too little of the wages matter. It is believed that the men objected to comparative wages statistics being published, and hence the incomplete nature of the report on this point. Wages details are, it is true, given in the appendix, but no attempt is made to contrast them with English wages.

Engineers who construct tube-making machinery are well engaged. Samuel Platt, Kings-hill, Wednesbury, are very busy on plant for machining seamless steel boiler and cycle tubes from start to finish. Their machinery begins operations by boring the ingots and reducing them by rolling; the ingots being cut with hot saws as they are extended in length. Several times during these operations they have to be put into various heating furnaces. They are then passed on to different descriptions of draw-benches, according to whether they are to finish for boiler or cycle tubes, and are passed through the annealing furnaces until they leave the benches as finished tubes ready for cutting off into lengths. This firm make machinery not only for seamless steel tubes, but also for lap-welded tubes, boiler tubes, and copper tubes—in fact, there is scarcely a tube firm in the country with whom they have not connections. Their business has been established forty or fifty years. The firm build also nut and bolt-making machinery, complete plants of which have been supplied by them to China and Japan, one of these complete plants being for the Chinese Government.

The wrought iron and steel tube makers, in the Wednesbury District more particularly, are this week informed that the Government Telegraph Authorities are considering the advisability of adopting metal poles for the construction of telegraph lines instead of the timber ones now in use. The particular pole which is believed to find favour with the authorities is a corrugated galvanised one which has been lately patented in this country and abroad, and which is said to be practically indestructible.

Engineers and machinists learn with pleasure that Sir Salter Pyne, C.S.I., who is again in this country on a brief visit from Afghanistan, intends to purchase on this occasion machinery and plant for the establishment of an ammunition factory at Cabul. Already the Ameer's factories have reached the full capacity of the present cartridge machinery, and 10,000 Martini cartridges and 10,000 Snider cartridges are turned out daily, besides field guns and rifles. The aggregate factories now cover an area of a third of a mile long by 200 yards wide, and 2000 hands, or 7 per cent. of the population of Cabul, are employed. The production of the Mint has increased to 120,000 coins per day, and electro-plating has lately been added to the previous industries.

The light railways question continues to be discussed amongst engineers here with much animation. In a communication which Mr. C. T. Sharp, consulting engineer, Birmingham, has just made on the subject, he insists that the Government should be called upon to construct and work the lines, and contends that, if the routes were judiciously selected, there would be no question that the Government would get their interest on the small capital absorbed.

The Bessemer basic steel manufactured by the Staffordshire Steel and Ingot Iron Company, Wolverhampton, has just been reported upon by Professor Ewing, F.R.S., of Cambridge. He remarks upon the material:—"Its permeability, especially for inductions such as are used in dynamo magnets, is remarkably high. The B.H. curve is almost coincident with a curve for 'pure iron,' given in the 'Proceedings' of the Royal Society for June 16th, 1892. Most forgings and steel castings give results which lie considerably below the 'pure iron' curve, and I have never before tested a specimen which approaches it so nearly as this does. The hysteresis losses are small in comparison with those generally found in forged metal; it is only in the best samples of thin transformer plates that I have found less. The general result of the test is to show that in regard to magnetic quality this is a first-class material for dynamo magnets."

I regret to have to announce the death, at the end of last week, of Mr. Clement Crowther, of Greenhill, Kidderminster, Chairman of Messrs. Knight and Crowther, the well-known tin-plate manufacturers. Previously to the constitution of the company, Mr. Crowther carried on the Stour Vale and Falling Sands Works at Kidderminster, and the Cookley Works at Brockmore. Mr. Crowther also carried on business as the Central Iron, Steel, and Tin-plate Co., at Kidderminster, and was largely interested in various other commercial undertakings. He was about sixty years of age and unmarried.

Mr. James Mansergh, C.E., has deposited his parliamentary estimate of the expense that will be incurred by the Birmingham Corporation in the event of their great Water Bill for next session receiving the sanction of Parliament. The total cost of the whole of the proposed works, including the purchase of the necessary property, and allowing for contingencies, is set down at £110,000. Of this sum the works connected with the proposed deviation of the authorised aqueduct will cost £103,090, and the proposed 7 furlongs 4 chains of railway will cost £6910. With this estimate the Town Clerk has lodged a declaration "that the rates and revenues of the Corporation, for which the moneys for making the works proposed to be authorised will with other moneys become chargeable, will amount to £231,000."

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester. — The market is gradually resuming the strong position which was somewhat shaken at the commencement of the year by the generally unsettled outlook, and although perhaps just for the immediate present the situation is not quite so satisfactory as it might be, the prospects for the future are regarded confidently. A steady, active trade, with advancing prices, is talked of in most quarters, and there is a disinclination amongst makers and manufacturers of iron to enter into anything like heavy forward engagements far ahead. The downward tendency of prices in outside brands of pig iron has not only been completely checked, but during the last week or ten days there has been a recovery of quite 1s. per ton upon the minimum figures which sellers in some instances were previously taking. Some classes of finished iron, such as sheets, in which there has been rather a severe relapse, are also recovering strength, whilst the volume of business all through is steadily on the increase.

There was a good average attendance on the Manchester Iron Exchange on Tuesday, with a fair amount of inquiry stirring and prices firm, the improvement reported last week being fully maintained. In pig iron moderate transactions are being put through, and for local and district brands, which were unaffected by the recent depression in the market, makers' quotations remain at 46s., less 2½, for No. 3 foundry Lancashire; 45s. 6d. to 46s. 6d. net cash for foundry Derbyshire; and 41s. 6d. for forge to 43s. 6d, for foundry Lincolnshire, net cash delivered Manchester. For outside brands of pig iron coming into this market prices are stronger, foundry Middlesbrough not being quoted under 45s. 10d. to 46s. 1d. net cash, delivered Manchester, with Eglinton fetching 47s. 3d. to 47s. 6d. net prompt cash, delivered Lancashire ports.

In the manufactured iron trade a steady business is reported generally, especially in bars, for which makers are securing new orders which are more than sufficient to keep them fully going, and they are firm at £5 10s. for Lancashire to £5 10s. and £5 15s. for North Staffordshire bars, delivered here; sheets are if anything not quite so firm as they were recently, and £7 10s. now represents about the average selling figure, but inquiries are again beginning to come forward more freely. Very little business is stirring in hoops, the orders now being secured by makers being scarcely sufficient to keep mills running two days per week; but Association list rates remain at £6 2s. 6d. for random to £6 7s. 6d. for special cut lengths, delivered Manchester district, and 2s. 6d. less for shipment.

Nut and bolt makers report a considerably enlarged demand for all descriptions of goods, with a stiffening upon recent selling rates in some instances, although there is no quotable advance in prices.

In the steel trade the only change to note is that hematites—although meeting with no appreciably increased demand in this district—are decidedly stronger in price, some special brands being quoted 57s. to 57s. 6d., less 2½, with 56s. about the minimum figure for ordinary foundry qualities, delivered here. Pending the settlement of the shipbuilding dispute, steel boiler plates are still obtainable at £6 to £6 5s. for immediate delivery in this district.

A fair business comes forward in the metal market, especially in tubes, but there has scarcely been so much doing in rolled metals as of late. Inquiries are increasing for all descriptions of fittings in connection with locomotive work, and a few fairly good orders have been booked, whilst it is reported that others are coming upon the market. List rates are well maintained, and the improvement in copper is tending to harden the market, the opinion generally being that any further change in prices will certainly not be in a downward direction.

The returns of the Steam Engine Makers' Society fully confirm those which I gave last week from the Amalgamated Society of Engineers. As, however, the Steam Engine Makers' returns were made up before the men had got into full work again after the holidays, it is difficult to give any precise estimate of the percentage of unemployed members on the books, except that it has now got back to what it was prior to the holidays. The reports received from the various districts connected with the Society as to the state of trade are of a very encouraging character; most branches are experiencing a steady improvement, establishments generally being well employed, whilst a special feature has been the increased activity in the Government dockyards.

The reports which I gather on 'Change from the principal representatives of the engineering trades also continue very satisfactory, new work in most departments coming forward freely. The boiler making and locomotive building industries are steadily improving; machine tool makers are in most cases securing a large weight of new orders, and stationary engine builders remain in much the same satisfactory position as they have been for some time past.

There have been reports during the past week on the Manchester Exchange, emanating from apparently well-informed quarters, to the effect that Messrs. Harland and Wolff, of Belfast, have in contemplation the establishment of an extensive shipyard on the banks of the Mersey, near Liverpool, and that land has actually been taken for this purpose. One reason assigned for Messrs. Harland and Wolf extending their operations to Liverpool, is that for many years past it has been serious ground of complaint, that in the case of vessels putting into Liverpool for repairs, application has to be made to the Mersey Dock and Harbour Board for a dock, and not infrequently the vessel is assigned to a dock miles away from the engineering shops of the firm who may have the repair in hand, the particular dock to which the vessel may be sent being, of course, altogether at the discretion of the Board and regulated according to their own convenience. If the reports are correct with regard to Messrs. Harland and Wolff's intentions, a very welcome stimulus will be given to the shipbuilding industry of the Liverpool side of the Mersey, which for some years past has been steadily declining.

For a long time past there has been considerable friction between the employers and workmen in the engineering trades of the Bolton district on the question of overtime, and I understand the men actually threatened to refuse altogether to work overtime, unless some satisfactory understanding could be come to with the masters. During the last two months a number of conferences have been held between representatives of the employers and the men, with a view of coming to some satisfactory arrangement, not only with regard to overtime, but also in order to arrive at a settlement of other minor questions, which from time to time have arisen. These conferences have at length resulted in an amicable arrangement being come to. I am not yet in possession of the official resolutions adopted, but I understand that the agreement with regard to overtime is practically to the effect that, except as regards breakdowns and repairs, where, on new work only, any workman has made in four successive weeks, more than ten hours' actual overtime per week, or more than forty in the aggregate, he shall not be called upon to work for the ensuing two months more than ten hours' actual overtime in any week. Other questions were discussed in a friendly spirit, and upon one matter, in which some of the machine fitters are rated under the standard rate, the masters conceded that they were entitled to an advance, and also the application of the smiths' strikers to be rated for all night-work the same as the smiths, viz., time and a-half.

For some time past the United Alkali Company, which is a large producer of copper, has been carrying out a series of experimental tests, with a view of manufacturing manganese alloys possessing high tensible strength, hardness, and ductility, which should meet the increasing demand for such metals in all branches of engineering work. As a result of these experiments, which have been very successful, the company is now making a high-class bronze, which fully meets the above requirements, whilst it also possesses high resistive power to the corrosive action of chemicals. The company has also gone into the question of amalgamating other metals, and is now manufacturing a special alloy for reducing friction and wear and tear in machinery.

In the coal trade only a moderate business is reported, with pits in many cases not working above four to five days per week. House-fire qualities are perhaps in somewhat better request, but there is no push of orders, and with supplies plentiful, prices are not more than maintained at late rates, averaging 10s. to 10s. 6d. for best Wigan Arley; 9s. to 9s. 6d. for Pemberton four feet and seconds Arley; and 7s. to 7s. 6d. for common house coal, at the pit mouth. The excessive supplies of steam and forge coals keep prices extremely low, not averaging above 6s. at the pit mouth for inland sales; whilst for shipment, surplus supplies continue to be offered at as low as 5s. 6d. per ton at the pit mouth, representing about 7s. to 7s. 6d. delivered ports on the Mersey. Engine fuel moves off fairly well, owing to the rather limited output of slack at many of the pits, and best sorts remain at 4s. 6d. to 5s.; with common descriptions 3s. to 3s. 6d. per ton at the pit mouth.

Considerable alterations are now being carried on in the Manchester Coal Exchange, with a view of increasing the accommodation of members, and the Committee in their annual report issued this week express the hope that when these were completed the comfort of the members would be fairly met, and also that the premises may be capable of earning larger revenue from other sources. The report adds that the Exchange continues to make steady progress financially, and that the number of members is fully maintained. The financial statement shows the income for the past year amounted to £593, of which £494 is represented by subscriptions, and the expenditure to £479, leaving a balance of profit of £114 to be carried forward. The general balance account shows the assets of the Exchange to be now valued at £1510, of which £1286 is invested in railway stock; with furniture, fittings, and goodwill accounts put down at £205, the balance being cash at bankers' and sundry accounts owing. The annual general meeting is fixed to take place on Tuesday, February 4th, and Mr. John Tomlinson, of Darwen, has been unanimously nominated president; Mr. Isaac Mosly, of Doncaster, as vice-president; and Mr. R. Peters, of Tyldesley, for re-election as treasurer. The two auditors, Mr. E. S. Wigan and Mr. H. Nield, are also nominated, without opposition, for re-election; but a ballot will be required for the Committee, there being five nominations for four vacancies.

Barrow.—There is a much stronger and more buoyant tone in the hematite pig iron trade of this district, and business is improving on local and general account. Makers are very well sold forward. Several furnaces have been ready for some time to put on blast so soon as an improvement in trade justified such a step, and it is now proposed to light some of these, as it is found that the production is not likely to be equal to the demand. Prices have improved to 47s 6d. for merchants, net cash sellers, and buyers offer ½d. less; makers' iron is qnoted at 40s. to 49s. per ton, and only forward deliveries can be negotiated. During the week 106 tons of iron have gone into warrant stocks, which now represent 297,978 tons, or an increase of 8803 tons since the beginning of the year.

Iron ore is in steady demand at about 10s. per ton net at mines for ordinary sorts. There is a large importation of Spanish ore into the district.

Steel makers are busy. There is a brisk demand for steel rails, which are quoted at £4 15s. for heavy sections, and makers are well booked forward. There is also a good demand for plates, and some good orders have been booked during the week. Billets, hoops, and heavy castings, have been largely ordered lately, and prospects all round in the steel trade are very good.

Shipbuilders and engineers have booked no new orders, but are expecting some from various sources, and in the meantime they are paying great attention to the important Admiralty contracts in hand.

Coal and coke are in better demand, and prospects of a better trade are presenting themselves.

His many friends will be glad to learn that Mr. James M'Kechnie, now engineering manager at the Naval Construction and Armaments Company's Works, at Barrow, has had his services to the Spanish Navy most fittingly acknowledged. The King and Queen Regent have conferred upon him the Commandership of the First Class of the Royal Order of Isabel la Catolica, which is a very ancient order, having been established when Spain had extensive colonial possessions on the Spanish main. In distinction it ranks next to the famous Golden Fleece and Calatrava, and the insignia is a gold Maltese cross with a star and a green laurel wreath. The motto of the order is "A la leultad acrisolada." Mr. M'Kechnie, it is scarcely necessary to explain, while engineering manager at the Nervion Works, at Bilbao, designed and constructed engines for three magnificent belted cruisers of 20¼ knot speed. Her Majesty the Queen of England has granted to Mr. M'Kechnie permission to accept and wear the decoration within the British Empire.

Shipping is not yet briskly employed, 6515 tons of pig iron and 6038 tons of steel were exported during last week from West Coast ports, as compared with 8130 tons of pig iron and 3516 tons of steel in the corresponding week of last year, being a decrease of 1615 tons of pig iron and an increase of 2522 tons of steel. The aggregate shipments this year to January 18th were 20,511 tons of pig iron and 29,186 tons of steel, as compared with 13,343 tons of pig iron and 19,120 tons of steel in the corresponding period of last year, an increase of 7168 tons of pig iron and 10,066 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

A STEADY business has to be reported in the South Yorkshire coal trade during the past week; still, complaint is freely heard on all sides of the limited wages to be earned. This is mainly due to the accumulation of stocks. The general condition of the coal trade is clear enough. It only requires a sharp spell of frosty weather to put it in an excellent way. London and the South have been taking but a poor tonnage. This shrinkage cannot be put down solely to the competition of seaborne coal, as the shipments from Newcastle during 1895 showed a decrease of 557,917 tons. Hardly an average trade is done with the Eastern and other markets. Quotations remain about the same as last week. Best qualities of Silkstone coal are at 9s. to 9s. 6d.; secondary sorts, 7s. 6d. to 7s. 9d.; Barnsley softs, 8s. to 8s. 6d., and Flockton at similar prices. Thin seam coal only fetches 6s. per ton at the present time. The steam fuel industry is, as is usual in January, in a quiet condition. A fair amount of coal, however, is being forwarded to Grimsby, although only a moderate tonnage is sent to Goole. The demand on contract account is very good. The North-Eastern Railway are now taking a good supply. Prices in the open market are 6s. 6d. to 7s. 3d. per ton, according to quantity and quality. A better business is also being done by the Barnsley thick seam pits, as well as the thin seam collieries, with the Yorkshire woollen districts, although the request from Lincolnshire is only moderate. Small nuts sell at 5s. to 5s. 6d.; good screened slack, 4s. 3d. to 4s. 6d.; and ordinary pit slack, 2s. 6d. per ton. Smudge can be procured in small quantities at 1s. 6d. to 1s. 9d., while larger tonnages are obtainable at 1s. to 1s. 3d. per ton. On the whole the coke trade is in a fair condition. The output is big and stocks are somewhat decreasing. Derbyshire is taking an average amount, and North Lincolnshire is requiring some 600 tons a week. The quotations run about 8s. to 10s. per ton.

In the heavy industries the New Year has opened very favourably in nearly all the departments. The political troubles in South Africa and other countries do not seem to have had the adverse effect at first anticipated, although it may be evident before long. The three firms engaged in the manufacture of armour-plates are extremely busy on orders for the British Admiralty. The war scare, which was prominent before the eyes of the world a few weeks ago, while affecting business in several departments, improved to a considerable extent the modern branches of local industry. The orders for shot and shell placed by the home Government do not in any way synchronise with those for armour-plates. The American Government have just given an order to a United States steel house for the manufacture of £50,000 worth of shells of a similar description to one of the Sheffield patterns, with the additional welcome news that there will be more to follow shortly. Two of our local houses have received orders from the British Government for shell. Messrs. Thomas Firth and Sons, Norfolk Works, are making 200 6in. armour-piercing shells, the order for which was settled before the late "scare." The Hadfield Steel Foundry Company is also in receipt of orders for shells. Those given to Sheffield, however, must be but the beginning of what the authorities will yet have to place.

The steel trade has been particularly brisk since the beginning of the year—one portion so brisk that it may be specifically mentioned. We refer to the demand for cycle steel. The extraordinary increase in cycles, owing to the pastime being taken up by females, is very clearly indicated in the larger value of orders received by firms who make a distinct speciality of that grade of steel. They inform us that not only is the quantity much larger than it used to be, but the quality of the steel demanded is continually getting higher. The great necessity of the machine, trustworthyness of material, is the cause of this call for the finer classes of steel, and it is expected that the business will be a continually advancing one. A vigorous effort is being made to localise the cycle manufacture in Sheffield, where it might have been to-day a most important trade. At one time the Stanley machine, made at the Stanley Works, Sheffield, had a great run, and if the swivel handle, which was a Sheffield invention, as applied to the cycle, had been patented at the time, the business would no doubt have assumed enormous local dimensions, and a great fortune would have been made out of it.

In the iron market the outlook is particularly encouraging, with prices very much steadier. There is a welcome absence of speculation in this district, and most of the orders given out have been of the hand-to-mouth character. Hematites are selling in this city at 57s. for West Coast and 54s. for East Coast, with common iron at 40s. per ton. Siemens-Martin and Bessemer are reported in better demand, while files and tools find ready purchasers. Makers of railway material specialities, such as axles, tires, springs, buffers, &c., are full up with work. Sheep shears have been in better request since the season—namely, the end of October—closed. The increase has been larger than has been the case for five or six years, and the improvement is pretty general all round.

In the cutlery and silver trades business is very plentiful. Several large orders for the complete fitting up of a few palatial hotels with silver plate will cause many men to have good employment for some months to come. The cutlery trade has not been so active during the present month as it was before Christmas, although it is a considerable increase on the trade done in January of 1895. Grinders are rather scarce at the present time. The adverse effect of the McKinley tariff caused a considerable number of artisans to be thrown out of employment. They drifted into other industries, and, when tariff troubles ended, did not come back, and their absence is now getting more keenly felt.

The Wigan Coal and Iron Company has leased from the Duke of Newcastle a large extent of ground, extending to 30,000 acres, it is said, to work the coal underneath the land in what is familiarly known as the Dukery District. The name comes from the fact that at one time five Dukes lived in or about the Sherwood Forest. The position of the new pits is said to be about midway between the Great Northern Railway and the new Lancashire, Derbyshire, and East Coast Railway, about three miles from Tuxford. The place is near Houghton Warren, and is one of the most picturesque parts of that delightful land. The first pit will be sunk at Bevercotes. The company, it is said, intends to work the coal there on a great scale—in fact, no other manner of coal-getting will pay in these days. The output will be some 2000 tons a day, and it is intended to extend a spur line from the Great Northern Railway, and probably the New Lancashire, Derbyshire, and East Coast Railway also, to serve the new colliery. The enterprise will make a remarkable change in that district, quite as remarkable as has been done at Cadeby, where the pleasant slopes on the banks of the Don, overlooking Conisbro' Castle, one of the scenes of "Ivanhoe," have been changed into a bleak coal country. That was inevitable with Denaby Main so close at hand, but no one anticipated that the Land of Robin Hood would ever be given over to railways, or, what is grimier still, become the colliery home of a Lancashire coal and iron company.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE political situation having become more quiescent, and there being an expectation that though the voting last week in connection with the Clyde-Belfast difficulty was abortive, the stoppage of work will last but a few days longer, the iron market has been very strong this week, and the improvement is progressing satisfactorily. A more confident tone is apparent, and a disposition is shown among the consumers to buy for forward delivery; indeed, a considerable number of inquiries have been received for pig iron, mostly from home users, and there is beginning to be more life as regards the demand from abroad, for it is the general opinion now that the war scares being over, prices will advance, and that those who wait will have to pay higher rates for spring delivery. As yet, the increased number of inquiries has not resulted in much increase in the actual orders placed, because producers are not prepared to commit themselves further ahead than the next six weeks or two months, by which time the spring trade will have fairly set in, and rates more favourable to the seller will in all probability prevail. On the whole, consumers are readier to buy than producers to sell, and the prospects are generally encouraging.

Pig iron prices have this week been further advanced—6d. in the case of No. 3 Cleveland and hematite, and 3d. in forge pigs—and Cleveland warrants, which on the 8th inst. were down to 36s. 2d., cash, have gained 1s. 5d. since then, of which 6d. has been recorded since Monday, and all that was lost in prices through the disturbed political relations which became acute in the middle of December, has been recovered. The improvement in demand is now of a *bona fide* rather than a speculative character, and in this it differs from what was experienced in the autumn, and is more likely to be kept up. There is more life in the pig iron consuming industries, and that itself affords ground for expecting an increasing pig iron trade during the spring. No. 3 Cleveland pig iron was sold early this week at 37s. per ton for immediate delivery, but the general price has been 37s. 3d., and a considerable number of sales have been made at this figure for January delivery, while 37s. 6d. has been paid for February, and 37s. 9d. for March. Buyers of No. 3, for spring delivery, at 37s. 6d. there have been in plenty, but sellers, both makers and merchants, have not been prepared to accept that, as they have no doubt that they will realise more. No. 1 Cleveland pig has been advanced to 38s. 6d. A brisker demand has sprung up for the lower qualities of Cleveland pig iron, but these are very scarce, as few of the furnaces are turning out any. It is a long time since the quality of the iron made at the Cleveland furnaces was so uniformly good, and in this they have been favoured by the open winter, which has allowed of a drier coke being used. Those who need forge pig iron now have much difficulty in getting it, and for No. 4 foundry have to pay 36s. 9d., while for grey forge 36s. 3d. has been given, and scarcely any of the latter can be had under that figure. White iron is at 35s.

A good deal of business has been done in East Coast hematite pig iron during the last few days, and the price has been advanced fully 6d. per ton, mixed numbers being quoted at 46s. for early f.o.b. delivery, and some of the leading brands cannot be had at that. The price of Spanish ore continues steady, and has not fallen with the easier rates of freight, as might be expected. Average Rubio ore is at 12s. 6d. per ton, delivered in the Tees. Mr. Joseph Angus, who for several years has been assistant manager at Messrs. Cochrane and Company's Ormesby Ironworks, Middlesbrough, has been appointed manager and engineer at the Claylane Iron Company's furnaces at Southbank.

The stock of Cleveland pig iron in the public warrant stores is accumulating less rapidly this month than was the case in December. On Wednesday night the stock held by Messrs. Connal and Co. was 178,416 tons, or 6716 tons increase this month.

The demand for finished iron and steel is improving. Especially is this the case with respect to steel rails and railway material, this department being undoubtedly in a very healthy condition; the works are in full operation, and orders are booked by manufacturers which, it is said, will keep them going during the greater part of the current half-year. Not for six years has there been such an active demand for rails as there is at present, and the price of heavy steel rails is fully maintained at £4 15s. net at works. Chairs and sleepers are also in more request, and there has sprung up also a good business in structural iron and steel, especially for bridge work and girders for abroad. The bar manufacturers, who have had a more prolonged experience of the depression than most of those engaged in the iron and steel trades, now speak more favourably of their business, orders are more numerous, competition less keen, and the price is stiffer, though it is not as high as it was in December, about £4 17s. 6d., less 2½ per cent. at works, is the general rate. The plate makers have been affected by the stoppage of work on the Clyde and at Belfast, and have had difficulty in getting specifications from consumers to keep their establishments fully going. In consequence of this they have had to look out for orders elsewhere, and to secure them have had to accept reduced prices. This explains the drop in prices as compared with December. Steel ship-plates can be got at £4 17s. 6d., less 2½ per cent. at works, if the order be for a fair quantity, but manufacturers ask 2s. 6d. more where the lot required is a small one. The same may be said of the angle trade; steel angles are at £4 15s., and iron angles at £4 12s. 6d., both less 2½ per cent. and f.o.t. The prospects for both branches are good, seeing the revival that is taking place in shipbuilding, partly owing to the work in hand and promised from the British Admiralty and other Governments. The demand is more for steel than iron plates and angles.

Engineers are experiencing fair improvement in their business, and are advancing their prices. The officials and workmen of the Stockton Malleable Iron and Steel Co. on Saturday made a presentation to Mr. Fred. G, Mills, late manager of the steel works department, on his leaving to take the management of the works of the Glasgow Steel and Iron Co. at Wishaw. A presentation was on Saturday made to Mr. Edward Wann, who has been fifty years in the employ of the North-Eastern Railway—forty-one years as engine driver. He was born at Elswick, and at the age of twelve entered the railway shops at Gateshead as cleaner. After four years he was promoted to be engine fireman, and was occupying that position when the Queen opened the Central Railway Station and High Level Bridge at Newcastle in 1850. In 1855 he became driver, and has for the last twenty-five years run expresses between York and Edinburgh. On several occasions he has been selected to act as driver to various members of the Royal Family, including the Prince of Wales and the German Emperor. Messrs. Arnett Brothers have within the last few days commenced operations at their new bolt, nut, and rivet works at Middlesbrough. They intend to make a specialty of fish-plate bolts for railway purposes, and they are intending to put down at least eight machines. It is expected that a good trade will be done with London in rivets, as it is claimed that they can be delivered there at less than is charged for Staffordshire rivets.

The coal trade of Northumberland is slack, and scarcely any of the collieries can be carried on full time. For best steam coals 7s. 9d. per ton f.o.b. will now be taken, but that is for early delivery only, and more has to be paid where spring delivery is required, as the trade will then be brisk again. The accountants to the Conciliation Board have certified that the average realised price of all the Northumberland coal delivered during the three months ending November 30th last was 5s. 5·07d., which is below that of the previous quarter, and in fact is the lowest price known for several years. The colder weather is making the house coal collieries rather busy, but the winter has been a disappointing one for coalowners and merchants, and higher prices have not been realised. As there were so many miners who abstained from voting when the question was put before them as to the abolition of the Conciliation Board in the Durham coal trade, it has been considered that the result of the voting was inconclusive, and therefore another vote is being taken this week. Coke is in good request, and the price is maintained at 13s. per ton, delivered at the furnaces on Tees-side.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Glasgow pig iron market was strong at the end of last week in consequence of the Clyde engineers having voted to return to work, and a substantial advance occurred in the price of warrants. Scotch iron lost about 6d. per ton at the beginning of this week owing to the adverse vote of the Belfast engineers, but the market has since been better, as it is held on 'Change that the engineers' dispute has too long influenced business, and is now practically decided. A large quantity of Scotch warrants have changed hands in the course of the week. A moderate business has been done in Cleveland and Cumberland iron.

It is reported that the ironmasters intend to reduce to some extent the output of pig iron, in order to prevent a further accumulation of stocks at their works. The requirements for the shipping trade have been so light that a steady increase in stocks was inevitable. On the other hand, it is pretty generally held that the production of iron at present low rates of fuel, and with a moderate outlay for wages, could scarcely fail to be remunerative in the end, were the masters inclined to invest their money in larger stocks, and wait for a favourable market. Since last week the output of ordinary Scotch pig iron has been reduced by about 600 tons per week. At the same time, there has been an increase of nearly that extent in the make of hematite. One ordinary furnace has been put out of blast at Glengarnock. There are now seventy-seven furnaces in operation in Scotland, compared with seventy-three at this time last year, and of the total, forty-two are making ordinary, thirty-one hematite, and four basic iron.

The values of g.m.b. and several other classes of iron are somewhat higher. The current quotations are as follow:—G.M.B., f.o.b. at Glasgow, No. 1, 47s.; No. 3, 45s. 6d.; Govan and Monkland, ditto, ditto; Carnbroe, No. 1, 47s.; No. 3, 45s. 6d.; Clyde, No. 1, 50s.; No. 3, 47s.; Calder, Gartsherrie, and Summerlee, Nos. 1, 51s.; Nos. 3, 48s.; Coltness, No. 1, 53s.; No. 3, 49s.; Glengarnock, at Ardrossan, No. 1, 50s. 6d.; No. 3, 46s. 6d.; Eglinton, No. 1, 48s.; No. 3, 46s.; Dalmellington, at Ayr, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Carron, at Grangemouth, No. 1, 53s.; No. 3, 49s.; Shotts, at Leith, No. 1, 53s.; No. 3, 48s. 6d.

The shipments of pig iron from Scottish ports in the past week were 4367 tons, compared with 5080 in the corresponding week of last year. To the United States 35, South America 50, India 78, Australia 578, France 55, Italy 50, Germany 165, Holland 70, Belgium 130, China and Japan 340, other countries 105, the coastwise shipments being 2711, against 4230 in the same week of 1895.

In the malleable iron department there is an improving tone. Business is opening out fairly well, and the makers are now endeavouring to obtain the best rates that were current in the latter half of last year. They quote bars at £5, and angles £4 17s. 6d., less the usual 5 per cent. for payment in one month. There is a moderate business in sheets. The demand from South Africa, which had grown to be an important item in the business, has of late been necessarily interfered with by events at the Cape, but a revival and even an extension of the business in that direction is confidently expected. The steel trade is quiet, but there is full employment, and the prospects are satisfactory.

There is rather more doing in coals. The shipment from Scottish ports in the past week amounted to 125,962 tons, compared with 92,963 in the preceding week, and 113,229 in the same week of 1895. For some classes of coals the inquiry is improving for home consumption, but the output is so large that it is impossible to obtain better prices, the current figures being practically those last quoted in this correspondence.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

I AM now enabled to confirm the statement made last week that the Admiralty had placed an additional large order in the Welsh market for steam coal. Instead of 100,000 tons, as stated, the order is 110,000 tons, and has been apportioned as follows:—Hill's Piymouth, 10,000 tons; Standard, 10,000 tons; Dowlais, 20,000 tons; Lewis's Merthyr, 15,000 tons; Cambrian, 10,000 tons; Powell Duffryn, 25,000 tons; National, 10,000 tons; and Cyfarthfa, 10,000 tons. The prices range from between 9s. 9d. to 10s. 3d., net.

The steam coal trade is remarkably strong in the Cardiff district, as evidenced by the fact that the exports last week totalled 340,000 tons, or 80,000 tons more than those of the preceding week. For some qualities of steam there was a pressure, principally due to the stoppage of two collieries in the Aberdare-Hirwain district. A marked feature has been an improved French trade, dry coals being particularly in demand. Monmouthshire coal has also been strongly booked, and prices are quite 3d. per ton better for this class of coal than last week.

The great coal export of last week naturally told heavily on the railways, and the result was a "record week" for the Taff Vale. The total carried by this line of rail was over 300,000 tons of coal. Local statists point out that this is equivalent to fifteen million tons per annum. As it is, it was the largest quantity ever carried down in one week. The closest approach was in January, 1895, when the total carried down was 294,000 tons.

Up to the eve of my despatch the prospect of a good week's work on rail and at docks was fairly assured. Shipments are numerous, and the Cape, Bombay, and Monte Video figure well. One cargo for Bombay amounted to 7000 tons.

Mid-week prices remained firm, with an upward tendency for some qualities. On 'Change, Cardiff, quotations were as follow:—Best steam coal, 10s. 6d.; seconds, 9s. 6d. to 10s. 3d.; drys, 9s. 6d. to 9s. 9d. Small steam easier, best, 5s.; seconds, 4s. 3d. to 4s. 6d.; drys, from 4s. f.o.b. The spurt in Monmouthshire coal, as I have stated, continues; best, Cardiff shipment, is quoted at 8s. 9d. to 9s.; seconds, 8s. to 8s. 3d.

The coming on of something like winter weather has told upon house coal in regard to demand, though prices remain much about the same. Prices now are:—Best, 10s. 9d. to 11s.; No. 3 Rhondda, 9s. 9d. to 10s.; brush, 8s.; small, 6s. 3d. to 6s. 6d.; No. 2 Rhondda, 8s.; through, 6s. to 6s. 3d.; small, 4s. 3d. to 4s. 6d.

Pitwood is at 15s. 9d., Cardiff. Patent fuel is rather weak at Swansea; better at Cardiff. Prices unchanged. Cardiff makers well booked ahead. For coke demand is increasing. Last prices, Cardiff:—Furnace, 12s. 6d. to 13s. 6d.; foundry, 15s. 6d. to 16s. 6d.; special, 19s. to 19s. 6d. Swansea prices:—Furnace, 12s. to 12s. 6d.; best foundry, 16s. to 17s. Swansea coal prices:—No. 3 Rhondda, 10s. to 10s. 6d.; No 2 Rhondda, 8s. 9d. to 9s. 6d.; best steam, 9s. 6d. to 10s. 6d.; anthracite, 8s. 9d. to 9s. 6d., and 11s. to 12s., according to quality. The coal trade at Swansea has little of the vitality which marks business at Cardiff. Last week the total shipment was below the average, only amounting to 28,630 tons. Destinations: France, Italy, Holland, Denmark, Portugal, Rio de Janeiro. The United States took 4879 tons.

The steel rail trade at Swansea is tolerably good. The depressed state of the tin-plate trade has told considerably upon tin bars at the chief works, Cyfarthfa, Dowlais, Ebbw Vale, Blaenavon. There is, however, an expectation that this class of trade will improve again. It may not be out of place to put into stock the overmake, as the Crawshays used to do with merchant bars. In steel rails there has been one fairly good cargo sent from Cardiff, the best that has been recorded for some time, 3726 tons for Kurachi. Imports continue noticeable. Large cargoes of steel bars continue from Harrington for Port Talbot, and 400 tons pig from the Grovesend Steel Company for Swansea. Ulverston also sent this week to the same destination 552 tons pig iron.

On 'Change, Swansea, this week, iron and steel prices were as follows:—Pig iron, Glasgow, 46s. 2d.; Middlesbrough, No. 3, 37s. 3½d.; hematites, 45s. 2d.; sheet iron and steel, £6 5s. to £6 10s.; Welsh bars, £5 5s. to £5 10s. Steel rails, heavy sections, £4 10s. to £4 15s.; light, £4 15s. to £5 10s. Bessemer steel, tin-plate bars, £3 17s. 6d. to £4. Tin-plates were not quoted, but it was understood that for large quantities figures ranged from 9s. 1½d. to 9s. 3d., f.o.b. Swansea. This was the quotation of the London metal market. In respect of shipment the trade is looking up again. Last week it amounted to 52,109 boxes, and 49,148 boxes were brought to stock, which now consists of 161,172 boxes.

Liverpool quotations, tin-plate, last week were slightly above those given by the London metal market. Bessemer, 9s. 4½d., 9s. 6d., 9s. 7½d., and 9s. 9d.; Siemens-Martin, 9s. 3d., 9s. 4½d., 9s. 6d., 9s. 7½d., 9s. 9d.; Siemens-Martin, I.C., 20 by 10, 13s. 4½d. to 13s. 9d.; ternes, 20 by 28, 17s. 6d. to 18s.; and better grades 18s. 3d. to 19s., all Wales, f.o.b.

At Briton Ferry trade has been very much like that of the previous week, the colliers only working half-time; but Baglan Bay, Vernon, Gwalia, and Earlswood, fully employed. The production of pig at Briton Ferry Works was about the average, and that of steel bar and ingots at Briton Ferry and at the Albion Works tolerably good.

An impression prevails in Swansea that an improvement in the trade is at hand. On Tuesday an important meeting was held in Swansea by the Tin-plate Makers' Association, with the object of "considering the question of promoting a company to provide new markets for tin-plates, by employing agents in China, Ceylon, Africa, Australia, and other countries, supplemented by sending out experts and machinery." At a previous meeting on the 17th of last month it was agreed that a company should be formed with a capital of £20,000 in £1 shares. At the meeting this week about 200 mills were represented, and, though private, it would appear to have given the necessary momentum to a movement calculated, in the opinion of the best judges of the situation, to improve trade considerably. The idea of the proposer is that 400 mills should join, the capital to be raised by annual contributions of £10 per mill, which would provide an income of £4000 for five years. Another meeting will be held next week, and weekly for a time. Cordial co-operation is, of course, essential to the success of the effort.

It is probable that the old Lodge Works, Llanelly, will re-start next week. The men have offered a concession of 10 per cent., and this is accepted.

A new jetty is decided upon for Pembroke Dockyard, and some of the chief officials from the Admiralty are to visit some time this month, to fix a site.

Enthusiastic meetings have been held during the week at Aberdare and Merthyr in order to devise some means of recognising in a practical manner the honour awarded by the Queen to Sir W. T. Lewis, Bart. It is expected that the whole of the mineral district will be united in getting up a substantial fund. The recognition is likely to take the form of a statue, in Sir William's native place, Merthyr.

The Great Western Railway continues much in evidence as regards Wales, and rumours as to changes and annexations are common. One of the last is "a probable coalition between the Great Western and Barry Dock," but I prefer waiting to see the fate of the Bill that will shortly be discussed in Committee before accepting any rumour of the kind.

Hopes are freely expressed that the shipbuilding dispute on the Clyde and at Belfast is coming to an end. The pig iron market in Wales has sensibly improved since the signs given of a turn of the tide.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE industrial position over here is, on the whole, satisfactory, although the employment at the works and mills is reported as moderate rather than brisk. The tendency of prices was a trifle less firm last week, but no doubt when more orders are coming in quotations will improve. For the present there is still much cause for complaint, especially where export trade is concerned, quotations leaving little or no profit.

In Silesia both the blast furnace works and the rolling mills are in fair activity, and tolerably good prices have been realised, those for bars and girders being, on an average, M. 20 p.t. higher than at this time last year. The business in tubes is particularly lively. Reviewing the position of the Silesian iron industry during the year that is now past, it appears that most branches have pretty favourably developed in the last two quarters. Silesian iron trade is always more or less dependent upon other German iron markets, especially that of Rheinland-Westphalia, which is much more favourably situated with regard to costs of production and means of conveyance. On the other hand, Silesian export business, especially to Russia, is of considerable importance to the German iron market in general; the rising of the iron industry in Russia, therefore, causes some uneasiness in iron circles, as Russian consumption in iron and steel is enormous. With regard to changes in quotations, basic price for best merchant bar was, in the beginning of 1895, M. 120 p.t., free Breslau stores; in April, M. 125 p.t. was quoted; in August, M. 135 p.t.; and at the end of September, M. 135 p.t. was the price asked. Plates and girders have met with a similar improvement.

	Beginning of 1895.	March—April.	End of 1895.
	Mark, per ton, free Breslau.		
Plates	140 to 145	140 to 150	145 to 155
Girders	120 to 122	120 to 125	125 to 145

There is still very little speculation on the Austro-Hungarian iron market, but a fair number of inquiries, chiefly on local account, have been coming in upon the week, and makers report themselves pretty well off for new work generally. Present quotations are, for common forge pig: 45fl. to 46fl. p.t.; grey, ditto, M. 48fl. to 51fl. p.t.; Bessemer, 48fl. to 51fl. p.t.; Bessemer and Styrian ingots, 78fl. p.t.; Styrian bars, 105fl. to 112fl. p.t.; girders, 106fl. p.t.; heavy plates, 165fl. p.t.; tank plates, 130fl. p.t.; steel plates, 140fl. to 160fl. p.t., free Vienna. Throughout last year the condition of the Austro-Hungarian iron market has been a trifle weak, but was, all things considered, more favourable than in 1894. The business done in structural iron was particularly good, and so was the demand for most articles of railway material, while the employment in the bar trade left much to be desired. Prices were anything but firm, owing to the generally depressed tone which prevailed on most iron markets during the first quarters of 1895, and also because German competition was very keen, rendering it impossible for Austrian makers to sell their articles at remunerative prices. The pig iron trade was, on the whole, better situated than the malleable iron business, for, though quotations were rather low, there was much firmness exhibited. Prospects for the development of the Austro-Hungarian iron industry in 1896 are generally considered as favourable. Prices were, in florins, per ton:—

	1895.	1894.	1893.
Styrian forge pig, at works	46 to 47	46 to 47	47·50 to 48·50
Styrian bars, free Vienna	105 to 112·50	107 to 115	115 to 125
Bohemian bars, free Vienna	102 to 107·50	107 to 115	111 to 112
Girders, free Vienna	106 to 110	106 to 110	106 to 110

Last week's reports state the iron industry in France to be in a pretty satisfactory condition, a fair demand coming in for raw iron, as well as for the different articles of manufactured iron; prices are inclined to be firm.

On the Belgian iron market there has been a comparatively brisk business doing upon the week, pig iron being in good call and firm in quotation. The prices for malleable iron, on the other hand, must be considered as very unremunerative, and there is a decided inclination on the part of makers to raise their quotations; the majority, however, prudently prefer to wait till the position of the iron trade has become more settled. The plate and sheet trade continues lively.

A very firm tone prevails in the iron and steel trade of Rheinland Westphalia. The rising tendency, both in raw and in finished material, continues. Pig iron has been very briskly called for, and there was a decided increase in demand perceptible when compared to last week, inquiries on foreign account coming in more freely. Stocks show a decrease. The rolling mills are, for the greater part at least, healthily occupied, but the prices realised are justly considered as unsatisfactory. But, as the general tone of the market is steady and inclined to improve, an advance in quotations is very likely to take place in a week or two. Plates are in regular request, and for sheets quite an active demand is experienced. At a meeting held at Düsseldorf on the 14th inst., the Rhenish-Westphalian Plate Convention resolved to raise the price for boiler plates M. 5 p.t.; that for tank plates M. 2·50 p.t.

Output of coal in the Ruhr district was, for 1895, 34,684,880 t., against 34,305,340 t. the year before; in the Saar district production of coal amounted to 5,324,980 t., against 5,111,010 t., and in Silesia 12,937,850 t., against 12,185,120 t. Output in the three districts together was 52,947,710 t., against 51,601,470 t. in the year before, This shows, for the Ruhr district, an increase of 1·1 p.c.; for the Saar district 4·2 p.c.; for Silesia 6·1 p.c.; and for the three districts together an increase of 2·6 p.c. against 1894.

Official statements show value of import in France to have been, for 1895, 3,698,742,000 f., against 3,850,445,000 f. for 1894; and value of export is statistically stated to have been 3,387,851,000 f. against 3,078,145,000 f. for 1894.

TRADE AND BUSINESS ANNOUNCEMENTS.—Messrs. Wiggin, mica merchants, announce that they have taken temporary premises at 62 and 63, Minories, during the enlargement of their establishment at 102, Minories, by rebuilding on this site, and on the site of No. 103, which they have purchased for the purpose of necessary extensions.—The Southgate Engineering Company has removed its London office from 170, Fenchurch-street to Leadenhall House, Leadenhall-street. The office will be under the management of Mr. James Reid.—We understand that Mr. L. Pyke, late of Messrs. Pyke, Harris, and Co., Westminster, has sent in his resignation to that company, as managing director, owing to his having entered into partnership with Mr. Owen Lucas and Mr. Leopold Lucas, under the title of Messrs. Owen Lucas and Pyke, as consulting engineers.—As from the 1st of January inst. the firm of Messrs. Tabor, Trego, and Co., of New Broad-street and Bow, will consist of the former partners with the exception of Mr. G. S. Hunt, who then retires from the firm on the termination of the late partnership by effluxion of time.—We are informed that Mr. J. E. Weyman has resigned his position as managing director of the Trusty Engine Works of Messrs. Weyman, Hitchcock, & Co., Ltd.. Cheltenham, in which he is so largely interested. As is generally known, Mr. Weyman has worked very successfully in collaboration with Mr. Knight to develope the Trusty oil engine, and had previously brought out the Trusty gas engine, with which good results are obtained, before the business of Weyman and Hitchcock was converted into that of a limited company.

LAUNCHES AND TRIAL TRIPS.

On the 17th inst. the s.s. Chiswick, recently built by Messrs. Ropner and Son, of Stockton-on-Tees, to the order of the Britain Steamship Company, London, left the river Tees on her trial trip. This steamer has been built under the supervision of Mr. Spence, the inspector to the company, who was present during the trial trip.

Messrs. Fleming and Ferguson, shipbuilders and engineers, Paisley, launched from their yard last week the second of three steam hopper steamers which they are constructing to the order of the Admiralty for Portsmouth Dockyard. The dimensions of the vessel are 155ft. by 31ft. by 12ft. 5in., and she has a carrying capacity of 600 tons. The engines and machinery will be supplied by the builders.

On Friday, the 17th inst., the s.s. Sonnenburg, which has been built by Messrs. Wigham, Richardson, and Co., at their Neptune Works, Newcastle-on-Tyne, to the order of the Deutsche Dampfschifffahrts Gesellschaft "Hansa," of Bremen, and especially constructed for the River Plate trade, went for a very successful trial trip. The engines of this steamer are of the quadruple expansion type, on four cranks, balanced on the Yarrow, Schlick, and Tweedy system—a system which continues to give excellent results, both as regards the small consumption of fuel and the complete absence of vibration. The owners were represented by Mr. Wulff, the superintendent engineer of the company, under whose guidance the steamer has been completed. During the trial trip the machinery worked without the slightest hitch, giving satisfaction to all concerned; and the vessel sailed at once to take her place in the service between Germany and the River Plate.

On January 20th Messrs. Wm. Simons and Co., Renfrew, launched the first of two very powerful barge-loading dredgers constructed to the order of the British Admiralty. The vessel, which is named the St. Ives, is to be employed at Portsmouth Dockyard, and is of the following dimensions:—Length, 195ft.; breadth, 35½ft.; depth, 13ft. She is propelled by two sets of compound surface condensing engines of 1000 indicated horse-power—either set of engines being available for dredging—and has all the latest improvements in dredging appliances. The hoisting gear for bucket ladder, the bow and stern winches, and the side shoots for filling hopper barges are driven by independent engines. The length of the bucket ladder enables the buckets to dredge to a depth of 46ft. The rooms for officers and crew are placed on each side of the bucket well, and are comfortably fitted up. The dredger was launched with all her machinery on board, and in a few days will leave the Clyde for Portsmouth. Messrs. Huxham, Stewart, and Scoggins, Admiralty overseers, upon whose direction the dredger was constructed, represented the Admiralty at the launch.

On the 14th inst. Messrs. Irvine and Co., West Hartlepool, launched a fine steel screw steamer of about 4100 tons deadweight carrying capacity, built to the order of Messrs. The London and Northern Steamship Company—Pyman Brothers, managers—London. The vessel will take Lloyd's highest class, and has been built under special survey. Her dimensions are 314ft. by 44ft. by 23ft. 3in. The deck erections consist of poop, bridge, and topgallant forecastle. The saloon and cabins for captain and officers are fitted up in poop. The engineers are berthed under bridge deck at sides of engine-room, and the crew in topgallant forecastle. The hull is built on the web frame principle, with double bottom for water ballast fore and aft. Large hatchways are fitted, four steam winches by Irvine and Co., steam steering gear amidships, screw gear aft, two large donkey boilers, and direct steam windlass. The boats are placed on beams overhead, and all modern appliances will be fitted for general trading. Engines of the triple-expansion type are being supplied by Messrs. Blair and Co., Stockton-on-Tees. The hull and machinery have been built under the supervision of the owners' superintendents, Captain T. A. Pyman and Mr. Cromar. Miss Madeline Pyman named the vessel Pendower.

On the 15th inst. there was launched from the shipbuilding yard of Messrs. Wm. Doxford and Sons, at Pallion, the largest cargo boat ever built on the Wear, and with the exception of the Georgic and her sister ship, built by Messrs. Harland and Wolff at Belfast, the largest cargo-carrying boat afloat. The vessel, which, as she left the ways, was named the Algoa, has been built to the order of Messrs. Crow, Rudolph, and Co., of Liverpool, and has a deadweight carrying capacity of 11,300 tons. The builders' description furnished to the press states that the vessel is 475ft. long, 58ft. wide, and 34ft. 8in. deep. She has been plated on the Bell-Rockcliff system, whereby packing is dispensed with, and besides being on this account some 68 tons lighter than if plated on the old system, she presents a much handsomer apppearance. It is not only by the absence of packing that the weight of material used under this new system of plating is lessened, but also by the employment of shorter rivets in fastening outside strakes, and by using a smaller quantity of cement in the vessel's interior. As the reduction from these three different sources of saving admits of the safe loading of extra cargo to an equal amount, it will be seen that the Algoa possesses quite a unique advantage as compared with most other large cargo boats. For the purpose of facilitating the loading and discharging of her cargo, the vessel is fitted with eighteen derricks. Her construction has been under the superintendence of Mr. F. J. Pilcher, of Liverpool. At the completion of the launch the vessel was moored under the shearlegs for the purpose of being fitted with her engines and boilers, which have been constructed in the engineering department of the firm, their nominal horse-power being registered at 3000.

On Saturday morning last the s.s. Nanette had her trial trip. The Nanette has been built by Messrs. Wm. Gray and Co., for the Pyman Steamship Company, of West Hartlepool. She is a fine steel screw steamer, built to Lloyd's highest class, and her dimensions are:—Length over all, 305ft.; breadth, 42ft.; and depth, 21ft. 9in. The deck erections consist of a full poop, bridge over machinery space, and topgallant forecastle. A handsome saloon and cabins for officers, &c., are fitted up aft, the engineers' rooms are in the bridge, and the crew's accommodation forward, including a bath-room for seamen and firemen. The hull is built on the web-frame system, with a cellular double bottom; large hatchways, four steam winches, steam steering gear amidships, hand screw gear aft, two donkey boilers, patent direct steam windlass, boats on beams overhead, shifting boards throughout, stockless anchors, two masts with schooner rig, and a complete outfit for a first-class cargo vessel. The engines are of the triple-expansion type, and have been supplied by the Central Marine Engine Works of Wm. Gray and Co. They have cylinders 22in., 35in., and 59in. in diameter, with a 39in. piston stroke, and there are two large steel boilers working at a pressure of 160 lb. per square inch. After adjustment of the compasses, the engines were put full speed ahead for about an hour, when the speed attained was found to be 11 knots, everything running perfectly well and giving great satisfaction to those on board. There were present Captain T. A. Pyman and Mr. Fred. Smythe, representing the owners; Capt. Murrell, representing the builders of the vessel; and Mr. T. Mudd, representing the Central Marine Engine Works. The vessel is in charge of Capt. Clarke, and on the conclusion of the trial at once proceeded on her first run round to Garston, to load for the River Plate.

On Thursday afternoon, January 16th, Messrs. Joseph L. Thompson and Sons, North Sands Shipbuilding Yard, Sunderland, launched a finely modelled steel screw steamer, built to the order of Messrs. Rickmers, Reismuhlen, Rhederei, and Schiffbau, A.G., of Bremen. The vessel is 427ft. long, 50ft. 6in. wide, and 30ft. deep, moulded, and is designed to carry a deadweight of over 7200 tons with Lloyd's summer freeboard. She has been built to Lloyd's highest class, under special survey, on the three-deck rules, and has full poop, long bridge, and topgallant forecastle. The poop is arranged for cargo, and the officers, engineers, spare state-rooms, and saloon, in a house built on top of the bridge deck. On the top of this saloon house is placed the chart and wheel house. The crew are berthed in the topgallant forecastle. The vessel is built on the web frame principle, with intercostal stringers right fore and aft. The upper and main decks are of steel, the poop, bridge, and forecastle decks being of wood. Special attention has been paid to the loading and discharging arrangements, nine derricks being fitted, six of which are of steel. Seven powerful steam winches are placed on deck at the hatches, while the steam windlass is on the forecastle deck. The steam steering gear is placed at the after end of the engine-room, and is controlled by a wheel from the steering house on the bridge forward. A powerful screw gear is placed at the after end of the poop. Water ballast is carried in a cellular double bottom right fore and aft and in the after peak. The vessel is fore and aft schooner rigged, with pole masts. On the upper bridge deck amidships are placed four large boats, the two lifeboats being of seamless steel. The vessel has a graceful clipper stem, finished off with a well carved figure-head, and elaborate trail boards running away from this. The steamer is intended for Messrs. Rickmers' line between Europe and the East, and will further add to the reputation of the builders, being a notable addition to the many modern up-to-date cargo carriers which they have recently turned out. The engines are by Messrs. George Clark, Limited, and are of the following sizes:—27in., 43in., and 72in., with a stroke of 48in. Steam is supplied by four large multitubular boilers working at 180 lb. pressure, and all the most modern improvements in propelling machinery are fitted. The launch, which was witnessed by a large number of people, was most successful, the vessel, on leaving the ways, being named the Maria Rickmers by Mrs. Adolph Heine, wife of Messrs. Rickmers' superintending engineer.

NEW RAILWAY FOR NEW YORK.—The proposed tunnel railway scheme of the New York and Long Island Railway Company was revived at the last stockholders' meeting, by voting to increase the stock from 100,000 to 20,000,000 dols. for this purpose, provided that the consent of the Railway Commissioners of New York and New Jersey can be obtained. This company proposes to build twenty-six miles of double-track railway, beginning in New Jersey, and to tunnel under the Hudson River, under 42nd-street, and under the East River to Long Island. The directors elected include Mr. A. J. Benedict, of London.

THAMES FLOODS.—The Thames Conservancy Board has transmitted to the Rivers Committee of the London County Council the report of a committee appointed by the Board to consider the question of the floods in the Thames Valley. The report, which has been unanimously adopted by the Board, expresses the opinion that the only effective method of reducing the floodings is by widening and deepening the channel of the river, but that great care would have to be shown in dealing with the matter, as it might affect agricultural lands. The question is one which the local authorities and landowners in the Thames Valley should consider, and in the event of their not having powers they should apply to Parliament for the right to raise money to enable works to be carried out to prevent floodings. The committee hopes that in future the Conservancy Board will have sufficient funds to enable the Board to execute dredging operations for navigation purposes, which will, at the same time, lower the level of the flood waters. Accompanying the report of the committee is a report by the Conservancy engineer, who states that, in his judgment, the weirs, as at present constructed, are not responsible for the inundations; but he agrees with the suggestion that at many of the bridges there is insufficient waterway, especially where the flood arches have been blocked or silted up, and that the old channels and backwaters should be cleared. The expense of enlarging the channel to effect an alteration of the level of extraordinary floods would be enormous. It would cost £85,000 for the works necessary to relieve the lands between Staines and Teddington.—*St. James's Gazette.*

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When patents have been "communicated" the name and address of the communicating party are printed in italics.

9th January, 1896.

596. Means for Fastening Boots, J. H. Howarth, London.
597. Window Frames, A. Csiszer and A. Karly, Birmingham.
598. Scales, A. R. Beal, London.
599. Safety Mechanism of Small Guns, W. Mansfield, London.
600. Greeting Cards, Valentines, &c., E. G. Law, London.
601. Preparing Extract of Coffee, T. O. Kent, London.
602. Apparatus for Beating Eggs, F. R. Saville, Birmingham.
603. Fixing of Bells to Cycles, J. W. Mützell, Birmingham.
604. Insulated Anchoring Apparatus, S. W. Baynes, London.
605. Mechanical Toys, J. A. Cave.—(*E. Weise, Germany.*)
606. Page Turner, W. S. Shepherd, London.
607. Revolving Nozzles for Liquids, E. E. Dulier, London.
608. Taps, J. Stewart, London.
609. Signalling Apparatus, J. Law and C. Ash, London.
610. New Brake for Velocipedes, F. Sparkes, London.
611. Attachment for Velocipedes, W. U. Paull, London.
612. Hurricane Lanterns, J. Hinks and Son, and H. D. Hinks, London.
613. Fare-registering Apparatus, F. W. G. Bruhn, London.
614. Manufacture of Castor Bowls, J. Harrington, London.
615. Tools for Slide Rests of Lathes, W. Hillman, London.
616. Rails, P. R. J. Willis.—(*H. Stearns and E. Doughty, United States.*)
617. Covering Ships' Bottoms, F. H. Snyder, London.
618. Extraction of Metals from Ores, J. B. Torres, London.
619. Ladies' Safety Bicycle Rest, F. Hooper, London.
620. Automatic Flushing Cisterns, J. J. Marsland, London.
621. Distending Sleeves, J. Alcock.—(*J. J. Konigs, Australia.*)
622. Tunnelling Apparatus, H. H. Dalrymple-Hay, London.
623. Devices for Typewriting Instruments, C. L. Baker, London.
624. Gas Engines, A. G. New, London.
625. Wheels, T. H. Deakin, F. S. Geath, and D. Powell, London.
626. Burglar Alarm, H. E. Lindo, London.
627. Music Cabinets, M. Liebich, Canada.
628. Fireplaces with Ventilating Shaft, A. H. Tiltman, London.
629. Curtain Poles, M. Lansing, London.
630. Screw Buttons, D. L. Richard and J. A. Bird, London.
631. Cylinders of Musical Boxes, P. Calame-Jaccard, London.
632. Chain Driving Gear, E. Barron, London.
633. Manufacture of Neck-ware, W. Willeringhaus, London.
634. Pictures, S. Hildesheimer and Co.—(*L. Sonn, Germany.*)
635. Gas Meters, S. J. Whitbread and J. R. Griffiths, London.
636. Bleaching of Flour, W. A. McArthur and J. Atherton, London.
637. Billiard and other Cues and Tips, H. Misener, London.
638. Waist Bands for Supporting Skirts, A. Breese, London.
639. Toys, J. W. H. Vivian, London.
640. Boxes, H. W. Chapman, London.
641. Application of Fuel to Furnaces, R. S. Richards, London.
642. Apparatus for Roasting Coffee, W. Parnall, London.
643. Stone Steps, A. W. Perriman and W. Owen, London.
644. Drinking Vessels and Saucers, W. A. C. Waller, London.
645. Means for Delivering Tickets, A. Marsh, London.
646. Construction of Bicycles and Tricycles, L. Frazer, London.
647. Device Applicable to Carboys, H. J. Gardiner, London.
648. Pneumatic Tires, J. S. Taylor and C. Davies, Liverpool.
649. Fuel, J. S. Taylor and C. Davies, Liverpool.
650. Waterproof Fabrics, I. Frankenburg, Manchester.
651. Waterproof Fabrics, I. Frankenburg, Manchester.
652. Wire Netting, Wire-work, &c., R. H. Silcock, Liverpool.
653. Rotary Machines for Printing, I. Lam, Liverpool.
654. Gutta-percha, E. Sérullas and F. Hourant, London.
655. Housings for Cycles, R. L. Hickes, London.

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656. Toy Windmill, T. Barter, Ross.
657. Drill, G. W. Davis, West Bromwich.
658. Seats, L. Dawes, London.
659. Safety Syphon Valve Taps, H. Sutcliffe, Halifax.
660. Chimney Cowl, G. Williams and W. Jackson, Tewkesbury.
661. Cricket Bats, F. Bryan, London.
662. Spittoon, J. G. Patterson, H. Tate, and J. S. Purvis, Gateshead.
663. Cotton Reel, E. W. Wynne, Liverpool.
664. Apparatus for Driving Tacks, W. H. Dorman, Stafford.
665. Metal Tubular Roller, E. Entwistle, sen., Ashton-under-Lyne.
666. Gravity Wheel, T. Haysman, Portsmouth.
667. Bobbins for Treating Fibrous Substances, T. Dixon, Keighley.
668. Looms for Weaving, A. Johnstone and J. W. Parker, Bradford.
669. Wigs, G. Hattersley, Keighley,
670. Stucco Glass, F. R. Cross, Birmingham.
671. Colanders, E. W. Holland, Birmingham.
672. Collar Stud and Tie Adjustment, E. A. Smeeton, London.
673. Separating the Cream from Milk, H. Lavens, Brussels.
674. Feeding Oil and Spirit Lamps, &c., H. Christy, Glasgow.
675. Non-slipping Guard for Tires, R. J. Glanvile, Burnham
676. Envelopes, F. Owen, Cardiff.
677. Fastening for Hampers, J. Rowlatt, Tunbridge Wells.
678. Indication of Boiling in Kettles, A. Smith, London.
679. Crank and Pedal Combination, A. Bills, London.
680. Velocipede Brakes, A. Lavelly and B. Hobi, London.
681. Photographic Apparatus, &c., J. D. Lysaght, London.
682. Artificial Fuel, H. C. B. Forester, London.
683. Corks, K. Fraser, jun., London.
684. Handle for Preserve Jars, R. J. Smith, Bromsgrove.
685. Power Gear for Bicycles, &c., W. T. Lord, London.
686. Pianos, J. E. Jansson, London.
687. Pie Dish, J. Pooley, London.
688. Rack for Cards and Photographs, H. C. Hall, London.
689. Reversible Ladies' Side Saddle, J. Kidman, London.
690. Extinguishing Candles, G. H. Laxton, London.
691. Construction of Baking Surfaces, P. Pfleiderer, London.
692. Clocks, E. P. West and C. A. Remane, London.
693. Life-belts, J. N. Layton, London.
694. Cover for Inspection Eyes of Drains, W. J. Bugler, London.
695. Billiard Cue Tip, C. Jessett and H. N. Phillips, London.
696. Umbrella Stands, E. T. Hughes.—(*T. C. Perry, United States.*)
697. Letter-boxes, Pillar-boxes, &c., T. J. Jenkins, London.
698. Colouring-matters, O. Imray.—(*The Society of Chemical Industry in Basle, Switzerland.*)
699. Electric Arc Lamps, H. N. Moody, London.
700. Stereoscopes, J. Carpentier and L. Gaumont, London.
701. Electric Signalling Apparatus, B. Marinovitch, London.
702. Packing Goods, S. Learoyd and W. Scott, London.
703. Utensils for Boiling Purposes, O. B. Bates, London.
704. Feed-water Cleaners, C. A. Houfe.—(*W. W. Houfe, China.*)
705. Printed Axminster Carpets, J. Nicholls, London.
706. Bottles, J. M. Richards.—(*H. K. Terry, United States.*)
707. Locomotive Grass Mower, &c., G. E. Arnold, London.
708. Manufacture of Scotch Fabrics, J. Joubert, London.
709. Velocipede Steering Heads, R. Haddan.—(*F. Chaligné, France.*)
710. Electric Accumulators, A. C. Miles and B. F. de Morgenstern, London.
711. Arc Lamps, A. C. Miles and B. F. de Morgenstern, London.
712. Electric Motors, A. C. Miles and B. F. de Morgenstern, London.
713. Velocipedes, B. C. Hicks, London.
714. Velocipedes, B. C. Hicks, London.
715. Fountains, H. H. Lake.—(*The firm of E. B. Söhne, Austria-Hungary.*)
716. Apparatus for Desiccating Fruit, J. Lewthwaite, London.
717. Hauling Boats on Rivers, &c., N. Gherassimoff, London.
718. Roundabouts, E. Tuteur, London.
719. Electrical Accumulators, B. Willcox.—(*La Société L'Accumulateur Fulmen, France.*)
720. Obtaining Hydro-sulphide of Sodium, &c., B. Willcox.—(*The firm of Chemische Fabrik Griesheim, Germany.*)
721. Driving Gear for Bicycles, &c., A. T. Collier, London.
722. Electric Arc Lamps, J. I. and J. E. Thornycroft, London.
723. Snaffle and Curb Reins, O. E. Hollingworth, Westminster.
724. Fastening Carpets to the Floor, O. E. Hollingworth, Westminster.
725. Furniture Castors, O. E. Hollingworth, Westminster.
726. Files for Holding Letters and Bills, W. Beller, London.
727. Files for Holding Letters and Bills, W. Beller, London.
728. Automatic Lever Pulleys, S. Wilcock, London.

11th January, 1896.

729. Shuttle Picker Check Swell for Looms, W. and R. F. Haigh, Skipton.
730. New Game, C. M. Linley, London.
731. Self-propelled Vehicles, J. H. Hamilton and A. Rollason, Sandiacre.
732. Calendars, C. Tyler, London.
733. Open Air Seats, T. H. Taylor, Belfast.
734. Renewing Sash Lines, J. R. Knight, Black Rock, Co. Dublin.
735. Lathes, H. Liebert, Manchester.
736. Electric Tramways or Railways, W. B. Edgar, Glasgow.
737. Doubling Frames, B. A. Dobson and W. Hamer, Manchester.
738. Corner and Frame for Beds, G. Rogers, Birmingham.
739. Signalling Apparatus, W. F. Balls and W. Lowes, South Shields.
740. Pillar, Wall, and other Letter Boxes, O. D. Kinnersley, Bristol.
741. Excluding Dust from Lamps, G. M. Archibald, Stockton-on-Tees.
742. Preventing Smoky Chimneys, S. J. Cairns, Southport.
743. Measuring and Draught Tap, G. M. Dudley, Dublin.
744. Cycle Driving Gear, J. McKenny and F. L. North, Dublin.
745. Cycle Stand, H. Budden, London.
746. Wood Screws and the like, C. Horton, Birmingham.
747. Table Knife, G. F. Vardy, London.
748. Regulating Spinning Machinery, C. Bergmann, London.
749. Collars for Rock Drills, W. H. Taylor.—(*J. Daniell, India.*)
750. Cycle Carrier and like Bags, A. M. Lermit, Birmingham.
751. Rubber Tipped Ferrule, S. R. Gladston, North Shields.
752. Calico Printers' Blanketing, J. Wood, Manchester.
753. Stopper for Bottles, J. Marcroft and T. Rawston, Rochdale.
754. Bottle Stoppers, J. Marcroft and T. Rawston, Rochdale.
755. Drop-down Guns and Rifles, J. W. Smallman, Nuneaton.
756. Fresh Air Inlet for Drains, G. W. Knowles, Somerset.
757. Outdoor Seats, A. W. Molloy, Tonbridge.
758. Grinding Spindles, W. Bodden and F. Ashton, Manchester.
759. Revivifying Spent Limes, &c., G. R. Hislop, Glasgow.
760. Street Gas Lamps, C. R. Bellamy, Liverpool.
761. Gas Fittings for Street Lamps, C. R. Bellamy, Liverpool.
762. Drain Stoppage Indicator, T. G. Goodwin, London.
763. Construction of Curling Tongs, G. Skinner, London.
764. Ship Construction, P. F. Maccallum, Helensburgh.
765. Coal Tipplers and like Machinery, J. Martin, London.
766. Treating Spent Hops, E. Davies and H. M. H. Goodfellow, London.
767. Internal Combustion Motors, F. O. Prince and The Setay Motor Engine Syndicate, Ld., London.
768. Door Handles, A. G. Green, London.
769. Form Turning Machines, C. A. Allison.—(*The Garvin Machine Company, United States.*)
770. Paper Articles, W. B. Benns.—(*G. Piprot, France.*)
771. Process for Combusting Coal Dust, M. Seipp, London.

772. Cycle Stands, F. S. Buckingham, London.
773. Machines for Necking Cylindrical Cases, &c., W. B. Challen and Taylor and Challen, Limited, London.
774. Lathes for Trimming Cylindrical Cases, &c., W. B. Challen and Taylor and Challen, Limited, London.
775. Making Barrel Root Cutters, E. E. Bentall, London.
776. Folding or Collapsible Boxes, W. Riley, London.
777. Oil Lamp Stands, H. Priest and J. W. B. Wright, London.
778. Secondary Batteries, H. W. Headland, London.
779. Sieves, H. Demant, London.
780. Secondary Electric Batteries, H. Leitner, London.
781. Non-fillable Bottles, W. C. Sherman, London.
782. Envelopes, A. Mortensen, London.
783. Cigarette Papers, I. Goldfar and L. R. Rowland, Glasgow.
784. Internal Combustion Motor Engines, P. Burt, Glasgow.
785. Valve Controlling Device, J. F. Batchelor, Brooklyn, U.S.A.
786. Gas and Oil Engines, M. H. Smith, London.
787. Cycles, L. Stein, London.
788. Combined Fabric and Threads in Hemming and Similar Work, J. Deeks.—(*H. H. Fefel, United States.*)
789. Photographic Cameras, L., L. E., and H. Holmes, London.
790. Refrigerators or Cooling Chambers, R. J. A. Hankow, London.
791. Voltaic Batteries, W. Walker, jun., F. R. Wilkins, J. Lones, and C. Vernon, London.
792. Refrigerating Chambers, &c., E. Willows, London.
793. Electrical Lamp, H. J. Dowsing and H. S. Keating, London.
794. Electrical Lamp, H. J. Dowsing and H. S. Keating, London.
795. Cooling the Inlet Valves of Gas and Oil Motor Engines, C. D. Abel.—(*The Gasmotoren Fabrik Deutz, Germany.*)
796. Propelling Vehicles, C. F. de Kierzkowski-Steuart, London.
797. Gas Brackets, H. Crawley and G. A. Metcalfe, Liverpool.
798. Enamel Tins, C. Davies and J. S. Taylor, Liverpool.
799. Separating Oil from Water, H. Hinterberger, London.
800. Motor Carriage, C. Keller, London.
801. Rendering the Joints of Cylinders Fluid-tight, J. P. Gauthier, N. Henriot, and A. Jourdanet, London.
802. Splitting or Cutting Cigar Ends, D. H. Fisher, London.
803. Fluid Pressure Regulating Valves, W. Ross, Glasgow.
804. Safety Valves for Domestic Boilers, J. Gourlay, Glasgow.
805. Window Flower Boxes, J. F. Struthers, Glasgow.
806. Wheels for Cycles, J. Sternberg and A. Maneau, London.
807. Appliance for Retaining Cigars, F. X. Hardt, London.
808. Tobacco Boxes, H. Hebden, Harrogate.
809. New Tobacco Pipe, M. Frilley, Brussels.
810. Supply of Electricity, Gas, &c., G. C. Fricker, London.
811. Refrigerating Machinery, F. W. Walker, London.
812. Chain Wheels of Cycles, &c., J. Blackmore, London.
813. Steering Arrangements of Cycles, L. Frazer, London.
814. Driving Gear of Cycles, S. H. Crocker, London.
815. Luggage Carrier for Cycles, J. W. Innes, London.
816. Producing Methyleneditannic Acids, E. Durkopf, London.
817. Sifting Machines, H. H. Lake —(*J. E. Mitchell and Harmon Manufacturing Company, United States.*)
818. Files for Holding Letters, Bills, &c., W. Beller, London.

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819. Incandescent Body for Lamps, W. P. Thompson. —(*The Continental-Gas-Glühlicht-Aktien gesellschaft "Meteor" vormals Kroll, Berger, and Co., Germany.*)
820. Sewing Machines, W. A. Robertson, Belfast.
821. Purification, &c., of Water, J. H. Williams, Waterford.
822. Syphon Cistern, S. Thompson, J. McEwen, and T. Keates, Birmingham.
823. Joints for Cornice Poles, J. Whitfield, Birmingham.
824. Tobacco Pipes, J. Bird and G. B. Shuttleworth, Birmingham.
825. The Luggage Traveller, W. Crabtree, Heywood, Lancs.
826. Protection of Cycle Chains, C. Eltringham, Sunderland.
827. Round Frames for Dressing Ores, W. Trevorrow, Redruth
828. Movable Bar of Coal Vehicles, I. Lewis and J. E. Price, Merthyr Tydvil.
829. Fastener for Driving Tapes of Spinning Frames, W. Dargue, Halifax.
830. Pneumatic Guns, D. M. Mefford, London.
831. Packing Cases, &c., F. W. Farr, London.
832. School Desks, F. H. Fisher, Birmingham.
833. Apparatus for Bending Strawboard, &c., J. E. Thornton, Altrincham.
834. Grinding the Ends of Spindles, W. Bodden and F. Ashton, Manchester.
835. Time-comparing Device, W. P. Thompson.—(*A. Koechlin, Germany.*)
836. Disinfecting Plants, &c., J. T. Wägener, Manchester.
837. Hydrocarbon Motors, E. Wiseman and J. Holroyd, Manchester.
838. Tires for Cycles, W. Guthrie, Glasgow.
839. Needles for Sewing Machinery, J. W. Blakey, Leeds.
840. Railway Carriages, J. H. Annandale, Glasgow.
841. Furnace for Producing Coke, G. W. Breffit and F. G. Treharne, London.
842. Manufacture of Electric Conductors, S. O. Cowper-Coles, London.
843. Waterproof Unbreakable Bootlace, J. C. Browne, Tewkesbury.
844. Automatic Carving-fork Guard, E. Putley, London.
845. Electrical Appliances, D. Weisz and E. Epstein, London.
846. Manufacture of Cigarettes, S. and A. Grunebaum, London.
847. Automatic Apparatus, J. I. and J. E. Thornycroft, London.
848. Steam Traps, J. I. and J. E. Thornycroft, London.
849. Reloading Apparatus, J. E. Grout, London.
850. Apparatus for Overarches, &c., E. H. Bradley, London.
851. Duplicate Bag Frame, J. F. Meek, London.
852. Grain Storage Bins, J. Donaldson, Liverpool.
853. Cigar and Cigarette Holders, J. H. Scott, London.
854. Rolling Mill, H. Ehrhardt, London.
855. Apparatus for Drying Tea, &c., W. W. Wardle, London.
856. Measuring Arrangement for Bottles, P. G. Challis, London.
857. Letters, &c., for Advertising, W. G. Pether, London.
858. Apparatus for Carburetting Air, A. Devis, London.
859. Toe-clip, J. W. Colling, London.
860. Construction of Glazed Roofing, H. Becker, London.
861. Life-saving Jackets, E. Channing, London.
862. Sight-feed Lubricators, F. Bamford and W. Wadsworth, London.
863. Pneumatic Tires, W. J. Goddard and A. H. Trigwell, London.
864. Supplying Water to Roots of Plants, F. C. Dame, London.
865. One-trigger Double-barrel Guns, T. Southgate, London.
866. Hydraulic Engines, P. Frenzeny and D. H. Fisher, London.
867. Centrifugal Roller Mills, H. Propfe and G. Zarniko, Liverpool.
868. Electric Meters, C. Raab, London.
869. Photographing Panoramic Views, L. Jeffery, London.
870. Pumps, J. C. Merryweather and G. Harris, London.
871. Preventing Halation in Dry Plates, W. Haydon, London.
872. Apparatus for Raising Sewage, S. H. Adams, York.
873. Obtaining Carbonic Acid from Gases, W. Raydt, London.
874. Hydraulic Machine Jiggers, C. Simon, London.
875. Tiles, W. A. C. Waller, London.
876. Cycle, C. J. Gregg, London.
877. Manufacture of Impermeable Fabrics, J. J. Mann, London.
878. Cricket Bat, W. L. N. Clayton, London.
879. Measuring Instruments, Evershed and Vignoles and S. Evershed, London.
880. Electric Heaters, G. Ewart and J. Vaughan-Sherrin, London.
881. Cutting Clay into Bricks or Blocks, T. Buck, London.
882. Preventing Gas Freezing in Mains, The Whessoe Foundry Co. —(*The Berlin - Anhaltische Maschinenbau-Aktiengesellschaft, Germany.*)
883. Clothes Peg, L. Doring, London.
884. Regulating Temperature of Motor Vaporisers, E. Capitaine, London.
885. Transmission of Force, E. Capitaine, London.
886. Road Vehicles, R. W. Hannah, London.
887. Varying the Driving Speed in Cycles, G. Delannoy, London.
888. Secondary Batterry, A. U. Alcock, London.
889. Apparatus for Refrigerating Liquids, F. Godard, London.
890. Diazo Compounds, G. W. Johnson.—(*Kalle and Co., Germany.*)
891. Boiler Furnaces, J. Brown and Co. and J. Nodder, London.
892. Boiler Furnaces, J. Brown and Co. and J. Nodder, London.
893. A Bicycle Alarm Brake, W. Woodham, London.
894. Bed Table, A. Wilks, London.

14th January, 1896.

895. Temples of Looms for Weaving, F. J. Dutcher, London.
896. Simplex Recording Indicator, A. Cotgreave, London.
897. Head Clips used by Furriers, W. G. Speck, London.
898. Lubrication of Spindles, E. and S. Tweedale, and J. Smalley, Castleton.
899. Cans for Delivery of Milk, H. W. Townsend, Newport.
900. Liquid Sealed Valves for Gases, J. W. Wailes, Liverpool.
901. Milling Machines, T. Lumb, T. Walshaw, and D. White, Bradford.
902. Fire Ranges, S. H. Jefferys, Halifax.
903. Tooth Brush, J. Brennan, Manchester.
904. Plug Cocks, W. Moorhouse, Manchester.
905. Appliances for Holding Cards, L. Myers, Birmingham.
906. Fixing or Securing Scarves, W. Garratt, Birmingham.
907. Metallic Cots, R. P. Taunton, Birmingham.
908. Textile Fabrics, J. H. MacMillan and J. Mason, Manchester.
909. Flexible Shafting, M. G. Gillette, London.
910. Rotary Brushes, M. G. Gillette, London.
911. Singeing Fabrics, F. Bosshardt.—(*G. Balfe, France.*)
912. Perfect Ring Stretcher and Closer, J. Hollis, Ilkeston.
913. Washing Photographic Prints, W. Kerr, Glasgow.
914. Surgical Splint, G. W. White, Bristol.
915. Electric Transformers, E. Scott, Wolverhampton.
916. Non-sparking Switch, E. Scott and E. J. Cochrane, Wolverhampton.
917. Sailor Dance for Stage Work, B. Seward, Bradford.
918. Apparatus for Barrels, W. Hazlehurst, Rochdale.
919. Stoppering Bottles, J. Fitton and E. Looker, Rochdale.
920. Mode of Testing Sewer Pipes, C. L. J. White, Dublin.
921. Mourning Label for Letter Paper, J. Laidlaw, Glasgow.
922. Machine for Crushing Ores, T. Lees and D. N Shaw, Glasgow.
923. Stoppering or Closing Bottles, W. Pasquill, Keighley.
924. Heating Clothes-drying Closets, H. C. Longsdon, Keighley.
925. Effervescent Beverages, J. Hargreaves, Farnworth-in-Widnes.
926. Door Curtains, R. Darling, Glasgow.
927. Hydrocalor, S. Reilly, Plymouth.
928. Discharging Salts from Evaporators, J. Foster, Glasgow.
929. Piston Rings, J. Menzies, Glasgow.
930. Boot and Shoe Ventilator, T. Grainger, Rhondda Valley.
931. Electrical Device for Igniting Gas, J. K. Semple, Glasgow.
932. Wheel Naves, P. Fyfe, Glasgow.
933. Air Valves, P. Fyfe and W. Dewar, Glasgow.
934. Tobacco Pipes, G. Gilman, London.
935. Machinery for Moulding Bricks, A. Pullan, London.
936. Bells for Cycles, H. Lucas and B. Steeley, London.
937. Hydraulic Rams, G. F. Hurst, London.
938. Utilising Energy of Fluid in Motion, G. A. Benoit, London.
939. Blanks for Horseshoe Nails, D. E. Kempster, London.
940. Taps for Emptying Closed Vessels, C. A. James, London.
941. Pads, D. Appleton, London.
942. Blow Lamps, T. Warwick, London.
943. Tongs, G. Skinner, London.
944. Game, R.Hurrell, Essex.
945. See-saw, E. J. Nowell, London.
946. Typewriting Machines, J. D. Daugherty, London.
947. Turning Malt on a Kiln Floor, C. E. Mumford, London.
948. Stowing of Chain Cables, J. Kennedy.—(*R. P. Baines, Belgium.*)
949. Reducing Cellulose Bodies, W. Theodorovic, London.
950. Tin Openers, G. Parrott, London.
951. Railway Signal Apparatus, A. G. Walker and P. Black, London.
952. Tobacco Pipes, E. W. Thurgar, London.
953. Aerial Transport of Performers, C. R. Cox, London.
954. Laundry Irons, J. Manning and J. R. S. Hayes, London.
955. Implement for Trimming the Nails, J. Cunningham, London.
956. Hock Boot, F. Elliott, London.
957. Lamps for Lighting, E. Thorpe and W. Brandon, London.
958. Warming Stoves, E. Thorpe and W. Brandon, London.
959. Magazine Repeating Fire-arms, P. Mauser, London.
960. Horse Collar, A. Lawton, London.
961. Instruments for Stopping Teeth, A. Meisinger, London.
962. Lap Machines, O. Schroeter, London.
963. Ships Driven by Motive Power, F. W. Jones, London.
964. Telephonic Apparatus, C. J. Schwarze, London.
965. Braiding Machines, H. H. Lake.—(*W. C. Fisher, United States.*)
966. Parlour Game, W. D. R. H. Kerr, London.
967. Nailless Horseshoes, G. L. Reynolds, London.
968. Administering Anæsthetics, J. K. Gailey and C. A. Dunbar, London.
969. Blowing Engines, &c., W. P. Thompson.—(*E. Reynolds, United States.*)
970. Plansichters, &c., W. P. Thompson.—(*G. Luther, Germany.*)
971. Automatic Weighing and Packing of Goods, S. Learoyd and W. Scott, London.
972. Artificial Light Apparatus, J. Parkinson, Liverpool.
973. Harness Fittings, T. A. Quilliam, Liverpool.
974. Indicating Rise or Movement of Valves, E. W. Beech, London.
975. Incandescent Gas Burners, R. Holbrook, London.
976. Electric Arc Lamps, H. J. Fisher, London.
977. Sychronising of Alternating Current Motors, H. F. Parshall, London.
978. Self-closing Door Hinges, E. Edwards.—(*C. Mine, Germany.*)
979. Folding Furniture, J. W. Morison, London.
980. Electrically Regulating Temperature, A. W. Isenthal, London.
981. Printing Telegraphic Messages in Type, G. M. Gibson, London.
982. Temporary Binders, A. L. Weis, London.
983. Bailway Frogs, D. MacPherson, London.
984. Stalls for Cattle, G. C. Marks. - (*S. M. Parker, United States.*)
985. Locking Apparatus for Windows, W. Nicholson, London.
986. Electro-deposition of Metals, J. C. Graham, London.
987. Sugar-boiling Furnaces, R. Buxton and A. Ball, London.
988. Sheaths for Pencil Erasers, A. de V. Hunt, London.
989. Projectiles, J. Luciani, London.
990. Gradient Finders, A. Moore, jun., London.
991. Blast Process for Engraving, H. H. Leigh.—(*T. Truchelut, France.*)
992. Calculagraphs, H. Abbott and E. A. Currier, London.
993. Street-sweeping Machines, P. Jensen.—(*The International Sweeping Machine Company, United States.*)
994. Street-sweeping Machines, P. Jensen.—(*The International Sweeping Machine Company, United States.*)
995. Motor-cycles, C. A. Jensen.—(*H. Muller, J. Sommer, and J. Broach, Austria.*)
996. Explosion Engines, E. J. Pennington, London.

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997. Lamp Adapted for Omnibuses, A. Clarke, London.
998. Compasses, E. Buchholtz, London.
999. Corks, S. Greenwood, Seaforth.
1000 Derricks and Cranes, W. M. Walter, Liverpool.
1001. Means for Decorating Tiles, G. H. Grundy, Derby.
1002. Pumps, A. G. Browning and W. W. Churchill, Manchester.
1003. Transmitting Rotary Motion, W. G. Heys.—(*C. Terrot, France.*)
1004. Mustard Pot, G. H. Ellis, London.
1005. Calendars, J. F. Bennet, London.
1006. Electrical Resistances, M. Zinner, jun., Manchester.
1007. Brooms for Washing Carriages, T. Watson, Durham.
1008. Method of Making Court Plaster, A. Nixon, London.
1009. Wheels, S. Burge, Poole.
1010. Screw Stoppers, J. Leslie and M. J. Caughey, Belfast.
1011. Cork Fabrics and Garments, J. E. Thurman, Manchester.
1012. Cycle Handle-bar, J. T. and G. H. Redfern, Sheffield.
1013. Boots and Shoes, H. O. Tilley, Leicester.
1014. Fenders and other like Articles, J. A. Crane, T. Waterhouse, H. P. Phillips, and G. A. Phillips, Birmingham.
1015. Metallic Bedsteads, &c., J. A. Crane, Birmingham.
1016. Cycle Chain and Chain Wheels, J. Hands, Birmingham.
1017. The "Wonder" Grass Mower, G. Farris, Salisbury.
1018. Aprons, M. Laird, Glasgow.
1019. Razor Sharpening Apparatus, R. Howarth, Wolverhampton.
1020. Thermostats for Gas Kettles, J. J. Royle, Manchester.
1021. Soap Trays, G. L. Lavington and E. A. Wright, London.
1022. Cyanogen Compounds, A. von Rad and J. Rosenfels, Manchester.
1023. Boots, C. H. Silson and F. Robinson, Bradford.
1024. Buffer for the Spindles of Looms, W. Atherton, Bradford.
1025. Paper File, H. Igel, Newcastle-on-Tyne.
1026. Brake Mechanisms for Cycles, W. T. Smith, Keighley.
1027. Steelyards, H. Allchin, London.
1028. Disengaging Gear for Ships' Boats, A. Logan, Glasgow.
1029. Writing Pens, H. Brams, Berlin.
1030. Stair Rod Eyes, H. Mee and J. D. Stone, Birmingham.
1031. Cycle Axle Bearings, F. W. Golby.—(*E. van Deroorde, Germany.*)
1032. Linoleum, Oil Cloth, and Carpet, C. Blake, Andover.
1033. The Express Toaster, E. M. Sutton, West Brighton.
1034. Soldering Lamps, R. Jones, London.
1035. Woven Figured End R.A. Bow, T. C. Seasbrook, London.
1036. Detecting Matter in Liquors, G. A. Smith, London
1037. Apparatus for Rope Railways, C. E. Kelway, London.
1038. Apparatus for Filtration of Sewage, R. E. von Lengerke, London.
1039. Making Iced Drinks, G. W., H. W., and P. S. Chinnery, London.
1040. Toasters, C. and R. Lansdown, London.
1041. Filters, W. Reeves and The Reeves Patent Filters Co., London.
1042. Cigarettes, A. C. Goodes, London
1043. Steam Engines, S. Pitt.—(*La Compagnie Internationale des Procédés Adolphe Seigle, France.*)
1044. Toy, M. A. Wier, London.
1045. Hand Brakes for Railway Wagons, V. I. Feeny, London.
1046. Hydromotor, S. J. Williamson, Liverpool.
1047. Berth for Deck Use, A. Maynew and H. J. Hitchins London.
1048. Mechanism for Dye Vats, W. P. Thompson.—(*E. Dambremé, Belgium.*)
1049. Boiler Tube Stoppers, W. E. Evans and C. K Horrocks, Liverpool.
1050. Carrying Lorry Shafts, T. Cooke and R. Edwards, Liverpool.
1051. Inkstands, E. P. Lehmann, Liverpool.
1052. Ladies' Dress Raiser and Holder, B. Benny London.
1053. Setting Free Draught Horses, J. Marquardt, London.
1054. Voltaic Batteries, D. G. FitzGerald and W. C. Bersey, London.
1055. Soldering Metals, A. J. Boult.—(*C. Prioux and C. Hugot, France.*)
1056. Inflatable Bags for Drain Testing, J. Jones, London.
1057. Belt Fasteners, J. Parr, London.
1058. Marine Sounding Instruments, A. J. Boult.—(*F. Deshoulières, France.*)
1059. Valves or Cocks, &c., M A G. Andriveau, London.
1060. Radiators for Petroleum Lamps, A. F. A. Roxendorff, London.
1061. Let-off Mechanism for Looms, J. Poyser, London.
1062. Heel Building, &c., Machines, O. Robinson, London.
1063. Pipes and Wire, A. I. Summers, London.
1064. Tubes, R. Bungeroth, London.
1065. Fittings for Syphons, R. G. G. and W. S. G. Ellis and R. O. Jones, London.
1066. Conveying Vehicles, E. R. Calthrop and J. C. Taite, London.
1067. Pneumatic Tires, C. Woolley and T. Dunn, London.
1068. Recovering Metals from Solutions, J. C. Graham, London.
1069. Electrical Condensers, C. Pollak, London.
1070. Teapots, J. Teasdale, London.
1071. Tobacco Pipe, F. G. Sayer, London.
1072. Ventilating Apparatus, D. Rees, London.

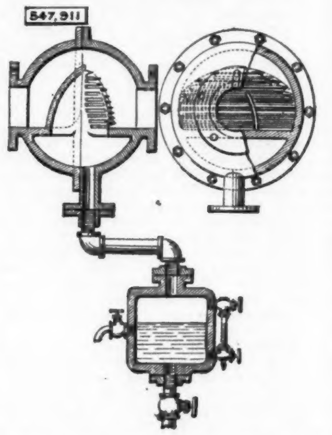
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

547,911. Steam Separator, *W. Christie, New York, N.Y.—Filed March 8th*, 1895.

Claim.—A steam separator, comprising a casing, a partition within the casing for dividing it into a steam chamber and a discharge chamber, the said partition being provided with an upwardly extending portion toward the outlet side of the casing and a baffle-plate extending upwardly on the inlet side of the casing, the said upwardly extending portion and baffle-plate being extended to within a short distance of the top of the casing, whereby the steam is caused to turn bodily upward and over the top of the baffle-plate for throwing the contained foreign substances through the baffle-plate into the discharge chamber, substantially as set forth.

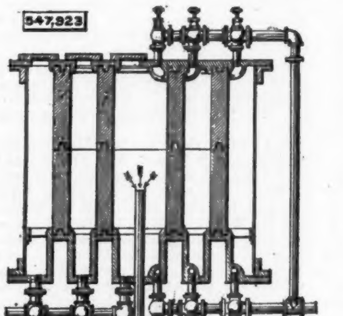
547,911



547,923. Filter, *C. W. Isbell, New York, N.Y.—Filed September 11th*, 1894.

Claim.—The combination of a cylinder of filtering material, a surrounding casing provided below the said cylinder with an annular pocket for the collection of impurities and having an inlet following the direction of the circumference of the cylinder, and one or more baffle-plates arranged across said pocket, substantially as and for the purposes herein set forth.

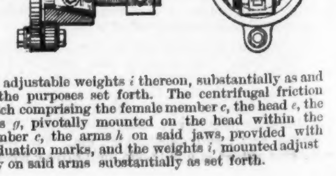
547,923



547,930. Coupling for Electro-motors, *F. Marburg jun., Buffalo, N.Y.—Filed May 14th*, 1895.

Claim.—The combination with an electro-motor and a main shaft to be driven thereby, of a coupling clutch C, one member of which is carried by said main shaft and the other member by the armature shaft of the motor, the male member of the clutch comprising the two jaws *g*, having graduated arms *h*, and adjustable weights *i* thereon, substantially as and for the purposes set forth. The centrifugal friction clutch comprising the female member *c*, the head *e*, the jaws *g*, pivotally mounted on the head within the member *c*, the arms *h* on said jaws, provided with graduation marks, and the weights *i*, mounted adjustably on said arms substantially as set forth.

547,930



AFTER THE GREAT RAILWAY RACE.

By CHARLES ROUS-MARTEN.

SEVERAL interesting questions suggest themselves with reference to the recent competitive accelerations of the East and West Coast expresses to Scotland, which the respective authorities forbid us to regard as a "race," it being merely an effort to see who could get to Aberdeen first! Now that the race has definitely resulted, for the present, in the West Coast accepting second place by the large beating of 50 minutes—the West Coast time to Aberdeen being 11 h. 15 min., as against 10 h. 25 min. of the East Coast—the occasion is a convenient one for noting more particularly what was actually achieved, than was possible during the struggle, and for considering what are the lessons that the experiences of July and August have taught.

In the first place, it may reasonably be asked: What were the actual record times? Which were the correct figures, of the half dozen or more different versions which have been published in various quarters?

The West Coast official times of the "record" run of August 22nd—23rd, as registered by the London and North-Western Railway, are as follow:—

Miles (Bradshaw)	Stations		Officially recorded times.	Officially recorded average speeds.	Remarks.
			h. m. s.	miles p. hr	
—	Euston	dep.	8 0 0	—	Engine Adriatic, No. 1309, load three eight-wheeled vehicles.
17½	Watford.. ..	pass	8 17 0	61·0	
31¾	Tring	,,	8 30 0	63·1	
46¾	Bletchley ..	,,	8 43 0	72·0	
82½	Rugby	,,	9 17 0	63·5	
97	Nuneaton ..	,,	9 30 30	64·9	
110	Tamworth ..	,,	9 41 30	70·9	
133½	Stafford.. ..	,,	10 4 0	62·4	
158	Crewe	arr.	10 27 30	62·8	Engine Hardwicke, No 790, same load.
		dep.	10 29 30	—	
182¼	Warrington ..	pass	10 51 25	66·0	
194	Wigan	,,	11 1 35	67·9	
209	Preston	,,	11 15 15	58·8	
230	Lancaster ..	,,	11 34 5	65·7	
236¼	Carnforth ..	,,	11 39 42	69·6	
249	Oxenholme ..	,,	11 51 10	67·0	
262	Tebay	,,	12 4 0	61·2	
267¾	Shap Summit	,,	12 10 0	58·0	
281¼	Penrith	,,	12 21 0	72·5	
299¼	Carlisle	arr.	12 35 30	74·4	Caledonian engine, No. 90, same load.
		dep.	12 38 0	—	
339	Beattock ..	pass	1 17 30	60·3	Caledonian timing is—Carlisle arr. 12.36.30, dep. 12.38.30. Stirling, pass 2.39.30.
349	B. Summit ..	,,	1 31 0	44·4	
372¾	Carstairs ..	,,	1 52 0	67·8	
383¼	Law	,,	2 2 30	60·0	
389	Holytown ..	,,	2 7 30	69·0	
408¾	Larbert	,,	2 27 0	61·5	
417	Stirling	,,	2 34 30	64·0	
450	Perth	arr.	3 7 30	60·0	Engine No. 17, same load.
		dep.	3 9 30		
482¼	Forfar	pass	3 39 0	66·1	
501½	Kinnaber ..	,,	3 57 0	64·2	
516¾	Drumlithie ..	,,	4 9 30	74·4	There is manifestly an error in this timing and speed estimate.
523¾	Stonehaven ..	,,	4 16 30	57·8	
539¼	Aberdeen ticket platform ..	arr.	4 30 0	61·9	
		dep.	4 31 0		
539¾	Aberdeen Sta.	arr.	4 32 0		

There are several discrepancies in these times. The Caledonian official notes made the train arrive at Carlisle a minute later than according to the London and North-Western time, and leave half a minute later. A third independent timing places the Carlisle arrival time between the two, viz., at 12.36; also the Crewe arrival at 10.28. Further, there is clearly an error in the time of passing Drumlithie. It is utterly improbable that the train maintained a speed of 74·4 m.h. up the somewhat steep ascending gradients from Kinnaber to Drumlithie, and then descended the incline to Stonehaven at only 57·8 m.h., a slower rate than that at which the Shap bank was ascended. The Caledonian timing of passing Stirling differs by five minutes from that of the London and North-Western. The latter is almost certainly the more correct, as it is absurd to suppose that after deliberately descending the long down grade to Stirling at 55 m.h., the train rushed violently up the steep bank to Kinbuck at 70 miles an hour. On the whole, it will be safer to regard the intermediate times as merely approximate—though very likely close approximations in most cases to accuracy—and not to base any theories or conclusions upon the exact figures. But, accepting the terminal figures as reasonably accurate, the following remarkable average speeds, from start to stop, result:—

	m.h.
Euston—Crewe	64·3
Crewe—Carlisle	67·2
Carlisle—Perth	60·5
Perth—Aberdeen ticket platform	66·7

It is noteworthy that whereas both the London and North-Western runs were "records," and while the final run of the Caledonian was apparently a "tie" with that of the same engine two days previously, the Carlisle-Perth run fell considerably short of what might have been expected, even allowing for the climb up the Beattock bank. Engine No. 90, with three vehicles, on this occasion took 149½ minutes to run the 150¾ miles from Carlisle to Perth without a stop, whereas on the previous day No. 78, of the same class, made the run with an additional vehicle, and including three minutes stoppage at Stirling, in half a minute less time, or in 3½ minutes less running time, without any allowance for loss in slackening to stop and starting again from Stirling. No. 78, with the heavier load, passed Beattock two minutes quicker, and stopped at Stirling in 3½ minutes quicker time than No. 90 on the "record" day took to *pass* the station; while No. 78, with the additional coach, ran from Stirling to Perth—start to stop—in the same time that No. 90 took from passing Stirling at speed to the stop at Perth. Clearly, then, this length could have been quickened by at least six minutes, and probably more, perhaps by ten minutes.

Again, it is curious that the comparatively easy length from Euston to Crewe should have been run at nearly 3 m.h. slower speed than was the very heavy length from Crewe to Carlisle. Here, however, we have two totally different classes of engines employed. And we have the apparent paradox of the slower speed over the easier road being done by the enormously more powerful locomotive, the engine from Euston—Adriatic—having two 14in. high-pressure cylinders and one 30in. low-pressure, with 175 lb. steam pressure and four 7ft. driving wheels, not coupled; while the engine from Crewe—Hardwicke—had two 17in. high-pressure cylinders, 150 lb. steam, and four 6ft. 6in. driving wheels coupled. In the absence of any allegations as to checks by signal in the former case, I venture to suggest that the inferior speed from Euston to Crewe may have been due to the fact that the engine had not a load sufficient to enable her to put forth her full power. In view of the immense loads so successfully managed under my own personal observation by one sister engine—Jeanie Deans, and of what I myself have seen another sister engine—Ionic—do on the Crewe-Carlisle run with a heavy train, I am inclined to suspect that this may possibly be the true explanation of that relative short-coming to Crewe when an average speed at least equal to the 67·2 m.h. run from Crewe to Carlisle should have been easily feasible. Indeed, if 67·2 m.h. could be done on a journey which included the ascent of such banks as Grayrigg and Shap, ranging up to 1 in 75, surely 68, 69, or even 70 should have been practicable to Crewe with no ascent steeper than 1 in 330, excepting for half a mile just after starting out of Euston, and if so, then Crewe should have been reached in about 2 h. 15 min. instead of 2 h. 27½ min., a saving of 12½ minutes.

If, then, those two slower lengths were done relatively as fast as the other two, and if that perfectly unnecessary stop at the Aberdeen ticket platform were cut out, it would manifestly be possible for the West Coast train to reach Aberdeen in 8¼ hours.

Turning now to the East Coast "record," the revised official figures do not appear to differ materially from those which I published in THE ENGINEER of August 30th. There are still certain unreconciled discrepancies, as in the case of the West Coast, but, as in that case, a very close approximation to absolute accuracy can be arrived at.

The official record of the times is as follows:—

Miles	Stations.		Offic'lly record'd times.	Aver. speed	Remarks
			h. m.	m.p.h	
—	King's Cross ..	dep.	8 0	—	G.N. engine No. 668, load 6 co'ches, slack Ouse Br. rep.
105½	Grantham	arr.	9 42	61·9	
		dep.	9 45		Engine No. 775, same load, slack over Selby Bridge
188	York	arr.	11 1	65·3	
		dep.	11 5		N.E. engine No. 1621, same load, slack over Durh'm B.
268½	Newcastle	arr.	12 25	60·4	
		dep.	12 27		No. 1620, same load, slack over Border Br. and thro' Berwick.
393	Edinburgh	arr.	2 19	66·7	
		dep.	2 21		
452¼	Dundee	arr.	3 21	59·2	N.B. engine No. 293, same load, several service slacks
		dep.	3 23		
523½	Aberdeen	..	4 40	55·6	No. 262, same load, several service slacks.

Here again we have to grapple with discrepancies. The times from London to Grantham have been variously given as 101 and 102 minutes; Grantham to York as 76 and 77 minutes; York-Newcastle, 79 and 80 minutes; Newcastle-Edinburgh, 112, 113, 114, and 115 minutes; Edinburgh-Dundee, 59 and 60 minutes; Dundee-Aberdeen, 76 and 77 minutes. So far as I can judge, the figures given in the accompanying "log" are the most accurate available.

On the East Coast, like the West, every run made, save one, was a record, or equal to record. In this case it was the length from York to Newcastle that alone failed to beat all previous performances over that portion of the road. It was, in fact, beaten by at least two former runs. The check over the bridge under repair at Durham, was common to all the trains. But it is worth noting that on the first night of the three when the concluding "rush" was made, when the racing train was stopped for three minutes by signal near Dalton, the actual running time, including that stop, was only half a minute longer than that of the record train. It is usual to allow three minutes for loss of time in starting and stopping. That would bring the "net" time down to 77½ minutes for the 80½ miles, without allowing for the two minutes lost at Durham Bridge. Taking the time from leaving York to passing Cowton, the station *before* the Dalton stop, and from passing Croft, the next station *after* starting again, to arrival at Newcastle, I find that the 76 miles occupied only 74¾ minutes. Thus, if that signal stop and the Durham check could have been eliminated, the run could certainly have been made in 75 minutes, or perhaps less.

Some surprise has been expressed that the Great Northern and its famous single-wheelers should have taken so low a place among the speed averages. The explanation given by the Great Northern authorities is, that up to the time when the "accelerated running"—in plain English, "racing"—was discontinued, no occasion had arisen for the Great Northern engines to be "extended" to their utmost power, but that in anticipation of further acceleration, some reserve had been kept in hand. Accordingly instructions were given to the drivers not to anticipate the prescribed arrival times in any material degree; and those instructions were duly acted upon. It is virtually certain, however, basing that calculation upon work actually done by the engines, that these 8ft. wheel engines could have made the run from London to Grantham in 95 min., and from Grantham to York in 71 or 72 min.; or, allowing 3 min. stop at Grantham, from London to York in 2 hours 50 min., or less.

The North British engines were debarred from showing higher averages by the special difficulties of their road; but their actual work was perhaps as meritorious *per se* as that performed by any of their rivals.

Summing up, then, the accelerations which were manifestly possible by the East Coast route, it appears certain that, even with the heavier loads run by the East Coast, fully 20 min. could have been saved between London and Edinburgh had the competition continued, bringing down the time from London within six hours. The extent to which time economy was possible north of Edinburgh would depend upon the special traffic arrangements that proved practicable.

Next we come to the respective loads. Here, again, there is great difficulty in arriving at certain results. The West Coast load has been variously estimated by competent authorities at from 60 to 83 tons. I believe, however, it was in reality as follows—according to the weights of the various classes of vehicles obtained from headquarters:—One sleeper, 25½ tons; one composite, 23½ tons; one van, 21½ tons; total, 70½ tons. All the vehicles were 8-wheeled. The East Coast load has been variously reckoned as from 101 to 105 tons, but I believe the correct weights to be—five 6-wheeled coaches, each 15½ tons; one 8-wheeled sleeper, 23½ tons; total, 101 tons. Further, the Great Northern tenders used in that service weigh 40 to 42 tons, the North-Eastern about the same, the London and North-Western 25 tons. Thus, the loads carried as far as Carlisle on the West, and Edinburgh on the East, were 95 tons and 143 respectively, exclusive of the engine, the bulk of whose own weight is, of course, the source of its adhesive power, and does not enter into a comparison of the loads hauled. The greater lightness of the North-Western tender is due, I need hardly explain, to the smaller tanks and less quantity of water carried, owing to the pick-up troughs being in use. These points are recorded simply for means of comparing the locomotive work performed, and of appraising its relative merit from the scientific view point. From the commercial view point it is sufficient that the loads of passenger-carrying and luggage-carrying vehicles weighed approximately 70½ tons by the West Coast, and 101 tons by the East.

Classifying the engines employed in the "race" since its inception in July, some rather curious facts present themselves. It might fairly be imagined that so great and unparalleled a trial of speed would naturally furnish an absolutely authoritative decision as to the type of locomotive best suited to fast running. Now, of the five companies which took part in the "race," the two Scottish ones—the Caledonian and North British—not merely employed each only one type of engine from first to last, but also both used practically the same class of engine originally designed by the same engineer, Mr. Dugald Drummond, who was successively locomotive superintendent on each line, and to whose main design his successors, Mr. Lambie and Mr. Holmes, have since adhered. That type, the 6ft. 6in. coupled, with cylinders 18in. × 26in. and leading bogie, does in effect all the express work of the two railways, and it did all the "racing" in this instance. The other three railways, Great Northern, North-Western, and North-Eastern, each used three different classes of engines. The Great Northern performed the bulk of the work with the late Mr. Patrick Stirling's oldest type of 8ft. singles, with outside cylinders 18in. or 18½in. by 28in., and 160 lb. steam, but also occasionally used the newer variety of these engines having 19½in. cylinders, 170 lb. steam pressure, and 20 tons on the driving wheels, and the 7ft. 7in. singles with inside cylinders 18in., 18½in., or 18⅞in. by 26in. The North-Western did most of the work with small 6ft. 6in. coupled engines, weighing barely 33 tons—and the record run was made with one of this class—but also used 7ft. 6in. singles for occasional piloting, and latterly employed Mr. Webb's 7ft. compounds between Euston and Crewe. The North-Eastern did most of its work with Mr. Wilson Worsdell's new 7ft. coupled engines, having cylinders 19in. by 26in., and 180 lb. of steam, but used the 7ft. 7in. singles, with cylinders 19in. by 24in., a good deal at first between York and Newcastle, and the compound singles with cylinders 20in. and 28in. by 24in., as pilots between Newcastle and Edinburgh.

Here there is variety enough to puzzle any judgment. Ten different classes of engines were employed. Can it be determined which did its work best? Is any moral of superiority in efficiency to be deduced from this notable competition?

In order of merit, as regards the highest average speed from start to stop, recorded during the last day's competitive running in each case, the respective engines stand in the following succession:—

		ft.	in.			Speed. m.h.	Load. tons.
(1	L. and N. W. ..	6	6	coupled ..	No. 790 ..	67·2 ..	70½
(2)	N. E.	7	1	coupled ..	No. 1620 ..	66·7 ..	101
(3)	C.	6	6	coupled ..	No. 17 ..	66·7 ..	70½
(4)	G. N.	8	1	single ..	No. 775 ..	65·3 ..	101
(5)	L. and N. W. ..	7	1	compound	No. 1309 ..	64·3 ..	70½
(6)	G. N.	8	1	single ..	No. 668 ..	61·9 ..	101
(7)	C.	6	6	coupled ..	No. 90 ..	60·5 ..	70½
(8)	N. B.	6	6	coupled ..	No. 293 ..	59·2 ..	101
(9)	N. B.	6	6	coupled ..	No. 262 ..	55·6 ..	101

The other classes of engines did not take part in the final and swiftest rush, but the newer Great Northern 8ft. 1in. singles, the Great Northern 7ft. 7in. singles, and the North-Eastern converted 7ft. 7in. singles, all exceeded averages of 60 m.h. from start to stop on various occasions.

Looking now to the roads run over, it must at once be admitted that the heaviest was that on which the highest mean speed was recorded, viz., from Crewe to Carlisle, which has a moderately stiff bank of about six miles approaching Coppull—1 in 100 to 1 in 330—and two very severe ascents, one of fifteen miles, averaging about 1 in 130, to Grayrigg; and the worst of all, two miles of 1 in 147, and 4½ miles of 1 in 75 to Shap Summit. There was also the service slack through Preston station. None of the other roads on which the best speeds were done were really severe, for the Caledonian best was between Perth and Aberdeen, which did not include the steep Beattock and Dunblane banks. The North British road, however, was much impeded by special difficulties in the way of curves, bridges, junctions, and single track. The Great Northern was seriously hindered by service checks at Retford and Doncaster, and by the very long and bad slack past Selby station and over the swing bridge. The North-Eastern had to contend with several banks, with the Morpeth, Berwick and Portobello curves, and with the bad slack through Berwick station. The North-Western length on which the slower run was made on the record night, had only the short but steep bank out of Euston and the slack through Rugby, in the way of obstacles, the gradients being as a rule very easy for the down trains.

Next arises the question, Which of the three trains that, in sporting parlance, were "placed" in the race—which took first, second, and third places—performed the most creditable work from a locomotive and engineering standpoint? It is not easy to appraise with exactness the relative merits of these three splendid performances. The North-Western 6ft. 6in. coupled engine ran at the highest average speed over the heaviest road for the longest distance of the three. But both that engine and the Caledonian 6ft. 6in. coupled, which is classed third in the list, conveyed a far lighter load than did the North-Eastern 7ft coupled, which, in fact, pulled about 50 per cent. more load, and yet attained within 0·5 mile per hour of the winner's average speed. That, however, was over far easier gradients, and so was the running of the Caledonian engine, which, moreover, drew the same light load as did the North-Western locomotive.

Further, the North-Eastern engine was enormously more powerful than the North-Western one—in fact, having 111 lb. of tractive force against the other engine's 88, for every pound of effective steam pressure in the cylinders, and having moreover 180 lb. of steam pressure in the boiler, against her rival's 150 lb., the North-Eastern racer may be regarded as possessing roughly 50 per cent. more power, as against the 50 per cent. greater load she pulled. So this leaves the North-Western engine with the full advantage of 0·5 mile per hour greater average speed over a very much more difficult road.

If, therefore, I were acting as judge in this race, after allowing for all the handicaps, I should be disposed to accord the victory to the London and North-Western engine No. 790—Hardwicke—but adjudging the North-Eastern and Caledonian engines a "tie" for a very good second place. It will be noticed that the winner's performance was relatively even finer uphill than down, the respective speeds to Grayrigg and Shap summits being, so far as I am aware, quite without parallel in railway records over grades so severe. At the same time there was very free and fast running down hill, although no excessive or "dangerous" velocity was attained. Superb work was done both up hill and down by the North-Eastern and Caledonian engines, which tied for second place; but they had easier grades in both cases than the comparatively small North-Western engine, which beat them by half a mile per hour.

It will naturally be asked, What was the absolute maximum speed attained during the fastest running? Here, again, only an approximate reply can be given, because no mechanical means of test—such as the Boyer recorder—was used, and but few attempts were made to test individual miles or shorter distances by the ordinary method, with stop watches or chronographs. Personally I was successful in obtaining a good many records of miles, or half or quarter miles; but it will readily be perceived, that this was a work of extreme difficulty in the pitch darkness of the night and travelling so swiftly.

On each route I obtained instances of a mile being run in 42 secs., which is equivalent to a speed of 85·7 miles an hour. I have no reason to believe that this rate was exceeded in any instance. At the places where I recorded these maxima, the time from one given point to another registered on the record night was the same as my own. No doubt the maxima intermediately reached were the same also.

This does not differ materially from the maximum which I recorded in the columns of THE ENGINEER a year ago.* The speed limit then—84·1 miles an hour—was the limit during the later race *on similar gradients*. The higher velocity was only attained on steeper descending gradients; that is to say, down 1 in 125, or 1 in 96, as against 1 in 200 in the other case.

Much indignation was expressed by some American engineering writers that I felt unable to accept as conclusively proved their alleged speeds of 102 and 112 miles an hour. But now comes my justification from America itself, and from one of the same engineering quarters whence proceeded the former remonstrances. After the English race concluded, a special effort was made in the United States to "break the British record." Practically, the result was a "tie." But the remarkable thing is that in this supreme American effort to lower the British record the engine used being, moreover, the same which was said to have attained 102 and 112 m.h.—the famous No. 999—the American official report states that the maximum speed was "about 81 miles an hour." Seeing that if No. 999 ever ran 100 miles an hour she would assuredly have done so on this supreme occasion, when, instead, she only attained "about 81," it is evident that we may safely dismiss that former casual unchecked timing by an irresponsible guard as being merely a pleasing little product of excited imagination. We may, at any rate, so regard it until the fact shall have been authentically established on the testimony of competent and trustworthy witnesses. Railway guards are admirable officers, but precise speed-timing is not their strong point. They have other and different duties to perform.

While my present observations have necessarily had relation mainly to the respective performances on the "record" night of each route, I may repeat a former remark that, marvellous as were these displays of speed even with "featherweight" trains, in my opinion they fell short, as locomotive work, of several other feats achieved during the progress of the "race," and even since its termination. For instance, that run of 52 min. 48 sec. from Carlisle to Beattock Summit—start to stop—with two Caledonian 6ft. 6in. coupled engines and 207 tons, passing Beattock station—39¾ miles—in 38 min. 14 sec., would not be easy to beat. Nor would a later run with one of these engines from Perth to Aberdeen—89¾ miles—in 93 minutes, with 160 tons behind the tender. It is amusing to observe the exaggerated fuss that is made about the Caledonian single, No. 123, on account of some very creditable performances in the race of 1888. These, however, have been widely surpassed by this year's work of the 6ft. 6in. coupled class; nor has No. 123 attained any higher maximum than they. There is, therefore, no reason whatever to suppose that No. 123 would have beaten or even equalled the achievement of No. 17 or No. 78 in this year's race, the latter having, on the last day but one, taken a train of four eight-wheeled coaches weighing 94 tons, from Carlisle to Stirling—117¾ miles—in 113 minutes—1 h. 53 min.—passing Beattock in 37 minutes, and Carstairs—73½ miles—in 70 minutes. This makes No. 123's record run of 75 minutes for the latter distance, with a load 18 or 20 tons lighter, look relatively small, fine as it undoubtedly was. Equally admirable was the run of 143 minutes from Crewe to Carlisle—141¼ miles—made by a 7ft. compound, with a 6ft. 6in. coupled as pilot, and a load of 234 tons — equal to fully nineteen 12-ton coaches — including a very smart ascent of the Shap bank; and certainly as fine as any was the achievement of one of the newest Great Northern 8ft. singles—having 19½in. cylinders, and 170 lb. of steam—which, starting from Grantham six minutes late owing to previous blocking of the train, stopped at York 1½ minute before time, having run the 82¾ miles with three slacks—a very long and bad one at Selby—in 80 min. 31 sec., hauling a load of eleven vehicles, weighing 186 tons. Nor was the effort of the North-Eastern 7ft. 7in. single much inferior when the distance of 80¼ miles from York to Newcastle was covered in 79¾ minutes, with a load of 134 tons, in spite of two minutes being lost at Durham Bridge, and another through a check at Gateshead. In that case, too, the train left York two minutes late and reached Newcastle ten minutes early. All these performances came under my personal notice, so that I am able to vouch for their authenticity.

It is almost impossible to avoid facing, in conclusion, the very reasonable question that must inevitably suggest itself:—After duly considering all these locomotive achievements, what is the deduction as to superiority of type for express duty? I regret very much that I can only return the lamentably feeble answer that there appears to be little or nothing to choose among the various types employed. Yet this seems really the only reply which can honestly be given by any unprejudiced observer who has impartially studied the results attained. There are no apparent grounds for doubting that any of the engines used in the "race" could have done as well as any other with a load proportionate to its nominal power; and above all, the race appears to have rendered still more abundantly clear the conclusion which I deduced previously in these columns from other experiences with British locomotives, that coupled engines will run just as fast as singles, and that singles can pull just as heavy loads as coupled and climb banks equally well, provided that in each case the loads and gradients are proportioned to the available tractive power.

As to the relative cost in working expenses at which all this splendid work is done, no authentic information is accessible; but it certainly does appear, so far as known results go, that no excessive expense was caused by the faster running. One thing at least is certain, that all the types of locomotive in use in our best British express-work are so admirably suited and proportioned to the duty they have to do, that it would be a task of extreme difficulty to award the palm to one as against another for merit of accomplishment.

THE GREATEST AUCTION SALE.—The world's greatest auction sale occurred at Topeka, Kan., on December 10th, when the vast property of the Atchison, Topeka, and Santa Fe Railroad Company was sold to Messrs. Edward King, Charles C. Beaman, and Victor Morawetz, representatives of the Re-organisation Committee. The reading of the notice of sale occupied thirty minutes. This done, Judge Johnson said that, in pursuance of the notice of sale just read, he offered the property to the highest bidder. "What am I offered?" the auctioneer asked. "I offer 60,000,000 dols.," said Edward King, in a low voice. "Do I hear any more bids?" cried Judge Johnson. "Once, twice, the last call. The property is sold to Edward King, Charles C. Beaman, and Victor Morawetz." This ended the greatest auction sale ever known, and the crowd dispersed to the Federal Building, where Judge Caldwell held a session of court to confirm the sale. As indicating the immensity of the sale, it may be stated that the system proper embraces 4670 miles of railroad, on which are now being used 864 locomotives, 28,187 freight cars, and 584 passenger cars. The system has practically been built within the past twenty years, the extension into Chicago being only about seven years old. Originally the line was intended to parallel the old Santa Fe trail, over which was transported the greater part of the commerce of the plains. Over 100 days were required to reach Santa Fe by freighters over this historic trail, the same route now being covered in twenty-eight hours by the road's overland trains. This commerce of the plains grew to such proportions that in 1858 there were on the trail 2500 men in some way engaged in this traffic. In that year there were registered at Council Grove, Kan., 1827 wagons, 429 horses, 5316 mules, 15,714 oxen, and 67 carriages or passenger vehicles. During that year there were 9608 tons of freight carried over the route, equal to about 500 car loads. There were over 2,500,000 dols. directly invested in this business, with another 1,000,000 dols. as an incidental investment. The trail started from Fort Leavenworth and from Independence Landing, formed a junction just below Lawrence, struck the Arkansas near where Great Bend is now situated, following the river 100 miles, crossed and passed through the sandy country for about sixty miles to the Cimarron, which stream it followed to near the south-west corner of Kansas, thence in a general south-westerly direction to Santa Fe, 780 miles from Independence Landing. The present line of the Santa Fe follows practically the same route of the trail. Great opposition was made by the freighters to the building of the line. The history of the management of the company since it was first organised has been a most varied one, and so many bright railroad officials have stepped to its head with great reputations as managers and had to retire beaten, and oftentimes with discredit to themselves, that the road has come to be known in railroad circles as a "man killer." In President E. P. Ripley, however, and Vice-Presidents D. B. Robinson and Paul Morton, an exceedingly able group of practical and progressive railroad men is now placed in control of this largest railroad in the world, and it is the confident expectation of those who know their ability and the resources of the road that the troubles of this great company are near an end.—*American Engineer and Carbuilder.*

STEAM LOCOMOTIVES ON COMMON ROADS.

By W. FLETCHER.

(Continued from page 86.)

THE compound road locomotive is coming into more general use. It has its advantages—by its use the boiler can be reduced in size, a saving in coal and water is also effected, and the noise from the exhaust in the chimney is suppressed, which is a valuable feature in its favour. If a compound engine is selected the cylinders will be 6¼in. and 10in. in diameter, and 12in. stroke. It is usual to fit the compound cylinders of road locomotives with an auxiliary valve, so that high-pressure steam can be made to enter the valve chest of the low-pressure cylinder, and both the cylinders exhaust into the common exhaust pipe, the compound principle being suspended for the moment when the engine has to start with a heavy load on an incline. As soon as the engine is running up to speed the auxiliary valve is closed. The steam chests should be placed outside so as to facilitate the examination of the slide-valves. Compound road engines with tandem and Woolf cylinders are used, but I should specify a side-by-side double-crank compound engine. A relief valve should be fixed on the low-pressure valve chest. A sleeve might be fitted on the exhaust pipe so as to further reduce the noise. As this engine is not intended for driving machinery from the fly-wheel, no governors need be provided.

The link motion reversing gear must be massive, with plenty of wearing surface, and deeply case-hardened. The lubrication of excentrics, the slide valve, and link motion must be properly carried out. Cast iron excentric straps are mostly used, and when properly turned, with all the corners rounded off, with careful attention they will run almost without wear. Circular-bored guides are often used now for the crosshead in lieu of guide bars. Little more need be said about the engine work; the chief consideration rests with the wheels and the driving gear. This brings me to the subject of the driving wheels. In Mr. John McLaren's paper[7] the ordinary road wheels are illustrated, but these are not suitable for this purpose. The driving wheels I should propose would be made of boiler plates and angle iron, in much the same manner as the rubber-tired wheels were made a few years ago; then spur rings would be riveted near the rim or tire of the wheels; both wheels would be driven from separate pinions on each end of the second countershaft. The main axle would in this case be fixed, the driving wheels would run loosely on it; the axle might be lighter than usual, as no power would be transmitted through it. Wrought iron case-hardened bushes would be secured in the naves for the wheels to run on; the axle ends would also be case-hardened. If these bushes are made a good length they will run for years without giving any trouble, provided they are well lubricated. This method of transmitting the power to the wheels is adopted for the sake of lightness. It will be necessary for the compensating gear to be made from small patterns, and be mounted upon the second countershaft; the rest of the gearing will be dealt with presently. The remaining part of the driving wheels will be made of india-rubber and wood. Possibly no driving wheels have answered so well for quick running as the rubber-tired ones, but as this type of wheel is too costly we must use less india-rubber, and place it around the cast iron nave of the driving wheel, as suggested by Mr. Pendred, also illustrated in Mr. McLaren's paper. Impinging upon the rubber will be blocks of wood endways of the grain, with iron hoops on the edges, with suitable provision for allowing the wood blocks to move endways, but securely kept in their places circumferentially. No driving stress would pass through these wheels, as the spur rings would be riveted near the rims. A wheel of this form, if properly made, would answer for light road locomotives.

If Boulton's wheels could be made of wrought iron plates they would answer. A small amount of elasticity in the wheels would be sufficient to take off the concussion and give greater adhesion; the disc wheels would afford the same flat surface on the road that the rubber-tired wheel did. In addition to an ordinary strap brake on the compensating gear, it may be advisable to fit a pair of brake blocks to rings on the wheels for hilly districts, to be used in cases of emergency. I should make the driving wheels 6ft. 4in. diameter and 1ft. 4in. on face.

The gearing will be made entirely of cast steel, the cogs will be carefully pitched and trimmed, and the teeth must not be of a very coarse pitch. The first and second motion gearing will be arranged between the bearings of the crank-shaft and countershafts, inside the box brackets. If a compound engine is employed, the gearing cannot be so nicely arranged, as the two cranks and four excentrics occupy too much room. The inside gear engines possess several advantages: the gearing runs with little noise, the engine can be made narrower than usual, the bearings are more fairly worn, and what is of the greatest importance, the gearing is maintained rigidly in truth. All the gearing will be covered in with guards, so as to protect it from dust and suppress the noise. Two travelling speeds will be provided for. A ratio of 6 to 1 for the fast gear, and 10 to 1 for the slow gear, is decided upon. As a general rule the quick travelling speed would be used, the slow gear being intended for cases of emergency, such as mounting inclines, traversing bad roads, or passing through crowded thoroughfares. These ratios will give a speed of six miles an hour, and ten miles, the engine running at 280 revolutions per minute; of course, any speed lower than these could be run when required.

I must now deal with the method of mounting this spur-geared engine on springs. It is very evident that a small amount of movement, due to the action of the springs, will be required for an engine running at the speeds named, and particularly as we have provided a certain amount of elasticity in the driving wheels. The springs must be so arranged that they can be adjusted to give the required range for taking off the concussion. If more than ¾in. play is given, the swaying of the passenger engine on some roads would become unpleasant. Three different methods of mounting engines on springs are already shown; these, however, are designed for heavy engines, in which the driving power passes through the main axle. It has already been said that the compensating gear will be fixed on the second countershaft, but the spring arrangement can be carried out on fairly simple lines. Good provisions for driving the winding drum on the axle can be made without complication.

The usual tender and extra tank under the boiler barrel are shown in the sketch of passenger train, Fig. 34, but if necessary, a separate tender could be mounted on a pair of wheels and attached to the foot-plate of the engine. A spare tender with tank filled and fuel replenished, could be taken on

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* December 14th, 1894

[7] "Steam on Common Roads," by John McLaren. Excerpt, "Minutes of Proceedings" of Institution of Civil Engineers, Session 1890-91.

SCHMIDT'S ENGINE AND BOILER FOR SUPERHEATED STEAM

(For description see page 109)

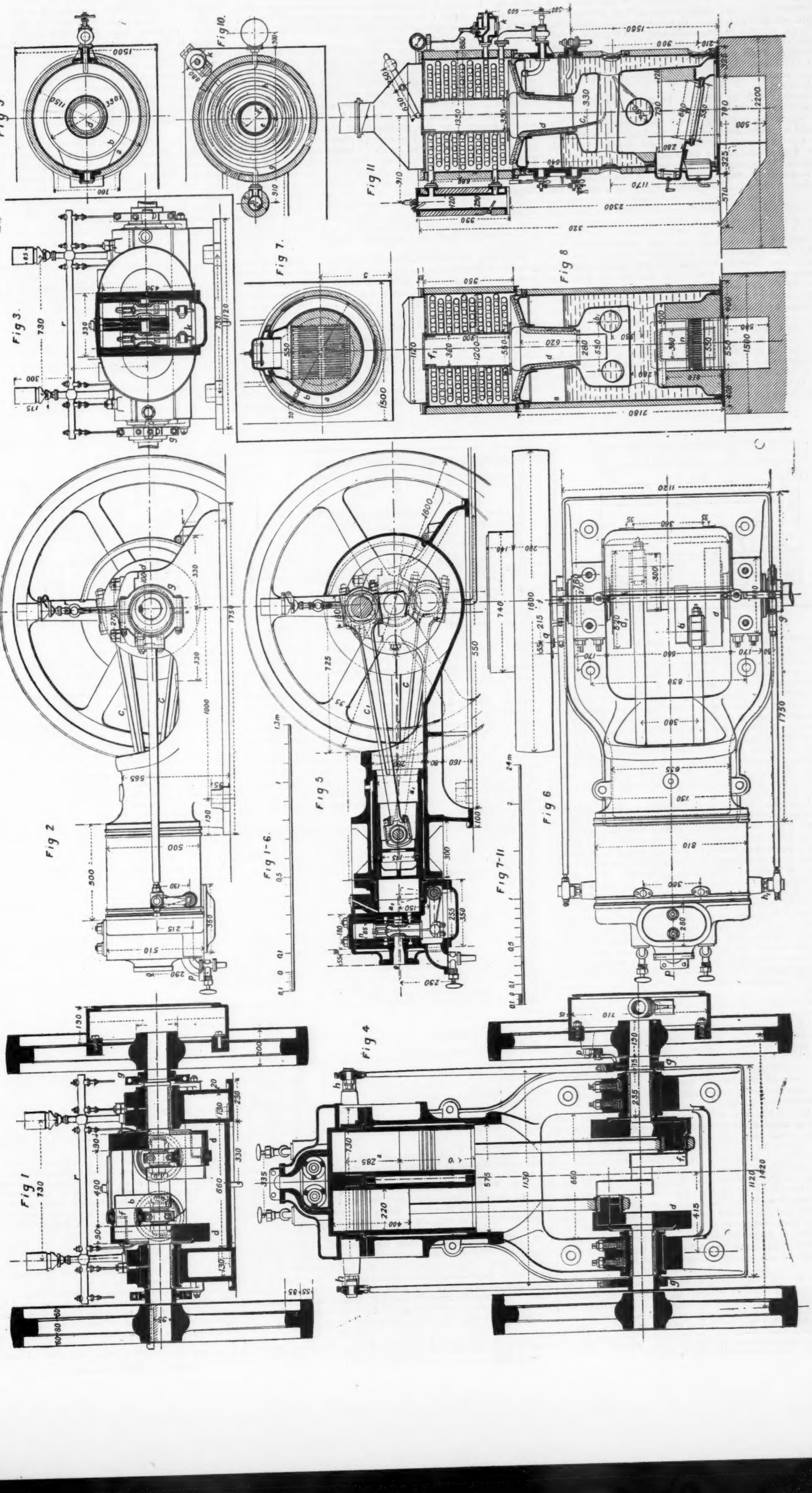
Fig 1
Fig 2
Fig 3.
Fig 4
Fig 5
Fig 6
Fig 7.
Fig 8
Fig 9
Fig 10.
Fig 11
Fig 1-6.
1.3m
Fig 7-11
2.4m

quickly, and the empty one left behind; this would save time on the road, clean water could be secured, and the total weight of the engine would be reduced by one ton. The draw-bar would be attached to the hornplates of the boiler. A spring draught iron is very useful for taking off all jolting when the engine starts with a load. In addition to the feed pump driven by an excentric on the crank shaft, an injector should be supplied, so that the boiler could be fed while the engine was standing. Both these appliances would be within the reach of the engine driver. A large water lifter and hose pipe is an essential appendage for the kind of tender shown on the drawing.

The steerage will be actuated from the foot-plate, but instead of the usual chains and chain barrel, I should recommend a large worm and rack under the boiler barrel. The rack would be guided and thus kept properly in gear with the worm. The connection between the rack and the front axle must be of a ball-and-socket arrangement, to allow for the up-and-down movement of the front axle. The front of the engine would be mounted on springs. A foot-board would be provided on the side of the boiler for gaining access to the engine for oiling, &c. A neat cab is erected over the tender and the shaft end of the engine; the windows are arranged so that a good look-out can be obtained. The head lamp must cast a good light on the road in front of the engine. All the handles for starting, stopping, and reversing the engine, for opening and closing the cylinder cocks, for starting the pump or the injector, for opening the sliding fire-door, for putting the road gear pinions in and out of gear, for opening and closing the ash pan doors, for applying the brake, for sounding the whistle, and for starting the water lifter, should be placed as conveniently as possible within reach of the engine driver. Two men will control the engine, one as driver and one as steersman. Another man will be required to take charge of the omnibus.

I have touched upon the details of importance composing the road locomotive proposed for the running of light road trains. A drawing in side elevation is given of the train, Fig. 34. It will be seen that the working parts of the engine are hidden from view; the fly-wheel is of the disc pattern of small diameter, and every possible care will be taken to remove any objectionable features that are liable to frighten horses. Care will be taken that the road train cannot truthfully be termed a nuisance by persons who object to the use of machinery on roads. The engine is shown drawing an omnibus mounted on springs, which will seat twenty to thirty passengers; there is shown also a light spring four-wheeled van for carrying market produce, parcels, &c., to the railway station or market town. The engine will not vary much in appearance for different districts. It is believed the character of the train will often differ; it may be altered to suit the requirements of the neighbourhood through which the train shall run. The omnibus may give place to a light-covered wagonette, so that more room and power would be available for hauling merchandise.

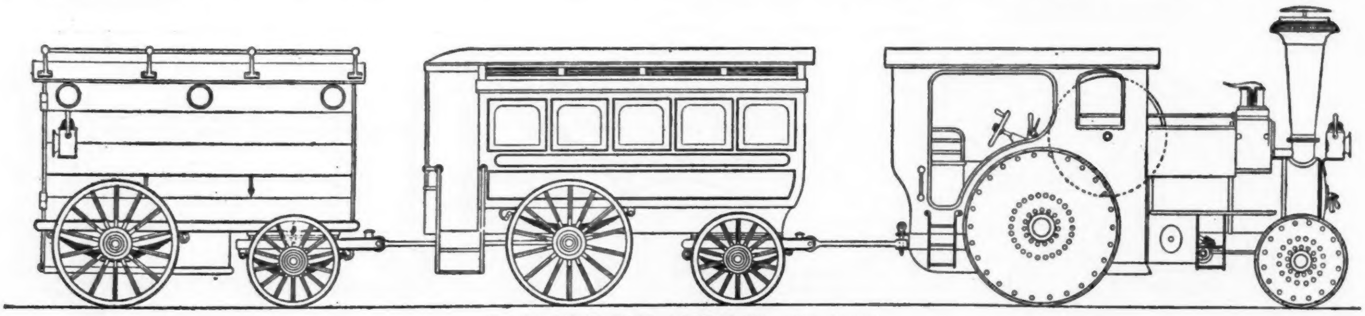
Fig. 34—LIGHT ROAD LOCOMOTIVE AND TRAIN

Mr. McLaren has referred to the legal restrictions relating to road locomotives,[8] but more may be said on the subject, as the laws affect us to such an extent that the traction engine proposed for the conveyance of passengers and light goods would not be permitted to run except at a crawling speed. The time has surely arrived for these Acts of Parliament to be modified, or removed altogether. Instead of giving the simple road locomotive fair play, engineers are at the present time discussing a far more costly means of transport, viz., light railways or tramways. This is one of the proposals which has been suggested for helping the farmer to tide over the depression. Such railways may be required in some districts. It has been said, however, that their adoption will only add to the farmer's burdens. It has been urged that they never can be remunerative. The advantages of light railways have been over-estimated, and without question the means of transport I am dealing with has been entirely overlooked.

I do not for one moment believe that the road locomotive can compete with the light railway for speed and long distances, but I do believe that if it were freed from the all but prohibitive laws its utility would be surprisingly increased. So many people entertain the idea that road locomotives are only suitable for drawing heavy loads at very slow speeds. It must be remembered that the law compels them to travel along the roads at this tedious pace, and because of this enactment they are made exceptionally heavy so as to draw as much weight as possible.

Our legislators, and not our engineers, are to blame for some of the greatest disadvantages of the present road locomotives. I cannot stop to enumerate them, but one is the extreme weight of the engine and the trucks, and another is the great width of the train. If quicker speeds had been permitted, smaller engines and trucks would have been used in preference to the heavy ones. With smaller and lighter road locomotives there would have been less risk of breaking bridges, reduced wear and tear to the roads, less risk of damaging old buildings near the road, and the road train would have been narrower, thus allowing more room for passing vehicles. Engineers and owners would gladly introduce a smaller road locomotive and train if they were allowed to run them at six or eight miles an hour in the open country.

Very few people know what a properly constructed road locomotive can do in the way of quick running, as such engines have been rarely tried in England. The arguments raised against their use for this purpose are all based on our present engines that are built for, and used for a totally different service. The remarks made in favour of quick-running traction engines are mostly based on experience. Messrs. McLaren's parcel service in France shows what can be done. Lyons and Grenoble are nearly seventy miles apart. Each engine covers this distance in the night, and runs for hours together at eight miles an hour, over the worst possible roads and up some steep gradients.[9]

Undoubtedly the road locomotive and train that have been described would in many cases answer all the requirements for the conveyance of passengers and goods at economical rates in sparsely populated districts out of the reach of the main railway line. The roads are ready, and we have the engines[10], so that this means of communication could be put into operation as soon as the laws are altered, without costing an extra penny to the ratepayers of the district through which it would travel. The engines would be narrow, light, noiseless, and constructed so as to travel on any ordinary road, mount steep inclines, turn sharp corners, and run close to the farmyard gate. If a light railway or a tramway was to run through a parish or village containing a number of farms in the neighbourhood, it would only touch a small number of these homesteads; the greater number to reach the railway must use their horses, carts and men. Whereas a road locomotive could enter the field or farmyard, take or deliver produce, and could serve any number of farms in the district.

Supposing two road trains were running regularly between a group of villages: on certain days of the week a different route could be taken, so as to put every doorstep in touch with the nearest market town and its main line railway station. A number of light road trucks would be left at any point of the journey, to be called for after they had been filled or emptied, so as not to keep the engine waiting. Such road engines are now helping the farmer, are working satisfactorily under the present fierce opposition and restrictions, doing such work as just described.

Road locomotives are appreciated on the Continent and in the Colonies. Our military authorities have proved the advantages of the engines when running at four miles an hour, and would gladly avail themselves of a greater number of engines if they were allowed to travel at eight miles an hour. It may safely be predicted that if the hindrances were removed, and the road locomotive were given fair play, this cheap and efficient means of transport would not only convey goods as at present, but passengers would be conveyed also. Many road trains would spring into existence, and bring life and activity to many a remote hamlet and farm. Other advantages would accrue that are not thought of. Many of our main roads are not suitable for tramways; to adapt them for laying the rails would entail an enormous expenditure of money. No one would think of allowing light railways to run on any of the roads, and to use valuable land for such a scheme appears to be a wasteful procedure. Instead of laying tram lines, let a tithe of the amount be expended in making and keeping our highways in thorough repair.

It appears to be so unreasonable to place every hindrance in the way of a simple system of communication which is ready to hand, and at the same time seek the means to build up an extravagant system that farmers cannot pay for. If Mr. Price Williams' estimate is correct, the cost of every mile of light railway would purchase two road locomotives, two omnibuses to carry twenty or thirty passengers, two covered vans and four light wagons, all mounted on springs and connected by spring draw-bars.

It must be remembered that very likely the large railway companies will construct some light railways as soon as they are decided upon. Not only so, but should light railways be constructed by private companies, many of them would probably come into the hands of the great railway companies. Both these contingencies must be resisted, otherwise no advantage would be gained by any number of light railways.

The railway interest is very powerful in the country, and this gigantic system is gaining possession of water-ways, and is seeking to gain power over the roads. One large railway has already forbidden traction engines to run over their bridges. The roads were free for all kinds of traffic before the railways came into existence. If the railway company cut one of these roads, they must provide a bridge strong enough to carry all loads, and they must not interfere with any vehicle that has occasion to travel along the road and cross the bridge. The railway companies surely possess no right to interfere with the users of the roads; their duty is to carry freight and passengers, and not to interfere with pre-existing rights as they are now endeavouring to do. We must retain our roads for the free use of the people, and not allow the railway companies to have any control over them whatever.

There are 8000 traction engines at work in this country. They are sufficiently harassed by the injurious laws that are in force without the railway companies seeking to add another burden. Can the railway companies forbid us to use a bridge over the railway, or canal, that is part of a main road, or even a level crossing that answers a similar purpose?

This much has been said respecting the railway interference with the traffic over the public roads, in the hope that this unjust proceeding may be nipped in the bud.

The main roads of this country are practically free, and must remain so. The engine and train that I am proposing to run on these roads will be mounted on springs, and will come under the term of ordinary traffic, as they will not injure any well-made macadam road. Let every effort be used to remove the burdensome road engine laws, and before two or three years have elapsed the problem of cheap transport will have become an accomplished fact, brought about by private enterprise and private money.

COAL DUST FUEL.*

THE use of coal dust as fuel, to which the attention of the technical world has lately been directed, is not—as might be supposed—a novelty. As far back as 1831 an English patent was taken out for an apparatus for burning finely divided combustible matters, and by the end of the sixties the number had increased to over a score. The great drawback in the way of the successful employment of these processes was the liability of the feed pipes and furnaces to choke up, and the difficulty of getting the fuel into a regular state of division. The first to overcome these difficulties was the process of Whelpley and Storer—patented in America in 1866—for roasting ores containing sulphur, whereby a finely-divided mixture of ore and coal was blown into a vertical furnace. At about the same time Crampton began his researches in connection with the same subject, which led to the erection in 1869 of a furnace at Woolwich for heating iron fagots, and subsequently of a puddling furnace, in both of which dust fuel was consumed. Crampton's apparatus consisted of a hopper, with a couple of screw-shaped stirrers, by which the coal dust was loosened and conveyed to the outlet, where it passed between a couple of feed rollers—the upper one adjustable for regulating the feed—into a funnel, whence it was blown into the furnace by an air current from several narrow tubes. For pulverising the coals, Crampton employed ordinary millstones. Notwithstanding the great expectations entertained of the development of this process, it seems to have fallen into oblivion until in 1892 Carl Wegener, of Berlin, began to experiment anew in this direction. He was quickly followed by Schwartzkopff, Friedeberg, Ruhl, and De Camp, all of whose methods are based on Crampton's process. The chief task consists in loosening the coal dust and conducting the material and air supply to the furnace.

The furnace is lined with fire-brick, and frequently provided with a bridge to retain the ash and unconsumed fuel. Frequently it is attempted by means of baffles to drive the gases in a zigzag direction. This, however, did not lead to satisfactory results in Crampton's apparatus, nor in that of Ruhl later, owing to the liability of the narrow spaces to become choked.

To start the combustion a small fire of wood is made at the bottom of the furnace, and when this is well alight coal dust is scattered over it from time to time, until the fire-brick walls are hot enough to ignite the coal dust blown in from the feeder. From this point all that the stoker has to do is to control the admission of air and dust, the ashes being only removed once a day.

TABLE A.

Apparatus.	Wegener.														Schwartzkopff.					
Boiler.	Double boiler.										Fire-box boiler with heating tubes.				Double-flue boiler.					
Fuel.	Upper Silesian hard coal (Karoline pit).				English hard coal.		Bohemian brown coal (Dux).				Hard coal. I.		Hard coal. III.		Hard coal Königin Lince.		West-phalian coal. Julia pit.		Bohemian brown coal. Agnes Deep.	
Steam pressure in kilos. per sq. m.	6·51		6·01		6·54		5·34		5·57		6·39		6·13		5·22		5·18		5·22	
Evaporative power calculated from feed-water at 0 deg., and steam at 100 deg. C..	8·0		8·25		8·1		6·48		6·46		7·58		7·27		6·924		7·293		4·363	
	units	p.c.	units	p.c.	units	p.c.	units	p.c.	units	p.c.	units	p.c.	units	p.c.	units	p.c.	units	p.c.	units	p.c.
Heat utilised in forming steam	5090	76·82	5256	79·33	5160	79·19	4130	78·46	4113	78·13	4826	70·63	4627	73·6	4411	60·23	4645	59·1	2779	59·66
Heat wasted, escaping through stack	888	13·41	890	13·43	913	13·45	829	15·76	767	14·56	740	10·83	601	9·55	1459	19·92	1467	18·66	1025	22·01
Heat wasted through unconsumed coal left in the ash	—	—	—	—	—	—	—	—	—	—	321	4·7	—	—	—	—	—	—	—	—
Heat wasted through radiation and conduction	648	9·77	480	7·24	443	7·36	305	5·78	384	7·31	946	13·84	1059	16·85	1453	19·85	1749	22·24	854	18·23
Calorific power of the coals	6626	—	6626	—	6516	—	5264	—	5264	—	6833	—	6287	—	7323	—	7861	—	4658	—

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[8] "Steam on Common Roads," by John McLaren. Excerpt, "Minutes of Proceedings" of the Institution of Civil Engineers.

[9] "Steam on Common Roads," by John McLaren. Excerpt, "Minutes of Proceedings" of the Institution of Civil Engineers. Session 1890-91.

[10] Such engines are now made for the Colonies.

* *Zeitschrift des Vereins Deutscher Ingenieure*, xxxix., 1379.

SCHMIDT'S BOILER AND SUPERHEATER

(*For description see page 109*)

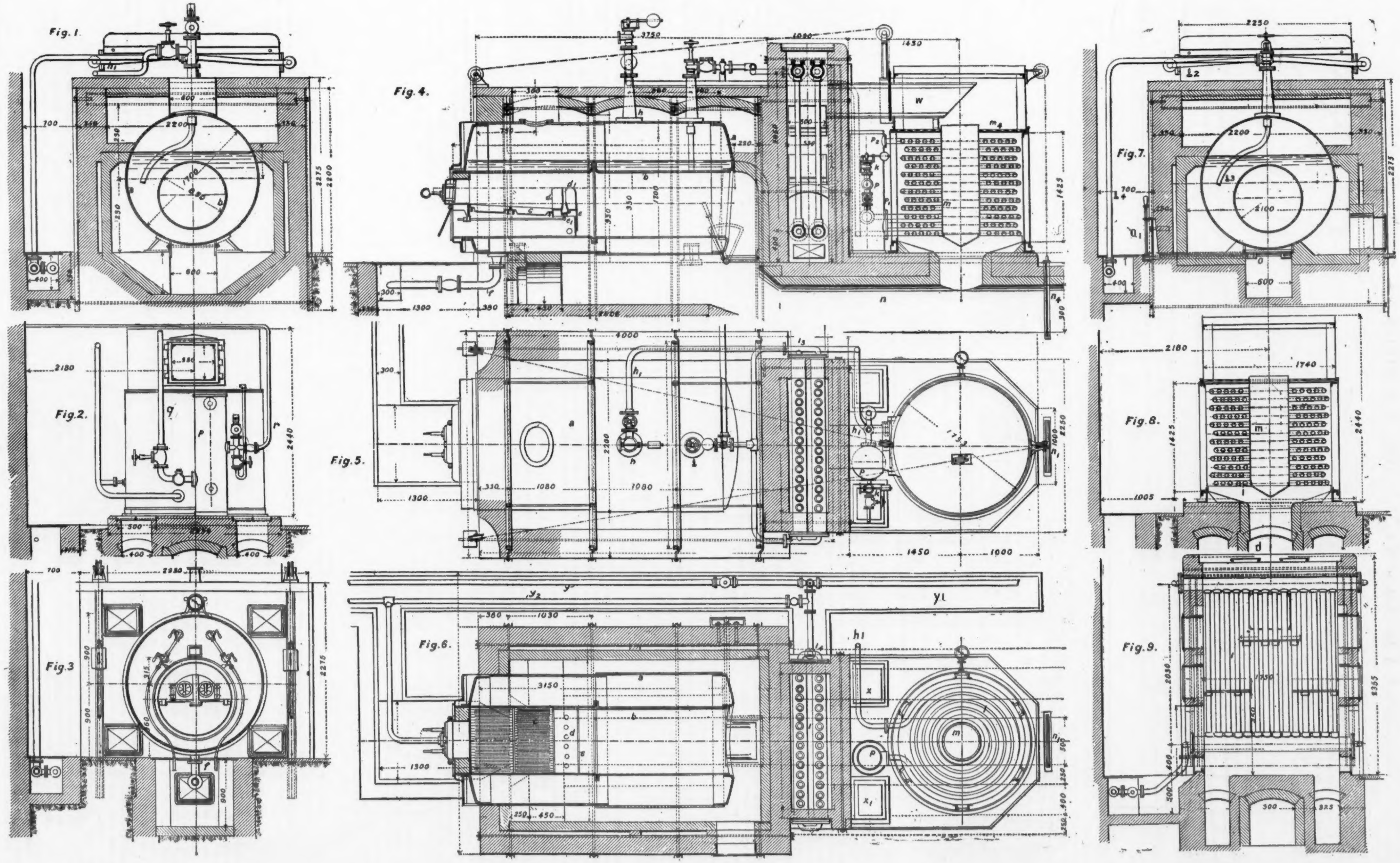
Fig. 1.
Fig. 2.
Fig. 3
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
3750
1090
1450
1425
4000
2300
1080
1080
330
1300
1000
2250
1733
2200
2275
2180
2440
2930
3150
1030
380
2250
2100
1740
1005
2030
2355
1750
700
600
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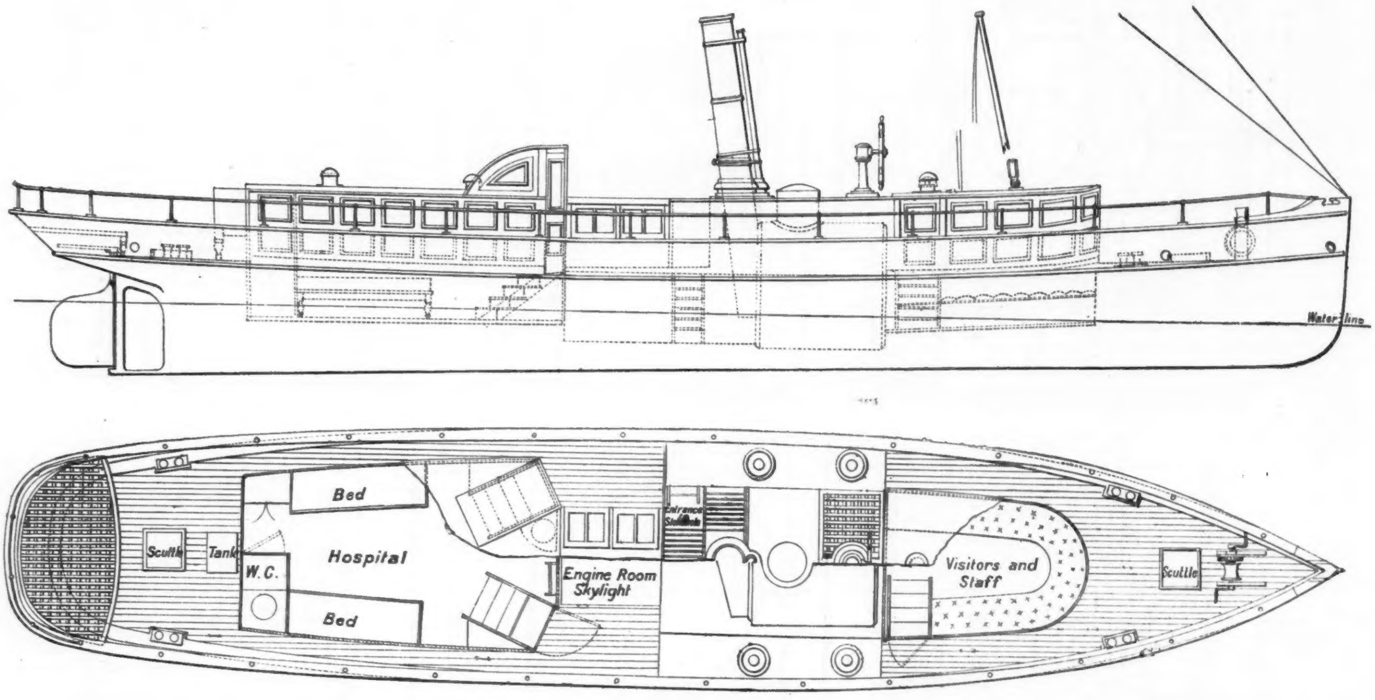
STEAM LAUNCH FOR AMBULANCE SERVICE



The only machine requiring no motive power is that of Wegener. The air is drawn in by the up draught of the chimney and rotates a horizontal fan, the axis of which, prolonged in an upward direction; moves a sieve, and thus loosens the coal dust in the hopper, causing it to fall on to a double cone, where it meets the air current, and is thereby blown into the furnace, the draught being increased at this point by the constriction caused by the cone. The current can be regulated by a valve at the base of the pipe, and an extra pipe is fixed at the side for increasing the air supply when necessary.

In the Schwartzkopff apparatus the air is drawn in by the chimney draught through adjustable openings, but the passage of the coal dust to the furnace is accelerated by a revolving wire brush. The outlet of the hopper is formed in two parts, one of which is regulated by a screw. The other consists of a spring, the end of which is struck by a hammer at each revolution of the brush, whereby it is forced up against the coal, and assists, by its return spring, in loosening the mass in the hopper.

Ruhl's stoker forwards the coal dust by means of an archimedean screw through an adjustable aperture into the blast pipe, the current being also in this case induced by the chimney draught. Any fuel not dropping into the aperture is taken back by a second screw.

De Camp's arrangement necessitates the use of a special fan to draw the air and dust fuel into the furnace, but possesses the advantage that it can be erected at a convenient distance away from the furnace. The coal is conveyed from the hopper by a screw and falls into a revolving sieve forming the intake of the fan, from which it is driven by cogwheel or belt gearing.

In Friedeberg's system no movable parts, beyond the fan—which can be situated in any suitable position—are necessary. The air current is passed through a vertical pipe, and is divided at the point where this is bent at right angles, the one portion going direct to the furnace, while the other is led through a chamber into which the coal falls from the hopper, and carries away the fuel into a cone-shaped delivery pipe, where the divided currents are re-united. Three throttle valves are provided for regulating the delivery, and the whole apparatus swings on the vertical pipe so as to be easily moved away from the furnace doors.

The chief engineer—Hr. Schneider—of the Berlin Boiler Inspection Association, has tested the Wegener and Schwartzkopff stokers, and the chief results of the experiment are given in the subjoined table. Of the two boilers heated by the aid of the Wegener apparatus, one was a double flue boiler surmounted by a tubular boiler, the connection being made by means of two pipes. The hot gases circulated through the flues passed along the outer walls of the lower boiler into the tubes of the upper one, and finally over the steam chamber. The heating surface amounted to 125 square metres, the furnace occupying a space of 2·8 square metres. The second boiler had a cylindrical fire-box and heating tubes; the outer walls were not in contact with the flame, but were coated. The dimensions of the furnace were 1·95 square metres, and the total heating surface 78 square metres. In only the first five experiments was the evolution of smoke determined, and was generally small, but could not be entirely prevented. A drawback incidental to the Wegener apparatus is the noise made by the blast and fuel.

The boiler fed with the Schwartzkopff stoker is one employed for testing safety valves, &c., and had to be kept unmounted, thereby suffering considerable loss of heat by radiation, &c. There were two flues, the one containing the furnace, and the other divided longitudinally by a fire-brick partition. The production of smoke was exceedingly minute. (Table A, page 106.)

These figures show that the employment of coal fuel in the state of dust gives an advantageous result from the point of view of the utilisation of the combustible material, in addition to which may be reckoned the diminution of smoke, as well as the minimum excess of air necessary to secure combustion—owing to the intimate admixture of air and fuel—and the regularity of temperature obtained in the furnace. Little attention is required, being limited, while the apparatus is working to regulating the admission of air and coal dust, and the heavy labour of shovelling coal is altogether avoided. Besides, the fire can be quickly extinguished in case of danger. Other advantages are—protection of the boiler and facility of regulating the fire according to the demand for steam, and also the fact that any combustible capable of conversion into powder can be utilised. Experiments have shown, however, that very ashy coals give rise to some inconvenience.

The instigator of the preceding tests asks why, in view of its manifest advantages, coal dust firing is not more largely practised. He considers the circumstance that most of the apparatus projected require mechanical power to be unimportant, but points out that the large quantity of ash deposited in the flues may be disadvantageous to the working of the system, which is, moreover, unsuitable for locomotive and marine engines.

Probably the greatest difficulty to be overcome is the production of the coal dust. This is generally accomplished by disintegrators, and a new centrifugal roller mill is said to give good results. The cost of the operation is somewhat high, reckoned by the inventor at about 1s. 8d. per ton, but would probably come out even more in practice.

STEAM LAUNCH FOR AMBULANCE SERVICE.

THE managers of the Metropolitan Asylums Board recently invited tenders for a screw steam launch for the river ambulance service. The above engraving shows the general arrangement of the vessel. It is intended to run her at 10 knots per hour. The following are the intended dimensions:—Length between perpendiculars, 60ft.; breadth, 12ft. 6in.; depth, 4ft.; draught of water when fully equipped to be a mean of 2ft. 8in. The hull is built of Siemens-Martin mild steel throughout to Board of Trade requirements for passenger certificate. She is built in five compartments. In the fore part of the vessel is a cabin for the accommodation of the staff and for visitors proceeding to visit patients in the hospital ships in Long Reach, Dartford, and is capable of accommodating about twenty persons. In the after part there is a cabin fitted up as a hospital, with four berths—two being fixed and two portable—and with all the necessary requirements for carrying four recumbent patients. Both of these cabins are heated with steam, and are provided with suitable skylights and all the necessary fittings for a boat of its class.

The machinery is fixed amidships, and is of the triple-expansion type, with surface condenser, and capable of driving the vessel at a speed of 10 knots. A water-tight trimming tank is built at the fore end of the vessel, of sufficient capacity that when filled with water it will bring the vessel to an even keel of 2ft. 8in. The top rail is of teak 3½in. by 2in., fitted all round with galvanised iron stanchions, with galvanised iron tubular rails passing through them. The deck is of 2in. pine, and fitted with bollard, windlass, &c., to lift anchor, metal chain conductor. The fore cabin is of teak, with American pine match-lining down to the floor. This cabin is provided with locker seats all round, upholstered with horsehair and American cloth. The cabin is entered on the starboard side by a teak ladder having brass treads. The top of cabin is of ¾in. teak grooved and tongued, and is covered with 4 lb. lead.

The funnel is hinged. The steering gear consists of a polished teak wheel, brass mounted, bearing the vessel's name. The mast is a light hinged pole mast, provided with fitting for carrying the steaming light. The vessel is provided with a one hundredweight anchor and 30 fathoms of ⅝in. chain cable, one metal ship's bell with name of vessel on it, one patent telegraph from deck to engine-room, and one siren.

If the speed at the steam trials does not come up to 10 knots per hour, deduction will be made from the contractor as follows: $\frac{1}{10}$ knot below 10 knots per hour, £10 will be deducted; $\frac{2}{10}$ knot, £20; $\frac{3}{10}$ knot, £40; $\frac{4}{10}$ knot, £80; $\frac{5}{10}$ knot, £150. The contractor has to provide engineer for one year, and to keep the vessel insured for six months, that being time allowed for building,

SOME RAILWAY SCHEMES OF 1846.

IN a facsimile of its first edition of January 21st, 1846, the *Daily News*, on the occasion of its jubilee, brings to light many curious old bits of railway news. The fourth column of the front page begins with an advertisement, signed by George Hudson, for tenders for the re-construction of the Whitby and Pickering Railway. This little known but most interesting line was laid out by George Stephenson, and with the exception only of the Leeds and Selby—1834—was the first railway in Yorkshire. A single line all the way, horse-power was the only mode of traction upon it, save upon an incline 1500 yards in length, and varying in steepness from 1 in 10·9 to 1 in 28·4, or about 1 in 15 on the average. A tank truck, being filled with water at the bank top, was run down one side of the slope, pulling the train up the other by a 4½in. rope running in sheaves. The inclines, and in fact most of the lines, were full of curves, some of them so sharp as ten or twelve chains radius. Beyond the incline just named the line still rose, but easily, the summit being precisely half-way between the termini and situated on a treacherous bog. After his experience at Chat Moss, however, it must have been a bad bog indeed that would have daunted George Stephenson, especially with a horse line. Many of his favourite peculiarities of construction were here displayed—stone block sleepers, fish-bellied rails, 35 lb. or 40 lb. per yard in weight; the gauge of 4ft. 8½in., an absurd castellated entrance to the solitary short tunnel. Some of the rails had half-lap joints, others were scarfed, the 15 lb. chairs resting on blocks containing four cubic feet of stone. A vehicle, built like a stage coach of enlarged dimensions, conveyed passengers over the 24 miles in about 2½ hours. There were also a few open conveyances, and it was found that one horse could draw four tons at ten miles an hour on the easy parts of the line.

The principal object of the Whitby and Pickering Railway, which was opened on May 26th, 1836, was to bring down stone and lime from Leaserigg and Grosmond for shipment at Whitby, and to carry coal in the opposite direction to Pickering and the places near it. Other works were established on the line, but though it only cost £5000 per mile it never paid, and was purchased in 1845 by the York and North Midland Railway Company, which soon connected it to its Scarborough line, doubling the track and adapting it for locomotives. The incline between Grosmont and Goathland, however, was worked by a stationary engine instead of water balance till July 1st, 1865, when the Whitby deviation was opened and substituted for it. An interesting account of the line and its opening, with views of the scenery, was published in 1836 by a Mr. Henry Belcher.

The first number of the *Daily News* also contains a lengthy prospectus of the Direct Northern Railway, with a comparison of the distances by it and the rival scheme of the London and York. Most of these figures are rather too good to be true; for instance, 176 miles to York, no less than 12 miles shorter than the present very direct line. Hudson was interested in the old route to York by Rugby, Derby, and Normanton—218½ miles—and fought the Direct Northern in the session of 1846 with his utmost energy. It was to no purpose though; the new line got its Act, amalgamated with the London and York, and became the Great Northern of to-day. A site in Holborn, between Furnival's Inn and the corner of Gray's Inn-road, was to have been the terminus of the Direct Northern, and separate lines for goods and passenger traffic seem to have been intended.

Besides being chairman of the Midland and the Eastern Counties, George Hudson was also head of most of the older lines now forming part of the North-Eastern. With all his faults he was an extremely able railway administrator, and until he got too many irons in the fire, invariably did well for the lines he controlled. Like the Stephensons he could see straight, and never for a moment was led away by the showy seductions of the broad gauge or the atmospheric system. A long report of a special meeting of the London and South-Western, in the paper in question, contains some interesting reminiscences. The company had a strong desire to make an extension from Nine Elms to London Bridge, although the calamities following the railway mania induced it to stop short at Waterloo in 1848. Plans involving some six millions of money were in hand for lines from Basingstoke to Penzance, much of which was carried out later on by separate companies, now absorbed by the South-Western. Broad gauge and narrow were meeting, or threatening to meet, in the Yeovil and Weymouth district, and the Duke of Wellington was in a fearful rage at the Great Western bringing "a d——d railroad" through his estate between Reading and Basingstoke.

In 1846 some of the South-Eastern trains started from Bricklayer's Arms, the present goods station, and of course went round by Redhill to Dover. A "courier's carriage" was run on the 11.0 p.m. goods for the convenience of early voyagers, but from Folkestone, at any rate, there was only one boat a day to Boulogne, and a bi-weekly service between Dover and Ostend.

Altogether, this old *Daily News* is a delightful record of the days when Hudson, Cobden, and Peel were probably the greatest men in England.

END OF THE ENGINEERING DISPUTES ON THE CLYDE AND LAGAN.

IN view of the many disappointments and kaleidoscopic changes which have characterised the wages dispute in the engineering trade of the Clyde and Belfast, it was only natural that there should be some inclination to reserve congratulations over the termination of the deadlock until the fact was actually beyond question. It is therefore with assurance made doubly sure by the actual resumption of work all round, that we can now regard and speak of the lamentable dispute as a thing of the past. Since Monday of this week the resumption of work in all the engineering shops of the Clyde and the Lagan has been gradually effected, not, of course, without the little jars and hitches only natural after so long a stoppage of the industrial machine, and to-day operations are being carried on with as much briskness, and perhaps greater spirit than before the dispute was commenced. The terms of settlement, while not all that the men had hoped for, and at first insisted on getting, are yet on the whole a satisfactory termination to the contest, especially seeing that they involve the acceptance of conditions as to a time-agreement in wages which will go far to prevent any repetition of such hurtful and harassing disputes in the future.

The means by which a satisfactory termination has been put to the industrial dislocation were not latterly any more free from delicacy and difficulty than earlier efforts, although an anxiety, only poorly disguised, on the part of the men to have done with idleness, helped materially to a settlement. Briefly told, negotiations proceeded thus:—Lord James of Hereford, and Lord Provost Bell, of Glasgow, whose efforts to bring about a settlement of the dispute have been unceasing, quietly but promptly availed themselves of the opportunity afforded by the third meeting of the Employers' Federation at Carlisle on the 16th instant, to arrange an informal conference of masters and men. The result was a representative and reasonably-disposed gathering, at which the employers practically repeated the offers balloted on five weeks previously. An agreement was drawn up, which the delegates of the men present at the conference undertook to recommend the workmen in both the Clyde and Belfast districts to accept and abide by. The following is the substance of this important agreement:—

Firstly, the employers agree to give the following advances immediately on work being simultaneously resumed in the shops of the associated employers of the upper and lower districts of the Clyde and at Belfast, viz.:—(1) To the Belfast operatives one shilling per week; (2) to the Clyde operatives (*a*) an advance of one farthing per hour to all who, prior to the stoppage, were in receipt of less than sevenpence per hour, and (*b*) a further advance of one farthing per hour all round—that is to say, an advance of one halfpenny per hour to all under sevenpence and one farthing per hour to all who earned at and above that rate. Secondly, the rate of wages to remain in force undisturbed for a period of six months from December 11th, 1895, *i.e.*, until June 11th, 1896. After May 11th, if any change is demanded, one months' notice to determine the arrangement may be given, the arrangement continuing in force during said month. Thirdly, the word "operatives" shall include the following classes of tradesmen on the Clyde and at Belfast, viz.:—Fitters, finishers, turners, planers, borers and slotters, and shall also include, so far as Belfast is concerned, any patternmakers, smiths, and brass finishers who are members of the Amalgamated Society of Engineers.

The agreement was signed on behalf of the Federated Employers by R. Sinclair Scott, chairman of Joint Committee, and Thomas Biggart, secretary. On behalf of the Executive Council of the Amalgamated Society of Engineers it was signed by Alfred Sellicks, President E.C., and John Anderson, General Secretary. It was countersigned by Lord James of Hereford. A note was appended to the effect that, "although not made a formal term of this settlement, the employers and operatives, with the hope of restoring perfect good feeling, will do their best to replace the state of employment in the same condition as it was before the strike and lock-out occurred. Neither the employers nor operatives to be subjected to any exceptional treatment on account of what has occurred."

The terms of the agreement, on being balloted upon, were accepted by the Clyde men by a large majority, but the Belfast men by as great a proportion rejected them. The Central Executive of the men's society in London hereupon resorted to measures which, if they had been exercised a little earlier in the dispute, might have had a like result, much to the advantage of the workmen and the prosperity of the engineering and allied industries. They wired on the 21st inst. to the recalcitrant operatives at Belfast as follows:—"Call mass meeting of men for to-morrow, Wednesday. Member of Central Executive will be present. Strike must be settled at any cost." This, as might have been expected, caused dissatisfaction and some consternation in the rank and file of the workers, while the Belfast officials themselves, it is said, felt resentment at this unexpected application of the coercive principle. The executive, however, having the large majority of the members of the society on their side, and the unmistakeable support of the general public, as well as the potent lever of control of the society's purse-strings, the issue was inevitable. The men, and the local officials, after hearing the statements of Mr. McDowell, the executive's representative, gave a reluctant assent to the terms of the Carlisle agreement, and accentuated their reluctance by a "protest," and by declining to start work until Thursday.

The Belfast men have been idle fifteen weeks, and the Clyde men twelve. Into the lessons to be drawn from this memorable dispute it is not intended here to enter, but it may shortly be asked—What has been the result of the dispute of these three months' duration? An enormous amount of money has been lost to Belfast and Glasgow workmen, especially in the shape of wages, and one of the most important British industries has got a shock from which it may take some time to recover. It is calculated that since the strike on 6th November, the Clyde engineers have lost in wages something like £45,000. When the loss of the labourers and the other trades depending upon the engineering industry is taken into account, the sum must be enormous. Then, besides, there has been drawn from the funds of the Amalgamated Society of Engineers, for the support of the Clyde men alone, a sum roughly estimated at £20,000. Though the men of Belfast have got half their demand, and the men of the Clyde have got a good deal more than they at first asked for, it will be long before these increases make up for the amount dropped in wages during the period of cessation.

One feature connected with the general resumption of work, both at Belfast and on the Clyde, remaining to be noticed, is the refusal of the employers to reinstate unconditionally the apprentices, who, during the height of the contest, "joined their lot" with the men on strike. This refusal might have been anticipated by both apprentices and workmen from the nature of the latter's position as indentured servants, as well as from their having stopped work directly in face of the advice and warning of their employers. Nevertheless, the refusal to reinstate the apprentices in a body, and unconditionally, caused friction, and a disinclination at first to refuse to resume work on the part of sections of the men.

This, however, has rectified itself, and it has become recognised that the masters are quite entitled to deal with their rebellious young servants as they may deem essential to a proper understanding of their position and future conduct. Stipulations to that end have been drawn out, and each apprentice is being compelled to sign the document before reinstatement. While to a certain extent dealing with the lads on disciplinary lines, the stipulations are chiefly designed to make clear, to both apprentices and workmen, that in future trade disputes of this kind the apprentices must in no way try to make themselves, or be made, active factors in the solution of the questions at issue.

Apart from the hitch in connection with the reinstatement of the apprentices, the start in the engineering shops of the Clyde has been general, although little difficulties presented themselves in at once finding jobs for all who applied. In some of the shops arrears are so heavy that work will be carried on day and night for a considerable time to come. Simultaneously with the resumption of work announcements have been made of several good contracts for ships and engines, and important orders which have been booked during the period of the strike and lock-out have not yet been made generally public. Steel merchants are having a large inquiry for material, but few are disposed to commit themselves unless at better prices. The Steel Company of Scotland a few days ago raised the price of angles to £4 15s., an advance of 2s. 6d. a ton. The same company has been quoting £5 5s. for ship plates; some other makers have accepted 2s. 6d. less, but the quotation now is generally at the higher figure, and sellers firm there. The total tonnage booked since the first day of the year will be seen, by the end of this month, to amount to a pretty big figure, considering the all but complete absence of launches. Port Glasgow and Greenock firms have booked most heavily. Messrs. R. Duncan and Co. since mid-month have contracted to build two steamers, one of them of 2500 tons; Messrs. A. Rodger and Co. have arranged to build two steel screw steamers for traffic on the river Amazon, the engines for which will be supplied by a Govan firm; and Messrs. Russell and Co. have booked an order for a third vessel for Amazon passenger traffic. Messrs. Rankin and Blackmore, engineers, Greenock, have contracted to build a first-class twin-screw land and dipper dredger for the Lancashire, Yorkshire, and London and North-Western Railway Company's marine service. The hull is to be constructed by Messrs. Murdoch and Murray, Port Glasgow, while Messrs. Rankine and Blackmore will provide the engines on their patent disconnecting triple-expansion principle. Messrs. Fleming and Ferguson, Paisley, have contracted to build for the Cork Harbour Commissioners a steel self-propelling dredger of about 1000 tons capacity. The general feeling is, that now the unfortunate engineering trouble is over, better trade experiences are in store for the Clyde and West of Scotland.

THE SCHMIDT SUPERHEATED STEAM MOTOR AND BOILER.

ONE of the most noticeable improvements in small steam engines in the direction of economy of fuel is the motor introduced by Messrs. W. Schmidt and Co., of Aschersleben, in Prussian Saxony, driven by "hot," *i.e.*, highly superheated steam, which is represented in both engine and boiler presenting considerable departures in form from those of ordinary steam generators and motors.

The boiler in its original form, represented in Figs. 7 to 11, page 105, is of an ordinary upright kind, with internal furnace and three cross circulating tubes, with a central chimney surrounded by a series of serpentine coils for superheating. These coils are not in continuous connection, but are divided into two series, the first and second counting upwards forming the so-called fore superheater, and the remaining eight the after superheater. A communication between the two series is provided in the vertical cylinder on the left, called the after evaporator. The cylinder containing the coils is covered with a cast plate perforated with numerous small holes, and the central chimney by a movable damper. When the latter is open the fire gases pass directly through the central tube into the chimney, but when it is closed they are diverted through the small flues in the bottom of the superheater covering, and pass upward through the coils, their distribution being regulated by the holes in the covering plate.

The proportions of the boiler are such as to admit of very rapid production of proportionately wet steam, the evaporation according to the experimental trials being at the rate of 45 to 50 kilos. per square metre of heating surface per hour. The mixture of steam and water passes from the boiler by the valve l, though the coils of the lower superheater, which are exposed to the hottest of the fire gases, but are protected against burning owing to the heat absorbed in the evaporation of the entangled water. The final drying is done in the after evaporator by an interchange of heat between the remaining water and the partially superheated steam. That such an interchange does go on is apparent from the difference in temperature between the top and bottom of the after evaporator, which is about 50 deg. C. The dry steam enters the main superheater at the top, coming out below heated to or about 350 deg. C., or 180 deg. above its saturation temperature, and passes by the valve K to the engine supply pipe.

All the exposed surfaces of the boiler and superheaters are closely covered with non-conducting materials. The fire-box has a thick fire-brick lining, whereby a certain portion of the heating surface is lost, but with the advantage of forming a mud pocket in the lowest part of the boiler, which being comparatively cooled allows the mineral matters separated from the feed-water to settle down in loose form instead of compacting as a hard incrustation upon the plates. The engine, which is of 20 nominal horse-power, is, as will be apparent from our illustration—Figs. 1 to 6, page 000—similar in appearance to a gas engine, having two single-acting cylinders, with pistons of 220 mm. diameter and 375 mm. stroke coupled upon the same shaft at 180 deg., with the valves placed up the back of the cylinders. The valves are of the vertical piston form, the steam being admitted through the central passage O in the framing, and passing out through the lower one at p. They are moved by levers $h\ h$ on a weigh shaft k from the excentrics $i\ g$ and $g\ i$, the former, which is connected with the exhaust, moving in an invariable path; while the latter, which controls the admission, is subject to the action of a governor attached to the fly-wheel. The lubrication of the main shaft bearings and excentrics is effected by the two oil vessels carried on the tubular frame v; the overflow collects in a reservoir in the lower part of the framing.

An engine and boiler of this class constructed by Mr. J. E. Christoph, of Niesky, in Silesia, of somewhat larger dimensions than those in our illustrations, were subjected to a series of trials by Professor Lewicki of Dresden, in order to determine the following points:—(1) Steam consumption of the engine when fully loaded. (2) Frictional resistance of the unloaded engine. (3) Useful effect under different conditions of work. The engine has two cylinders of 250 mm. diameter and 400 mm. stroke. The heating surface of the boiler was 5·8 square metres. The principal results are tabulated as follows:—

Duration of trial	5 hr. 10 min.
Steam pressure in boiler, effective	8·81 atm.
Temperature of feed-water	17 deg. C.
Temperature of feed-water from feed-water heater	84·1 ,,
Pyrometer reading, bottom of fore superheater	596·1 ,,
Pyrometer reading, bottom of after superheater	412·9 ,,
Steam temperature in after evaporator, below	296·2 ,,
Steam temperature in after evaporator, above	287·8 ,,
Steam temperature, engine admission	345·7 ,,
Steam temperature, engine exhaust	143·3 ,,
Steam temperature, feed-water heater	101·1 ,,
Air temperature in engine-room	27·3 ,,
Feed-water per hour	331·19 kilogs.
Revolutions of engine per minute	157·93
Indicated horse-power	48·48
Effective horse-power	41·47
Steam consumption per I.H.P. per hour	6·83
Steam consumption per effective H.P. per hour	7·98
Coal	1·10 kilogs.

The friction of the unloaded engine when running at 159·46 revolutions per minute represented 2·12-horse power, and the difference in speed between the engine when light and when fully loaded was only 0·96 per cent.

The effective power under different conditions of steam admission and speed varied as follows:—

Stage.	Revolutions per minute.	Indicated horse-power.	Effective horse-power.	Efficiency, per cent.
1	160·55	15·35	11·09	72·2
2	158·55	26·95	21·99	81·3
3	157·55	38·65	32·66	84·5
4	157·93	48·48	41·47	85·5

An ordinary non-condensing steam engine would probably require for the same work 16·38 kilogs. of steam and 2·10 kilogs. of coal per horse-power hour effective, so that the saving by high superheating is 351·76 kilogs. of water and 41·47 kilogs. of coal on the power developed, or about 52 per cent.

A new form of construction of the Schmidt boiler by the Gritzner Engine-building Company of Durlach, in Baden, is shown on page 107, in which the superheating elements are placed behind the main boiler instead of above it, and a feed-water heater is added.

The boiler is on the ordinary single furnace tube Cornish pattern, has a heating surface of 15 square metres, and is intended to work at 12 atmospheres pressure. Provision is made for smokeless combustion by an accessory air-feed introduced through perforations in the firebrick bridge, such air being slightly warmed in its passage over the hot ashes below the grate. By means of a damper on the flue behind the furnace tube the gases may, when it is closed, be turned round the outside of the boiler in the ordinary way, but when open they pass into the bottom flue n and up through the superheater coils in the back chamber. These, as in the vertical form of the boiler, are divided into two series, a preliminary or drying set at the bottom, and a larger number above forming the superheater proper. The gases are deflected by the conical point at the bottom of the cone tube m, and distributed by the perforated plate m_1, as previously described.

The rectangular flue W leads the gases into the chamber containing the feed-water heater between the boiler and the superheater. This consists of a series of vertical cast iron pipes socketed into connecting mains above and below. At the top they are connected by the tubes g and g_2 with the feed admission of the boiler, a stop valve and three-way cock being placed between these latter pipes, so that the feed pumps may either send cold water directly into the boiler or draw from the heater. The final exit of the gases to the chimney is effected by two side flues, which are accessible by the covered manholes $x\ x_1$. The re-evaporator p is connected below with the drying coils, and above with those for superheating, as previously described. The superheated steam is conveyed to the engine by the pipe q. The remaining peculiarities of the design will be sufficiently apparent from the drawing, without special description.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Fleet engineer: Charles H. Pellow to the Penelope. Staff engineer: Stephen H. Blundell to the President, additional. Assistant-engineer: Gordon Robertson to the Vivid.

THE INSTITUTION OF CIVIL ENGINEERS.

RECENT DEVELOPMENTS IN GAS ENGINES.

AT the ordinary meeting on Tuesday, the 28th January, Sir Benjamin Baker, K.C.M.G., the President in the chair, the paper read was on "Recent Developments in Gas Engines," by Mr. Dugald Clerk, Assoc. M. Inst. C.E.

The author stated that the theory of the gas engine outlined in a paper read by him before the Institution in 1882 was now generally accepted, while the stratification theory had vanished. Great advances had since been made in gas engine construction, and the heat efficiency of such engines had been much improved, while their dimensions and power had increased. Engines working on the Otto cycle had been proved to be the best adapted of all yet invented for present needs, and their popularity had gradually led to the extinction of other types. The mechanical development of the Otto type was illustrated by the comparison of drawings of an engine built thirteen years ago with those of one recently constructed. The advance in heat efficiency was almost, if not completely, due to increase in the pressure of compression before explosion. It was shown that each step of diminished gas consumption of the Crossley Otto engine was attended by an increase in compression. The results were summarised in the following table, showing the absolute indicated efficiency of Crossley Otto engines of similar size since 1882:—

	Efficiency.	Pressure of compression above atmosphere. lbs. per sq. in.
1882-88	0·16	38·0
1888-94	0·19	66·6
1894	0·25	87·5

These results showed that economy increased with the compression, but it was open to question whether the increased compression completely accounted for the improved performance. To test this the author had calculated, by the formula $E = 1 - \left(\frac{c_c}{v}\right)^{\gamma - 1}$, the theoretical efficiency of an air engine in which no practical loss occurred, the air engine having the same ratio of compression space as the actual gas engine. These theoretical efficiencies, as well as the actual efficiencies obtained in the gas engine, were shown in a table, from which it appeared that the economy had improved, chiefly on account of the increased compression. It was noted that in every case the actual indicated efficiency obtained from the various gas engines was about one-half that which would have been given by an ideal air engine following the same cycle in a perfect manner without loss to the sides of the cylinder. Also that the actual efficiency improved more rapidly with the increase of compression than did the thermodynamic advantage due to the compression. Thus, when the theoretical efficiency was 0·33, the actual experimental efficiency was $0·33 \times 0·45 = 0·15$; and with the theoretical efficiency 0·39, the actual efficiency was $0·39 \times 0·48 = 0·19$; while with 0·428 theoretical efficiency, the actual efficiency was $0·428 \times 0·58 = 0·25$. The ratio of actual to ideal efficiency thus rose with increase of compression from 0·45 to 0·58, and this, it was stated, meant that with higher compressions two advantages were obtained, the thermodynamic advantage, due to improvement in cycle, and a further advantage due to diminution of the proportional loss of heat to the cylinder walls.

In comparing the earlier with the recent Crossley Otto gas engine, it was pointed out that the great differences between the two engines, which resulted in the superior economy of the later, were found in (*a*) the abandonment of the flame slide-valve ignition, and the substitution for it of ignition by an incandescent tube of metal or other material; (*b*) the diminution in the relative volume of the compression space; (*c*) the improved proportioning of the valves and ports in order to minimise the throttling of the charges during the inlet period, and the back pressure of the exhaust gases during discharge. This statement was illustrated by reference to numerous indicator diagrams. The author described his tests of the new Crossley Otto scavenging engine, stating that although it was highly desirable to discharge all the exhaust gases and replace them by pure air, as so long contended by him, yet that such displacement was not accountable for more than 5 per cent. of the improvement produced in the Otto scavenging engine. It was stated that scavenging possessed practical advantages quite apart from improvement in gas consumption. Otto gas engines, constructed by Messrs. Andrew and Co., of Reddish, and by Messrs. T. B. Barker and Co., of Birmingham, were also described and illustrated, and the various peculiarities of the different Otto-cycle engines were pointed out. It was stated in discussing these engines that engineers had not sufficiently recognised the importance of limiting the port-surface to the utmost, in order to minimise the cooling surface in contact with the intensely hot gases. The Barker engine was referred to as one in which this point had been kept well in mind by the designer. Various self-starting gears were described, more particularly the Clerk pressure starter, the Clerk-Lanchester starter and the Lanchester low-pressure starter.

From a mechanical point of view the Otto cycle was a very imperfect one, allowing at most an impulse for every two revolutions of the crank shaft for each single-acting power cylinder; but the mechanical imperfections of the engine had until now been more than compensated by the simplicity of the single cylinder and piston, and the readiness with which the practical conditions of charging, exploding, expanding, and exhausting could be made to comply with the requirements of economical working. The great difficulty of the problems involved in impulse-every-revolution gas engines was then referred to, and the author described several engines which had been designed with a view to overcome those difficulties. In the first engine built by the author, early in 1878, there were two cylinders, each having a diameter of 6in., with a length of stroke of 8in., one a pump cylinder, and the other a motor cylinder. The pump crank followed the motor crank at right angles, and it pumped the mixture of gas and air into an intermediate reservoir through a check valve. From this reservoir the explosive mixture was supplied to the motor cylinder by means of a slide valve, and was compressed in the reservoir to a pressure of 70 lb. per square inch above the atmosphere. The motor piston moved back to the end of the cylinder, leaving only a mechanical clearance, and the exhaust valve was shut a little early in order to cushion the piston, as was done with steam engines. The motor piston moved forward from the end of its stroke about 2in., taking in the compressed mixture from the reservoir: the slide valve then cut off the supply, and ignition was effected by an incandescent platinum cage carried in the slide. The engine had been exhibited at the Royal Agricultural Society's Show at Kilburn in 1879, and was, the author believed, the first compression gas engine working by explosion ever built which gave an impulse for each revolution of the crank shaft. The difficulties which prevented the success of this type of engine were described. The author's 1881, 1886, and 1889 engines, as well as the "Differential" engine and the "Cycle" engine of Mr. Atkinson, were similarly dealt with.

The author then considered the modifications still to be made in the indicator diagram of a gas engine to further increase its heat efficiency, and in this he particularly referred to the Otto cycle, although he stated that it was to be remembered that impulse-every-revolution engines could now be arranged to produce any of the results brought about by the Otto engine. It was pointed out that the actual indicated efficiency of a gas engine increased with the theoretical efficiency, and that the actual efficiency varied between 0·45 and 0·58 of the theoretical efficiency. It was also stated that the indicated efficiency increased with the dimensions of the engine, other things being similar, when the ratio of compression space—and therefore the theoretical efficiency—remained constant. Thus an engine having a cylinder 9½in. in diameter with a length of stroke of 18in. had a theoretical efficiency of 0·40, and gave an indicated efficiency of 0·19 or 0·47 of that theoretically attainable. An engine, having a cylinder 14in. in diameter with a length of stroke of 25in., of which the theoretical efficiency was 0·41, gave an actual efficiency of 0·277, that was 0·675 of the theoretical efficiency. The actual efficiency, instead of being only 0·47 of the theoretical, increased to 0·675 without practical change in the compression. This comparison proved that efficiency increased with the dimensions. It was pointed out that a limit was reached to the increase of efficiency due to increase of dimensions, and the conditions were calculated. It was shown that further economy might be obtained by increasing the compression and expansion, but it was considered that for high compressions and large gas engines it would be advisable to adopt the compound principle, although the conditions of success, for compound gas engines, were not yet fully understood.

In conclusion, the author considered that the gas engine would yet assuredly be applied upon railways and to ships, just as it was now used in factories; its principles were better understood, and engineers were daily improving their knowledge of the properties of flame, and the means of harnessing flame instead of steam.

MOTOR CARRIAGE NOTES.

A NOVEL case came before Police Judge Mitchell at the Central Police Court, Glasgow, on Wednesday, the 22nd inst. George Johnston, Mosesfield House, Springburn, was charged with having contravened the Locomotives Amendment Act, 1878, Sec. 6, in so far as he, being in charge of a locomotive propelled by steam, oil, or other than animal power, and designated a horseless carriage, did, on January 4th, 1896, between 4 and 5 p.m., drive the locomotive along Buchanan-street, St. Enoch-square, and Dixon-street, being highways along which locomotives are prohibited to pass between 9 a.m. and 5 p.m., whereby he was liable to a penalty of £5, or one month's imprisonment. He pleaded not guilty.

David Menzies, portioner, 7, Buckingham-terrace, stated, in reply to the Procurator-Fiscal, that he was the companion of the accused on the carriage on the day libelled. He would describe it as a phaeton, not as a locomotive. There was no appearance of mechanical power outside.

By Mr. Johnston—Going at the rate of from four to eight miles an hour it would stop within one and a-half yards. On their way from Springburn to Paisley they passed about 200 horses, and only two of them noticed it. None of the tramway horses shied. It was much easier handled than an ordinary spirited horse. It could be turned in a shorter distance than an ordinary vehicle. It did not make so much noise as a cab. There was no discharge from it. There was no boiler or furnace.

Mr. Johnston said it was more or less an experimental carriage. He would be very glad if the magistrate examined it.

Constable Melvin said he was stationed at the junction of Argyll-street and St. Enoch-square. About 4.20 on the day libelled accused was driving a horseless carriage. The machinery seemed to be set in motion by the foot. There was a little vapour came out below the carriage. There was no discharge of oil on the ground.

By Mr. Johnston: The machine sometimes made a slight noise. It made more noise than an ordinary cab. It drew up very quickly. The carriage passed close in front of the horses of a tramway car, but they were not startled. He had seen the carriage pass before, but had never seen a horse startled by it.

For the defence,

David Simpson, 23, Saracen-street, said he was an engineer in the employ of the accused. He had been working at horseless carriages for several months. This was an ordinary vehicle without shafts. It had four wheels, and was seated for three persons. There was no appearance of machinery. It was impossible for vapour to come from the carriage unless as a result of gross carelessness or of an accident. There was no boiler or furnace. The driver only required to touch the brake with his foot, and then the machinery stopped working, and the brake was applied. It was a strap brake, as on a train.

By the Assessor (Mr. Young): The carriage was propelled by machinery, by an oil motor. There might be a discharge of a little vapour on a long journey. It was impossible to see the products of combustion.

Norman Fulton, engineer, Mount Vernon, gave similar evidence. In reply to the Fiscal, he defined a locomotive as essentially an engine used for traction purposes. In this case the essential part of the vehicle was the carriage.

The Fiscal said that Mr. Lang had advised the magistrates that the definition of a locomotive applied to every locomotive propelled by steam or other than animal power.

Mr. Johnston quoted from various dictionaries in favour of his contention that this carriage was not a locomotive within the meaning of the Act. He had been compelled to take out an Excise licence, which authorised him to run a carriage propelled by not more than two horses or mules, or by mechanical power. No licence was required for a locomotive. At the time this Act was passed it was impossible for the Legislature to have had in contemplation a vehicle of this description. The motor only weighed 1¼ cwt. out of the 10 cwt. which the carriage weighed.

The magistrate continued the case for judgment till the 24th, when a nominal penalty of 2s. 6d. was imposed, as it was the first case of the kind.

THE award of prizes for the motor carriages which took part in the recent competition at Chicago has been announced, and is given below. All the carriages have been illustrated and described in THE ENGINEER of November 22nd, 1895, and January 3rd, 1896. (1) Morris and Salom, electric carriage.—Gold medal awarded for the best showing made in the official tests; for safety, ease of control, absence of noise, vibration, heat or odour, cleanliness, and general excellence of design and workmanship. (2) Duryea Motor Wagon Company, gasoline carriage.—An award of £400 for the best performance in the road race, and for range of speed and pull, with compactness of design. (3) H. Mueller and Co., gasoline carriage.—An award of £300 for performance in the road race, and for economy in operation. (4) R. H. Maey and Co., gasoline carriage.—An award of £100 for the performance in the road race. (5) Sturges Electric Moto-cycle Company, electric carriage.—An award of £100 for the performance in the road race.

The following special awards were made by the committee on tests for meritorious features in design:—(6) G. W. Lewis.—An award of £40 for friction driving device and brake, and a reduction gear for increasing the speed. (7) Haynes and Apperson.—An award of £30 for the plan of preventing vibration by the balance of the driving engines. (8) Max Hertel.—An award of £20 for a device for starting the motor from the operator's seat in the carriage. (9) De La Vergne Refrigerating Machine Co.—An award of £10 for the counterbalance on the engine.

The American Motor League has been organised as an outcome of this competition, and will be devoted to the interest of the horseless carriage or motor carriage, by encouraging the improvement of the motors, the carriages, and the public roads. Its objects are to hold meetings for the presentation and discussion of papers and reports, to direct favourable legislation, to defend the rights of motor carriages on the public roads, to aid in the mechanical improvement of the machinery, and to aid also in the existing movements for securing good roads. Mr. Charles E. Duryea, of the Duryea Motor Wagon Company, is president, and Mr. J. Allan Hornsby is secretary.

AT the Tunbridge Police-court, Mr. Walter Arnold, the owner of a motor carriage, was summoned on four informations with reference to using a motor carriage on the highway. The first was for using a locomotive without a horse from the County Council, the second for having less than three persons in charge of the same, the third for going at a greater rate than two miles an hour, and the fourth for not having his name and address placed on the machine. The evidence was that the carriage was going at the rate of eight miles an hour. Mr. Cripps, who defended, contended that the machine was not one contemplated when the Locomotive Acts were passed, and said that in the past these carriages had been used by Sir David Salomons and the Hon. Evelyn Ellis without any notice being taken. If the Bench considered that the carriage was a locomotive, he asked for the imposition of a nominal penalty. The Bench inflicted a penalty of 5s. and £2 0s. 11d. costs for using the carriage without a horse, and 1s. and 9s. costs in each of the other three cases—£4 7s. altogether.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE following circular is now being issued by the Council of the Institution:—

28, Victoria-street, Westminster, January, 1896.

The Council of the Institution of Electrical Engineers have resolved, "That steps should be taken to render available for purposes of national defence the technical skill of electrical engineers, and that a committee be appointed with instructions to take such steps as it thinks fit to attain that end," and have appointed the following gentlemen as members of the committee:—The President—Dr. J. Hopkinson, M.A., F.R.S.—Sir Frederick Abel, Bart., K.C.B., D.C.L., F.R.S., Mr. R. E. Crompton, and Major-General C. E. Webber, C.B.—Past Presidents—Mr. H. Edmunds, Mr. R. S. Erskine, and Mr. A. E. Mavor, to whom have since been added Sir Benjamin Baker, K.C.M.G., LL.D., F.R.S., and Professor A. B. W. Kennedy, LL.D., F.R.S.

It hardly seems necessary to point out in how many ways a practical knowledge of electrical science could be made useful in time of war. Everyone knows that the acquiring of a knowledge of this science is a not unimportant part of the training of military engineers. This knowledge electrical engineers already possess, but they have at present no opportunity in time of peace of preparing for the practical application of that knowledge for the purposes of war.

In order to carry out their instructions, it is necessary for this committee to ascertain what support it may expect from members of the Institution, and others engaged in electrical industries. Hence the present communication and the following questions are addressed to you:—

(1) Are you willing as an electrical engineer to register your name as ready to undergo training, and to serve in case of urgent need? (2) Are you willing to begin training at an early date, and to accept a commission in the Reserve Forces if obtainable, or to join the ranks of a Volunteer Corps? (3) Which branch of the Reserve Forces do you prefer? (4) Would you prefer to join a special corps of electrical engineers?—(*a*) as an officer; (*b*) in the ranks. (5) Are you at present a member of any Volunteer Corps?

One of the objects of this committee is to ascertain if there are candidates amongst the electrical engineers to fill the vacancies in the list of officers.

In order to enable you to judge of the matter, it may be well shortly to state the existing conditions of service in the various corps, particularly of military engineers, which now form part of the Reserve Forces of this country.

These are divided between Militia and Volunteers, and are described, with a list of the names of the commissioned officers, in the monthly "Army List," which also gives the various places where those corps are located.

With one exception—the Corps of Railway Managers and Engineers—they are formed in battalions and companies, having the usual military organisation.

The Volunteer Force is composed of the following arms:—Light Horse, Artillery, Engineers—Fortress and Submarine Mining, Rifles, and Medical Staff Corps.

The Corps of Engineers—Submarine Mining—is perhaps the arm to which electrical knowledge is most extensively applied at the present time. There exist divisions located on the Clyde, Forth, Mersey, Severn, Tay, Tees, and Tyne. The divisions are in general highly efficient, but there is a lack of officers. The preliminary training of officers requires in all about six weeks' work, which may be spread over two years. The duties of officers include attendance in camp at the headquarters of their division for not less than eight or more than fifteen days, and at forty-eight drills, a full day's work counting as six drills. The advantages are very interesting and healthful work, and an allowance of 10s. a day employed in training or in camp.

In the other arms there is much less need for attendance at a camp which may be remote from the home of the volunteer. The corps of Fortress Engineers is recommended to those who cannot afford time for prolonged attendance at a distance from their residence. The following is a list of the existing regiments of Fortress Engineers:—1st Middlesex, 1st Lanarkshire, Edinburgh City, 1st Lancashire, 1st Newcastle-on-Tyne, Yorkshire (West Riding), 1st (Sheffield), 2nd (Leeds), Gloucestershire 1st (Cheltenham), Cheshire 1st (Birkenhead), 2nd (Railway) Crewe, Denbigh, Tower Hamlets 2nd (East London), Cumberland, Surrey, Hampshire 1st (Portsmouth), Glamorgan, Essex, Devonshire and Somerset 1st (Exeter), London 1st (North), Flintshire 1st (Buckley), Northamptonshire 1st (Peterborough), Durham 1st (Jarrow), Aberdeenshire 1st.

In the case of the Militia, longer attendance is required in camp than in the case of the Volunteers; for example, the Militia Submarine Miners have annually fifty-five days in camp, and during the first year four months' training. Of this arm there are divisions located at Portsmouth, the Needles, Plymouth, the Thames, the Medway, Harwich, Milford Haven, Western—Severn—the Humber, and Falmouth.

Special corps.—The modern development of the uses of electricity is certain to lead to its extended application in war time. It is proposed, therefore, subject to the approval of the War-office, to organise and train a special corps of electrical engineers, whose duties will be defined at a later date.

It will further be the object of the committee to ascertain if the military authorities will regard favourably the enrolment of electrical engineers on some such basis as was followed in the case of the railway engineers, by which the services of many who cannot afford the time for organised training, but who are willing to seek certificates of efficiency suitable to their attainments, can be promptly utilised by the War-office in case of national emergency.

This statement will, we believe, enable you to judge which branch of the force you could most usefully join. Will you kindly reply to the questions put on the accompanying form? Later, if you are disposed to take an active part in the movement, you may expect to hear from us further.

If you occupy a leading position, superintending the work of artisans, will you also ascertain and inform the committee how many of these in your employment would be willing to join such a special corps as has been suggested.—On behalf of the committee,

J. HOPKINSON, President.

IT is stated that an estate, known as the Hafslund, near the great waterfall called the Sarpsfos, between there and Göteborg, has been acquired by a syndicate, consisting chiefly of German and American capitalists, for the sum of 800,000 kroner. The purchasers intend to form a large company with a capital of three to five million kroner, in order to utilise the water power of the falls for electrical power, and establishing aluminium works on the same principle as planned at the Falls of Foyers in Scotland. The Sarpsfos is one of the finest falls in south-eastern Norway being 74ft. in height and 116ft. in width.

RAILWAY MATTERS.

A Chicago paper reports the number of persons killed on railroad tracks—other than street surface roads—in that city during the year 1895 as 274, including seven passenger, 55 employés, and 212 other persons. There were six suicides. A list is given showing the number killed on each road in each month. The coroner gives the number of cases on each road in which the company was censured by the jury. The largest on any one road is six, and the total is 49, or about one case out of six. There were 62 fatal accidents on the street railroads.

The first number of the tenth volume of the "Bulletin of the International Railway Congress," English edition, edited by Mr. W. M. Acworth, and published by M. Weissenbruch, Brussels, contains, amongst other things, a paper on "Economical Methods for Increasing the Delivery of Water Cranes Without Having Recourse to the Use of Reservoir Cranes or Water Towers," by Sig. C. Coda, of the Italian Mediterranean Railway. It also contains a paper on "Lubrication of the Vehicles on the Eastern Railway of France," by M. Saloman, the chief mechanical engineer of the line.

A presentation was made in the "Hamilton Room" of the Great Eastern Hotel, Liverpool-street, E.C., on the 22nd inst., to Mr. Charles Langbridge Morgan, M. Inst. C.E., on his retiring from the Great Eastern Railway to take up the appointment of Engineer-in-Chief to the London, Brighton, and South Coast Railway. The presentation was made on behalf of the subscribers by Mr. John Wilson, M. Inst. C.E., Engineer-in-Chief to the Great Eastern Railway, and consisted of a very handsome silver tea and coffee service and salver, together with an album containing an illuminated inscription on vellum, and the names of the subscribers.

The tunnel of the underground electric railway connecting Waterloo Station with the City is making rapid strides towards completion, for there remains to be made now only about 1500 yards near the terminal stations. As during the past six months a total length of 1635 yards was driven, it is confidently estimated that the work of tunnelling will be finished before Midsummer Day. At present the tunnel citywards has reached a point about midway between Benet's Hill and Lambeth Hill, near the College of Arms. At the Waterloo end the tunnel has been driven about 150 yards eastward of the junction of the Waterloo Bridge-road with Stamford-street.

The Board of Works of the city of Newark, N. J., has passed an ordinance prohibiting the street railroads of that city from carrying freight or doing an express business. The electric railroad companies have, however, according to the *Railroad Gazette*, made extensive plans looking to the transportation of freight, and it is said that the Consolidated Traction Company already has a number of freight and express cars. An officer of one of the street lines has published a letter warning the city that in prohibiting the transportation of freight on street car tracks it is injuring its own interests, as several manufacturers now looking for sites for factories will come to Newark, if they can have track connections, and will stay away if they cannot.

At the recent meeting of the committee of the Light Railways Association of Great Britain, the committee discussed the report of the Board of Trade Committee and afterwards considered the Light Railways Bill of the late Government. Clauses were added for the purpose of regulating the charges upon light railways, for enabling tenants for life to exercise their powers as to improvements under Lord Cairn's Act, and for conferring permissive powers enabling local authorities to assist such undertakings by funds or guarantees. Powers were also inserted giving to local authorities the right to purchase the railways after a certain time, in cases where such pecuniary assistance had been rendered. A clause was also agreed to providing that no deposit should be required until lines had been authorised. A sub-committee was appointed to draw up a report to be presented to the President of the Board of Trade by the deputation.

A Board of Trade report on the collision which occurred on the night of November 25th last at Wortley South Junction on the Great Northern Railway has been published. As a Lancashire and Yorkshire Company's train from Leeds to Wakefield was passing the signal-box at the junction it ran into a Great Northern light engine, which was standing on the Great Northern up main line. Thirty-five passengers were reported to have complained of injuries, but in no case were the injuries serious. The driver and fireman of the train engine were also rather badly hurt, but the men on the light engine jumped off just before the collision took place and escaped. The inspector finds that the accident was due to a mistake on the part of signalman George Reed in the Wortley south signal-box. Reed, under the impression that the light engine was in the West Yorkshire siding, accepted the Lancashire and Yorkshire train from Leeds on the up main line, and lowered all the signals for it. The Government inspector is satisfied, however, that the signalman acted in good faith, but he says that the misunderstanding which led to the collision would not have occurred had there been less shouting. and if each of the three officials concerned had been at a little more pains to explain his intentions.

The officers of the New York and Brooklyn Bridge have tried the experiment of communicating by telephone between the Train Dispatcher's-office and the motormen on the cable cars running across the bridge, and it is reported that such a telephone connection will be made a permanent thing. Electrical communication with the moving cars was made by means of the overhead wire strung along the tracks, which at night is used for conveying a lighting current to the cars. It would seem to be at least doubtful, however, whether this will be a successful expedient for preventing such collisions as that of November 19th. That collision was between trains which normally run only a minute or a minute and a-half apart, and in the absence of automatic block signals placed very close together—say at intervals of 500ft.—and worked on the absolute plan, it is difficult to see how there is any better way of running on time during dense fogs than by employing men to signal by flag, lamp, or torpedo. To communicate from one car to another through a central office, by word of mouth, besides being clumsy, would demand almost impossible vigilance on the part of the dispatcher. There would be frequent occasions when a signal ought to be conveyed in a good deal less than fourteen seconds, as claimed for the telephone arrangements.

In a short paper on locomotive service read by Mr. J. H. McConnell before the Western Railway Club, U.S.A., writes against the temptation to the motive power official to subordinate the freight train load to the fuel and repair account of his locomotives. The *Railroad Gazette*, referring to this, says:—"A freight locomotive should be made to haul every ton of freight it is capable of hauling regardless of cost for repairs and fuel. It is perhaps this one thing which more than any other has enabled the railways of the United States to give the extraordinarily low freight rates, compared with those of foreign countries, which the American shipper enjoys. To subordinate the coal and repairs expense to the heavy train load has come to be the distinguishing principle of railway operations peculiar to American railway practice. While there is little danger that American railway managers will go back on this principle, there is always a danger that the mechanical department, particularly if it does not keep in close relation with the operating department, will gradually lose sight of it and devote its attention to increasing the locomotive mileage and reducing fuel expenses until low repair and fuel accounts come to be regarded as the great goal of its efforts. Mr. McConnell as a motive power official has done a good thing in calling the attention of those in charge of railway machinery to the fallacy of such ideas, and in showing from his own experience how the results he urges can be attained."

NOTES AND MEMORANDA.

At the last meeting of the Physical Society Mr. Campbell Swinton exhibited some photographs which he had taken by Professor Röntgen's method. These included several of metal objects inside wooden and cardboard boxes, and a very clear and sharp photograph of the bones of the hand.

As a single chemical individual of high illuminating power now easily obtained in a state of purity, acetylene offers obvious advantages as a secondary photometric standard. A flat flame of acetylene burning under a pressure of 30 cm. of water, and used with a screen, gave perfectly satisfactory results.

The average daily supply of water delivered from the Thames to London consumers during November was 113,148,287 gallons; from the Lea, 54,938,740 gallons; from springs and wells, 28,161,066 gallons; from ponds at Hampstead and Highgate, 153,199 gallons. The last is used for non-domestic purposes only. The daily total was, therefore, 196,401,292 gallons for a population estimated at 5,550,012, representing a daily consumption per head of 35·39 gallons for all purposes.

At a recent meeting of the Paris Academy of Sciences a paper was read "On the Calendar," by M. Flamant. A criticism of an alteration of the Gregorian rule for finding leap-year, suggested by M. Auric. The alternative proposed by the author, not to consider as leap-years the dates $(32)^n \times 100$, that is, 3200, 6400, &c., has the advantage of postponing any departure from the Gregorian rule for 1200 years. The length of the mean solar year deduced from this is only two-millionths of a mean solar day in excess of the truth.

The relative proportions of the supplies of water to London from the various sources were as follows, during last November:—From the Thames, 57·61 per cent; from the Lea, 27·97 per cent.; from springs and wells, 14·34 per cent.; from ponds, 0·08 per cent. for street watering. If the sea water scheme is realised, this will enormously reduce the draught on the Thames, and make the proposed pipe line from Wales to London unnecessary. London must not be made dependent on a pipe for its supply.

The annual report of the Superintendent of Public Works, State of New York, says:—"The whole number of tons carried upon the canals of this State during the season of 1895 was 3,500,314 tons, of which 2,327,481 tons was in transit towards tidewater and 1,172,835 tons was moved westward. Of these amounts 1,762,663 tons were through freight and 1,797,651 tons were way freight. The amounts carried by the several canals were as follows: Erie Canal, 2,356,084 tons; Champlain Canal, 966,335 tons; Oswego Canal, 64,691 tons; Black River Canal, 64,154 tons; Cayuga and Seneca Canal, 49,050 tons; total, 3,500,314 tons."

The *Gorno-Sawodsky Listok* states that, in the Sabutschine region of the Transcaucasus, a naphtha well lately bored to the depth of 140 saschen—160½ fathoms—in the Ararat concession, throws out daily as much as 50,000 pud—820 tons—of naphtha; and that another well was bored at Bibi-Eibat, in the territory of the Black and Caspian Sea Association, which during fourteen hours poured forth 800,000 pud—13,120 tons—of naphtha, and in a period of six days yielded, though not regularly, nearly 2,000,000 pud—32,800 tons. Owing to an obstruction, however, which had formed in the borehole, which is 10in. in diameter and 189 saschen—220½ fathoms—deep, the spring ceased flowing on 19th April, but again gushed out on 1st May, since which period it has yielded daily 200,000 pud—3280 tons—of pure naphtha.

An interesting article on "The History of the Introduction of the First Hermetically-sealed Thermometer into France," was published in a recent number of the *Cosmos*, with extracts from the correspondence of Pierre des Noyers, secretary to the Queen of Poland. In 1657 he sent a description of a Florentine thermometer to M. Boulliau, of Paris, with a drawing of it, which is reproduced in *Cosmos*, and in 1658 a specimen of the instrument was sent to Paris, and was apparently used by M. Boulliau on June 25th of that year. This thermometer was graduated by means of small black enamelled knobs on the outside of the tube, and was subsequently improved by the Accademia del Cimento. A full description, *Nature* says, of the instrument is contained in Professor Hellmann's "Anfänge der Meteorologischen Beobachtungen und Instrumente," in *Himmel und Erde*, vol. ii., page 175—see *Nature*, vol. xlii, page 207.

Referring to some lecture experiments on the nodes of a bell described in *Nature* by Mr. Osborn, Mr. R. L. Taylor, Manchester, writes:—"For some years I have been in the habit of showing these nodes in the following way. An ordinary glass bell-jar, 8in. or 10in. high, with a moderately broad, flat, ground edge, is held with the edge upright, and fine sand scattered all over the flat edge. It is comparatively easy to excite the edge with a bow in such a way that the sand will be driven off everywhere except at the four nodes. I have never been able, however, to obtain more than four nodes in this way. I have also employed a similar method for showing the nodes of a tuning-fork. If the fork is a moderately large one, it is held horizontally in the hand, and the upper prong is covered with sand. By bowing sharply near the middle and near the root of the prongs, two overtones can usually be obtained, the nodes of which are clearly marked by the sand."

The largest specimen yet found of natural crystallised carbon, a variety of the black diamond, such as is used for the crowns in diamond boring, was lately brought to the notice of the Paris Academy of Science, by M. Henry Moissan. This carbon, which weighs 630 grammes—3075 carats—was found in the province of Bahia, Brazil, between the Rio de Rancadcor and the Bicas stream, in the Lençoes territory. It is of rounded form and decidedly black, while its surface is partly smooth and partly wrinkled, the latter, when examined by a magnifying glass or microscope of small power, presenting the appearance of a substance which has given out gas while still in a pasty condition. The external aspect greatly resembles that of the minute grains of carbon obtained by M. Moissan in the buttons of iron and silver compressed by sudden cooling in water, while the colour is also identical. This large specimen is porous, having lost about 19 grammes since it was discovered in July last.

Professor Agassiz, in the *American Journal of Science* for December, gives some results of a series of tests which he has been making of rock temperatures at great depths in the Calumet and Hecla mines. The greatest depth so far obtained there is 4712ft., and the temperature has been taken at 105ft.; 655ft., or the depth of the level of Lake Superior; at 1257ft., or the level of the sea; at 1663ft., a depth equal to that of the deepest part of Lake Superior, and at four additional stations, each respectively 500ft., 550ft., 561ft. and 1256ft. below the preceding one. The deepest point at which temperatures have been taken was 4580ft. It is proposed to take a last reading, when the final depth of 4900ft. is reached, and at that time the details of the observations will be published in full. In the meantime, some of the results obtained are interesting. The highest rock temperature obtained at the depth of 4580ft. was only 79 deg.; that at 105ft. was 59 deg., which makes the average increase 1 deg. of temperature 223ft. Lord Kelvin had found this to be 51ft. for a change of 1 deg. of temperature, and the observations in the St. Gothard tunnel gave results of 60ft. for a similar change. Calculations based upon the latter observations make the crust of the earth approximately 20 and 26 miles thick. Professor Agassiz's observations make the crust over 80 miles thick, and give a temperature at a depth of 19 miles of only 470 deg., the older ratios showing for this depth 2000 deg. Perhaps these results would indicate different thicknesses of the earth's crust at different points on the earth's surface.

MISCELLANEA.

Messrs. John Fowler and Co. (Leeds), Limited, have asked us to announce that they are issuing £200,000 of Four per Cent. First Mortgage Debentures. For further particulars see our advertisement columns.

A Sheffield steel manufacturer, who has spent some months in the Transvaal, found in Johannesburg alone no fewer than thirty-two representatives of steel houses—English and Scotch—competing for orders in the Golden City.

In giving an account of the inventions of Alfred Ely Beach, its late editor, the *Scientific American* publishes an engraving of a typewriter, showing its mechanism, as made in 1856, and awarded a gold medal by the American Institute. His pneumatic postal receiving and despatch system is also illustrated and described.

Prizes having been offered for the best designs for a steel bridge over the Medway, at Snodland, Kent, that of Mr. H. Woodhouse, Liverpool, has been accepted. The bridge is 4380ft. long over all, of which 2880ft. is carried by steel arches, The centre span, over the Medway, is 240ft., and 75ft. high above T.H.W. to underside of bottom boom.

A quadricycle, fitted with a rotary pump and with fire hose, is described and illustrated in *La vie Scientifique*, as ready for the road and ready for pumping. In the latter case the rear wheels are raised above the ground and the pump put into gear, and the four men then work the pedals as though for propulsion on the road. It makes a very handy little fire engine.

The Board of Naval Bureau Chiefs has decided to furnish Gunboat No. 10, to be built by Lewis Nixon, at Elizabeth, N.J., with water-tube boilers. This will be the first vessel of the United States Navy to be completely supplied with such boilers, although the Monterey has one-half her boilers of this type. The Chicago will also be supplied with them for one-half of her battery. The other half will be Scotch boilers.

The death is announced of Mr. Abraham Davy, of the Oaks, Pitsmoor, Sheffield. Mr. Davy was the eldest son of the late Mr. Joseph Davy, one of the founders of the firm of Messrs. Davy Brothers, Park Ironworks, Sheffield, and was actively associated with its management from boyhood until his retirement a few years ago. He was also interested in the coal trade, and a director both of the Whitwood and the Eckington Collieries.

We understand that Mr. William O'Brien, who has been in the employ of the Fairfield Shipbuilding and Engineering Company since 1868, has just now severed his connection with that firm. During this period he held the position of outside manager for the last sixteen years, and successfully engined, amongst others of our noted greyhounds, the Arizona, Alaska, and Oregon, for the Guion Line; Umbria, Etruria, Campania, and Lucania, for the Cunard Company; and s.y. Livadia and Peter the Great.

A plate representing 415 tons of 8in. turret and barbette armour for the battleship Iowa and the armoured cruiser Brooklyn was tested at the Indian Head Proving Grounds on January 8th, with results unsatisfactory to the manufacturers, the Carnegie Steel Company. Two ports were cut in the plate to make it represent as nearly as possible the port-plate of a turret. A 6in. armour-piercing projectile of the Wheeler type, weighing 100 lb., was fired at the plate with a velocity of 1700ft. a second. The plate broke into three pieces. A second shot was fired at one of the pieces, which also failed to meet requirements.

President Cleveland's Message to Congress has had rather an adverse effect on the cutlery trade done by this country with the States. At the end of the last quarter of 1895 business had crept up to a satisfactory figure. In fact, the total trade done during that period had only once been reached since 1880, and that was during the year 1881. The first few weeks of this year, however, have seen a large falling off in the demand from the States. One of our leading establishments, mainly engaged on the American trade, have put their men upon short time. A similar remark applies to another large house who do a large business with the United States.

The five new 20-knot third-class cruisers, which are to be built for the Royal Navy by contract, will differ, the *Central News* learns, but slightly from the Petorius, which was designed by Sir W. H. White, K.C.B., Director of Naval Construction, in the early part of last year. Provision for the building of the new vessels will be made in the Navy Estimates for 1896-97, and the drawings for the new vessels are being prepared with all possible despatch, in order that their keels may be laid as soon as practicable. The cruisers will be equipped with eight 25-pounder and eight 3-pounder quick-firing guns, and two 16in. torpedo tubes, and will probably be ready for the pennant in the spring of 1897.

The work of making the surveys for the Erie New York State Canal improvements was begun on January 13th. The plan is to divide the canal into eleven sections, with an assistant engineer in charge of each section. Each engineer will have a force of ten to twelve men, not including three or four labourers. Mr. J. L. Little, Division Engineer, is quoted by the daily papers as follows:—"The first work on the improvement of the canals under the new law will probably be done in Buffalo. Buffalo is a feeder for sixty miles of canal, and it is necessary to get water there before anywhere else. The depth of water there is the keynote for the whole canal system. The scheme of the State engineer is to first start at Buffalo, and deepen the channel in the canal about 3ft. to Tonawanda Creek."

Railway material firms in the Birmingham district receive with satisfaction this week the intelligence that the result of a survey made by Mr. Grieve Macrone, C.E., to establish the practicability of a line of railway from the upper to the lower Shiré in Africa has proved to be even more satisfactory than was hoped for. Mr. Macrone was, it is understood, commissioned by a syndicate connected with the African Lakes Company, the most powerful trading corporation in British Central Africa; and it is now proposed to form a separate company for constructing a line between Chimoro and Blantyre. Chimoro is the highest point on the Shiré River to which steamers can ascend at all times of the year, and it is obviously desirable, therefore, that the railway should start at this place. A rival scheme has, however, been set on foot for building a line to Maperera and Blantyre, and it is greatly to be desired that the promoters of the two projects should come to some understanding.

In accordance with a resolution passed at the last meeting of the London County Council, a joint committee has been formed of the Parliamentary and Water Committees of the Council for the purpose of considering and dealing with the various Bills relating to the water questions coming before Parliament during the ensuing session. The joint committee has drawn up a report on the Staines Reservoirs Bill, the New River Company's Bill, and the Southwark and Vauxhall Company's Bill, in which power is sought to obtain the supplemental supply of water required for London by drawing on the river Thames and its tributaries, and by pumping water from Hertfordshire and Middlesex. The committee consider that the several Bills deposited by the water companies must be regarded as a definite attempt to obtain such new statutory powers as might enable the companies for many years to escape coming under the purview of Parliament and the local authorities, while the result of the companies obtaining such powers would be a large addition to the cost of purchase. Of course the committee are strongly of opinion that the Bills must be opposed by the Council.

EXPERIMENTS WITH KRUPP ARMOUR PLATES

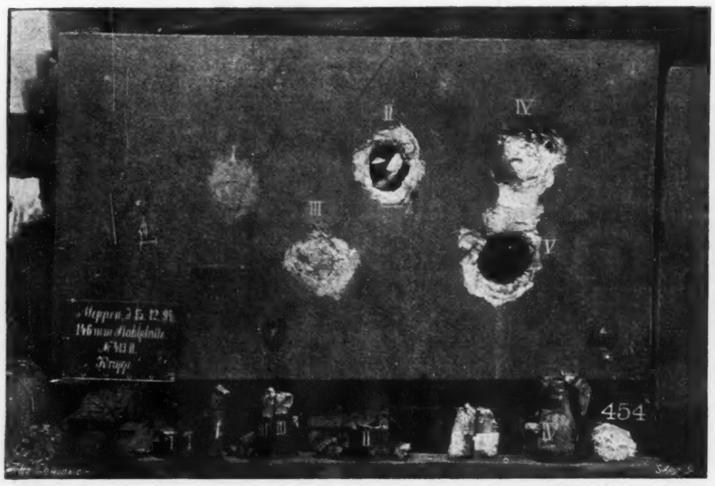


Fig. 1—KRUPP 5·75in. TREATED NICKEL-STEEL PLATE—FRONT

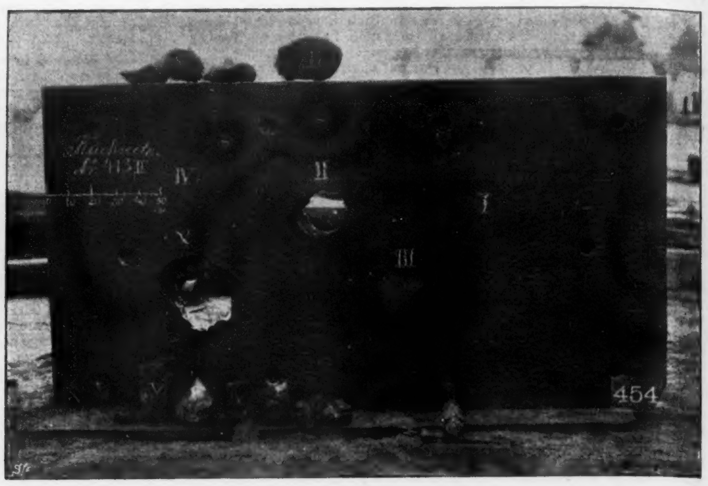


Fig. 2—BACK OF PLATE, FIG. 1

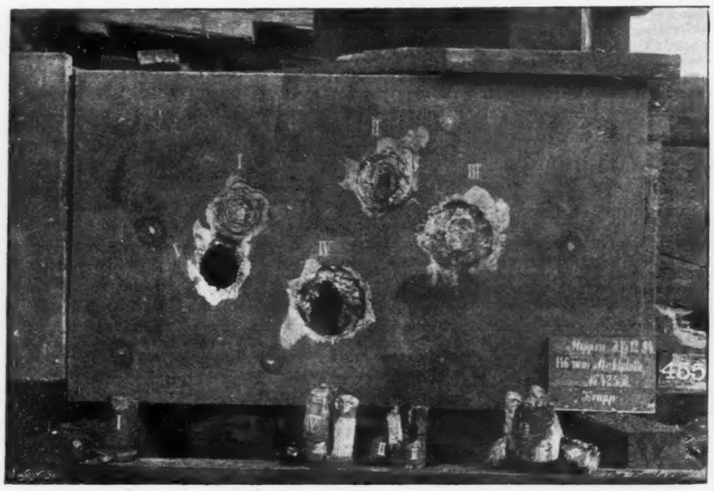


Fig. 3-KRUPP 5·7in. TREATED NICKEL-STEEL PLATE—FRONT

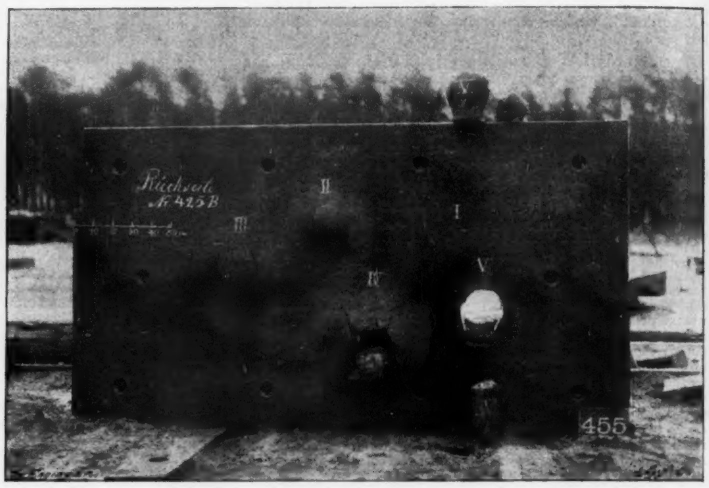


Fig. 4—BACK OF PLATE, FIG. 3

KRUPP'S ARMOUR IN 1894-1895.

WITH a short notice of a paper in *Stahl und Eisen*, by J. Castner, September 15th, 1895, are given in a pamphlet prints of photographs of results obtained by Krupp's armour within the year. We have, as well as the copies of this pamphlet, obtained in answer to our request, actual photographs furnished by Herr Krupp. We propose to deal with these rather more fully than we should usually do in support of the assertion which we have made that, in spite of the excellent work of our manufacturers, our neglect of nickel, and our want of system in grappling with the question has caused other nations to get ahead of us in armour, especially, we fear, in the manufacture of thick plates.

In the pamphlet to which we refer, is mentioned the fact that all nations, except England, have pushed on with the manufacture of nickel steel armour. Success was obtained with nickel and chromium by St. Chamond, but nickel only was adopted by the United States. Difficulties of blow-holes and blisters are referred to, but these, while they interfered but little with the actual strength of the armour, have been in a great measure got over, and armour-plates have been turned out by Messrs. Krupp free from them. Captain Sampson's opinion is quoted as to the beneficial effect of nickel, both in increasing the depth of the carbonising action and in giving security in the final water hardening. The difficulties and disappointments at first experienced with thick plates are referred to. These have been at length overcome, but it has been found that metal for treated and water-hardened faced armour must be more carefully selected than for that which is for oil tempering. There is a liability during cementation to the formation of blisters and flaws, which may be developed seriously in subsequent forging. Thick treated plates, however, have been at length successfully produced on both sides of the ocean with care and experience. It has been found important to prevent the production of gas arising from the action of carbon on an oxide film on the metal; also rapid carbonisation has been found to destroy the fine grain in the metal and to produce large crystals like those in cast iron. Instead of wood charcoal animal charcoal has been used in America, the surface of the plate being covered with it to a depth of from 12 mm. to 15 mm.—4¾in. to nearly 6in.—over which is laid the usual charcoal mixture. The Grambow process is mentioned, and the Creusot process of carbonising by means of ordinary illuminating gas. The results obtained by the Creusot process have not been published, and Captain Jaques guesses that Krupp uses a similar process; but how far this guess is correct is not stated. Gas is, however, said to offer the following advantages over charcoal in any solid form:—First, its action is more even, and gives greater uniformity; secondly, it is more certain or sure; thirdly, its action extends deeper; fourthly, it takes a shorter time; fifthly, it does not need so high a temperature. Consequently, it improves the quality of the plate and saves expense. A system is noticed which was tried in the States—we presume, that of Lieutenant Ackerman—of grooving plates before carbonising them, in order to make this action penetrate more easily into the plate. The success of these plates is not established; but it has been proved, and additional evidence to the same effect is furnished by the experiments with which we are about to deal, that furrows in the face of a plate do not predispose it to fracture, nor influence the direction of lines of fracture when the plate is broken. Gruson proved the same thing with regard to the surface furrows which are found on chilled iron castings; and Whitworth experiments are referred to, which proved that steel plates in whose surfaces a network of artificial cracks had been made, resisted as well as plain plates. Indeed, in one case the grooved plate was the best. The hardening action has been at length successfully graduated into the tough foundation, so as to avoid the danger of producing a hard layer which would scale off, and the depth of metal rendered too hard to drill has been brought to from 20 mm. to 30 mm. (7·9in. to 11·8in.). The account of the success achieved by Carnegie's double-forged 14in. plate for the Oregon line-of-battle ship, tried at Indianhead, is remarked on, which has been compared with one of Krupp's of 300 mm. (11·8in.) thick, tried on March 16th; which comparison, the writer observes, should have resulted in the superiority being accorded to Krupp. We do not note the elements of this comparison here, because we wish to devote our space to the more important matter of actual accounts of the trials following, which took place on December 15th and 17th, 1894, and on March 15th and 16th, 1895, in the presence of representatives of the German navy.

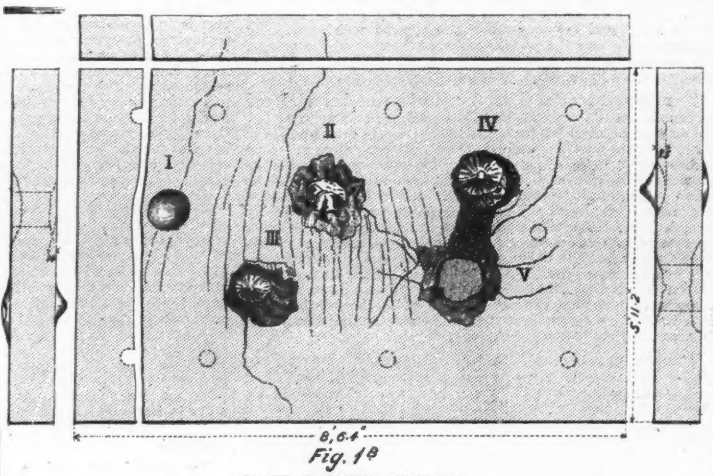


Fig. 1ᴮ

PLATE SHOWING FISSURES

Figs. 1 and 2 show the effect of an experiment made to ascertain whether a number of hair furrows or surface cracks—twenty-six in all—developed in a 146 mm. (5·75in.) plate in manufacture, acted injuriously on the plate under trial. The plate, No. 413 II., was 2·73 m. × 1·5 m. (8ft. 11·1in. × 4ft. 11in.) treated Krupp nickel steel plate. It weighed 4580 kilos (4½ tons). It was held up by ten 65 mm. (2·6in.) bolts. The following rounds were fired at it, with armour-piercing steel projectiles:—

No of round.	Calibre in		Weight of projectile.	Striking velocity.	Calculated perforation through iron.	
					Fairbairn or Maitland.	Tresidder.
	c.m.	in.	lb.	f.s.	in.	in.
I. ...	15	5·9	112·4	1560	10·4	10·2
II. ...	15	5·9	112·4	1891	12·8	13·6
III. ...	15	5·9	112·4	1734	11·7	11·8
IV. ...	21	8·27	209·4	1431	10·9	10·3
V. ...	21	8·27	209·4	1641	12·7	12·6

It will be seen by Figs. 1 and 2, that only Rounds II. and V. perforated. The shot most nearly matching the plate is No. III., and the resistance is very good. The

EXPERIMENTS WITH KRUPP ARMOUR PLATES

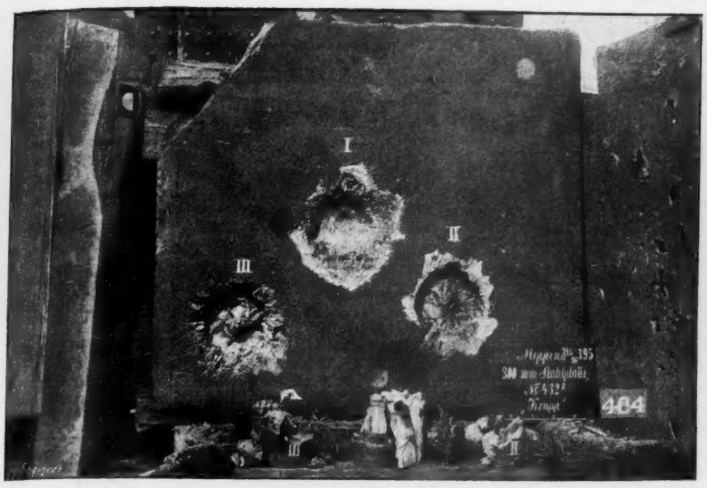


Fig. 5 KRUPP 11·8in. TREATED NICKEL-STEEL PLATE—FRONT

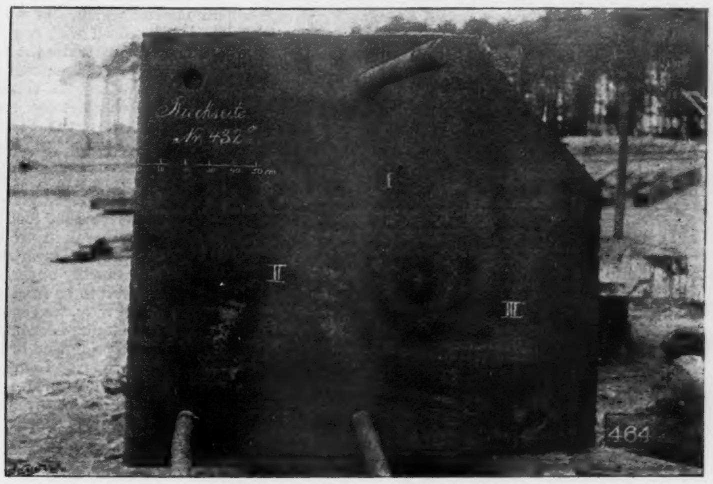


Fig. 6—BACK OF PLATE, FIG. 5

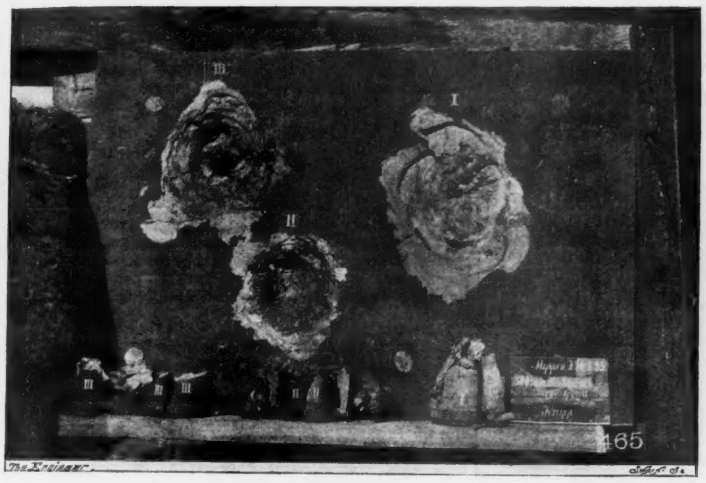


Fig. 7—KRUPP 11·8in. NICKEL-STEEL TREATED PLATE—FRONT

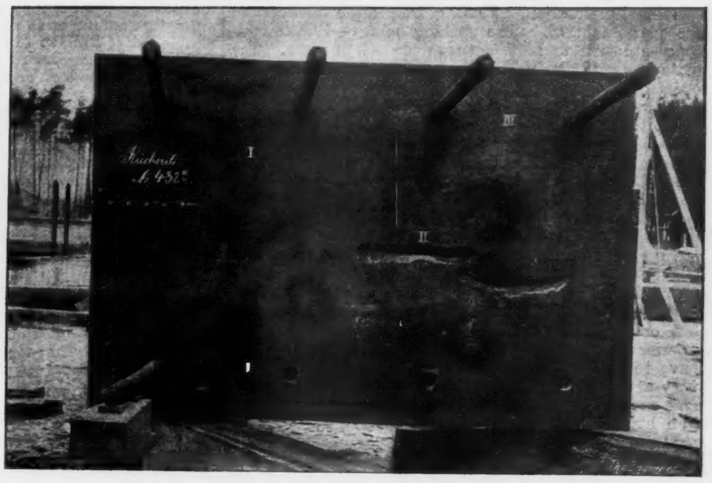


Fig. 8—BACK OF PLATE, FIG. 7

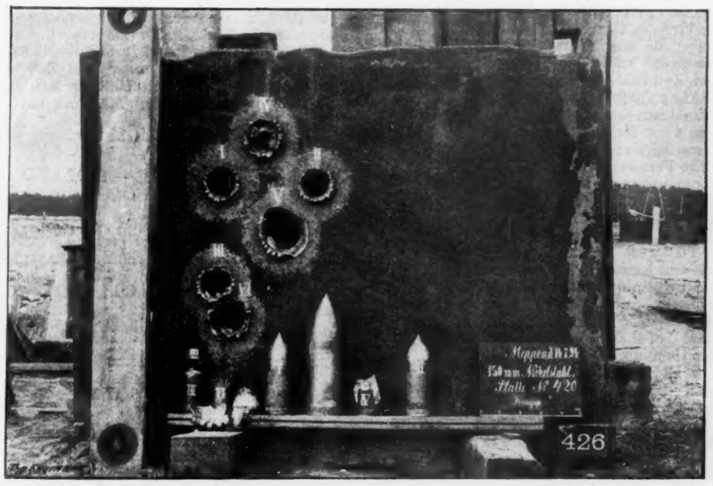


Fig. 9—KRUPP 6·1in. NICKEL-STEEL PLATE UNTREATED—FRONT

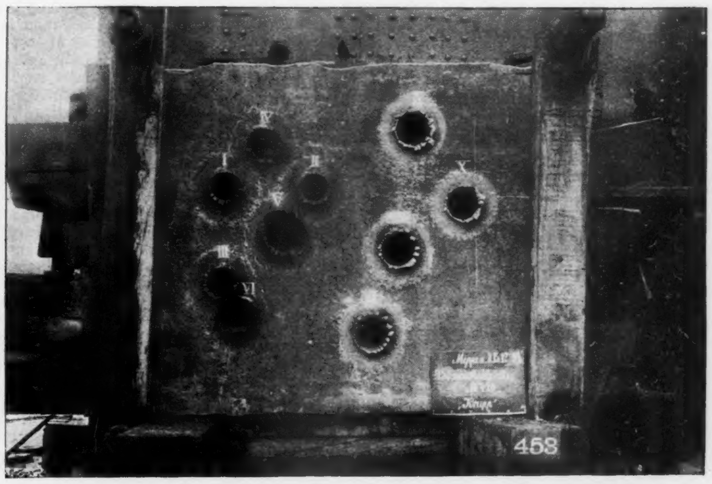


Fig. 10—PLATE FIG. 9, AFTER FOUR ADDITIONAL ROUNDS

actual equivalent of wrought iron suggested on best authority perhaps is $1\frac{7}{8}$in. the thickness of the treated steel, so that we may consider a treated plate which is equal to double its thickness of wrought iron a very good one. In this case, then, the plate would be a first-class plate if it was equal to 11·5in. of wrought iron. That it resists the passage of a projectile of 11·7in. or 11·8in. calculated perforation shows that it possesses remarkable excellence. The fissures ran down the face in nearly parallel lines; they are not very easily seen in the photograph, but are shown in Fig. Iʙ. It is evident that they produced no effect, for the only cracking developed by the attack consisted in a few more or less radial cracks from Round V., and one or two others from III., II., and I.—see Fig. Iʙ. Space forbids giving effects in more detail. Fig. 2 shows the back with a bulge partly opened at III., clean holes at II. and V., and bulges at I. and IV.

Next comes a plate, No. 425ʙ, of the same dimensions, and presumably similarly treated in manufacture, as it is termed a sister plate, but weighing 4760 kilos. (4 tons 13·6 cwt.) This was attacked by the rounds shown below, with results given in Figs. 3 and 4.

No. of round.	Calibre in		Weight of projectile.	Striking velocity.	Calculated perforation through iron by Tresidder.
	c.m.	in.	lb.	f.s.	in.
I.	15	5·90	112·4	1560	10·2
II. ...	15	5·90	112·4	1890	13·5
III. ...	21	8·27	211·0	1562	11·8
IV. ...	21	8·27	210·5	1627	12·5
V. ...	15	5·90	112·4	2022	15·0

It will be seen that rounds IV. and V. perforated the plate; the others were defeated, breaking up without getting through. Fig. 4 shows clean holes for IV. and V., bulges partly separated for II. and III., and insignificant for I. Round II. is the case of the greatest perforation defeated, being, as shown in table, 13·5in. of iron, which bears a ratio of 1·16 to the thickness of the plate. This argues considerably still greater power of resistance than that of the first-mentioned plate. Round III. delivered the greatest breaking shock, the total striking energy being 7424 foot-tons, or 1584 foot-tons per ton of plate, which is a very severe tax. Most of the attacks on modern steel plate have consisted in blows with great perforating power but insignificant shock, seldom exceeding 500 or 600 foot-tons per ton of plate. This, then, is a shock out of all comparison with that to which plates have generally been subjected.

The next trial given is that of a plate numbered 432 V, 300 mm. (11·81in.) thick. The area was 20 m. × 1·8 m. (6ft. 6·7in. × 5ft. 10·8in.) Its weight was 7·83 tons. It was held up by bolts 80 mm. (3·15in.) thick of nickel steel entering 50 mm. (2·0in.) into the plate back. The following rounds were fired at it. (See Table C in next page).

Figs. 5 and 6 show the results of this attack. The projectiles all broke in the plate face; the greatest test for perforation is the last blow, having a calculated perforation of 24·5in. of iron, or 2·27 times the thickness of the plate. The greatest shock is that of the first round, whose striking energy is 11,500 foot-tons, or 1469 foot-tons per ton of plate, the weight of the latter being 7·83 tons.

Krupp's report calls attention to the fact that projectile No. III. struck 430 mm. (16·93in.) from the side, and 360 mm. (14·17in.) from the bottom, and severely tested the toughness of the plate. Two small cracks were developed, but the plate held wonderfully well together.

TABLE C.

No. of round.	Calibre in		Weight of projectile.	Striking velocity.	Calculated perforation through iron by Tresidder.
	c.m.	in.	lb.	f.s.	in.
I.	28	11·02	508·4	1813	19·9
II. ...	21	8·23	305·1	2174	23·3
III. ...	21	8·23	305·5	2240	24·5

We now pass on to the most remarkable plate of the series, No. 432 U. Its dimensions were 3·0 m. (9ft. 10·1in.) × 1·90 m. (6ft. 2·8in.) × 300 mm. (11·81in.) It weighed 13·27 tons. The following rounds were fired at it:—

No. of round.	Calibre in		Projectile weight.	Striking velocity.	Calculated perforation through iron by Tresidder.
	c.m.	in.	lb.	f.s.	in.
I.	30·5	12·01	716·1	1753	21·5
II. ...	30·5	12·01	715·4	1889	23·9
III. ...	30·5	12·01	712·7	1993	25·9

The whole of the projectiles were broken up without effecting perforation, as shown in Figs. 7 and 8. There were no serious cracks. Round III. was a tremendous test, both as to perforation and shock. The rate of the calculated perforation, 25·9in., of iron to the thickness of the plate, is 2·19. The striking energy—19,630 foot-tons—amounts to 1479 foot-tons per ton of plate. The plate has entirely defeated the attack, and may be fairly claimed as exhibiting an extraordinary union of hardness and toughness. We take it to be the best result that we have ever seen, not only because it has exhibited extraordinary qualities, as shown by the above figures, but also because being a thick plate these qualities are exhibited under the conditions which make them specially difficult of realisation. We only see two grounds on which what has been said could be in any way qualified. One, it may be objected that the projectiles are perhaps inferior to those used in the States or elsewhere. This is a question that could only be solved by a competition. The Wheeler-Sterling shot in the States have performed the greatest feats that we have heard of, but only competition would prove that Krupp's are inferior; and very inferior indeed would these projectiles have to be to make the plate before us anything but a very extraordinary one. A more reasonable objection, and one that ought in justice to be made—and to give him his due, the writer of the report raises the very question himself—is that this plate is a champion one, made only for attack, and not, like the American plates, samples taken from a supply for ships. The gist of this objection lies in the fact that the treatment of plates must necessarily be hampered by the circumstance that they have to be shaped to an exact form. Allowance on this score may be freely conceded. The plate may very well take its stand on its merits as a champion plate. It is added in the report that the excellent plate with treated face exhibited by Krupp at Chicago, and noticed in our report on the same, was produced by metallurgical means which could be applied to a plate which was required to be brought to any desired form.

The last plate whose trial is reported is of a totally different character, being an untreated nickel plate 8ft. 6·4in. × 5ft. 11·3in. × 6·10in., weighing 5 tons 6·1 cwt. This was subjected to an attack shown in the following table:—

No. of round.	Calibre in		Weight of projectile.	Striking velocity.	Calculated perforation through iron by Tresidder.	Penetration achieved.	Effect.
	c.m	in.	lb.	f.s.	in.	in.	
I. ..	12	4·72	57·32	1641	8·8	7·0	Projectile set up 0·35in.
II. ..	12	4·72	57·32	1690	9·2	7·2	Projectile set up 0·43in.
III. ..	12	4·72	57·32	1894	10·9	9·6	Projectile broken.
IV. ..	12	4·72	57·32	1950	11·4	9·4	Projectile broken.
V. ..	17	6·69	169·8	1408	10·5	Through	Projectile set up 0·08in.
VI. ..	12	4·72	57·3	2148	13·1	Through	Shot broken.
VII. ..	15	5·91	112·4	1338	8·1	6·7	Projectiles unbroken but set up, amounts not exceeding 0·81in.
VIII. .	15	5·91	112·4	1516	9·7	10·8	
IX. ..	15	5·91	112·4	1566	10·2	9·5	
X. ..	15	5·91	112·4	1636	10·9	Through	

This plate had thus borne, it is observed, blows whose total striking energy amounted to 5109·9 m.t. (16,500 foot-tons). The breaking up of the 12 c.m. projectiles as the velocity increased, caused the conclusion to be arrived at that they were overmatched by the plate; and the 17 c.m. appearing, on the other hand, to be an overmatch. The last four rounds were fired with the 15 c.m. gun. The plate showed no cracks—see Fig. 9—and the metal exhibited the usual even fringed edge to the holes, the concentric discoloration and other phenomena common to sound, even untreated steel under severe treatment having received blows amounting to 3113 foot-tons per ton of metal. The report concludes by observing that this plate showed remarkable qualities, having remarkable toughness, combined with an amount of hardness which offered great resistance to penetration.

In this verdict we fully concur. It will be seen that projectiles whose calculated power of perforation was over 10in. of wrought iron or 8in. of ordinary steel, and in one case 11·4in. of iron or 9·1in. of steel, and which should, therefore, have easily perforated this untreated plate, whose thickness was only 6·1in., were stopped by it, although they got their points through. It is a little difficult to make out what the backing was. It appears to have been changed and the plate set up anew after the sixth round. Judging from the photographs it consisted only of wood baulks set up vertically in the first instance and horizontally in the second. These may or may not have received support from structures behind; it is immaterial which. It will be observed that the three projectiles fired with a velocity of 1894 foot-seconds or over, broke up, while the whole of the remainder set up more or less, the extreme limit being 0·81in. in length. We are inclined to think them rather soft, and not equal to those now made in the United States. We have seen the results of a trial when Krupp projectiles beat "all comers," and we should not like to speak positively, but we think that projectiles are now made which would refuse to set up thus on striking an untreated plate with a velocity of from 1340 foot-seconds to 1650 foot-seconds. We should prefer a projectile to break in preference to so behaving, and we think that projectiles now exist which would neither break nor set up sensibly under such conditions, but to establish this they need to be fired against the plates in question. Be this as it may, we regard this plate as the beau ideal of what is required for inland shields, which are intended to resist the prolonged breaching attack of siege guns of medium power; and certainly if plates approaching the standard of the previous plates can be placed on ship's sides, the German naval officers may indeed congratulate themselves on the excellence of their armour.

THE TYLORSTOWN EXPLOSION.

IT would be an undeserved reproach to engineering science to protest or admit that colliery explosions, with their always appalling death-roll, however few or however many, are an inevitable incident of the coal-mining industry, in the same sense, for example, as to fall on the field of battle is a recognisable risk of a soldier—his risk, his fate, and perchance his glory. There is commonly a mystery in these disasters; the better the pit has been regulated the greater is the mystery; and the calamity announced from Tylorstown this week would appear to be, more distinctly than the greater catastrophe at the Albion Colliery in 1894—according to the testimony of the most expert mining engineers on the spot—altogether inexplicable.

For a moment let us describe the position from its geographical and engineering points of view. The valley of the Little Rhondda strikes northwards from the Rhondda River at a point where the ancient watercourses trisect the best of the more modern developments of the Welsh steam coal beds. At the head of this once picturesque ravine, which until twenty years ago deserved its name of "the valley of ferns," Messrs. Davis sunk pits which are known now as the Ferndale, but were originally called the Bllaenclechan Collieries. In those almost virgin seams terrible explosions occurred in 1867 and 1869. They were then the only sinkings in a district which has since been proved to contain one of the richest, and at the same time the fieriest steam coal beds in the kingdom. The Standard Colliery, the National Colliery, the Boedringallt, have subsequently been opened. The managers in each case knew the dangers; they took precautions; they adopted every scientific safeguard as it made its appearance; and yet every pit in the little valley has been the scene of a more or less dreadful explosion, except that at Ynishir.

The Tylorstown pits had been sunk to the southern dip of the Ferndale seams, and the working of the coal from the time that Tylor Brothers began this enterprise was always as safe as it turned out in the end to be lucrative. The Tylor property was transferred to the hands of David Davis and Co., Limited, and since then the workings of the two collieries, which had before almost impinged on one another, have been made physically and geographically continuous, though the output has been kept distinct, and the coal won in each was brought up distinctly from the four shafts of the Ferndale and the separate shafts of the Tylorstown pits. Roughly, one might say, you could walk more than four miles through underground roadways, from the southern shaft of the Tylors' colliery to the northern shaft of the Ferndale pits. And this enormous subterranean area was continually watched with the same vigilance as a Kimberley overseer surveys his diamond deposits; supervised by the best men whose services could be retained by high salaries; supplied with every device which science could suggest for the free and ample ventilation of the roadways and headings. It was but the other day that we were told by mining amateurs that every colliery should have three shafts, which is well enough in its way, only the amateur used to insist that the upcast shaft should always be at the "face" of the workings. Even the Home-office, when there were then no colliery experts—and it is doubtful if Sir Matthew Ridley has yet a colliery department attached to his staff—laughed at the idea of making a new upcast for every year's advances into the "face'6 of the coal measures. But at Tylorstown there were three shafts, and at the upcast there was a Schiele fan, which was thrown out of gear for a couple of hours as one of the effects of the explosion. Despite of the interruption of the fans, and with the doorways separating the Tylorstown workings from the Ferndale workings, it is to be inferred that the ventilation of the Tylorstown Colliery continued to receive a supply of air, or so many men would not have been enabled to reach the downcast shafts in safety, and Mr. Hannah, the manager of the Ferndale and Tylorstown pits, could not have made his heroic march—as brave a march as anything done in war—from seven in the morning until three in the afternoon, throughout the labyrinth in search of the poor fellows who might still be succoured from the effects of the deadly afterdamp.

But here is a problem for the mining engineer who has combined chemistry with his other attainments. In two or more instances Mr. Hannah, the manager, in his perilous exploration of the shattered mine, climbed over falls to be encountered by groups of colliers with their lamps alight. The men were dead, and had died painlessly; there were the lamps in the midst of their peaceful circle, still burning as vividly as a shielded Clanny will ever burn, in the opaque interstices of the pit. Mr. Hannah, with his three brave companions, had to go back thrice to the inlet of fresh air to give his lamp a light again. He went back with a re-illumined wick, and found a ghastly group around the still lighted hooded Clanny lamps. The mystery of the explosion is not greater than the mystery as to how or why the spark of life in the lamps should live when the human spark of life had fled. There were cases in the western part of the workings in which men were found with their clothing torn off them by the blast, which is interpreted to mean that the explosion broke out there; but it is in the mid-distance, and also to the eastward, where the men were found as though they had just sat down to rest until a sudden "fall" had been removed from the shaft side. These men on the eastern side could not have heard the full volume of the sound of the explosion, and then the afterdamp reached them, and there, where they sat, they became at rest for ever.

THE KANE-PENNINGTON MOTOR.

THE Kane-Pennington motors illustrated in our impression of the 3rd inst., and the Racine carriage and a bicycle driven by these motors, have lately been exhibited at Brown's Grounds, Nunhead, where we have had an opportunity of inspecting them. The motors as used for the bicycle and for the four-wheeled carriage have two cylinders, as shown at page 3, and two pairs of cylinders respectively. Those used on the carriage have pistons 2·5in. diameter and 6in. stroke, working in water-jacketed cylinders, the water circulation being natural, and the water supply being kept in a cylinder along the front of the carriage beneath the oil receiver, shown by Fig. 12, page 3. The four-cylinder motor has been removed from the carriage since it reached this country, and a two-cylinder motor similar to that used on a bicycle, but with a water-jacket, put in its place. The motor is extremely lightly made in nearly all its parts, and drives an intermediate shaft by means of a strong bicycle chain. On this shaft are a compensating motion and two friction clutches for two different speeds, the motion being conveyed to the road wheels of about 24in. diameter, with very large pneumatic tires, by means of light bicycle chains. The hydrocarbon used in the cylinder falls by gravity into a little receiver on a pipe connecting the two cylinders, and its quantity is regulated by a little hand valve under the seat. This hand valve and the two friction clutch levers and the switch for the ignition spark current are all easily reached by one of the two riders on the seat of the carriage. Most of the features of the motor are decribed in the specification of the patent of Mr. Thomas Kane, No. 20,305 of 1895, but some improving modifications have been made in the electrodes used in the cylinders for the ignition of the charge by electric spark, the spring wire or elastic contact piece being on the electrode inserted in the cylinder, instead of on the end of the piston. The cam circuit maker on the crank shaft is replaced by a commutator on the crank shaft, formed with brass strips on a circular piece of vulcanised fibre. When the piston on its in-stroke compresses the charge of air and vapour from the hydrocarbon, and when its stroke is very nearly completed, and full compression pressure nearly reached, the rigid electrode on the piston body comes into contact with the elastic insulated electrode, and a spark is formed. On the return of the piston this contact is, of course, repeated, the two make and break sparks occurring within the time occupied by the piston in moving about a quarter of an inch. If the explosive mixture is not ignited on the in-stroke of the piston, as perhaps it usually is, the second spark prevents any chance of a misfire and of a consequent back ignition. At the very high speed of about 500 to 600 revolutions per minute, a little lead in the ignition is always desirable, and the spark made on the ingoing make and break is desirable in this respect. The battery used by Mr. Pennington consists of from ten to twelve small dry cells occupying little space.

Mr. Pennington shows the carriage at work, driven at high speed by this little two-cylinder motor, and carrying four persons over good, bad, and very rough roads, and soft grass covered ground, and he shows by it that such a light carriage may be operated by small power and light mechanism. Some of the details of his motor are very much lighter than English engineers would think of using for the purpose, and probably he will make some modifications in this respect. The kind of hydro-carbon used will be gathered from a consideration of the details of the engine, and we understand that in a short time Mr. Pennington will show in Holborn how he uses the heavier oils, such as Russolene or Tea Rose, in his new motors.

EXPRESS PASSENGER ENGINE—MIDLAND RAILWAY.

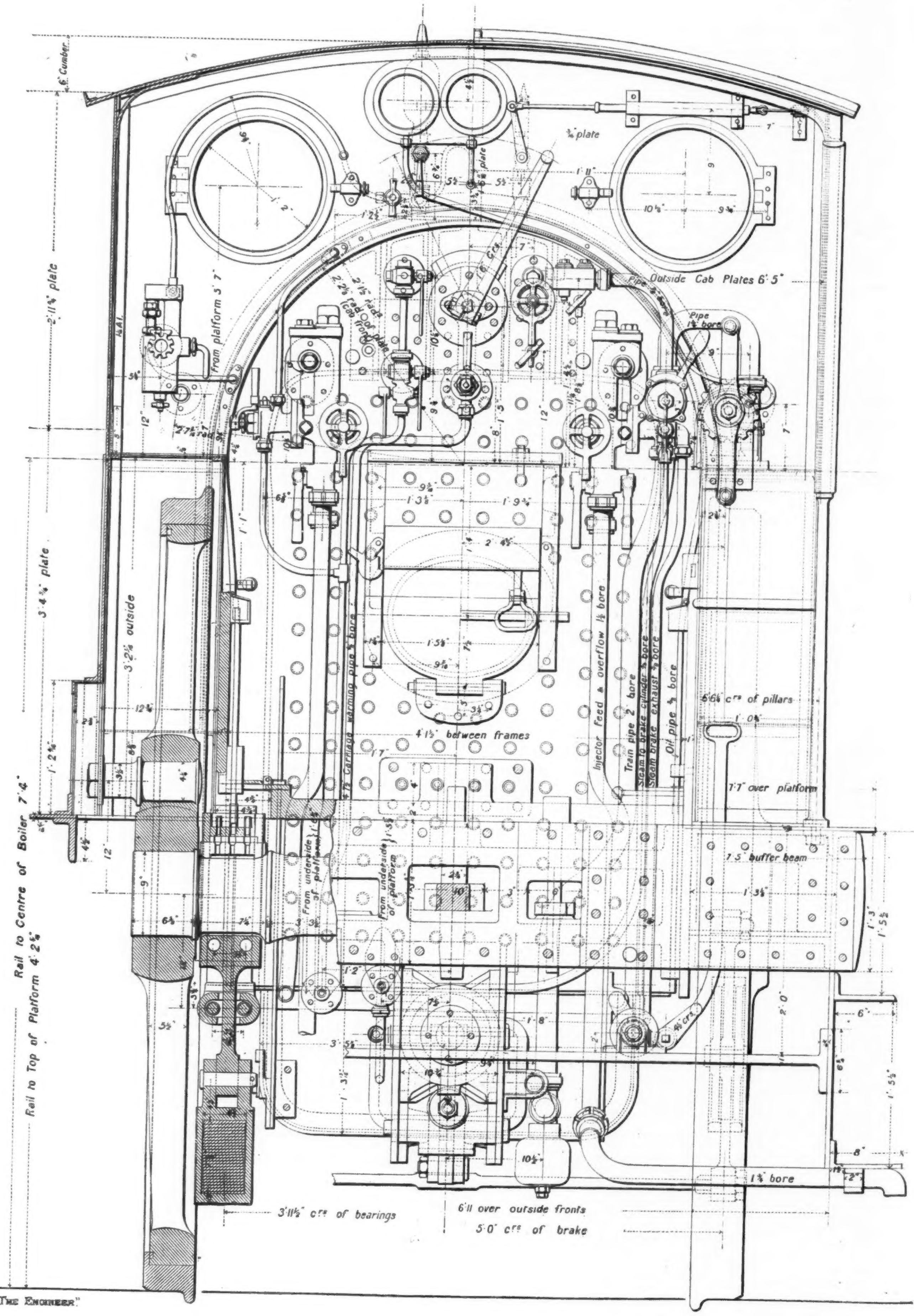
IN our impression for December 13th, 1895, we published an external elevation of one of the four coupled express engines, designed and built by Mr. Samuel Johnson, for working the fast traffic of the Midland Railway.

We now publish an end view and cross section of the same engine as a supplement. For full particulars, we must refer our readers to our issue of December 13th, before mentioned.

RAILWAYS IN CHINA.—The Leeds Chamber of Commerce recently received a report on the respective advantages of the Kunlon Ferry Railway and Railways leading to Szumao. That report has been sent to the Under Secretary for Foreign Affairs, with a request that the attention of Lord Salisbury may be drawn to the conclusions, which are:—"Owing to the character of the intervening country, which belongs to China, there is apparently not the slightest reason to hope that the Kunlon Ferry Railway can be extended eastwards to Szumao, or north-eastwards to Tali-fu. With a railway from their Tonquin seaboard to Szumao, the French would gain the trade of Southern Yunnan, which we have learned is the richest part of that province of China, containing as it does all the large plains, cities, and towns; they would be able to push on the projected extension of that railway from Szumao through Yunnan, and would be assured of attracting to a French port the trade of the landlocked western half of China. If we should fail to make a railway from a British seaport to Szumao, we could not compete with the French in facilities. We should have to resign ourselves to a trade with a sparsely populated, barren, wild upland, which possesses little means of communication, and which would not open up to us any important outlet or inlet for the trade of Yunnan. By the cession of parts of the Shan State of Kiang Hung to France, the Chinese Government has shown either want of will or powerlessness to protect that State from French aggression. This being the case, the breach of its engagement with this country has, we would submit, absolved us from carrying out our part of the Burmo-Chinese Boundary Convention. We have thus the power to resume our rights to the Burmese Shan States of Kiang Hung and Munglem. By bringing Kiang Hung again within our dominions, and by arranging with Siam for the return to us of a small track of territory neighbouring Kiang Hsen, the Burmah-Karenni-China Railway can be made from Rangoon to Szumao entirely through British territory, without encountering inordinate physical difficulties. If these steps are taken by her Majesty's Government, and the Burmah-Karenni-China Railway is constructed, important military, administrative, and commercial advantages will accrue to our Indian Empire.

EXPRESS PASSENGER LO

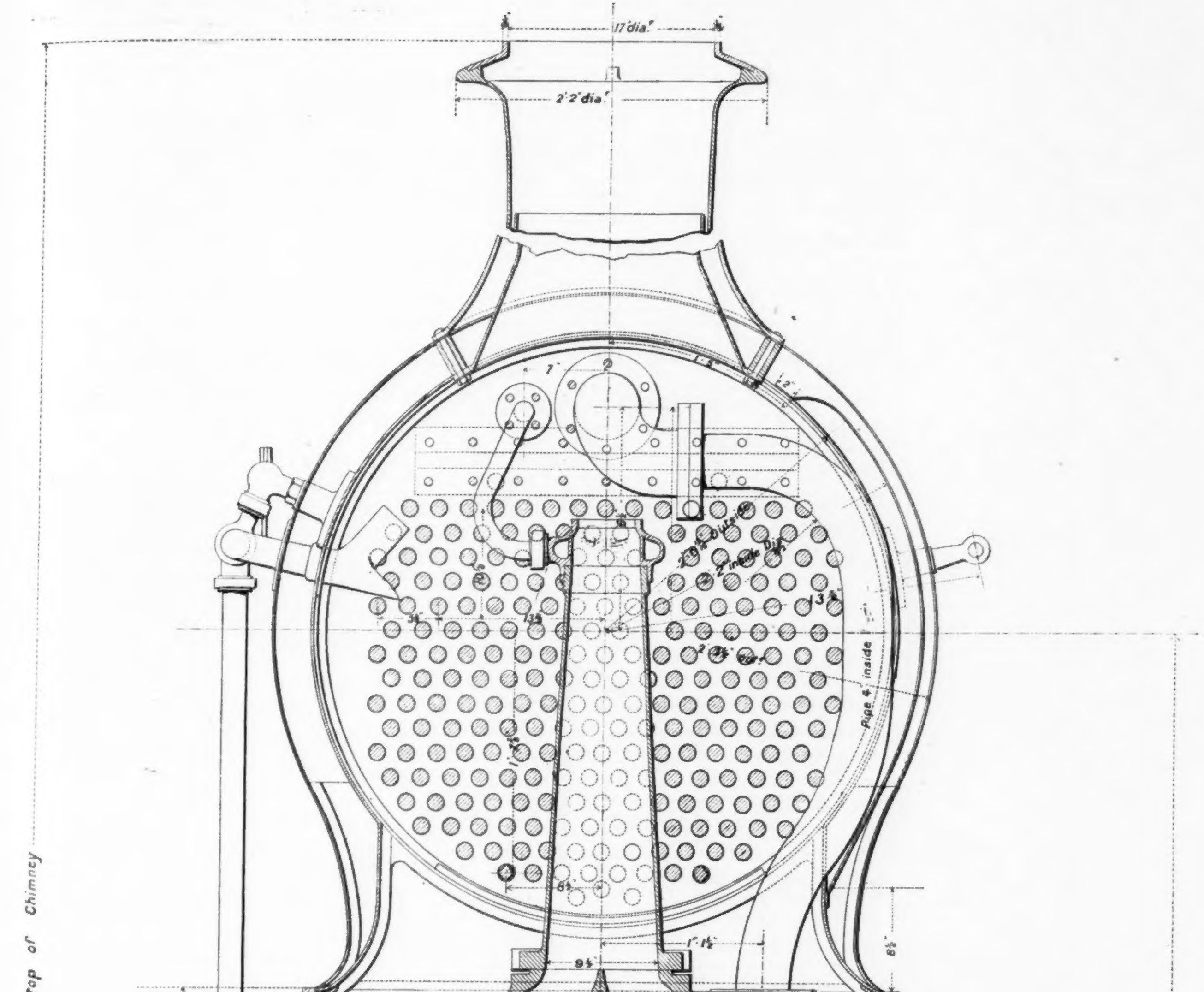
MR. S. JOHNSON, M DERBY


6" Camber
2' 11¾" plate
3' 4¾" plate
3' 2⅛" outside
Rail to Centre of Boiler 7' 4"
Rail to Top of Platform 4' 2⅝"
From platform 5' 7"
¾ plate
Outside Cab Plates 6' 5"
Pipe 1¼ bore
2' 1½" rad.
2' 2⅛" rad. of plate (cab front)
2' 7⅛" rad.
Carriage warming pipe ⅞ bore
Injector feed & overflow 1¼ bore
Train pipe 2 bore
Steam to brake cylinder ⅞ bore
Steam brake exhaust ⅞ bore
Oil pipe ⅝ bore
4' 1½" between frames
6' 6¼" c^rs of pillars
7' 7" over platform
7' 5" buffer beam
From underside of platform
4¼ crs.
1¾ bore
3' 11½" c^rs of bearings
6' 11 over outside fronts
5' 0" c^rs of brake

"THE ENGINEER"

LO OTIVE, MIDLAND RAILWAY

NSON, M. DERBY, ENGINEER


17"dia.
2'2"dia.
1'5"
2"
7"
2⅛" Outside
2" inside Dia.
1'3⅜"
1'3⅜"
2'3¼" Rad.
Pipe 4" inside
12'1½" Rail to top of Chimney
Rail to Cr. of Boiler 7'4"
1'4½"
8½"
1'1½"
9½"
Furness
Furness
5½
3½
1'8⅜"
2¼"
1½"
11¼"
10¼"
18½" × 26"

Swain Eng.

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PUBLISHER'S NOTICE.

⁂ With this week's number is issued as a Supplement a Two-page Engraving of an Express Passenger Locomotive, Midland Railway. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it. Price 6d.

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TO CORRESPONDENTS.

Registered Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

⁂ In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and bearing a penny postage stamp, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.

⁂ All letters intended for insertion in THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

⁂ We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.

WEATHER AND DISEASE.—*The Graphotone Company, 1, MacLean-buildings, E.C.*

J. M.—*You can get full particulars by applying to the Marine Department of the Board of Trade, Whitehall. Reed's "Handbook," a well-known publication, is used for passing the examinations. It is published in Sunderland by the author.*

H. AND SONS (Norwich).—*You do not give particulars as to the quantity, but there can be no difficulty in blowing the dust directly into the furnace above the fire-bars. If you send it into the chimney it will not be burned, and may cause a nuisance. No screen would be needed. If the arrangements are properly carried out, the blast of air over the fire will act to prevent smoke. A small steam jet may be used, or a fan, as most convenient.*

COKE SCREENING MACHINERY.

(*To the Editor of The Engineer.*)

SIR,—Can any reader give me any information of any machine that will economically separate coke from cinders? W.

Liverpool, January 27th.

HARDENING STEEL TO CUT HARD STEEL.

(*To the Editor of The Engineer.*)

SIR,—Would you please allow me to ask in the correspondence columns of THE ENGINEER, how to harden a drill to cut through a hard file? Milling tools are often made on this principle. Reamers and other tools are cut out of self-hardening steel after hardening by some means.

Camberwell, January 27th. TOOLMAKER.

LEATHER DRESSING MACHINERY.

A CORRESPONDENT in Barcelona, Señor J., wishes for information about skin and hide dressing machinery, with figures and details as to prices. Address Señor José Julia, San Juan de Horta, Barcelona, Spain.

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Prices for Displayed Advertisements in "ordinary" and "special" positions will be sent on application.

Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Three o'clock on Wednesday afternoon in each week.

Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, February 4th, at 8 p.m. Paper to be further discussed: "Recent Developments in Gas Engines," by Mr. Dugald Clerk, Assoc. M. Inst. C.E.

SOCIETY OF ENGINEERS.—Monday, February 3rd, at 7.30 p.m. The President for the past year, Mr. William George Pierce, will present the premiums awarded for papers read during the year. The President for the year 1896, Mr. Samuel Herbert Cox, will deliver his inaugural address.

INSTITUTION OF JUNIOR ENGINEERS.—Monday, February 3rd, at 7.30 p.m. Lecture I. of special course of Marine Engineering Design, by Mr. H. M. Rounthwaite, M.I. Mech. E., M.I.N.A.

SOUTH STAFFORDSHIRE INSTITUTE OF IRON AND STEEL WORKS' MANAGERS.—Saturday, February 8th, at 7 p.m. Paper: "Technical Instruction in its Application to Ironmaking," by Mr. Thos. Turner, A.R.S.M., F.I.C., Director of Technical Instruction to the Staffordshire County Council.

GEOLOGISTS' ASSOCIATION.—Friday, February 7th, at 8 p.m. Paper: "Some Structural Characteristics of the Granite of the North-West Himalayas,' by Lieut.-General C. A. McMahon, F.G.S.

SOCIETY OF ARTS.—Monday, February 3rd, at 8 p.m. Cantor Lecture: "Alternate Current Transformers," by Dr. J. A. Fleming, F.R.S. Tuesday, February 4th, at 8 p.m. Applied Art Section. Paper: "The Garden in Relation to the House," by F. Inigo Thomas. T. G. Jackson, A.R.A., will preside. Wednesday, February 5th, at 8 p.m. Paper: "The Mexican Drainage Canal," by Frederick Henry Cheesewright, M. Inst. C.E.

DEATHS.

On the 26th inst., at 35, Upper Tollington-park, ARCHIBALD STURROCK, son of the late JOHN BUDGE, formerly Locomotive Superintendent, Great Northern Railway, age 43.

On January 22nd, at 8, Buckingham-street, Strand, DANIEL KINNEAR CLARK, M. Inst. C.E., M. Inst. M.E., &c., aged 74 years.

THE ENGINEER.

JANUARY 31, 1896.

THE ROYAL ORDNANCE FACTORIES.

IN a recent article on the constitution of the Ordnance Factories, we showed that the inception of warlike stores, and their final inspection and sentence, was entirely in the hands of naval and military men, and that it was, consequently, absurd to state that the naval and military authorities had lost touch with the factories. The actual manufacture, only, is under a civilian Director-General, but space prevented us from pointing out that, with the exception of the Small Arms Factory at Enfield, the Superintendents and their assistants were still all naval or military officers, and have remained so since the reorganisation carried out by an officer of the artillery in 1887. A colonel of artillery and two captains of the same arm manage the Royal Laboratory; a captain of the Navy and a lieutenant manage the Royal Gun Factory; a colonel of engineers is responsible for the Royal Carriage Department; a colonel of artillery, a captain, and a lieutenant, are responsible for the Royal Gunpowder Factory; and a colonel of artillery manages the factory in Birmingham. The Director-General has two military assistants, one a commander in the Navy, and one a captain in the artillery, and it would thus appear that he is assisted by no less than twelve officers of the Army and Navy, and therefore if the work turned out to be bad and dear—as it is alleged to be by the writers in the *Times*—that circumstance seems to us to be a strong argument in favour of the proposition that military and naval men are unfit, from want of technical knowledge and special training as manufacturers, to carry on manufacturing operations, and confirms the view which we have expressed of the imprudence of placing important factories under such management, and thus severely hampering a competent civilian Director-General.

It may, indeed, be pleaded that the cause of the alleged bad results is the incompetence of the Director-General, and that if he were replaced by an officer of artillery who, of necessity, could have had no technical training or experience as a manufacturer working for profit, the ordnance factories would once more resume their former supposed efficiency, by which we presume that they would revert to the condition which called forth the inquiry instituted by Lord Morley's committee, whose report it was that prompted the reorganisation now complained of. We are not concerned to defend the fitness of the present Director-General for the office he fills, we can only say that Mr. Stanhope selected a man who had achieved for himself a high position in the engineering and scientific world, and who had for thirty-six years managed successfully large manufacturing concerns engaged in the production of a great variety of things.

We must point out that there are two ways of managing a factory. One is to be the real head, to know more of every detail than any of the subordinates, and to be able to make such dispositions as will reduce the cost of production without endangering the quality.

The other method is to become a nominal head, nursed by the civilian managers and foremen, and acting really according to their direction, and as their mouthpiece. To the second category the military chiefs of necessity belong, and experience has shown that it is only in exceptional cases that an officer's natural talents and proclivities enable him, after a time, to take up a proper position. Such a man was General Maitland, who had served a good apprenticeship in the gun factory before he was charged with the duty of reorganising the factories, and it is well known that he strongly advocated working the shops by means of trained civilian managers.

In our judgment no substantial improvement in economical management is to be looked for till there is a complete separation between the military advisers of the Director-General and the civil assistants who are charged with the actual carrying out of the work and the keeping of the accounts; and we sincerely trust that in the administration of the factories the present Government will faithfully carry out the principles laid down by the last Conservative administration, and loyally acquiesced in by their Liberal successors, who, we may remark by the way, were so satisfied with their predecessors' choice of a Director-General, that one of their last acts was to recommend him to the Queen for special honour.

CONTINENTAL COMPETITION AND RAILWAY RATES.

IN our last impression we directed attention to some of the more important features of the report of the delegates of the British Iron Trade Association on the iron and steel industry in Belgium and Germany. A great deal remains to be said. Indeed, the more carefully the report is examined, the more prominently do subjects for discussion thrust themselves on our notice. One of the most interesting is the statement already referred to in our columns, that English manufacturers are handicapped, as compared with Belgian and German iron and steel makers, by the cost of transport. Many examples are given. Thus the rate per ton for finished iron and steel on English railways, for large quantities, varies between 1·06d. and 1·415d. per mile, which is about three times the Belgian rate. We need scarcely insist on the importance of cheap carriage in every trade. But, on the other hand, it will not answer any good purpose whatever to denounce railway companies, and assert, as has been done, that they are ruining the iron and steel trades of the country. The proper course is to take all the available evidence, and estimate the value of the facts by their significance and pertinence to the matter at issue. In this way—and only in this way—can sound conclusions be formed.

At first sight it no doubt appears that if a ton of iron can be carried 150 miles for 3s. 6d. in Belgium, it cannot be right to charge 12s. 6d. for carrying a ton of iron 134 miles in this country. There are two explanations of the fact. One is that the English railway companies charge a great deal too much; the other is that they manage their business so badly that they cannot charge less. That, in short, they waste money. We think the first count may be dismissed at once, if for no other reason than that extortion would not pay. The other argument seems to be equally devoid of foundation. It is not possible that the able men who conduct traffic on English railways would blunder continually to such an extent as to waste two-thirds of the receipts for goods. Again, it must not be forgotten that a railway is a commercial enterprise, and that it is quite as important that our railways should pay as it is that our iron and steel trade should be prosperous. The capital invested in railways is, indeed, very much larger than that invested in the blast furnaces and rolling mills of Great Britain. There are two reasons why railway carriage is cheaper in Belgium than this country; one is that it is much slower as regards goods, and another is that many of the railways are State property, and consequently profit becomes a secondary consideration. No doubt it would be possible, if the State owned the railways in this country, to reduce the cost of transport very much. Roughly speaking, working and maintenance expenses are 55 per cent. of the total receipts; the remaining 45 per cent. goes to pay dividends, and it is well known that these dividends are in no case excessive, and in many cases very small. The fact that the Belgian State railways can afford to carry at very low rates is precisely akin in many respects to the action of the German Government in giving a bounty on sugar, and is entirely opposed to all the principles of free trade. It might, of course, be argued that the nation at large ought to make arrangements for the cheap transport of coal, iron, and such like; but it is clear that if the railway companies do not make more than a legitimate charge now, to do anything of the kind would be simply to subsidise an industry, while any legal enactment reducing the cost of carriage in such a way that dividends would be reduced as a consequence, would simply be to rob Peter to pay Paul; to, in a word, take money out of the pockets of one set of shareholders and put it into the pockets of another set. Beyond question this is done in Germany and Belgium, where the community is taxed to support special industries; but the practice does not commend itself to the British mind, and we fancy that in this direction the iron and steel trades will get no relief.

But although we may exonerate the railway companies from the charge of extortion, it does not follow that they are wholly blameless. It remains to be considered whether it is not possible to reduce the cost of carriage in this country. In approaching this very difficult and complicated question, many points must be weighed. In Belgium, for example, we have a very flat country, and haulage can no doubt be effected with a minimum expenditure of power. We find, too, that the rates are anything but uniformly low. Thus, while Germany can send iron through Belgium to Antwerp, 150 miles, for 3s. 6d. per ton, Couillet has to pay 3s. per ton for sending it 70 miles only to the same port. But the bare statement made in the report is very inadequate. We are not told whether carriage is effected in private wagons, or in those of the railway company; nor is a syllable said concerning terminal charges. A most important factor in the whole question is the quantity of iron or steel or coal to be moved, and the accommodation available for moving it. It should be quite well known that in this country many of our railway companies are at their wits' end to accommodate traffic which is enormous as compared to anything to be met with on the Continent. Bristol station, for example, on the Great Western Railway, has been congested for years, and a very large recent outlay has been necessary to secure some relief. Most of our main lines have been doubled for long distances at great expense. But there are districts where it is next to impossible to provide greater facilities than now exist, because of the difficult nature of the country to be traversed. Belgium, on the contrary, is an ideal railway country, and in Germany, while much of it leaves nothing to be desired in this respect, the Government provides, at the cost of the taxpayer, cheap transport. It is very difficult for the outsider to realise the magnitude of the operations carried on on English railways. At Edge Hill, on the London and North-Western Railway, there are more than 60 miles of sidings and space for 7000 wagons. Where can we find abroad a railway company owning 70,000 wagons? One of the principal complaints urged against our railway companies is not that they charge too much, but that they will not forward goods. It is not extreme to say that most of the railways in the country which have anything of importance to do in the way of transporting finished iron and steel and coal, have usually about as much traffic as they can conduct with certainty, comfort, and despatch, on the present system. It remains to be considered whether the present system is the best that can be adopted.

We cannot find that there is anything about the management of Belgian or German railways to encourage the belief that a substantial reduction in working expenses would be effected in this country by assimilating our practice with theirs. It is much to be regretted that on this subject the report before us is silent. Nothing is said as to systems of loading and unloading, locomotives, wagons, &c. With the general facts we are, of course, familiar. The principal difference between transport practice in the three countries is that the engine coal used in Germany and Belgium is much inferior to that used in this country; but the difference in the cost of coal is, after all, an insignificant item. It is possible that in this country a saving might be effected by using a more powerful type of goods engine than that now in vogue; but account would have to be taken with the Board of Trade before these heavy engines could be adopted, and the conditions suitable for their employment are far from being universal.

But a much more important question than the possibility of reducing railway rates suggests itself. How far do the present rates hamper operations and restrict trade? It is to be assumed that high cost of transport must do harm, but we want to know how much harm. On this point, again, the report is silent, singularly silent. "It seems difficult to understand," runs the report, "how works situated at Liége in Belgium, more than a hundred miles from a shipping port, and at Oberhausen, Dortmund, and Ruhrort in Germany, which are at least a hundred and twenty miles from tide-water, and having no advantage in the cost and the conditions of supply of ores and fuel, should be able to compete as they do with work of the same class and character in England situated upon or within a few miles of tide-water, as are most of the works in Cleveland, Scotland, Wales, and Cumberland." The answer given is that "one of the obvious causes is the low rate of transport which the works of both Belgium and Germany enjoy." The importance of the passage we have quoted lies in the value to be attached to the words "able to compete," and this can only be determined when we know something of the weight of goods affected by railway rates. It has been known for years that carriage was in certain ways and under certain conditions cheaper on the Continent than in this country. The report adds nothing to our information on the question. The bald statement that rates are lower, without hinting at the reason why they are lower, is most unsatisfactory. It is in the abstract extremely desirable that railway rates should be as low as possible, but to reduce them to an extent which would rob shareholders would be not only unjust but impolitic. On the other hand, however, it is not, we think, too much to suppose that good might be done by laying definite evidence before the railway companies for their consideration. Thus, for example, let us suppose that the steel makers of Sheffield combined together, and having ascertained all the facts, formulated a scheme by which the cost of transporting steel to shipping ports might be reduced, and submitted it to the directors of the principal railways concerned. Is it not to be supposed that such a scheme would form the subject for careful deliberation, and how much would the hands of the steel makers be strengthened if they could cite the example of Belgium or Germany in such detail as would be convincing? We fear that the delegates of the Iron and Steel Trades Association have missed a great opportunity. Nothing to be found in the works which they went out to examine could be of more importance than the details of the railway management of the two principal countries concerned. The report is in many ways calm, dispassionate, even colourless, but it contains statements, nevertheless, which may easily be twisted to support wild doctrines. If our railway companies allege that they cannot reduce the rates because of the high prices charged by the steelmakers for rails and axles, and the coalowners for fuel, they receive little sympathy. Yet, after all, it should be clear that the railway industry is at least as important and as deserving consideration as any other; and the companies may just as well say that the ironmasters are doing them harm as the ironmasters may say that railway rates are too high—there should be no waste on a railway, there should be no waste in an ironworks. If it can be proved that the English companies are spending more on transport than need be spent, then a change for the better ought to be made; but until this is done there is nothing to be gained by blaming the companies. Without suggesting a way to improve matters, we have already said that cheap transport is highly desirable. But if it can only be attained by cutting down wages, augmenting risk, and reducing the number of hands employed on our railways, the gain may not compensate for the loss. We do not say that there is no room for improvement. We do say that the report of the Iron and Steel Trades' Association does not help us, as it should, to a way in which rates may be reduced. The report before us may be taken as a basis for further action, but those seeking relief will have to complete their case; in its present aspect it amounts to a bald statement, implied rather than defined, that because railway rates are less in Belgium and Germany than they are here, the rates are too high in this country. This is not enough. The public must be told the why and the wherefore of these things before it can be in a position to decide between the iron trade aud the railway companies. More light, much more light, is wanted.

LONDON FIRES AND THE BRIGADE.

THE report addressed to the Fire Brigade Committee of the London County Council by the chief officer of the Brigade, Captain Sexton Simonds, on the fires in the metropolis during the past year, is remarkable as showing a considerable increase in the aggregate, and at the same time an exceptionally low percentage of serious fires. Never were fires so numerous, and yet we must go back seven years to find a lesser number of those which inflict serious damage. In 1866 one-fourth the fires were of a destructive nature; after 1878 they fell below 10 per cent., the average of the ten years ending with 1894 was 6·2 per cent., and last year the proportion went down to 3·9, the lowest percentage on record. It is satisfactory to find the ratio declining steadily rather than spasmodically. In 1879 it was 9 per cent.; in 1885 it was 7 per cent.; afterwards it was 6 per cent., then it became 5 per cent., and now we may call it 4 per cent. This is the more worthy of consideration, seeing that the total number of fires, year by year, has gone up at so great a rate. Until 1883, the fires were under 2000 per annum, until 1891 they were under 3000, and now in 1895 they reach 3633, being more than 1000 above the annual average of the previous decennium. Has petroleum anything to do with this? Mineral oil lamps are a fruitful source of fires on a small scale, and possibly they affect the statistics which appear in these annual reports. In the list of "causes of fires" for 1882, we find 120 cases attributed to the upsetting of spirit lamps. In 1895, 314 fires were caused by the upsetting of mineral oil lamps, 12 by the upsetting of spirit lamps, and 112 by the explosion of lamps described as burning mineral oil. Fires caused in various ways by lamps fed with mineral oil or spirit, omitting those in which there was simple contact with curtains or window blinds, were 152 in the year 1882, but were no less than 485 last year. It would therefore seem that the more extended use of mineral oil or spirit is having something to do with the astounding increase of London fires. Still the explanation is partial, the fires from all causes having increased by as many as 1707 since 1882.

A test which we have applied on former occasions in respect to the prevalence of London fires, is that of the ratio between fires and population. Fires were numerous in 1893, being then 3410, and the number per 100,000 of the population was 79. But the ratio last year was 82·72. In 1894 the number of fires dropped, and the ratio was not much above 70. The rise last year, therefore, was very decided. In 1892 the ratio was under 74. The year 1894 appears exceptionally good among the last four, but it has yet a higher ratio than that of earlier periods. In the sixteen years ending with 1880 the average annual ratio was little more than 48. The present Sir Eyre Shaw commenced to keep the record in 1866, and in that year the ratio was rather more than 44, while the average from 1848 to 1864 was 41. Allowing for some fluctuations, it is obvious that the general tendency in London is for fires to increase more rapidly than the people. The fires last year were more than double the number in 1879, but the population had increased by less than one-third. The most encouraging feature is the decrease in the number of serious fires, and this is a testimony to the efficiency of the Brigade.

In the report by the then Captain Shaw for 1867, there is the striking statement that the serious fires in London in 1865 were as many as 512, or fully one-third of the total. In that year London had simply a Fire Engine Establishment, and the Metropolitan Fire Brigade had not been created. A great enlargement of the force and its appliances began as soon as the Metropolitan Board took charge of the affair. How fearfully weak was London in protection against fire before this change took place, will be seen by the circumstance that in 1865 the firemen numbered only 129. In a single year the Metropolitan Fire Brigade made the number 230. In like manner 87 fire engines were substituted for 38, and 39 land stations for 17. Now the Brigade includes 820 firemen, 17 "pilots," and 75 coachmen, together with a troop of 137 horses. Instead of 38 fire engines, or even 87, there are 144, and 64 of these are worked by steam. The appliances compared with those of 1865 are immeasurably superior, as in the use of the telephone and the establishment of alarm call points, of which there are as many as 570. The multiplication of fire escapes tells of the increased security for human life, though fatalities from fire are still painfully numerous—the lives lost in this way last year in London being 91, while it is satisfactory to find that as many as 215 were rescued. Captain Simonds specifies that in 22 instances mineral oil lamps exploding, or being upset, caused 23 deaths. In Captain Shaw's report for 1867 we find only 21 fires brought about by sundry accidents with lamps, whereas nearly 500 are reported as occurring last year. Smoking tobacco caused 32 fires in 1867, and in this respect recent years seem to have witnessed an improvement, Captain Simonds only reporting 15 such cases for 1895.

The work of the Brigade, while replete with detail, is marvellous in extent. The number of journeys made by the fire engines and hose vans during the past year exceeded 36,000, and the total distance run was above 73,000 miles. The quantity of water used for extinguishing fires was more than 100,000 tons, nearly half of which was taken from the street pipes. It is a matter for regret that in the course of the year there were four occasions in which there was a late attendance of the turncock, and in one case there was no attendance at all. In four instances there was a short supply of water, making, as Captain Simonds says, "nine cases in all in which the water arrangements were not altogether satisfactory." Perhaps the water companies could give some kind of explanation, though they never seem to do so. What the arrangements are for calling the turncock we are not told. But the general system is excellent, and the Brigade deserve hearty commendation both for their toil and their courage. They are a gallant set of men, notwithstanding the disparaging remarks made concerning them within the compass of the County Hall, a quarter where unstinted praise might have been looked for. But the criticism is perfectly exceptional, and scarcely anyone can be brought to believe that the rank and file of the Metropolitan Fire Brigade are petted or spoiled. Never was London so dependent upon them for its safety as now, when the population is so vast, and buildings are assuming such enormous dimensions. The elements of danger which exist in modern society may also be taken into account, malicious damage being quite a possible outcome of social and political disaffection. The police on the one hand, and the Fire Brigade on the other, safeguard the metropolis against perils such as are peculiar to a highly developed civilisation and the visible growth of wealth.

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COAL.

THE Miners' Federation and the Federated Coalowners are engaging in a friendly warfare of words concerning the present position of the British coal trade. The president of the former body—Mr. B. Pickard, M.P.—in his recent address at Birmingham to its annual conference, sought to show that the coal trade was doing well, and was able to bear the present, if not indeed, an advanced rate of wages. The Federated Owners have this week replied in a long letter which they have had published in the chief newspapers in the kingdom. This is an unusual step to take, but the importance of the whole matter becomes evident when it is remembered that in a few months' time Lord Rosebery's agreement adopted by the Conciliation Board expires by lapse of time, and that juncture may be a critical one for the British coal trade unless care is exercised. Hence the coalowners feel that it is necessary that public opinion shall have before it, not an *ex parte* statement of the position, but a fair presentation of both sides. The Miners' Federation president relied mainly on the circumstance that the shares in several limited companies which he named are now quoted at a higher price than they were in the year 1888. The owners' association point out in reply, not only that in that year the coal trade was admittedly in a very depressed condition, but that within the federated area there are between 300 and 400 companies and firms, and the Stock Exchange quotation of the price of the shares of any particular company, or of any dozen companies, is scarcely sufficient material upon which to pronounce an opinion upon the general conditions of the entire trade. In comparing the selling prices of fuel for the quarter ending the 30th September, 1895, with the prices submitted to the Conciliation Board in the July of 1894, and upon which the Board recommended a reduction in wages of 10 per cent., it is found that selling prices have fallen very considerably in every district within the federated area, and in some cases by as much as 17 per cent. The returns for the December quarter are not yet complete, but the owners' secretary expects them to show a still further drop. The Employers' Association quotes the average number of days per week on which coal was hewn and wound during each of the twelve months from August, 1894, to July, 1895, in the various districts of the United Kingdom; and proves from these figures that the number of days within the federated district—bound by the agreement and by the high fixed wage—was considerably less than in the districts outside the federation. Thus, the federated owners, by paying a higher rate of wages and working so much less time, were saddled with an increased working cost compared with their outside competitors. The mean averages of days per week for these twelve months are:—United Kingdom, 4·72; Northumberland and Durham, 5·10; Yorkshire, 4·47; Lancashire and Cheshire, 4·64; the Midlands, 4·17; South Wales and Monmouthshire, 5·26; Scotland, 4·90.

CABLE REPAIRING AND CABLE DANGER.

THE value of the cable communication between this country and its colonies and the United States has been of late amply demonstrated; and some of the facts that have been brought to light of late show again the vastness of the resources of the great companies who now control these submarine communications. It may be remembered that just prior to the exciting events in the Transvaal at the beginning of the year, one of the cords of communication between Africa and this country was interrupted. The story of the repair is told by the Marquis of Tweeddale, who states that on the 24th December, the Aden-Zanzibar cable was interrupted, and who details the steps taken by which the repairs were completed and communication restored by the 4th January. There was one cable repairing steamer at Capetown, belonging to the company owning the cable, the Eastern and South African Company, but another cable steamer was near Aden, and that was chartered, and by its use "a saving of about a week could be effected," and thus the continuity of the wires was restored, and the enormous work that followed the crisis in the Transvaal could be met. It is only by lavish expenditure that such quick repairs can be met, and by the maintenance of large fleets of cable steamers—the Eastern Telegraph Company alone owning five, by one of which the Aden-Zanzibar cable was repaired. At the meeting of the Direct United States Cable Company, a few days ago, Sir J. Pender stated that the company had just repaired the cable on this, the European side, "which has been hanging on a rock for twenty-two years," a most "interesting illustration of the length of time a cable will wear hanging on a rock," but which is now avoided by the taking of the repaired cable round it. At the latter meeting, the question of the cutting of cables in time of war was referred to, but it seemed to be the general opinion that there would be, as the uses of ocean telegraphy extended, and as the duplication of cables and of routes proceeded, less and less danger in this direction. The incalculable value of that communication to the nations has been shown by the results of the action that it enabled to be taken, both in regard to the African and the American crises, and it would be a national danger now if, with the rapid land communication, there were not also a certainty of as rapid international communication by the cables.

LITERATURE.

Minutes of Proceedings of the Institution of Civil Engineers. Vols. cix., cxx., cxxi., cxxii. Edited by JAMES FORREST, Associate I.C.E., Secretary. Together 2026 pages, with 27 plates. London: Published by the Institution. 1895.

FOR the first time we have to record a reduction in the size of the yearly volumes recording the work of the Institution of Civil Engineers in the session just completed. This, however, is due to no diminution in activity among the contributors, but has been caused by the necessities of the new building operations which shortened the session by nearly six weeks in order that the alterations in the Theatre might be completed in time to render it available for use in November, 1895, and might, therefore, have caused a greater contraction than the 264 pages and 13 plates, which is the net difference between these volumes and their predecessors in 1893-4.

The session opened on November 13th, 1894, with the inaugural address of the President, Sir Robert Rawlinson, K.C.B., which, although it contained some valuable remarks upon questions of immediate interest, such as the water supply and main drainage of London, was, appropriately enough, to a great extent of a retrospective character, it being the last address that was delivered in the old building. A feature in connection with this meeting which will be pleasantly remembered by those who were present was the telling autobiographical sketch of his career given by the venerable President in replying to the customary vote of thanks.

During the session between November, 1894, and April, 1895, fourteen papers were read and discussed at length. These range over a large number of subjects, both of civil and mechanical engineering, the latter being perhaps the more numerous. Among the former, the group of papers on mountain railways, read in January last, is most prominent. This includes descriptions of the St. Gothard Tunnel approaches, and the Stanzer Horn Cable Railway, by Mr. S. J. Berg; the Monistrol and Montserrat Rack Railway, by Mr. A. Collett, both authors including a large amount of general information upon mountain lines in appendices; and the Usin Mountain Line in Japan, also on the rack system, by Mr. C. A. W. Pownall. The discussion and correspondence upon these papers was very voluminous, extending to nearly a hundred pages, which include a great deal of supplementary information upon other lines in other parts of the world. Among new engineering works, Mr. W. D. Bruce's paper on the Kidderpur Docks, in the Hooghley, below Calcutta, is perhaps the most interesting as describing an important harbour improvement carried out on ground of an extremely difficult character, as was evidenced by the movement of the walls during construction. The character of this accident, and the method adopted for repairing it, form the subjects of a supplemental paper by Mr. H. J. Apjohn, the resident engineer in charge of the works. The special difficulties of this class of work were abundantly evidenced in the discussion, which was one of the most instructive of the session.

The mechanical papers discussed were comparatively few in number, including a paper on "Boiler Explosions," by Mr. W. H. Fowler, which, although presented in an abridged form, gave a broad, general summary of the causes of steam boiler failures, and afforded the opportunity for a fairly good discussion. Mr. John Richardson's paper on the "Regulation of Steam Engines" gave a sketch of the development of the centrifugal regulator, from the original invention of James Watt down to the present time, and the further refinements to be obtained by combining electrical with mechanical regulation. Of greater interest, however, than either of the foregoing was the paper by Mr. H. Davey on "Steam Engine Economy," who considers that the efficiency of the Cornish engine has not been exceeded by any of the newer developments, and that the compound Cornish cycle, when coupled with a good feed-water heater, will be found to be from 8 to 10 per cent. more economical per actual horse-power than the triple-expansion engine. This view found support in the discussion from Mr. Robinson, who pointed out the essential similarity in principle between the Willans and the Cornish single-acting engines, in spite of their great difference of form.

Mining and metallurgical matters were represented by Messrs. Butters and Smart's paper on "Cyanide Extraction Plant," a useful description of the working of the MacArthur Forrest process in the Transvaal gold mines. Mr. E. B. Wain's, on "Colliery Surface Works," giving the details of the surface plant of a North Staffordshire colliery, which was followed by an extremely able discussion; and a pair of grouped papers on "Electrical Appliances in Mining;" one by Mr. R. Robertson describing the electrical underground haulage at Earnock Colliery; and the other, by Mr. Robert Hay, dealt with the problem of working a bucket dredger in a river channel by a mountain stream two miles away, which has been satisfactorily solved by the agency of a Pelton wheel driving two Brush Victoria dynamos, giving a current of 730 ampères at 1170 volts. This power is applied in lifting auriferous alluvium from the river bottom, which is then washed over blanket tables, the waste falling back into the river. The weekly return of gold is from 10 oz. to 70 oz. per week for a working cost of £85. The discussion on these papers showed a general tendency to favour the use of electricity in preference to other usual methods of haulage, and a point of interest was raised, but not settled, as to the mechanical efficiency of impact water wheels working under a very high head of water.

Naval matters were under consideration, both at the beginning and the ending of the session, in the papers by Mr. A. J. Durston on the "Machinery of Warships," and on "Torpedo Boat Destroyers," by Messrs. Thornycroft and Barnaby. The first of these—a review of the machinery fitted in the seventy ships built under the Naval Defence Act of 1889, with a large amount of detail in a statistical appendix—was instrumental in raising a long and well sustained discussion upon the numerous controversial points associated with the subject, such as design of framings, forced draught, water-tube boilers, &c., many of which appeared in an intensified form, with the addition of the question of vibration at high speeds in the discussion on the second paper. The last paper, in addition to numerous diagrams and models, was illustrated by a series of excellent lantern views from original photographs, which is noticeable as a departure from the former practice of the Institution in the matter of illustrations.

The second section of selected papers published without reading and discussion contains 47 contributions, ranging over a large number of subjects: hydraulic works in the different forms of river and sea improvements, docks and harbours, &c., being very fully represented. Among these some of the more important are Mr. O. Güttmann's paper on the "Removal of the Iron Gates on the Danube;" Mr. Kenny's on "Machinery for Sea Works," which covers similar ground to that of Mr. Walter Pitt, published in Vol. cxiii., but treats the subject from the point of view of the executive engineer rather than that of the machine designer, the experience recorded being that obtained in the construction of harbours in New Zealand; and Mr. Adam Scott's on the "Deep-water Quays at Newcastle-upon-Tyne." A complete account of the Tilbury Docks is supplied by Mr. T. F. Scott for the first time, the publication of the paper having been delayed pending the settlement of legal proceedings; and Professor Vernon Harcourt has compiled a series of brief notices of such important works as Portland Harbour, the Severn Tunnel, the Forth and Tower Bridges, and the Clyde and Tyne River Improvement Works, none of which have been completely described in the "Minutes of Proceedings." One of the most remarkable of the structural works described is the bridge over the Danube at Munderkingen, by Mr. C. A. Leibbrand, in which the link-bearing system of iron bridges is reproduced in a flat concrete arch of 164ft. span, and 13½ft. rise.

The papers on water supply and filtration are so numerous that we are unable to mention even a small proportion of them. Indian and Colonial undertakings are largely represented, and a melancholy interest attaches to one of them, that on "The Muggel Lake Filtration," as being a posthumous work of the late Mr. Henry Gill, who was so long and honourably associated with the Berlin water supply.

In mechanical subjects Mr. Archibald Sharp has continued his former study of circular forms of wheel teeth into a general memoir upon the subject, which is perhaps the most considerable analytical study presented; and the same position may be accorded on the experimental side to Mr. Bryan Donkin's "Experiments on Centrifugal Fans," which, being the last paper in vol. cxxii., may appropriately conclude our survey of the work of the session.

The James Forrest Lecture, by Prof. Unwin, on "The Experimental Study of Heat Engines," is so well known to most of our readers, that we record only the fact of its appearance in the proper place in the same volume.

Although the losses of the Institution by deaths and resignations have been unusually large—amounting to 170—the additions to the roll have been 325, so that the net increase was 155; the final numbers in all classes being 5921, as against 5766 in March, 1894. The associate class shows a slight diminution from 376 to 355, which may be expected to continue; the student class for the first time in several years shows a slight increase from 791 to 816 on the numbers in the preceding year. The financial position of the Institution still continues to be satisfactory, although it is not possible to give any very detailed comparison with the results of former years, owing to the disturbing element introduced by the new building operations, and which may probably be expected to influence the accounts for some years to come. We hope by the time our notice of the successors of these volumes becomes due, that the members may be comfortably housed in their new home. The editorial work continues to be done in the same excellent manner as before, leaving little to be desired in the way of improvement. We may, however, suggest—supposing it to be possible—that some restraint might be placed upon the exuberance of discussion by correspondence. The correspondents, unlike the author who is subjected to the referee, and the speakers in discussion who are controlled by the chair, the clock, and the patience of the audience, seem to enjoy complete liberty of space, which in some instances seems to be rather unmercifully exercised.

Besides the four columns of "Minutes of Proceedings," an important addition has been made during the year to the publications of the Institution in the second part of the subject index, containing an analysis of the contents of the sixty volumes that have appeared in the fifteen sessions, 1879-80 to 1893-94, both inclusive. The system followed is the same as that adopted in the first volume published in 1881, from which it differs principally in size, being about one-half larger, or 533 instead of 374 pages, and as each page contains about forty entries, the volume may be said to contain 20,000 or more references, or probably three or four to each title. Another improvement is the new library catalogue which has lately been completed, and steps are taken to keep it up by printing the titles of new additions every month. It will be necessary, however, to have the library arranged in its new quarters to fully realise the value of these alterations.

Plate Girder Railway Bridges. By MAURICE FITZMAURICE, B.A., B.E., M. Inst. C.E. London: E. and F. N. Spon, 125, Strand. 1895. 8vo.

As the title indicates, Mr. Fitzmaurice deals only with one class of girders, but this limitation has its value, in that he is able within the space of the 102 pages of his book to deal with them in such a way as to make the book of practical as well as theoretical value. Much of that part of the book which shows, by little other than simple arithmetic, the methods of arriving at the nature and value of the stresses in plate girders, is, of course, equally applicable to lattice girders, but the stresses in struts and ties of the latter are not touched upon, though the means of arriving at shearing stresses gives the student, in large part, a key to them. As well as the diagrams necessary to the elucidation of the simple formula used for bending, shearing, compression, and tension moments under dead and rolling loads, the author gives a series of engravings from drawings of actual girders, including transverse sections of plate girder bridges and floors, which will make the book useful, not only to the student, but more particularly to young engineers, and some of their elders, who are called upon to devote their attention to plate girder railway bridges.

A Treatise on Hydraulics. By HENRY T. BOVEY, M. Inst. C.E., LL.D., F.R.S.E. New York: John Wiley and Sons. London: Chapman and Hall. 8vo. 1895.

THIS is an eminently practical, albeit theoretical, book, and is evidently written by one who appreciates the points in hydraulics much as they would occur as questions in practice of an engineer. It is, of course, impossible to deal with in 332 pages at that length with which we are accustomed to find some questions treated in books on hydraulics, but the essential subjects are in general nevertheless most satisfactorily dealt with, and a large number of examples of an instructive kind are given at the end of each chapter. Some questions have recently arisen which make it doubtful whether the rate of discharge of water from a cylindrical tube horizontally projecting from a tank, varies precisely in proportion to the square root of the head in that tank, and it is questionable whether any very recent experiments have been made to redetermine the results obtained on this subject by Berneouille and others. Mr. Bovey deals with the flow through orifices and over weirs, through pipes and in open channels, with fluid friction, and with methods of gauging. A chapter on impact leads to the final chapter on hydraulic motors and centrifugal pumps, these two chapters occupying 147 pages, and into these the author has compressed the greater part of all that is essential on the theory of water wheels and turbines, including that very excellent and simple motor, the Pelton wheel. With regard to this latter, however, considering its practical importance, and the very high efficiency with which he credits it, it would have been better had he illustrated as well as described the form and section of the cups or buckets, to which that efficiency is ascribed in comparison with its predecessor, the "hurdy gurdy." Mr Bovey's book is one which may be highly recommended.

SHORT NOTICES.

International Railway Congress. Fifth Session. London: June-July. 1895. Summary of proceedings. Bruxelles, P. Weissenbruch, Imprimeur du Roi, 45, rue du Poincon, 45. 1895.—This summary will be found by many interested in railway matters a very useful index to the whole of the proceedings of last year's London Congress. The reports and discussions are given in abstract, but not illustrated. The Bulletin de la Commission Internationale du Congress des Chemins de fer, of which Nos. 10, 11, and 12 of vol. ix. have been issued in one part, will in future be printed entirely in English and separately in French, so English readers can have theirs complete in English only, thus occupying much less space.

The "Shipping World" Year Book. A desk manual on Trade, Commerce, and Navigation. Edited by Evan Rowland Jones. 1896. London: *Shipping World* Office. 1896.—This is the tenth issue of a very useful book. It is bulkier than its predecessors, but still very compendious. The "Tariffs of Foreign Countries" is a valuable compilation, and is corrected to December 15th last. We have tested the book in various ways, and have almost always found the information we sought. But we did not find anything about the regulations of the Royal Naval Reserve, nor the present rules for fixing light screens.

BOOKS RECEIVED.

Annual Report of the Commissioner of Patents for the Year 1894. Washington: Government Printing Office. 1895.

Index to the Literature of Didymium, 1842-1893. By A. C. Langmuir, Ph.D. City of Washington: The Smithsonian Institution. 1894.

Indexes to the Literatures of Cerium and Lanthanum. By W. H. Magee, Ph.D. City of Washington: The Smithsonian Institution. 1895.

The Exhibit of the Smithsonian Institution at the Cotton States Exposition, Atalanta, 1895. City of Washington: For distribution at the Exposition. 1895.

An Account of the Smithsonian Institution. Its Origin, History, Objects, and Achievements. City of Washington: For distribution at the Atalanta Exposition. 1895.

On the Densities of Oxygen and Hydrogen, and on the Ratio of their Atomic Weights. By Edward W. Morley, Ph.D. City of Washington: The Smithsonian Institution. 1895.

Cassell's History of England, from the Earliest Period to the Present Time. With original illustrations. Part I. To be completed in fifty-two weekly parts. London: Cassell and Company, Ld. Price 6d.

Notes on Permanent Way Material, Platelaying, and Points and Crossings, with a few Remarks on Signalling and Interlocking. By W. H. Cole, M. Inst. C.E. Second edition. London: E. and F. N. Spon. 1896.

Sell's Directory of Registered Telegraphic Addresses: National Directory of Large Commercial Houses, and Buyer's Guide. Published annually, with three quarterly editions. By Henry Sell. 1896. Prices, including supplements: Subscribers, 18s.; non-subscribers, 21s. London: Henry Sell.

DANIEL KINNEAR CLARK.

THE death of Mr. Daniel Kinnear Clark severs another of those links with the railways of the past now all too few. Albeit he never carried out any great engineering work, he was a noteworthy man, and will not soon be forgotten. He died at his residence, 8, Buckingham-street, Adelphi, on January 22nd, aged 74. Of his early years and parentage little is known. We first hear of him as an apprentice in the Phœnix Ironworks, Glasgow, then carried on by Messrs. Thomas Eddington and Sons. Subsequently he was an assistant to Mr. Miller, who had an extensive practice as a civil engineer in Edinburgh. Mr. Miller had a good deal to do with railways, and after young Clark had been with him for three years, he was appointed locomotive superintendent to the Great North of Scotland Railway. While there he was diligent in obtaining information on the performance of locomotives, consumption of fuel, train resistance, &c. For some reason, however, probably inherent in the man, he does not seem to have taken kindly to practical engineering. So long as experiments or investigations were to be carried out or conducted, he was happy; but the everyday routine duties of an engineer in a responsible position did not appear to suit him. He had a strong literary bent. In 1855 he published his book on the locomotive engine and the machinery of railways. Nothing so complete and altogether satisfactory had been published before; nothing equal to it has appeared since. Colburn's treatise, modelled on the same lines, never was completed by the author. To this moment Clark's book is a standard work of reference. Of course, the lapse of time has rendered much that it contains obsolete. Locomotives of much greater power than Clark dreamed of are running, but the fact remains that Clark made scarcely any mistakes. The most prominent is, perhaps, his statement concerning train resistante, and the formulæ for calculating it, namely:—Total resistance, including engine, $R = 8 + \frac{v^2}{171}$; resistance of train alone, $R^1 = 6 + \frac{v^2}{240}$, when v = speed in miles per hour. To apply this to a recent instance. For a speed of 73 miles an hour we have $R = 8 \frac{\cdot 73^2}{171} = 39$ lb. nearly per ton, instead of 15 lb., the American estimate. But before we condemn Clark it is well to remember that the modern road is very different from that on which he carried out his experiments. It is beyond doubt that the stiffness of the road is a measure of the resistance, and Clark's experiments were made on a weak track, and with rolling stock whose resistance was much greater than that of the modern long-bodied car. The resistance per ton of train diminishes rapidly with the dead weight of the vehicle, the bulk or air displacement remaining the same, and Clark had no opportunities for measuring resistance at high velocities.

The success of his book was so great that Mr. Clark left the Great North of Scotland Railway and started in business as a consulting engineer in London. In 1857 he established himself in 8, Buckingham-street, Adelphi, and there for forty years he lived and worked. Of how few can a similar story of long residence be told? The fact bears testimony to the remarkable adhesiveness of the man. He had no desire to wander; he did curiously little to bring himself into notice, and yet where is the engineer of the last generation who did not know D. K. Clark either personally or by reputation.

In 1861 it became necessary to appoint an engineer to take charge of the machinery department of the International Exhibition of 1862. The choice devolved on Mr. Clark, and he carried out the work and discharged the duties with a skill and tact and an absence of friction worthy of all praise. The putting in of the mains to supply steam to the machinery in motion was at that time a very difficult task. The mains were laid underground, and much skill and forethought had to be used to get rid of water, and avoid leakage due to unequal expansion and contraction, Even in the present day work of this kind is not always properly done. But Mr. Clark's work was quite satisfactory. His employment at the Exhibition just suited him, and he there conducted several experiments, the most noteworthy perhaps being a trial of centrifugal pumps. Then he wrote a book, "The Exhibited Machinery of 1862," which, if it did not add to his reputation, constituted a most useful volume for reference.

During the next few years we find him acting as judge for the Royal Agricultural Society, and carrying out experiments, almost always in connection with steam or fuel. In connection with the Smoke Abatement Exhibition at South Kensington in 1881, he conducted an elaborate series of experiments, and his treatise on the subject embodying the results of his experiments may be said to contain all that is known or worth knowing concerning the domestic consumption of fuel.

But before this, that is to say in 1877, he produced the book which will do more to keep his name alive than any other which he wrote; we refer to "A Manual of Rules, Tables, and Data for Mechanical Engineers." Those of our readers who do not possess this monumental volume of 984 pages could form no idea of what it is from a few lines of description here. Those who have it—and they include no doubt the great majority of mechanical engineers—know that there is no other work like it. Is it not a volume in which we can always find just the information sought. Of how many reference volumes can that be said? The work has gone through several editions. In 1878 he brought out a small volume on "Tramway Construction," subsequently much enlarged and improved, and in 1892 his work on "The Steam Engine and Boilers," which deserves to rank with the very best treatises ever written. This was the last work of any importance Mr. Clark accomplished. During the last few years his health has been gradually failing; of late years he lived a very retired life, and was seldom seen in public. He was a member of the Institution of Civil Engineers, joining that body as far back as 1854, and he contributed to it no fewer than eight papers, among which those on the "St. Gothard Tunnel," "Railway Locomotive Stock," and "The Evaporative Performance of Steam Boilers," deserve special mention.

A NEW MAP OF METROPOLITAN RAILWAYS, Tramways, and miscellaneous improvements deposited, at the Private Bill Office, November 30th, 1895, for session 1896, has been published by Edward Stanford, of London, as usual. The new tramways are, as in the past few years, very few and insignificant, except of the effect of the London County Council policy of preventing enterprise by trying to get everything into its hands for good or ill. The proposed railway work is also very small, and public works for London under private Bills of but scant importance.

LETTERS TO THE EDITOR.

We do not hold ourselves responsible for the opinions of our correspondents.)

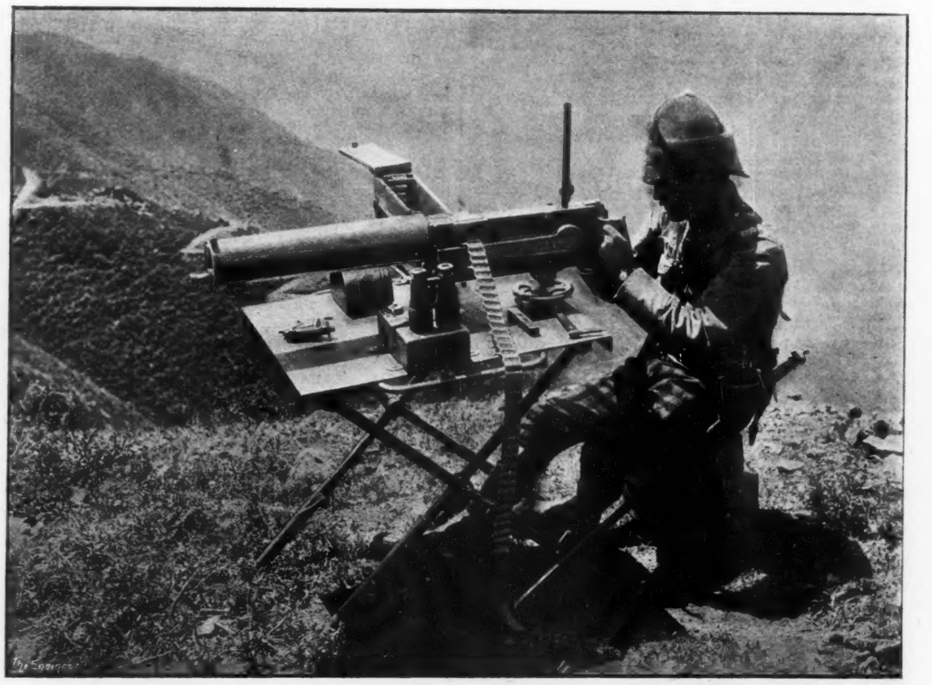
RAILWAY SHOPS IN WAR.

SIR,—The following extract from a letter I have received from my brother, who is superintendent of the locomotive department of the North-Western Railway at Rawul Pindi, may be of interest to your readers as showing the great assistance rendered to the military authorities by the railway shops, at a time when the work in transporting troops and camp followers assembling for the Chitral campaign was exceedingly heavy. He says:—

"I am sending you a ferrotype drawing and two photographs—taken by a sergeant of the Royal Engineers—of a table that I designed and made for the King's Own Scottish Borderers for their Maxim gun, as they could not take the regulation wheeled carriage up into Chitral. Lieutenant McAlister, who had charge of the Maxim gun, failing to get any kind of table made in the Rawul Pindi Arsenal, obtained permission from the General officer commanding the division to apply to me to help him. He brought the gun and carriage to my office at the North-Western Railway shops at 4 p.m. on March 18th, and explained that he wanted a table with hinged telescopic legs to take the pivot of the gun, traversing gear, &c., the weight not to exceed a mule's load—160 lb. After a brief consultation with Mr. T. O'Brien, the erecting-shop foreman, I made a rough sketch with a few principal dimensions, which Lieutenant A. accepted as embodying his ideas. We commenced work on the job on the morning of the 19th, and after three days the unfinished table was taken to the ranges and tried; but the elevating gear did not work satisfactorily. Lieutenant A. explained what was required, and the fault was rectified by the foreman at once. The drawing—which, however, was not made till some fourteen days later—shows fairly clearly all the different parts. The table was finished by 4 p.m. on March 24th, and so steady was it that at 700 yards they made 230 hits out of 250 shots on a target 6ft. square. It weighed complete 158 lb., and was approved by all who saw it. At the last moment we had also to make a special saddle to carry the table, as the mule greatly objected to carry it on the regulation Government saddle.

"Lieutenant McAlister wrote to me on June 8th saying, 'I must again thank you for all the trouble you took in thinking out the machine—table—which proved most successful, and which, in spite of your pessimistic views when comparing with the other'—I also made a tripod pivot for the Highlanders' Maxim gun—'has been held by the authorities to be infinitely superior. The great fault, of course, is its weight, and also its confined traversing gear.' You will understand the difficulties under which the table was made, when I tell you that the King's Own Scottish Borderers had to start on March 26th, and that at the time we were engaged in forwarding to the base at Nowshera 15,000 troops, 20,000 followers, 35,000 camels, horses, cattle, ponies, mules, and donkeys, not to mention several trains full of commissariat and transport stores, the regular daily service of two passenger trains each way being maintained throughout." I enclose the drawing and photographs.

Chatham, January 1st. R. M. H. BUCKLAND, Capt. R.E.



BUCKLAND'S MAXIM GUN TABLE

HORSELESS CARRIAGES.

SIR,—I have read with great interest the descriptions you have published from time to time of mechanically-propelled road carriages, and look forward to obtaining a great deal of information through the medium of your journal, which will, no doubt, be brought out in your proposed road carriage competition.

My object in writing to you is to ask you to be kind enough to put me in communication with inventors or builders of these carriages, as I believe there is a vast field for them here on our goldfields, where a large number of finds are scattered over an enormous area, in some cases 200 miles apart, and many of the roads are entirely dependent on condensers, at which water is sold at prices ranging from 3d. to 1s. per gallon.

Horses have been chiefly used up to the present, but owing to the cost of feed they are being replaced by camels, which, in my opinion, must give way to the motor carriage.

These carriages should be of very strong construction to stand the jolts and jars of travelling on bad roads, and special care should be taken to exclude dust, which is extremely fine, from bearings, &c. The workmanship should be good on account of the difficulty of effecting repairs, and the mechanism as simple as possible. INQUIRER.

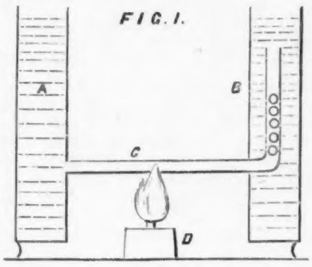
Western Australia.

[We shall have pleasure in forwarding to our correspondent any letters endorsed, "Horseless Carriages, Western Australia," which may be sent to our care.—ED. E.]

CIRCULATION IN WATER-TUBE BOILERS.

SIR,—M. Bellens' letter in THE ENGINEER of January 17th is another proof—not wanted, for the thing is certain—that there is no conformity of belief as to the way in which circulation is made to take place in a boiler. There are many theories and many theorists, and there is no agreement, for everyone claims that he only is right, and the rest are wrong. Now a great many persons have carried out experiments, more or less elaborate, with glass and other models, and the experiments made seem to have given different answers to the questions they were intended to settle. I myself have studied the subject for many years, and although I have succeeded in getting circulation in water-tube boilers to any desired extent, I am not ashamed to confess that I do not know with any certainty why circulation takes place. Neither, I am sure, does Mr. Yarrow, nor Mr. Thornycroft, nor M. Normand, nor M. Bellens. They believe they know, but I am certain they do not.

FIG. 1.



But I think I may say that I know what will not produce circulation. I have had so many disappointments, so many schemes perfect in theory, which failed utterly in practice, that on this point I can speak with a fair approach to conviction that I really know. It may be well to name one or two of these negatives.

In the first place, then, the theory that circulation takes place because there is steam and water in one leg of a U tube, and water only in the other, is not true. Your statement that the hydraulic head prevents circulation from that cause is perfectly correct. Some years ago I was engaged in carrying out an elaborate series of experiments, and the following, among others, is, I think, conclusive.

A and B are two flat vessels, united by a pipe not shown, and away from flame. C is a glass tube, bent up at one end as shown. The details of the apparatus and the method of putting it together are immaterial. When the water contained was made to boil, equality of temperature was obtained, and I assumed that I could use a horizontal tube at C, if only I got a fair start with bubbles in the bent-up leg B. Nothing of the kind. There was no certainty of circulation either way. When circulation was going on all right, it was only necessary to raise A ever so little to start the circulation the other way, and the water flowed down B instead of up it. Now, if the mere lightness of the contents of B as compared with A could cause circulation, why should inclining C the least trifle beat the ascending power in B? Precisely the same action took place in C that takes place in a spirit level, and no bubbles in B made any difference.

Now take another experiment, very easily carried out. M. Bellens' diagram will almost serve to show what I mean, but not quite. Put in water enough only just to fill the tube and a little over, as at A, and apply a lamp at B. Circulation will take place freely. Now let some water boil away. Still circulation will go on; but it will be seen that the down pipe is full of solid water, while the rising pipe is half bubbles. Now take away the lamp, and it will be seen that there is not water to fill the tube more than two-thirds full. It follows that the rising pipe contained as much steam as water, bulk for bulk. How did half a pound of water in C balance so nearly a pound of water in D? Obviously by the hydraulic head. Again, take the same general arrangements, but fit a stop cock at the lower bend of the tube. Let this be shut while action is going on, and then take away the lamp. D will be found full of water, or nearly so, and C half empty. Why? These two experiments can be varied, always with the same result, that we can get the down pipe quite full, while the rising pipe is half empty. And a further experiment, which it would take up too much space to detail, will show that water is not being delivered by the rising pipe at anything like the rate required to keep D full. Indeed, if we like we may partially plug D at the top, and still it will be found to be full when the stop cock is turned and the lamp removed.

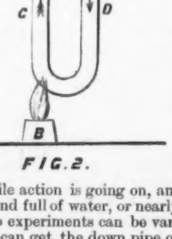
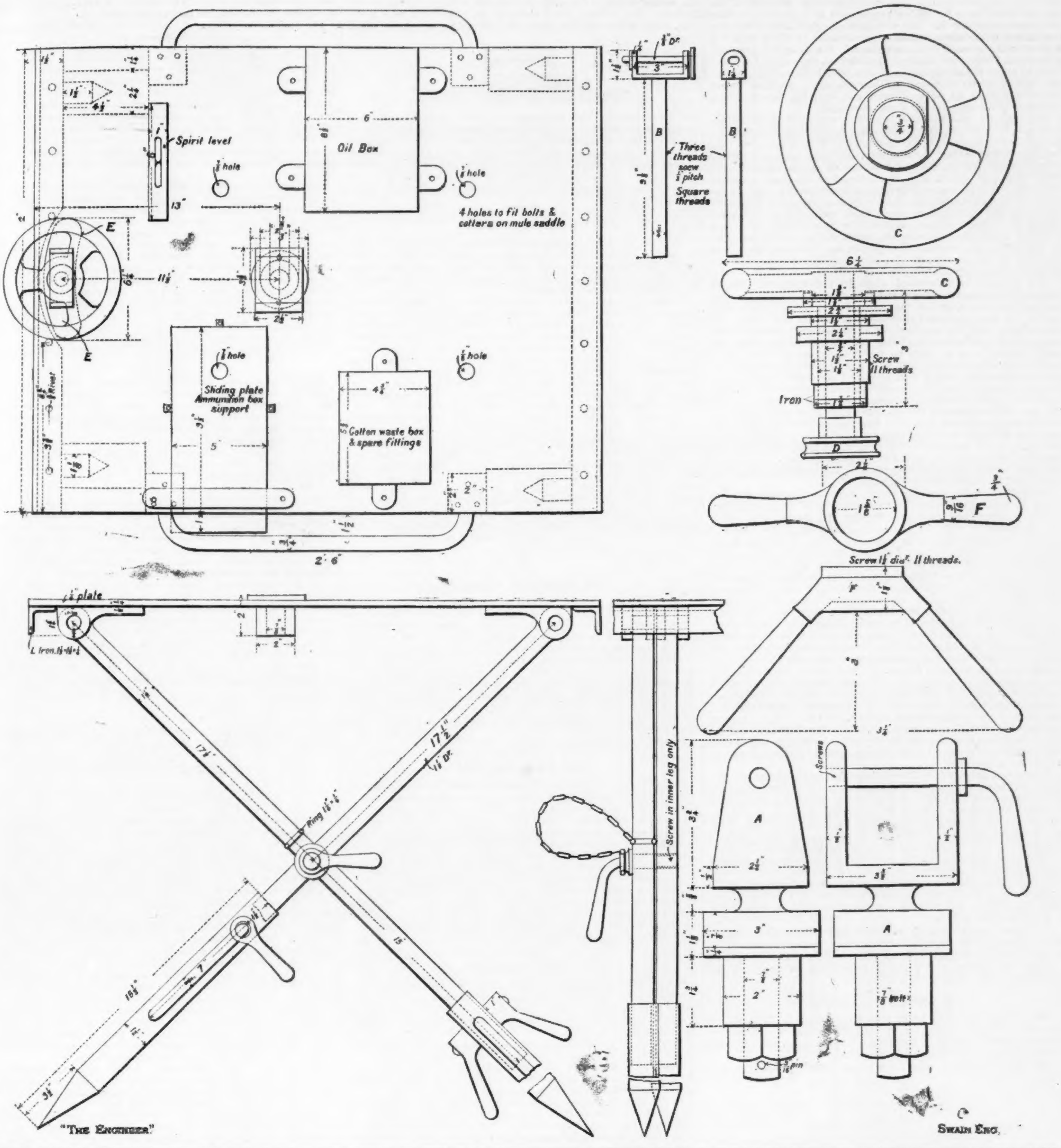


FIG. 2.

I have amply confirmed Mr. Yarrow's observations in that I know that the circulation in a water-tube boiler, however effective and even violent in appearance, is very easily overset. In a word, the force producing it is very small indeed, whatever that force is.

BUCKLAND'S TABLE FOR MAXIM GUNS


Spirit level
Oil Box
6"
13"
4 holes to fit bolts & cotters on mule saddle
Sliding plate Ammunition box support
5"
4½"
Cotton waste box & spare fittings
E
E
2' 6"
B
B
Three threads screw pitch Square threads
C
C
6½
Screw 11 threads
Iron
D
F
Screw 1½ dia. 11 threads.
F
¼ plate
L Iron
Ring
17½
15
Screw in inner leg only
Screws
A
A
3"
2"
pin

"THE ENGINEER."

SWAIN ENG.

I could say much more on this subject, but I think I have written enough for the moment. I see younger men going over ground that I have not only trodden, but sifted and searched. There are many puzzles in nature, but I know of none more perplexing than circulation in boilers and its causes. OLD TUBE.

Birkenhead, January 25th.

"THE ORIGIN AND RATIONALE OF COLLIERY EXPLOSIONS."

SIR,—The review upon my book bearing the above title in THE ENGINEER of the 27th ult. gives much ground for complaint, especially those parts which offer misleading and incorrect summaries of my views; and I am compelled to ask you for space to point out the misrepresentations.

The reviewer says:—"As far as we have been able to apprehend the author's views, they are to the effect that the primary cause of an explosion in a non-gaseous mine is the destructive distillation of a portion of the coal dust lying in the neighbourhood of a blown out shot." The accepted meaning of the technicality "a blown out shot" is that the products of the explosive are wholly expelled from the shot hole without rupturing the walls of the hole, or displacing any strata, and that the heat energy is wholly available for other purposes. The shot referred to in a non-gaseous mine in my book was not a "blown out shot." On page 13 it is recorded, "the hole was found fractured from end to end, with the excavated *débris* lying underneath." Only a portion of the heat energy was, therefore, available, and it is correctly described on page 68: "The unexpended heat in the charge of mining powder was projected into the small coal and coal dust on the floor in the vicinity of the shot, and instituted distillatory action.

The reviewer proceeds:—"It is also advanced that lack of oxygen is the usual reason for those blanks in the explosion which are its most curious feature, and that similar breaks may be caused by the dampness of a part of the workings through which the transmission of the explosion might occur under less favourable conditions." The phrase "Blanks in the explosion" does not convey what the book says. On page 13 the words are:—"The field of disaster presented the phenomena of numerous disturbances in falls of roof, shattered doors, and broken trams, at widely distant points; but the spaces that intervened between these disruptions betrayed no evidence of violent forces—the timber, trams, and loose materials they contained, were neither displaced nor damaged." These disturbances are subsequently examined in detail, and shown to have been caused by local subsidiary explosions, and to have occurred where the normal volumes of air were largely increased—see pages 108-113. The statement that "dampness" may cause "similar breaks" has no foundation. At page 129 I have shown that dampness will not arrest the propagation of an explosion or cause a gap in the explosive phenomena.

Again, the reviewer says:—"The first statement, viz., that hydrogen is the chief agent in the explosion [this phrase is not in the book, nor is it warranted] is supported by the fact that carbon, both as coked residues and as finely divided smoke, *i.e.*, lamp-black, is found on examining the scene of an explosion, and, further, that there is evidence of the substantial absence of the most characteristic product—often combustion of carbon—viz., carbon dioxide. But surely all this may be true without imagining the previous liberation of hydrogen by destructive distillation or the dissociation of hydrocarbons, upon which the author insists." The fallacy of this argument is in the reviewer's partial statement of the phenomena which the book records. The coked residues are unquestionably produced by the destructive distillation of coal. The deposits of impalpable carbon—diamond-black, see page 58, not lamp-black, as the reviewer states—could only have been produced by the oxidation of the hydrogen constituent of some of the educts of the coal in the first place, and subsequently by dissociation at the elevated temperature that would then be present—see pages 56, 57, and 63—as no other source existed. My words on page 57 are:—"The educts could only have obtained limited supplies of oxygen—sufficient to oxidise the hydrogen constituent of a portion of the gaseous hydrocarbons. This oxidation of hydrogen would generate large quantities of heat, and necessarily produce the observed elevation of temperature. In the process of the oxidation of the hydrogen the carbon constituent could not be converted into carbon dioxide, because there was no oxygen for that purpose, therefore it was unchanged, and deposited in the condition in which it was found, and the temperature due to the oxidation of hydrogen being considerably higher than the temperatures of dissociation of gaseous hydrocarbons, the remaining portion of these gases would be decomposed, yielding further quantities of carbon."

Carbon dioxide was not appreciably present in the gaseous products that filled the mine after the disaster. The reviewer omits and ignores the important phenomenon of the disaster, viz., the exhibitions of explosive violence, and thus shows the fallacy of his argument. He suggests that the partial phenomena he quotes from the book has its illustration in the preparation of lamp-black, saying—"No one who has seen the flame of a pan of dead oil burning at the entrance of a set of lamp-black chambers, and yielding crude finely divided carbon in rich abundance, could doubt this possibility—the tendency to oxidation of hydrogen rather than carbon, in limited quantities of air—and it is indisputable that the same preferential oxidation will take place with any fuel containing carbon and hydrogen. An appreciation of this fact saves the necessity for constructing any special theory to account for the presence of coked and carbonised residues after the occurrence of an explosion."

I have shown at pages 52, 53, and 54 that there was no such flame as that arising from burning "dead oil," or in the combustion of gaseous hydrocarbons, at Timsbury Colliery. It is well known that no explosive violence is exerted in burning hydrocarbons distilled from coal, when the hydrogen only is oxidised and the carbon is separated out in solid form. It is superfluous to add that, after the oxidation of the hydrogen constituent, there can be no explosion from the residual or resultant gas. The principal phenomena of colliery explosions, viz., the exhibitions of explosive violence, therefore remain inexplicable upon the reviewer's hypothesis, and he should have observed on page 54 the following words, "The combustion of gaseous hydrocarbons at the locus, and at the moment of their evolution, exerts no more mechanical force than is exhibited in a burning gas jet; consequently the isolated and widely-separated exhibitions of violence over the field of the disaster would be as inexplicable upon such an hypothesis as they are inconsistent with it. The disconnected exhibitions of violence are facts of observation, and an adequate cause for them must find a place in the *rationale* of the explosion." Whatever the processes were which yielded the finely-divided carbon, they must have also brought about the accumulation of successive bodies of an explosive gas, which, by its explosive combustion, could produce violent effects and yield no carbon-dioxide gas, and the theory I have advanced above accounts for these phenomena.

The reviewer continues:—"It is likely enough that the author is correct in supposing the arrest of an explosion is often due to a local defect of oxygen; but even when this idea is accepted fully it is not easy to see how the explosion can begin again at a further point without leaving marked evidence of action between each adjacent pair of points. If it be assumed that the gases remaining after the first explosion contain enough combustible matter, or can generate enough combustible matter by their supposed distillatory action on the coal dust, to prove again explosive when a fresh supply of oxygen is reached, it is still far from clear how the heat required to raise the explosive mixture at the far and distant point to the initial temperature of explosion can be transmitted from the first to the second explosive centre without seriously burning all intermediate objects."

It is difficult to understand what the reviewer means by his assumption of gases remaining after the first explosion containing combustible matter, or that they can generate enough combustible matter by their supposed distillatory action on coal dust. He should know that the principal agent immediately arising in the first explosion is the heat due to the oxidation of the hydrogen, and ought to have seen on page 63 that "the propagation of No. 1 explosion presents no difficulty, as it is only necessary to recall the series of chemical actions that produced the initial explosion to recognise the fact that No. 2 explosion would be brought about by a repetition of this series of actions; and when it is known that the heat that originated the disaster at the shot represents that due to the oxidation of less than four grammes of hydrogen, and that the 500 cubic feet suggested to have been ignited in No. 1 explosion would generate more than three hundred times that quantity, an idea will be gained of the enormous resources of heat that were now available for re-instituting the activities and propagating the explosion through the mine."

The difficulty the reviewer chiefly expresses, however, is, in a word, his desire for evidence of "burning" upon all intermediate objects between the explosions. He should have read the following on pages 108-109:—"The spaces between the propagated explosions, though free from explosive violence, exhibited the effects due to immense thermal changes, the ordinary temperature being from 20 deg. C. to 25 deg. C., while the educts of the coal were raised to the heat due to the partial combustion that was constantly going on, representing a temperature of over 2000 deg. C. The educts at this exalted temperature were travelling through the passages, heating the strata upon which they were impinged; but were immediately followed by gases at the ordinary temperature, which were loaded with the condensed water due to the oxidation of the hydrogen. The old method of breaking the strata by heating with fire and cooling with water was therefore in operation, though for a comparatively momentary period, but sufficient to bring about disintegration of loose strata and scaling of faces of stone to which timber was wedged." The book also records that bodies of victims found in the spaces between the explosions were badly burnt, and the walls of the passages were covered, and the stagnant gases between the disturbances were laden with the flocculent carbon, which indicated the temperature of burning hydrogen, and showed the unbroken presence of gases at an exalted temperature from one explosion to the other.

I have now shown the reviewer's imperfect acquaintance with my book, and the inaccuracy of the statements he makes purporting to be taken from the book. It is not surprising that a work which involved an immense amount of labour and research should not be understood upon the superficial and fragmentary perusal which the reviewer appears to have given to it; but when, with a synopsis of each chapter and an index at his disposal, he says, "In it data and deductions, facts and hypotheses, are mingled inextricably, and in places it is with the utmost difficulty that the line of argument can be followed," he makes a statement that is opposed by over a dozen technical reviewers who have carefully read the book, and for which there is absolutely no foundation.

Bristol, January 21st. DONALD M. D. STUART.

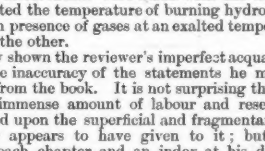
[We have broken through our rules by publishing Mr. Stuart's letter, simply because we desire to avoid the smallest cause of suspicion that he has not had fair play; but we must add that on matters of opinion, our reviewer is at least as competent an authority as Mr. Stuart.—ED. E.]

SLIDE VALVE FRICTION.

SIR,—Referring to the letter from Mr. Edward I. M. Davies on the above subject, in your issue of the 10th inst., I was pleased to see the question discussed, and with your permission will give the results of some experiments I have made.

Mr. Davies gives a case from actual practice, taking a constant pressure on the back of the slide valve of $9\frac{1}{4}$in. × 17in. × 140 lb. steam pressure = 22,015 lb.; here I think he makes a mistake. I would take the pressure at the position the valve stands at ($5\frac{1}{4}$in. × 15in. + $1\frac{1}{4}$in. × 15in.) × 140 lb. = 13,650 lb. The reason for this I will show.

FIG. 1



If Mr. Davies makes an experiment, takes a flat plate lying on a flat face representing a cylinder face and slide valve but no ports, when a pressure of steam is turned on to the back of the valve, the valve will require just the same pull on the valve spindle to move it as when the steam is shut off. Next drill a hole A in cylinder face one square inch area, turn a pressure of 140 lb. steam on, and the pull on the valve spindle will be increased by $\frac{140}{8} = 17\frac{1}{2}$ lb. I have also found by experiment that the coefficient of friction for a slide valve moistened by steam is one-eighth. Next take the flat plate off, and put the slide valve on to face, turn 140 lb. pressure on, and the pull on valve spindle will be increased to $\frac{5\frac{1}{4} \times 15 \times 140}{8} = 1378{\cdot}125$ lb.

FIG. 2

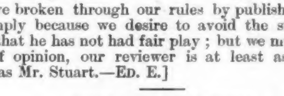
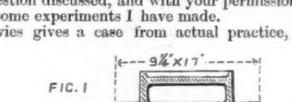


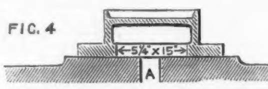
FIG. 3



When the valve travels to near the centre, the area of the ports A and C will require to be added to area of port in slide valve, $(1\frac{1}{4} + 1\frac{1}{4} + 5\frac{1}{4}) \times 15$in., to get total pressure on slide valve. The back pressure in ports in A, B, C can then be deducted.

I have also found by experiment that if the ports are not altered, the surface of slide valve may be increased without adding to the friction. For instance, if the above shown slide valve were made 19in. wide, instead of 17in. wide, the pull on valve spindle would not be increased. The experiments can be made on a reduced scale. If Mr. Davies or anyone else should try this, I will be pleased to hear if the results agree with mine, as in any text-book I have seen the pressure on back of slide valve is given = total area of valve, minus area of port in valve, multiplied by pressure of steam, the writers, perhaps, thinking it was too trifling a point to trouble much about; but I see it is a point of interest to many.

FIG. 4



January 18th. C. D.

NAVAL ENGINEERS.

SIR,—As the time is approaching when the Admiralty will expect to receive entries for the examination admitting to the Royal Naval Engineering College, Keyham, perhaps you will permit me space to direct attention to the value which "My Lords" attach to the training which they provide.

Lean's Navy List, p. 44A, is as follows:—Harding, *Loveridge*, Butland, Maxwell, Stokes, Stocker, Magrath, *Wallace*, *Gordon*, Kelly, Steil, Roberton, *Durston*, *Cleave*, Ware, Smith, Page, Hall, Charlton, Stocker, Thompson, Soper, Hare. All the foregoing are dated July 1st, 1894—probationary—but those whose names are in italics do not appear to have attended the Royal Naval Engineering College, and yet they are placed before the last nine who have been trained at Keyham and Greenwich. What examination have the five passed which places them before those who have been trained under their lordships' direction?

Again, six assistant-engineers for temporary service are entered for July 2nd, 1894, apparently one day junior to those trained in the Royal Naval Engineering College, but seeing that they are appointed and date from July 2nd, 1894, whereas the Keyham students are entered as probationary, and judging from past experience, will only date from confirmation, *i.e.*, July 1st, 1895, the temporary service men will be one year senior. From this it would seem that the smaller the training the better for the position, and avoid going to the Royal Naval College, Greenwich. The arrangement may be perfectly satisfactory to individuals, but is not calculated to encourage capable men to join the service, and is likely to lead to disaster if pursued. CIVILIAN.

January 18th.

THE TEMPER OF HANDSAWS.

SIR,—Will any of your Sheffield readers tell me why it is that handsaws in most cases lose their stiffness and elasticity after about a year's work? Now and again we come across a saw which is good to the last inch, but very rarely. The saws are not overheated, they are not subject to blows, but they become soft, and bend on the least provocation. One man in this shop says that it is caused by the vibration due to filing, and that if the saw is properly blocked while being filed it will not soften. Another theory is that they are only hard planished, and that the least loss of skin will leave them soft, just as a watch mainspring is useless if the blue is taken off. If any reader can help to a solution, I shall be obliged. PATTERN MAKER.

Birmingham, Jan. 30th.

THE LINDE PROCESS.

SIR,—The article in your last number clears up the points on which I was in doubt. Of course, so soon as it is clear that the so-called Joule's effect is not needed, all the rest is plain sailing.

It may be well to say a word here concerning a mistake which I have often heard made concerning refrigerating machines. It is that energy is got out of air in the cooler. So it is, but not more than has been put into it by the compressing pump. This will be made clear by remembering that the energy in a given weight of air is measured by its temperature, and by nothing else. The total energy in a pound of air isothermally compressed is just the same after compression as before, provided the temperature is the same, but its available energy may be greater. The available energy, however, is quite a different thing from the total energy.

Woodstock, January 28th. M. A.

EARLY LOCOMOTIVES.

SIR,—Your correspondent who writes under the name of "G. A. Sekon" is certainly most indefatigable in his attempts to silence every one who differs from himself. He also shows a most remarkable propensity for twisting about the statements made by his antagonists to suit his own ends. Mr. Sekon either fails to understand, or he will not understand, that those who differ from him have been all along writing about early Great Western engines—engines which actually ran on wheels and did work, not about designs and theories, and steamboats on wheels, nor even about special contrivances rigged up for special purposes.

In the first place, even if we admit, for the sake of argument, that such an engine as that shown in Mr. Wilson's drawing ever existed, it has yet to be proved that it was built for and delivered to the Great Western Railway. The quotations with which your correspondent favours us cannot be urged as evidence of this. It does not in the very least follow that if such experiments as are referred to took place, the engines used necessarily belonged to the Great Western Railway. In the next place, I wish to draw attention to a point which is entirely ignored by Mr. Sekon: even if it be admitted that the engines used in such experiments actually did belong to the Great Western Railway, it does not follow that they were built in the form of steamboats. I have seen many engines with snow ploughs attached in front, but no one would on that account, in describing these engines, describe them as "being fitted at the leading end with a contrivance specially designed for the purpose of removing snow." It no more follows that an air-cutting apparatus of the form shown could be considered as part of the engine than a snow plough or the indicator and necessary appendages used in taking diagrams would be so considered. Such adjuncts are attached when required, either for practical or experimental purposes, and are removed when the purpose for which they were required is accomplished. If it were necessary our engines would be fitted with snow ploughs all the year round; it is not necessary, therefore they are only so fitted at certain seasons. The arrangement shown could be attached as easily as a snow plough. Mr. Sekon's argument, therefore, falls to the ground.

I note that Mr. Sekon has been in communication with a gentleman who is unable to remember anything. This is most instructive. The evidence of one who does not remember anything is certainly of most unquestionable value.

It is a very remarkable circumstance that Mr. Wilson should write to Mr. Sekon as to the drawing which appeared in THE ENGINEER of 3rd inst. Why does he not write to THE ENGINEER and tell us all he knows? We want to know whence he got his drawing, and we also require all the other information he can give us if he wishes to prove his contention. This drawing has been referred to by Mr. Sekon as an authentic drawing. Its authenticity has yet to be proved. As the matter now stands, the drawing is of no value whatever as evidence.

Can Mr. Sekon explain how it is that the Great Western Railway Company sent drawings of every class of engine which had run on their rails to the Chicago Exhibition, and stated that they never had more than one 10ft. wheel engine, if they really had more than one? And why is it that the company have no drawings of the remarkable engines Mr. Sekon contends for, seeing that they have drawings of all their engines? I have asked Mr. Sekon to explain this before, but he has never done so.

Dundee, January 25th. D. H. LITTLEJOHN.

SIR,—My statement that "no engine was ever built for the Great Western Railway with a projector" is perfectly true, and in accordance with the information possessed by the company. Mr. G. A. Sekon should know that when Dr. Lardner made some experiments upon the subject of air resistance, he had a temporary projecting wind-cutting device constructed, but it formed no part of the engine, and was simply attached to the fronts of the engines by bolts. The device was tried on several engines; for instance, North Star, Vulcan, Lion, Ajax, and Hurricane. In view of these facts, most certainly I do not "withdraw" any statement which I have made.

Mr. Sekon tell us he has communicated with a gentleman who is "unable to remember;" surely that is of little importance, and the fact that Mr. Sekon has had a private letter from Mr. Wilson does not throw light on the matter. What is required is a reply from Mr. Wilson himself to the questions I have asked in your columns. Of course the Grasshopper had 10ft. wheels, as it was but the third name of the Hurricane. Mr. Acworth in his "Railways of England," page 254, makes this quite clear. "Mr. Dean," he tells us, gives "the true explanation of the third alias of the Hurricane, namely, that it was a shed nickname." I have in my possession the complete list of every early engine which ever ran on the Great Western rails, and can tell Mr. Sekon that there was not one named Grasshopper, and the company gave this information to the authorities of the Chicago Exhibition.

Leicester, January 27th. CLEMENT E. STRETTON.

SIR,—The engines fitted with "cut airs" referred to by Dr. Lardner were in every respect ordinary locomotives, such as have been illustrated over and over again. They were fitted with conical fronts or bows made of deal boards, and for the purpose of experiment were run with and without them alternately. An account of these experiments will be found in Dr. Lardner's "Treatise on the Steam Engine." My edition is dated 1856. Mr. Sekon has interpreted Dr. Lardner erroneously. J. W.

Gorton, January 28th.

SIR,—Mr. Sekon's letter in last week's issue compels me again to point out that the Ajax was not of the construction Mr. Wilson's sketch shows. A true drawing of this engine was given by Mr. C. E. Stretton some months back, and on this drawing being shown to an engineman who had been on this engine it was at once pronounced correct. The wheel was spokeless, 8ft. in diameter, and the framing the same as the Premier.

If Mr. Sekon means, when he says the Ajax had a 10ft. driving wheel, the nickname of Hurricane, I quite agree with him, except that this engine, sometimes called the Grasshopper, did not have a boiler plate disc wheel, but an ordinary spoked 10ft. wheel, and that it was made at Messrs. R. and W. Hawthorn's, Newcastle-on-Tyne, to the designs of Mr. T. E. Harrison—an illustration of which is given in the "Locomotive and its Development," by Mr. C. E. Stretton. Did not Mr. Dean tell Mr. W. M. Ackworth that the Grasshopper and the Hurricane were one and the same locomotive? HENRY GREENLY.

36, Third-avenue, London, W.,
January 27th.

[We can insert no further references to 10ft. driving wheels—the Grasshopper, Ajax, or Hurricane.—ED. E.]

A CENTURY OF "SOHO."

A HUNDRED years ago, January 30th, 1796, there was a famous celebration of a memorable incident in the history of the far-famed Soho Works. In 1766 the place was rapidly increasing under the untiring management of Matthew Boulton, and very soon after the fame of Soho was known the wide world over. Celebrities of all sorts rushed to see the famous works and to purchase the dainty "toys" which had won fame in every part of Europe, and had made "Brummagem" the "toyshop of Europe." Boswell and Johnson gave their praise, and repeated Boulton's famous phrase, that he "sold what all the world wants—Power." His rare energy, intelligence, and skill, his undaunted perseverance, his appreciation of his famous colleagues—Watt, Murdock, and many others—rapidly raised the Soho Works to unrivalled fame. Year after year the western slopes from the Handsworth-road to Hockley Brook were covered with new buildings, filled with new machinery, and were pouring forth tons of fabrics, from huge steam engines down to sword-hilts, shoe-buckles, ladies' nick-nacks, silver and plated wares, which were previously unknown, and have never been surpassed. The tide of fame flowed on for many years, and in 1796 a large "annex" was built for the use and work of the larger machinery and manufactures.

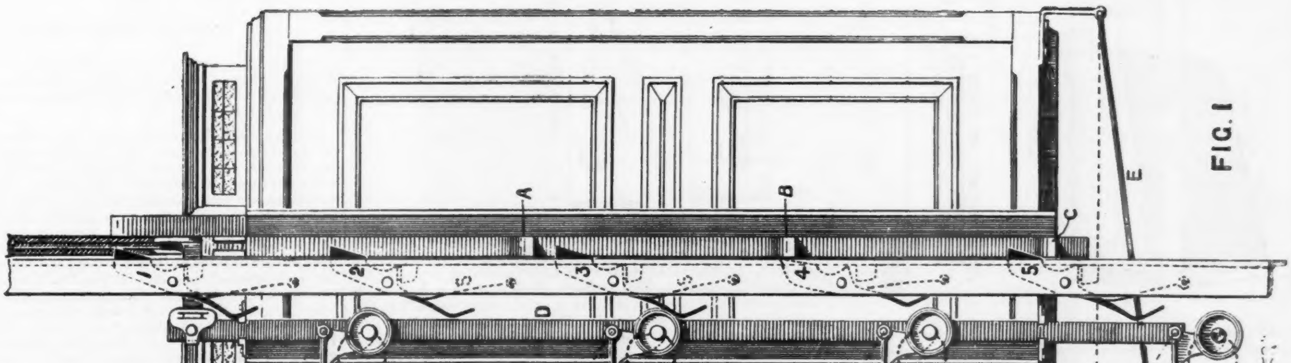
About a mile from "The Soho" a vast area was prepared for the engineering productions of James Watt and the workpeople of the time. "The Soho Foundry" was completed in 1796, and on January 30th a famous "rearing feast" the full details of which have been preserved—was generously provided, and was served in the most "classic" style. "The first fruits of the cultivated land at Soho were sacrificed at the Altar of Vulcan, and eaten by the Cyclops in the great Hall of the Temple, which (was) 46ft. wide and 100ft. long;" and, after a generous dinner and a good band of martial music, "the Founder of Soho entered, and consecrated this new branch of it by sprinkling the walls with wine, and then, in the name of Vulcan and all the Gods and Goddesses of Fire and Water, pronounced the name of it 'Soho Foundry,' and all the people cried 'Amen.'" A benediction was then "pronounced on the undertaking, and a thanksgiving offered for the protection and preservation of the lives and limbs of the workmen during the erection;" and Mr. Boulton gave his benediction, "May this establishment be ever prosperous, may no misfortune ever happen to it, may it give birth to many useful arts and inventions, may it prove beneficial to all mankind, and yield comfort and happiness to all who may be employed in it."

In 1850-1851 the inevitable changes of fortune and fame led to the dismantling of the Soho, and the rare and useful tools and products were sold; but some of the more modern and useful order were removed to the Soho Foundry. Here they remained for many years, partly in continuing the coinage of the bronze pence for the Mint, and partly in the large machinery which could be used for great sea-going steamers and other large orders. During some years there had been many competitions in engineering works, and the orders and improvements declined till, in 1895, when the Soho Foundry, and all its machinery—the work of many of the most famous "fathers of Soho"—came to the hammer of the auctioneer, and have now been scattered far and wide. Only one consolation remains: That the memories of the "heroes of Soho," Boulton, Watt, Murdock, Creighton, Buckle, Keir, Southern, Wright, Harden, Barnsley, Hamilton, Jas. Watt, jun., and Blake will ever have the *aere perennius* of print in the records of the rare energy and engineering skill so deservedly honoured during a hundred years. Another consolation remains, that the records of Soho Foundry—1765-1850—have fortunately been saved from loss or damage, and that they have been carefully preserved by a generous neighbour of the Soho Foundry, and will hereafter, when fully examined, reveal and record a mass of facts of the famous Soho heroes and their work, which are of priceless value in the history of engineering and scientific skill. Exit Soho—Resurget.—*Birmingham Post.*

SUSPENDED SAFETY LIFT

MESSRS. J. AND H. BROOKES, SMETHWICK, BIRMINGHAM, ENGINEERS

(For description see page 122)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THE ENGINEER

FIG. 1

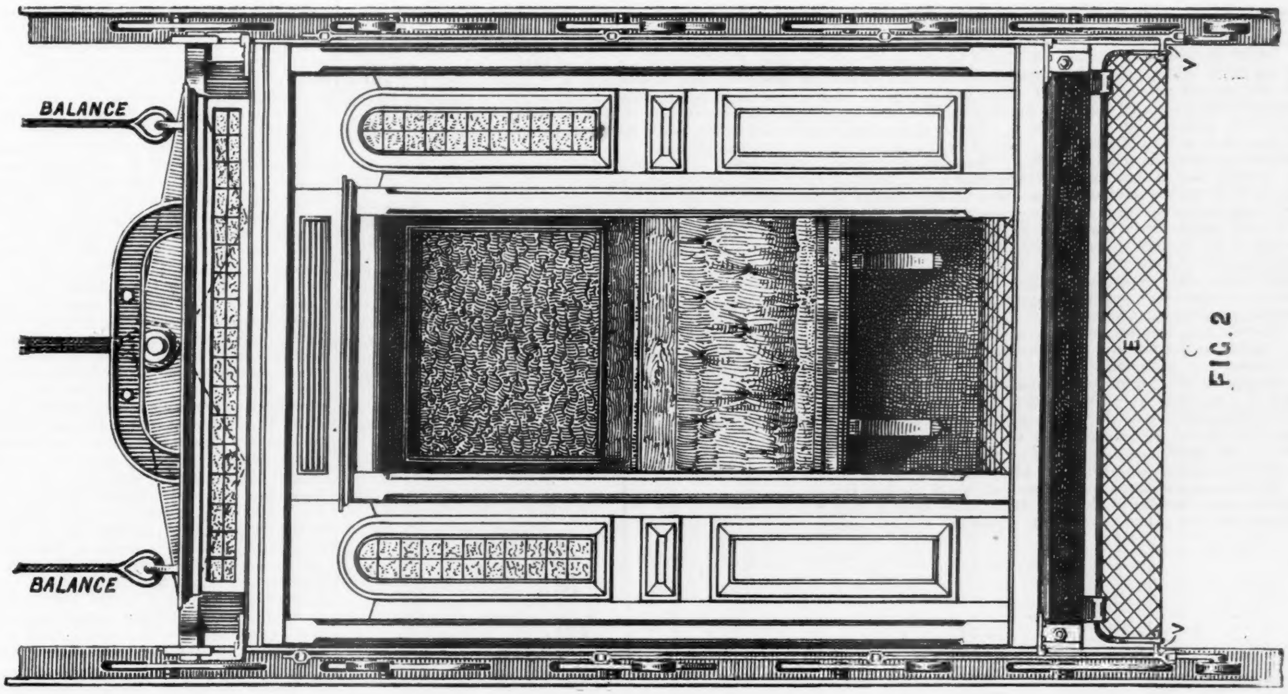
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FIG. 2

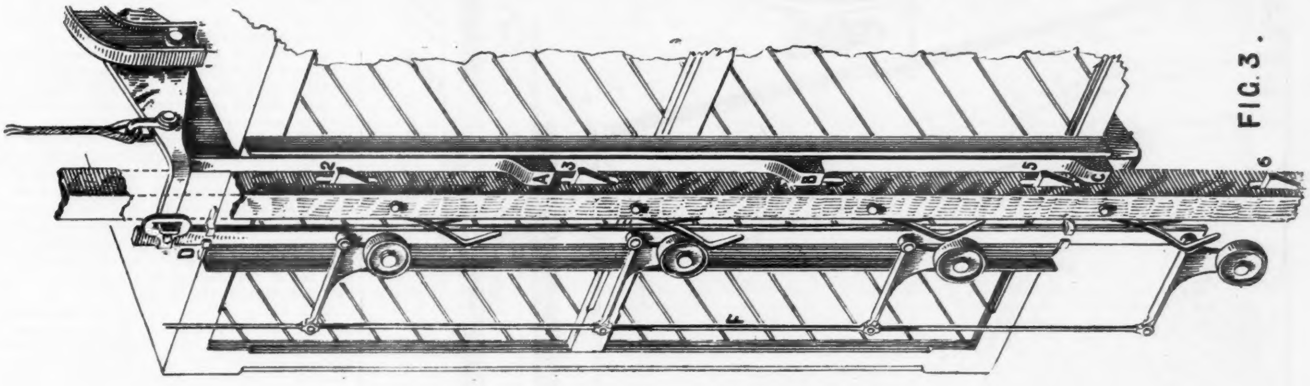
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FIG. 3.

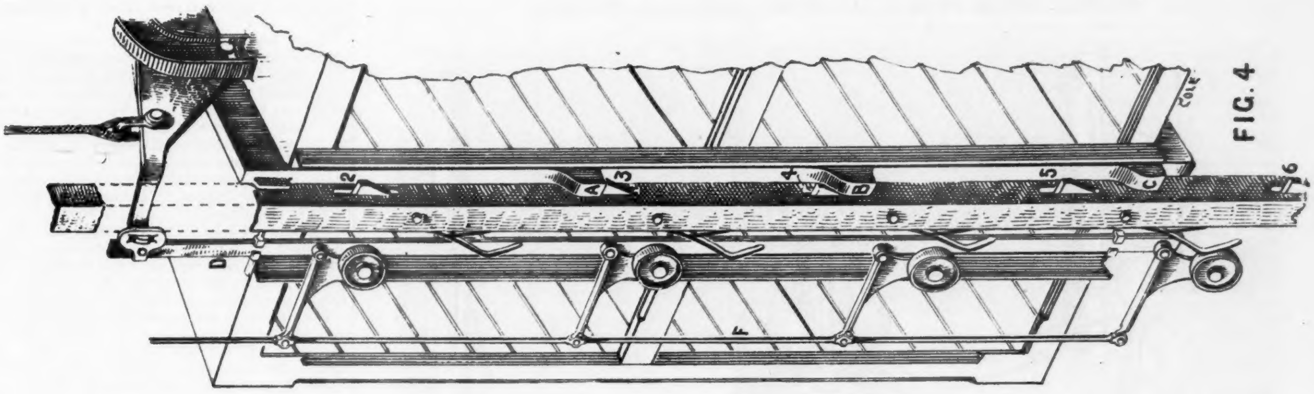
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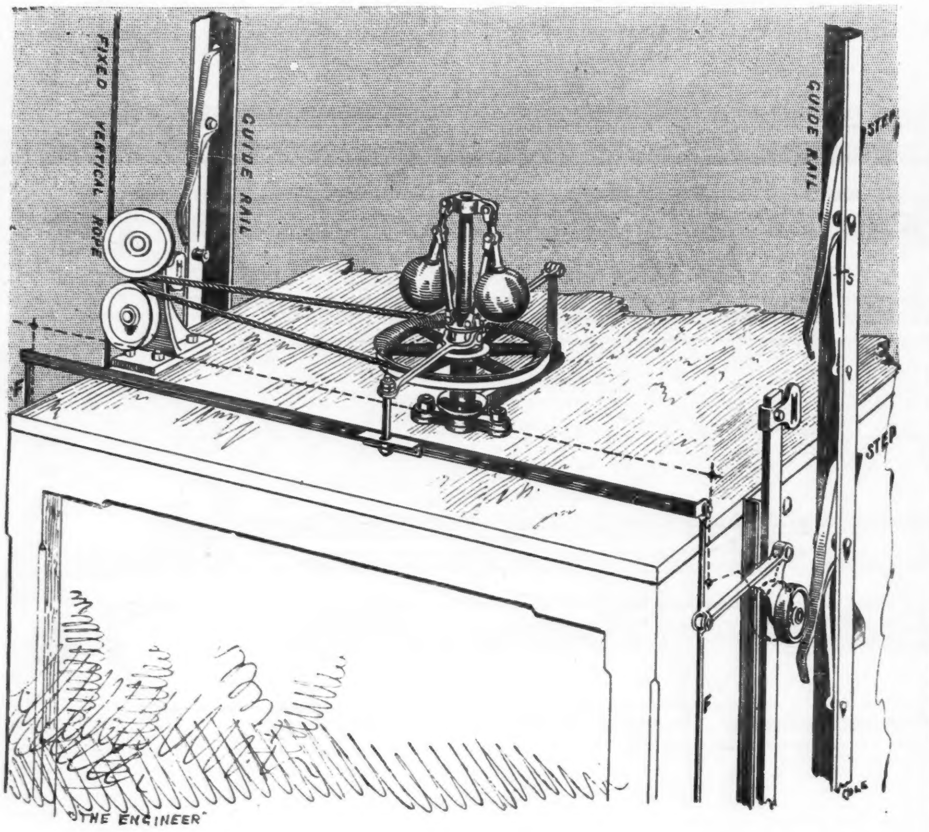
FIG. 4

SUSPENDED SAFETY LIFT

MESSRS. J. AND H. BROOKES, CAPE WORKS, SMETHWICK, ENGINEERS

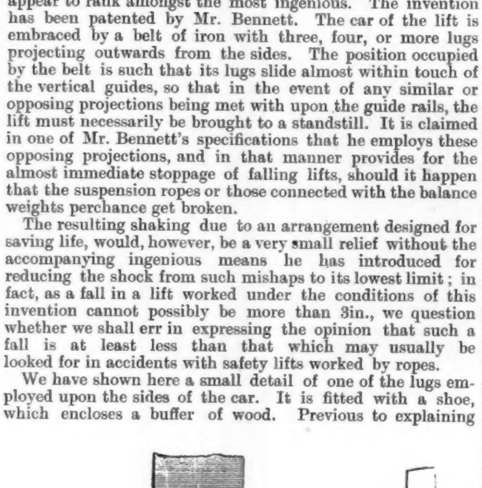


THE EUREKA SUSPENDED LIFT.

AMONG the several inventions introduced for the prevention of accidents in suspended lifts, those which form the subject of our present notice, illustrated above and on page 121, appear to rank amongst the most ingenious. The invention has been patented by Mr. Bennett. The car of the lift is embraced by a belt of iron with three, four, or more lugs projecting outwards from the sides. The position occupied by the belt is such that its lugs slide almost within touch of the vertical guides, so that in the event of any similar or opposing projections being met with upon the guide rails, the lift must necessarily be brought to a standstill. It is claimed in one of Mr. Bennett's specifications that he employs these opposing projections, and in that manner provides for the almost immediate stoppage of falling lifts, should it happen that the suspension ropes or those connected with the balance weights perchance get broken.

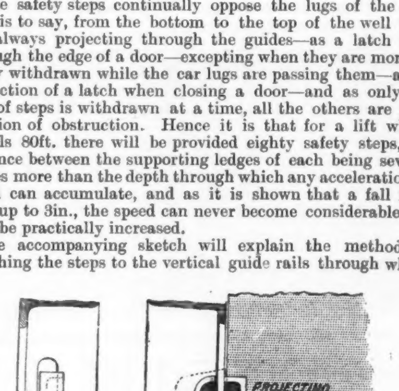
The resulting shaking due to an arrangement designed for saving life, would, however, be a very small relief without the accompanying ingenious means he has introduced for reducing the shock from such mishaps to its lowest limit; in fact, as a fall in a lift worked under the conditions of this invention cannot possibly be more than 3in., we question whether we shall err in expressing the opinion that such a fall is at least less than that which may usually be looked for in accidents with safety lifts worked by ropes.

We have shown here a small detail of one of the lugs employed upon the sides of the car. It is fitted with a shoe, which encloses a buffer of wood. Previous to explaining the arrangement adopted for removing the opposing projections so that the others may pass, it will be necessary to explain, in conjunction with a former paragraph, the reason why an accidental fall of a lift under these conditions will be confined to a maximum distance of 3in. The opposing projections or "steps," as they may now be called, occur at distances not exceeding 2ft. throughout the entire height of the lift space, and on the opposite side of the well they are situated at intermediate distances, so that by their alternate levels the actual space between the safety ledges is the same as if the full complement had been fixed at a pitch of 12in. on one guide rail. Still further to reduce the fall of a car in case of accident, it is arranged that in all passenger lifts at least four lugs, as shown at A, B, and C, Figs. 1, 3, and 4, are provided, and these are timed to engage the steps at different intervals, thus further reducing the maximum possible fall of 3in., while it is probable that the actual drop may be considerably less.



The safety steps continually oppose the lugs of the car, that is to say, from the bottom to the top of the well they are always projecting through the guides—as a latch does through the edge of a door—excepting when they are momentarily withdrawn while the car lugs are passing them—as in the action of a latch when closing a door—and as only one pair of steps is withdrawn at a time, all the others are in a position of obstruction. Hence it is that for a lift which travels 80ft. there will be provided eighty safety steps, the distance between the supporting ledges of each being several inches more than the depth through which any acceleration of speed can accumulate, and as it is shown that a fall may vary up to 3in., the speed can never become considerable nor even be practically increased.

The accompanying sketch will explain the method of attaching the steps to the vertical guide rails through which they project, and thereby become, when in their normal position, the obstructions already referred to.



In our illustration, Fig. 1 shows that step No. 4 is withdrawn when the lug B is passing it, while steps 3 and 5 at the same moment are in the position of obstruction, should the suspension gear give way, and in the same figure the relative positions of the lug A and the step No. 3 will explain that if the car fell when it was in the position shown in the illustration, its descent would not exceed 3in., whereas if fracture occurred when step No. 3 was withdrawn, No. 4 would be projecting, and the fall might be as much as 20in. This, however, is only applicable in cases where the steps are 2ft. apart, and when the safety of the hoist depended upon step No. 4 alone. But owing to the special arrangement already described, since the steps are placed alternately, and the lugs A, B, and C are also timed for different intervals, there would always be several lugs—in passenger lifts at least seven—each of them nearer than step No. 3 is to the lug A, and the nearer the opposing projections approach each other so much the less will be the fall.

The preceding sketch of one of the steps, shows its position in dotted lines when withdrawn, due to its contact with the trip gear which is carried on the car, and represented in side elevation in Fig. 1. A bar D on the side of the car carries four sets of trip gear; there are duplicate sets upon the opposite side differently timed, the drawings of which will be found explanatory. It will be noted that the pitch of the gear centres does not correspond with that of the steps, it being essential, as previously explained, that only one pair should be tripped at a time; thus, if we consider the car to be in the act of descending in Fig. 1, step No. 4 shows that it has already been tripped to make way for passing the lug B, whilst No. 3 is in contact with its gear and is just about to be withdrawn, but will not clear the lug A until No. 4 projects. At the same time step No. 5 is in obstruction, and thus protection is provided for throughout.

It will now be understood that as long as the bar D and its four sets of trip gear bear the same relative position with the steps as they now occupy—and they will remain so as long as the suspension gear is in proper condition—see Figs. 1 and 3—they will upset the steps whenever the car lugs A, B, and C are approaching; but should the bar D be raised so as to allow the opposing projections to meet each other before the trip rollers arrive at the striking point, the car will consequently be caused to stop.

Figs. 3 and 4 are perspective views illustrating the latter alternative, and also indicating how the bar D is controlled by the suspension beams, which in Figs. 1, 2, and 3 are seen in their ordinary working position, and in Fig. 4 that of having been upset.

In the case of the breakage of suspension ropes, as assumed in Fig. 4, the counterbalance weights assert their power, and haul up the outer ends of the beams, and as these are interlocked with the side bars D, the latter are simultaneously carried up with the beams, and the trip gear becomes inoperative as is shown; the supposition being that the suspension gear gave way when the car was in the position indicated in Fig, 3, and as the trip gear was not in time to withdraw the step No. 3, it remained in the position for obstructing the car, and stopped it at the lug A.

As it has now been explained that safety is assured by causing delay in the arrival of the trip gear at the tipping lever of the steps, Mr. Bennett has devised other means whereby the trip gear may be bodily lifted away from the steps by the use of a governor which is carried on the top of the car. Further reference to Fig. 1 will show that by raising the rod F with which the four sets of trip motion are coupled, their rollers will be moved into the positions shown by dotted lines, without interfering with the bar D.

We give an illustration showing how the governor will act, and in order to avoid confusion of parts, besides assisting our explanation, we have preferred separating this arrangement from those previously described. It is frequently the case that lifts are overloaded, and it is with a view to arrest any undue speed arising from this cause that the services of a governor are enlisted for causing the trip motion to become inoperative.

A vertical rope which is fixed in the well is traversed by guide pulleys, leading it to and from the motion pulley of the governor, and our drawing, which shows a perspective view of the general arrangement, will explain the simple and effectual way in which the safety steps are prevented from avoiding the passage of the car by the elevation of the coupling rods F.

We have now considered the case of the breakage of suspension ropes, with the result that a falling car must inevitably rest upon the inactive steps, and we have also shown how, in a similar manner, overloading can be counteracted. The governing apparatus, however, supplies a further safeguard; in the event of both suspension and counter-balance ropes parting at the same time, the suspension beams would fail to lift the bars D, and the steps would still be upset as the car descended; but, as the governor acts at the slightest sign of acceleration in the speed of the lift, the steps are not tripped, and the car rests upon the first step it would otherwise have passed.

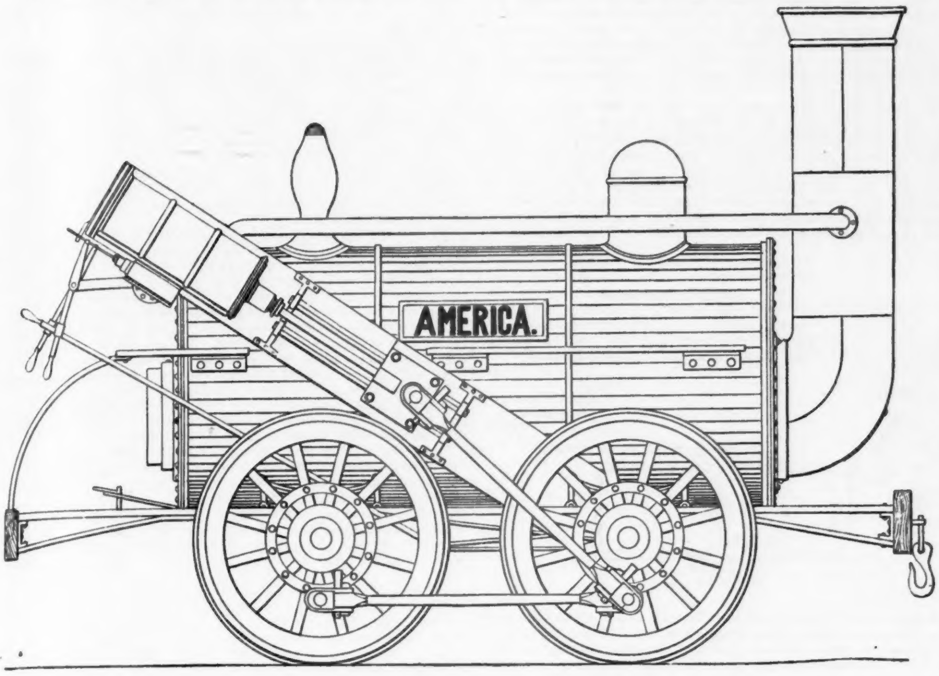
Most of our readers can doubtless recall instances when, owing to misadventure, men have stood within the area of descending lifts, very frequently paying for it with their lives. A screen E—Figs. 1 and 2—is hinged underneath and at the back part of the car, leaving its front edge hanging loosely, with freedom to move upwards, but normally lying at an incline, similarly to that shown in Fig. 1. At both of its front corners it is in touch with pins V on the coupling rods F, so that in the event of the front edge meeting with an obstruction the rods F are pushed upwards, communicating to the trip gear the same moment, with a like result as when actuated by an increased speed of the governor.

There are two excellent examples of these lifts constructed by Messrs. J. and H. Brookes, of Smethwick, running in Birmingham, one having been in continual work for four years, and we have carefully inspected a large working model with very satisfactory results.

TRADE AND BUSINESS ANNOUNCEMENTS. — Messrs. Samuel Denison and Sons, of Old Grammar School Foundry, Leeds, have established a London office at 7, Billister-buildings, 49, Leadenhall-street, E.C.

DEATH OF MR. THOMAS HOWARD, C.E.—The death is announced of Mr. Thomas Howard, C.E., at the advanced age of eighty. Mr. Howard, who had for some time past resided at Netherleigh, in the Shrubbery, Weston-super-Mare, was in 1855 appointed the first docks engineer under the Bristol Corporation. The *Bristol Mercury* says:—"He filled the office with benefit to the city and distinction to himself until November, 1882, when he resigned after a period of honourable service extending over twenty-seven years. Early in his career he made elaborate surveys and plans in connection with the dockisation of the river. It was Mr. Howard, indeed, who first conceived the bold idea of that project, to which he devoted many years' labour. Mr. Howard was directly concerned with the works of river improvement which were carried on under the Bristol Docks Act of 1865, and also designed and made the fine new lock at Cumberland Basin, and the new junction lock with the harbour, and also the pontoon. Other special works executed in Mr. Howard's period of office were the Harbour Railway Wharf, the deepening of the harbour and construction of the quay wall at Mardyke, and the reconstruction of Bath Bridge, after the wrought iron structure was smashed by a barge in 'the fifties.' Mr. Howard's reputation will be always sustained by the voluminous and clear reports which he has left as records of all the engineering points connected not only with the Docks Estate, but with every branch of Corporation work."

THE FIRST LOCOMOTIVE IN THE UNITED STATES



THE FIRST LOCOMOTIVE IN THE UNITED STATES.

The books and records of the Delaware and Hudson Canal Company show that early in the year 1828, having heard of the success of the Stockton and Darlington Railway, it was resolved to send Mr. Horatio Allen to England with instructions to obtain information and purchase rails and four locomotives. There is a report made by Mr. Allen, in which he gives details of English railways, and informs the company that he has given an order for three engines to Foster, Rastrick and Co., of Stourbridge, and has just given an order to Mr. Stephenson for one. This report was written in 1828, at Newcastle-upon-Tyne.

Stephenson's engine was named America; it was built in 1828, and arrived in New York, on board the ship Columbia, about the middle of January, 1829, and the "bill of lading" still exists, and was at the Chicago Exhibition.

The official diagram shows that the America ran on four wheels, had an iron bar framing and inclined cylinders, and was No. 12 in the books of Stephenson and Co.:—

	ft. in.
Diameter of boiler	4 1
Length of boiler	9 6
Dimensions of fire-place	4ft. by 3ft.
Diameter of cylinders	0 9
Length of stroke	2 0
Size of chimney	1 8
Size of feed-pump	0 1¼
Length of pump stroke	2 0
Wheels, diameter (wood)	4 0
Number of wheels	Four.
Angle of cylinders to the horizontal	33 deg.
Size of fire-tubes	1 7
Number of fire-tubes	Two.
Tubes were straight.	

Although Stephenson's engine America was undoubtedly the first railroad locomotive to *arrive* in the United States, it was *not* the first to be used.

The first part of the Delaware and Hudson Canal Company's railroad was not ready till 9th August, 1829, and on that day the Stourbridge Lion was worked by Mr. Allen, that engine having arrived in New York, in May, 1829, or about four months *after* the America. The America was a sister engine to the Lancaster Witch, of 1828, and was very like the Invicta, with the position of the cylinders reversed.

TRACTION ENGINE WHEELS.

On Thursday week, at the Glossop County Sessions, Messrs. William Preston and John Mason, trading as Preston and Mason, bleachers, Charlesworth, were summoned by Herbert Turley Chapman, surveyor of highways, Chapel-en-le-Frith, on behalf of the Derbyshire County Council, with being the owners of a certain locomotive on the Glossop and Marple Bridge main road, on December 17th, the driving wheels of which were not in accordance with the Act of Parliament. Other charges were preferred, embracing December 18th, 19th, and 21st. Mr. N. J. Hughes-Hallett, clerk to the Derbyshire County Council, appeared in support of the prosecution, and Mr. J. W. Tweedale defended, and pleaded not guilty to all five charges.

Mr. Hughes-Hallett, in opening the case, said the summonses were taken out formally in the name of Mr. Chapman, who was the main road surveyor for the district named, and the charge against the defendants was for a breach of the Act of Parliament, the Highways and Locomotives Amendment Act, 1878. The Act provided that the wheels of these locomotives shall be cylindrical and smooth-soled, or shod with diagonal cross-bars not less than 3in. in width, and not more than ¾in. in thickness. In the event of a breach of this Act of Parliament, a person was liable to a penalty not exceeding £5. It appeared that Messrs. Preston and Mason were the owners of two traction engines, one of which was already licensed to run in this county, and the other was not. On December 19th last he received an application, dated the 18th, from Messrs. Preston and Mason for a licence in respect to the engine that was the subject of the present charge. In accordance with the requirements of the County Council, a form had to be filled up, but it was not properly filled up; he returned it for further information, and he found that the wheels of the traction engine were not in accordance with the Act of Parliament, and he therefore drew defendants' attention to the fact. It was, however, not a question of the bye-laws, but the Act of Parliament; and therefore the licence was refused. It appeared that before making application for this licence, namely, on the 17th, the first day for which the summons was taken out, the defendants had used this engine, with the wheels not in accordance with the Act. He thought it was only right to say that he did not propose to do anything in the way of complaining against defendants for not having a licence, for at that time they enclosed a cheque for £10 which was required for it, but it was for not having the wheels of the engine in accordance with the Act of Parliament. On the first day mentioned a roadman in the employ of the County Council saw this engine running, and knowing that it had not been previously licensed he stopped the driver and made inquiries, and drew attention to the fact that the wheels were not the same as on the other engine, but although this fact was brought before defendants, the engine continued running for the four following days. The wheels of the engine, instead of being in accordance with the Act of Parliament, were made with what was known as "Boulton's studs," and the driving wheels of the engine, instead of having diagonal cross-bars, had studs 6in. square projecting 2in. from the surface of the wheels, and being 2in. apart. These studs are wood enclosed in iron ¾in. thick. These wheels, as a matter of fact—it was not a mere technical error on the part of the defendants—did considerable damage to the roads, and the County Council was bound to take proceedings in that matter, even apart from the question of the Act of Parliament. It might be pointed out for the defence that these wheels were in use in other districts. The Act, however, said that certain wheels shall be used, and to use a common expression, "Two blacks do not make one white." If other authorities did not enforce the law, that was no reason why the Derbyshire County Council should not enforce it.

Samuel Turner, roadman, in the employ of the County Council, gave evidence as to seeing the engine used with the wheels complained of.

By the Chairman: These blocks on the wheels in his opinion made bigger holes in the ground than the cross-bars.

Herbert Turley Chapman, surveyor of highways, Chapel-en-le-Frith, spoke to the damage done to the roads by the wheels. He held that on an ordinary macadamised road the present wheels complained of did considerably more damage than the ordinary cross-bars. In soft weather the springs did not give, but sunk in the road, making holes in which the water congregated.

The Chairman — Captain Partington — remarked that these engines were bound to be used largely in the future, and in his opinion this Boulton wheel had been devised to save the roads, and it did seem hard that this firm should be proceeded against when they had obtained the wheels with this intention.

Mr. Hughes-Hallett replied that the county authorities took a different view of the matter in regard to the roads.

Mr. Tweedale, replying for the defence, submitted that of all the miserable, petty cases ever brought before a Court of Justice this must strike them as being the very worst. What his clients had done in the matter had been done with perfect *bonâ fides*. The first day mentioned in the charges was the 17th December. On the 16th December his clients wrote to Mr. Hughes-Hallett, and sent a cheque for £10, asking for the usual licence for this particular engine, which, as they had heard, had on Boulton's patent wheels. In reply, Mr. Hughes-Hallett acknowledged the cheque, but wanted more particulars filling up. That was complied with, and everything that possibly could be done by his clients was done in the way of filling up the particulars. On the 23rd December, Mr. Hughes-Hallett wrote again to his clients, returning the cheque for £10, having found that the wheels were not in accordance with the Act of Parliament, and he refused the licence. He might point out that on the 19th December Mr. Hughes-Hallett returned the application, and wanted the answers completed, and in the meantime, having retained the cheque, his—Mr. Tweedale's—clients used the engine. After the 23rd December, when the letter came and the cheque was returned, refusing the licence, the engine was not used again. He thought if that first case had not been taken against defendants some time ago, the present case would not have been heard of. He characterised it as "persecution" rather than a "prosecution."

Mr. Hughes-Hallett—interrupting—objected to the expression, and said these cases had been taken all over the county. It was a breach of the bye-laws, and that the case had been taken through spite was absolutely untrue.

Mr. Tweedale said the whole thing was of such a trivial nature. He thought when his clients ceased to use the engine, that should have been enough for the County Council, instead of bringing everybody to Court that day to take part in such a case as the present one. He would place an expert in the box to prove that these Boulton wheels were the very best known, and did macadamised roads the least damage of any known. He would call the borough surveyor from Ashton-under-Lyne. In that borough a fee of 5s. was charged for traction engines passing through, but special facilities were given to those with Boulton's wheels, and no fee was charged. It was quite clear, whether there was a technical offence or not, that his clients had done everything they could in the matter.

Mr. J. T. Earnshaw, borough surveyor, Ashton-under-Lyne, which position it was stated he had occupied eighteen years, said he had had experience of traction engines ever since 1879, and traction engines passed through the borough of Ashton every day. Messrs. Gartside had an engine that passed through twice each day on its journey from Carrbrook to Manchester and back. In Ashton they made a special allowance to those people who used Boulton's wheels. Other engines that had not these wheels were charged 5s. for coming through. In his opinion Boulton's wheels did considerably less damage to the roads than those prescribed by Act of Parliament. He considered that if it had to be passed now the present Act of Parliament would not be framed in its present form. With regard to macadam roads, the engine wheels prescribed by Act of Parliament would damage the roads worse than the wheels now complained of. There was a greater surface of wheel on the road by using Messrs. Boulton's wheels.

Cross-examined by Mr. Hughes-Hallett, witness admitted that there were few macadamised roads at Ashton. He had, however, noticed the effect of the engines on macadamised roads. The cross-bar wheel was one that bore the whole of the weight, whereas the springs on the Boulton wheel would give under weight, and present more of a flat surface to the road. Mr. Hughes-Hallett contended that it was not a question of expert evidence—he could have brought expert evidence—but it was a question of the breach of the Act of Parliament.

The magistrates retired, along with the clerk, and on returning into Court, Captain Partington said they had discussed the matter, and they had to admit that defendants had broken the law, but they believed had broken it unknowingly. Defendants had made a very good effort to get a better wheel than the Act of Parliament described. The magistrates had decided to fine defendants 1s. in each case, with Court costs. The bench also thought that this matter should be represented to the authorities at Derby, and pointed out that the defendants had been making, and were making an effort, and that they had got a better wheel than the one mentioned in the Act of Parliament. The authorities ought to consider whether the defendants should be put to further trouble.

Mr. Hughes-Hallett said he would take care that the matter should be brought before his committee, which met the following day.

Mr. Tweedale said he had been informed since coming into court that notice was given in the House of Commons with regard to this section, and it was going to be brought forward in the next session of Parliament, to repeal it.

Mr. Boulton, whose patent was referred to in the case, was present in Court during the proceedings.—*Buxton Chronicle.*

TESTS TO SHOW THE DISTRIBUTION OF MOISTURE IN STEAM WHEN FLOWING THROUGH A HORIZONTAL PIPE.*

By D. S. Jacobus, Hoboken, N.J.

In a previous paper preliminary tests were presented which were made in connection with an investigation undertaken for the Babcock and Wilcox Company by Professor Denton.† In this paper it was demonstrated that various calorimeter nozzles, such as are now used in practice, do not give an average sample of the steam flowing though the steam main. It was also stated that tests were in progress to determine the efficiency of a nozzle devised by Professor Denton, which consists of a ½in. tube open at the end, passing through a stuffing-box, and so arranged that it may be moved to any position across the pipe under a full head of steam.

The tests made with the tube passing through a stuffing-box indicated that a greater part of the moisture was near the bottom of a horizontal pipe, and that it probably ran along in a small stream. If this was true, then an opening in the bottom of the pipe, so arranged that the water could run freely into it, would glean off all, or the greater part, of the moisture. The tests which are the subject of this paper were made to determine to what extent such an action takes place, and are a continuation of the preliminary investigation above referred to.

It was found that after steam had passed through 8ft. of horizontal 3in. pipe, 95 per cent. of the entrained moisture, or over, could be drawn from a ½in. pipe leading from the bottom of the 3in. pipe, for quantities of moisture as high as 8 per cent., and velocities as high as 25ft. per second.

The moisture was thoroughly mingled with the steam before entering the 3in. pipe. The apparatus was so arranged that the greater part of the moisture was initially near the top of the pipe, so that it had to fall through the steam during the time taken to travel over the space of 8ft. The theoretical time required for a body falling freely in space to travel from the top to the bottom of the pipe is about ⅛ of a second. Hence, the maximum initial horizontal velocity that such a body could have and reach the bottom in a horizontal space of 8ft. would be 64ft. per second.

It appears from the experiments, therefore, that for the particular set of conditions which existed, 95 per cent of the moisture can be gleaned from the bottom of a pipe, if the velocity of the steam is ⅜ that corresponding to the theoretical velocity already mentioned. For a velocity of 20ft. per second, or about ⅓ the theoretical velocity, 98 per cent. of the moisture was drawn from the bottom of the pipe for quantities of moisture as high as 10 per cent. For a velocity of 43ft. per second, or $\frac{7}{10}$ of the theoretical velocity, about 60 per cent. of the total moisture was drawn from the bottom of the pipe, and at half of the theoretical velocity about 90 per cent. was drawn out.

It cannot be said that these ratios will apply to all cases, and for this reason additional tests are to be made to determine the effect of increasing the length of the horizontal pipe.

A special series of experiments was made, in which a horizontal plate was placed about ¾in. above the bottom of the 3in. pipe, and over the ½in. pipe leading to the calorimeter. The plate was arranged so that all the moisture which collected under it would run into the calorimeter. The object of introducing the plate was to collect all the water which was near the bottom of the pipe, so as to determine to what extent a nozzle, simply tapped into the bottom of the pipe, would remove such moisture. The results of corresponding tests, with and without the plate over the calorimeter nozzle, are about the same, which indicate that a nozzle connected so that its inner end is flush, or slightly below the bottom of the pipe, will remove practically all the moisture which flows near the bottom of the pipe.

The results of the experiments on the 3in. pipe are given in detail in Table I.

In Professor Denton's experiments a single calorimeter was at first attached to the bottom of a horizontal 12in. pipe by means of a nozzle, which could be raised and lowered so as to draw steam from various sections of the pipe, as has been already described. It was found that the weight of moisture ranged between about 5 and 50 per cent. of the weight of steam passing through the calorimeter when the nozzle was lowered so as to be near the bottom of the pipe; whereas, when the nozzle was raised so as to be about 1¾in. above the bottom of the pipe, the steam which passed through the calorimeter was practically dry. In these tests the steam passed from the boiler through about 10ft. of horizontal 12in. pipe to an elbow, and thence through a second horizontal 12in. pipe. The calorimeter was attached to the second horizontal pipe about 6ft. from the elbow. The velocity of the steam was about 17ft. per second, representing about 500-horse power.

After making the tests with a single calorimeter, a second series of tests was made with two calorimeters, to determine if the moisture was all at the bottom, or if it was also creeping along the sides of the pipe. To make these tests the second calorimeter was placed at the same cross-section of the pipe as the first, but it was moved to one side, so as to be 4in. from the calorimeter attached directly to the bottom of the pipe. It was found that when both nozzles were set so that the ends were flush with the inner surface of the pipe, the calorimeter at the bottom of the pipe indicated

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[*] Presented at the Detroit meeting of the American Society of Mechanical Engineers.

[†] "Results of Measurement to Test the Accuracy of Small Throttling Calorimeters," "Transaction," vol. xii., p. 448.

excessive moisture, whereas the calorimeter 4in. from it toward the side of the pipe showed practically dry steam. This indicated that all the moisture was at the bottom of the pipe.

The general arrangement of apparatus for conducting the tests on the 3in. horizontal pipe is represented in Fig. 1.

Superheated steam entered at A, and passed through a 3in. pipe surrounding a cooling pipe B. The cooling water entered at C and passed off at G. After passing the cooling pipe the steam passed through a device at D, which thoroughly mixed the steam with the water. This consisted of two plates placed about 1in. apart, in which were two holes about ⅝in. in diameter. The hole in the first plate encountered by the steam was at the bottom of the pipe, so that all moisture in the steam would be drawn from the bottom of the pipe. The steam and moisture then passed upward between the plates and out of the hole in the second plate. The hole in the second plate was placed near the top, so as to introduce the steam and moisture near the top of the 3in. pipe E. The calorimeter was attached at V. K is the separator portion of the calorimeter, and L the heat gauge. The temperature and pressure of the steam was measured on leaving the pipe E by means of the thermometer H, and the pressure gauge J. The thermometer H, was placed in a mercury well having an enlargement at its lower end and a thin neck. The steam was throttled by means of the valve M, from a pressure of about 80 lb. above the atmosphere in the pipe E, to about the pressure of the atmosphere in the 12in. drum N. The temperature of the steam after throttling was measured by a thermometer Q, placed in a mercury well, and by a thermometer P, which came in direct contact with the steam. The pressure in the drum N was measured by means of a mercury gauge. The steam flowing into the drum N was led to a surface condenser, and finally weighed.

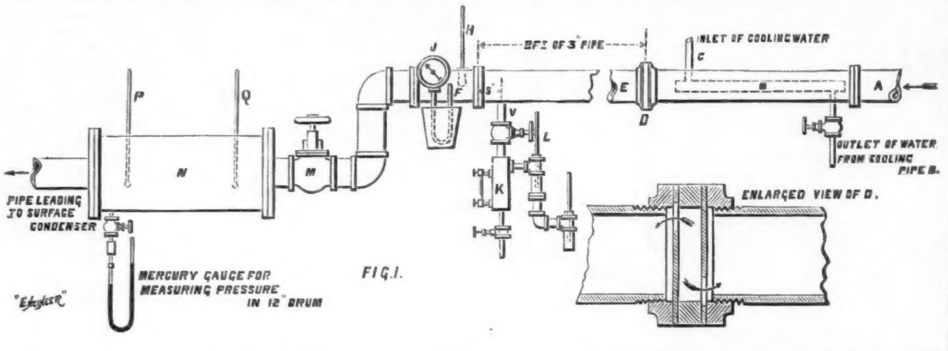
P
Q
N
M
J
H
F
S
V
L
K
E
D
C
A
B
8FT OF 3" PIPE
INLET OF COOLING WATER
OUTLET OF WATER FROM COOLING PIPE B.
ENLARGED VIEW OF D.
PIPE LEADING TO SURFACE CONDENSER
MERCURY GAUGE FOR MEASURING PRESSURE IN 12" DRUM
"ENGINEER"

FIG. 1.

The amount of moisture in the steam passing through the valve M was indicated by the amount of superheating in the 12in. drum N. This moisture, added to the moisture in the steam entering the Barrus calorimeter, gave the total moisture contained in the steam passing through the 3in. pipe. Corrections, determined directly by experiment, were made for all radiation. The factor of 0·48, for the specific heat of steam, was employed in calculating the percentage of moisture, and special experiments were made to show how nearly this method would agree, in the case of the 12in. drum, with the experimental normal reading for dry steam. These experiments, from the nature of the apparatus, could be made only with steam just at the point of superheating or with slightly superheated steam, and the results obtained were the same as in similar tests made on a Barrus calorimeter, and given in the paper on "Errors of Calorimeters."

TABLE I.

Percentage of Total Moisture Entering a 3in. Horizontal Steam Pipe that is Removed by a ½in. Drip Pipe.

The moisture in each case was either thoroughly mingled with the steam, or the greater part of it was near the top of the 3in. pipe at a point 8ft. distant from the ½in. drip pipe. Much of the moisture had, therefore, to fall through a distance nearly equal to the diameter of the 3in. pipe before it was drawn out at the ½in. drip pipe.

Conditions under which the tests were made.	Number of test.	Velocity of steam in 3in. pipe in feet per second.	Percentage of priming in steam passing thro' 3in. pipe.		Percentage of total moisture removed by the ½in. drip pipe leading to the Barrus calorimeter.
			Before reaching drip pipe.	After passing drip pipe*	
1	2	3	4	5	6
First series of tests. Moisture produced by the cooling pipe marked B in Fig. 1. No mixing device at D.	1	65·1	3·9	2·2	45·6
	2	64·7	1·9	0·9	55·7
	3	63·3	1·5	0·4	71·7
	4	52·3	1·6	0·3	84·4
	5	52·2	4·2	1·6	62·8
	6	41·9	3·3	0·3	91·5
Second series of tests, in which a mixing device was placed at D to thoroughly mingle the steam and water.	7	38·1	4·8	0·6	88·6
	8	38·1	2·6	0·5	82·8
	9	38·1	2·4	0·4	85·6
	10	38·1	0·3	0·0	100·0
	11	38·0	1·6	0·2	89·0
	12	38·0	0·4	-0·1	100·0
	13	24·9	4·8	0·1	98·7
	14	24·8	3·1	-0·1	100·0
	15	24·5	8·2	0·5	95·0
	16	19·2	8·8	0·5	95·5
	17	16·0	6·6	0·1	98·1
	18	16·0	6·6	0·1	98·1
	19	15·9	1·0	-0·1	100·0
	20	15·6	5·4	-0·1	100·0
Third series of tests, in which the steam and entrained moisture was supplied through a vertical 3in. pipe, and flowed through an elbow into the horizontal 3in. pipe.	21	43·1	3·5	1·2	67·3
	22	42·7	2·3	0·7	68·8
	23	35·9	1·3	0·2	85·2
	24	35·8	3·4	0·7	89·8
	25	31·1	3·5	0·3	91·7
	26	31·1	2·1	0·1	95·0
	27	20·9	12·1	0·5	96·8
	28	20·6	7·8	0·0	100·0
	29	20·5	2·5	-0·1	100·0
	30	20·2	3·8	0·1	97·1
	31	15·8	5·6	-0·2	100·0
	32	15·4	8·7	-0·2	100·0
Special tests in third series, in which a plate was placed over the drip pipe leading to the calorimeter, so as to collect all moisture that was near the bottom of the pipe.	33	42·1	3·5	1·1	66·6
	34	42·1	2·2	1·2	49·4
	35	41·9	2·4	1·1	57·4
	36	38·1	2·4	0·6	77·8
	37	34·3	2·5	0·1	96·7
	38	33·1	3·4	0·0	100·0
	39	26·9	7·3	-0·1	100·0
	40	26·8	4·8	0·0	100·0
	41	20·5	4·3	-0·1	100·0
	42	20·2	13·1	0·4	97·4
	43	20·2	4·9	0·0	100·0

* The percentages of priming given in this column are calculated from the superheating in the 12in. drum, and are correct to within about $\frac{1}{10}$ per cent. The minus values are either accidental discrepancies, or they are caused by the fact that the steam was initially superheated, and tended to retain the property of producing a slightly higher "normal reading" than that given by the theoretical formula.

It was found that the experimental normal reading for steam in a maximum state of dryness, when corrections were made for all radiation, and the temperatures were corrected so as to correspond to those registered by an air thermometer, was 3 deg. higher than the theoretical normal reading.

The initial pressure in all the tests was about 80 lb. per square inch above the atmosphere. With steam that was slowly condensing the tests made in connection with the "Errors of Calorimeters" showed that the normal reading with a Barrus calorimeter was 3 deg. lower than for steam of the maximum dryness, so that if this same difference applies to the 12in. drum, the experimental normal reading for steam which is slowly condensing, and therefore contains the maximum amount of moisture, would be the same as the theoretical normal reading, employing a factor of 0·48 for the specific heat of steam.

Three series of tests were made. In the first there was no mixing device placed at D. In these it was found that the thermometer H would indicate superheating with considerable moisture entering the calorimeter nozzle V. The second series of tests were made after adding the mixing device D. In the third series of tests the 3in. pipe containing the cooling pipe B was lowered, together with the mixing device D, and the steam was made to pass through an S-shaped connection of 3in. pipe into the pipe E. This caused the steam which was admitted to E to pass upward through a vertical pipe, then turn through an elbow into the pipe E. The object of the latter arrangement was to make the mixture of steam and water enter the pipe E at the same velocity at which it flowed through the pipe E. When the steam and moisture entered the 3in. pipe directly from a ⅞in. hole in the mixing device D, it was initially at a much greater velocity than the average velocity in the pipe E, but it was considered best to make tests in this way so as to have one set of tests in which the conditions were as severe as possible.

An appendix is added. which gives the calculation of one of the tests in detail, together with the results of experiments to determine the radiation, and the details of the tests made to obtain the normal reading of the 12in. drum.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

AN average attendance of members was on 'Change to-day. Enquiries for steam coal continue good, and prices are firm at last week's quotations. Stems are generally well filled, and both docks are well occupied with tonnage. A slight decrease has taken place in the price of pitwood. Due to arrive in two or three weeks' time is the large steamer Algoa, to load her first cargo of about 13,000 tons of coal. This will be the largest vessel which has ever visited the port, or even the Bristol Channel. The s.s. Maroa broke the record last year with a cargo of 10,000 tons; the Algoa, as will be observed, will take away 3000 tons more than her. The Samoa, another big steamer, is also stemmed to load here shortly. The agents for both boats are Messrs. R. Gething and Co. A greater activity has taken place in the ship-repairing trade during the week than was the case the previous one.

Prices ruling on 'Change to-day were as follows:—Coal: Best steam, 8s. 6d. to 9s.; seconds, 8s. to 8s. 3d.; best house coal, 10s. 6d.; dock screenings, 5s. to 5s. 6d.; colliery small, 4s. 6d. to 5s.; smiths' coal, 6s. 6d.; patent fuel, 10s. 6d. Pig iron: Scotch warrants, 46s. 8d.; hematite warrants, 48s., f.o.b. Cumberland; Middlesbrough, No. 3, 37s. 10d. prompt; Middlesbrough hematite, 45s. 10d. Iron ore: Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel rails: Heavy sections, £4 10s.; light ditto, £5 to £5 10s., f.o.t. Tin-plate bars, £3 17s. 6d.; Siemens tin-plate bars, best, £4; all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel coke, 9s. to 9s. 3d.; Siemens (coke finish), 9s. 6d.; Ternes, per double box, 28 by 20 C, 21s. to 22s. Pitwood, 15s. 6d. to 15s. 9d. London Exchange telegram: Copper £43 7s. 6d.; Straits tin, £60 7s. 6d.; freights continue firm.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

THE Midland Iron and Steel Wages Board met at Dudley, on Monday, to receive the accountant's certificate for November and December. It showed the net average selling price to be £5 15s. 3d. per ton. This compares with £5 12s. 7d. for September and October, or an improvement of 2s. 8d. per ton, and with £5 14s. 4d. for November and December of 1894. The average is reckoned on the selling rates of bars, hoops, sheets, plates, and strips, and regulates wages in Staffordshire and the Midlands, and also at a number of works affiliated to the Board, which are located in Lancashire, Yorkshire, and Wales.

The rise in the average occasioned much satisfaction on 'Change this—Thursday—afternoon, and was commented upon as a further satisfactory indication of the trade recovery which marked the latter portion of the year. The interruption occasioned by the foreign political disturbances has, it is pleasing to know, been succeeded by a resumption of the revival. Sheets, however, are the department in which prices mostly lag. Galvanised corrugated sheets are quoted this week a minimum of £10 5s. in bundles, but the more general figure is £10 10s. f.o.b. Black sheets are still quoted on the open market £7 2s. 6d. to £7 5s. for doubles, but the price is just now hardly more than a nominal one, and sales were reported to-day at £7 and occasionally under. Lattens were 15s. per ton additional upon doubles, whilst singles were in some cases as low as £6 15s. to £6 17s. 6d. per ton. Soft sheets for bucket making and working-up purposes were 2s. 6d. per ton over the price of hard sheets. Trunk sheets remain at £8 to £8 2s. 6d. for 24 w.g., with a good sale, and 7s. 6d. on for steel material, and deep stamping sheets of steel were £9 10s. to £10 10s. for doubles and trebles respectively.

Sales of steel to the sheet-rolling firms, in the form of tin bars, and billets, and slabs, are steadily increasing, and these descriptions are being rolled down to an augmented extent into steel sheets, to take the place of the sheets of iron hitherto chiefly employed. Steel all round was active, and prices were quoted £4 5s. to £4 10s. for Bessemer blooms, and billets, and tin bars, though some consumers declared themselves still able to place orders at £4 2s. 6d. —a figure which was generally considered to be exceptional. Imported steel angles and boiler plates were quoted £5 10s. to £5 17s. 6d.; sheets, £7 5s. to £7 10s.; and bars, £5 15s. to £6. Basic steel girders and angles were £5 5s. to £5 10s., and boiler plates £6 5s. per ton.

Pig iron sellers again reported increased business to-day, both in Staffordshire and Midland sorts, buyers being desirous of anticipating the market, lest it should go against them. Prices are decidedly stronger. All mine hot-air Staffordshire pigs are quoted 55s. to 57s. 6d.; part mines, 40s. to 42s. 6d.; and cinder sorts, 36s. to 37s. per ton. Northampton forge iron is quoted 41s. to 41s. 6d., and Derbyshire 42s. to 43s.; with sales taking place at 1s. per ton under these figures. Lincolns are 44s. 7d. per ton net.

The building of a line past the rapids and across the Shiré Highlands in Africa is greatly to be desired in the interest of the Protectorate, as a better means of communication and transport would give a great impetus to the development of the coffee plantations, which already produce some of the finest coffee that is placed on the London market, and are capable of almost indefinite extension. Should the projected line through Portuguese East Africa from the Ruo to Quillimane be seriously undertaken by the Zambesi Company, British Central Africa would practically be in direct railway connection with the East Coast, as the building of a section between Chimor and the termination of the Portuguese line would present no difficulties.

A reconstruction scheme is to be submitted to the shareholders of the Metropolitan Carriage and Wagon Co. on the 3rd of February. Particulars are given in a circular issued this week and signed by the board's chairman, from which it would seem that the conversion is more a matter of convenience than necessity. Apparently no anxiety need be entertained regarding it. A sum of £300,000 of authorised capital in excess of present requirements now stands upon the books. To get rid of the crushing liability of £5 per share on this amount, and to release as an asset a large and valuable freehold building estate, which at present is practically unrealisable, it is proposed to sell the business to a new company registered in the same name, but with more modern memorandum and articles of association. The new capital would be £150,000, divided into 30,000 shares of £5 each, fully paid.

Local engineering firms interested in the light railways movement are discussing this week information from Belgium regarding the light railways so extensively in operation there, which seems to suggest that more difficulties would probably be found in carrying out the system in our own country. It is stated that the primary conditions in England and Belgium are entirely different. Flanders is absolutely flat, densely peopled, occupied entirely by small owners who are able to cultivate their small holdings, of very light sandy soil, with little comparative labour and difficulty. Then, these lines run alongside the roads, without fence or protection of any kind. It seems risky to run trains at twelve or sixteen miles an hour under these conditions; but accidents very rarely happen. These lines have no works, bridges, fences, cuttings, stations, or signals. Their cost to make must be very slight, and their cost to maintain equally so.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—A generally steady business was reported on the Manchester Iron Exchange on Tuesday, with makers' prices very firm, both for raw and manufactured material. In pig iron, although the buying was not perhaps quite so large as last week, when some fairly heavy transactions were put through, there was quite as much inquiry as makers cared to entertain, and in some instances they were so heavily sold as to be practically out of the market. Here and there underselling on the part of speculative merchants is reported, but much more would seem to be made of this than is actually warranted, and certainly in the present condition of the market, anything like "bear" operations would be exceedingly risky. Lancashire makers are booking orders freely at their full list rates, which remain firm at 46s., less 2½, as the minimum for No. 3 foundry, delivered equal to Manchester. In district brands, one or two Lincolnshire makers are practically declining to book further orders, either in forge or foundry qualities, and there is some talk of a general advance in the arranged prices at a meeting to be held at the close of the present week. Already there is some hardening up, and delivered equal to Manchester, quotations for Lincolnshire now range from 41s. 6d. and 42s. for forge, to 43s. 6d. and 44s. 6d. for foundry, whilst Derbyshire foundry, which is also stronger, averages 46s. to 47s. net cash, delivered here. The current market quotations for outside brands offering here are much the same as last week. Middlesbrough is perhaps a trifle firmer, makers not quoting anything under 46s. 4d. net cash for good named foundry brands, whilst it would be difficult to buy ordinary brands, even through second hands, at much under 45s. 10d. delivered Manchester. For Scotch iron, prices are maintained, but there are a few cheap parcels in the market, and Eglinton might be brought at about 47s. 3d. to 47s. 6d. delivered Lancashire ports, and about 49s. 6d. delivered dock quays, Manchester—where a gradually increasing proportion of the business in this immediate district is now being put through—and Glengarnock about 1s. over the above figures.

No really material change can be noticed in the finished iron trade, except that makers report a better tone generally. Bars continue in active demand, and with makers books well filled prices are very firm at £5 10s. for Lancashire to £5 10s. and £5 15s. for North Staffordshire bars; sheets remain at about £7 10s. to £7 12s. 6d.; and the Association list rates for hoops at £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths, delivered Manchester district, with 2s. 6d. less for shipment.

Nut and bolt makers report the improvement I noticed recently in this branch of trade, fully maintained, business for general requirements coming forward freely, but as yet no materially better prices are obtainable. Girder manufacturers are also securing a large weight of work for general constructive purposes, and have been able to advance their prices upon recent minimum quotations about 5s. per ton; steel girders of ordinary section, delivered in this district, being now quoted about £5 12s. 6d. per ton.

In the steel trade the improvement which it was anticipated would follow upon a settlement of the shipbuilding dispute is scarcely yet making itself felt to any appreciable extent. Ordinary foundry hematites can still be bought at about 55s. 6d., although general quotations are about 56s. 6d., less 2½; and steel boiler plates are obtainable without difficulty at £6 5s., delivered in this district.

In the metal market all descriptions of manufactured goods continue in active request, orders coming to hand freely from the various engineering branches of trade, whilst the continued upward movement in copper goods gives a hardening tendency to prices, which may possibly result in some official advance in list rates before very long.

Wire netting manufacturers also report not only an active demand on home accounts, but what is perhaps still more satisfactory, a revival of the Australian demand, which has been exceedingly quiet for the last couple of years, some firms having now orders from the above quarter for rabbit netting which will keep them well employed over the next three or four months.

Locomotive builders in this district, who for a long time past have been very short of work, are securing a very fair weight of orders, one firm having during last week booked a tolerably good one from Japan, and most of the establishments in this district, which are now tolerably well engaged, are, I believe, in a much better position than similar establishments in Yorkshire, and the north boilermakers are also booking new work more freely than they have been for some time past. With regard to other branches of the engineering trade, they continue well engaged, the improvement I have recently reported being well maintained.

As the official report with reference to the settlement of the dispute in the Bolton engineering trade, which I noticed last week, practically confirms the particulars I then gave, I need not refer further to this matter.

A special plant of machine tools for manufacturing dynamo brushes by an improved process has just been put down by Messrs. Johnson, Clapham, and Morris at their works in Manchester. By this new process the wire cloth is specially compressed, in such a manner as to render the dynamo brushes—which are being manufactured not only in copper, but also in brass wire—more solid, thus giving them an increased stiffness. When brought in contact with the revolving armature, the advantage gained being that they maintain a much steadier pressure upon the armature as compared with the ordinary brushes in use generally.

An interesting paper on the transmission and application of power to machine tools, &c., written by the late Mr. R. H. Tweddell, M. Inst. C.E., of London, was read before the members of the Manchester Association of Engineers at their meeting on Saturday. The paper stated that in the author's opinion there was a large field open for the application of electric motors to machine tools, not only on the score of transmission of power over long distances, but also its convenience when the question of working sections only of a shop or a single machine placed amongst many others was to be considered. It would, however, be well for works' managers to proceed cautiously in adopting electricity, or they might soon be metaphorically struggling in tunics sewed up for them by too impulsive electricians. For transmitting power over long distances, both water and electricity had their special advantages. Electricity as a motive power for moderate sized machines in frequent work certainly seemed to fulfil most of the conditions, but one disadvantage was that the machines had to wait till the speed of the motor was got up, and a similar loss of power occurred when the machine was being stopped, whereas the hydraulic machine only consumed power while work was actually being done. There were, of course, losses peculiar to the hydraulic system, and climatic conditions to be considered, and the final verdict as to the power selected could only be the result of experience and judgment in each particular case.

In many classes of work it was essential that the exact pressure exerted be known, and that the same pressure be exerted every time it was applied under similar conditions. This was especially the case in the riveting, and for this hydraulic machines were particularly applicable, the range of travel being one of their chief advantages, which was practically unobtainable in geared machines, whether driven by shafting or electric motors. Simplicity and fewness of parts should be the aim of the hydraulic engineers. Many apparently satisfactory mechanical devices had been brought out to economise the water consumed, but the only really efficient one—when suitable—was that due to the use of an overhead tank and simple non-return valve, or in some special cases the use of three rams. There was no doubt but that in the future electricity would have to be considered as one of the factors in an economical works plant, and in some cases it would supplant both shafting and hydraulic pressure, but there would always be applications left for the older systems.

A short discussion followed upon the paper, during which the president (Mr. Nasmith) remarked that where they had to do heavy work quickly, as in flanging up a boiler front, or in stamping, &c., the hydraulic system filled all requirements, as a large force could be applied very quickly and with the least possible loss. The claim now made for electrical transmission of power from a central source was simply a resuscitation of that made by Mr. Tweddell for hydraulic power twenty years ago, *i.e.*, that it was a more economical method of transmitting power over long distances than any at present existing. Mr. Jenkins observed that electricity had many conveniences that no other power could have. For instance, they could put electrical machines almost anywhere in a works. As compared with shafting, it was no doubt in some cases less, but in many cases—especially where coal was dear—it was more economical. Two drawbacks to hydraulic power were the comparatively small power that could be transmitted through a pipe of ordinary dimensions and its inapplicability to rotary machines.

The coal trade still shows an absence of improvement—many collieries working only about four, and in some cases not more than three days per week — with supplies of all descriptions of fuel plentiful, notwithstanding the restricted get. House-fire qualities are moving off but very indifferently for the time of the year, and prices are barely maintained at late rates. Although the lower descriptions of round coal meet with a fair demand for ironmaking, steam and general manufacturing purposes, supplies continue largely in excess of requirements, and prices extremely low, not averaging above 6s. per ton at the pit mouth for good ordinary steam and forge coals. Engine fuel moves off fairly well, owing to the limited production of slack at many of the collieries, and prices are steady at 3s. to 3s. 6d. for common sorts to 4s. 6d. for better qualities, and 5s. for some special descriptions, at the pit mouth.

For shipment a moderate business comes forward, but prices continue excessively low, ordinary steam coal being still sold at 7s. to 7s. 6d.. with better qualities fetching about 7s. 9d., delivered Mersey ports.

Barrow.—The hematite pig iron trade is gaining strength, and there is a distinct improvement on the week, not only in prompt but forward demand, and prices are firmer at 47s. 7½d. per ton, net cash, sellers; 1d. less buyers. Makers' iron is nominally quoted at 48s. 6d. to 50s. per ton, net, f.o.b. The trade in Bessemer for forward delivery is increasing. Makers are arranging to light several idle furnaces. At present only 35 out of 75 furnaces are in blast, compared with 29 in blast in the corresponding week of last year. Stocks of iron are steady, there being only an increase of 42 tons on the week. Stocks in hand now represent 298,020 tons, being 8845 tons more than at the beginning of the year.

There is not so much life in the iron ore trade owing to a big importation of Spanish ores, value being at 10s. per ton net at mines, and Spanish at 12s., delivered at West Coast ports. The latter is 60 per cent. quality.

Steel makers are as busy as can be with rails, plates, and merchant qualities. There is also a good demand for billets and hoops, but the mills at Barrow will be stopped for a few works longer in consequence of the recent accident. In tin-plate bars, slabs and blooms, a very quiet trade is doing.

The shipbuilding trade is very busy chiefly on Admiralty work, but new commercial orders are expected this year as well as additional Admiralty orders.

The Furness Railway Company has ordered three new passenger locomotives from Messrs. Sharp, Stewart, and Co., Glasgow. They are to have 6ft. driving wheels, 18in. cylinders, 24in. stroke, and a water carrying capacity in the tenders of 2500 gallons.

The coal trade is firmer and steady. Orders are on the increase for coal as well as for coke, and prices are firmer, but not higher.

The shipping trade is still depressed. The exports from West Coast ports during last week represented 2080 tons of pig iron, and 4951 tons of steel, compared with 2075 tons of pig iron, and 2461 tons of steel in the corresponding week of last year, an increase of five tons of pig iron and 2490 tons of steel. The aggregate total of shipments to date represents 22,591 tons of pig iron, and 34,137 tons of steel, compared with 15,418 tons of pig iron, and 21,581 tons of steel in the corresponding period of last year, an increase of 7173 tons of pig iron, and 12,556 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

IN South Yorkshire and adjoining coalfields, the pits are fairly well employed, notwithstanding the excessively mild weather and the fact that the production amply meets the present demand. A dispute at one of the local collieries is now happily settled, although there are indications of another rupture which may culminate in a strike or lockout in the near future. House coal, owing to the remarkable geniality of the month, is but indifferently ordered. Reports from all parts of the coalfield are similarly discouraging in house sorts. A slight tonnage, for the season of the year, is going to London, both in Silkstone and Barnsley thick seam, and prices are rather below those ordinarily obtained during the first month. Consumers in the Metropolis exhibit a preference for Silkstone over other household coal, and this class of fuel is at present quoted at from 8s. 6d. to 9s. 6d. for the best, with 7s. to 7s. 6d. for secondary sorts; Barnsley thick seam is sold at 7s. 9d. to 8s. 6d.; while Flockton fetches about the same price; thin seam, even of the finest qualities, can only realise 6s. to 6s. 3d. at the pits. The demand for steam coal is very limited, and only a poor tonnage is leaving the district for exportation. The bulk of the weight sent to Hull from this coalfield is mainly for the use of steamers in that port. Grimsby is taking a fair supply; business with Goole is very poor. Railway companies continue to require an average amount of locomotive fuel on contract account. Prices in the open market are from 6s. 6d. to 7s. 3d. per ton at the pits. The request, however, is not large enough to prevent the accumulation of stocks. Gas coal is reported in less demand, a fact which is also due to the open weather at present prevailing. Small coal and slack, which a month ago showed some slight advance, has again fallen back to languid request. All descriptions of slack are plentiful, and quotations are about the same. Good screened makes from 3s. 9d. to 4s. 3d. per ton; ordinary pit slack at 2s. 3d. to 2s. 6d., with some difficulty in disposing of quantities. Smudge is obtainable for 1s. per ton. Coke is reported in steady demand both from Derbyshire and North Lincolnshire. Values are better, being 8s. to 9s. 6d., with 6d. less for contracts, as compared with the price obtained three months ago.

Notwithstanding the political troubles which at present gather about this country, all the heavy industries of Sheffield are in a good condition. Foreign markets have opened their business very well during the New Year. This remark applies more particularly to the United States and the South American markets. The Australian business is again beginning to look up. Bar iron and Bessemer steel are in excellent request. Inquiries for the former are so numerous that it is not unlikely that prices will advance shortly. Quotations are as follows:—Hematites are obtainable at 57s. 6d. for West Coast varieties delivered in Sheffield; East Coast irons 2s. 6d. a ton less. Lincolnshire forge iron, 39s.; Bessemer billets, special carbons, used in the Sheffield trades, £5 12s. 6d. and upwards; bar iron at from £5 10s. at makers' works; foundry iron fetches 41s. to 42s. The end of the dispute in the shipbuilding trade is likely to have a most beneficial effect on the Sheffield industries. During the strike our local manufacturers have been much hampered by Scotch firms, who, deprived of their ordinary source of employment, were compelled to look to other markets to keep their works going. They therefore entered into competition with Sheffield and other makers, and literally took the work out of their fingers by accepting it at almost any price they could get. Directly the shipbuilding yards get fairly to work some considerable relief will thus be afforded by the dropping off of these competitors, and the resumption of employment in their own districts. The makers of railway tires, axles, buffers, springs, &c., are now fully employed. A good demand has sprung up with the New Year for cross cut and circular saws for the great wood-growing markets. Russia is one of the principal customers for this class of goods. Continental as well as home makers are placing a considerable number of orders for special steel. The engineering trades have received a slight spurt, although this has been rather damped by the troubles in the Transvaal, which have had the effect of rather decreasing the export of mining tools. It is expected, however, that this business will soon revive and be as active as before Dr. Jameson's raid.

The British Government have placed a large order for common shells of the smaller calibres with the Hadfield Steel Foundry Company, Attercliffe, where this department has as much work as will keep the staff fully employed for several months. Messrs. Thomas Firth and Sons, Norfolk Works, have also received orders in this class of war goods for the Admiralty—their order for two hundred 6in. armour-piercing shell. The company is in a position to turn out very large quantities of this kind of military material, and further favours are expected and desired. The present orders were arranged for before the war clouds appeared.

It was mentioned some time ago in THE ENGINEER that upon inquiries being made it was found that the Emperor of Germany's ill-considered telegram to President Kruger had greatly affected the business done in goods "made in Germany." This opinion has been backed up by many London as well as provincial papers, and in no district has this been so marked as in Sheffield and South Yorkshire. An attempt, which has proved universally unsuccessful, has been made by many merchants to dispose of foreign goods without letting their customers know where they were made. Buyers, however, have been more careful of late to inquire into this matter, and in nine cases out of every ten have rejected the German-made article for the English, even although there has been a substantial difference in the price asked. The German-made productions have been improved upon by many makers, and customers have been completely satisfied with the change. One Sheffield firm alone has done a trade for several years now amounting to about £2000 a year in German goods. Last year they were unable to sell even £100 worth of foreign articles, the English goods taking their place to a large degree. German skate makers have felt this "incident" acutely.

Our cutlery business with South Africa does not seem to have been interfered with so much as was expected by the rather unfriendly relations at present existing between the Boers and the English Government. When the outbreak occurred some very good orders were in hand, and this week large consignments have been forwarded to the Transvaal. Some very good requirements have also been placed with Sheffield firms for steel, files, mining tools, and general hardware goods, all pointing to the fact that confidence is being readily restored. Good reports are coming in from the Australasian markets, and a similar remark applies to the Continent.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE improvement in the iron and allied industries of this district proceeds apace, and almost every manufacturer and merchant gives a good account of his business. and regards the future with confidence. The demand in all departments is certainly brisker than it has been at any time this month, and the termination of the difficulty in the Clyde - Belfast engineering industries has brought consumers forward in greater numbers, and people who were obliged to hold back their specifications on account of the strike, are now sending them in without further delay, so that there is locally a good deal more work being executed on Scotch account than there has been for some months, and nearly all the plate and angle manufacturers are as fully occupied as they can be, with every probability that they will be able to continue as regularly at work.

On this account, also, the tendency of prices of plates and angles is upwards; indeed, some firms have added an extra half-crown to their quotations during the last few days, and with every chance of their securing it, as there are so few producers seeking work. Steel ship plates are not below £4 17s. 6d.; steel ship angles, £4 15s.; iron ship plates, £4 15s.; and iron angles £4 12s. 6d., all less 2½ per cent. and f.o.t. There is also more doing in iron bars, and the price of common bars is firm at £4 17s. 6d., less 2½ per cent. and f.o.t.

But the steel rail makers are the people who have profited most by the revival of trade; they have been able to advance their prices 25s. per ton from the minimum, which is very much more than can be expected by manufacturers engaged in any other branch of the iron and steel trades. Their mills are kept in full operation, and judging from the numerous inquiries that are being received there is every reason to believe that the present activity will be continued for a long time. Consumers both at home and abroad are thoroughly aroused to the necessity of buying without delay, and are no longer hanging off. Railway enterprise is being generally stimulated, and prospects are undoubtedly good. Among the orders which have been booked in this district within the last few days was one of 8000 tons for Japan, taken by Messrs. Bolckow, Vaughan and Co. One of the local rail manufacturers states that within the current month they have been asked to quote for in the aggregate over 150,000 tons of steel rails, and there is no abatement in the inquiries. The present quotation for heavy steel rails is £4 15s. net at works.

The return of Mr. Waterhouse to the Conciliation and Arbitration Board for the North of England Manufactured Iron Trade shows that during November-December the average net realised price of finished iron in the district was £4 16s. 3·69d. per ton, this being 1s. 3·98d. in excess of that of the previous two months, but it does not justify any advance of wages at the mills and forges, for the realised price must get up to £4 17s. 6d. before any rise can be given in accordance with the sliding scale, and then the advance will be 2½ per cent. The price for November-December was 6½d. less than that for the corresponding period of 1894, but was 2s. 2·41d. better than the minimum, which ruled last May-June. Rails— iron — in the last two months advanced 1·91d.; plates, 1s. 5·09d.; bars, 3·34d.; and angles, 3s. 7·03d. The deliveries declined 16 per cent., owing to the Christmas holidays, and doubtless some of the decline was due to the strike in Scotland delaying specifications in that quarter, as the falling off is most marked in plates and angles. The deliveries during 1895 by manufacturers connected with the Board have amounted to 123,584 tons, as compared with 143,000 tons in 1894; 171,000 tons in 1893; 171,000 tons in 1892; 251,000 tons in 1891; 283,000 tons in 1890, and 337,000 tons in 1889. These figures do not indicate the total output of finished iron in the North of England, as there are several firms who are unconnected with the Board and who do not make any returns. It is estimated that the total production will be about 20 per cent. more than is reported by the Conciliation Board.

Within the last few days the negotiations which have been in progress for nearly three months past, for the sale of the works of the Tees-side Iron and Engine Works Company, Middlesbrough, have been completed, and the whole of the establishment, comprising blast furnaces, shipyard, and engineering and bridge-building works, will pass into the hands of a syndicate headed by Sir Christopher Furness, of West Hartlepool. The concern, the present capital of which is £175,000, is one of the oldest in the Cleveland district. It was established under the style of Hopkins, Gilkes, and Co. in 1846, when engineering works were started in Commercial-street, Middlesbrough, which for a long time constructed locomotives, many of them for the old Stockton and Darlington Railway, but it is a good many years since this branch of the business was given up. Then it was the directors discussed the advisability of entering upon the manufacture of marine engines, but ultimately decided to go in for pipe and chair founding, which business they continued to carry on until within the last five or six years, when they sold the pipe founding plant to a neighbouring firm. In connection with the Commercial-street works a bridge-building business has for many years been carried on, and many well-known bridges have been constructed, among them the Deepdale and Beelah Viaducts, on the Barnard Castle and Tebay line; the first Tay Bridge; the viaduct at Saltburn; the Nerbudda Bridge, in India—for which over 13,000 tons of iron were used; the railway bridge over the Wear, at Sunderland; &c. The Company was among the first in Clevelannd to enter upon the manufacture of pig iron after the discovery of the main seam of Cleveland ironstone in 1850, for in 1854 it built two furnaces. It now owns four. of which two are in operation making hematite pig iron. The company was also a large manufacturer of finished iron, and in the palmy days of that industry had eighty-four puddling furnaces, and it rolled both bars and angles. In 1872 it experimented with the Danks revolving puddling furnace, which it was believed was going to solve the question of mechanical puddling. The Iron and Steel Institute sent out to America a commission of practical men to report upon the furnace in actual operation, and they spoke so highly of it that Mr. Danks was offered £30,000 for the patent rights in this country, but refused it. At the Tees-side Works a Danks plant was laid down, but after spending £20,000 on it the thing turned out a dismal failure. The keen competition of steel put a stop to any more experimenting with a view of puddling mechanically. About the year 1880 the manufacture of finished iron itself at the Tees-side Works was abandoned, and the works demolished, a shipyard being established on the site. At this yard the Tees-side Company has never built a vessel, but it was leased for some years to Sir Raylton Dixon and Co. It is stated that Sir C. Furness intends to form three companies to work the concern—one taking over the blast furnaces; the second the shipyard, and in connection therewith there will be constructed the largest graving dock on the North-East Coast; and the third company will take the engineering works, which will be partly devoted to marine engine building, and with this will be amalgamated the marine engineering works of Messrs. Westgarth, English, and Co., also at Middlesbrough, Sir Christopher Furness having acquired a large interest in them some months ago.

A sample of Japanese pig iron has been shown in Middlesbrough this week. which is regarded as a curiosity, and has excited considerable interest among ironmasters. It was made at the only furnaces that exist in Japan—and these were erected by Messrs. Head, Wrightson, and Co., of the Teesdale Iron and Engineworks Company, Thornaby-on-Tees—from native ore, smelted with native coke. The iron is of good No. 3 quality, and was sold in London at 38s. per ton; but it was brought over under exceptional circumstances, and could not profitably have been sold at that figure if the regular freight—which is about £1 per ton—had been paid. It was carried partly as ballast in a tea ship, and samples of it were left at each port of call, so that the freight paid was very small. An analysis has been made of the pig iron in a Middlesbrough laboratory, and it was found to contain:—Silicon, 3·26 per cent., as against 2·8 per cent. in a representative Cleveland pig; sulphur, 0·38 per cent., against 0·04; phosphorus, 0·81, against 1·46; and manganese, 1·44, against 0·52. It is stated that in Japan it is never used alone for foundry purposes, but is mixed with Cleveland iron, which is now largely sent to Japan, over 26,000 tons having been sent last year from the Tees direct, and some was also despatched *viâ* Hamburg and Antwerp. The sample is now in the hands of Mr. Richard Howson, consulting engineer, Middlesbrough.

The Consett Iron Company will pay an interim dividend of 6s. 6d. per share to the ordinary shareholders, this being at the rate of 8⅝ per cent. per annum, and 4s. per share will be paid to the 8 per cent. preference shareholders. The Consett Spanish Ore Company will pay an interim dividend of 3s. 9d. per share, or 37½ per cent. per annum.

The demand for Cleveland pig iron is improving, though it is difficult to sell it for prompt delivery, as is usual at this time of the year. Consumers, however, are anxious to buy for forward delivery, as there is not much chance of their doing better by waiting, now that the slack season is so far advanced. Only about 37s. 3d. per ton has this week been obtainable for prompt f.o.b. deliveries of No. 3 Cleveland pig iron, but 37s. 6d. would readily be paid for delivery up to the end of the quarter. Sellers, however, generally stood out for 37s. 9d. The price of Cleveland warrants has been steady, and at the close on Wednesday 37s. 8½d. cash was the figure. The stock of Cleveland pig iron in Connal's stores on Wednesday evening was 180,122 tons, an increase of 8422 tons for the month, or only a little more than half the quantity reported in December. No. 1 is 38s. 6d.; No. 4 foundry, 36s. 9d.; and grey forge, 36s.; while mixed numbers of Cleveland hematite pig iron are firm at 46s., and No. 3 basic iron at 39s. 9d. It is estimated that this month an increase of 25,000 tons will be reported in the stock of Cleveland pig iron, which will make the increase for the last three months about 64,000 tons.

It is calculated that the shipments of pig from the Tees this month will be 70,000 tons, of which 10,000 tons will be of hematite quality. The Skinningrove Iron Co. has within the last few days blown in the second of the two new blast furnaces, and it now has all their four furnaces in operation, producing 2500 tons of Cleveland iron weekly, most of which is sent to Scotland.

The coal trade is depressed, especially the steam coal department, and a good many collieries are undoubtedly carried on without profit. But the coke trade is brisk, owing to the revival in the iron and steel industries, and 13s. delivered Middlesbrough is the average price, with 14s. to 15s. as the f.o.b. price.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

AFTER being strong, the iron market fell away considerably towards the end of last week, but it has again been marked by a firmer tone. Prices continue to fluctuate, but on the whole the course seems upward, as if indicating that while the market is sensitive to passing occurrences of an unfavourable kind, its normal tendency is towards improvement. Scotch warrants sold this week from 46s. 4d. to 46s. 6d. cash, the quantity of iron really changing hands being considerably smaller than in some recent weeks. The inquiry for Cleveland warrants has been of a halting description, the price, however, for such business as was done rising in sympathy with Scotch, cash iron being from 27s. 3d. to 37s. 7d. Business took place in Cumberland hematite from 47s. 3d. to 47s. 7d. Advices to merchants from abroad, as well as from home districts, are generally of a favourable nature.

Since last report one furnace producing ordinary pig iron has been put out of blast, and there are reports current that makers intend to curtail production if the demand should not without delay grow to such an extent as altogether to prevent additions to stock, or reduce these to small proportions. There was the slight decrease last week of 25 tons in the stock in Connal and Co.'s Glasgow stores, but it is calculated that with the current rate of production the additions to makers' holdings must be very considerable. This week there are 41 furnaces producing ordinary, 31 hematite, and 4 basic iron—total 76, compared with 77 last week, and 75 in the corresponding week of last year.

The prices of makers' pig iron are as follows:—Govan, Monkland, and Carnbroe, No. 1, 47s.; No. 3, 45s. 6d.; Clyde, No. 1, 50s.; No 3, 47s.; Gartsherrie, Calder, and Summerlee, No. 1, 51s.; No. 3, 48s.; Coltness, No. 1, 53s.; No. 3, 49s.; Glengarnock at Ardrossan, No. 1, 50s. 6d.; No. 3, 46s. 6d.; Eglinton, No. 1, 48s.; No. 3, 46s.; Dalmellington, at Ayr, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Shotts, at Leith, No. 1, 53s.; No. 3, 48s. 6d.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 49s.

The export business in Scotch pig iron is very quiet, and the shipments altogether are considerably behind what they were at this time last year. The clearances of the past week amounted to 5037 tons, compared with 5691 in the corresponding week of last year. To Italy 200 tons were despatched, India 140, Australia 100, France 40, Germany 20, Holland 173, Belgium 10, Spain and Portugal 30, China and Japan 30, other countries 24, the coastwise shipments being 4270, against 4093 in the same week of 1895.

The improving tendency noticed last week in the malleable iron department continues, and it is hoped that business may now take a more satisfactory turn. On all hands it is admitted that the inquiry is better, and it is easier for sellers to obtain full prices than for some time past.

The steel trade is more active, both in the manufacturing and merchant branches. A considerable increase in the available work specifications is expected as certain now that the marine engineering operators have returned to work, and in addition to this, inquiries are being freely made for a variety of material other than that employed in shipbuilding and marine engineering. It is reported that some orders have been received by West of Scotland makers for steel to be used in war vessels now in course of construction for the Admiralty. Steel has for some time been at very low prices, but an effort is being made to obtain an improvement in this respect. The quotations for angles is £4 15s., and for ship plates £5 5s., less 5 per cent. in each case for delivery in Glasgow district.

A large number of contracts for a variety of constructive material are under consideration in various branches, and some good orders have been placed. These embrace a number of fresh shipbuilding contracts. Messrs. Sharp, Stewart and Co., of Glasgow, have obtained orders to construct thirty-four engines and a large amount of duplicate work for India, as well as several engines for the Barry Railway, and it is stated that the locomotive builders have now about twelve months' work on their books.

There is little change to note in the position of the coal trade. Rather more inquiry is experienced for the better qualities of house coal, and the consumption in manufactories is on the increase; but so far the tone of the market has scarcely improved. The shipments of coals from Scottish ports in the past week have been 125,003 tons, compared with 125,959 in the preceding week, and 80,753 in the corresponding week of 1895. There is practically no alteration in coal prices.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

LAST year passed by without any colliery accident of large proportions in Wales, but this year has begun badly, with one of a startling character in the lesser Rhondda Valley. The scene of the accident was Tylorstown, one of the spurs of the Rhondda. At this place there are three sinkings in the steam coal seam, and the collieries, at one time owned by Mr. Tylor and others, now form part of the Ferndale property. The depths of the three pits range from 500 to 600 yards. About 1000 men are employed, and the output is between 1800 and 1900 tons a day. The coal has a high reputation, in common with Ferndale coal generally.

On Sunday night last about 150 men and boys descended the three pits, and having "done their turn," were rapidly leaving work for the day men to descend, when a tremendous explosion occurred—how caused is yet uncertain, and soon there was the wildest excitement, followed by the terrible scenes which are associated with the history of most of the Welsh collieries. The latest roll call is 66. A very short time would have brought, as in the case of Cilfynydd or the "Albion," June, 1894, the day men into the jaws of death. Luckily they escaped, another proof of the wisdom of the regulation that one shift shall leave before the next enters.

Sir William T. Lewis, was early upon the scene, and with Mr. W. Jenkins, Ocean, Messrs. W. Thomas, Brynawel, Foster Brown, and various colliery managers, rendered excellent service. The chief agent of the collieries, Mr. Hannah, was one of the first of the rescue parties, and at one time was despaired of, having been perilously near a great fall and in the very thick of the after-damp. Speculation is rife as to cause, and the coal dust theory has again been raised. Atmospheric conditions have been bad of late, fog prevailing and south-east winds prominent; but it may be stated that there are underlying reasons apart from these matters. Great colliery accidents in Wales have occurred in every month of the year, December as well as June. The coroner has held a preliminary inquiry, and is certain to institute a keen inquiry. It was at this colliery that Mr. Kirkhouse, placed his invention, the "Harbour of Refuge." This was to afford a means of escape at an explosion.

This week may prove a slightly broken one, as colliers always make an explosion the excuse for a holiday; still there can be no question but that the demand for best steam, and even ordinary kinds, is being well sustained, and will be for some time to come. After my despatches last week the Admiralty orders were substantially increased for the third time, the Albion Colliery securing one good order for 25,000 tons, and Ferndale another for 65,000 tons. The price is understood to be between 10s. and 10s. 3d. Last week the shipment from Cardiff was again large. Cargoes to Bombay, Buenos Ayres, Rio, Santos, being specially noticeable. Genoa also figured well.

Cardiff prices remain very firm, and fully 3d. per ton better than they were last week. Best steam this week is quoted at 10s. 6d. to 10s. 9d.; seconds, 9s. 6d. to 10s. 3d.; drys, 9s. 3d. to 9s. 9d.; best Monmouthshire, 8s. 9d. to 9s.; seconds, 8s. 3d. to 8s. 6d.; best small is at 5s.; second best, 4s. 6d.; seconds, from 4s. House coal continues brisk, though without change in price. Best, 10s. 6d. to 11s.; No. 2 Rhondda, 9s. 9d. to 10s.; brush, 8s.; small, 6s. 3d. to 6s. 6d.; No. 3 Rhondda, 8s.; through, 6s. 3d. to 6s. 6d.; small, 4s. 3d. to 4s. 6d. Swansea prices are:—Best steam, 9s. 6d. to 10s. 6d.; seconds, 8s. 6d. to 9s. 6d.; No. 3 Rhondda, 10s. to 10s. 6d.; No. 2 Rhondda, 8s. 9d. to 9s. 6d.; anthracite, from 8s. 9d. to 12s., according to quality. Patent fuel, Cardiff, 10s. to 10s. 6d.; Swansea, 10s. 3d. to 10s. 6d. Trade only moderate.

Both at Swansea and Newport, Mon., the coal trade was brisk last week, Newport totalling over 87,000 tons, and Swansea exceeding 42,000 tons. From the latter port 5100 tons went to America, where the anthracite of the west of Wales is in growing favour.

Pitwood stocks are steadily increasing, and, in consequence, prices are showing a drooping tendency. Good French fir is quoted in Cardiff at 15s. 6d., but sales have been effected at lower figures. Coke remains fairly good in demand and price; furnace coke, 12s. to 13s. 6d.; foundry, 15s. 6d. to 16s. 6d.; special foundry, 19s. to 19s. 6d. Cardiff. Swansea prices are:—Furnace from 12s.; foundry from 16s. to 17s.

The directors of the Taff Vale Railway have declared a dividend of 3½ per cent. per annum for the past half-year, placing £5000 to reserve and carrying forward £4853. Large cargoes of iron ore have been coming in during the week, the Blaenavon Company one day receiving 3240 tons; Cyfarthfa and Dowlais have also figured for large quantities. I am glad to record another large consignment of rails to Kurachee—1900 tons—from Cardiff. The rail trade is passably good in some quarters, but the old staple business—that of steel bar—for the tin-plate works is slack, and prospects are against anything like a revival until the tin-plate trade improves.

On 'Change Swansea, this week, pig iron showed an improvement, fully 3d. per ton Glasgow, and 4d. upon Middlesbrough; hematite also indicated an advance to the extent of 4s. as compared with preceding week's prices. A sharp run on copper and also in block tin was reported. Quotations were as follows:—Glasgow pig, 46s. 5d.; Middlesbrough, No. 3, 37s. 6½d.; hematite, 45s. 7½d.; Welsh bars, £5 5s. to £5 10s.; sheets, iron and steel, £6 10s. to £6 15s. Bessemer steel; tin-plate bars, £3 17s. 6d.; Siemens best, £4; block tin, £59 12s. 6d. to £59 15s.; Copper, Chili bars, £42 6s. 3d. to £42 8s. 9d.; lead, English, £11 5s. to £11 7s. 6d.; Spanish, £11 3s. 9d. to £11 5s.

The tin-plate trade has presented little encouragement of late. The only hopeful feature worth reporting is that the movement to find new markets is progressing, and in the opinion of the leaders, is full of promise. Up to the present time the make has been tolerably large, sometimes exceeding that of the export. Last week it was small, and as discussed on 'Change, showed a lesser trade with America. In many places mills have been laid off, prices no longer yielding a margin of profit, but, on the contrary, entailing loss. There is now to the front a serious outlook. A meeting of the Council of the Tin-plate Workers' Union of South Wales and Monmouthshire was held at Swansea on Saturday, when, after a long discussion, it was resolved to bring about a general stoppage on the first week in March, and that the men be directed to put in notices the first week in February. Since this decision a prominent leader has stated publicly, that if the owners of tin-plate works can prove a reduction to be necessary, he would be quite willing to recommend the men to concede a 25 per cent. reduction.

It is very evident to the simplest intellect who knows anything about the trade that, if a reduction cannot be arranged, the ordering of a stoppage by the men will in all probability be anticipated by action of the employers. One has stated that a twelvemonth's stoppage would improve matters, though this is regarded as an extreme measure. Shipments of tin-plates last week amounted to 48,041 boxes only, while from works only 32,496 boxes came to hand. Stocks amount to 142,627 boxes. The serious condition of trade was shown this week by the quotations:—Bessemer steel cokes, 9s. 1½d. to 9s. 3d.; Siemens, 9s. 4½d. to 9s. 6d.; ternes, 17s. 6d. to 22s.; best charcoal, 12s. 6d. to 13s. 6d. There is more activity shown in loading plates this week than last, and larger consignments to America and Russia are noticeable, so a better total may be expected.

The report of the directors, Port Talbot Railway, in anticipation of the ordinary general meeting, has been issued, and indicates a satisfactory progress in the undertaking with docks and railway.

The dispute at the Plymouth Collieries remains unsettled, and mid-week it was announced on the part of the men that they would bring out their tools on Friday. The opinion of one of the colliers, given to me personally, was a much more reasonable one, and I hope will be carried, "to work under protest for three months, and place the dispute before the Sliding Scale Committee to decide."

This week there was a miners' conference at Cardiff, with a view to amend the Sliding Scale. The following resolutions were carried:—The question of a minimum wage: the 8¾ per cent. per shilling to be altered to 10 per cent. per shilling. In the matter of disputes: power be given to call in an umpire, and notice be four weeks instead of one month. It was further decided to move for a weekly payment of wages instead of "monthly."

The Cardiff share market has been lively of late through the action of the "Bears" operating against the projected Bute and Rhymney alliance, but from all I glean the operators have had to suffer considerably. Rhymney Rails, 4 per cent., issued at 100, are now at 140 to 143.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

OVER here the iron trade is still rather quiet, new orders being scarce in most departments; but, generally, establishments have been kept well engaged on work previously secured.

With regard to the Silesian iron business, there have been fairly good accounts received upon the week. For pig iron a regular demand is experienced, and prices show some firmness. The rolling mills are reported in brisk activity. There has been a good amount of orders booked lately, both on home and on foreign account, and the engineering establishments are also, with comparatively few exceptions, well employed.

On the Austro-Hungarian iron market a slight improvement has been noticed for some articles. However, the present state of the iron industry must, on the whole, be considered as not favourable, demand in most branches remaining languid and prices low. The steel trades and general engineering departments form an exception, being actively engaged in consequence of the lively trade that is doing in railway and structural material.

French iron business has not shown any change upon the week, most departments being regularly if not satisfactorily occupied. Paris quotations are—Merchant bars, 135f. p.t.; girders, 145f. p.t. The year 1895 has been, on the whole, less favourable for the French iron industry than the preceding year, the large Government and railway orders which were expected to be given out having but partly been secured, while the iron trade in general turned out much less satisfactory than was anticipated, partly on account of the very keen competition among the dealers. While in the beginning of 1895 merchant bars No. 2 were sold in Paris at 145 to 150f. p.t., girders 150 to 155f. p.t., the year closed with 135 to 138f. p.t. for bars, and 145 to 150f. p.t. for girders. In spite of all this, the position of the French ironworks cannot be termed exactly unfavourable; especially during the latter part of 1895 there was more life stirring in the different branches.

Last week's business on the Belgian iron market has been a fairly good one, and the prices realised were, on the whole, better than those paid a few weeks ago. Makers report themselves pretty well satisfied with the orders booked, and are expecting a further increase in demand. Export trade, though a trifle more animated, still leaves much to be desired. Present official quotations are:—Luxemburg foundry pig, 45f.; common forge pig, 45·50f. to 48f.; merchant bars, f.o.b. Antwerp, No. 2., 115f.; No. 3, 120f.; the same Belgian stations, No. 2, 120f.; No. 3. 125f.; girders, f.o.b. Antwerp, 112f.; the same Belgian station, 115f. to 120f.; plates for export, No. 2, 128f.; No. 3, 148f. to 150t.; sheets, free Belgian station, 153f.; steel plates, 143f. to 145f.; steel rails, 105f. to 107·50f.; all per ton. During the year now past the Belgian business in iron and steel has been altogether quiet, and even depressed. In the early part of the year especially times were hard for the ironmasters, as many of them could only keep their concerns going three to four days in the week owing to the scarcity of orders. In summer, and particularly during the last quarter of 1895, a good business was transacted on local as well as on foreign account, all sorts of railway material and structural iron being specially well inquired for. Pig iron also showed an improvement, but remained, on the whole, in moderate request. Average prices were:—

	Beginning 1895. Francs.	Middle 1895. Francs.	End 1895. Francs.
Luxemburg forge	45·50	45	44·50
Luxemburg foundry pig	48	47	45·50
Bars, No. 2, for export	115	112·50	112·50
Iron plates, No. 2, for export	125	126	128
Girders, for export	108·50	108	108
Steel rails	95	95	100

Production of iron in Belgium was:—

	1895.	1894.
Forge pig	350,640	408,320
Foundry pig	84,440	83,910
Basic	393,430	412,480
Totals	828,510	904,710

At the end of 1895 there were twenty-seven blast furnaces in blow in Belgium, sixteen being damped down or blown out.

From the Rheinish-Westphalian district pretty good accounts have been received upon the week, the tone of the iron market being firm, and generally satisfactory. Iron ore has been a trifle neglected lately, but this week a better inquiry has again been experienced, with prices tending to firmness. Spathose iron ore is quoted M. 8 to 8·60 p.t.; roasted ditto, M. 12 to 14 p.t. Nassau red iron ore fetches M. 9 p.t.; and for Lorraine minette, M. 2·60 to 3·20 p.t. is given, according to the quality required. A healthy demand is coming in for most sorts of pig iron; export orders have, on the whole, increased, and there is altogether a good activity noticeable at the blast furnace works.

In the Siegerland there is comparatively little life stirring in the pig iron trade. Last week's quotations were:—Spiegeleisen, 10 to 12 p.c. grade, M. 54 to 55 p.t.; forge pig, No. 1., M. 48 to 49 p.t.; No. 3, M. 42 p.t.; hematite, M. 65 p.t.; foundry pig, No. 1., M. 65 p.t.; No. 3, M. 56 p.t.; basic, M. 50 p.t.; German Bessemer, M. 54 to 55 p.t.; Luxemburg forge pig, M. 45 p.t.

A satisfactory business has been transacted on the malleable iron market. Bars are in quiet call, and so are girders; but for plates and sheets a brisk demand is experienced, both from inland and abroad. Wire and wire nails, though in improving request, still show considerable weakness; the same holds for rivets. In the railway and engineering department a brisk activity is going on, which is likely to continue for several months to come, a large amount of fresh orders having been secured just lately. On the 14th instant the Berlin Railway Administration invited tenders for the supply of 230 locomotives, and orders have now been granted to Hendschel-Cassel for about M. 3,000,000; Hanover machine factory, formerly Egestorff, M. 2,000,000; Schwartzkopf, Berlin; M. 1,600,000; Vulkau, Stettin, M. 800,000; Union Foundry, Königsberg, M. 850,000; Borsig, Berlin, M. 750,000; machine factory, Gravenstaden, M. 750,000; Schichau, Elbing, M. 700,000; and Hohenzollern, Düsseldorf, M. 600,000.

German export to Sumatra is stated to have been for the year 1894:—Knives, in value, M. 20,000; wire nails, M. 20,000; locks, M. 8500; tools and small articles in finished iron, M. 30,000; machines, M. 3000; sewing machines, M. 42,000; needles, M. 1700; tin boxes, M. 10,000. A large quantity of rails, sleepers, wheels and axles, and general railway rolling stock has likewise been sent to Sumatra, and there has also been a good business done in bridge-building and engineering requirements.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, January 23rd.

THE reorganisation of a number of railroad properties, beginning with the Reading and the Baltimore and Ohio properties, is encouraging financial managers to hope that we are close to the end of our prolonged depression in railroad affairs. The return of gold, even if only one shipment, has been encouraging. The assurances of successfully placing the big Government bond loan, and of adjusting revenue legislation on a satisfactory basis, all have exerted a favourable influence. Every American knows that the straightening out of a few entanglements means a general expansion of industrial activity and higher prices. It is this that keeps markets unsettled and large buying and selling interests irresolute. Within two or three days a slight reaction has shown itself in billets, but plates and shapes keep low. Bar iron averages 1·20, 1·30 for refined. Pipes and tubes are active. The window glass houses are all idle. Coke ovens are run to full capacity. Western shops and factories are quite busy, but there is lacking a vigorous impulse to all business. Wages are to be reduced in some directions, but no general reduction will be attempted, as all industries are anxious to pass over the critical May 1st period, the day fixed for eight-hour agitations. There is but little agitation in labour circles, and from present indications there will be no outbreaks. Prices of most articles of general consumption are lower than for many years.

The commercial and financial situation in the States has brightened somewhat. The New York banks are getting ready for the bond issue. General business shows an improvement. The wild rush of pig iron production from 70,000 tons eighteen months ago to 220,000 tons in December is now over, and a decline in weekly production of 20,000 tons has been made. The Treasury free gold is down to 54,000,000 dols. Deficit for January to date over ten millions. The popular loan will succeed, and that without seriously interfering with the Government gold reserves.

This is the "dead of winter," consequently railroad traffic is moderate. Manufacturing interests are preparing for a general revival of business in the early spring. The iron trade is unsettled and season contracts for ore, coal, coke, pig iron, and steel billets are all held in abeyance. When prices are fixed to the satisfaction of large iron and steel using interests, there will be a rushing demand for a few weeks. Whether this will result in a general advance is unknown. Bessemer and billets have advanced 1 dol., because 50,000 tons were ordered within a week. Ship, and car, and lake boat-building requirements resulted in contracts for structural material for 17,000 tons during the past week General conditions are improving, but not rapidly. Factory activity promises to be regular. Agricultural interests continue to hold grain for better prices. Cotton-producing interests are well satisfied with results of last season. Diversified crops relieve Southern agriculturists of such exclusive dependence on northern sources. Mining interests are prosperous, and the gold yield of 1896 will surprise the world. Makers of mining machinery are crowded with orders.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

⁂ When patents have been "communicated" the name and address of the communicating party are printed in italics.

16th January, 1896.

1073. Printing Machine, W. Gunson and W. Pesco London.
1074. Milk Can Protector, A. W. Johnson, London.
1075. Spinning Bobbins, &c., R. Atkinson, Shipley, Yorks.
1076. Cycle Saddle Support, A. J. Southey, Colnbrook.
1077. Pickers of Looms for Weaving, J. E. Livsey, London.
1078. Golfing Instrument Heads, W. Mills, Newcastle-on-Tyne.
1079. Horseshoe, G. H. Corbett, Stourbridge.
1080. Malt Kilns, F. Ayton, Bristol.
1081. Nail, The Whitecross Co. and W. Carson, Liverpool.
1082. Portable Tea and Coffee Strainer, J. G. Plater, London.
1083. Small-arms, T. King.—(*J. King, South America.*)
1084. Lubricators, W. Brierley, Rochdale.
1085. Lasting Coverings for the Feet, T. Gare, Manchester.
1086. Lathe Chucks, H. Liebert, Manchester.
1087. Joint Hinges for Tables, J. Miller, Dundee.
1088. Automatic Clockwork Motor, T. Illingworth, London.
1089. Automatic Window Wedge, J. Hill, Devon.
1090. Motor Vehicles, J. Clough and R. Illingworth, London.
1091. Cycle and Walking Gaiters, C. J. Allen, Birmingham.
1092. Securing Stoppers, G. T. Richardson, Hampton Wick.
1093. Mould Press for Dental Purposes, E. Speight, Leeds.
1094. Heating Stoves, G. H. Cartland and J. H. Ross, Birmingham.
1095. Hydrocarbon Engines, T. W. Beverley, Sheffield.
1096. Manufacture of Steel, T. Hampton, Sheffield.
1097. Spiked Window Tickets, &c., E. J. Woollen, Sheffield.
1098. Railways, P. J. Kane, sen., and P. J. Kane, jun., London.
1099. Drop Down Small Arms, W. Baker, Birmingham.
1100. Supplying Water, W. C. Macnaughton.—(*S. Manpoey, Spain.*)
1101. Treating the Bye-products of Sugar Works, M. Sachs, Glasgow.
1102. Steam Carriages, Motors, &c., G. Rose, Bishopbriggs.
1103. Spraying Apparatus, A. G. Browning and W. W. Churchill, Manchester.
1104. Manufacture of Yarn, J. L. Bottomley, Manchester.
1105. Fabrics, F. D. Haddon and A. A. Kuenemann, Manchester.
1106. Tires for Cycles and other Vehicles, A. Barr, Glasgow.
1107. Soles and Heels of Boots and Shoes, A. Barr, Glasgow.
1108. Cork Drawers or Extractors, A. Bruce, Glasgow.
1109. Apparatus for Signalling, J. S. Thomson, Glasgow.
1110. Ornaments, M. B. Church and L. B. Denton, Michigan.
1111. Apparatus for Feeding Boilers, D. A. Quiggin, Liverpool.
1112. Evaporators, Condensers, &c., D. A. Quiggin, Liverpool.
1113. Steam Boilers, J. Barbe, London.
1114. Corset Fasteners, T. Wyatt, Brighouse.
1115. Shuttle Guards, C. and K. Fulton, Hollin Bank.
1116. Production of Acetylene Gas, F. Rossbach-Rousset, London.
1117. Spout for Jars, F. A. Forster and H. D. Payne, London.
1118. Contrivance for Ironing Silk Hats, C. H. Fitzmaurice, London.
1119. A New Notice Card, W. E. Partridge, Birmingham.
1120. Letter Boxes, E. Fielden, Manchester.
1121. Cotton Wastes, S. Hopkinson and W. P. Kinsman, London.
1122. Shoe, H. Kohn, London.
1123. Ironclad Field Magnets, T. Pilkington, London.
1124. Brake for Cycles, J. H. Smith and J. J. R. Green, London.
1125. Tap for Drawing-off Liquids, M. Ballinger, London.
1126. Liquid Receptacles, P. R. J. Willis.—(*A. C. Smith and J. F. Moyer, United States.*)
1127. Seltzogenes, E. de Pass.—(*V. E. Durafort, Als, France.*)
1128. Weather Glass, J. O. Roche, London.
1129. Producing Light, F. Knoeferl, London.
1130. Loading and Unloading Vessels, F. Ridgway, London.
1131. Knee Protector, T. B. Walker, London.
1132. Bicycle Brakes, H. S. Rexworthy and W. King, London.
1133. Incubator, E. F. Griffin, London.
1134. Tap and Measurer for Bottles, S. Johnson, London.
1135. Protector for Incandescent Gaslight, F. Thomas, Cologne.
1136. Body for Illuminating Purposes, F. Kollm, London.
1137. Bearings, P. R. Jackson and Co., Ld., and J. S. Lewis, London.
1138. Rotary Engines, J. S. Lewis, London.
1139. Rods for Curtains and the like, H. Löwenthal, London.
1140. Knitting Machines, J. Raynor, sen., and J. Raynor, jun., London.
1141. Preparing Seeds, N. H. Nilsson and E. T. Thermænius, London.
1142. Optical Lanterns, B. Acres, London.
1143. Carpet Lining, W. A. Mauran, London.
1144. Electrodes, W. Heraeus, London.
1145. Impregnating Wood, H. H. Lake.—(*A. D. Tyler, jun., United States.*)
1146. Preparing Metal, L. Doig.—(*Russell and Erwin Manufacturing Company, United States.*)
1147. Milling Machine, H. Greenwood, London.
1148. Braces for Surgical Purposes, A. C. A. Alexander, London.
1149. Extracting Gold, W. H. Hyatt and J. Henochsberg, London.
1150. Chain Wheels, &c., for Cycles, I. A. Timmis, London.
1151. Brushes, W. Addis, London.
1152. Garment for Ladies' Wear, T. J. Curwood, London.
1153. Tea Mixers, C. H. Bartlett, London.
1154. Castor, G. A. Drysdale, London.
1155. Chandeliers, T. Ford, London.
1156. Manufacture of Steel Tubes, J. W. Fitter, London.
1157. Cookers, E. May, London.
1158. Ink Bottles, F. Christ and E. R. Witt, London.
1159. Games, J. W. Davison, London.
1160. Chair, A. E. Andersson, London.
1161. Thill Couplings, J. C. Walker, M. N. Bedford, and F. M. Younglove, London.
1162. Gasifying Apparatus for Lamps, G. Tresenreuter, London.
1163. Neck Adornments, H. D. Booth, London.
1164. Rolling Mill for Round Bars, P. J. Delay, London.
1165. Stirrup Bar, G. Biebuyck, London.
1166. Protecting Dress Stiffeners, G. Rosenwald, London.
1167. Ventilating Box witn Flap Valve, C. H. Rogers, Swansea.
1168. Gas Valves, R. B. Anderson, London.
1169. Railway Signalling Appliances, J. H. Rose, London.
1170. Traction Engine, E. Ingleton, Philadelphia, U.S.A

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1171. Moulding Vases, W. E. Clark and J. J. Slack, Derby.
1172. Pneumatic or Air Tires, A. J. D. Harris, Enfield Lock.
1173. Superheated Steam, A. Alison, Bolton.
1174. Non-rustable Metallic Tube, C. W. Summerskill, Birmingham.
1175. Extracting Machine, J. Cammis and T. Sheppardson, West Hartlepool.
1176. Lifeboat Carriages, J. M. Croom and N. S. Arthur, Leith.
1177. Separating Bodies in Liquids, C. S. Meacham, Maidstone.
1178. Weather Indicator, W. Thomson and H. Smith, Manchester.
1179. Safety Valve, A. McFarlane and G. Whitfield, Dunston-on-Tyne.
1180. Rotary Tippler, F. Turnbull, Spennymoor.
1181. Passengers' Accommodation Indicator, J. M. Barbour, London.
1182. Cement Body with Wirework, R. Wolf, Berlin.
1183. Packing Cases and Boxes, T. J. B. Pitiot, Marseilles.
1184. Fastening Seats to Vehicles, H. Millier, Gloucester.
1185. Drilling Rock, Stone, &c., E. J. Baldwin, London.
1186. Carpet Fastener, W. D. Le Fevre, London.
1187. Heating Tires, H. Fouse, London.
1188. Cotton Cords, T. Ivers and J. G. Ivers, Manchester.
1189. Heating Metallic Cylinders, F. S. Carter, Manchester.
1190. Pneumatic Tire Fittings, D. Learmonth, Glasgow.
1191. Discharging Coal, T. Wrightson, Stockton-on-Tees.
1192. Water-tube Boilers, C. W. Dodgin, Lydney.
1193. Heating Carriages, R. R. Jardine and A. J. Kallaway, Birmingham.
1194. Match-box, T. J. Cox, Doncaster.
1195. Bottles for Liquids, A. S. Tyler and G. W. Dawes, Birmingham.
1196. Hinges, J. Whitfield, Birmingham.
1197. Fire Lighter, W. F. Horn, Liverpool.
1198. Electric Railways, J. W. Darley, jun., London.
1199. Machines for Slaughtering Cattle, L. Gobel, Bradford.
1200. Running on Light Welts, F. W. Coe, T. J. Coe, D. H. McPherson, and H. Q. Church, Bristol.
1201. Locking Cycle Steering Wheels, J. C. Wilson, Nottingham.
1202. New Medicinal Compounds, J. Y. Johnson.—(*Vereinigte Chininfabriken, Zimmer and Co., Germany.*)
1203. Bottles, F. Earle, London.
1204. Controlling Road Carriages, C. Crastin, London.
1205. Clip for Holding Letters, &c., L. Myers, Birmingham.
1206. Looms, A. Wilkinson, Bradford.
1207. Preparing Cotton, B. A. Dobson and J. Thornton, Manchester.
1208. Textile Fabrics, S. Schwabe and Co., Ld., and A. Binz, Manchester.
1209. Wrapper, E. J. Reynolds, Chesham.
1210. Washing Machines, E. Williamson and C. Hammerton, London.
1211. Band for Pneumatic Tires, L. Hugonnet, Brussels.
1212. Automatic Cork, A. Barnet, Brussels.
1213. Safety Vest, O. Coquiart, Brussels.
1214. Artificial Whalebone, W. Hunkmöller, Brussels.
1215. Producing Motive Power, Sir W. E. J. Vavasour, Bart., London.
1216. Rolling Tea Leaf, W. H. Davies.—(*G. Robson, Ceylon.*)
1217. Dredgers, W. H. Diestelhorst, London.
1218. Electric Railways, G. Tolmie, London.
1219. Stopping Leaks, H. W. Grove, Sheffield.
1220. Roofs for Buildings, T. W. Willard, Birmingham.
1221. Applying Brush, W. Philipson, London.
1222. Blinds, C. Gardiner, London.
1223. Drying Macaroni, G. Falchi, London.
1224. Hair Pins, L. Ousey, London.
1225. Steering Cycles, J. R. Quain and F. W. Dunlap, London.
1226. Explosive Compounds, R. H. Courtenay, London.
1227. Turbine, H. Wentzky, London.
1228. Battery Cells, D. M. Hawes, London.
1229. Potato Digging Machines, C. J. Moulton and A. J. Keeble, London.
1230. Measuring Electricity, E. H. P. Humphreys, London.
1231. Furniture, R. Oliver, London.
1232. Waist Bands for Skirt Holders, A. Harrit, London.
1233. Chain Links for Coat Suspenders, R. Bender, London.
1234. Velocipedes, E. Anthony, London.
1235. Horseshoe Screw Caulk, C. Richter and E. Härtel, London.
1236. Auotmatic Regulating Pump, J. W. Ward, London.
1237. Electric Incandescent Lamps, C. J. P. Robertson, London.
1238. Electric Batteries, P. A. Newton.—(*C. Willms, United States.*)
1239. Furnace Grates, A. J. Boult.—(*G. Dupmeyer, Belgium.*)
1240. Measuring Taps, A. Smith and J. King, London.
1241. Boxing Gloves, A. Smith and J. King, London.
1242. Stands and similar Supports, A. Sehroth, Liverpool.
1243. Stirrup Bars, W. H. Boyens, R. J. McCullough, and R. Cunliffe, Blackpool.
1244. Pipe Joints, W. J. Douglass, London.
1245. Water Gauges for Boilers, F. Wilkinson, London.
1246. Stay Guides, H. H. Lake.—(*F. W. Merrick, United States.*)
1247. Hydraulic Steering Apparatus, A. F. Wiking, London.
1248. Window Sashes, L. Aston, London.
1249. Synchronising Mechanisms, H. F. Parshall, London.
1250. Roller Blind Fittings, H. H. Hemmings, London.
1251. Conveyor Chains, H. Hack and H. Giles, London.
1252. Producing Diagrams or Designs, S. Maier, London.
1253. Butter and Cheese, R. Backhaus and P. Schach, London.
1254. Bottles, W. R. Ridings and C. Inglefield, London.
1255. Attaching Tires to Wheel Rims, J. Barns, London.
1256. Electric Impedance Coils, W. J. Davy, London.
1257. Extracting Gold from its Ore, J. Armstrong, London.
1258. Flask with Race Glass Case, G. B. Winter, London.
1259. Furnaces, B. G. Sinclair, London.

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1260. Cigarette Machines, J. Player and Sons, Ld., and R. G. Schwarz, London.
1261. Bye-pass Connection for Gas Lights, W. Gummer, Bristol.
1262. Raising Lamp Globes, A. H. Griffiths and T. B. Smith, Birmingham.
1263. Pumps, P. Crowther, Halifax.
1264. Boilers, T. Williamson, Wishaw.
1265. Power Mortising Machines, E. Jackson, Prescot.
1266. Waste Water Apparatus, A. W. Sutton and W. J. Cotterill, Wolverhampton.
1267. Trestles, P. R. J. Willis.—(*E. V. Sigler and J. A. Schwaffach, United States.*)
1268. Preventing Leakage in Tins, J. W. Paton, Liverpool.
1269. Speed Variation Gear, W. E. Gibbon, Colchester.
1270. Tobacco Cutter, P. Gardiner.—(*C. C. Morris, New Zealand.*)
1271. Reduction of Refractory Ores, H. R. Angel, London.
1272. Bee Hives, F. W. L. Sladen, Dover.
1273. Electrified Spectacle Frames, A. V. Ford, Southsea.
1274. Reflector, J. C. Bayley and T. A. Beeching, Bournemouth.
1275. Making Silicofluoride of Ammonium, W. Mills, London.
1276. Packing Cases, W. M. Le Huray, Southampton.
1277. Propulsion of Road Vehicles, W. T. Smith, Keighley.
1278. Ladder, A. Engelsmann, Liverpool.
1279. Tires, J. A. Pettigrew, Glasgow.
1280. Buckle, W. Dargue, Halifax.
1281. Surface Printing Rollers, G. A. Bowden, Manchester.
1282. Pickers for Looms for Weaving, J. Pollard, Manchester.
1283. Ashpan, R. Rowbotham, Manchester.
1284. Clutch, R. Harrington, Wolverhampton.
1285. Knife Holder, W. Gadd and W. F. Mason, Manchester.
1286. Making Parts of Velocipedes, O. Pihlfeldt, Birmingham.
1287. Fire Lighters, J. H. and H. W. Wilson and J. Greenwood, Manchester.
1288. Injector, E. G. Peyton, Greenock.
1289. Pneumatic Tires for Cycles and Cabs, J. Watt, Glasgow.
1290. Fixing Colouring Matters on Yarns, J. Stalker and C. C. Connor, Glasgow.
1291. Support for Table Leaves, &c., G. B. Breeze, Glasgow.
1292. Saucepan, T. Llewellyn and D. Llewellyn, Rhondda.
1293. Corrugated Metal Sheeting, J. A. Main, Glasgow.
1294. Carbonating Machine, C. B. Inman, Leeds.
1295. Bottle Rinsers, C. B. Inman, Leeds.
1296. Clearing Apparatus for Yarn Machines, L. Drach, London.
1297. Fireplaces, O. B. Perkins and A. J. Vestal, London.
1298. Spring Tires for Cycles, &c., A. Wadham, London.
1299. Supporting Book and like Shelves, C. Chivers, London.
1300. Furnace Installation, C. Polony, London.
1301. Syphon Cisterns, H I. Dakin, London.
1302. Nozzles of Pipes, H. A. Murphy, London.
1303. Crucible Melting Furnaces, W. Kirkham, Sheffield.
1304. Barriers and Barricades, W. R. Harvey, Liverpool.
1305. Irrigator or Enema, A. Kwilecki, Manchester.
1306. Boiler and other Furnaces, F. A. R. Neill, Liverpool.
1307. Mounting Photographic Cameras, J. H. Fay, London.
1308. Lamps, F. Remmler, London.
1309. Lamps for Cycles and Vehicles, R. Fitch, London.
1310. Electrical Igniting Apparatus, H. Hirst and A. E. Angold, London.
1311. Rotary Movement for Dolls, J. B. Adams, London.
1312. New Gunpowder, O. Imray.—(*F. C. Glaser, Germany.*)
1313. An Automaton Flying Toy Bird, A. Keller, London.
1314. Hydraulic Motors, A. J. Boult.—(*E. J. Landes, France.*)
1315. Driving Bands, W. K. Birkinshaw, London.
1316. Iron and Steel, A. J. Boult.—(*C. J. L. Otto, Germany.*)
1317. Cistern Valve, J. Garner, London.
1318. Busks and Steels for Corsets, W. Edwards, London.
1319. Chain Gear for Cycles, L. Luden, London.
1320. Ball-bearings, F. W. Engels and The Wilkinson Sword Co., London.
1321. Travelling Box for Holding Hats, M. Madler, London.
1322. Coin-freed Race Game, T. W. Doughty and C. A. Barrett, London.
1323. Revolving Shutters, K. Ottstadt, K. Muller, and J. Brubacher, London.
1324. Lamps for Burning Hydrocarbons, J. H. Lee, London.
1325. Drawing Tubes of Aluminium Alloy, F. A. Ellis, London.
1326. Apparatus for Advertising, G. C. Fricker, London.
1327. Governing Gas Engines, A. Dougill and J. Marks, London.
1328. Flues, &c., for Steam Boilers, W. R. Marshall, Sheffield.
1329. Quick-firing Guns, A. Welin, London.
1330. Submarine Mines, C. A. McEvoy and Siemens Bros. and Co., London.
1331. Colouring-matters, H. H. Lake.—(*K. Oehler, Germany.*)
1332. Production of Acetylene Gas, C. G. Luis, London.
1333. Moistening Sheets of Copying Paper, A. Hellwig, London.
1334. Velocipedes, &c., C. Morel and H. Gerard, London.
1335. Automatic Guns, H. S. Maxim, London.

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1336. Gas Burners, W. B. Williams, London.
1337. Rails, W. Towler, Leeds.
1338. Trap, J. Walker, Liverpool.
1339. Washing Photographic Prints, W. M. Simpson, Hastings.
1340. Tie-clips, W. Pearce and T. Morton, Birmingham.
1341. Reed for Taking End of a Warp, G. Walker, Halifax.
1342. Flexible Elastic Tubing, W. Brookes, Manchester.
1343. Motor, E. Walker, Yorks.
1344. Dowel-brackets, A. Beaujean, Germany.
1345. Metallic Bedsteads, S. I. Whitfield, Birmingham.
1346. Ventilators, W. Cotter, Liverpool.
1347. Machine for Making Dominoes, W. P. Thompson.—(*M. Stein and J. B. Freud, Austria.*)
1348. Drying Drinking Vessels, J. Ford and H. Beresford, jun., London.
1349. Musical Instrument, R. Prigge, Cologne.
1350. Roller-bars for Machinery, C. Crookes, Sheffield.
1351. Wood Grids for Gas Purifiers, J. Hawley, Sheffield.
1352. Spanners, Keys, Wrenches, &c., D. Fulton Glasgow.
1353. Mats, C. Dirlam, Glasgow.
1354. Crossings for Railways, J. Graham, Workington.
1355. Scale, G. R. Hughes, London.
1356. Brackets for Supporting Mirrors, L. Kaufman, Manchester.
1357. Kitchen Range Boilers, C. and H. Boddy, Manchester.
1358. Cork, R. Plummer, Paris.
1359. Carriages, H. E. Brown, Dublin.
1360. Improvements in Perambulators, A. English, Staffs.
1361. Antihæmorrhage, H. L. Fitzgerald, London.
1362. Supports for Holding Bicycles, J. A. McNaughton, Glasgow.
1363. Mantles of Gas Lights, &c., W. Beal, Birmingham.
1364. Preventing Refilling of Bottles, W. A. Levis Youghal.
1365. Compressed Air Motion for Bicycles, J. J. Ridley, Bolton.
1366. Wire or Wheel Spoke Cutter, J. H. Bury, Lancashire.
1367. Theatrical Performances, H. T. Wood and C. Green, jun., London.
1368. Gas Burners, T. Hewett, London.
1369. Type-writing Machines, E. W. Hearn, London.
1370. Degreasing and Cleansing Wool, F. N. Turney, London.
1371. Holder for Venetian Blind, W. H. Greatorex, London.
1372. Wrapper, H. S. Jay, Sussex.
1373. Stoppers, L. E. Wheeler, London.
1374. Weighing Cotton Goods, E. Cunningham, Liverpool.
1375. Printing of Waterproof Fabrics, J. Berry, Manchester.
1376. Preparation for Epilepsy, &c., G. Diettrich, London.
1377. Frames of Bicycles, F. Hulme, Manchester.
1378. Castors, The Automatic Castor and Wheel Co., T. C. Fairweather and E. Hentschel, London.
1379. Driving Gear for Velocipedes, W. R. G. Roebuck, London.
1380. Detachable Moustache Guard, W. R. G. Roebuck, London.
1381. Change Boxes for Cameras, F. S. Litchfield, London.
1382. Combination Inkstand, W. Ward and B. L. Hawkins, London.
1383. Cauldrons, C. J. Bosdet, London.
1384. Method of Figuring Sheet-metal, T. Shepherd, London.
1385. Prevention of Frost Bursts, F. Coney, London.
1386. Measuring Taps, H. T. Sadler and E. Wand, London.
1387. Tires for Wheels of Carriages, A. A. and F. Trimmings, London.
1388. Means for Protecting Cash Boxes, R. Cellarius, London.
1389. Fastener and Opener for Skylights, T. E. Simmonds, London.
1390. Shears, J. Goebel, London.
1391. Burnishing Photographic Prints, W. Pratt, London.
1392. Dough Brakes, W. Pratt, London.
1393. Automatic Ball Coupling, H. Oberläuter, London.
1394. Luggage Carriers, H. H. Lake.—(*C. J. Brosnan, United States.*)
1395. Bedding for Horses, W. H. Burt, London.
1396. Machinery for Transmitting Motors, W. W. Hulse, London.
1397. Breakwater, C. Hill, London.
1398. Revolving Toys, T. Hooper and S. G. Moore, London.
1399. Filters, S. D. Rowland, London.
1400. Boxes, C. K. Mills.—(*The Drummond Tobacco Company* ——.)
1401. Electrical Gas Reaction Apparatus, A. A. Naville and P. A. and C. E. Guye, London.
1402. Toilet Case, A. Cohn, London.
1403. Gas Valves, Southgate Engineering Company.—(*J. Stewart, China.*)
1404. Producing and Utilising Motive Power, H Maxim, London.
1405. Pumps, A. F. Abrahamson-Rosendorff, London.
1406. Cycles, W. S. Simpson, London.
1407. Production of Coloured Figures, J. Y. Johnson.—(*E. G. M. Söhne, Germany.*)
1408. Blocks for Flooring, &c., G. L. Falconar London.
1409. Antiseptic Disinfectant, A. J. Boult.—(*F. Fritzsche and Co., Germany.*)
1410. Handles of Cricket Bats, E. Sefton, London.
1411. Spring Mattresses, D. G. Wehrlin, London.
1412. Removing Pitch from Casks, A. J. Boult.—(*C. F. L. Frohberg, Germany.*)
1413. Bicycle Saddles, H. Mesinger and F. Mesinger, London.
1414. Vapour-burning Apparatus, H. A. House and R. R. Symon, London.
1415. Small-arms, E. Bennett, London.

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1416. Combined Coal Saver, &c., J. H. Harrison, jun. and A. R. Osborne, Derbyshire.
1417. Utilising Weldon Mud, &c. Wastes, P. C. Bunn, London.
1418. Phlegethon Powder, H. Barrow, London.
1419. Air Berth Pillow and Life-buoy Combined, F. Wellington, London.
1420. Substituted Clasps for Garments, K. M. Moran, London.
1421. Holding Gear for Machines, J. W. Claridge, London.
1422. Saws for Sawing Stone, D. Hall and A. Hall, Leeds.
1423. Changing Sensitive Photographic Plates, J. Bidgood, Gateshead.
1424. Washing Device for Domestic Linen, E. E. West, Norwich.
1425. Dies for Brick-making Machinery, S. S. Anderson, Northumberland.
1426. Domestic Cooking Apparatus, J. Brown, Manchester.
1427. Telephonic Apparatus, H. Marcuse, Manchester.
1428. Spinning Machinery, A. H. Briggs, Bradford.
1429. Reversible Desks for Schools, S. Bridge, Stourbridge.
1430. Penholders, J. Darling, Glasgow.
1431. Window Sashes, F. G. Borissow, Bradford.
1432. Double-bodied Chimney Top, T. Rendle, Ilfracombe.
1433. Shuttles for Looms, T. Shackleton, Bradford.
1434. Waste-water Latrine Closets, J. J. Green and W. Oates, Halifax.
1435. One-wheeled Folding Barrows, R. R. Thom, Kilmarnock.
1436. Non-slipping Can-opener, J. S. and C. W. Leach, London.
1437. Making Doors, &c., Water-tight, W. Freeman, Ilford.
1438. Furnaces for Heating Steel Billets, G. Tomkinson and A. J. Ash, Wolverhampton.
1439. Combination Apparatus for Conveying Coke, G. Love, Durham.
1440. Smokeless Explosive, T. Hawkins, E. E. Carr and A. Wellby, London.
1441. Receptacles for Matches, A. H. Maclean Glasgow.
1442. Boiler Feeder, O. J. Scott, London.
1443. Intercommunication by Telephone, J. J. Mann Manchester.
1444. Pirn-winding Machines, Keddie, Gordon, an Co. and D. Sanderson, Galashiels.
1445. Cycles, R. O. Gilders, London.
1446. Apparatus for use of Worshippers, M. Denison Leeds

1447. Buckets for Elevating Grain, F. W. Staveley, Leeds.
1448. Steam Boiler Furnaces, J. Buchanan, Glasgow.
1449. Taps and Valves, H. Babington, Birmingham.
1450. Cultivators, J. Bamford, Birmingham.
1451. Oil Stoves, S. T. Richardson and R. Price, Birmingham.
1452. Locking Apparatus for Doors, F. Collins and W. Hazlehurst, Cheshire.
1453. Hand and Automatic Stop Motion, J. Booth, Lancashire.
1454. Discharging Residues from Retorts, H. Martin, Glamorganshire.
1455. Machine for Charging Retorts, H. Martin, Glamorganshire.
1456. Indicator, T. H. Hutchinson, Newp rt, Mon.
1457. Incandescent Electric Lamps, C. F. Stearn.—(*C. F. Topham, Switzerland.*)
1458. Manufacture of Sodic Cyanide, J. F. Hutcheson, Glasgow.
1459. Sleeve Links, &c., J. Cheshire, Birmingham.
1460. Cattle Truck Partition Board Fastenings, P. Lennon, Liverpool.
1461. Heating Rollers for Ironing, R. Hacking and J. Bennett, London.
1462. Extracting Metals from Ores, J. B. Torres, London.
1463. Brakes for Cycles, &c., T. L. Wilkinson, London.
1464. Bread Platters, W. H. J. Lance, London.
1465. Advertising, J. Moren, jun., and L. F. St. John, London.
1466. Bobbins or Reels for Cotton, &c., F. W. Coe, London.
1467. Sidesticks, G. E. S. Garde, London.
1468. Ice-making Machinery, T. Hewett, London.
1469. Amalgamation of Gold and Metals, E. L. Oppermann, London.
1470. Scale Weighing Machines, F. W. Bentall. London.
1471. Opening, &c., Windows, C. E. Batcock and J. H. Kenyon, London.
1472. Device for Operating Mechanism, F. W. Bentall, London.
1473. Driving Mechanism for Cycles, H. G. B. Smith, London.
1474. Holders or Receptacles for Soap, O. H. Huebel, London.
1475. Production of Gases from Oils, R. Harrison, Little Berkhamstead.
1476. Velocipedes, W. G. Ligget, London.
1477. Connecting Aprons to Seat Backs, C. Fell, London.
1478. Utilising the Fall of Water, J. E. Lairdet, London.
1479. Steering Locks for Cycles, A. A. Crozier, London.
1480. Electric Gas Lighting Apparatus, E. G. Brewer.—(*H. C. Farquharson and D. F. Root, United States.*)
1481. Stands for Holding Photographs, T. Gaze, London.
1482. Knitting Machines, E. R. Branson, London.
1483. Valves for Engines, H. H. Lake.—(*F. C. Weir, United States.*)
1484. Tension Devices for Sewing Machines, H. H. Lake.—(*G. W. La Rue, United States.*)
1485. Pipe Wrenches and like Tools, J. K. Sheffy, London.
1486. Attaching Shades to Rollers, E. F. Hartshorn, London.
1487. Microphonic Transmitter, P. Charollois, London.
1488. Explosive Projectiles or Shells, F. M. Hale, London.
1489. Colouring Matters, J. Imray.—(*La Société Anonyme des Matières Colorantes et Produits Chimiques de St. Denis, France.*)
1490. Pianoforte Actions, G. D. Rose, London.
1491. Parcel Carrier, J. Cole, London.
1492. Tea-cups, F. I. Lumley, London.
1493. Conveying or Transporting Grain, O. Gulbrandsen, London.
1494. Truck Frames for Railway Cars, C. T. Schoen, London.
1495. Card-setting Machines, N. C. Estes, London.
1496. Water-meters, A. J. Boult.—(*T. Derichs and H. Frères, Belgium.*)
1497. Jacketing of Furnaces, A. J. Boult.—(*M. W. Judell, Australia.*)
1498. Electric Batteries, W. Grimes, London.
1499. Finishing Boots and Shoes, W. Jackson, London.
1500. Hand Tacker for Boots, A. J. Boult.—(*The Goodyear Shoe Machinery Company, United States.*)
1501. Mining Rock, &c., A. J. Boult.—(*L. Thomas, Belgium.*)
1502. Utilising Gas for Heating Purposes, J. T. and H. Brunner, Liverpool.
1503. Steam Boilers, B. R. Body, London.
1504. Nails, M. Reutt, Liverpool.
1505. Basket Fasteners, J. W. Dobson, London.
1506. Billiard Table, W. S. Leng, London.
1507. Burning Hydrocarbon Oil, R. Kiesow.—(*A. Kiesow, Germany.*)
1508. Crane Jibs, &c., S. O. Cowper-Coles and W. P. Routh, London.
1509. Tram Bearings, T. H. Deakin, F. S. Geach, and D. Powell, London.
1510. Recorder for Vehicles, J. G. Lorrain.—(*L. M. V. de Gonzalez, Mexico.*)
1511. Filaments for Incandescent Lamps, F. E. W. Bowen, London.
1512. Pedal Printing Machines, &c., J. Michaud, London.
1513. Enabling Ships to Clear Obstacles, W. H. Wright, London.
1514. Rear Fork Ends for Bicycles, F. D. Owen, London.
1515. Process Patent, H. S. Blackmore, London.
1516. Alarm, W. Glover, London.
1517. Flower Pots, J. Curtze and T. S. Paynter, London.
1518. Distribution of Electricity, H. Edmunds.—(*G. Mengarini, Italy.*)

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1519. Tires, A. Harvey, London.
1520. Superheating Wet Steam, W. Schmidt, Birmingham.
1521. Gas Lighting, N. T. M. Wilsmore.—(*D. Little, Australia.*)
1522. Spinning Cotton Substances, T. F. Wallwork, Manchester.
1523. Tires, A. A. Verel, Glasgow.
1524. Underclothing for Ladies' Wear, L. Schmitt, London.
1525. Water-closets, J. Day, Wolverhampton.
1526. Seat, J. T. Williams, Swansea.
1527. Feeders of Machines, B. A. Dobson, Manchester.
1528. Shuttle Guards, W. Haythornthwaite and J. A. Ormerod, Manchester.
1529. Safety Appliances for Hoists, A. H. Lloyd and C. Hopkinson, Manchester.
1530. Wheels of Vehicles, H. Hollick, Coventry.
1531. Bell, A. Walker, Bristol.
1532. Oil Lamps, E. F. Hulse, Manchester
1533. Cutting-out Leather, G. H. Faire and Pearson and Bennion, Ld., Leicester.
1534. Lamps for Cycles, N. C. Harrison, Stockton-on-Tees.
1535. Construction of Printers' Rollers, F. Wood, Stockton-on-Tees.
1536. Trays, M. Fechner and H. Kadelburgh, Manchester.
1537. Folded Hinges of Landaus, J. E. H. Colclough, Dublin.
1538. Cycles, J. Leach, Rochdale.
1539. Bottle Stoppers, J. Chandler, Liverpool.
1540. Piston-rod and Like Packing, H. R. Curry, Glasgow.
1541. Window Sashes, G. Wylie, Glasgow.
1542. Spinning Frames, W. H. Lawlor and J. Esdale, Balnamore.
1543. Registering Ticket Punches, F. Marley, London.
1544. Metal Belts and Wheels for Cycles, W. G. Potter, London.
1545. Indicator for Funnels, O. H. Ricketts, East Grinstead.
1546. Construction of Roofs, &c., C. Erlinghagen, London.
1547. Vertical Boilers, G. W. Barnes, London.
1548. Elastic Envelope for Powder, M. Haselbach, London.
1549. System of Advertisment, &c., J. Henderson, London.
1550. Tobacco Pouch and Pipe Case, P. E. Ward, London.
1551. Corking or Stoppering Bottles, F. T. Marwood, London.
1552. Pianofortes, T. C. Lewis, London.
1553. Lamp Extinguisher, G. J. J. Legrand and G. Price, London.
1554. Cigarettes, M. Abecassis, London.
1555. Treatment of Sewage, W. D. Scott-Moncrieff, London.
1556. Manufacture of Gelantinised Paper, C. Raymond, London.
1557. Nut Locking Devices, W. Ogle, London.
1558. Additions to Beer Machines, C. Chambers, London.
1559. Making Gases, J. H. Dunn and J. Parsons, London.
1560. Levels and Clinometers, W. O. Smith, London.
1561. Bedsteads, H. G. Lancaster, London.
1562. Road Vehicles, B. G. King, London.
1563. Gravity Electrical Contact Maker, R. Pearson, London.
1564. Voltaic Batteries, D. G. FitzGerald and C. N. Stewart, London.
1565. Electric Switches, T. Harper, London.
1566. Pneumatic Tires, D. A. Martin, London.
1567. Studs, H. J. Garbutt, London.
1568. Pulleys, G. A. Bateman, London.
1569. Printing Machines, Jahncke, Ld., E. A. Jahncke, and F. A. G. Gmelin, London.
1570. Automotor Carriages, E. H. Hodgkinson, London.
1571. Glass Bottles, T. W. Simpson and W. H. Bradshaw, London.
1572. A New Card Game, E. N. Frankenstein, London.
1573. Photographic Films, J. B. B. Wellington, Elstree.
1574. Meters, Siemens Bros. and Co. and J. Nebel, London.
1575. Zinc, Siemens Bros. and Co.—(*Siemens and Halske, Germany.*)
1576. Incandescent Lighting, L. Denayrouze, London
1577. Lamps, B. Cars.—(*J. Hirschorn, Germany.*)
1578. Envelopes, J. M. McLeod, London.
1579. Corn Cutters, A. Holsopple, London.
1580. Bottles, W. Murray, J. A. Johnston, and J. Kellow, jun., London.
1581. Wrenches, T. Curley, London.
1582. Puzzles, J. L. Mahoney, London.
1583. Cutting Machine, K. Hedberg, London.
1584. Can Openers, F. E. Garner, London.
1585. Curtain Poles, B. C. Jones, London.
1586. Pocket Poison Case, A. F. Lambert, London.
1587. New Compounds, M. Hocquet, London.
1588. Wheels for Cycles, G. Hayes, London.
1589. Folding Gate, C. Bayer and P. Scherbner, London.
1590. Bleaching Wheat, W. A. McArthur and J. Atherton, London.
1591. The Aria, J. Weaver, London.

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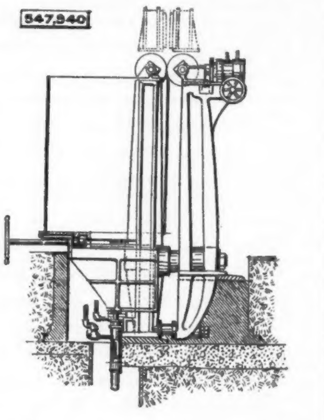
1592. Stove Appliances, S. Fossati, London.
1593. Interchangeable Oven for Gas or Oil, W. A. Cliffe, Blackburn.
1594. Sights for Military, &c., Weapons, A. J. Wake, London.
1595. Fuel Economiser, F. Evans, Warrington.
1596. Dress Fastener, D. Kirk, Halifax.
1597. Cycle Mud-guard Cleaning Brush, D. P. Bleasby, Southport.
1598. Omnibuses, H. W. Orford, London.
1599. Paper Bags, T. Orr, Glasgow.
1600. Magnifying Attachment for Sewing Machines, A. McAllister, Glasgow.
1601. Pocket-book for Holding Artificial Flies, S. Allcock, Redditch.
1602. Wheel Tires, A. A. Verel, Glasgow.
1603. Stands for Candles, &c., E. H. Ledger, Birmingham.
1604. Rolling Mills, P. Robinson, Birmingham.
1605. Shuttles of Looms for Weaving H. Whittaker, Halifax.
1606. Billiard Cues and Rests, E. Fleming, Halifax.
1607. Oil Lamps, W. Hewson and P. C. Davies, Liverpool.
1608. Humidifying the Atmosphere when Spinning, F. Baynes, Halifax.
1609. Reducing Valves, W. E. Heys.—(*Schaffer and Budenberg, Germany.*)
1610. Cycling Shoes, G. Griffin, Northampton.
1611. Holders for Incandescent Electric Lamps, W. McGreoch, jun., Glasgow.
1612. Hot-air Engine, A. R., H. W., and H. E. White and H. A. Fenn, Southampton.
1613. Feeding Wool to Carding Engines, J. Leach, Huddersfield.
1614. Attaching Brass Ornaments to Bedsteads, F. Hoskins and J. W. Lawrence, Birmingham.
1615. Hurricane Lanterns, T. G. Blood, Birmingham.
1616. India-rubber Tires for Vehicles, J. A. Harrison, Birmingham.
1617. Securing and Locking Milk Cans, S. J. Wiseman, Southampton.
1618. Production of Designs on Woven Fabrics, W. Hirsch, Manchester.
1619. An Instantaneously-igniting Tinder-box, F. Grimal, Brussels.
1620. Heating, &c., Appliances, G. Robertson, Glasgow.
1621. Collapsible Section Wrapper, M. Clutterbuck, Brighton.
1622. School Desks, D. Greig, Glasgow.
1623. Door Fastenings for Shafts, E. Gofferje, Cologne.
1624. Anti-friction and Anti-vibration Combination Washer, H. D. Booth, London.
1625 Water-tube Boiler, G. Hutson and H. McIntyre, Glasgow.
1626. Construction of Floors, W. Horsfall and R. Berry, London.
1627. Pocket Knife with Pen and Pencil Holder, F. W. Kohlsaat, Birmingham.
1628. String Cutter, W. H. Caldecourt and J. R. Caldecourt, jun., London.
1629. Braces, A. J. Sewell, London.
1630. Trigger Mechanism for Guns, E. C. Lawrence, London.
1631. Cabinets, &c., L. H. Ellington, London.
1632. New Game, W. Pindard, London.
1633. Stop Motions for Doubling Machinery, L. Hargreaves, London.
1634. Affixing Badges to Cycles, J. le Riche, Birmingham.
1635. Fittings for Sliding Windows, J. Ingram, London.
1636. Combined Liquid Measure and Funnel, W. J. Bassett, London.
1637. Driving Gear for Safety Bicycles, A. B. Coomber, London.
1638. Lids of Cooking Utensils, H. H. M. West, London.
1639. Safety Valve for Flasks, &c., M. Crawford, London.
1640. Cowl, W. Bennett, London.

SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

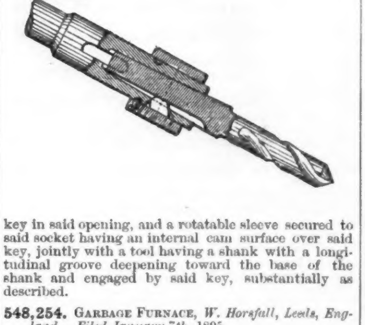
547,940. Tube Welding Machine, *T. F. Rowland, New York, N.Y.—Filed July 5th*, 1894.

Claim.—(1) The combination in a welding machine, of two welding rolls arranged to conjointly operate upon opposite sides of a blank, mechanism for advancing and retracting one of said rolls relatively to the other, and an adjustable piece carrying stops adapted to limit the movement of the movable roll in both directions toward and from the other roll, for the purposes set forth. (2) The combination in a welding machine, of two welding rolls arranged to conjointly operate upon opposite sides of a blank mechanism for advancing and retracting one of said rolls relatively to the other, and an adjustable stop limiting the movement in both directions of the said movable roll, and mechanism for effecting the adjustment of said stop, for the purpose set forth. (3) In combination in a welding machine and with a fixed and an adjustable welding roll, a blank carrying carriage, a main ram connected to said carriage, and one or more supplemental rams arranged to disconnectedly engage said carriage, and means substantially as described whereby said main ram can be caused to operate the carriage with or independently of said supplemental rams, for the purpose set forth.


547,940

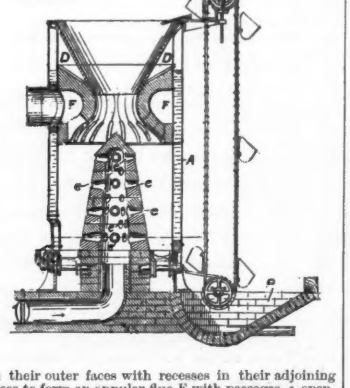
548,037. Means for Holding Twist-drills or other Tools, *J. D. Cox, jun., and W. T. Armstrong, Cleveland, Ohio.—Filed February 9th*, 1894.

Claim.—The common and well-known form of drill or tool socket as shown and described, and constructed with an opening through its side for a locking key, a key in said opening, and a rotatable sleeve secured to said socket having an internal cam surface over said key, jointly with a tool having a shank with a longitudinal groove deepening toward the base of the shank and engaged by said key, substantially as described.


548,037

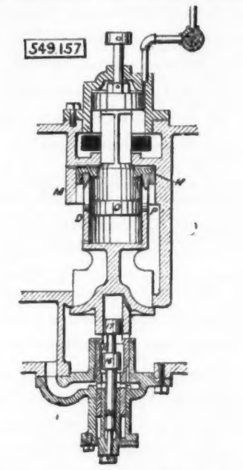
548,254. Garbage Furnace, *W. Horsfall, Leeds, England.—Filed January 7th*, 1895.

Claim.—(1) The combination in a garbage furnace, of the upright annular boiler body A open at its top, the central hollow and perforated cone A arranged within the same, and a rotary grate, occupying the annular space between the cone and the body A, said body being provided with an opening N located on a level with the grate, for removing the clinker as it is brought opposite said opening by the rotating grate, substantially as shown and described. (2) In an upright annular garbage furnace such as described, a ring of fire-brick blocks D, said blocks having a curve in their outer faces with recesses in their adjoining faces to form an annular flue F with passages c opening into said flue, said ring being located within and near the top of the furnace body, substantially as and for the purpose set forth. (3) In combination with the upright furnace arranged to be fed at its top, the dumping pit P provided with one or more outlets for draining away the liquid portions of the garbage, with an elevator provided with perforated buckets, arranged to take the solid portion of the material from the pit and deliver it at the top or mouth of the furnace, substantially as described.


548,254

549,157. Valve Device for Compound Engines, *C. W. Russell, Richmond, Va.—Filed March 24th*, 1894.

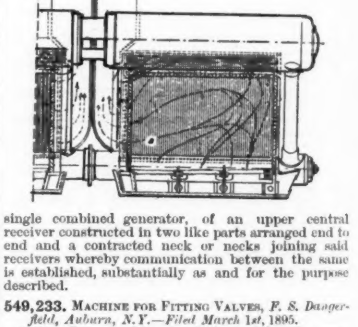
Claim.—(1) The combination in a compound engine valve device of an emergency valve and motor for shifting the same, an intercepting valve and a piston N connected therewith and fitting a cylinder open to the receiver, whereby the receiver pressure is brought upon the piston to move the latter and closing the intercepting valve when the emergency valve is opened, substantially as set forth. (2) The combination with the intercepting and emergency valves, of a piston head on the intercepting valve, adapted to a dashpot cylinder communicating with the port of the emergency valve and through a vent with the receiver, substantially as described. (3) The combination of the intercepting valve, exhaust valve and intermediate cylinder D, and piston O, the said cylinder having ports controlled by said piston, substantially as described. (4) The combination of the intercepting valve, emergency valve, and intermediate cylinder D, and piston O, constituting a dashpot for both valves, substantially as described. (5) The combination of the intercepting valve carrying the cylinder D, with por P, and having a head or piston N, and exhaust valve having a piston fitting the cylinder D, the cylinder M receiving the head N, substantially as described. (6


549,157

The combination of the intercepting valve, exhaust valve, intermediate cylinder D, and piston O, and ports P and vent v in said cylinder, and a cylinder M receiving the end or head of the cylinder D and having a vent w, substantially as described. (7) The combination of the intercepting valve having a hollow stem, ports 10, v^2, and chamber K, and a reducing valve sliding within the hollow stem having pistons 16, 17, port 19 and stem 20, substantially as set forth

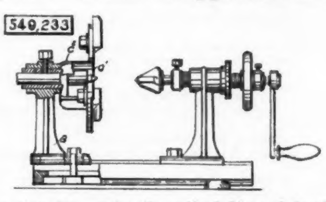
548,451. Multitubular Steam Generator, *J. A. Normand and P. Sigaudy, Havre, France.—Filed March 28th*, 1895.

Claim.—In a multitubular steam generator, the combination with two generators of like character provided with distinct furnaces and united to form a single combined generator, of an upper central receiver constructed in two like parts arranged end to end and a contracted neck or necks joining said receivers whereby communication between the same is established, substantially as and for the purpose described.


548,451

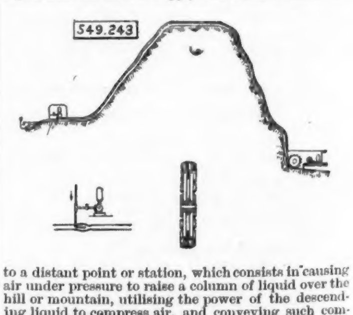
549,233. Machine for Fitting Valves, *F. S. Dangerfield, Auburn, N.Y.—Filed March 1st*, 1895.

Claim.—In a machine for fitting valves, the combination of a standard B provided with a bearing B^4, a cutter-holder C' having a hollow shank C^2 arranged in said bearing and provided with a side aperature C^3, and adjustable stem G removably mounted within the shank and provided with a socket g extending inwardly from its outer end, a clamp F movable in the bearing radially through said aperature in the shank and engaged with the side of the stem for securing the cutter-holder and stem in position and permitting the adjustment of the latter, a yielding centre G' movable in the socket and provided with a longitudinal groove g^2 and stop shoulders at its ends, a spring G^2 within the socket forcing the centre outward, and a stop pin g' having its opposite ends supported by the walls of the socket and its centre resting in said groove, as and for the purpose set forth.


549,233

549,243. Method of and Apparatus for Conveying Water, *R. Mannesmann, New York, N.Y.—Filed January 19th*, 1895.

Claim.—The method herein described, of conveying liquid from a source or supply over a hill or mountain to a distant point or station, which consists in causing air under pressure to raise a column of liquid over the hill or mountain, utilising the power of the descending liquid to compress air, and conveying such compressed air to the starting point and causing it to continue the movement of the liquid over the hill or mountain, substantially as set forth.


549.243

NAVAL ARCHITECTURE.—A FEW PRINCIPLES POPULARLY EXPLAINED.

No. II.—STABILITY.

By the stability of a floating body is meant the tendency it possesses to resist capsizing; and in the case of a ship it is therefore a very important quality indeed, especially when she is propelled by sails. The possession of the quality of stability in a floating body may be due either to its form, to the position of its centre of gravity, or to both combined.

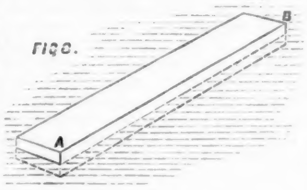


FIG. 8.

For instance, a plank floating on its broad side, as shown by Fig. 8, will be stable, or possess stability, inasmuch as it offers resistance to floating in any other position; whereas when floating on its edge, as shown by Fig. 9, it is unstable, or without stability, inasmuch as it seeks to turn over to the position shown by Fig. 8. In this case the stability is due to the form of the floating body. But if a heavy strip of lead were nailed against the edge A B of the plank shown in Fig. 8, the latter would turn over and find stability when floating in the position shown by Fig. 9. In that case stability would be due to the position of the common centre of gravity of the plank and lead.

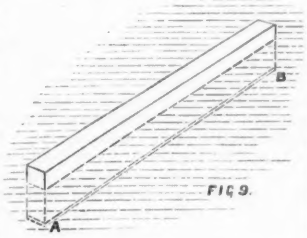


FIG. 9.

If, again, the lead were removed from the edge of the plank and nailed instead along the middle of its broad side, stability would be once more found in the position shown by Fig. 8, and the stability would be greater than it was before. In that case stability would be the result both of form of body and the position of its centre of gravity.

Taking three cases of a more practically useful character, it may be said that a Thames barge owes her stability chiefly to her form; a modern racing yacht chiefly to her heavy lead keel; and a clipper sailing ship to her form and the stowage of her cargo combined.

The foregoing are general principles, broadly stated. Let us now look into the matter with a little more precision. Among the common inquiries which reach us, to which allusion was made in the last article, are requests for information regarding the meaning of the terms "metacentre," "centre of buoyancy," and "centre of gravity," as used by naval architects in discussing the qualities of a ship's design. Now, the stability of a ship is determined by her displacement, and by the positions of the three points above mentioned.

Centre of gravity.—Consider first, then, the centre of gravity of a body, whether floating or otherwise. It need, perhaps, scarcely be said that the centre of gravity of any body is the centre of its weight, or the point at which its weight operates. In a homogeneous body it is the centre of its volume; in any body it is the centre of its mass. In an empty ship it is the centre at which gravitation operates upon the materials composing the ship, and in a loaded ship it is the centre at which gravitation acts upon ship and cargo. When a vessel is afloat the position of her centre of gravity can be determined by experimental means, to be explained in a future paper; but to obtain the position of the centre of gravity from the drawings of a ship before she is built involves a laborious although by no means difficult calculation. The centres of gravity of ships for the Royal Navy are calculated from their designs, before they are built, and verified by experiment afterwards. The same is, in general, true of racing yachts; but in trading vessels the positions of their centres of gravity are so much affected by the nature and stowage of their cargoes that precise determinations beforehand of those points are not generally attempted for the empty hulls; the designer being for the most part guided by experience obtained in other and similar cases. The position of the centre of gravity is, however, in any case of vital importance to the stability of a ship and it must be below the metacentre as will presently be seen.

Centre of buoyancy.—The centre of buoyancy of a floating body is the centre of gravity of the water it displaces; or, in other words, the centre of volume of the immersed portion of the floating body. When a ship is floating at rest the centre of buoyancy is, of course, a fixed point; but when she rolls or pitches the form of the immersed volume is continually changing, and, consequently, the centre of that volume changes in position correspondingly. When a ship rolls over to starboard her centre of buoyancy moves in that direction and *vice versâ*. Hence, while the centre of gravity of the ship remains a fixed point in the ship, however she may roll or pitch—provided the cargo does not shift—the position of the centre of buoyancy moves with every inclination she may make away from the upright position.

Referring to Fig. 10, we have the midship section of a vessel floating upright at a load water-line L L. G shows the position of her centre of gravity, and B that of her centre of buoyancy. If the vessel be heeled over until L_1 L_1 is the load water-line, then, while G remains where it was, the centre of buoyancy will move over to B_1. It is to a large degree upon the extent of this movement that the stability of the vessel depends.

Let us, however, before proceeding further, ascertain in what way the position of B, the centre of buoyancy of the vessel in the upright position, is determined. Afterwards, we will make a similar inquiry in regard to the position of B_1. Now to find the position of B is a comparatively easy matter; not so, however, in regard to B_1, and it is because the positions of the centres of buoyancy in inclined conditions of a vessel are so difficult to determine, that calculations of what are known as "curves of stability" were so rarely made, even for ships of the Royal Navy, until about a quarter of a century ago, and are so seldom made for mercantile vessels today. To find the position of B in the upright condition, is, as already remarked, to determine the centre of gravity of the displacement.

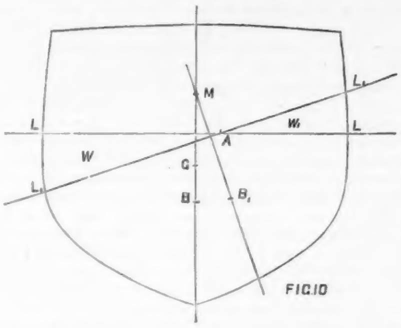


FIG. 10

In our first paper we showed how the volume of displacement is calculated. Areas of equidistant transverse vertical sections of the vessel were first found in the manner then indicated, and their areas were then treated as ordinates; the even numbered ones being multiplied by 4, the odd numbered ones by 2, and the end ones by unity. The sum of the products so obtained were multiplied by one-third the common distance between the vertical transverse sections, and the result gave us the volume of one-half the immersed body of the vessel.

Similarly, the areas of the equidistant horizontal sections parallel to the water plane were first found, and these were multiplied—the even numbered ones by 4, the odd numbered ones by 2, and the end ones by unity. The sum of the products so obtained when multiplied by one-third the common distance between the horizontal plane sections gave also one-half the volume of the immersed body of the vessel. The two results being alike showed each to be correct.

This recapitulation seems necessary in order to explain how the centre of gravity of the volume of displacement is determined. Now, that centre of volume will, in the case of a symmetrical figure like that of a ship, be somewhere in the longitudinal vertical middle line plane, which would cut her into two equal portions. To fix the position of the point accurately we must know its distance down from the load-water plane and its distance before or abaft the midship section or middle of the vessel's length. For purposes of transverse stability, or resistance to a rolling inclination, we want the distance of the centre of buoyancy below the load-water plane.

Consider, then, each of the horizontal sections into which the immersed body of the vessel is cut by means of equidistant planes, parallel to the water plane—see Fig. 11. The areas of these were found in calculating the displacement. The leverage of the load water plane area, considered as a thin slice of water, acting about that plane will be nil. If the horizontal sections are, say 2ft. apart, then the leverage of the second plane area, considered as a similarly thin slice of water, and acting about the load water plane, will be the area of that plane multiplied by 2ft. and again multiplied by the weight of water in a square foot of the thin slice. Omit the weight of the slice and consider the plane surface as having weight in proportion to the extent of its area. The leverage or "moment" of the third plane section will be its area multiplied by 4ft. That of the fourth will be its area multiplied by 6ft., and so on. Let A, B, C, D, E represent the several areas in square feet, then

$$\begin{array}{l} A \times 0 \\ B \times 2 \\ C \times 4 \\ D \times 6 \\ E \times 8 \end{array}$$

will be the several leverages or moments of the plane sections acting about the load water plane A.

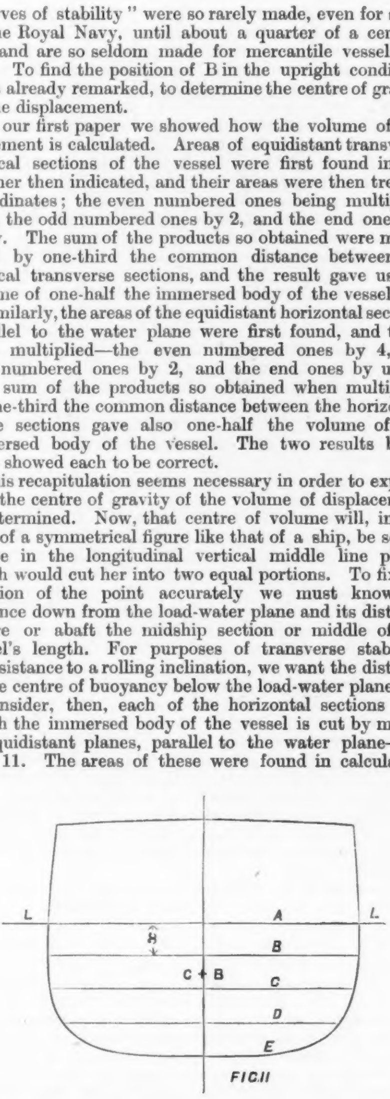


FIG. 11

For greater simplicity, omit for the present the common factor of 2ft. which is the common distance between the horizontal sections; we then have

$$\begin{array}{l} A \times 0 \\ B \times 1 \\ C \times 2 \\ D \times 3 \\ E \times 4 \end{array}$$

as the measure of these leverages.

Having got thus far, we proceed to apply the same principle that was adopted in calculating displacement in order to take into account the infinite number of other thin slices enclosed between those of which we have already expressed their areas and moments.

Stated in simple formula it becomes:—

$$\frac{x}{3}\left\{(A \times 0)1 + (B \times 1)4 + (C \times 2)2 + (D \times 3)4 + (E \times 4)1\right\}$$

where x is the common distance between the horizontal sections. Simplified, this appears:—

$$\frac{x}{3}(0 + 4\,B + 4\,C + 12\,D + 4\,E).$$

$$\begin{array}{lll} \text{Suppose} & A = 110 & \text{square feet} \\ & B = 100 & ,, \quad ,, \\ & C = 80 & ,, \quad ,, \\ & D = 60 & ,, \quad ,, \\ & E = 5 & ,, \quad ,, \\ & \text{and } x = 2\text{ft.} & \end{array}$$

then the total leverage or moment of the half displacement about the load water plane is

$$\tfrac{2}{3}\,(0 + 400 + 320 + 720 + 20) = 973\tfrac{1}{3}$$

cubic feet of sea water at a leverage of 2ft., because the common factor of 2ft. was omitted previously for purposes of simplicity. That is to say, 1946⅔ cubic feet of sea water at a leverage of 1ft. But the volume of half the displacement is

$$\begin{aligned} & \tfrac{2}{3}\,(A + 4\,B + 2\,C + 4\,D + E) \\ = & \tfrac{2}{3}\,(110 + 400 + 160 + 240 + 5) \\ = & \tfrac{2}{3} \times 915 = 610 \text{ cubic feet.} \end{aligned}$$

Hence, dividing the moment of half the displacement about the load water plane by the volume of half the displacement, we have

$$\frac{1946\tfrac{2}{3}}{610} = 3{\cdot}19\text{ft.}$$

which is, therefore, the distance of the centre of buoyancy in the upright condition below the load water-line. In Fig. 11 the centre of buoyancy, indicated by the point C B, is therefore 3·19ft. below the load water plane A.

Again referring to Fig. 10, B is the point already found, that is to say, the centre of buoyancy in the upright position of which the load water-line is L L. When the vessel is inclined through the angle L A L_1, so that L_1 L_1 becomes the water-line, the centre of buoyancy moves to the point B_1; to ascertain the position of which involves a long and laborious calculation.

Suffice it to say that the purpose of the calculation is to determine the effect upon the centre of gravity of displacement produced by the transference of the wedge-shaped volume of water L A L_1, denoted by the letter W, to the opposite side of the vessel, marked W_1. It need scarcely be remarked that as the volume of displacement remains constant, however the vessel may be inclined, these two wedge-shaped volumes are also equal.

Metacentre.—It remains for us in this paper now to explain the term "metacentre." Suppose that the position of B_1 has been determined by the calculation just alluded to, the vessel being floating at the time with L_1 L_1 as the load water-line. Through B_1 draw a perpendicular line B_1 M to the line L_1 L_1. Where this perpendicular line intersects the line B M, drawn through the centre of buoyancy in the upright condition, is the transverse metacentre at that inclination of the vessel. The point M in Fig. 10 is, then, the transverse metacentre corresponding to the centres of buoyancy B and B_1.

Similarly, referring to Fig. 12. If B is the position of the centre of buoyancy when the vessel is floating with L L as a load water-line, and she be inclined longitudinally, so that L_1 L_1 becomes her water-line, and B_1 the new position of the centre of buoyancy; then the intersection of a line B_1 M, perpendicular to L_1 L_1, with the original perpendicular from B, gives a point M, which is the longitudinal metacentre, at that longitudinal inclination of the vessel corresponding with the centres of buoyancy B and B_1, shown in the figure.

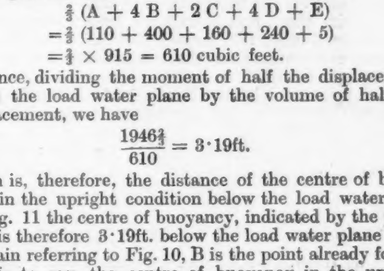


FIG. 12

Consider, for the present, the transverse metace only. It will be seen that it is a variable, and not a fixed point, having a different height from B for every different transverse angle of inclination given to the vessel. From this fact, as will be seen in a future paper, the moment of stability of a vessel is different at different angles of inclination, increasing up to a certain point, where it reaches a maximum, then diminishing until it becomes zero, and ultimately becoming a negative or upsetting value.

For purposes of comparison between different vessels, and for affording a general idea of a vessel's ultimate stability, it is usual to calculate her "initial" stability, or in other words, the moment required to incline her through a very small angle. It is assumed that the angle is so small a departure from the upright position that M remains at a constant height above B throughout the range of that small angle. In ordinary vessels the point M remains fixed, or practically so, for an inclination of 10 deg. to 15 deg., but beyond that range the difference in the form of the portion of the vessel emerging from the water as compared with that entering it, causes the positions of M and B_1 to vary rapidly.

Enough has, perhaps, been said in this paper to explain the meaning of the terms centre of buoyancy, centre of gravity, and metacentre, and to convey a general idea of how the positions of those points are determined. It will be the purpose of our next article to show their relation to the stability of a vessel and how the moment of stability is determined.

PARKHEAD FORGE, ROLLING MILLS AND STEEL WORKS.

Established for considerably over half a century—for the past sixty years, in fact—and constantly marching with the needs of the times, the "Parkhead Forge"—a name which long usage and business brevity have familiarised, but which actual development has long rendered only partially descriptive—is at the present day a vast, well-arranged and well-housed aggregation of manufacturing plant and appliances busily employed with an exceptionally varied range of steel productions. The works cover an area of over twenty-five acres, and embrace ranges of open-hearth steel furnaces, casting pits and re-heating furnaces, cogging, plate, sheet, bar and tire mills; machinery for the manufacture of bolts and rivets; steam hammers ranging from 1 ton to 20 tons, and other machinery for the manipulation of heavy masses of metal up to a 12,000-ton hydraulic forging press now being laid down; a plant for the manufacture of armour-plates, and large machine shops replete with the most modern appliances for machining the various descriptions of finished manufactures required in the shipbuilding and marine engineering industries.

Originally started by Mr. Reoch in 1835 for the work of forging simply, the chief agent then employed for that purpose was the helve or trip-hammer; of some potency as a machine tool prior to the day when the "Nasmyth" and Rigby hammers came irresistibly to the front. About 1840 the works came into the possession of Mr. David Napier, one of the earliest and most enterprising pioneers of marine engineering on the Clyde. In his hands, however, they did not answer the expectations formed of them, and his brother, Mr. Robert Napier, founder of the celebrated firm of R. Napier and Sons, who was then entering upon the work of making the engines for the first of the Cunard steamers, took over the Parkhead Forge as an adjunct to the engineering business he had established at Lancefield Foundry. About 1860 the Napiers disposed of the forge works to Mr. William Rigby, inventor of the Rigby hammer, and to Mr. William Beardmore, father of the present proprietor. Under the title of Rigby and Beardmore, these gentlemen conducted the business for some years and did much to lay the foundation for that fame which has ever since surrounded the name of Parkead Forge. On Mr. Rigby retiring from the co-partnery some years later, Mr. Beardmore assumed as partner his brother Isaac, the firm's designation then becoming W. and I. Beardmore. Mr. William Beardmore, senior, died in 1877, and, in conjuction with his trustees, Mr. Isaac Beardmore carried on the works until 1886, when they came into the possession of their present owner, Mr. William Beardmore, eldest son of Mr. William Beardmore, deceased. Under the present proprietor's spirited rule the works have been largely re-arranged and much extended, while at the same time they have been engaged turning out the productions for which they have long been celebrated.

Long before steel manufacture had assumed the proportions it now possesses, and when iron-puddling furnaces were a necessity, and hammering all potent, marine forgings formed the chief feature of the work produced at Parkhead. Previous to the adoption of steel in the Royal Navy, a large proportion of the crank shafts and other forgings used in her Majesty's ships were of Parkhead make; one notable example, to mention no others, being the double crank shaft of the Monarch, which weighed in the rough 32 tons. Since steel has displaced iron, the firm of William Beardmore and Co. has been equally to the front in this department, having again and again produced crank shafts that required ingots of 60 tons to 80 tons weight. The second firm in Scotland to go in for the mild steel industry, Messrs. William Beardmore and Company, have also earned the distinction of having manufactured the first crank shaft of the built type—that for the engines of the ss. Arizona, of 6000 indicated horse-power, and 31ft. 6in. long by 23in. in diameter.

While it has been mainly in the direction of its forged shafting of all kinds, and especially of its crank shafts, that the name and fame of Parkhead have been so long identified, it is also in the direction of forging on the larger and broader modern significance of the term, that much of its present-day vitality is being expended, when shafting is only one of the several important branches of manufacture being carried on.

Adequately to meet modern requirements, whether on the part of shipbuilder, boilermaker, or engine-builder, modern steel works and forges must be splendidly equipped with the most capable tools in their machining departments. The practice is being more and more adopted of requisitioning the capabilities of steel works, forges and foundries, not only for rough forming, but for minute finishing of heavy items in the make up of ships' hulls, marine engines, and their auxiliaries. Analogous in kind to the system of stone dressing in modern house-building stone quarries, but exceeding it in degree of refinement, this practice demands, at the hands of steel makers and others, heavy uses, specially shaped, trimmed, and otherwise prepared for individual positions in the general structure of which they are to form part. From steel makers are required plates "to sketch," designed for particular positions in ships' hulls; from forge and foundry proprietors are demanded forgings and castings in a condition as near the finished stage as the accuracy of fitting required in engine building will admit of. The flanging of boiler fronts and ends, combustion chambers and furnaces, the rough and finished turning of shafting, the centre boring of hollow shafting, the slotting or saw cutting of crank shaft webs and pins, the preparation of the several parts of crank shafts of the built type; all these, and numberless other tasks, have now to be undertaken by works which formerly were only expected to supply material in the rough; the shipbuilder, boiler-maker, and engineer in this way being saved a large proportion of the heavy preparatory work of shaping, rough-dressing, and finishing structural items; and saved in addition the cost of heavy machines which could only be kept partially at work.

For discharging this highly important function in the economy of the production of modern engineering details, the Parkhead Forge has been undergoing transformation ever since the present proprietor took charge—some ten years ago. A gradual and extensive equipment of suitable machinery has been laid down at the same time that the ordinary work of production has been carried on. First, there was the simple flanging and preparation of boiler work; then the finished production of marine shafting, and later on marine crank shafts, both built up and solid, finished accurately to gauge and, what is of great importance, accurately round. More recently, work of this nature has been further complicated by the demand for hollow shafting, necessitating the boring of shafts from end to end, often of as great length as 70ft.

But the crowning enterprise which has led us to give this descriptive notice of Parkhead, is the introduction of what is virtually a new industry for Scotland, viz., the production of armour-plates in their most complicated and difficult character, such as casemate plates, conning towers, gun shields, ammunition trunks, torpedo tubes, &c. We speak of this accession to the Parkhead department as introducing to Scotland what is virtually a new industry. We use the term "virtually" advisedly, because it may not be generally known, and is certainly an important circumstance connected with the history of these old-established works, that Parkhead Forge and Rolling Mills produced iron armour-plates as far back as 1862, the same year in which the rolling of armour-plates up to 5½in. thick was inaugurated by Sir—then Mr.—John Brown, at the Atlas Works, Sheffield, and continued to do so till 1865-66. These were supplied in considerable quantities to shipbuilders undertaking Government contracts, and some of these earlier hammered plates stood what were for the time very severe tests. Generally speaking, however, the thickness then required did not exceed 6in., and when, in the course of a year or two, heavier machinery was put down at the Atlas Works, Sheffield, with which plates were rolled up to 12in., and later on even to 24in. thick, the plant at Parkhead was found unable to undertake such heavy work, and the manufacture ceased. The procedure at that early time consisted in producing from the then most powerful Parkhead hammer "Hercules" slabs large enough for the size and weight of the plates required, which were then transferred to the rolling department, in which a specially constructed furnace and heavy rolling machinery respectively heated and rolled out the slabs to the required dimensions. The material used for the great bulk of these armour-plates was made from cold blast iron brought from South Wales. They had to pass the firing and other tests prescribed by the Admiralty, and, as already said, these were for the time very severe.

Since the era of mild steel, with all its possibilities in the way of alliance with other metals set in, armour-plate manufacture has formed no inconsiderable part of the work carried on at Parkhead. Nickel steel plates in particular, up to a considerable weight and thickness, have been produced, as have also "Harveyised" plates, which are now so much in request by naval authorities. The manufacture of armour plates of both kinds in Parkhead is, as has been said, the particular enterprise which renders these long-established works of special interest at the present time.

Proceeding to describe the departments in detail, and following the sequence of daily operations, the first feature in the equipment of the works to arrest attention—as it is almost the first in the order of manufacturing operations—is a range of seven steel melting furnaces of the Siemens open-hearth description. There are, it should be stated, eleven furnaces in all of this type in the works; but the range of seven now under notice occupies the original site of the melting furnaces along the northern side of the works. The other four furnaces are situated elsewhere, and in closer proximity to the re-heating furnaces, mills, &c. The capacities of these eleven furnaces range from 20 tons to 40 tons, and on their discharge side they are tapped into ladles of suitable capacity, which are borne along by a portable crane commanding the various-sized ingot moulds ranged in the casting pit. The pit extends the whole length of the range of furnaces, and is of ample capacity for accommodating moulds of varying dimensions and shape, according to the purpose to which the ingots are to be applied. The portable crane just alluded to as conducting the ladles over the pit, also lifts the ingots from their moulds, and deposits them on bogies on the line of railway alongside. By locomotive and bogie, ingots large and small are borne to the cogging and forging sections of the works. At one end of the pit and range of furnaces is the foundry section, occupying a space 40ft. in line with the furnaces by 110ft. in their rear. This department is fully equipped with overhead crane and other appliances, has large stoves for drying moulds, and ample accommodation for dressing castings. Facilities are provided for the production of castings up to the largest dimensions, and ingots for forge purposes, under Admiralty, Board of Trade, and Lloyd's regulations, have long been a speciality. Ingots up to 60in. diameter, or even larger if necessary, can be produced, and of any length up to 23ft. Here, it may be mentioned, was cast the ponderous cylinder of 64 tons weight, intended for the hydraulic forging press, elsewhere alluded to in this article, and shown being operated on in lathe by Fig. 1 on page 140. The overhead travelling crane here lifts the masses of metal from the casting pit, and deposits them on specially-constructed steel bogie carriages which traverse the line of railway, already described as running parallel with the whole length of the pit.

Gas for this range of furnaces, as well as for re-heating furnaces, is supplied from a group of gas producers at the far end of the furnaces. The producers are of the Wilson type, but with improved features which everyday experience has suggested. Originally the whole of the producers here were of the Siemens type, and several of these are still in operation, but the whole group is in course of being transformed to the newer and more efficient type. Already twelve of the latter are completed and in operation, and others are in course of erection in room of the older type gradually being demolished. All the new producers are of the wet-bottom type and are mechanically charged, the waste due to manual, irregular, and open charging, as in the older producing plant, being reduced to a minimum. Similar gas producers—ten in number—supply the needs of the four additional steel furnaces already mentioned, situated within even more convenient touch of the re-heating, cogging, and hammering sections of the works.

For the long list of vessels built and building for the British Navy under what is known as the Spencer programme, Parkhead has supplied the shafting, the list including the Majestic, Renown, Powerful, Prince George, Victorious, Hannibal, Illustrious, Cæsar. Amongst the orders now on hand are the crank and other shafting for the three first-class cruisers contracted for in December last, the Andromeda, Diadem, and Niobe, building respectively at Pembroke, Fairfield, and Barrow.

A powerful agent in the work of producing crank and straight shafting, piston and other rods, is the mammoth steam hammer "Goliath," laid down by Messrs. Beardmore themselves about eight years ago, in a position contiguous to the still older and equally renowned "Samson," which did such magnificent service prior to the cogging era. Although at present partly dismantled, and a seeming melancholy shadow of its former self, "Samson," it may here be stated, is about to be rehabilitated and given important duties in connection with the piercing of tires produced by the tire mill now being laid down.

The hammer frame of "Goliath" is built of wrought iron, and the weight of the striking block is 15 tons. "Goliath" is served by two very noteworthy steam cranes, one at each side, of great capacity, and of the most improved construction. These are by Messrs. John Grieve and Co., of Motherwell; one being of 60 tons lifting capacity and the other of 30 tons, the radius in each case being 24ft. The mast and jib in each case are built entirely of steel beams, and they revolve round a strong steel central pillar fixed in foundation plates. In the case of the 60-ton crane, the load is partly balanced by a weight hung from jib at back of crane. Both cranes have two pairs of engines, one pair undertaking the hoisting and lowering, and the other pair the slewing, racking, and also the turning of the forging under the hammer in any direction. All the motions, including this moving of the ingot underneath the hammer, are under the control of one man on the crane platform. In each case the steam is admitted and the exhaust let out at the top centre of crane. All the toothed wheels on the cranes are of cast steel—steel, in short, being almost entirely used in their construction so as to withstand the shocks to which such cranes are subject.

While "Goliath"—and "Samson, when rehabilitated—are the most notable of the agents employed in the forging department, there is of course a large number of smaller hammers, mostly of the Rigby type, situated and doing service in the older forging section of the works. Contiguous to this section, is the older machine shop—spoken of in the works as "the turning shop"—where, besides a large number of turning lathes, there are machines for ripping, planing, slotting, drilling, &c. Of this department, however, we need scarcely say anything when so much that is of greater novelty calls for description.

Occupying the extensive covered-in space which lies between the two series of furnaces, are the cogging and plate mills, hydraulic press, steam plate shears, and the vertical re-heating furnaces. At the rear end of the powerful cogging mill are the gas-fired re-heating furnaces of the type originally introduced to the steel trade by Messrs. Beardmore. These furnaces, it is almost needless to explain, are sunk so that their crown or roof is on the floor level. This facilitates the ingots being deposited and withdrawn in an upright position, thus affording the gas flames greater play about the ingot, and imparting a more intense and generally uniform heat.

The depositing and withdrawing of the ingots from the furnaces is effected by a powerful steam crane of special design by well-known makers. The jib of this crane commands all the apertures to the furnaces, and the crane has three sets of coupled reversing engines; one set for lifting, one for slewing, and one for racking or radiating; and it serves the furnaces with great ease, depositing the ingots and raising them again, after the necessary interval, with precision and despatch. All the motions are performed separately and simultaneously without the use of clutches, and are easily under the control of the craneman on platform so placed in front of the crane as to have an uninterrupted view of the load.

This crane also commands the tipping-chair or cradle at the end of the table of live rollers which feed the cogging mill. It deposits the hot ingot on this cradle in a vertical position, and at once and automatically, through the weight of the superimposed ingot, the cradle begins to tip over towards the bed of rollers. In this it is restrained and guided by an arrangement of hydraulic cylinder and ram which has hold of an arm of the cradle, the arrangement allowing the cradle to tip steadily downwards, so that the ingot is deposited easily and without shock upon the live rollers of the cogging mill. About 40ft. length of live rollers conduct to the cogging rolls, while beyond these the live rollers extend for other 30ft., delivering the ingot to the hot-bloom shears or guillotine. Fig. 2 on page 140 shows a fore-shortened view of the cogging rolls, live rollers, and hot-bloom shears.

This notable item in the equipment of Parkhead is shown in its workaday condition, the roughness observable on the cheeks, &c., of the cogging mill being simply the grease drip from the journals, &c.

The cogging mill, with gearing, was made by Messrs. Miller and Co., of Coatbridge, and is driven by a set of coupled reversing engines supplied by Messrs. Duncan, Stewart, and Co., London-road, Glasgow. These have 42in. cylinders, 5ft. stroke, geared $2\frac{1}{4}$ to 1, and work at a steam pressure of 120 lb. per square inch. The cogging rolls proper are of steel, of Parkhead make, $8\frac{1}{2}$ft. wide and 40in. diameter, and weigh 14 tons each. They have grooves at each end for "edging" the ingots. The top roll is balanced by hydraulic power in cylinders placed under the bed-plate, while a small pair of 6in. cylinder steam engines work the screw, which raises or lowers the top roller as occasion requires. When the live rollers before and behind have passed and repassed the ingot through the cogging rolls, until of the desired flatness, the edging arrangement is brought into action. Between the feed rollers of the mill there are hydraulic arms, which tilt up the ingot from the flat to the vertical position and place it in front of the edging grooves in the rolls, and tilt it back again to the flat position after the edging has been accomplished. The arms are actuated by hydraulic cylinders, placed under the feed rollers. This edging process, it will be understood, gives to cogging its most distinguishing feature. Edging at this particular stage squeezes off all troublesome scale, &c., from the surface, and enables the plate to be finished with a fine clear skin on it. All sizes of blooms or slabs from 6in. square up to 3ft. by $12\frac{1}{2}$in., and of any length required, can be accomplished by one set of rolls. This mill is in charge of and operated by two men, assisted by a boy, by whom the tilting and roller gear are manipulated.

After being sufficiently cogged down in the rolls the slabs are carried on the continuation of the live rollers to the large guillotine or hot-bloom shears, by which they are cut down into pieces of any desired size. The guillotine is actuated by vertical coupled reversing engines, having cylinders 26in. diameter by 30in. stroke, the working pressure being 120 lb., and it cuts slabs 36in. wide by $12\frac{1}{2}$in. thick with the greatest ease. From the guillotine the pieces are picked up by a travelling steam crane, which transfers them to one or other of three vertical heating furnaces of the type first introduced by Messrs. Beardmore, which are adjacent to the plate rolling mills. The crane in question is a massive portable crane of special make, capable of lifting and travelling with its heavy load at a radius of $16\frac{1}{2}$ft. It runs on four rails, two of which are of the ordinary gauge and two of 8ft. gauge. It has four flanged wheels running on the ordinary gauge, and four steel rollers on the 8ft. gauge, and is so arranged that it can be used throughout the works on the ordinary gauge only. The jib is curved and has three pulleys on it at various radii, the object being to vary the radius for lifting without lowering the jib, as the headroom from floor to roof is limited.

(*To be continued.*)

BERRYMAN FEED-WATER HEATERS.

FUEL consumption is gradually becoming as important a question at collieries as elsewhere, and it frequently happens that the quantity of actual waste or dross available is insufficient, and that during the winter months most, if not all of it, could be sold with advantage. This fact, combined with the necessity for dealing in some way with the hard water difficulty, coupled with a growing desire to obtain the full possible evaporative duty from each boiler, has induced many colliery proprietors to avail themselves of the enormous quantity of heat thrown away in the exhaust steam of winding, fan and other bank engines, to obtain a high temperature of feed-water previous to its entering the boilers by means of suitable feed-water heaters. The advantages that can be derived are various, and can be obtained if the nature of the feed-water is ascertained so that its impurities can be deposited in and removed from the heater and kept out of the boilers at all.

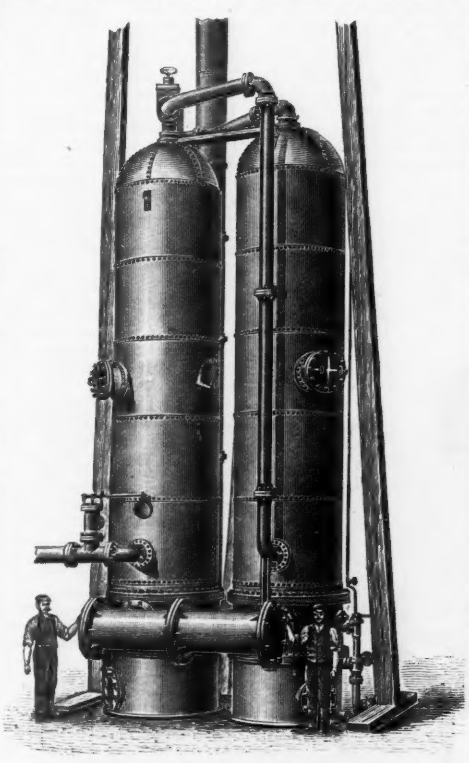
An extensive and successful plant of this sort has recently been completed at the Carlton Main Colliery of the Yorkshire and Derbyshire Coal Company, near Barnsley, by Messrs. Joseph Wright and Co., Tipton, the makers of the Berryman patent feed-water heater.

At this colliery there are seven Galloway boilers, 7ft. diameter by 30ft. long, and four ordinary Lancashire boilers, 6ft. 6in. diameter by 30ft. long. Besides these there are six boilers, 5ft. 6in. diameter by 30ft. long, fired by the gases from a range of coking ovens. The whole are connected together and work at 60 lb. pressure. The evaporation was ascertained by measurement to be about 10,000 gallons per hour, and previous to the alterations the boilers were fed by cold water by means of a Cameron pump.

There are two pairs of winding engines, but the exhaust of only one pair is made use of, this being the pair employed for winding the coal, and therefore working constantly; their cylinders are 36in. diameter, and the exhaust from each cylinder is 12in. in diameter. The cut-off—as is usual with winding engines—is very late, almost indeed at the end of the stroke. The fan engine has one cylinder, 32in. diameter, running at fifty-two revolutions per minute, with a 10in. exhaust. The two 12in. exhausts of the winding engines are connected together, and carried by means of a 20in. wrought iron pipe a considerable distance across a yard to the Berryman heaters, which are shown by the annexed engraving, the internal construction being similar to that of the smaller heaters. One of the old exhausts is however retained as a branch, and controlled by a valve, so that some portion of the steam—or all if desired—can be passed direct to the atmosphere. The heaters which are applied to these engines and boilers are two of Messrs. Joseph Wright and Co.'s special Berryman patent heaters, with 20in. exhaust steam inlets and outlets. Total height 28ft. 6in. These heaters weigh about 70 tons when at work, and are equal in power to about $4\frac{1}{2}$ extra double-flued Lancashire boilers, 28ft. by 7ft., which they are intended to represent, with this important difference, viz.: that whereas the $4\frac{1}{2}$ boilers would burn 4500 to 6000 tons of coal per annum, the heaters cost nothing after their initial cost, which is about half that of the boilers, to say nothing of cost of repairs, &c. Entering the first heater the steam passes through its solid drawn brass tubes and is then led to the tubes of the second heater, whence the remaining uncondensed steam escapes to the atmosphere. The cold feed-water coming from the boiler feed pump passes first into the casing surrounding the tubes of the second heater, whence it emerges at the top and is carried down to the entrance of the casing of the first heater. Its final exit is from the top of this heater direct to the feed service pipe serving the whole range of boilers. By this arrangement the hottest steam operates upon the hottest water, and the cold water entering the second heater has its best effect in cooling the already partially condensed steam.

The exhaust from the fan engine does not enter the first heater at all, but is conducted by the external connecting branch to the second heater. A large quantity of condensed steam water is recovered, it being collected in the patent syphon bottom of the heaters whence it overflows to a suction tank, and is fed by a separate pump direct into the boilers with the other feed. No trouble whatever is found to arise from the small portion of grease in this water, in fact, the result has been gradually to cleanse the boilers, which, we are informed, are now in much better condition than before the heaters were applied.

The Colliery Company has given Messrs. Wright and Co. some statistics of its boiler coal consumption and total output for the months of June to October inclusive, 1894, without the heaters, and the same months for 1895, with the heaters. The fan engine was not connected until June, 1895, after the photograph, from which our illustration is produced, was taken.



HEATERS, CARLTON MAIN COLLIERY

Without heaters, 1894:—Total output for five months, 160,208 tons; coal burnt in boilers for same period, 5871 tons. With heaters, 1895:—Total output for five months, 166,483 tons; coal burnt in boilers for same period, 4328 tons; giving for 1894, a ratio of consumption to output of 3·66 per cent.; and for 1895, 2·60 per cent.; showing an aggregate saving for the five months of 29·0 per cent.

In addition to this fuel economy, the firing has been very much easier. The usual result of the introduction of heaters has been obtained, sufficient steam for the various engines now being available with ease, and two boilers can at any time be stopped for cleaning purposes. The labour and expense of cleaning the boilers are considerably diminished, and the amount of deposit obtained at each cleaning is much less. The heaters have been opened and examined several times since commencing to work, and the tubes are found to be clean as when new. The average temperature of the boiler feed is about 208 deg. F.

HARBOURS AND WATERWAYS.

Welsh ports.—The Parliamentary plans and estimates for the proposed Windsor dock at Cardiff show that it will be situated in a convenient and accessible position both as regards water approach and railway service, in the latter respect having a direct run for traffic from the Taff Vale Company's main line at Penarth, the length of the junctions being about two miles. A well-sheltered entrance inside Penarth Head will lead through deep water, and the dock is intended to take the largest cargo vessels afloat. The total cost is put at £659,308, of which the dock works absorb £504,080; the embankment and sea wall for reclaiming the sixty-nine acres of Penarth Flats, £30,160; the two piers commencing at the end of the embankment, £39,600; and the railway, £85,558. The engineers of the scheme are Sir Alexander Rendel and Mr. G. T. Sibbering. The promoters, although nominally an independent company, are supposed to be backed up by the Taff Vale Railway Company.

The Bute Docks Company proposes amongst other works to close the Glamorganshire and Aberdare Canals, and to convert the same into a railway. Although all the shares in these canals are the property of the Bute Trust, who took them over in 1887, it would be entirely contrary to the provisions of the Railway and Canal Traffic Act of 1888 to allow an existing waterway over which there is considerable traffic to be destroyed for the purpose of creating a new railway. Throughout the whole length of the Glamorganshire Canal it competes with the Taff Vale, and the Aberdare and Merthyr sections with the Great Western and Rhymney companies. The amount of traffic along these canals at one time was very great, the tolls in one year—1853—amounting to £50,000 more than the original cost. When these canals were acquired by the Marquis of Bute the traffic had greatly fallen off, owing to the construction of railways. Since the Bute Trust had had the control the management had been greatly improved and the traffic increased. Steam towage has been introduced and a regular service of boats is maintained, the goods being collected and delivered as by railway companies; a through rate system has been introduced to and from all points, and the boats run in connection with the Bristol, Liverpool, London, Bridgwater, and Cork steamboats.

The contract for the proposed extension of the dock at Swansea has been let to Sir J. Jackson, of Westminster, for £58,263, subject to increase or decrease according to the amount of work done. The bridge for the new cut is being made by Messrs. Handyside and Co. The total expenditure is estimated at £100,000.

Harwich.—The condition of the entrance to this harbour, to which attention was recently directed in THE ENGINEER, was taken into consideration at the quarterly meeting of the Conservancy Board. It appeared that the Board had some time since applied to the Admiralty for a general re-survey of the harbour and its approaches, and in reply a surveying vessel was sent for a couple of days, the report made being that there was no sign of shoaling or silting up. A resolution was passed by the Board to the effect "that the state of the harbour requires the immediate and serious attention of the Board, and that the proper authorities be approached on the subject." From the information which has been made public, it appears that at Harwich, as in the case of the Thames, the difficulty in getting vessels of large size into and out of the harbour does not arise from any deterioration or shoaling of the channels and approaches, but from the greater draught of water now required, owing to the constantly increasing size of steamers. Harwich Harbour is the only safe harbour of refuge between the Thames and the North Coast, and the only safe place where the larger vessels of the Navy could enter if the depth of water of the approaches was sufficient. With the exception of two narrow channels which have 19ft. at low water, but which are not provided with leading lights, there is only 14ft. at low water over the shoals lying directly in the main approach, and frequently the Great Eastern steamers touch on these shoals at low tide. What is asked for now is that the waterway over these shoals shall be deepened. There is plenty of water and ample room inside, and it is urged that it would be better policy to make the most of a splendid natural harbour by means of a small expenditure, than in spending millions in creating harbours of refuge in other places.

Hastings.—A tender for the construction of the proposed harbour offered by Messrs. Punchard, McTaggart, Lowther, and Co. has been approved by the Harbour Commissioners, the amount being £120,000. The sanction of the Board of Trade has yet to be obtained. A guarantee of £50,000 has to be provided in case the harbour is left unfinished by the Commissioners. The area of the harbour is to be 25 acres, with a depth of 10ft. to 14ft. at low spring tide, and 25ft. to 26ft. at high water. The width of the entrance is to be 300ft., opening to the south-east. The engineer is Mr. A. E. Carey, M.I.C.E. The Commissioners are making an issue of £200,000 four per cent. bonds secured on the undertaking of the Commissioners, and the carrying out of the contract will be subject to this money being obtained.

Whitehills.—The Fishery Board for Scotland have intimated their intention to proceed with the construction of a new fishery harbour at an estimated cost of £10,000. About six years ago, at a public meeting of the fishermen and inhabitants, it was determined to petition the Board to take this matter up, and to raise by public subscription the one-third of the cost which the Fishery Board require before undertaking the construction of these local harbours. The Dowager Countess of Seafield, the principal landowner, offered to give up the site of the old harbour and the additional land required, and also to contribute £1000. The fishermen agreed to contribute a fixed sum weekly, which has amounted to £500, and the remainder has been raised by a bazaar, which produced £400, and by donations from the inhabitants. The plans of the proposed harbour have been prepared by Messrs. D. and C. Stevenson, of Edinburgh, and the necessary provisional order obtained last session. The engineers have now received instructions to proceed with the working plans and specification, and to report to the Board what arrangements they propose for carrying out the work.

Removal of wreck.—A case which is of interest to Harbour Authorities was lately tried in the Queen's Bench. The s.s. J. M. Lennard, of Middlesbrough, after leaving Goole Dock with a cargo of coal, ran on the training walls and became a wreck. The owners abandoned the vessel, and the Harbour Authority had to undertake the removal, which cost £3278. For this sum they sued the owners, who defended the action, on the ground that they were not liable, as they had given notice of abandonment, and obtained a judgment in their favour.

WOKING MAIN DRAINAGE.—An inquiry was held at Woking, on the 30th ult., by Major-General Crozier, R.E., into an application for sanction to borrow £50,000 for the purpose of a drainage scheme, and with reference to a Provisional Order to enable the local authority to acquire certain land required for the purposes of the works. The scheme before the inspector was prepared by Messrs. Taylor, Sons, and Crimp, of Westminster, and the details were explained by Mr. Santo Crimp, M. Inst. C.E., from which it appeared that the population to be drained amounted to about 10,000 persons, extending over a very large area, necessitating the construction of twenty-five miles of sewers, whilst there were four low places in the district from which the sewage had to be lifted by mechanical means. It was intended to employ hydraulic machinery for transmitting the power, the length of mains required being about six miles. As the volume of sewage to be raised at each station was small, it was intended to use water at the comparatively low pressure of 220 lb., the waste water after passing through the motors being employed for flushing purposes. The system of mains for transmitting the power would also supply several flushing stations situated upon their route, thus providing the necessary water without having to buy it for the purpose. It was intended to ventilate the sewers by means of shafts placed at suitable points, and carried up sufficiently high to admit of the sewer air escaping without giving offence, and the system was divided into sections both for flushing and ventilation purposes. The gravitation outfall sewer, which drained about 90 per cent. of the area, had a discharging capacity of $4\frac{1}{2}$ million gallons per twenty-four hours. Upon arriving at the proposed outfall works it was intended to clarify the sewage by means of settling tanks and filters, and then to apply the sewage for final purification to land, of which it was intended to clarify $42\frac{1}{2}$ acres. Filter presses were to be employed for dealing with the sludge, and the scheme was designed to meet the requirements of about 20,000 people, the district being a favourite residential one, and likely to grow rapidly when provided with efficient means of drainage.

SOME STEAM ROAD CARRIAGES

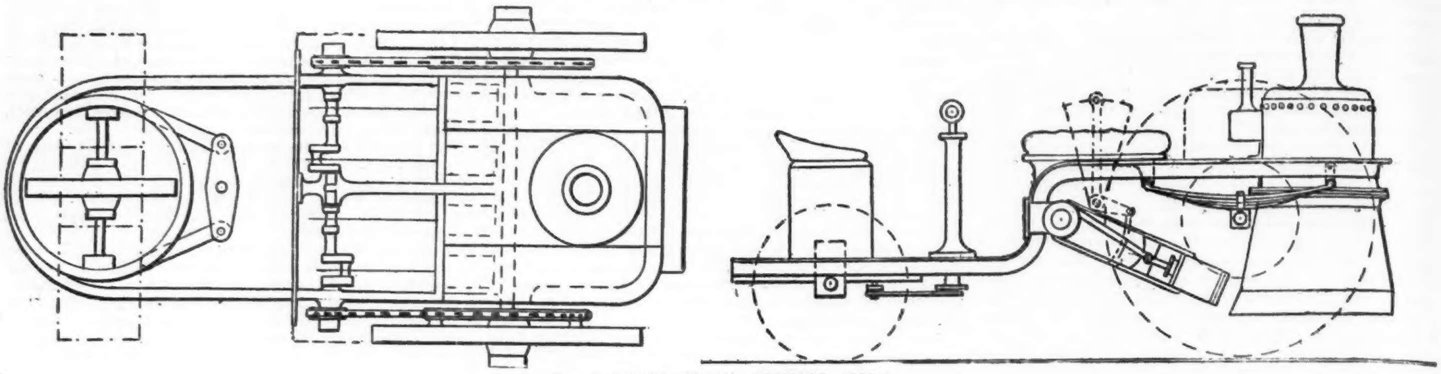


Fig. 1—HOLT'S STEAM CARRIAGE, 1866-7

SOME STEAM ROAD CARRIAGES.

DURING the long period of growth of the road locomotive and traction engine there have been from time to time departures from this line of development, and light road vehicles have been made which are particularly worth attention. Three of these we illustrate by the accompanying engravings.

First in order of date is a steam carriage made in 1866-67 by Mr. H. Percy-Holt, Assoc. M. Inst. C.E., and shown by Fig. 1. It is a carriage which contains several features of interest in connection with the construction of a light road vehicle. It was carried on three wheels, the driving wheels being 4ft. 6in. in diameter, and the front wheels 2ft. 6in. in diameter. At the rear of the carriage, the frame of which was formed of light angle iron, 3in. by 3in., was suspended a field boiler 4ft. in height and 2ft. in diameter at the upper part, with 50ft. of heating surface, and three square feet of grate surface. This supplied steam at a pressure of 250 lb. to a pair of engines consisting of four cylinders. Each pair of cylinders was 3in. diameter and 6in. stroke, the pistons being connected to two separate crank shafts, on the outer ends of which were pitch chain pinions 8in. in diameter, connected to pitch chain wheels 24in. in diameter on the drivers by two separate chains. The cylinders were disposed as shown in the plan, and at an angle as shown in the elevation, the whole of the machinery being boxed in, including two feed pumps worked direct from the crossheads. The exhaust from the engines passed into a cast iron box which formed a baffle plate at the bottom of the uptake above the fire where it was superheated. It then issued in five continuous jets up the chimney. This arrangement, owing to the large number of beats from four cylinders, made comparatively little noise. Part of the exhaust was used to heat the feed-water when required. The feed pumps were of novel design; the plunger uncovered a port near the end of its out stroke through which water was admitted from a water tank above it. On the return stroke this suction port was covered by the plunger and the water forced through the delivery valve into the boiler. The carriage complete weighed, in running order, about 30 cwt., and carried from six to eight people, including the steersman and engine and boiler attendant. It ascended gradients of 1 in 14 at about seven miles per hour easily, and on ordinary roads ran from fifteen to twenty miles per hour, and was thus much more powerful than will be required for the moderate speed vehicles of the future. The safety valve used was of the Naylor type, 2in. in diameter. The bunkers carried sufficient coke to run about forty miles, and the tanks would hold water for about twenty miles, the coke consumption being about 5 lb. per mile under favourable conditions.

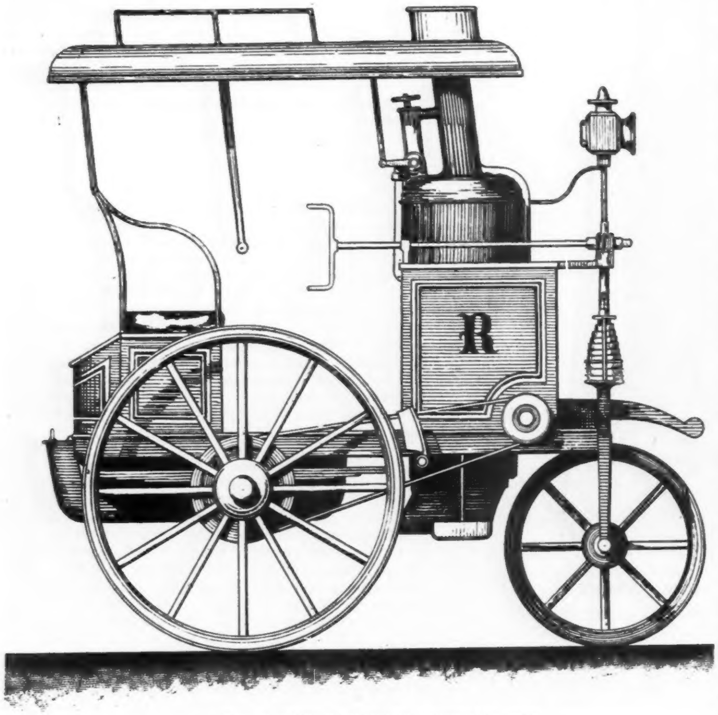


Fig. 2—TODD'S STEAM CARRIAGE 1870

The steering wheel was worked by a vertical shaft and cross-bar connected at the bottom of the former by a beam and a pair of rods, connecting it to the table supporting the steering-wheel bearings. The reversing levers for the two pairs of engines could be grasped either separately or together, ordinary link motions being used, working valves in a steam chest between the two cylinders. Each pair of engines, being independent, could be used with the reversing gear as a brake, and the very great advantage of the independence of these engines was the smoothness with which they suited the speed of the wheels in running round corners and made any form of compensating gear unnecessary. A further advantage was that of being able to use on good level roads only one engine, or to link it up so that very little steam was used. The water tanks were arranged on each side of the steering-wheel, and the coke-bunkers on either side of the boiler. The greater portion of the weight was carried on the driving wheels, which were of usual omnibus pattern, of wood with 3in. iron tires. The chain wheel was fastened to the wood spokes by clips. The rear part of the carriage was carried on large leaf springs. It was built at Headingly, near Leeds, and used by Mr. Holt for some time.

The steam carriage shown by Figs. 2 and 3 was made by Mr. Leonard J. Todd in 1870. This carriage was 8ft. 6in. long, 4ft. 6in. wide. It ran on three wheels, the drivers being 4ft. 6in., and the leading steering wheel 2ft., all ordinary carriage wheels. The engine consisted of two vertical cylinders, 2½in. diameter and 4in. stroke, each contained in a box in front of a coal bunker on either side. They were completely protected, and each separately drove a driving-wheel by means of ½in. gut belt running on a loose cone, so that the carriage could be readily steered in any direction. The steam exhaust from the two small cylinders was so small in quantity as to be almost inappreciable. The boiler was 16in. diameter, 3ft. 9in. high, and contained a large number of Field tubes, 1in. diameter, the heating surface being 16ft., and the grate surface 0·75ft. The carriage carried two persons, was a practical success, and many would have been made but for the Road Locomotive Acts, Mr. Todd having received numerous orders and inquiries for them.

Another vehicle of very considerable interest now is the steam brougham illustrated by Figs. 4 and 5. This was a three-wheeled carriage, built in 1875-6 by Mr. H. A. O. Mackenzie, at the rear of which was a Field boiler with about 34 square feet of heating surface and 1·76 of grate surface; it was 4ft. high and 2ft. in diameter. The engine was a two-cylinder vertical, driving by one or other of two spur-wheels of different sizes, a second motion shaft, in the centre of which was a compensating gear, and on the ends of which were pitch chain pinions, on which, and on toothed rings on the road wheels, ran two pitch chains, the ratio of engine speed to road wheel speed being 6 to 1 and 13 to 1. The driving wheels were 4ft. in diameter. The boiler pressure was 135 lb.; and, as fuel, foundry coke was used. The boiler was large enough to give considerable reserve capacity, so that on the one hand the water level need not for a few minutes be a cause of anxiety, when road matters were occupying attention, and, on the other, steam did not begin to blow off immediately a stop had to be made. The engine cylinders were 3·75in. by 4·5in., and an ordinary link reversing motion was used, with which Mr. Mackenzie used to drive, rather than with the regulator. It was found that one change of speed was sufficient for all purposes, intermediate variations being easily obtained from the engines; and, in fact, Mr. Mackenzie considers that a change gear may be made unnecessary by using cylinders of somewhat larger diameter. For this reason he did not provide any lever arrangement for changing the position of two gear wheels, shown on the crank shaft, but used simply a broad cylinder of leather, stiffened with ¼in. rods, and encircled by a small buckled strap. When both wheels were out of gear, as shown, this leather cylinder was between them. When either of the wheels was put into gear, this leather collar was taken off, the wheel pushed into gear, and the collar put on behind it. This arrangement was pending experience as to the necessity or otherwise of change of

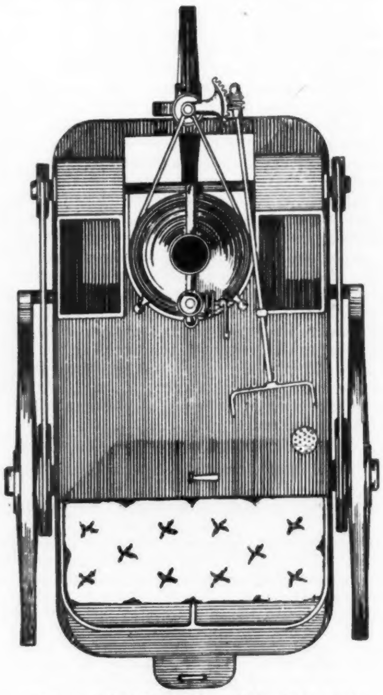


Fig. 3—TODD'S STEAM CARRIAGE, 1870

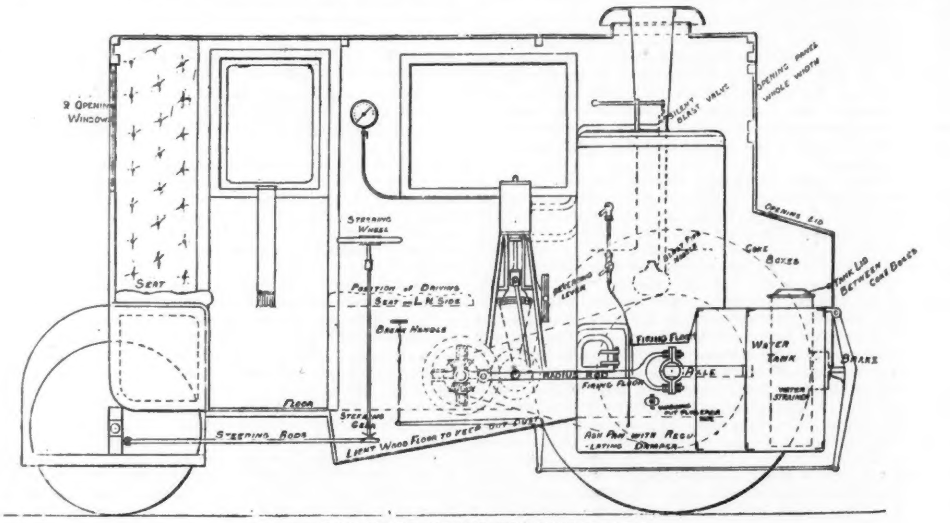


Fig. 4 - MACKENZIE'S STEAM BROUGHAM, 1875-3

speed by gearing. When the larger wheel on the crank shaft was in gear, the speed of the carriage was from ten to twelve miles an hour. The gear wheels on the counter shaft had wood teeth, to avoid noise, and the driving wheels ran loose on the main axle, which was bent, to escape the boiler, as shown.

The wheels were ordinary wood carriage wheels with iron tires. Mr. Mackenzie found the Field boiler very satisfactory, as it gave him plenty of reserve power for emergencies and to meet the varying requirements of the road. The water, in passing into the water tank, passed through a strainer, a necessary precaution for a boiler which may have to take water from ponds and streams. The boiler was fed by an injector, which was probably the first so used. The exhaust steam from the engine passed into a cast iron pot at the bottom of the uptake, from the centre of which it issued up the chimney. A blast valve was also used and opened a notch or two when the road did not require a strong blast, the valve acting as a variable blast and enabling the rider to occasionally reduce the back pressure in the cylinders. Radius rods shown in the elevation connected the chain pinion bearings to the axle close to the boss of the driving wheels. These maintained the proper distance between the chain wheels. None of the machinery was visible from the outside, but everything was accessible inside for experimental purposes. The brake tackle was fitted after the carriage was made as, it was intended, in the first instance, to brake by means of the reversing lever only. To allow for and compensate for the chain wearing out of pitch, the chain wheel is fitted with teeth, as shown in Fig. 6. The teeth of the form shown were held in the toothed ring by a pair of nuts on a screwed stem, and when it became necessary, the diameter of the ring was increased by putting thin strips of iron under each tooth, as indicated by the dotted lines A A.

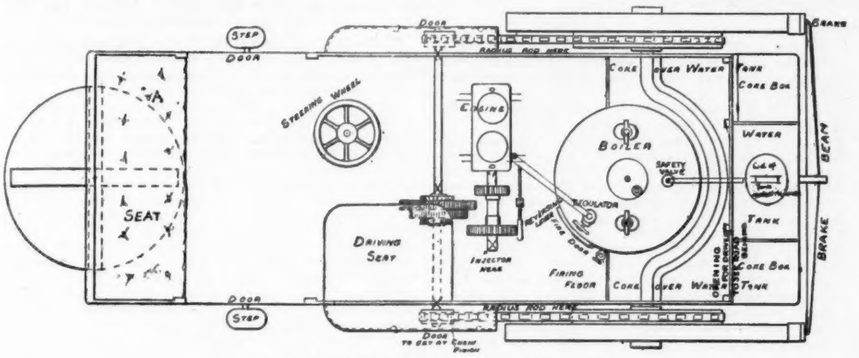


Fig. 5—MACKENZIE'S STEAM BROUGHAM, 1875-6

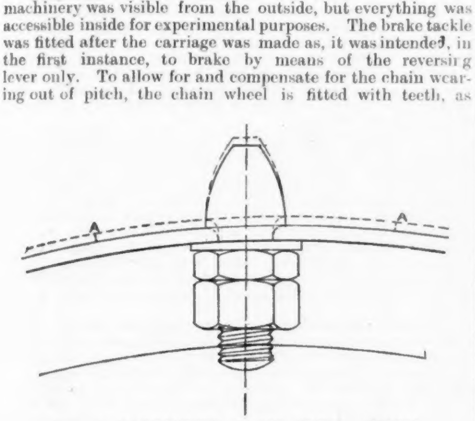


Fig. 6—MACKENZIE'S CHAIN WHEEL TOOTH

In the constructor's hands this carriage was found quite satisfactory, but the Road Locomotive Act forced him to discontinue its use.

THE SIMPLEX WIND ENGINE.

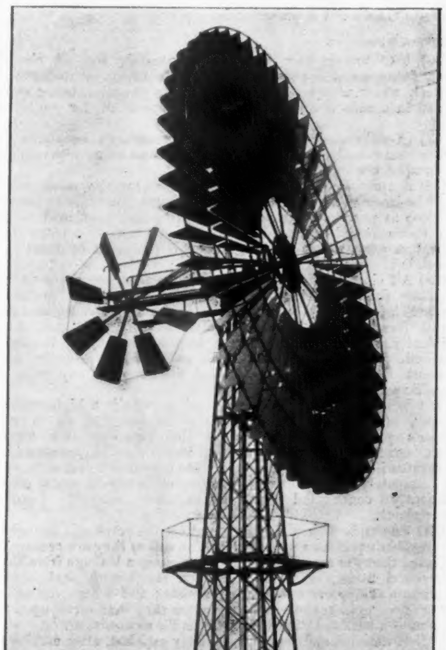
A REPRESENTATIVE of THE ENGINEER a few days ago inspected the wind engine which has just been erected at Lockinge, Lord Wantage's Berkshire estate, by Mr. John Wallis Titt, of Woodcock Ironworks, Warminster, Wilts. The general construction of the engine will be evident from the illustration. It consists of a wheel 35ft. in diameter, mounted on a steel tower 40ft. high, situated on one of the most elevated positions on the estate. The engine actuates a treble-barrelled pump, raising water from a well which was specially sunk 150ft. in the chalk. A capacious reservoir has been formed in close proximity, and an ample supply of water for all purposes connected with the estate, has been provided. The sail is kept head to wind by a smaller wheel, and consists of a large number of vanes stretched on iron. The number of revolutions can be perfectly controlled by means of a lever at the base of the tower. When the engine is working in a fair wind the vanes are inclined to the wind at their maximum angle, *i.e.*, 45 deg. If the wind is very high, or it is desired to work at reduced speed, the vanes can be set at an angle of 30, 20, 10, or even 5 deg. to the wind. But whatever the angle there is no danger of a sudden increase of wind-velocity carrying away the whole structure—a catastrophe not unknown with some wind motors; indeed, the machinery would not even travel at a dangerous pace, for any abnormal pressure of wind automatically opens the sails, and when they are completely open, whether by the pressure of the wind or by the movement of the lever, the wheel ceases to revolve.

The approximate useful horse-power developed by the Simplex wind engine is shown in the following table:—

Diameter of wind wheel.	Horse-power.				
Feet.	10-mile wind.	12-m.w.	16-m.w.	20-m.w.	25-m.w.
14	¼	½	1	1¾	2½
16	⅜	¾	1½	2¼	3¼
18	¾	1¼	2	3	4
20	1¼	2	3	4	5½
25	1¾	3	4½	6	8
30	3	4	5½	7	9
35	4	5¼	6¾	8½	10
40	5	6½	8	10	12

The engines will do good work with as little as four or five-mile wind, but there is practically no necessity to work out the table to this point, because the returns specially compiled for Mr. Titt at the Royal Observatory, Greenwich, the Falmouth Meteorological-office, Devon, and the Birmingham and Midland Institute Observatory, at Edgbaston, demonstrate that there is always sufficient wind per month at the pressures tabulated. Mr. Titt states that a reservoir which holds ten days' consumption will fully provide for calms.

The engine is made in various sizes. The energy costs nothing, and the original outlay, with wear and tear, spread over a few years, amounts to so little that the wind engine is an inexpensive motor. For water supply and drainage the wind engine has long ago achieved distinction. It is now coming to the front for electrical purposes. The War-office and the Local Government Board have both sanctioned the use of the Simplex wind engine for water supply purposes, and, in addition to this, Lord Spencer, Lord Heytesbury, the Earl of Radnor, the Duke of Sutherland, the Duke of Portland, Earl Powis, the Dover Town Council, the Bath Union Rural District Council, the Southport—Lancs.—Council, the Earl of Carnarvon, and many other owners and bodies, public and private, have expressed satisfaction with the results obtained with Mr. Titt's engines, which really seem to have approached a very high degree of perfection.



WIND PUMPING ENGINE AT LOCKINGE

SOCIETY OF ENGINEERS.

THE first ordinary meeting of the Society of Engineers for the present year was held on Monday evening, February 3rd, at the Royal United Service Institution, Whitehall. Mr. Wm. George Peirce, the President for 1895, occupied the chair, and presented the premiums awarded for papers read during that year, viz.:—The President's gold medal to Mr. R. E. Middleton for his paper on "The Relative Value of Percolation Gauges." The Bessemer premium to Mr. Thomas Andrews, F.R.S., for his paper on "The Effect of Strain on Railway Axles and the Minimum Flexion Resistance Point in Axles." The Rawlinson premium to Mr. D. B. Butler for his paper on "Portland Cement, some points in its Testing, Uses and Abuses," and a Society's premium to Mr. W. T. Sugg for his paper on "Ventilation and Warming."

Mr. Peirce introduced the President for the present year, Mr. Samuel Herbert Cox, to the meeting, and retired from the chair, receiving a hearty and unanimous vote of thanks for his services during the past year.

Mr. Cox having thanked the members for electing him as president, reviewed briefly the present position of the Society, and alluded to the arrangements which had been made for holding the ordinary meetings of the Society in the Theatre of the United Service Institution. He then referred to the vacation visits which had been paid to the Waterloo and City Railway Works; the New City of London Brewery; the Outer Harbour Extension Works at Dover; the Admiralty Pier and Inner Harbour at Dover; the Dover Electricity Supply Company's Station and the School of Gunnery and New Experimental Ranges at Shoeburyness; and expressed the thanks of the Society to those gentlemen who had so kindly acted as guides and afforded the members every information regarding the important works in question. The remainder of his address was devoted to a review of the gold mining industry from an engineering point of view, and the developments and improvements in systems of treatment which had been brought about since the discoveries of gold in large quantities in California in 1848. He reviewed the development in alluvial mining from those simple processes carried on by individual miners who, with no more appliances than a tin dish, "Cradles" or "Toms," in many cases succeeded in amassing considerable sums of money, to the methods of hydraulic mining by which gravels of exceedingly low grade were made to yield very profitable returns, and also gave some interesting details regarding working deposits of this class, in which, no dumping ground being available, the whole of the gravel had to be elevated by mechanical means. Some allusions were made to the quantity of water which was necessary to deal with deposits of this class and the pressure under which it was necessary that it should be brought on to the ground. Passing from this branch of the subject to quartz mining, he alluded to the differences which exist between free milling and refractory ores, and subdivided the free milling ores into those in which the gold was coarse and those in which it was very fine, pointing out the different systems of treatment which had been adopted under varying conditions. The systems of crushing and concentration were mentioned, and some remarks made upon the crushing battery of the present day, as compared with those which were employed twenty or thirty years ago, and the systems adopted of dry crushing were also referred to. The difficulties of a dry treatment of gold-bearing ores was also explained, and the President urged upon members of the Society the necessity which existed for a new process which would be applicable in those districts in which sufficient water could not be obtained to allow of ordinary battery treatment being employed. Some remarks were offered regarding roasting ores which were not susceptible to treatment without undergoing this operation, and a brief description was given of the chlorination and cyanide processes as applied during the present decade. The Sulman-Teed process for using bromide of cyanogen in conjunction with potassic cyanide was also described, and a hope expressed that before the close of the present year some very successful results would be achieved by it. The address was concluded by some pertinent remarks regarding the conditions under which mines were worked, and the necessity of thoroughly studying the conditions which prevail before deciding what working capital was necessary to bring a mine to a successful issue.

ELECTRIC LIGHTING ACTS, 1882 AND 1888.

THE Board of Trade have just issued the following regulations (*a*) for securing the safety of the public, and (*b*) for ensuring a proper and sufficient supply of electrical energy.

Definitions.—In the following regulations the expression "the Order" means the Order, the expression "the Undertakers" means the undertakers for the purposes of the Order. The expression "consumer's wires" means any electric lines on a consumer's premises which are connected with the service lines of the undertakers at the consumer's terminals. The expression "aërial line" means any electric line which is placed above ground and in the open air. The expression "pressure" means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and the earth; and (*a*) where the conditions of the supply are such that the pressure may at any time exceed 500 volts if continuous, or 250 volts if alternating, but cannot exceed 3000 volts, whether continuous or alternating, the supply shall be deemed a high pressure supply. (*b*) Where the conditions of the supply are such that the pressure may on either system exceed 3000 volts, the supply shall be deemed an extra high-pressure supply. The expressions "high pressure" and "extra high pressure" respectively are used in relation to electric lines, conductors, circuits, and apparatus, according to the conditions of the supply delivered through the same or particular portions thereof.

Where these regulations require any metallic body to be "efficiently connected with earth," it shall be connected with the general mass of earth in such manner as will ensure at all times an immediate and safe discharge of electrical energy. Other expressions to which meanings are assigned in the Order or in the above-mentioned Acts have the same respective meanings in these regulations.

A.—REGULATIONS FOR SECURING THE SAFETY OF THE PUBLIC.

General.—(1) The pressure of a supply delivered to any consumer shall not exceed 250 volts at any pair of terminals, except with the express approval of the Board of Trade. Such approval will only be given for special purposes and on the joint application of the consumer and the undertakers, and the supply will be subject to such further regulations as the Board of Trade may from time to time prescribe.

(2) The pressure of a supply delivered to transforming stations or to transforming apparatus on a consumer's premises may exceed 250 volts, but shall not exceed the limits of high-pressure.

(3) An extra high-pressure supply shall not be given except to distributing stations or other premises in the sole occupation of the undertakers, and with the written consent of the Board of Trade, and subject to such regulations and conditions as the Board may prescribe.

(4) The maximum working current in any conductor shall not be sufficient to raise the temperature of the conductor or any part thereof to such an extent as to materially alter the physical condition or specific resistance of the insulating covering, if any, or in any case to raise such temperature to a greater extent than 30 deg. Fah.; the cross sectional area and conductivity at joints must be sufficient to avoid local heating, and the joints must be protected against corrosion.

(5) The sectional area of the conductor in any electric line laid or erected in any street after the date of these regulations shall not be less than the area of a circle of one-tenth of an inch diameter, and, where the conductor is formed of a strand of wires, each separate wire shall be at least as large as No. 20 standard wire gauge.

(6) All material used for insulating electric lines or apparatus shall be of the best quality, and thoroughly durable and efficient, having regard to the conditions of its use. Suitable provision shall be made for the protection of the insulating material against injury or removal.

If the protection so provided be wholly or partly metallic it shall be efficiently connected with earth.

(7) Every main shall be tested for insulation after having been placed in position and before it is used for the purposes of supply, the testing pressure being at least 200 volts, and the undertakers shall duly record the results of the tests of each main, or section of a main.

(8) The insulation of every complete circuit used for the supply of energy, including all machinery, apparatus, and devices forming part of, or in connection with, such circuit, shall be so maintained that the leakage current shall not under any conditions exceed one-thousandth part of the maximum supply current; and suitable means shall be provided for the immediate indication and

localisation of leakage. Every leakage shall be remedied without delay.

Every such circuit shall be tested for insulation at least once in every week, and the undertakers shall duly record the results of the testings.

Provided that where the Board of Trade have approved of any part of any electric circuit being connected with earth, the provisions of this regulation shall not apply to that circuit so long as the connection with earth exists.

(9) Every high-pressure conductor laid after the date of these regulations shall be continuously covered with insulating material to a thickness of not less than one-tenth part of an inch, and in cases where the extreme difference of potential in the circuit exceeds 2000 volts, the thickness of insulating material shall not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000.

(10) A high-pressure circuit shall not be brought into use unless the insulation of every part thereof has withstood the continuous application, during one hour, of pressure exceeding the maximum pressure to which it is intended to be subjected in use—that is to say, in the case of every electric line a pressure twice the said maximum pressure, and in the case of every machine, device, or apparatus, a pressure 50 per cent. greater than the said maximum pressure.

The undertakers shall duly record the results of each test.

(11) Every high-pressure electric line, conductor, or other apparatus shall be protected by a suitable automatic quick-acting cut-off.

Provided that it shall not be incumbent upon the undertakers to provide such a cut-off for the outer conductor of a concentric main which is, with the approval of the Board of Trade, efficiently connected with earth.

(12) In every case where a high-pressure supply is transformed for the purpose of supply to one or more consumers, some suitable automatic and quick-acting means shall be provided to protect the consumer's wires from any accidental contact with or leakage from the high-pressure system, either within or without the transforming apparatus.

(13) A high-pressure electric line shall not be used for the transmission of more than 300,000 watts, or in the case of an aërial line 50,000 watts, except with the consent in writing of the Board of Trade, and efficient means shall be provided to prevent this limit being at any time exceeded.

(14) Where any portion of any electric line or any support for an electric line is exposed in such a position as to be liable to injury from lightning, it shall be efficiently protected against such injury.

(15) Where any accident by explosion or fire, or any other accident of such kind as to have caused or to be likely to have caused loss of life or personal injury, has occurred at any part of any electric line or work, the undertakers shall give immediate notice thereof to the Board of Trade.

Aërial lines where erected with the necessary consents.

(16) Every aërial line shall be attached to supports at intervals not exceeding 200ft. where the direction of the line is straight, or 150ft. where the direction is curved, or where the lines make a horizontal angle at the point of support.

(17) Every support of an aërial line shall be of a durable material, and properly stayed against forces due to wind pressure, change of direction of the line, or unequal lengths of span. The factor of safety shall be for aërial lines and suspended wires at least 6, and for all other parts of the structure at least 12, taking the maximum possible wind pressure at 50 lb. per square foot. No addition need be made for a possible accumulation of snow.

Every support if of metal shall be efficiently connected with earth.

(18) Aërial lines shall be attached to insulators, and shall be so guarded that they cannot fall away from the support. Conductors covered with insulating material shall not be attached to the insulators by uninsulated metal binders.

(19) An aërial line shall not in any part thereof be at a less height from the ground than 18ft., or where it crosses a street, 30ft.—in the County of London 20ft. and 35ft.—or within 5ft. measured horizontally or 7ft. measured vertically from any building or erection other than a support for the line, except where brought into a building for the purpose of supply.

(20) Service lines from aërial lines shall be led as directly as possible to insulators firmly attached to some portion of the consumer's premises which is not accessible to any person without the use of a ladder or other special appliance, and from this point of attachment they shall be enclosed and protected in accordance with the subsequent regulations as to electric lines on the consumer's premises. Every portion of any service line which is outside a building, but is within 7ft. from the building, shall be completely enclosed in stout india-rubber tubing.

(21) Where an aërial line crosses a street, the angle between the line and the direction of the street at the place of crossing shall not be less than 60 deg., and the spans shall be as short as possible.

(22) Where an aërial line crosses, or is in proximity to, any metallic substance, precautions shall be taken by the undertakers against the possibility of the line coming into contact with the metallic substance, or of the metallic substance coming into contact with the line by breakage or otherwise.

(23) Every high-pressure aërial line shall be efficiently suspended by means of insulating ligaments to suspending wires, so that the weight of the line does not produce any sensible stress in the direction of its length. All suspending wires, if of iron or steel, shall be galvanised.

(24) In the case of any high-pressure aërial line exceeding one-half mile in total length, means shall be provided whereby the pressure may be discharged from any portion of the line erected over or alongside of any building or buildings without loss of time in case of fire or other emergency.

(25) Every aërial line, including its supports and all the structural parts and electrical appliances and devices belonging to or connected with the line, shall be duly and efficiently supervised and maintained as regards both electrical and mechanical conditions.

(26) An aërial line shall not be permitted to remain erected after it has ceased to be used for the supply of energy, unless the undertakers intend within a reasonable time again to take it into use.

Electric lines other than aërial lines.

(27) All conduits, pipes, casings, and street boxes used as receptacles for electric lines shall be constructed of durable material, and where laid under carriage ways shall be of ample strength to prevent damage from heavy traffic; and reasonable means shall be taken by the undertakers to prevent accumulation of gas in such receptacles.

(28) Where any electric line crosses or is in proximity to any metallic substance, special precautions shall be taken by the undertakers against the possibility of any electrical discharge to the metallic substance from the line or from any metal conduit pipe or casing enclosing the line.

(29) All metal conduits, pipes, or casings containing any electric line shall be efficiently connected with earth, and shall be so jointed and connected across all street boxes and other openings as to make good electrical connection throughout their whole length.

(30) Where isolated lengths of metal conduit, pipe, or casing are used for the protection of any electric line at road crossings or similar positions, special precautions shall be taken to prevent the possibility of any electrical charging thereof.

(31) Where the conductors of electric lines placed in any conduit are not continuously covered with insulating material, they shall be secured in position, and no unfixed uninsulated material of a conducting nature shall be contained in the conduit. No such conductor shall be at a higher potential than 300 volts.

Adequate precautions shall also be taken to ensure that no accumulation of water shall take place in any part of the conduit, and to prevent any dangerous access of moisture to the conductors or the insulators.

In the case of any such electric lines laid in conduits after the date of these regulations, the insulators shall be so disposed that they can be readily inspected.

(32) Every portion of any high-pressure electric line placed above the surface of the ground, or in any subway not in the sole occupation of the undertakers, shall be completely enclosed either in a tube of highly insulating material embedded in brickwork, masonry, or cement concrete, or in strong metal casing efficiently connected with earth.

(33) Where any high-pressure electric line is laid beneath the surface of the ground, efficient means shall be taken to render it impossible that the surface of the ground or any neighbouring electric line or conductor shall become charged by leakage from the high-pressure electric line.

Street boxes.

(34) In addition to the provisions contained in Regulation 27 as to the construction of receptacles for electric lines, the following regulations shall be observed with respect to the construction of street boxes:—

(*a*) The covers of all street boxes shall be so secured that they cannot be opened except by means of a special appliance.

(*b*) The covers of all street boxes containing high-pressure apparatus other than cables shall be connected to strips of metal laid immediately underneath the adjacent roadway, and efficient means shall be taken to render it impossible that the covers or other exposed parts of these boxes, or any adjacent material forming the surface of the street, shall become electrically charged, whether by reason of leakage, defect, or otherwise.

(*c*) Where street boxes are used as transformer chambers, reasonable means shall be taken to prevent as far as possible any influx of water, either from the adjacent soil or by means of pipes; and in the case of any such street box exceeding one cubic yard in capacity, ample provision shall be made, by ventilation or otherwise, for the immediate escape of any gas which may by accident have obtained access to the box, and for the prevention of danger from sparking.

(*d*) All street boxes shall be regularly inspected for the presence of gas, and if any influx or accumulation is discovered, the undertakers shall give immediate notice to the authority or company whose gas mains are laid in the neighbourhood of the street box.

Transforming stations.

(35) Transforming stations, or points in a system of distribution in which a high pressure supply is transformed for the purpose of supply to consumers, and which are not on the consumer's premises, shall be established in suitable places which are in the sole occupation and charge of the undertakers.

Consumer's premises.

(36) The undertakers shall be responsible for all electric lines, fittings, and apparatus belonging to them, or under their control, which may be upon a consumer's premises, being maintained in a safe condition and in all respects fit for supplying energy.

(37) In delivering the energy to a consumer's terminals the undertakers shall exercise all due precautions so as to avoid risk of causing fire on the premises.

(38) A suitable safety fuse or other automatic disconnector shall be inserted in each service line within a consumer's premises as close as possible to the point of entry, and contained within a suitable locked or sealed receptacle of fireproof construction, except in cases where the service line is protected by fuses in a street box.

(39) All electric lines and apparatus placed on a consumer's premises shall be highly insulated and thoroughly protected against injury to the insulation or access of moisture, and any metal forming part of the electric circuit, shall not unless efficiently connected with earth be exposed so that it can be touched. All electric lines shall be so fixed and protected as to prevent the possibility of electrical discharge to any adjacent metallic substance.

(40) Where the general supply of energy is a high-pressure supply, and transforming apparatus is installed on a consumer's premises, the whole of the high-pressure service lines, conductors, and apparatus, including the transforming apparatus itself so far as they are on the consumer's premises, shall be completely enclosed in solid walls, or in strong metal casing efficiently connnected with earth and securely fastened throughout.

(41) The undertakers shall not connect the wires and fittings on a consumer's premises with their mains unless they are reasonably satisfied that the connection would not cause a leakage from those wires and fittings exceeding one ten thousandth part of the maximum supply current to the premises; and where the undertakers decline to make such connection they shall serve upon the consumer a notice stating their reasons for so declining.

(42) If the undertakers are reasonably satisfied, after making all proper examination by testing or otherwise, that a leakage exists at some part of a circuit of such extent as to be a source of danger, and that such leakage does not exist at any part of the circuit belonging to the undertakers, then and in such case any officer of the undertakers, duly authorised by them in writing, or, if the undertakers so require, an electric inspector may, for the purpose of discovering whether the leakage exists at any part of a circuit within or upon any consumer's premises, by notice require the consumer at some reasonable time after the service of the notice to permit him to inspect and test the wires and fittings belonging to the consumer and forming part of the circuit.

In any case where the undertakers require the services of an electric inspector under this regulation they shall pay him the prescribed fee.

If on such testing the officer or the electric inspector discovers a leakage from the consumer's wires exceeding one ten thousandth part of the maximum supply current to the premises, or if the consumer does not give all due facilities for inspection and testing, the undertakers shall forthwith discontinue the supply of energy to the premises in question, giving immediate notice of the discontinuance to the consumer, and shall not recommence the supply until they are reasonably satisfied that the connection with earth has been removed. This regulation shall not affect any power contained in the order or otherwise enabling the undertakers to discontinue the supply.

(43) If any consumer is dissatisfied with the action of the undertakers in refusing to give or in discontinuing or in not recommencing the supply of energy to his premises, the wires and fittings of that consumer may, on his application and on payment of the prescribed fee, be tested for the existence of leakage by an electric inspector.

This regulation shall be endorsed on every notice given under the provisions of either of the two last preceding regulations.

Arc lighting.—

(44) All arc lamps shall be so guarded as to prevent pieces of ignited carbon or broken glass falling from them, and shall not be used in situations where there is any danger of the presence of explosive dust or gas.

(45) Arc lamps used in any street for public lighting shall be so fixed as not to be in any part at a less height than 10ft. from the ground.

(46) Arc lamps used in any street for private lighting shall be fixed so as not to be in any part at a less height than 8ft. from the ground, and shall be so screened as to prevent risk of contact with persons. A cut-off switch, fixed in a suitable locked receptacle, shall be provided for every high-pressure arc lamp, and such switch shall be of such pattern and construction as will provide:—

(*a*) That the lamp can by its means be entirely disconnected from the supply circuit;

(*b*) That the switch itself can be safely operated in the dark without special precautions; and

(*c*) That there shall be no danger of any injurious electrical arcing, sparking, or heating being caused by the operation of the switch.

(47) If the undertakers make default in complying with any of the preceding regulations, they shall on conviction be liable to a penalty not exceeding £10 for every such default, and to a daily penalty not exceeding £10.

The recovery of a penalty under these regulations shall not affect the liability of the undertakers to make compensation in respect of any damage or injury which may be caused by reason of the default.

B.—REGULATIONS FOR SECURING A PROPER AND SUFFICIENT SUPPLY OF ELECTRICAL ENERGY.

(1) Forty-eight hours at least before the undertakers are ready to commence to supply energy through any feeding, charging, or distributing main, they shall serve a notice upon the local authority of their intention to commence such supply.

(2) From and after the time when the undertakers commence to supply energy through any distributing main, they shall maintain a supply of sufficient power for the use of all the consumers for the time being entitled to be supplied from such main; and such supply shall, except so far as may be otherwise agreed upon from time to time between the local authority and the undertakers, be constantly maintained. Provided that, for the purposes of testing, or for any other purposes connected with the efficient working of the undertaking, the authority by whom the electric inspector is appointed may give permission to the undertakers to discontinue the supply at such intervals of time and for such periods as that authority may think expedient. When the supply is so discontinued, notice of such discontinuance, and of the probable duration thereof, shall be forthwith served upon the local authority.

(3) The system of distributing mains shall be so arranged that in case it becomes necessary to stop the supply through any portion of a main for more than one hour, for the purposes of repairs, or for any other reason, the stoppage of supply will in no case exceed in amount a maximum power of 200,000 watts, or extend to the premises of more than eighty consumers, and in the case of every stoppage for more than one hour reasonable notice shall be previously given by the undertakers to every consumer affected thereby except in cases of emergency.

(4) During the whole of the period when a supply of energy is required to be maintained by the undertakers in the distributing mains under the order and these regulations, it shall be maintained at a constant pressure, in these regulations termed the "standard pressure;" but the standard pressure may be different for different portions of the distributing mains. Provided that the undertakers shall be deemed to have complied with the requirements of this regulation, so long as the pressure does not at any point vary more than 2 per cent. from the corresponding standard pressure in the case of a general supply at high pressure, or 3 per cent. in other cases, unless changes in pressure recur so frequently as to cause unsteadiness in the supply.

(5) The standard pressure shall be fixed by the undertakers, and notice of the amount of such standard pressure shall be given to the local authority before the undertakers commence to supply energy to consumers, and such standard pressure shall not be altered except by permission of the local authority, and upon such terms and conditions as the local authority may impose, and after public notice has been given during a period of one month, in such manner as the local authority may require, of the intention of the undertakers to apply for permission to alter the same. The undertakers may appeal against any decision of the local authority under this regulation to the Board of Trade, whose decision shall be final.

(6) Before commencing to give a supply of energy to any consumer, the undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of consumer's terminals shall not at any time be altered or departed from except in consequence of any authorised alteration of the corresponding standard pressure. In the case of a transformation of energy on the consumer's premises, the undertakers shall give the consumer the choice of a supply at either of two different pressures, one of which shall be approximately half the other, and in such case the pressure so chosen by the consumer shall be the declared constant pressure.

Provided that no change shall be made in the pressure of the supply to any premises which at the date of these regulations are supplied with energy by the undertakers except with the consent of the consumer.

(7) The variation of pressure at any consumer's terminals shall not under any conditions of the supply which the consumer is entitled to receive exceed 4 per cent. from the declared constant pressure.

(8) If the undertakers make default in complying with any of these regulations as to supply, they shall, subject to the provisions of the order, be liable on conviction to a penalty not exceeding £5 for every such default, and to a daily penalty not exceeding £5.

These regulations are made subject to the power of the Board of Trade to make such further or other regulations as they may think expedient; and nothing in these regulations shall be construed to authorise the undertakers to lay any electric line or work their undertaking otherwise than in accordance with the order and the principal Act, or to supply energy otherwise than by a system for the time being approved of by the Board of Trade under the order.

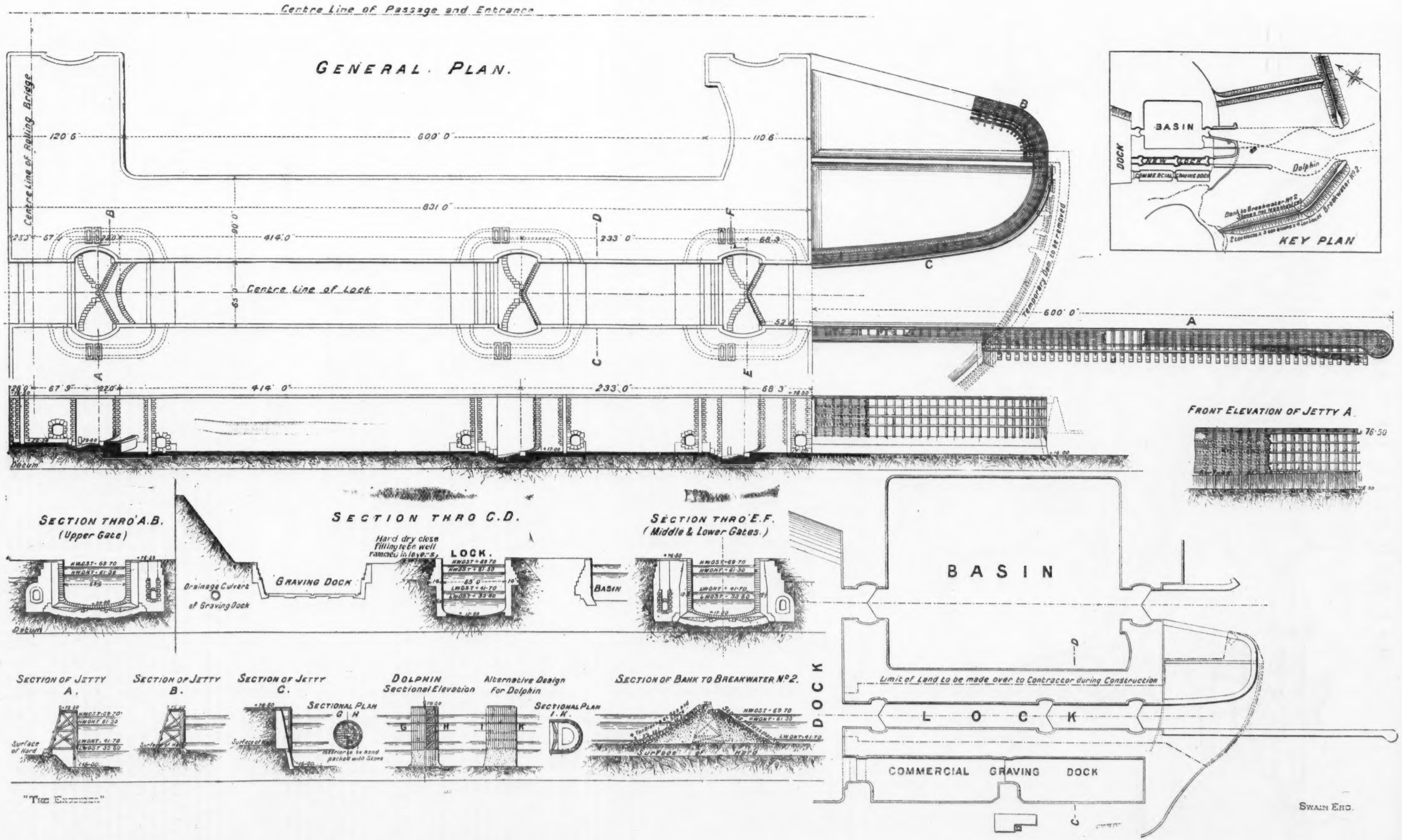
THE TORPEDO-BOAT DESTROYER PORCUPINE returned to Chatham on Wednesday, her steam trials not having proved quite successful owing to the excessive priming of her boilers, the defect being attributed to a leak of salt water into the condenser. The mean indicated horse-power obtained in two hours was 3129, and the mean speed 25 knots per hour. The contract stipulates 27 knots. The engineers entertain no doubt that the Porcupine is quite capable of this performance when the defects are remedied.

ROYAL SCHOOL OF MINES.—A dinner of the old students of the Royal School of Mines was recently held at the Criterion. The chair was taken by Mr. A. G. Charleton, Assoc. R.S.M., and he was supported by a hundred and twenty guests, including Professors Judd, Roberts-Austen, Le Neve Foster, Tilden, &c., and Messrs. Bannerman, Louis, Brough, Hughes, Grey, Holloway, McNeill, Cox, Rose, Kitto, &c. In proposing the toast of the "Mining and Metallurgical Industries," the chairman reviewed their influence on the events of the year, and showed the value of the training given by the school both to the mine owner and the mining engineer. Replies for the two industries were given by Professors Roberts-Austen and Le Neve Foster. Other toasts were the "Professors," with Professors F. J. M. Page and Judd as speakers; the "Learned Societies," with Mr. G. T. Holloway and Professor Tilden; The "Visitors," with Mr. M. H. Gray, and Mr. R. C. Richards; and the "Old Students," proposed by Mr. B. H. Brough and replied to by Mr. S. H. Cox. The proceedings terminated with the toasts of the "Chair" and of the "Honorary Secretary," Mr. H. G. Grave. During the evening the question of the publication of the register of old students evoked much enthusiasm, and a guarantee fund of over £100 was formed.

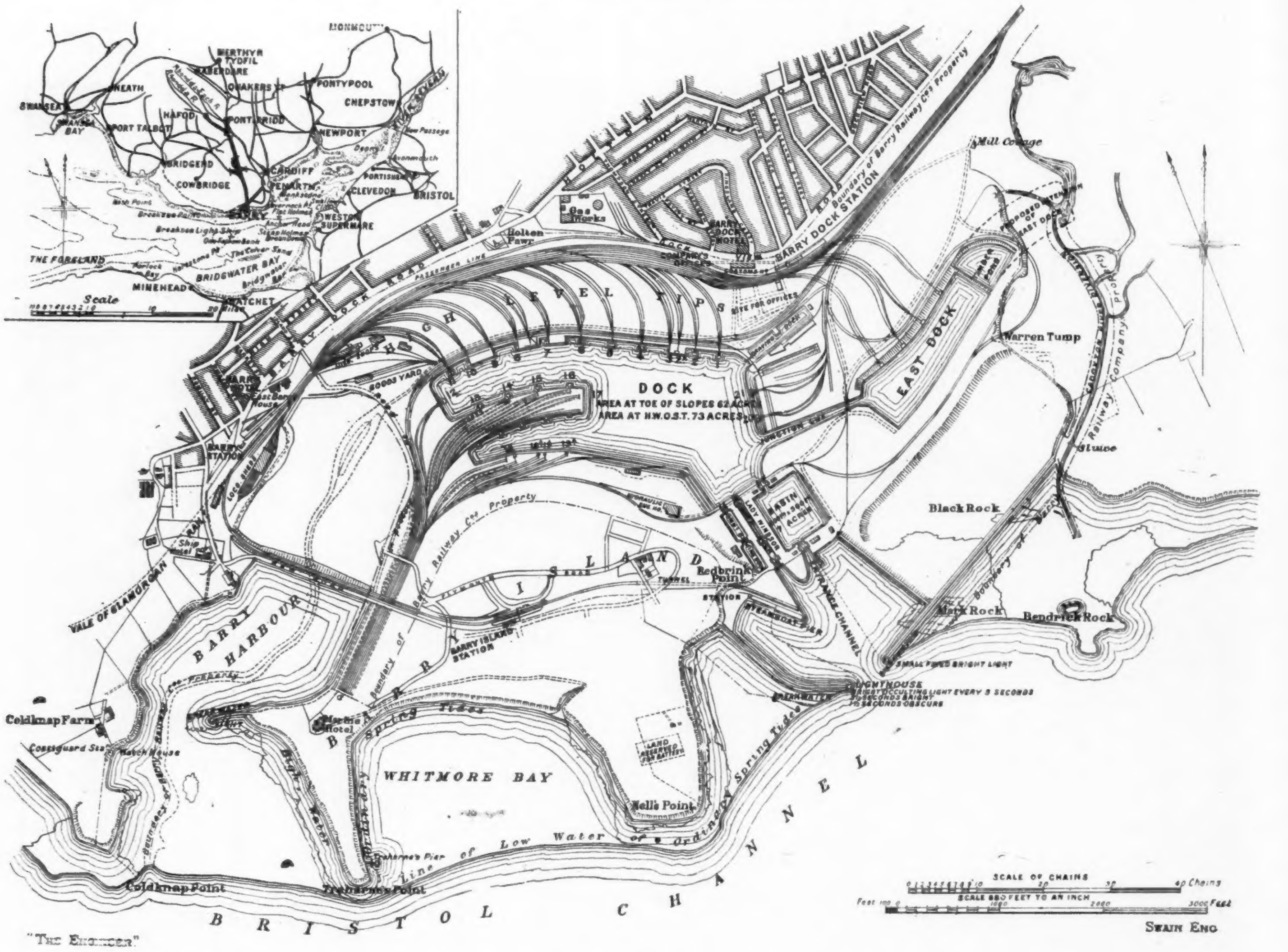
THE LADY WINDSOR DEEP LOCK, BARRY DOCKS—LOCK PLAN AND DETAILS

MR. JOHN WOLFE BARRY, C.B., M. INST. C.E., ENGINEER

(*For description see page* 136)


Centre Line of Passage and Entrance
GENERAL PLAN.
Centre Line of Rolling Bridge
120' 6"
600' 0"
110' 6"
831' 0"
90' 0"
414' 0"
233' 0"
68' 3"
67' 9"
22' 0"
52' 0"
65' 0"
Centre Line of Lock
A
B
C
D
E
F
Temporary Dam to be removed
600' 0"
FRONT ELEVATION OF JETTY A
76·50
Datum
+17·00
SECTION THRO' A.B.
(Upper Gate)
SECTION THRO C.D.
Drainage Culvert of Graving Dock
GRAVING DOCK
Hard dry close filling to be well rammed in layers
LOCK.
BASIN
SECTION THRO' E.F.
(Middle & Lower Gates.)
H.W.O.S.T. + 69·70
H.W.O.N.T. + 61·30
L.W.O.N.T. + 41·70
L.W.O.S.T. + 33·60
SECTION OF JETTY A.
SECTION OF JETTY B.
SECTION OF JETTY C.
Surface of Hard
SECTIONAL PLAN G H
Interior to be hand packed with Stone
DOLPHIN Sectional Elevation
Alternative Design for Dolphin
SECTIONAL PLAN I. K.
SECTION OF BANK TO BREAKWATER No. 2.
BASIN
DOCK
L O C K
Limit of Land to be made over to Contractor during Construction
COMMERCIAL GRAVING DOCK
KEY PLAN
BASIN
DOCK
NEW LOCK
COMMERCIAL GRAVING DOCK
Dolphin
Breakwater No. 2
Bank to Breakwater No. 2
"THE ENGINEER"
SWAIN ENG.

MAP AND PLAN OF THE BARRY DOCKS



BARRY DOCKS.

Eleven years ago, when the first sod was cut by Lord Windsor preparatory to digging the big holes for the Barry Docks and basin, Barry Island was much what it had been for centuries, and perhaps ever since the days when the Roman residents, of whose handiwork remains have recently been found, or when the Britons, whose bones have been upturned in large numbers, were resident there. In 1883 a Bill for the construction of docks and railways on Barry Island was submitted to Parliament and passed by it, but rejected by the House of Lords. In 1884 an Act was obtained, the first sod cut in November, and the work continued to completion in July, 1889. On Friday last a large party of engineers and others, invited by Mr. John Wolfe Barry, C.B., M. Inst. C.E., the engineer of the works, and by the directors, were conducted over the works under construction, including the East Dock and the nearly completed Lady Windsor deep lock adjoining the entrance basin, and they spent an enjoyable day in inspecting the most successful and remarkable of modern dock works. These works have converted an almost barren island into a great shipping port, with an export of about two and a-half millions of tons carried in the largest vessels, of which numbers were seen in the docks. The population of the district has grown in eleven years from a few dozens to about twenty thousand.

Site.—Barry Dock is situated on the north shore of the Bristol Channel, between Barry Island and the mainland, seven miles south-west of Cardiff, and thirty-one miles east of Swansea, as seen in the map and plan above. The dock occupies the eastern portion of the Channel, which formerly ran between the Island and the mainland, about ¼ mile in width. The western portion of the Channel has been reserved as a harbour for pilot-boats and small coasting craft. The greater portion of the dock area consisted of mud and silt, with some sand and a few thin layers of peat; but the eastern end was composed of rocky marl and magnesian limestone. Deers' antlers, trunks of trees, human remains, fisherman's bone netting needles, &c., were found in the excavations. The strata are broken up by numerous faults, the principal one running from Warren Tump, across the eastern end of the dock, to the north-west corner of Barry Island, and to Coldknap Point.

General description.—The works—Fig. 1—comprise a tidal basin of seven acres, a dock of seventy-three acres at the top of the slopes, and sixty-two acres at their toe, and a timber pond of twenty-four acres. There is also a graving dock belonging to a private company. Between the graving dock referred to and the entrance basin has been built the Lady Windsor deep lock, the deepest in the world, now nearly completed. The dock, as originally designed, had a water area of forty acres; but the foundations for the south wall were set further back, in order to obtain firm ground, and the area thus increased. An excellent paper on the works, by Mr. John Robinson, M.I.C.E., completed in 1889, is published in the "Proceedings" of the Institution of Civil Engineers, from which we may quote.

The Barry Dock is designed to afford efficient accommodation for the shipment of coal from South Wales, the annual exportation of which, from Cardiff and Penarth alone during the past twenty years, has risen from 3,000,000 to 11,000,000 tons. Barry Island is about one mile in length, by ½ mile in width, and rises 120ft. above mean sea level; and the mainland north of the dock also rises considerably. The site is therefore well sheltered, particularly from south-westerly winds, which, together with easterly winds, are the strongest in the Bristol Channel. The entrance to the dock is at the eastern end of the island under the high land of Nell's Point, which excellent natural shelter is supplemented by two outlying converging breakwaters; these protect the entrance to the south, where the "fetch" is fourteen miles, and to the south-east with a fetch of sixteen miles. The approach to the breakwaters is free from rocks and shoals, and is also efficiently lighted. Between the heads of the breakwaters there is an opening of 350ft., which is close to deep water. There is good anchorage ground for the largest vessels to the east of the dock, between Barry and Sully Islands, a distance of three miles. The tidal range is 36ft. at ordinary spring tides, increasing to 40ft. at extraordinary springs; and 19½ft. at ordinary neap tides, diminishing to 16ft. at extraordinary neaps. The dock is not fed with water from any river. A channel has been dredged between the breakwater heads and the entrance to the dock to a depth of 1ft. below the lowest part of the sills. On the seaward side of the entrance are two timber jetties, 200ft. long, with horizontal fenders along the face. The entrance is 80ft. wide, with a single pair of wrought iron gates, and gives access to a basin 500ft. wide and 600ft. long. Between the basin and the dock is the passage, having also a width of 80ft. The sides of the entrance and passage have two horizontal elm fenders for the protection of ships. The depth of water on the working part of the sills, which are curved, is as follows:—

	Feet.
High-water ordinary spring tides	37·7
Low-water ordinary spring tides	1·6
High-water ordinary neap tides	29·3
Low-water ordinary neap tides	9 7

The available depths, however, at the centre of the inverts are 3ft. more. On the west side of the entrance is a culvert having a minimum width of 10ft., with a pair of greenheart sluices, raised and lowered by direct-acting hydraulic cylinders and pistons. There are no sluice-ways through the walls of the entrance or passage; but twelve sluices, having an area of 200 square feet, are provided in the gates. In the passage is a pair of wrought iron gates; and there is a culvert on the west side 8ft. in diameter. The culverts serve to draw down rapidly the water when the flow of water through the gate sluices becomes slow from the decreasing head. The basin is used as a large lock, by lowering its water level to the level of the water outside; and, as a rule, the dock is worked to the tide of the day, but at low neaps the basin is used wholly as a lock. As the middle of the sills is lower than the bottom of the basin, a channel has been made along the basin, between the entrance and passage, 1ft. deeper than the lowest part of the sills, so that vessels which can pass over the sills can enter the basin. The dock is 3400ft. in length, the maximum width being 1100ft., divided into two arms at the western end by a mole. The northern arm is 1500ft. long and 500ft. wide, and the southern arm 1200ft. long and 300ft. wide. The full width is left at the eastern end, for a length of 1600ft., where the largest vessels can swing, even when all the berths at the tips and quays are occupied. The bottom of the dock—which is not puddled—is 20ft. below mean sea-level, and the quay roads are 26½ft. above the same level. To the north-east of the main dock is the East Dock, now under construction, and of which we shall give some details.

(*To be continued.*)

TORPEDO BOAT DESTROYERS.

Two very successful trials of torpedo boat destroyers, built and engined by Messrs. R. W. Hawthorn, Leslie, and Co., Newcastle-on-Tyne, have recently taken place. The vessels are the Sunfish and the Opossum. The following particulars will be read with interest. The Yarrow boilers have given perfect satisfaction. They have no down-comers, and thus practically refute the contention of some writers that down-comers are essential:—

Particulars of Three Hours' Full Power Trial of H.M.S. Sunfish.

Date of trial, 15th January, 1896.

Draught of water, forward	5ft. 1in.
" " aft	8ft. 1in.
Displacement	281 tons
Speed of vessel	28·08 knots mean of 6 mile runs
Speed of vessel	27·581 " " 3 hours
Steam pressure in boilers	188 lb. per sq. in.
Air pressure in stokeholds	2·95in. of water

		Starboard.	Port.
Vacuum in condensers		25·3	24·1
Revolutions per minute		353·8	349·8
Mean pressure in cylinders	H.P.	81·4	82·8
	I.P.	35·4	35·9
	L.P.	15·1	15·4
Mean I.H.P...	H.P.	702	707
	I.P.	702	704
	L.P.	676	683
		2,080	2,094
Grand total..		4,174	

Eight boilers of the Yarrow straight-tube type, with 8506 square feet total heating surface and 160 square feet total grate surface.

Length of vessel, 200ft.; beam of vessel, 19ft.

Particulars of Three Hours' Full Power Trial of H.M.S. Opossum.

Date of trial, 3rd February, 1896.

Draught of water, forward	5ft.
" " aft	8ft. 1¼in.
Displacement	279 tons
Speed of vessel	28·242 knots, mean of 6 mile runs
Speed of vessel	27·131 " " 3 hours

		Starboard.	Port.
Mean pressure in cylinders	H.P.	81·9	80·3
	I.P.	33·9	34·1
	L.P.	13·6	14·9
Mean I.H.P.	H.P.	683	674
	I.P.	650	657
	L.P.	585	646
		1,918	1,977
Grand total..		3,895	

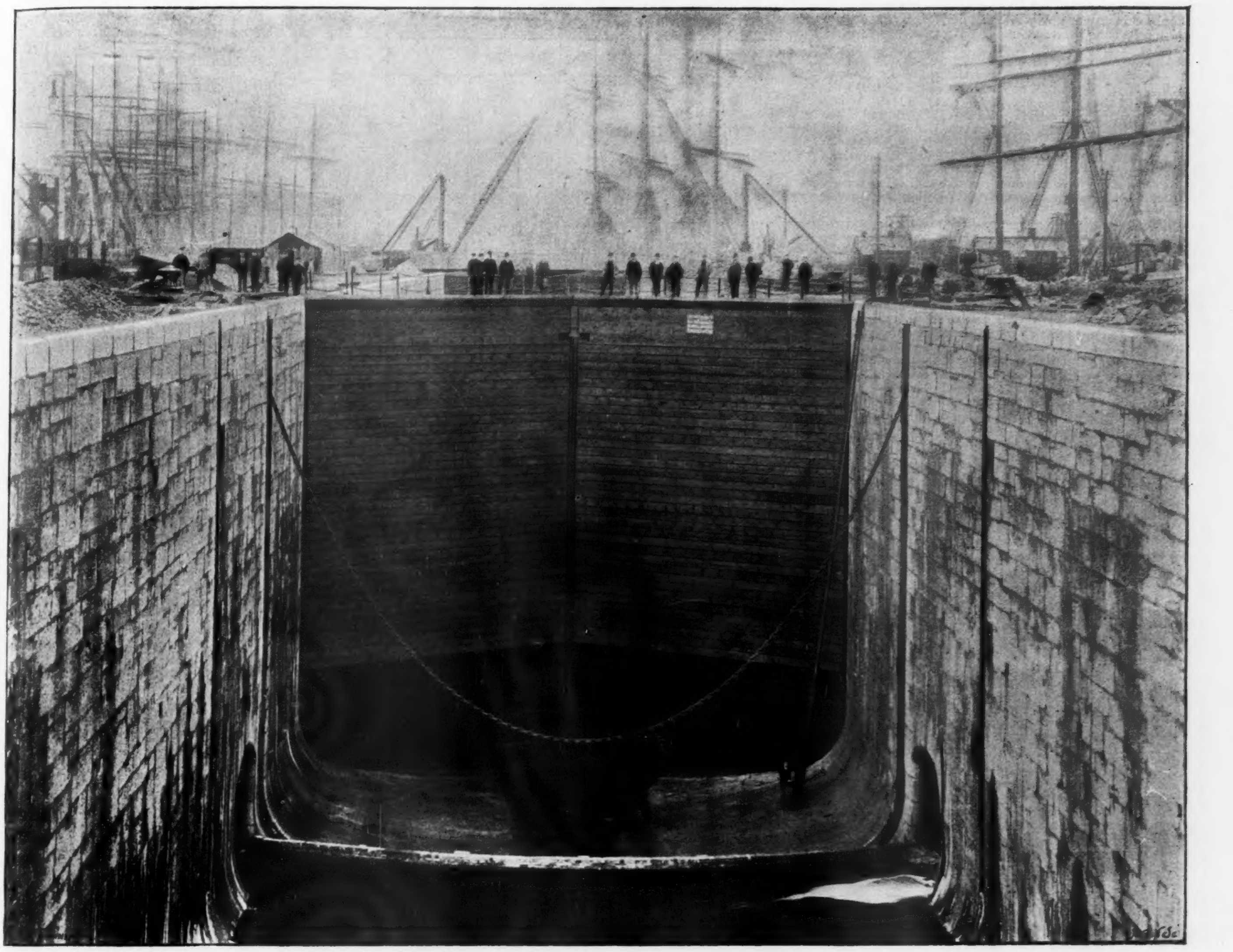
Steam pressure in boilers	192 lb. per sq. in.
Air pressure in stokeholds	3in. of water
Vacuum in condensers	26·5in.
Revolutions per minute, starboard	341·6
" " port	344·3

Boilers same as Sunfish; vessel same as Sunfish.

THE LADY WINDSOR NEW DEEP LOCK, BARRY DOCKS

MR. JOHN WOLFE BARRY, C.B., M. INST. C.E., ENGINEER

(*For description see page* 136)



VIEW INSIDE DEEP LOCK, SHOWING INSIDE OF MIDDLE GATES

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

THE REFORM OF THE INSTITUTION OF CIVIL ENGINEERS.

SIR,—Now that it is suggested that the constitution of the Institution of Civil Engineers should be reorganised so as to fill more adequately and satisfactorily its magnificent *rôle* as the *alma mater* of engineering science, it would perhaps not be considered inopportune to suggest a programme of reform.

The expression of civil engineering as defined by the Charter of the Institution of Civil Engineers is now understood to embrace a field of such wide and ever widening area that the subjects dealt with at the meetings, as at present arranged, represent merely a fraction of those that are ripe for and demand serious and immediate consideration.

Such has been the inadequacy of the scope for discussion that various branches of the profession are now represented by independent organisations, the formation of which has reduced the value of the Institution of Civil Engineers. We have the Waterworks Engineers now banding themselves together. There are also separate organisations to represent the electrical, municipal, mining and metallurgy, and gas engineering interests.

It is suggested that separate councils should be formed of eminent representatives of the following fields of engineering enterprise:—(*a*) Council on subjects relating to harbour, waterworks, canals, tramways, and railway construction; (*b*) council on municipal engineering, embracing sewage disposal, sanitary work, and gas engineering; (*c*) council on metallurgy, mining, and practical geology; (*d*) council on electrical engineering; (*e*) council on applied mathematics and physics.

Meetings should be held during the active sessional term on four nights weekly, or fortnightly, under the presidency of the different councils. Of course this would involve a considerable increase in secretarial work, but the extra labour would be well justified.

Only at the general and extraordinary meetings—presidential addresses and elections—would the Grand Council attend. Many are the complaints one has heard of relating to the inadequacy of the treatment of some particular branch of engineering science, and that this is justified a reference to the "Minutes of the Proceedings" of the various institutions mentioned abundantly proves.

Then as to the method of election. Provincial and foreign members have often expressed their annoyance and surprise at the method of election, and the uselessness of forwarding ballot papers with the absurd qualification of personal delivery attached to them.

I think in this respect we can with advantage take a leaf out of the charter of the constitution of the American Society of Civil Engineers:—"At least thirty days before the annual meeting there shall be mailed to every corporate member, whose address is known, a letter-ballot, with envelopes for voting. The names of the nominees for any one office shall be arranged alphabetically without distinguishing marks of any kind. Voters may erase names from the printed ballot-list, and may substitute the name or names of any other person or persons eligible for any office. But the number of names for each office on the ballot voted must not exceed the number to be elected at that time to such office. Ballots may be sent by mail to the secretary, or may be presented to him at the Society House. They must be enclosed in two sealed envelopes, and the outer envelope shall be endorsed by the voter's signature."

Instead of the three weeks I would suggest the substitution of the words three months. This would enable 90 per cent. of the members—scattered as they are all over the world—to have the privilege of voting for those in whom he wished to repose the duty of sustaining the dignity and full measure of usefulness of his beloved *alma mater*. B. H. THWAITE.

29, Great George-street, Westminster, January 31st.

STEEL SLEEPERS.

SIR.—As you have allowed me to sustain in your columns my view of the superiority of the bullhead rail, I trust I may be permitted to say something in favour of the other part of my original proposition, viz., the advantage of steel over wooden sleepers.

The question is, of course, mainly one of economy, for in view of what has been done abroad, the suitability of the material for the purpose cannot be reasonably disputed; but it is well to bear in mind the whole case set up against steel sleepers. which may be summarised as follows. It has been said that:—(1) They bend or break; (2) they shift laterally in the ballast; (3) they make a hard road; (4) they wear at the holes by the hammering of fastenings; and (5) they corrode rapidly in a moist climate.

Taking these objections in order, the first is only another way of saying that the sleepers which broke were not properly designed. In case of the failure of a steel bridge, nobody would suggest replacing it by a wooden one for greater security. Where steel sleepers have bent, the fault has been deficient depth of section between the rails; and the breakages have generally occurred near the rail seatings where weakened by holes for fastenings, and either from want of sufficient thickness, or from having rectangular holes with sharp corners, which originated cracks—often, probably, in the operation of punching. When the cause is known, it is easy to guard against the evil, and this has been done in later designs.

The second objection is of the same character, but requires rather more notice. There is no doubt that friction between the ballast and a wooden sleeper is much greater than between ballast and a flat metal surface, and, therefore, that a straight steel sleeper would oppose less resistance to lateral displacement on curves than a wooden one with equal surface in effective contact with the ballast. The prevailing opinion seems to be that the remedy lies in packing ballast outside the closed ends of the sleepers, but this, I think, is a mistake. The undoubted advantages obtained by closing the ends of straight trough sleepers are due, I believe, to the inclusion of ballast between the ends and under the weight of the passing train; so that the closed end on the inside of a curve is doing effective duty far more than that on the outside. In other words, it is the resistance of the ballast to slide upon itself when loaded with the weight of the locomotive, and not the resistance of the loose ballast outside, that prevents the sleeper from shifting.

The above view is quite in harmony with the form of steel sleeper now developed by practical evolution, and used on the Netherlands State, German, Swiss, and other foreign lines. This is a sleeper of inverted trough section, wide and shallow under the rails, and gradually bent downwards to a narrow and deep trough or channel in the centre of the track; the parts outside the rails being also bent downwards and widened. There is thus provided a large bearing area without too great rigidity under the load; the ballast is confined where the pressure is greatest, and where, consequently, it offers the greatest frictional resistance to displacement; and in addition to this the deepening of the trough between the rails gives stiffness where it is required to resist deformation. In fact, this form yields all the advantages that could be claimed severally for the pot and cross sleeper types, without the disadvantages peculiar to each of them.

Some approach to this natural form has been made on Indian railways, and in sleepers for collieries and other light lines; but the practical trials—if so they may be called—on English railways have been made with sleepers of altogether obsolete type. Straight, and of uniform section from end to end, they followed as neatly as possible the form of the old wooden sleepers, just as early iron bridges took the form of the masonry arch; and if they were found deficient, the cause and its remedy are apparent.

A proper understanding of this question of lateral stability of track is important, amongst other reasons, because it involves a saving in the quantity of ballast needed. A well-designed steel sleeper, being wider under the rail bearings than a wooden sleeper suitable for the same duty, requires less length—say 8ft. instead of 9ft. for standard gauge—and thus a foot in width, or say 880 cubic yards per mile of ballast may be saved in each track. If, on the other hand, it were thought that stability depended upon piling loose ballast outside the ends of sleepers, it would be difficult to assign a limit to waste.

The third and fourth objections, I think, both originate from loose fastenings. Any desired degree of elasticity can be afforded in designing the form of a steel sleeper, and those of the Netherlands type are quite elastic enough. Moreover, we have heard no complaints on the score of hardness in the 56 miles of the North-Western Railway laid on steel sleepers, and travelled over by millions of passengers at high speeds. In this latter case the sleeper was in no way up to date. Straight, of uniform section, and uniform thickness, they represented the survival of an unfit type, but the chair brackets were riveted to them, and could not shake, and for that reason the road was not found to be "hard." What is called hardness on a metal track is, I submit, mainly the clattering due to loose fastenings, and in the North-Western experiment this was prevented by riveting the connections; but it may also be prevented by other means not involving a permanent attachment.

As regards destructive wear, it is well known that metal sleepers have failed from the elongation of holes when fastenings have been loose; and indeed this has been the most troublesome practical difficulty encountered by our continental friends who have been enterprising enough to lead us. The trouble may be met in a very simple and inexpensive way—as explained in my letter published in THE ENGINEER of 25th October, 1895—in all cases where rails are fastened by keys of either wood or metal, and I suppose that in one form or another the key is likely to find a place in rail fastenings for a long time to come.

The last and most important of all the objections is corrosion, for upon this depends the paramount question of economy. It is said that although steel sleepers may be sufficiently durable in dry climates, they will rust rapidly when much moisture is present, as in this country. Now the last of the Macdonnell sleepers laid on the Bristol and Exeter line in 1853 were not taken up until 1888, having thus been in service thirty-five years. Again, the climate in Holland and Belgium is rather humid, but experience in those countries has been quite favourable as regards the endurance of metal sleepers wherever they have been laid in suitable ballast; and this leads us to the root of the corrosion question. More or less humidity is of very little importance compared with the chemical nature of the material in contact with the metal. Where the soil is impregnated with nitrate, as in parts of India and South America, and where cinder ballast has been used, as on the London and North-Western Railway in England, and on many railways on the Continent, serious corrosion has ensued; but that has happened only in such exceptional cases.

I hope that nothing I have advanced can be construed as a claim that one particular form of permanent way is absolutely the best under all circumstances, but I submit that in a large majority of cases bullhead rails on steel sleepers afford the best and most economical road. It happens that whilst I have on my side English practice as regards the rail section, and foreign practice to a large extent in the matter of sleepers, there exists an indisposition at home and abroad to combine the best features of the two systems. The matter as regards sleepers is mainly a question of economy: and although exact figures must vary with the special conditions of particular cases, the subjoined comparative estimates represent, I believe, a fair average for this country, and at any rate afford material for criticism. They are based on an assumed life of twelve years for wood and thirty-six years for steel, which proportion is not, as far as I can ascertain, unduly favourable to the latter. The sleepers would be of the type introduced by Mr. Post on the Netherlands State railways, with the thickness of metal increased at the rail seatings, and although nearly 5 per cent. lighter in weight than those used on the London and North-Western, would be considerably stronger. Lastly, the fastenings would be as described in my previous letter above referred to.

The capital outlay in laying and maintaining for thirty-six years one mile of permanent way, exclusive of ballast, rails, and keys, is:—

Present System.

	£	s.	d.	£	s.	d.
First cost—						
2011 wooden sleepers, each 3s. 8d.	368	13	8			
Trenails and spikes, at per sleeper 4d.	33	10	4			
1760 yards, labour laying road, 1s.	88	0	0			
	490	4	0			
4022 cast iron chairs, 40 lb. each, say 72 tons at £3 10s.	252	0	0			
				742	4	0
Renewals of sleepers and fastenings—						
£490 4s. at end of 12th year, present value at 5 per cent.				272	18	0
£490 4s. at end of 24th year, present value at 5 per cent.				152	0	2
£490 4s. at end of 36th year, present value at 5 per cent.				84	13	2
				1251	16	2

Suggested System.

	£	s.	d.	£	s.	d.
First cost—						
2011 steel sleepers, 130 lb. each, say 116¾ tons at £5	583	15	0			
1760 yards, labour laying road, at 6d...	44	0	0			
	627	15	0			
8044 cast iron chair brackets, say 56½ tons at £3 10s.	197	15	0			
				825	10	0
Renewal of sleepers—						
£627 15s. at end of 36th year, present value at 5 per cent.				108	8	3
				933	18	3

The difference of £317 17s. 11d. between the totals is the present value of the saving per mile to be effected in thirty-six years, the track in each case being left at the end of that time in perfect condition with new sleepers throughout. It is assumed that the cast iron chairs and brackets will be in good condition at the end of the period in both cases. If renewals of these should be taken into account, the difference would be still more in favour of the suggested system.

Perhaps the economy is more strikingly apparent if the same figures are regarded in another way. The sinking fund required for the maintenance of wooden sleepers and fastenings renewable every twelve years, and taking the value of money at 5 per cent., is £30 16s. per mile per annum; and for steel sleepers and fastenings renewable every thirty-six years, £6 11s. per mile per annum, so that on the data assumed there would be a saving in maintenance charges of about 78 per cent. The result is somewhat startling, and perhaps the data may be disputed, but I think that at any rate a *prima facie* case is presented which is worthy of serious consideration.

JAMES WHITESTONE.

113, Queen Victoria-street, E.C., January 28th.

STEAMSHIP PROPULSION.

SIR,—Having been favoured by Messrs. Yarrow and Co. with a copy of the progressive speed curve of the torpedo boat destroyer Sokol, I have made a comparison between it and the curve of the Hornet, with results which may, I hope, be of interest.

For facilities of reference I have put the calculated results side by side. They are:—(1) The indicated horse-power at each half knot; from 15 to 28 knots for the Hornet and from 15 to 31 knots for the Sokol; (2) the difference of indicated horse-power for each half knot; (3) the power of the velocity at which the indicated horse-power varies at each knot; and (4) the difference of indicated horse-power for each knot. It will be at once apparent that the indicated horse-power does not vary as any power of the velocity.

Mr. Mansel has for many years urged that the resistance of a steamship increases in a totally different manner, which I may perhaps describe popularly as by compound interest "knotly." I am compelled to coin the word; but though this is generally very nearly correct for most ships, it is certainly not absolutely correct for these torpedo boat destroyers. The indicated horse-power appears to increase by what I may call a kind of compound arithmetical progression, which at high speeds appears to change to an ordinary arithmetical progression, when of course the relation between the indicated horse-power and the velocity can be expressed by the equation to a straight line.

For the Sokol the relation may be expressed by:—

$$E_V = 475 + (V - 15)(2V - 17)5,$$

which will give results correct to within 10-horse power for all speeds from 15 to 25 knots.

At speeds above 28 knots the equation appears to be:—

$$E_V = 3115 + 430(V - 28),$$

which gives absolutely correct results up to the limit of the curve.

The Sokol has some 20 tons more displacement than the Hornet, but, notwithstanding that, a comparison of the indicated horse-power will show that she was propelled at 15 knots with actually 43 per cent. less horse-power than was the Hornet at the same speed; at 24 knots the reduction in horse-power was 35 per cent. less. This is really a very magnificent performance, though I do not think the limit has been reached yet.

At speeds above 24 knots the curve of the Sokol is not as satisfactory as that of the Hornet, and the results are most disappointing. Taking the equation for speeds above 28 knots,

$$E_V = 3115 + 430(V - 28),$$

it will be seen that if this relation holds good for speeds above 31 knots, the Sokol would require 8275 indicated horse-power to propel her at 40 knots, whilst the Hornet, whose equation for high speeds is

$$E_V = 3125 + 270(V - 25),$$

would only require 7725 indicated horse-power to propel her at the same speed. Had the performance of the Sokol above 25 knots been as good as that of the Hornet, the equation for higher speeds should have been

$$E_V = 2115 + 270(V - 25),$$

when the indicated horse-power for 40 knots would have worked out at 6615, instead of 8275, and she ought to have travelled at 33 knots for an indicated horse-power of 4275.

R. DE VILLAMIL.

London, January 30th.

English Torpedo Boat Destroyer Hornet.—Built by Messrs. Yarrow and Co., 1894.

Speed in knots.	I.H.P.	Difference.	P. varies as	H.P per knot.
15	865			
		100	$V.^{3\cdot33}$	
15½	965			
		100		200
16	1065			
		102	$V.^{3\cdot05}$	
16½	1167			
		103		205
17	1270			
		107	$V.^{2\cdot74}$	
17½	1377			
		107		214
18	1484			
		108	$V.^{2\cdot52}$	
18½	1592			
		108		216
19	1700			
		112	$V.^{2\cdot45}$	
19½	1812			
		113		225
20	1925			
		115	$V.^{2\cdot35}$	
20½	2040			
		115		230
21	2155			
		117	$V.^{2\cdot25}$	
21½	2272			
		118		235
22	2390			
		120	$V.^{2\cdot18}$	
22½	2510			
		120		240
23	2630			
		122	$V.^{2\cdot11}$	
23½	2752			
		123		245
24	2875			
		125	$V.^{2\cdot05}$	
24½	3000			
		125		250
25	3125			
		135	$V.^{2\cdot01}$	
25½	3260			
		135		270
26	3395			
		135	$V.^{2\cdot04}$	
26½	3530			
		135		270
27	3665			
		135	$V.^{1\cdot97}$	
27½	3800			
		135		270
28	3935		$V.^{1\cdot93}$	

Russian Torpedo Boat Destroyer Sokol.—Built by Messrs. Yarrow and Co., 1895.

Knots.	I.H.P.	Difference.	P. varies as	H.P. per knot.
15	480			
		40	$V.^{2\cdot44}$	
15½	520			
		40		80
16	560			
		45	$V.^{2\cdot52}$	
16½	605			
		50		95
17	655			
		50	$V.^{2\cdot54}$	
17½	705			
		60		110
18	765			
		60	$V.^{2\cdot74}$	
18½	825			
		70		130
19	895			
		70	$V.^{2\cdot89}$	
19½	965			
		80		150
20	1045			
		80	$V.^{2\cdot98}$	
20½	1125			
		90		170
21	1215			
		95	$V.^{3\cdot2}$	
21½	1310			
		100		195
22	1410			
		100	$V.^{3\cdot05}$	
22½	1510			
		115		215
23	1625			
		115	$V.^{3\cdot18}$	
23½	1740			
		120		235
24	1860			
		125	$V.^{3\cdot15}$	
24½	1985			
		130		255
25	2115			
		140	$V.^{3\cdot23}$	
25½	2255			
		160		300
26	2415			
		160	$V.^{3\cdot37}$	
26½	2575			
		175		335
27	2750			
		180	$V.^{3\cdot45}$	
27½	2930			
		185		365
28	3115			
		215	$V.^{3\cdot77}$	
28½	3330			
		215		430
29	3545			
		215	$V.^{3\cdot44}$	
29½	3760			
		215		430
30	3975			
		215	$V.^{3\cdot17}$	
30½	4190			
		215		430
31	4405		$V.^{3\cdot1}$	

SLIDE VALVE FRICTION.

SIR,—Referring to the letter from "C. D." on the above subject in your last issue, his method of investigation appears contrary to that generally followed in connection with this subject. He considers that I made a mistake by taking the whole area of the valve and multiplying it by the steam chest pressure, viz., 9¼in. × 17in. × 140 lb. = 22,015 lb.; and goes on to say, "If Mr. Davies makes an experiment, takes a flat plate lying on a flat face, representing a cylinder face and slide valve but no ports, when a pressure of steam is turned on to the back of the valve, the valve will require just the same pull on the valve spindle to move it as when the steam is shut off." This condition could only be obtained, of course, in the case of a valve which had such a rough approximation between its face and that of its seating, that the steam would be admitted over all the surface of the valve, including its upper and lower faces. Under such circumstances the valve would be in equilibrium, and it is quite evident would be unaffected by the admission of the steam to the steam chest; at the same time, it would also be quite unfit to perform its functions of effectually cutting off the steam from the ports at the proper periods, as the steam would leak through in spite of its position relative to the ports. Such a valve we may at once dismiss from our argument, and will only consider one which is competent to perform its duties; that is to say, one in which a very close approximation exists between its face and that of its seating, so that the valve will effectually prevent steam escaping, except at the proper periods, from the steam chest to the ports, and thus to the cylinder. With such a valve it is quite clear that when the steam is shut off from the steam chest, the force F required to move it, supposing it to be resting on its seating, will be its weight W, multiplied by the coefficient of friction, viz., μ, the value of which will depend upon the condition of the rubbing surfaces, *i.e.*, whether they are dry or moistened by steam or oil. In this case we shall have the relation $F = W\mu$.

Again, let us assume that steam is admitted to the steam chest, the pressure of which is p lb. per square inch. In this case it is quite evident that, since the faces of the valve and its seating approximate sufficiently close to prevent the admission of steam between these faces, the steam can only act on the remaining surface of the valve. Now the sides will be in equilibrium, but the back of the valve—to the extent of area equal to that of its face in contact with its seating—viz., (a) will be acted on by the steam, so that we shall have in this case—supposing there are no ports, but that the valve is resting on a plain flat surface—the relation $F = (W + p\,a)\,\mu$. Which will be considerably in excess over that in the preceding case. Of course, if an actual case is considered—that is to say, one having ports in the face of its seating—then it will be necessary to deduct the back pressures, as already pointed out in my previous letter contained in your issue of the 10th ultimo. The results of the experiments carried out and communicated to you by "Frottoir," Paris, in his letter contained in your issue of the 17th ultimo, tend to confirm my calculations, for when the necessary correction was made to obtain the percentage of work absorbed in driving the slide, with reference to that done on the piston in the same time, our results were almost identical.

If your correspondent will refer to Professor Unwin's "Machine Design," part 2, page 93, he will observe that some space is devoted to the subject in question, the experiments of Mr. Aspinall on the friction of locomotive slide valves—"Proceedings" Inst. Civil Engineers, vol. xcv., page 176—being referred to. Mr. Aspinall takes the load on the valve to be the steam chest pressure on the back of the valve, less the cylinder pressure on one steam port, and less the back pressure in the exhaust passage, the values of which were obtained from indicator diagrams. The measurement of the resistance to the motion of the valve at mid-stroke was also obtained, and the mean values of (μ) for three different values were 0·068, 0·054, and 0·051. Let us consider the indicator diagram given in my previous letter already referred to. The cylinder pressure will evidently be that given by the compression and steam curves (B_1 and C_1 to C_2 and A to A_1), the mean value of which is about 76 lb. per square inch, and this will act upon an area equal to that of one steam port, viz., 1¼in. × 15in. = 18·75 square inches, the total pressure on this area being 18·75 square inches × 76 lb. = 1425 lb. The back pressure in the exhaust passage will be that given by the exhaust and back pressure curves (A_1 to A_2 and B and C to B_1 and C_1), the mean value of which is about 14 lb. per square inch, and this will act upon an area equal to that on the exhaust side of the valve, viz., 5¼in. × 15in. = 78·75 square inches, the total back pressure in this case being 78·75 square inches × 14 lb. = 1102·5 lb. The work done in moving the slide valve corresponding to one stroke of the piston being, according to Mr. Aspinall, equal to

$$\left\{(9\tfrac{1}{4}\text{in.} \times 17\text{in.} \times 140\text{lb.}) - (1\tfrac{1}{4}\text{in.} \times 15\text{in.} \times 76\text{lb.}) - (5\tfrac{1}{4}\text{in.} \times 15\text{in.} \times 14\text{lb.})\right\}\frac{2\frac{1}{2}\,\mu}{12}$$

$$= (22015 - 1425 - 1102\cdot5)\frac{2\frac{1}{2}\,\mu}{12}$$

$$= 4059\cdot89\,\mu \text{ foot-pounds, or say } 4060\,\mu \text{ foot-pounds.}$$

Taking the mean of the three values for (μ) given above, viz., 0·058, the work done in one stroke of the piston in moving the valve will be (4060 × 0·058) = 235·48 foot-pounds, and the percentage of the work done on the piston, which will be absorbed in driving the slide, will be

$$\frac{23{,}548}{34{,}608} = 0\cdot68 \text{ per cent.}$$

This low result follows, of course, from the low values of (μ) quoted above, but if taken the same as that given in my previous letter, viz., ⅓ and ⅕, for dry and moistened surfaces respectively, the result will approximate very closely with that already obtained by me, and objected to by your correspondent from the manner in which it was derived,

The value obtained by me for the work done in moving the slide valve through its cycle corresponding to one stroke of the piston, was 3976·2 μ foot-pounds, as against the value 4060 μ, obtained by Mr. Aspinall's method, or a difference of about 2 per cent. So that the same values of (μ) being taken, the results will be almost identical; thus taking the above low value, viz., 0·058, we have the work done for the above period, when calculated according to my method, equal to (3976·2 × 0·058) = 230·62 foot-pounds, as against Mr. Aspinall's 235·48 foot-pounds. The percentage for my result corresponding to that quoted above, viz., 0·68 per cent., being

$$\frac{23{,}062}{34{,}608} = 0\cdot666 \text{ per cent.}$$

EDWARD J. M. DAVIES.

24, Harrington-square, London, N.W., February 1st.

[There is always steam between the faces of the valve and its seat, although there is no leakage. Whitworth's experiments are definite on this point. Mr. Davies will find that, however highly polished two surfaces in contact may be, they are not held together by any pressure but that due to the weight of the uppermost. Very special conditions which do not exist in the case of a slide valve are necessary to exclude the steam or air from between surfaces apparently in contact.—ED. E.]

(*For continuation of Letters see page* 145.)

FERDINAND SCHICHAU.—A Reuter's telegram from Elbing announces that the proprietor of the well-known shipbuilding yard there Commerzienrath Ferdinand Schichau, died on the 23rd ult. He was born at Elbing on February 2nd, 1812, and founded his great machinery factory and dockyard in 1837. The first iron ship constructed in Germany was made in his yard.

RAILWAY MATTERS.

Captain Armstrong, who has been in command of some of the liners sailing from London, and who is a relation of one of the Great Western Railway officials, has been appointed dockmaster at the North-Eastern Railway Company's dock at Middlesbrough.

The ticket-collecting staff at the Vauxhall Station of the London and South-Western Railway have had served out to them small electric lamps, which are fixed on their overcoats, the current being supplied from a miniature battery carried in the breast pocket. The experiment is to be tried for a month, and if it finds favour with the officials electricity will supersede the old-fashioned and somewhat cumbersome hand-lamp.

A report on the St. Neots accident by Major Marindin has been sent to the Board of Trade, and is now published. It shows that the Bessemer steel rails which broke into, in one case, seventeen pieces were originally 80 lb. per yard, and had worn down to from 73 to 70 lb. per yard, and that the faulty rails exhibited minute cracks along the upper flanges. The rails had been in use thirteen years, from 1873 to 1886, then taken up and not used for some years, and afterwards again put down. Major Marindin thinks the first fracture of the rail took place at an induced flaw which could not have been detected by the naked eye.

The Administration Report on the railways of India for 1894-95 states that the total capital outlay on railways open for traffic to December 31st, 1894, amounted to Rs. 237·79 crores, being an increase of Rs. 46·1 crores during the year. The total length of lines open and sanctioned on March 31st, 1895, was 21,072¾ miles, an increase of 650¼ miles for the year. The length open for traffic was 18,855¼ miles, or an increase of 355¼ miles, there being 2217½ miles under construction. Of the total mileage open 10,875¾ miles were of standard gauge, and 7712 miles metre gauge, the remaining 267½ miles being of special gauges. In addition there were 91¼ miles of steam tramways working outside municipal limits. Since the close of the year 1894-95 up to the writing of the report—May 30th—some further lengths of line, amounting to 119½ miles, have been opened for traffic.

The overhead electric traction system of tramways has just been conditionally sanctioned by the Birmingham City Council for the Nechells tramways. A six months' trial of this method has been permitted to the Birmingham and Central Tramways Company, who complain that the present method of horse traction over the short distance of 2¼ miles in question entails a loss of £2000 a year, and that they are unable to run a sufficiently quick service to meet the requirements of the district. The principle and equipment will be the same as that with which the public is familiar at Walsall, Leeds, Bristol and elsewhere, but the columns supporting the overhead wires, are to be made "reasonably ornamental," and also to carry lamp brackets which will light the route. The overhead route has worked capitally at Walsall. The tramways company state that they cannot afford the extra expense entailed by the underground or conduit plan.

Mr. Thomas Nicholls, writing from Birmingham to a daily paper in that town, has suggested for the Nechells route, as an alternative, a gas traction system. A gas compressor and receiver would comprise the whole installation. Gas from the mains is compressed to 120 lb. per square inch and then delivered by an ordinary india-rubber tube to the car, where it is stored in reservoirs carried underneath, containing when fully charged about 300ft. of gas, or sufficient for an eight miles' run. He states that from reliable data, taken from the working of the gas traction system over a mileage of nearly 150,000 miles and with 634,000 passengers carried, the cost of working per mile is 4·752d. He concludes by announcing that "the Blackpool, St. Anne's, and Lytham Tramways will shortly be worked entirely by gas traction; and cars on the same system will shortly be running in Paris, Copenhagen, and St. Petersburg, some having been contracted for with a working speed of twelve miles per hour."

In concluding a report to the Board of Trade on the collision which occurred on the 22nd November, at Gorgie Junction on the North British Railway, Major Marindin says:—"The most important lesson to be learnt from this collision, however, is that there is great risk in allowing two converging trains to approach a junction at the same time, even when one of them has been accepted under the 'section clear but station or junction blocked' signal, and the driver has been properly cautioned. It shows that, even under such circumstances, a small defect in a signal, or a slight neglect of duty on the part of a driver, may cause a very terrible disaster, and it is to be hoped that the North British Railway Company will take this warning to heart, and will give up the use of this block signal, save at very exceptional places, as has been done by other companies who have suffered from the use of it. At this place the three junctions are so near together that very little inconvenience or delay should arise from strictly blocking back in every direction, and the sooner this is done the better."

The inspector's report to the Board of Trade on the railway accident at Cleckheaton Junction, near Mirfield Station, on the Lancashire and Yorkshire Railway, on November 16th, has just been issued. In this case the 7.40 p.m. London and North-Western passenger train, from Leeds to Liverpool, came into collision with the 7.45 p.m. Great Northern passenger train from Wakefield to Halifax, at the converging point of the north and south up main lines. The Great Northern train, after standing about a minute and a-half on the south line at the outer home signal, had moved forward when the signals were lowered for the North-Western train, which was approaching on the north line. The London and North-Western engine struck the trailing end of the second carriage of the Great Northern train, and the engine and the three vehicles next to it left the rails. Three out of the four vehicles of the Great Northern train were also derailed, one of which was nearly overturned. Seven passengers complained of being shaken and other injuries, and a goods guard, travelling as a passenger in the Great Northern train, had his head cut. The damage to rolling stock was considerable. It is stated that the driver of the Great Northern was to blame for the accident.

A statement of the earnings of railways in the United States for the fiscal year ending June 30th, 1895, has been published. The statement, as published in the *Engineering News*, shows that in the year covered by the report the earnings and expenditures were almost the same as in the previous year, which showed a great falling off from the record in the year ending June 30th, 1893. The figures given cover 650 roads, with a total of 164,529 miles of railway, or 92 per cent. of the total mileage in the United States. The gross earnings were 1,003,022,853 dols., of which 293,465,792 dols. were from passenger service, 683,022,988 dols. from freight service, and 26,217,595 dols. were other earnings from operation, covering earnings from telegraph, car mileage balances, switching charges, &c. The operating expenses were 677,667,635 dols., leaving net earnings of 325,355,218 dols., as compared with net earnings of 320,137,670 dols. for the same roads in 1894. Reduced to a mileage basis, gross earnings were 6096 dols., operating expenses were 4119 dols., and net earnings were 1977 dols., or a decrease in gross earnings of 13 dols. per mile as compared with 1894, and of 1094 dols. per mile as compared with 1893; a decrease in operating expenses of 44 dols. per mile as compared with 1894, and of 757 dols. per mile as compared with 1893. Net earnings show a gain over 1894 of 31 dols. per mile of line, but a decrease of 337 dols. per mile as compared with 1893. Passenger receipts were 336 dols. per mile less than in 1893, and freight receipts show a decrease as compared with that year of 755 dols. per mile, leaving a deficit from the operation of the year of 31,075,030 dols.

NOTES AND MEMORANDA.

The Board of Trade have published the Model Regulations which that department, after full consideration of the representations made by undertakers under electric lighting orders, and by associations, &c., interested in the matter, propose to adopt.

A patent has been applied for by Herr Paul Brand, of Berlin, for a compressed gas rifle to fire fifty shots a minute. It is said to contain sufficient gas to explode 2500 charges. The German War-office has tested the weapon with, it is said, excellent results, and the Emperor has expressed a wish to see it.

The rainfall at Oxford during the month of December was 2·08in., as against 2·10in., the average for the past twenty-five years. This shows a slight decrease, viz., 0·02in., as compared with the average. The rainfall for the year was 22·69in., the mean of twenty-five years being 26·16in., and there was thus a deficiency of 3·47in., chiefly during February, May, June, and September.

A paper was recently read before the Paris Academy of Sciences "On the Silicides of Nickel and Cobalt," by M. Vigouroux. These compounds of silicon and nickel or cobalt are produced in similar ways to the chromium and iron silicides. They have the composition $SiNi_2$, $SiCo_2$. They have a steel-grey metallic appearance, a specific gravity of about 7·1, and are more fusible than either of the constituents. Their properties in relation to halogens, halogen acids, oxygen, alkalies, and potassium nitrate are given in detail.

A recently issued return gives the average amount of water supplied daily by each of the London water companies as follows:—Chelsea, 12,684,760 gallons from the Thames; East London, 43·83 millions of gallons from all sources; Grand Junction, 18,621,017 gallons from the Thames at Hampton; Kent Waterworks, 17,377,469 gallons from pumping stations; Lambeth, 25,575,294 gallons from the Thames and pumping stations; New River, 39,345,000 gallons from ponds, springs, and wells, and from the river Lea; Southwark and Vauxhall, 38,628,138 gallons from all sources; and West Middlesex, 20,831,299 gallons from the Thames at Hampton.

In a recent paper "On the Hardening of Extra Hard Steels," M. F. Osmond says that with steels containing 0·35 to about 1·3 per cent. of carbon there is a gradual increase of hardness with increase of carbon contents; beyond 1·3 per cent. the steel becomes softer. A description is given of the method of investigating the structure of steel by abrasion with the sewing needle, and microscopic examination of the scratch, and it is shown that the structure thus investigated leads to the conclusion that hard steels consist of two interpenetrating types of steel, of which one is much harder than the other. The same conclusion may be drawn by examination of etching figures, using iodine tincture or dilute nitric acid for the attack.

A modified form of hatchet planimeter was recently exhibited to the Physical Society which Mr. Scott has devised with a view of avoiding some of the defects of the ordinary form of instrument; thus, to avoid the cutting of the paper, which occurs when the knife-edge is sharp, and the side-slip, which occurs when the knife-edge is blunt, the author uses a wheel with a sharp edge. To avoid the inclination of the instrument to one side, which may easily occur with the ordinary form, a flat celluloid plate with a dot at the centre is used as the "tracing point," this plate being kept pressed flat on the surface of the paper. A small wheel with a recording disc is attached, and may be used to measure the distance between the first and last position of the knife-edge.

A paper was recently read "On keeping up the Motion of a Pendulum without Interference with its Time of Oscillation," by M. G. Lippmann. In a pendulum clock certain minute impulses must be given by the movement to the pendulum to overcome the energy losses due to friction, and these interfere to a slight extent with the natural period of vibration. In an ordinary precision clock attention is directed rather to keeping this disturbance constant than to eliminating it. That a given instantaneous impulse, however, considered by itself, should give rise to no disturbance, it is necessary and sufficient that it should take place exactly at the instant that the pendulum passes through its position of equilibrium. An electrical arrangement is described which fulfils this condition.

Writing to a contemporary concerning the so-called new photography by means of Crooke's tubes by Prof. Röntgen, an old photographer says:—"Photography means delineations by means of light, whereas it is clear that, whatever the medium utilised by Röntgen may be, it certainly is not light, as it permeates bodies opaque to light, and does not pass through glass, which is transparent to light. That ordinary light is accompanied by chemical rays is well known, as also that these extend beyond the visible rays of the spectrum; but it is also apparent that these chemical rays do permeate glass by the fact of their producing the ordinary photographs. It seems pretty certain that, though not rays of light, Prof. Röntgen's discovery is of rays of some sort; why not then adopt the word 'Actinography' to designate delineation by their agency from ακτίν—a ray?"

A paper on the variations in the ratio of the two specific heats of gases was recently read before the Paris Academy by M. E. H. Amagat. From calculations of the values of the ratio of the specific heats of air at 50 deg. C. under pressures varying from 1 to 50 atmospheres, widely differing results are obtained according as the determinations of the specific heat at constant volume by Joly, or those at constant pressure by Lussana, are taken as the basis of the calculation. The results of Joly are shown to be the most probable. The expression $p(v-\epsilon)^\gamma =$ constant, where ϵ is $\frac{d(pv)}{dp}$ and p, v, and γ have their usual significations, is then developed, as giving the adiabatic expansion for fluids, including highly compressed gases. For low pressures ϵ is negligible, and the equation reduces to the ordinary form.

At a recent meeting of the Chemical Society a paper was read on "The Acetylene Theory of Luminosity," by Vivian B. Lewes. The author pointed out that in 1882 Professors Dewar and Liveing—"Proceedings," Royal Society, xxxiv. 438—came to the conclusion that the "formation of acetylene in ordinary combustion seems to be the agent through which a very high local temperature is produced," whilst Guequen—"Transactions," Société Technique, 1884—claims to have put forward the acetylene theory of luminosity in 1884. The author considers that the criticism offered against the acetylene theory by Smithells—"Transactions," 1895, lxvii. 1049—in no way affects the considerations upon which the theory is based, which are—(1) That the unsaturated hydrocarbons in the inner region of the flame are largely converted into acetylene before luminosity commences. (2) That acetylene developes luminosity when heated whilst flowing through a hard glass tube, no air being present. (3) That the temperature necessary to decompose acetylene with evolution of light does not raise to incandescence the carbon liberated by the decomposition. (4) That in luminous hydrocarbon flames of sufficiently high temperature the luminosity varies directly with the amount of acetylene present at the point where luminosity commences. The author contends that the flame is in reality divided into two zones—(1) The outer sheath of combustion; (2) the inner region of non-combustion; and that the latter consists of an internal portion in which radiant heat is converting the hydrocarbons into acetylene: a luminous envelope which caps it, and in which more intense heat is decomposing the acetylene with emission of light, and the blue calyx at the bottom of the inner zone where the hydrocarbons are undergoing decomposition by water vapour and carbon dioxide without previous separation of carbon.

MISCELLANEA.

The French battleship Jaureguiberry has just been put into commission for her trials.

The Dublin Corporation have resolved, it appears, on trying the experiment of lighting the public streets with the aid of the incandescent lamps, and already Harcourt-street is illuminated with them.

It is stated that the Russian naval authorities have decided to substitute in the battleships Sissoi Veliky and Navarin, as well as in the cruiser Rossia, a telephone invented by Lieutenant Kolbasyeff for the speaking tubes now used. According to the *Novosti*, these vessels are also to be fitted with the electric alarm bells invented by Captain Vassilyeff for showing the ship has been hulled by shot.

An attachment for bass brooms, consisting of a bar along the back which may be set at a suitable distance from the end of the bass, is made by H. A. Wanklyn, of Manchester-avenue, so that the bass is supported in doing its work, and the part left free for flexibility may be as required when the broom is new or worn. When the bar is set low down the broom answers the purpose of a squeegee.

A paper was read on January 30th before the Civil and Mechanical Engineers' Society, by Mr. W. M. Binny, C.E., on "Hot Water Heating," which was one of considerable interest, as it introduced to the notice of the public an improved method for doing this. The method advocated has recently been used in a new block of residential chambers very successfully. A discussion followed the reading of the paper.

The following are the results of invitations for tenders for pumping engines for the Enfield District Council:—Britannia Ironworks Company, £5700; Kershaw, £5760; Andrew Barclay, Sons and Company, Limited, £6099; Barr, £6280; Lilleshall Company, £7500; Easton and Anderson, £7693; Simpson and Co., £7700; Warner and Co., £9831; Stewart and Co., £9950; Foden and Co., £10,620; Fleming and Ferguson, £10,800.

On the 29th ult., Colonel J. T. Marsh, R.E., held a Local Government Board inquiry with respect to an application of the Holmfirth Urban District Council for sanction to borrow £16,500 for the purpose of sewage works. It was explained that the Council were compelled to take the present steps by the decision of the County Court judge in the action instituted by the West Riding County Council under the Rivers Pollution Act, 1875. Mr. F. Beesley, M. Inst. C.E., of Westminster, is the engineer for the scheme, which is to be that known as the International process of ferozone and polarite.

A paper on "Punjab Irrigation, Ancient and Modern," will be read before the Indian Section of the Society of Arts on Thursday afternoon next, the 13th inst., by Sir James Lyall, G.C.I.E., late Lieutenant-Governor of the Punjab. Lieutenant-General Strachey, R.E., C.S.I., F.R.S., will take the chair at half-past four, and there will be a discussion. Another paper of engineering interest is to be read before the section next month, Mr. J. H. Glass, C.I.E., a well-known member of the Indian Public Works Department, having accepted an invitation to describe the great landslip at Gohna in the North-West Provinces, and the measures taken under his direction to prevent a serious loss of life.

The Stanton Ironworks Company, who about twelve months ago erected a new blowing engine in order to increase the output of its blast furnaces, has found the result so satisfactory that it has been resolved to erect a further blowing engine of a similar type. The newest engines put up at the Stanton Ironworks were designed and constructed by the Lilleshall Company, of Oakengates, Shropshire. The engines are of the vertical inverted cylinder description, sometimes known as the "Middlesbro'" type. The steam cylinder is 44in. diameter by 5ft. stroke, and the air cylinder is 100in. diameter by 5ft. stroke. We understand that the latest additions to the blowing engine plant are to be made by the Lilleshall Company.

A great deal has recently been written on the importance of the commerce and shipping interests of the United States of completing the canal across the Isthmus of Nicaragua. Mr. Joseph Nimmo, jun., a well-known American economist, has recently been examining the prospects of such a canal, and has arrived at the conclusion that the traffic likely to use it should not be calculated at more than 300,000 tons, and that, having regard to first cost and maintenance, the charge for canal tolls could not be estimated at less than 9·50 dols., or roughly, £2 per ton. "In a word," he says, "the scheme is without any commercial merit, and in that sense is chimerical." Mr. Archibald Colquhoun, as we know, has arrived at a different conclusion; but, as the *Engineering Review* says, Mr. Nimmo's estimates are founded on the actual existing commerce across the Isthmus and that of Panama, which should be a fairly safe guide.

Within the past few days a new design of triple-expansion engine has been submitted to naval engineers in the locality of Glasgow. The arrangement of cylinders corresponds to the disposition usually found in the ordinary three-cylinder triple-expansion engine, but there are six pistons instead of three. The pistons are connected to their respective cranks by T-shaped arms. Mr. Wigzell, the inventor, who, by the way, is well-known in naval circles through the admirable sounding machine which bears his name, claims for the new engine greater power with smaller diameter of cylinders than now obtains in practice, and much less space. According to the *Naval and Military Record*, the engine is also much better balanced, and only two main bearings are required. It appears particularly well adapted for high piston speeds, and on account of the smallness of space required might with advantage be used for the propulsion of light cruisers and torpedo boats.

An American engineer in England, writing on his visit to some engineering works, says, in the *Quarterly Review*, of machine tools:—"There is, to me, a wonderful lot of old machines at work. I am certain that this don't pay here any better than in our country. Machine tools that are thirty or forty years old are not a good recommendation to a manufacturer's reputation. One works that I saw contained a shaper by Nasmyth, made in 1837, and the owner said it was as good as any of the latest machines. He took evident pleasure in showing me a planer, certainly about fifty years old. He said that it did not perhaps plane quite so smooth as one of the new-fangled planers, but it did well enough for his work. Of course I expressed great interest in these old tools, with the result that instead of showing me any of his best machines, he went from one old tool to another throughout the place. It was meant kindly on his part; but if I was looking about to spend money on machines, I think his order from me would all go on one page of his order book, with considerable space left. This appreciation of old tools here in England is one of the most distressing things that I have come across. An old tool is never thrown out because it is out of date. It may be too small, and not suited to the work, in which case it is sold to someone who don't know better. There is always a market for a machine, even if it was dated 1740 instead of 1840. Another very strange matter to me is to learn that even an old tool, made by a celebrated maker, will always sell at a good price at an auction. A friend told me, since I arrived, that at a sale he recently attended, a shaper by Whitworth, at least fifty years old, sold for the same money for which a new one could be purchased to-day. Perhaps they think the machines are like the name on them—they don't wear out, so why should the machine."

THE PARKHEAD FORGE

(*For description see page 130*)

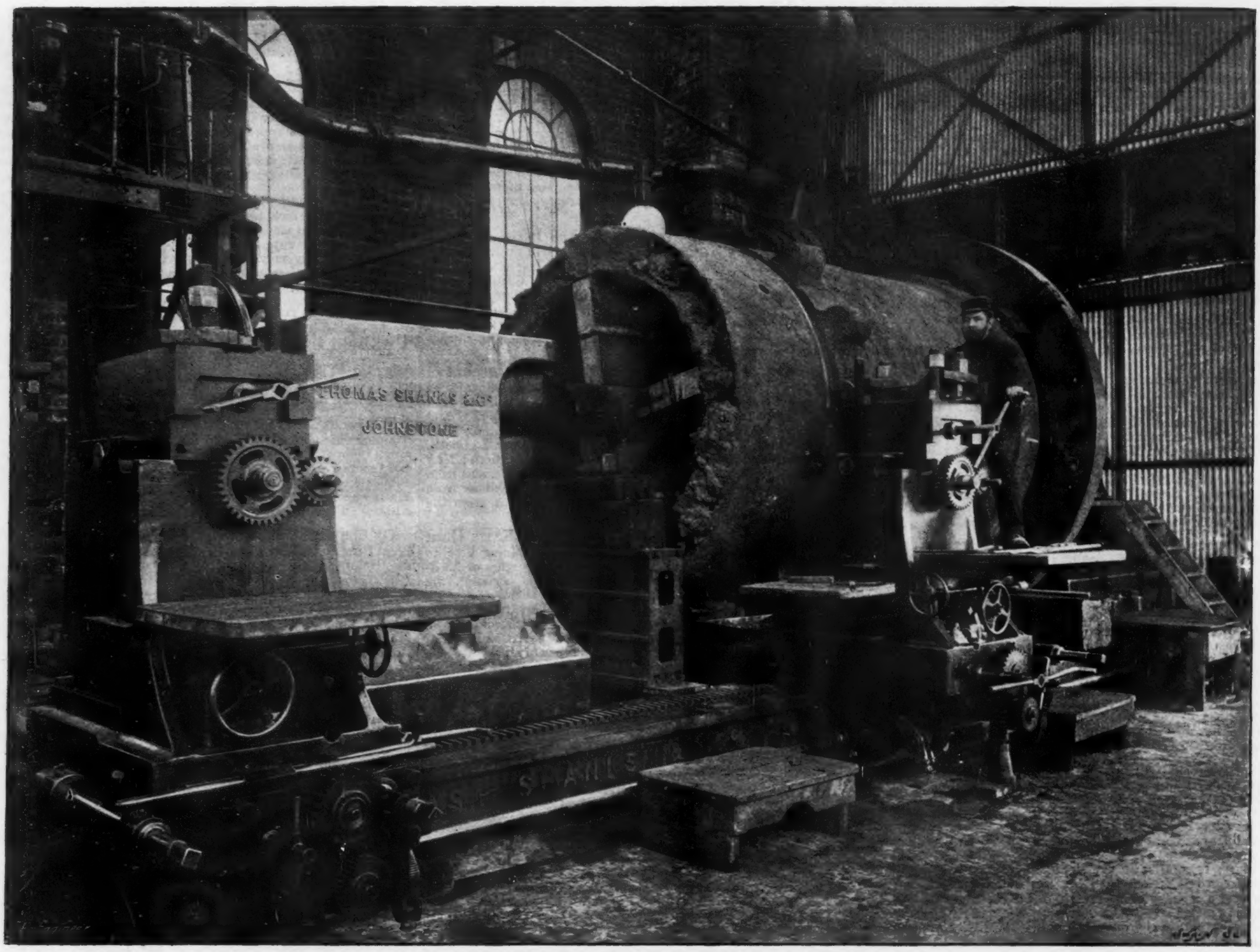

THOMAS SHANKS & Co
JOHNSTONE

Fig. 1—LATHE ENGAGED CUTTING 64-TON NICKEL STEEL CYLINDER FOR 12,000-TON HYDRAULIC FORGING PRESS

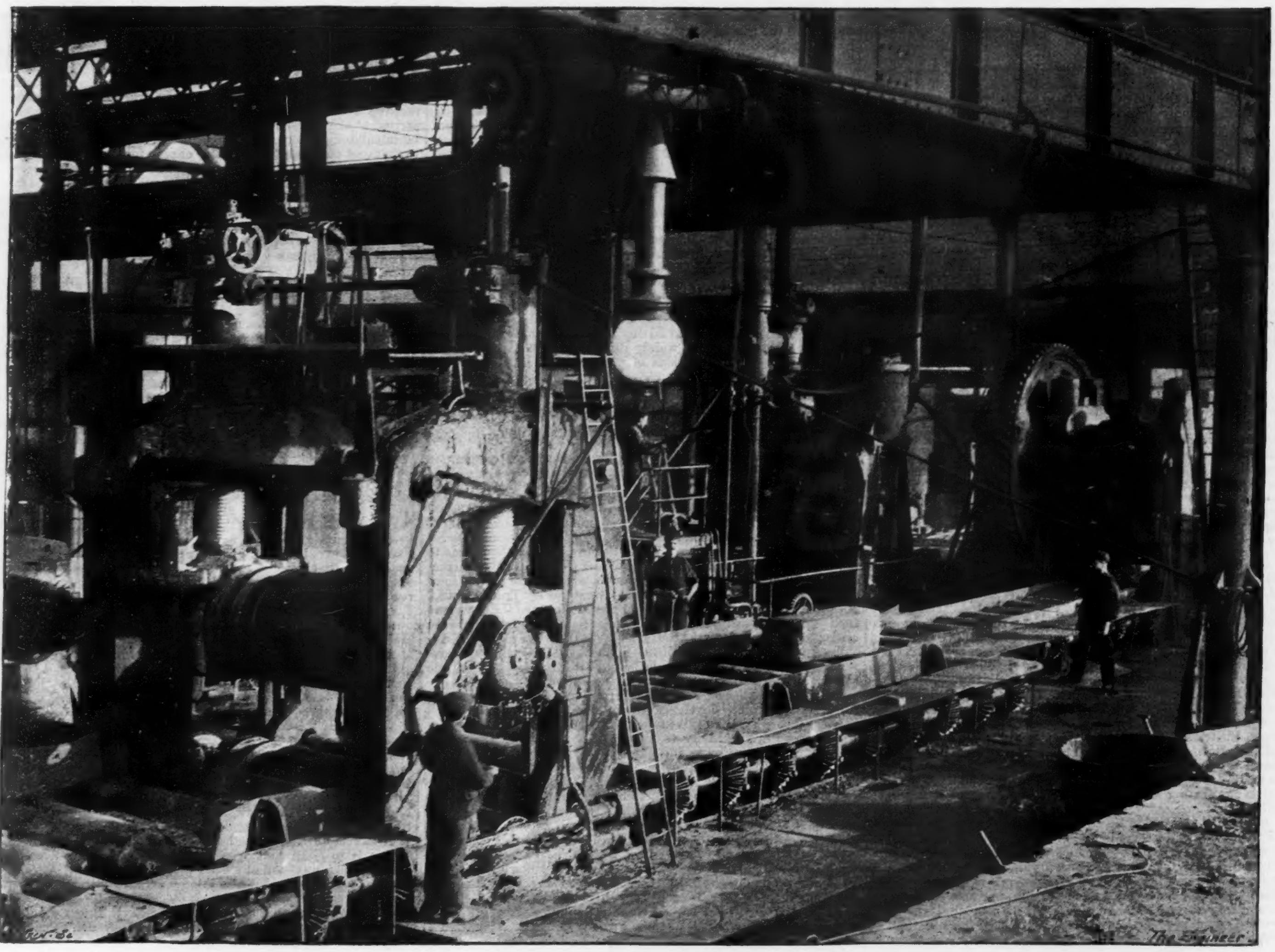

The Engineer

Fig. 2—COGGING MILL AND HOT-BLOOM SHEARS

FOREIGN AGENTS FOR SALE OF THE ENGINEER.

AUSTRIA.—GEROLD AND CO., *Vienna.*
FRANCE.—BOYVEAU AND CHEVILLET, *Rue de la Banque, Paris.*
GERMANY.—ASHER AND CO., *5, Unter den Linden, Berlin.*
A. TWEITMEYER, *Leipsic.*
ITALY.—LOESCHER AND CO., *307, Corso, Rome.*
BOCCA FRERES, *Turin.*
RUSSIA.—CARL RICKER, *14, Nevsky Prospect, St. Petersburg.*
S. AFRICA.—R. A. THOMPSON AND CO, *33, Loop-street, Capetown.*
J. C. JUTA AND CO., *Capetown, Port Elizabeth, and Johannesburg.*
AUSTRALIA.—R. A. THOMPSON AND CO., *180, Pitt-street, Sydney.*
362, Little Collins-st., Melbourne.
7, King William-street, Adelaide.
Edward-street, Brisbane.
CANADA.—MONTREAL NEWS CO., *386, St. James-street, Montreal.*
TORONTO NEWS CO., *42, Yonge-street, Toronto.*
UNITED STATES OF AMERICA.—INTERNATIONAL NEWS CO., *83 and 85, Duane-street, New York.*
SUBSCRIPTION NEWS CO., *Chicago.*
CHINA.—KELLY AND WALSH, LD., *Shanghai and Hong Kong.*
JAPAN.—KELLY AND WALSH, LD., *Yokohama.*
SINGAPORE.—KELLY AND WALSH, LD.

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MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, February 11th, at 8 p.m. Paper: "The Manufacture of Aluminium by Electrolysis, and the Plant at Niagara for its Extraction," by Mr. Alfred Ephraim Hunt, M. Inst. C.E. Friday, February 14th, at 8 p.m. Students' meeting. Paper: "The Construction of the Molong to Forbes Railway, New South Wales," by Mr. Sydney Thow, Stud. Inst. C.E. Mr. W. Shelford, Member of Council, will preside.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, February 13th, at 8 p.m. Papers to be discussed: "The Electric Wiring Question," by F. Bathurst, Assoc. "Concentric Wiring," by Sam Mavor, Member.

THE INSTITUTION OF JUNIOR ENGINEERS.—Friday, February 14th, at 8 p.m. Paper: "The Stability of Tall Chimneys," by Mr. F. J. Bancroft, B.Sc. Synopsis:—Characteristics of Instability—Tensional stress undesirable—Limiting position of centre of pressure (*a*) for solid square column, (*b*) for square chimneys of various relative thicknesses of brickwork, (*c*) for solid circular column, (*d*) for round chimneys, (*e*) Rankine's values—Resistance to wind—Practical example—Results of calculations—Should chimneys rock?—Increasing height dangerous. The paper will be illustrated by diagrams and table.

HULL AND DISTRICT INSTITUTION OF ENGINEERS AND NAVAL ARCHITECTS.—Monday, February 10th, at 8 p.m. Paper: "The Removal of the Marsh-lane Tunnel, Leeds," by Mr. H. J. Rudgard.

ROYAL INSTITUTION OF GREAT BRITAIN.—Tuesday, February 11th, at 3 p.m. Lecture: "The External Covering of Plants and Animals: Its Structures and Functions," by Professor Charles Stewart, M.R.C.S., F.L.S. Thursday, February 13th, at 3 p.m. Lecture: "Some Aspects of Modern Botany," by Professor H. Marshall Ward, D.Sc., F.R.S., F.L.S., Professor of Botany in the University of Cambridge. Friday, February 14th, at 9 p.m. Discourse: "Fish Culture," by J. J. Armistead, Esq., Member of the Royal Commission on Tweed and Solway Fisheries. Saturday, February 15th, at 3 p.m. Lecture: "Realism and Idealism in Musical Art, with Musical Illustrations," by Professor C. Hubert H. Parry, D.C.L., Mus. Doc., M.A.

SOCIETY OF ARTS.—Monday, February 10th, at 8 p.m. Cantor Lecture: "Alternate Current Transformers," by Dr. J. A. Fleming, F.R.S. Wednesday, February 12th, at 8 p.m. Paper: "Water Purification by Means of Iron," by F. A. Anderson. Sir Douglas Galton, K.C.B., F.R.S., will preside. Thursday, February 13th, at 4.30 p.m. Indian section. "Punjab Irrigation—Ancient and Modern," by Sir James Broadwood Lyall, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab. Lieut.-General R. Strachey, R.E., C.S.I., F.R.S., will preside.

THE ENGINEER.

FEBRUARY 7, 1896.

THE NAVY AND THE ADMIRALTY.

MR. GOSCHEN will have no difficulty this year in persuading Parliament to give him money. A party has always existed in this country which regards money spent on the British Navy as money wasted. Recent events have, however, silenced alike theoretical political economists and amiable humanitarians. It is easy to show on paper that the labour and material expended on an ironclad are labour and material wasted. But the arguments used depend for their cogency on the assumption of an unreal aspect of human nature. Mankind ought not to fight; but mankind always has fought, and so far as can be seen always will fight. To ignore this truth is to court disaster. Money expended on police is money wasted as far as useful labour is concerned—the policeman producing nothing; but it is admitted by all classes save the criminal that policemen are necessary. Very considerable sums of money are spent on fire brigades. The men produce nothing, and the engines and horses drive no manufacturing machinery. Yet we must have them. Certain conditions rule the course of events in the world. The political economist who asserts that money spent on warships is money wasted, asserts that which is not scientifically true. Sound science takes note of all ruling factors. It does not neglect one because it is immoral or inconsistent with law and order; and sound political economy will take count of the manifestation of passion, or jealousy, or ill will as much as of a desire for particular products, or the relative values of gold and corn. Wars ought not to be, but wars do take place, and the nations that wish to be safe will be prepared to fight if the necessity should arise.

The duty—the immediate duty—that devolves upon the Admiralty is very onerous. To the Navy we look, we shall not say for defence alone, but for the maintenance of peace. Courteous things may be said, but who among us doubts that if England's navy were not the most powerful in the world we should have been at war now? At this moment it is admitted that very large additions must be made to our naval strength, and that without delay. Mr. Goschen can have £50,000,000 for this purpose if he asks for it. He will find it more difficult to propose to do too much than to do too little. We do not pretend to know what the Naval Estimates will be; we are not in Mr. Goschen's confidence. But we do know that if he does not contemplate a very large addition to the naval strength of Great Britain, he will not long remain First Lord of the Admiralty. The country is thoroughly aroused now; and the Little England party would be brushed aside by a gesture if it attempted to urge parsimony. We may take it for granted that very large sums will be spent in the immediate future on the Navy. What direction will the expenditure take? In considering the question we do not propose now to say anything concerning the ships that may be built, their size, type, or armament. With these things we may deal at another time. It is more important at this moment to consider Admiralty policy, and its operations on the contracts which will be carried out. Mr. Goschen has a great opportunity before him. For years past the dealings of the Admiralty with contractors on the one hand, and naval engineers on the other, have been unsatisfactory. The time has arrived when a complete change for the better in all respects can be carried out. It is at all times difficult to deal briefly with questions of Admiralty policy, because the subject is very large and very complex. We can do little more than indicate the direction which that policy should take, we cannot go into minute detail. Generally speaking, then, we maintain that a broader and more liberal view of the position which the Admiralty hold should be adopted. Its dignity should be raised and, if need be, its position and importance asserted. We have recently dealt at some length with the subject of Admiralty contracts. We see with satisfaction that an evening contemporary has followed in our steps. Beyond doubt, the Admiralty contract system must be remodelled—if not in the letter, then in the spirit.

The theory on which the Lords of the Admiralty, from Pepys' time down, have dealt with contractors is, that the money voted by Parliament for the construction of ships has been given under protest; that it represents waste; and that it must be made to go as far as possible, cheapness being the great essential. We may digress here for a moment to give an example of what we mean. It is well known by those who have the opportunity of acquiring this information that the machinery in our larger ships of war is in no case so highly finished as that in the best mercantile steamships. We do not say that the machinery is not sufficiently good. We do say that its finish is neither equal to that of the engines in such vessels as the Teutonic or Campania, for example, nor to that of the machinery of some of the crack warships built for foreign Governments; and the reason is simply that the Admiralty will not pay for finish. It is regarded as a luxury which the nation cannot afford. It is not necessary to explain to our readers what high finish implies, and we may pass on. Now, this theory, it is easy to show, is founded on a delusion, and that delusion has been fostered, if not called into existence, by a mischievous school of political economists, who, as we have said in our opening sentences, ignore human nature, and are never weary of advocating a policy which is entirely mistaken. What would be said of a Chancellor of the Exchequer who, in framing his Budget, ignored beer as a source of income on the ground that it was immoral to drink it, and that consequently it would not be drunk? The great fact overlooked continuously is that we in this country do not waste money when we build ships of war. It is true that large sums are taken from the taxpayer to pay for them, but the whole of this money to the last farthing is spent *in* this country, with the exception of what goes abroad to pay for the ore used in making steel and the timber used in construction, and even of this last much is grown in our own colonies. Can it be doubted for a moment that the expenditure of £20,000,000 would at once give employment in a dozen industrial centres where it is much needed? Would it be nothing to Liverpool, for example, that a couple of first-class battleships should be built on the Mersey within the next two years? Who can doubt the value of contracts to the amount of a couple of millions to the district of the Tyne? It may be argued that the men might be better employed. That is disputable; but without dwelling on that circumstance, we may face the fact that they are not employed The "better" work is not to be had. We take things as they are, not as they might be, and we say that it is impossible to consider the life and activity with which the construction of warships would endow our great shipbuilding centres without a feeling of satisfaction, and the conviction that while we were doing all that lay in our power to prevent war, we were also promoting peace and prosperity among our own working classes, surely one of the highest aims that a Government can have.

If once the fact be accepted that the expenditure of money on the construction of ironclads, far from being an unmixed evil, may with propriety be regarded as conferring benefits on the community. questions connected with contracts appear in a new light. The Admiralty is no longer compelled to go to that port or that firm which can build for the least money. On the contrary, the money will be spent to the best advantage, but a new meaning will be given to the words.

In the *Times* of Monday will be found a long and very able letter from Mr. A. F. Hills, chairman of the Thames Ironworks and Shipbuilding Company. Mr. Hills admits that labour is more expensive on the Thames than it is in the North, but he maintains, and rightly maintains, that this is not a sufficient reason for refusing to place orders for men-of-war on the Thames. The arguments he uses are not identical with ours; on some points we do not agree with him. They are based on the assumption that because all orders for ships of war go to the North, labour crowds there in search of employment, and that competition pulls down wages until a strike results. With this aspect of the case we need not concern ourselves. The broad argument we use is that as the money comes from all parts of the country, it should be distributed again as fairly as possible; and it is but right that London, contributing as it does an enormous sum to the national exchequer, should have some of it spent in the Metropolis. In one word, we are entirely opposed to the notion that the Admiralty is in the position of a private individual who buys in the cheapest market, without any consideration whatever for those who make what he wants. That is the position, say, of the Japanese Government, who come to this country and give gold in exchange for warships. The Admiralty is entrusted by the nation with large sums of money to be spent in the way that will do most good, and if the construction of ironclads on the Thames will relieve the distress in the East End, then the game is worth the candle. We look on the whole matter, in short, from the Imperial point of view, and it remains to be proved that this liberal policy is not in the long run as advantageous to the Navy as it is to the country at large. Although the Admiralty cannot see their way to build a ship of war on the Thames, the Japanese Government can. "Soon after the 'Spencer' programme had left the Thames hungry and desolate," writes Mr. Hills, "a Japanese commission, which for three years had been making official inquiry into the shipbuilding resources of Germany, France, America, and the United Kingdom, reported to its Government that the firm with the best record for the building of vessels of war, the firm most to be recommended for the building of the proposed Japanese ironclads, was the Thames Ironworks and Shipbuilding Company, Limited, Blackwall. And in accordance with this recommendation, and in spite of the clamour of cheapness, the Japanese Government intrusted the building of their first new ironclad, 13,000 tons displacement, to my firm."

In our impression for December 17th, it will be remembered that we described the works of the company at considerable length, and among the illustrations were several of the great Japanese ship the Fuji, now approaching completion. How, we may ask, does it happen that the Japanese Government, seeking nothing but direct value for their money, can get warships on the Thames, when our Government, with both a direct and an indirect purpose to serve, cannot? In great things and in small alike the policy of the Admiralty has hitherto been quite unworthy of the nation. Mr. Goschen has an unprecedented opportunity of effecting a change for the better.

It is not, however, in the matter of contracts alone that the necessity for a more liberal policy is manifested. At the outset we said that changes were needed in two matters—with one, contracts, we have dealt. There remains much to be said on the second—the supply, pay, and position of naval engineers. Through inadvertence Mr. Goschen recently in public ignored the engineers, while he had a good word to say for every other branch of the service. It is true that since he has apologised handsomely, but it is impossible to avoid drawing a conclusion from the whole affair. If the engineers had occupied anything like their legitimate place in the estimation of the First Lord of the Admiralty he *could* not have forgotten them; they would have been ever present to him. He would not have thought about the Navy at all without thinking of them. But in future it is essential that the Admiralty must think of the engineer branch of the service, and that to some purpose. We beg our readers to turn to The Engineer for March the 8th, 1895. In it they will find an elaborate table setting forth the Admiralty distribution of engineers in the fleet, and a full discussion of the lesson taught by the figures in our table. The principal fact is that last March there were 318 engineers needed and there were only 85 available. While peace prevails it is possible for the Admiralty to pursue a policy of foolish economy; but when war threatens—when, in fact, it is within measurable distance—any policy which endangers the national safety becomes criminal. We have not engineers enough for the ships we now have; whence are they to be had for the large additions that must be made to our fleet? It is commonly said that the Admiralty reckon on getting all the men they might want out of the mercantile marine. How then does it happen that the Admiralty maintain that the engineers of the mercantile marine have not received the proper training; that they are not nearly scientific enough for sea service in ships of war? If these men are good enough for the severest possible test, that of actual warfare, surely they must be good enough for peace service, and if this be so, then the expensive technical training which the modern naval engineer undergoes is unnecessary. If, on the other hand, it is necessary, is it not fatuous to reckon on the mercantile engineer to help the country in its distress? The truth will have to be recognised that without the engineer the admiral, the captain, the bluejacket, the whole executive branch of the service, are useless. The naval supremacy of Great Britain rests in the hands of the engineers. War rumours force such truths home, and they will be driven yet more forcibly home to the Admiralty before the year is out. Mr. Goschen *must* take steps to add to the number of engineer officers. He will have the opportunity. Men cannot be had now, because the position and pay are not good enough. We have dealt with the question a dozen times. The Admiralty for a comparatively moderate sum can do a great work. Is it too much to hope that Mr. Goschen will use his own eyes, and his own ears, and his own great common sense, and instead of allowing himself to be led by others, take the initiative, and recognising the importance of the naval engineer, place the profession on such a footing that entrance to its ranks may come to be sought for with eager anxiety?

THE USE OF HEATING GAS.

Notwithstanding the rapid extension of electric lighting in the metropolis, the directors of the Gas Light and Coke Company, in the report to be laid before their shareholders to-day, are able to announce an increase in the sale of gas during the past half-year, to the extent of 4·86 per cent., compared with the quantity sold during the December half-year in 1894. A yet larger ratio of increase appears in the case of the South Metropolitan Gas Company, the report to be presented to the proprietors of that Company on Wednesday next showing an increase of as much as 7·88 per cent. in the sale of gas in the last half-year, as compared with the previous corresponding period. In the South Metropolitan report an opinion is expressed that this increase is largely due to the remarkable success of the "penny-in-the-slot" system, which is rapidly extending among the numerous class of weekly tenants. But we also observe a very considerable increase in the number of gas stoves for cooking purposes, hired out by the Company. Hence there is reason to believe that although other causes tend in the same direction, yet the more general use of gas for heating purposes—itself promoted by the "penny-in-the-slot" system—has much to do with the growth of the demand for gas, as shown by the foregoing figures. The increase in the population, taken alone, does not sufficiently account for the advance. That increase is only 1 per cent. per annum.

The falling off in the coal traffic on one of the principal railways connected with the metropolis favours the conclusion which we have thus put forward. The population is multiplying with especial rapidity in the eastern part of London, yet the railway which runs into that district exhibits a very decided diminution in the quantity of coal which it has to carry. Lord Claud Hamilton, the Chairman of the Great Eastern Railway Company, is fully convinced that the consumption of coal in private dwellings is affected in the way to which we have referred. At the meeting of his company six months ago, Lord Claud announced a falling-off in the coal traffic to the extent of £36,000. Making due allowance for the diversion of trade caused by the great coal strike of 1893, he considered that one cause of this diminution was to be found in the substitution of gas and oil stoves for open grates, a change which he asserted "was really working a silent revolution in the domestic arrangements of large masses of the people." In the suburbs which were served by the Great Eastern Company, the large gas companies estimated that they had hired-out 90,000 gas stoves, whereas the number at the end of 1893 was only 80,000. Taking the number of stoves mentioned, his lordship calculated that about 90,000 tons of coal less were consumed in the district than would otherwise have been the case. The use of gas stoves was stated to be thus not only large, but to be "steadily increasing." Coming down to the half-yearly meeting of the Great Eastern Company which has just been held, we find the chairman joining in the telling of the same tale. A contributing cause is to be observed in the mildness of the season, rendering coal fires less necessary, and leaving waterways free from ice. But still there had been "an extraordinary increase in the whole of the suburban districts of gas stoves and stoves heated by oil." Lord Claud Hamilton certainly puts the case very strongly, but he goes on to say, it is estimated roughly that the railway had probably carried 100,000 tons less coal than if those stoves had not existed. This reckoning apparently has reference to the half-year, the decrease being 10,000 tons more than we find in the calculation for the half-year which went before. A reduction of 190,000 tons in the annual consumption of coal in the eastern districts of London, as resulting from the introduction of gas and oil stoves, is certainly a matter for astonishment. Even taken at 100,000 tons the quantity is surprising. Of course the real meaning of the calculation is this, that so much more coal would be carried by the railway were it not for the number of stoves in which gas or oil is burned instead of coal.

Although Lord Claud Hamilton may have indulged in unintentional exaggeration, there is enough of evident truth in his statements to awaken interest. Gaseous fuel is, to an appreciable extent, taking the place of the solid article. Mild winters and hot summers will promote the change, and seasons of the opposite kind have a contrary effect. Still, there can be no doubt that the use of gas for heating purposes is disturbing the coal traffic, and serving at the same time to help the gas companies in their struggle against the electric light. If all the coal consumed by the London gas companies had to come to town by rail, Lord Claud Hamilton's lament would not be uttered. But it happens that the largest company of all has its own fleet of steam colliers, discharging enormous quantities of coal at Beckton, besides delivering a portion higher up the stream. The South Metropolitan Company also fetches its coal supply by way of the Thames, and we may presume that the Commercial Company has a similar resource. On the whole, we may conclude that by far the greater portion of the coal required in the manufacture of gas in London is water borne. On the other hand, the coal consumed for domestic purposes is to a considerable extent brought by rail, so that when the gas stove takes the place of the open grate the coal traffic of the railway suffers a diminution. But setting aside the statistics of the Great Eastern Railway, there can be no question that the London gas companies are largely benefited by the extent to which gaseous fuel is being adopted for domestic purposes. At the back of all comes the great coal question itself, and it will be asked—in what direction, and in what degree, is the exhaustion of our coal measures affected by the use of gaseous fuel? A somewhat similar inquiry presents itself with respect to the electric light, which, while it supersedes illumination by means of gas, still demands the combustion of coal. We may fall back on oil, and of course this directly cuts at the coal traffic. The Great Eastern Railway Company, anxious to carry coal, is setting a curious example by using oil to make steam in twenty-five of its engines. Another matter connected with this subject is the extent to which our towns will be relieved of smoke by the use of gas instead of raw coal for domestic purposes. Neither is it out of bounds to suppose that the day will come when gas specially adapted for heating purposes will be laid on to houses in the same manner that illuminating gas is at the present time. Such gas could be cheap, and would come in sharp competition with coal. When that day arrives, some future Lord Claud Hamilton—if not the present—will have to lament the almost total extinction of the metropolitan coal traffic of the Great Eastern Railway, while the locomotives themselves will be getting up steam by the combustion of oil.

CONTINENTAL WORKMEN.

The lessons learned by the delegates of the Iron and Steel Trades Association support the contention of those who hold that trade would be better than it is in this country if the men adopted a different policy from that enforced by the Trades Unions. It should be evident that iron and steel, to confine our attention to those matters with which the report of the delegates is concerned, can be made to more advantage when workmen and managers are in harmony, than under conditions of veiled hostility. It is impossible to watch the methods of work usual in an English ironworks without seeing that there is very little discipline. The exception is to be found in our armour-plate mills, where it would be quite impossible to carry on work unless strict discipline were enforced. At the root of this want of discipline lies the notion of individual independence. The British workman has a foolish objection to taking orders of any kind. A remarkable manifestation of a similar spirit took place just after the French Revolution. The privates held that they were as good as the officers of the army, and would not obey orders. The result was that the armies of the Republic were defeated in every action; and they attained only qualified success until a man of iron will, Buonaparte, taught them that obedience was the first duty of the soldier. Captain Mahan tells us that the sailors in the French fleet refused to obey their captains or their admirals, and took ship where they pleased. English sailors taught them the lesson at sea that Napoleon taught his soldiers on land. As a matter of fact, there is, of course, nothing derogatory, much less degrading, in yielding implicit obedience to those who are entitled to ask for it. It is true that in this country the orders of the foreman or the manager are usually obeyed; but there is a vague feeling extant that obedience is yielded under protest. One result is that the foreman has of necessity to make his authority felt. Such discipline as exists has to be enforced, and this fact goes far to make the relations of employers and employed unsatisfactory. The delegates find that on the Continent a very different state of affairs existed. "One of the most admirable features," say the delegates "of the administration and operation of the iron and steel works that we visited on the Continent, almost without exception, was the splendid discipline maintained. The workmen generally discharged their duties as if they were acting under military commands. There was no slovenliness, no undue haste, no noise, no idling about, and the foreman, in a quiet and unobtrusive manner, appeared to control everything without commotion. Each man worked as if he were a piece of machinery fitted into its proper place, which did exactly the right thing at the right moment, because it could not do otherwise. The operations, as a rule, were carried on with the regularity of clockwork." To what cause are we to attribute the mental attitude of the men? We reply mainly to education. The German youth is taught from his earliest years to obey. So much cannot be said of the youths of England. But, furthermore, it must be remembered that every German man has to serve for a fixed period in the army, and in no army in the world is rigid discipline so vigorously enforced. The lessons taught in the barrack yard are utilised in the works. It is gradually coming to be admitted, even in this country, that compulsory service in the army for a year or two is not by any means an unmixed evil; and it is certain that in Germany and Belgium it is productive of good in various ways.

When things proceed regularly, and the men discharge their duties with care and promptitude, managers and foremen are satisfied. There is a minimum of wrangling and fault finding. In a word, good temper prevails, and it is well known that good temper tends to increase and to become better and better. More than half the troubles that distract trade are due to ill temper. Men irritate foremen; the foremen irritate the managers; the managers vex the souls of the proprietors; every reader will be familiar with conditions where but a spark was needed to create a quarrel. Time after time strikes have originated in what appeared at first to be a trifle. The delegates find in discipline and order not only means of cheapening production, but of promoting harmony. Quoting again from the report:—"We were greatly struck with the splendid physique of the men employed in the works that were visited in Germany, and not less so with their sobriety, their steadiness, and their readiness to act on instructions. These qualities are manifestly of much value alike to employers and employed. The workman who is regularly and steadily engaged at work is not only earning better wages for himself, but is in a better position to do good work, while the effect of such a state of matters on the employer is that he gets the maximum production out of his plant, no heats being lost through broken time. Equally prominent was the cordial relations exhibited by the managers and foremen towards the workmen, and the absence of anything like a display of dogmatic commands or inconsiderate attitude towards those under their superintendence. Ability to direct and control was no less conspicuous than readiness to act upon instructions." Where obedience is cheerfully rendered, and every man knows his work, and does it without grumbling, there is no longer a stimulus afforded for bullying or "rowing." The men are respectable and respected.

In the iron and steel works of Germany and Belgium strikes are almost unknown. The reason is mainly, we think, that the men are not paid for their services by the hour, week, or month alone. For the most part in this country, all work is paid for in coin. That is not the case on the Continent. Before the Truck Act was passed in this country, men were largely paid in kind, and the capitalist, or mill, or mineowner kept shops, where the workmen obtained "Truck," that is, flour, bread, meat, groceries, and such like. Very grave abuses sprang up, and the sale of commodities by the employer in this way became illegal. But it is questionable if we have not gone too far. In Belgium, at all events, the masters in many cases provide flour, &c., for the men; purchasing in quantity, on, of course, much more advantageous circumstances than the men could. If our readers will turn to The Engineer for September 7th, 1894, they will find on page 215 a description of the system on which the great works of Marcinelle and Couillet are carried on. They will see there that the men really receive remuneration and enjoy benefits which cannot be properly estimated in money value. In fact, some of the advantages they enjoy could not be bought by them for any money they could possibly earn. Take, for instance, houses. In not a few English districts it is almost impossible to get a house at all, and exorbitant rents have to be paid for such accommodation as is available, the men having often to walk miles to and fro daily. But the Marcinelle and Couillet Company provide houses and a plot of land, under such conditions that any one possessing thrift can purchase them in a few years. In a word, great pains are taken by the employers to bind their hands to the locality; to hold out inducements for them to stay. But such a policy is directly opposed to that of the British Trade Union, which aims to make the men independent of locality, and beyond question this mischievous spirit is aided and fostered by legislation, which renders it very difficult for the employers to do anything for the workmen, save pay him his wages. The lesson taught by the report is that the relations between employer and employed are more harmonious on the Continent than they are in this country. But that harmony is beyond question promoted by what we may term the indirect payment of wages, a thing abhorred by the trade unions, because it never fails to prevent strikes. Thus, for example, a strike in our Government factories is never heard of—why? It is not because wages are higher, nor is it because discipline is more lax. It is simply because the men who work in the Arsenal and dockyards enjoy privileges which cannot be had in private establishments; and similar and more important privileges are enjoyed by the Belgian and German workmen. In another page will be found certain facts bearing on the point, to which we beg leave to direct the attention of our readers.

The report before us only confirms the views we have long held, that the principal advantage which the German and Belgian iron and steel manufacturers enjoy as compared with those of Great Britain lies in the harmony which prevails between capital and labour. That harmony is largely due to the military training of the men, foremen, managers, and masters alike, and to the remuneration of the men indirectly in the way we have indicated and the delegates have very fully explained. In this country military service on the one hand and indirect payment on the other have been strenuously and successfully opposed. We must take the consequences. But our readers may rest assured that it is neither in better machinery nor in technical education that the strength of our rivals consists. In what it does consist we have long since endeavoured to explain, and the strongest confirmation of the accuracy of our views is to be found in the pages of the report of the delegates of the Iron and Steel Trades Association.

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CANALS.

THERE seems to be a growing impression that if the canal system is to take its proper place as a factor in the trade prosperity of the United Kingdom, it must be placed on a new footing. Either the whole system must be formed into one great public trust or canals must be grouped so as to obtain the means and benefit of organisation. Fifty years ago, when the railway fever was at its height, Parliament allowed a number of railway companies to buy 776 miles of canal, seventeen Acts being passed in 1846 for that purpose. A Parliamentary Committee in 1872 reported definitely that railways ought not to be permitted to buy up canals, but the Legislature has done nothing to save the rest of the waterways, and the result is that nearly one-third of the 3813 miles of canal in the kingdom are owned by railway companies. It is no secret that this control of competition has been put forward as one of the main reasons for the maintenance of abnormally high railway rates. A very different policy has been adopted in France, where the Government made or acquired the canals, and in 1880 made them toll-free. No wonder Continental railway rates are so much lower than our own, and that Continental engineering and other firms can get their manufactures, both by rail and inland waterway, from the interior to the coast at about half the cost than can those of Britain. From York southwards there is a network of canals the total length of which approximates to 4000 miles. Independent companies own 2550 miles, and the railway companies have possession of 1400 miles, whilst 300 are derelict or abandoned. Manufacturers will agree with Mr. L. B. Wells, who, in a paper on the subject this week before the Manchester Geographical Society, declared that the time has come when the question of inland waterways must be faced in a serious spirit. The abstract of this paper, which we publish on another page, shows how great must be the advantages of the low freight rates customary on the Continent. But it must not be forgotten that foreign railways are owned and worked on a footing quite different from that of our railways, so that it is difficult to draw any legitimate conclusion between the two.

THE INSTITUTION OF MECHANICAL ENGINEERS.

ON Thursday and Friday, the 6th and 7th inst., at the meeting of the Institution of Mechanical Engineers, papers were read on "Telemeters and Range Finders," by Professors Barr and Stroud; "Calculation of Horse-Power," by Lieutenant-Colonel English; and "Notes on Superheating," by Mr. W. Patchell. The latter paper is that which possesses most interest. The author dealt at considerable length with the McPhail superheater, which, it will be remembered, has already been very fully described and illustrated in our pages. But Mr. Patchell did more than this. The literature of superheating is very scanty, and he has done excellent service in collecting apparently nearly all that is available, though curiously enough he has overlooked Isherwood's experiments carried out in the United States. It would be useless to print Mr. Patchell's paper, or to deal in any way with the discussion which followed until the illustrations of the apparatus described are available. These are prepared from photographs supplied by the Institution, and we hope to receive these in time for our next impression. The subject is one of great importance, for in superheating lies the "promise and potency" of further economy in steam engineering.

LITERATURE.

John Dalton and the Rise of Modern Chemistry. By Sir HENRY E. ROSCOE. 8vo, pp. 216. *Justus von Liebig: his Life and Work* (1803-1873). By W. A. STENSTONE. pp. 219. London: Cassell and Co., Limited. 1895. The Century Science Series.

THE books under notice deal with the life and work of two remarkable men, who although far from wealthy, were able to follow earnestly and zealously the exact course of life dictated by their own aspirations, and they thus furnish examples of the remarkable success that attends such circumstances where men of intellect and industry are concerned, of whatever nationality. Dalton, the placid Quaker Englishman, a profound, deliberate, original thinker, endowed with indomitable perseverance; a plodding, persistent, crude experimenter, "finishing off with his head what he began with his hands;" a rough, uncouth lecturer but successful tutor, leading a serene, methodical, frugal, and secluded life; and Liebig, the impetuous German, enthusiastic and impulsive in imagination, with invincible activity; a brilliant, versatile experimenter, demonstrating with his hands what he imagined in his head; an impressive lecturer, an ideal teacher of his subject, and leading mostly the peculiar active life of the earnest professor in a small German university. He was precipitous in forming conclusions and tenacious of holding them, so we find him frequently engaged in lively controversies, and when wrong gracefully admitting his error. His life was, therefore, not as peaceful as Dalton's. Both men rose to high eminence. The one endowed the world with a remarkable hypothesis that has reigned supreme ever since; the other enriched it with brilliant discoveries of new methods, new processes, new compounds, and new ideas. The one became the father of modern chemistry; the other the foster parent of the practice of chemical research. The one laid the foundation, and the other was one of the most distinguished fashioners of the modern edifice of chemical science. Dalton, born in Cumberland in 1766, the son of a hand-loom weaver, attends the village school with such success that he becomes a teacher when twelve years old; at fifteen he removes to Kendal, where he is first teacher, and then one of the principals. He during this period teaches himself Latin, Greek, French, mathematics, and natural philosophy. At twenty-seven he goes to Manchester, where, with but few occasional excursions, he teaches for a livelihood, and works in his laboratory for recreation until his death in 1844. In fact, his spare time is passed in making experiments with extraordinarily crude apparatus. Nevertheless, he was able to elaborate astounding general laws from the crude results. His most remarkable achievement was the announcement of the atomic theory, a mere speculation that can never be substantiated, for, as the author points out, "No mortal eye has ever seen, or ever will see, an atom;" and in spite of an examination reply of one of his students that "Dalton's Atomic Theory consists of cubical blocks of wood painted various colours." Nevertheless, Dalton thoroughly persuaded himself of their existence, drew diagrams of them, and arranged them in order to make representations of compounds; and although his own numerical results did not agree, he announced the theory to the world, and held his ground so well that he soon convinced even the most sceptical of the correctness of his assumptions.

Liebig, born in Darmstadt in 1803, the son of a dealer in colours, a regular dunce at school, where he caused much merriment by publicly expressing his determination to become a chemist, is sent to an apothecary, but illicit experimenting brought about an explosion and his discharge. He goes to Bonn and Erlanger, and laments that there is no chance of his becoming a chemist in Germany, it being then, 1822, "a wretched time for chemistry" in that country. Fortunately, he comes under the notice of the Grand Duke of Hesse, who provides the funds for him to go to Paris—a contrast to the reception given Dalton when he visited William IV. All his Majesty apparently did was to ask, "Well, Dr. Dalton, how are you getting on in Manchester—all quiet, I suppose?" There, under the guidance of Gay-Lussac, Liebig soon rose to eminence, and in 1824 returned to Germany to fill the chemical chair at Geissen, being in 1852 transferred to Munich, where he died in 1873. It was at these places that he established that unrivalled system of chemical instruction that attracted students from all parts a few decades ago. His labours were many and varied, and, *inter alia*, he elaborated the well-known method of organic analysis, introduced the Liebig's bulbs and the Liebig's condenser, and with or without collaboration, established the doctrine of isomerism and the theory of compound radicals on a sound basis, and produced chloroform and chloral for the first time. In agriculture he demolished the humus theory, and initiated the mineral theory, and held the very opinion that all who have the farmer's interest at heart hold now-a-days, that farmers should be acquainted with the principles of their art and capable of intelligently applying them. In physiology he showed, as Lavoisier had suggested, that animal heat was due to oxidation, and overthrew single-handed the false doctrines of the day. He classified foods; he showed the chemical relationship between vegetable and animal substances. In the ordinary run of life he introduced an improved method of silvering mirrors, he suggested rational systems of cooking, and modes of making extracts of meat. It is, in fact, by the latter utilitarian discovery that he is mostly known to the non-chemical and non agricultural public, and we have to thank the author of the present neat little volume for making the world better acquainted with this versatile scientific genius. We personally would have preferred a little more about Liebig and his methods and processes and a little less of the "Familiar Letters;" but perhaps people do not generally read them, and so the author has thought it well to introduce as much of Liebig's scientific autobiography as he has.

Sir Henry Roscoe has succeeded admirably in producing a bright, sympathetic volume out of Dalton's comparatively uneventful time; for, besides many interesting incidents of this simple but charming life, he has introduced so much of his own individuality into the volume. His enthusiasm for Manchester leads to its being mentioned so favourably and so often, that one is almost led to regard it as the main centre of enlightened progress of the century; then his educational lore daintily shows us how advanced our North-country men and women were a hundred years ago, for although there were no "sweet girl graduates," yet there were young women who made use of "decimal fractions—a snare and stumbling-block even to some 'great' men of the present day." And, again, we are told that the syllabus of Dalton's school reminds us of a technical school of the present day; the syllabus included twenty-six subjects, and terminated with an "&c." Then his political ardour furnishes some delightfully irrelevant remarks. Thus, in connection with Dalton's father's loom, we are reminded that the "grey coats of Cumberland" was a well known appellation for sturdy Liberal opinion. Then, too, Dalton, who apparently was absolutely devoid of political instincts, is thrust among Liberal-Conservatives, or those men, we are told, who think things ought to progress but would rather they remained as they are. But it is a delightful little book.

Both books, in fact, are neither too long nor too technical; they are interesting and fascinating reading, and repay well for perusal.

BOOKS RECEIVED.

Cyanide Processes. By E. B. Wilson, E.M. First edition. First thousand. New York: John Wiley and Sons. London: Chapman and Hall, Ld. 1896.

Roads and Pavements in France. By Alfred Perkins Rothwell, A.M., Ph.D. First edition. First thousand. New York: John Wiley and Sons. London: Chapman and Hall, Ld. 1896.

Heating and Ventilating Buildings. An Elementary Treatise. By Rolla C. Carpenter, M.S., C.E., M.M.E. First edition. First thousand. New York: John Wiley and Sons. London: Chapman and Hall, Ld. 1895.

Manual of Lithology: Treating of the Principles of the Science, with special reference to Megascopic Analysis. By Edward H. Williams, jun., E.M., F.G.S.A. With six plates. Second edition. First thousand. New York: John Wiley and Sons. London: Chapman and Hall, Ld. 1895.

Petroleum. A Treatise on the Geographical Distribution and Geological Occurrence of Petroleum and Natural Gas, &c. &c. By Boverton Redwood, assisted by Geo. T. Holloway and other contributors. In two volumes, with numerous maps, plates, and illustrations in the text. Vols. 1 and 2. London: Charles Griffin and Co., Ld. 1896.

THE BALANCE SHEET OF A GERMAN STEEL WORKS.

OUR contemporary *Stahl und Eisen* gives in its periodical industrial reviews abstracts of the published reports and balance sheets of many of the principal ironmaking and engineering works in Germany, and from this we extract the following figures taken from the report of the Gütehoffnungs Hütte Mining and Smelting Company, of Oberhausen, in Westphalia, which may be of interest as giving an idea of the conditions governing the iron trade in Germany. The business is a very large one, combining coal, lime, and ironstone mining, blast furnaces, foundries, forges, and rolling mills, with general mechanical engineering and bridge building. During the period under review—1894-95—the average number of blast furnaces blowing was 7·48, the bulk of the ore being purchased. The capital of the company is about £800,000, divided into preference and ordinary shares in the proportion of about 5 to 3, the former receiving 5 per cent. and the latter 4 per cent. dividend.

Output, Year 1894-95.

	Metric tons.
Coal	1,294,354
Iron ore	168,175
Limestone	53,669
Pig iron	276,773
Malleable iron and steel	189,861
Machinery, boilers, bridgework, castings, &c.	30,839
Total number of hands employed	11,313
Wages paid	£579,409

Taxation.

	£	£
State income tax	2337	
State trade tax	472	
State ground and building tax	586	
Local income tax	6590	
Mining taxes (nine months)	5226	
	—	15,211
Contributions to Works Sick and Pension Fund	3936	
" " " Miners' Fund	6655	
" " Rhenish-Westphalian Smelters' Common Fund	5258	
Contributions to Rhenish-Westphalian Miners' Common Fund	5747	
Contributions to Imperial Pension and Insurance Fund	3932	
	—	25,528

The amount paid in taxes and compulsory benefit funds was larger than the dividend paid to the shareholders, the former corresponding to 5·08 per cent., and the latter to 4·62 per cent. on the capital. Or looking at it in another way, 60 per cent. of the divisible profits were assigned to the shareholders, and 40 per cent. to the benefit and insurance funds for the workmen. The contributions to the funds represent 4·46 per cent on the wages paid.

In the commencement of the report the directors state that the improvement in business in January, 1894, consequent on the Treaty of Commerce with Russia, was not maintained, and towards the end of the year the prices of merchant bars, sections, and plates were depressed at times below prime cost. This was especially the case with shipbuilding materials, which, being free from import duties, could be supplied from England to German shipyards at prices which excluded the producer, burdened with social political loads and suffering from excessive railway freights, from competition. Thus it appears that the railways are singled out in Belgium, as in England, as the direct cause of bad trade. This is scarcely consistent with the Report of the Iron and Steel Trade Association.

DRONFIELD SEWAGE DISPOSAL SCHEME.—A Local Government Board inquiry was recently held by Colonel Durnford, R.E., into an application of the Dronfield District Council for a loan for the purpose of sewage disposal works. Dr. Mackintosh, Medical Officer of Health, gave evidence in favour of the scheme, and Mr. George White, C.E., of Mexborough, the engineer for the new works, exhibited the plans and levels, and stated that the method of purification to be adopted was that known as the International system of ferozone and polarite.

THE ROYAL INSTITUTION.—The following is a list of the lectures to be given on Friday evenings before Easter:—February 7th: The Hon. John Collier, "Portrait Painting in its Historical Aspects." February 14th: Mr. J. J. Armistead, Member of the Royal Commission on Tweed and Solway Fisheries, "Fish Culture." February 21st: Mr. Edward Frankland, D.C.L., LL.D., F.R.S., M.R.I., "The Past. Present, and Future Water Supply of London." February 28th: Mr. John Murray, LL.D., Ph.D., D.Sc., "Marine Organisms and their Conditions of Environment." March 6th: Mr. A. R. Binnie, M. Inst. C.E., F.G.S., M.R.I., chief engineer, L.C.C., "The Tunnel under the Thames at Blackwall." March 13th: Mr. William Samuel Lilley, M.A., Hon. Fellow of Peterhouse, Cambridge, "The Theory of the Ludicrous." March 20th: Professor T. R. Fraser, M.D., LL.D., F.R.S, "Immunisation against Serpents' Venom and the Treatment of Snake-bite with Antivenene." March 27th: Professor Dewar, M.A., LL.D., F.R.S., M.R.I., "New Researches on Liquid Air,"

THE CHIMNEY DISASTER AT BURNLEY.

THE accidental falling of large chimney stacks in this country is, we are glad to be able to say, of rare occurrence, but it is nevertheless unfortunate that these accidents are always attended by loss of life, independently of the great destruction of property. On Saturday, January 4th—this year—at about 6.30 p.m., the weather being particularly calm and mild, without the slightest warning of coming danger, a chimney stack, situated practically in the centre and most crowded part of the busy manufacturing town of Burnley, Lancashire, fell with a tremendous crash, destroying and damaging several shops, and causing the presumably instantaneous death of three persons, and severe injuries to another. Nearly four years ago—March, 1892—we had occasion to chronicle a similar catastrophe in connection with the fall of the Marsh Mills chimney, Cleckheaton, Yorks, whereby fourteen lives were lost, and little more than fourteen years has elapsed since fifty-four persons met their death by the falling of the stack connected with the Newlands Mill, Bradford, Yorks, belonging to Sir Hy. Wm. Ripley, Bart., and it may be interesting to some of our readers if we give a short account of these disasters

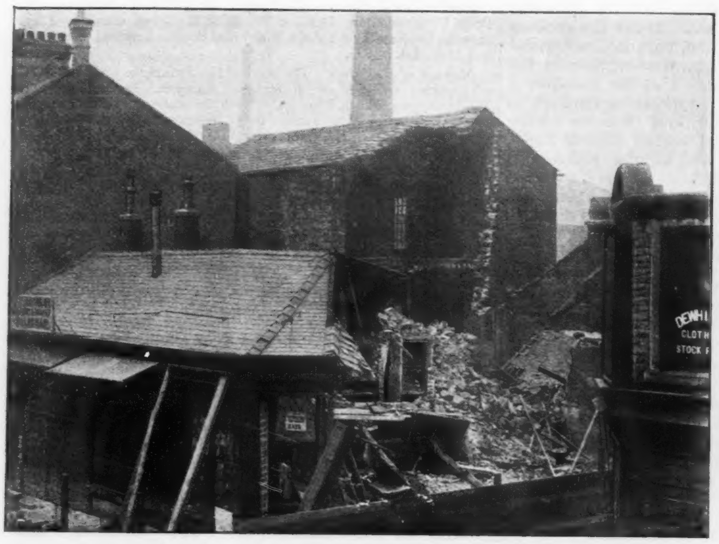


Fig. 2—VIEW FROM ST. JAMES' STREET

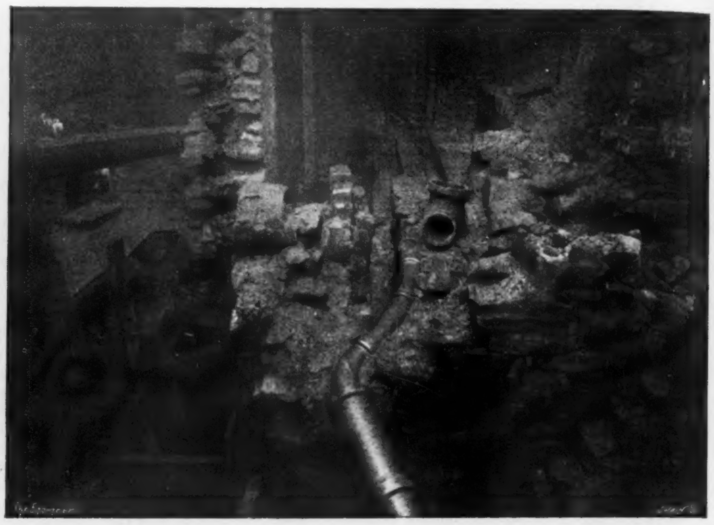


Fig. 4—VIEW SHOWING DRAIN PIPES

The chimney in connection with the Newlands Mill, Bradford, was erected in 1863, being 240ft. high and 24ft. square at the base, built of coursed stone, with brick lining and backing, at a cost of about £950; the site being over an old coal shaft and workings, the disused pit being filled up with concrete, thus forming a centre pillar with four piers of lime concrete and packing of stones and oak wedges round the same. When the structure had attained the height of 70 yards—210ft.—it was found to be bulged out on one side, and hollow on the other, and after careful examination it was decided to straighten the work, and for this purpose one course of stones, about 53ft. from the base, and on the opposite side to the canting, was cut out and replaced by others of reduced thickness; but as this did not prove sufficient, the chimney still not being plumb, a second cut was carried out about 2ft. above the first one, and the stack was then declared to be "as nearly perpendicular as possible." Some three years after completion, cracks were observed in the chimney, on the opposite side to where the cuts had been made, and several stones were broken, and again repairs were carried out, whilst six years later cracks reappeared and the chimney was again repaired.

About two months before the collapse several people employed in the mill began to be alarmed at the general appearances of certain cracks they found in the chimney, and consequently persons were called in to advise, and it was decided to pull out the bulged portions and repair the outer casing, this outer casing being considered the sole cause of defect. On December 23rd, 1882, about 10 yards in length of the damaged portion of the outside casing was pulled down on the east side, and an attempt was made to also remove a bad piece on the south-east face, but the stones being so tightly fixed together it was found impossible to deal with them.

Three days later a small portion of the outer casing fell, and on the day following another portion of this outside walling came down, and it was discovered that this was part of the stonework which could not be removed a few days previously. The night of December 27th, 1882, was very stormy, the wind pressure being estimated at 16lb. per square foot, and on the morning of the 28th December more stones fell, and shortly after 8 a.m. the stack began to settle down, stones and lime falling on all sides from the part where the chimney had been cut, then followed a bursting out of the lower portion, and after reeling a little the huge erection fell with a terrific crash in a south-easterly direction, killing fifty-four persons and destroying about £20,000 worth of property.

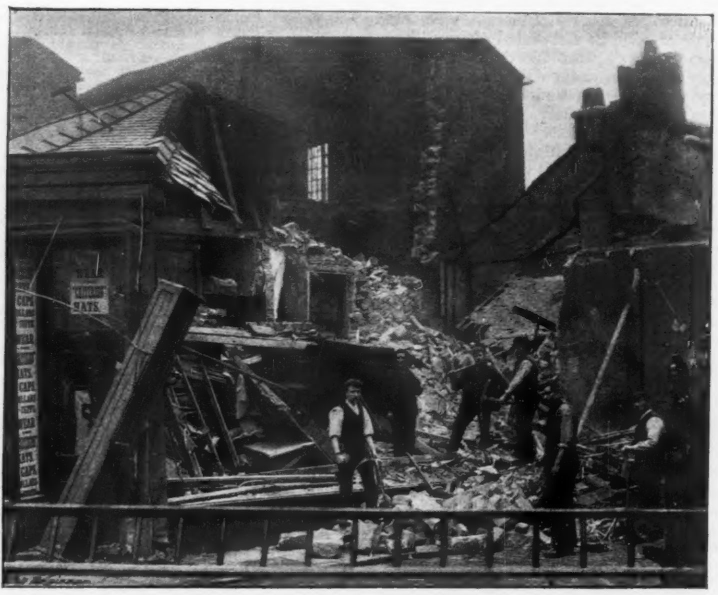


Fig. 3—VIEW FROM ST. JAMES' STREET

After a careful examination and protracted inquiry, the reasons assigned for this accident were as follows, viz.:—(1) Bad foundation, the site selected, being over an old coal pit, was unfortunate. (2) The piers being of lime concrete, were incapable of sustaining a weight of over 4000 tons, estimated. The foundations should have been brought up solid in cement concrete. (3) Bad construction, with regard to the inner lining. (4) The two cuts in the chimney especially being so near to each other. Suggestions were at this time given that all chimneys should be periodically inspected, in order to try and guard against similar accidents in future, but we are not aware of any such suggestions being carried out.

A little over nine years later we recorded a similar accident at Marsh Mills, Cleckheaton, also in the county of York, where the chimney fell and fourteen persons perished by the accident. This chimney was of brick throughout, erected about 1859 to a height of 179ft., and 15ft. diameter at the base. When in course of erection this stack had reached a height of about 120ft., it was found to have given way and got out of perpendicular by about 6in., and this was attributed to the effects of a very wild night. Operations were suspended for some time, but subsequently the structure was cut on one side—as in the case at Newlands Mill—straightened, and then completed. This chimney appears to have been more fortunate than the other referred to, in not requiring so many interim repairs, for nothing seems to have been noticed as to defects until a few months before its fall, when a large piece of stone fell from the underside of the coping, and cracks began to show themselves near the base. Upon this being made known, and rumours getting about as to the safety of the chimney, the owners at once called in a firm of builders, who were instructed to see to the question of repairs.

On a careful internal examination it was discovered:—(1) That water had got into the chimney near the main flue, and the ground at the bottom of the flue was very wet. (2) That some of the bricks inside the shaft near the base were decayed. (3) That the inner and outer shells were only 14in. thick. To remedy these defects, pieces of brickwork were cut out and new walling inserted, and it was whilst these operations were practically in hand—the workmen having just finished for the day, and were fixing some stays outside to support the loose brickwork until morning—when the chimney burst out at the bottom, settled down, and the top portion fell over towards the east, inclined to the south, and, as we said previously, killed fourteen people and destroyed an immense amount of property, machinery, &c.; and we may add that the day was a very calm one, so the structure was not influenced by the wind.

The causes assigned for this accident were:—(1) Weak construction and faulty in design; (2) the presence of so much moisture; (3) inferior quality of bricks; (4) deterioration of the structure consequent upon moisture; (5) the *modus operandi* of the repairs.

The verdict of the coroner's jury was one of accidental death by the fall of a chimney under repair, and they considered the owners to blame—not criminally—for not having the chimney looked to by way of repair at an earlier date. Again were suggestions made for the regular examinations of such structures, but we presume with the same result as in the former case.

Having given a brief sketch of these two disasters, we now turn to the one of recent date at Burnley. The principal industry in the town of Burnley is that of cotton spinning and weaving, and in addition there are several ironworks, brickworks, &c. &c., to all and every one of which large chimneys are attached; and in a concentrated area of about 1700 acres there are upwards of 250 chimneys, surrounded by works, shops, dwellings, &c., representing a population of about 50,000 within that area, although the town and population of Burnley has greatly increased in area and numbers of late years. These chimneys vary so in height, construction, and general description, that there are practically no two alike. The chimney directly under our notice was connected with the works locally known as "Howarth's Factory," or "Bottom-o'-th'-Town Mills," where years ago employment was afforded for many hands in the manufacture of cotton; the building was upwards of eighty years old, and at one time projected considerably into one of the main thoroughfares of the town, but on a large portion of the mill being burnt down, about twenty years ago, street improvements were effected, and on the remaining portion of the site of the old works lock-up shops were erected. The chimney was, however, left standing in connection with a portion of the original building to which it was directly connected, being practically built in and partially surrounded by, the walls thereof, though not bonded or tied thereto, and situated in the "Pack-horse Yard." It was located on the north side of St. James'-street, one of the main streets of the town, and along which the tramway is laid between the two towns of Padiham on the west and Nelson on the east, Burnley being about half way between. The distance from this main thoroughfare to the chimney was only 35ft., or less than one-half of its own height, and this intervening space is occupied by the lock-up shops mentioned above, with the exception of a passage, situated immediately against the stack, of about 5ft. wide.

On the easterly side of the chimney, and at a distance of 32ft., is another public roadway called Calder-street, the space between being devoted to a passage 5ft. 6in. wide, and lock-up shops as before, whilst in the west and north-westerly side is the river Calder. The lock-up shops on the south and east sides were only one storey high, and occupied by various tradesmen who had access to the passages which surrounded the chimney at the rear of their respective premises, as well as the usual front entrances in the main streets. The chimney, as before stated, was connected with a portion of the old mill, and this building had of late years been used as a bakery, but more recently as a warehouse and stables, the existing flues and stack being out of use.

The structure was built of rough rubble stonework for the outer casing, the dimensions of the portion of the base after the accident being, so far as could be ascertained, 1ft. 6in. thick for the south wall and 1ft. 11in. for the east wall, the chimney being a little wider from north to south than from east to west, and probably about 8ft. 6in. by 7ft. at the base. Inside the shell was a common red brick lining, which had evidently been put in 9in. thick, and perfectly separate and independent of the outside wall; but to what height this lining had been carried it is impossible to say. The chimney had evidently been originally erected to a height of about 60ft., all of rubble stone with a slight taper, and finished with a projecting stone cap or coping; but at some subsequent period an additional height in brickwork had been added, probably to meet with the requirements of the local bye-law, which, when it came into operation, made it compulsory for "all chimneys, already or hereafter erected, for carrying away smoke from the furnace of any mill factory," &c., should be "raised to the height of 90ft. at least from the level of the centre of the street nearest thereto," such height above 90ft. being regulated by the amount of horse-power of the engines in use on the works. Therefore this additional height in brickwork would probably be over 30ft., and the total weight of the structure, based on these dimensions, was about 125 tons. Since the time when the main portion of the premises was burnt down, the chimney had shown signs of decay, and had a cant towards the south-east, with a perceptible bulge on the opposite side. Cracks in the structure had also been noticed, and it is stated, "there was a large vertical crack extending a considerable length" on the south side.

Some time ago a portion of the brickwork forming the top of the shaft was taken down, and flat iron strap bands or cramps were fixed—seven in number—at intervals in the stonework, though the straps did not encompass the shaft, but appeared to fit along the face of one side and round the two angles at the corners. The chimney, however, continued to deteriorate, and frequently stones and bricks fell from it, especially when the weather was boisterous, and the mortar, in the form of dust, came out of the interstices in the rubble stone wall of the shell. These and other symptoms indicative of the unsound condition of the shaft aroused the fear of the various persons whose lot it was to be constantly in close proximity to this building, and naturally they became more and more alarmed as time passed on and the structure went from bad to worse, and various complaints were made to the owners of the premises—which included the shops—from the tenants of these shops, which surrounded the chimney. Notices were also served by the borough engineer of the town, who wrote to the agent for the property in July, 1894, as follows, viz.:—"I understand you are the agent for certain property in the Packhorse Yard, which is in a very dilapidated condition, and I shall be glad if you will give instructions for the necessary repairs to be attended to at once." Again, on May 10th, 1895, the same official wrote direct to the owners, saying:—"I beg to draw your attention to the dangerous condition of the chimney at the rear of the Packhorse Inn, and shall be glad if the same is repaired and made secure as early as possible."

No notice whatever was taken of those communications, not even an acknowledgment being sent, and although, according to the evidence, the agent and the owners came upon the ground on many occasions, and heard the complaints of the tenants and others, nothing was done to the structure, nor was any inspection made to ascertain whether the allegation concerning the "dilapidated or dangerous condition" of the chimney had any foundation in fact or otherwise.

Consequently, matters remained *in statu quo*, with the threatened danger still unheeded, but going from bad to worse as time went on.

On the Monday previous to the disaster, *i.e.*, five days before, it was noticed that the flags forming the floor of the passage on the south side of the chimney had slightly risen or buckled, and these continued to get worse until the day preceding the fall, when they—the flags—were very considerably out of level, having the appearance of having been pushed in at the sides, and consequently risen at the joints towards the centre, and one of the shop tenants who observed this called the attention of others to it, but did not communicate with the owners, though resolved to do so on the first occasion which presented itself. However, nothing further was done or particularly observed, but on the following day, Saturday, January 4th, about 6.30 p.m. the weather being perfectly calm and fine, and with the busy traffic of the day in full operation, without a moment's warning, but accompanied by a rumbling sound, the structure fell in a south-easterly direction, and directly upon the shops occupied by Mr. Richard Boys and Mr. Grant, killing the former gentleman and his wife, who was in the shop with him at the time, and a little girl named McCluskey, who was a customer in the shop of Mr. Grant, the latter gentleman being subsequently rescued from the *débris*, though very seriously injured. The news of the disaster caused great excitement and consternation in Burnley and district, and much sympathy was expressed for the family of Mr. Boys—four in number—who was well known in the town, being highly respected, and a prominent local cricketer of considerable repute.

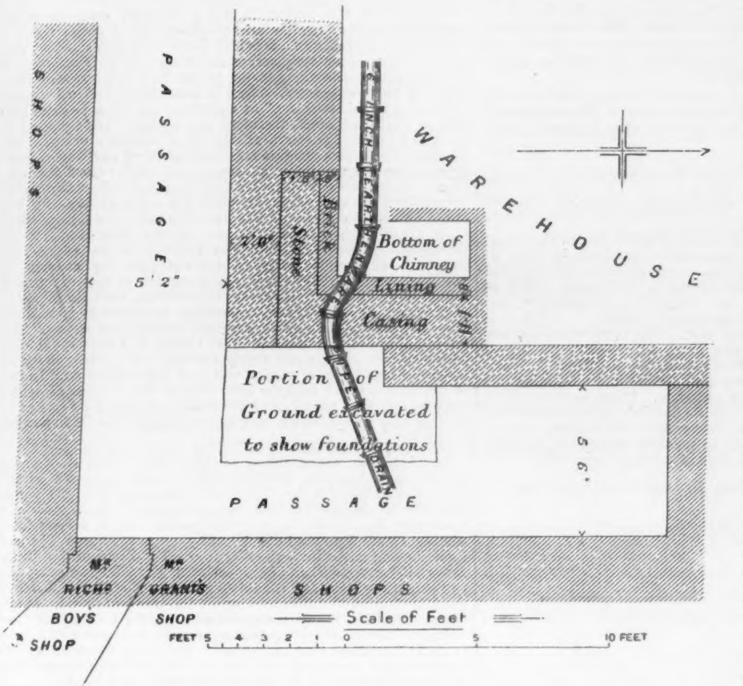


Fig. 1—GENERAL PLAN

At the inquest held in the Burnley Town Hall on the 7th ult., formal evidence only was given, and the inquiry was adjourned until the 14th ult., in order that an examination might be made of the remains, if any, of the chimney after the *débris* had been cleared away, for the two shops occupied by Mr. Boys and Mr. Grant had been completely destroyed, and the amount of material to be cleared away was very considerable, and in fact, so much so, that the inquiry was further postponed until the 21st ult.

The work of clearing the *débris* was proceeded with under the direction of the borough surveyor, who issued instructions to the workmen engaged that every care had to be observed in trying to leave intact as much of the remaining portion of the chimney as was possible, in order to afford every opportunity of a careful examination. This work was at last completed, and an inspection took place on the 18th ult., when it was found that a small portion only of the chimney—about 4ft. long and 3ft. high—of the outside casing and lining on the south side had been left standing above the level of the ground; and this remnant consisted of rough rubble stone walling, of which the shell was composed, and measuring about 18in. thick, and common brick lining 8in. thick. The rubble walling was of a very inferior quality, the stones being particularly small, without the usual "throughs," and very short of mortar, which was also reduced to a pulverised substance of no definite analytical composition, and of no use as a building compound. The brick lining, which abutted directly on the inside of the stone casing, and without any cavity, was also of a poor description, and had evidently been reduced from 9in. to 8in. thick by the action of the heat to which it had been exposed. There was practically no bond at the angle—south-east—and in the portion remaining there was a straight vertical open joint of 22in. in length, though the mortar in connection with this brickwork had evidently been of fair quality, though, like the bricks, had been subject to a heavy calcination. In both the outside casing and inside lining several cracks of long-standing were in evidence, and no doubt could have been detected by an ordinary inspection whilst the chimney was in existence.

On the level of the ground, and presumably the bottom of the inside of the chimney, a 6in. internal diameter drain had been laid, passing through the structure at the south-east corner, and directly in the angle thereof, and out through the west wall, though no trace of this wall was in existence. This drain was of earthenware socket-jointed pipes and quite intact, and had evidently been laid within the past few years.

At the adjourned inquiry on the 21st ult., evidence was adduced as to the falling of the chimney, together with the particulars of the warnings given to the owners and agent at various times, and details of the inspection of the ruins, as named above; but as it had been suggested that the foundations of the structure should be exposed, the inquiry was further postponed until the 28th ult., in order that this might be done; and on the 24th ult. these foundations had been bared to a depth of 6ft. 6in. on the south and east sides, but not for their entire depth. These foundations were similar in construction to the superstructure, *i.e.*, of very inferior rubble walling of stone, and an insufficiency of mortar. The top portion—at ground level—of the south side had canted over, but not to any great extent, and this was caused no doubt by the spreading of the chimney at the base, which was considerably confined in its movement, owing to the existence of one of the outside walls, about 2ft. thick, of the building adjoining, which was situated on the south side of the chimney, and abutting thereon, though entirely independent of each other—see enlarged plan. The south-east corner was also much shaken, and a portion at the top broken away; but with these exceptious the foundations appeared to be intact, and no subsidence or settlement had apparently taken place. The pipe drain before referred to, when exposed on the east side of the foundations, revealed a most extraordinary line, especially so where it pierced the chimney, though the pipes themselves were all practically in the same condition as when laid.

At the further hearing of the matter on the 28th ult., evidence was given as to the state of the foundations, the laying of the drain, the probable cause of the accident, &c. &c., and the agent for the property was also examined. He stated that the drain was laid to satisfy the requirements of the Health Department of the Burnley Corporation, who, however, did not dictate the route or line of this drain, which was laid for the owner by a local contractor; but neither the agent nor the contractor—who was also put in the box—could suggest why the pipes were laid through the chimney, except it was in order to connect with a private sewer belonging to the owners of the property, and situate nearer to the new work than the existing public drain in Packhorse Yard.

Important evidence was given by Mr. Joseph Smith, of Rochdale—a famous steeplejack—whose business or calling is the repairs of chimneys and their removal when necessary. He informed the Court that in August, 1892, he was in Burnley and noticed the chimney in question, which he considered to be from 60ft. to 70ft. high, but had evidently been intended and built for a 20 yards chimney, hence the two portions in stone and brick. He wrote to the owners at that time, saying he would be glad to send a tender for taking the structure down, but received no reply. He considered that a chimney which had been stopped working for five years should be pulled down, especially rubble stone chimneys like this, which ought to have come down at once, and he attributed the fall of the structure to:—(1) Faulty construction; (2) bad mortar; (3) the raised brick top; and (4) the laying of the drain.

Other expert evidence was given in condemnation of the stack, and the general opinion was that the chimney had fallen through (1) Faulty construction when erected; (2) the outside casing and lining having deteriorated by heat, weather, and general decay; (3) overstrain at some period subsequent to the building thereof, by an additional weight being put upon it; (4) want of attention in repairs from time to time, especially as cracks were numerous and observable; (5) the cutting of the drain through the structure, particularly at a corner. The result of the above being that the chimney literally "burst" at the bottom, and would probably have fallen before, had not the wall on the south side abutting on the stack formed a considerable support, and no doubt it was the pushing out of this wall at the foot which caused the flags in the passage—between this wall and the back of the shops—to "buckle up," as mentioned in evidence by one of the witnesses, through the high compressive strain on their horizontal position.

The unanimous verdict of the jury was:—"That Richard Boys, Mrs. Boys, and Margaret McCluskey have accidentally met their death through the falling of a chimney, off St. James-street and Calder-street, property belonging to Mrs. Dale and others. The jury attach the whole of the blame to the owners, inasmuch as they have had repeated warnings of the dangerous condition of the chimney, two official notices having been served by the borough surveyor, one in July, 1894, and the other in May, 1895, besides several warnings from the tenants, and yet they refused to take the chimney down. The jury are of one opinion, viz., that the loss of life and property is due to the negligence and indifference of the owners. The jury also desire to say that in their opinion no blame whatever is to be attached to Mr. Christopher Slater, the late nuisance inspector, with regard to the construction of the drain."

We may add that it is rather a singular coincidence that in each of the three accidents recorded the chimneys fell in a south-easterly direction, which we understand is considered the weather side of such structures, and therefore the weaker.

Fig. 1 is a plan showing the remnant of chimney after the accident, also the drain, the excavation to foundations, the wall support on south side, passages, &c. Fig. 2 is photograph of the ruins taken from south-east corner in St. James'-street. Fig. 3 is the same from a different point of view. Fig. 4 is a photograph taken for evidence at the inquest, showing the foundations, excavation, and remaining portion of outside casing and inside lining of chimney, also the drain referred to, and was taken from the passage on the east side.

LETTERS TO THE EDITOR.

(*Continued from page* 138.)

THE PELTON WHEEL.

SIR,—With reference to your notice of Mr. Bovey's book, and to your remarks on the absence of information as to the Pelton wheel, I think it is hardly necessary to give the exact shape of the buckets, but what is badly wanted is trustworthy tests as to its efficiency.

Full details should be given of the head at the nozzle and the method of measuring the water, so that any engineer could check the calculated results for himself. I may say I have tried to get such data, and have failed to find any in which I can have confidence. Either no authority has been given for the published statements, or the tests have been carried out in a very rough manner, with essential details left out, or have been what may be termed "makers' tests;" and we all know that makers' statements and the achieved results when independently tested do not always tally. It has been largely adopted, mostly in mining districts, where its advantages of low price—under great heads—cheapness of transport and erection, and extreme simplicity, far outweigh any questions as to efficiency, provided that it is reasonably high. For ordinary work, where the load and water supply vary considerably, its principal defect is a difficulty in efficiently governing it, though that can be partly got over by a system of multiple nozzles.

From its theory there appears no reason why this machine should not give at least as high an efficiency as any other impulse turbine, at all events, at full load; but after all, "the proof of the pudding is in the eating."

I understand that the essential feature of the Pelton wheel is the "splitting piece" in the centre of the bucket, which takes the place of a body of water more or less solid, which was carried over by the wheel of an earlier improvement on the "hurdy-gurdy," wheel which had simple cup-shaped buckets, the water so carried over being thrown off by the centrifugal action of the wheel, with a corresponding loss of energy.

From tests made by Mr. Hamilton Smith, jun., at N. Bloomfield, Cal., it appears that the efficiency of the old "hurdy-gurdy," with flat buckets (?), working under a head of 300ft. of water, varied from 31 to 41 per cent., according to the shape of the nozzle, the best results appearing to be obtained with a straight nozzle, and with a ratio $\frac{\text{velocity of bucket}}{\text{velocity of jet}} = 0{\cdot}57$.

In conclusion, what is wanted is not a theoretical examination of the wheel—that is simple enough—but carefully made tests published by someone who has "eaten the pudding."

GEO. F. PARDOE.

81, Harrow-road, Paddington, January 31st.

ENGINE TESTS.

SIR,—I herewith beg to hand you copy of a test made by the Association pour la Surveillance des Chaudières à Vapeur—directeur, M. R. Vinçotte—at Brussels, controlled by the engineers of the Cie. du Nord—Messrs. Ranciat, Leaurent, and Aliamet—on two single-condensing automatic cut-off—system Arthur Bollinckx—engines, supplied and erected by us to the electric light central station at Erquelinnes. The engines were 450 mm. diameter and 900 mm. stroke.

The result as per enclosed test is very remarkable, the consumption of steam was 7·05 kilos. only per indicated horse-power per hour, inclusive of condensed water of the jacket. This test shows what we can do in this line, and we hope you will place it under the eyes of the readers of your valuable paper, as it will be of interest to all those concerned in the discussion that took place in the columns of your valuable paper concerning gas engines *v.* steam engines.

Association pour la Surveillance des Chaudières à Vapeur—Directeur, M. R. Vinçotte, à Bruxelles.—Extract of the Report on the Test.

Both engines have given the same result, and have consumed only 7·05 kilos. of steam per indicated horse-power and per hour. They were, besides, in the same conditions, as indicated hereunder:—

Date	January 7th	January 7th
Engine	No. 92	No. 91
Mean pressure at boiler	7·1 atms.	7·1 atms.
Mean effective pressure in cylinder	2·2 kilos.	2·52 kilos.
Vacuum measured on the indicator cards	0·945 kilos.	0·947 kilos.
Maximum of horse-power developed	116·5	134·8
Minimum " "	104·1	117·7
Cut-off corresponding to maximum I.H.P.	8·3 p.c.	9·9 p.c.
" " minimum "	6·9 p.c.	7·7 p.c.
" " mean "	7·8 p.c.	9·1 p.c.
Mean speed	80·53	79·90
I.H.P. to overcome friction without belt on fly-wheel	9·02-h.p.	9·45-h.p.
Trial without condenser, steam consumption	—	9·93 kilos.

All these tests result in the following:—

(1) That the engines have consumed on an average 879 grammes of coal with 10 per cent. ashes and 5·65 per cent. of moisture.

(2) That the effective work is with the proportion to the indicated horse-power 92·85 per cent. That is to say, the mechanical efficiency is 92·85 per cent.

(3) That one single boiler is quite sufficient to supply all the steam for one engine working non-condensing and developing 130 indicated horse-power.

(4) That all the conditions of regularity have been fulfilled.

(5) That the consumption of the engine, non-condensing, has been 9·93 kilos. of steam only per indicated horse-power per hour; that is, 40 per cent. more than condensing.

(Signed) LE SOUS-DIRECTEUR DEJACE.

Seen and approved: R. VINCOTTE.

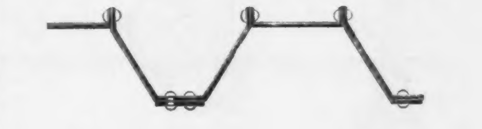
About coal consumption it may be said that the boilers, which were not made by us—our exclusive speciality being steam engines—have vaporised 7·79 kilos. of water per kilo. of coal, owing to their tubular system. Should same have been Cornish-Galloways, then the production of steam might have been 9 kilos. of water per kilo. of coal, and in these conditions coal consumption would have been reduced to 783 grammes per indicated horse-power per hour.

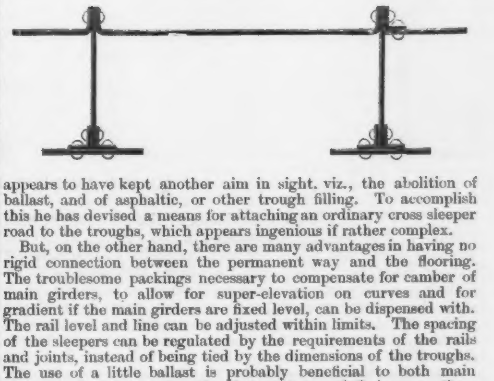
Brussels, February 1st. H. BOLLINCKX.

BRIDGE FLOORING.

SIR,—I read with interest the description of Barker's bridge flooring appearing in your issue of the 24th inst., it being in several features identical with a flooring which I designed some two years ago. The main points kept in view in my design are:—(1) That all rivets can be put in by machine. (2) That temporary staging may be dispensed with, so far as the erection of the flooring is concerned. The manner in which these desiderata are secured is shown by the accompanying tracing, but numerous modifications will suggest themselves to every engineer.

Fig. 1 shows an ordinary trough used in conjunction with a channel iron. The troughs may be filled with tar concrete, and the whole asphalted over. Fig. 2 is a system of girders, the top flanges of which are formed of floor-plates attached to the webs of the girders in the manner shown. In either case the principle observed is much the same as in Mr. Barker's flooring. But he appears to have kept another aim in sight. viz., the abolition of ballast, and of asphaltic, or other trough filling. To accomplish this he has devised a means for attaching an ordinary cross sleeper road to the troughs, which appears ingenious if rather complex.





But, on the other hand, there are many advantages in having no rigid connection between the permanent way and the flooring. The troublesome packings necessary to compensate for camber of main girders, to allow for super-elevation on curves and for gradient if the main girders are fixed level, can be dispensed with. The rail level and line can be adjusted within limits. The spacing of the sleepers can be regulated by the requirements of the rails and joints, instead of being tied by the dimensions of the troughs. The use of a little ballast is probably beneficial to both main girders and rolling stock. Crossings, points, and their connections can be laid without making special arrangements. The cost and weight of asphalte and filling would generally be less than for Z-bars and other special connections.

I think that bridge floors of the type under consideration should have a wide use in the future, but if so, it will depend on their simplicity, ease, and cheapness in erection.

J. W. TWINBERROW.

Leicester, January 31st.

THE TRUSTY GAS ENGINE.

SIR,—Will you allow me a small space in your valuable paper to correct an error appearing in the "Trade and Business Announcements" of THE ENGINEER, dated January 24th last? I beg to say that it is generally known Mr. Weyman did not bring out the Trusty gas engine, or develope the oil engine with Mr. Knight. When I joined Messrs. Weyman and Hitchcock at Guildford in 1889, they were agricultural engineers only. In 1890 I introduced the Trusty gas engine as it is to-day, and I also worked with Mr. Knight improving the oil engine, for which in both cases patents have been taken out in my name jointly with those of the firm, and for which I am in the receipt of royalties at the present time.

I resigned my appointment with Messrs. Weyman and Hitchcock, Limited, in February, 1895. This was a limited company long before their removal to Cheltenham. J. A. DRAKE.

64, Westbourne-grove, Bayswater, W.
February 4th.

CIRCULATION IN WATER-TUBE BOILERS.

SIR,—Thinking that the following facts may prove useful in the investigation of the above-named subject, I now note them thus:—

A hot-water tank placed on the upper floor of a house was connected by two pipes to a kitchen boiler at the bottom of the house. The circulation was most unsatisfactory until it was discovered that there was only a difference of half an inch between the heights of the two pipes where they entered the bottom of the tank. An internal pipe about 12in. long was then screwed vertically into the pipe—inside the tank—leading from the top of the boiler; on refilling the tank, the circulation was found quite satisfactory, and is continuous in one direction. Before the alteration it was difficult to know from feeling the pipes which was the hotter of the two. IRON.

London, February 1st.

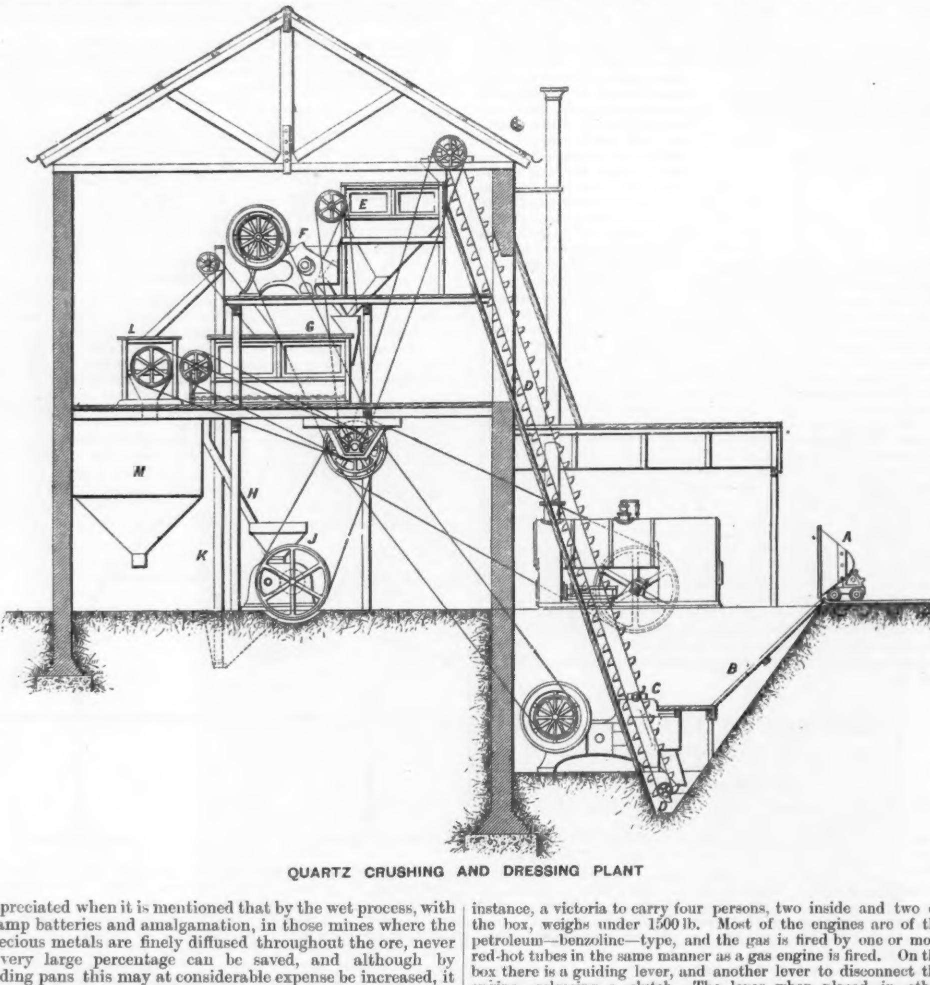
REGENERATORS.

SIR,—In your excellent article on "Regenerative Cold," which has been so beautifully utilised by Dr. Linde in his system of liquefying gases, I think the word "regenerator" is scarcely explanatory of the process. It is not a process of generation, but a process of the transfer of heat from one body to another, this name being first used—as you point out—by Dr. Stirling in his hot-air engine, and then by Captain Ericsson in his caloric engine, and then by Siemens in his air engines and gas producers. I would suggest that the process be called "transheating," and the apparatus be named a "transheater," and in the reverse process a "transcooler." These names will more distinctly explain the process. J. ROBSON.

Essex-street, Birmingham, February 4th.

THE DRY PROCESS AS APPLIED TO GOLD MINING.

THE more extended introduction of the dry process in gold mining in connection with leaching, particularly with cyanide, has necessitated the production of new and improved arrangements of machinery and has given a considerable impetus to English and foreign mining engineers. This will be readily appreciated when it is mentioned that by the wet process, with stamp batteries and amalgamation, in those mines where the precious metals are finely diffused throughout the ore, never a very large percentage can be saved, and although by adding pans this may at considerable expense be increased, it even then rarely exceeds with the two operations 60 per cent. By the dry process, however, followed by efficient leaching, it is proved that more of the gold may be recovered.



QUARTZ CRUSHING AND DRESSING PLANT

The engraving above gives an illustration of a modern set and improved arrangement of machinery, forming a complete plant of quartz crushing and dressing machinery. On reference to the engraving it will be seen that the quartz, as brought in trucks to the reduction mill, is first dropped on to a grill, which is termed a grizzly, from whence it is fed into a stone breaker. This machine reduces the large lumps of quartz into pieces about the size of an egg. This broken material is then taken up to the top of the building by an elevator D, and, passing through a rotary screen E, enters a second and smaller stone breaker F, which still further reduces the quartz to about the size of a nut. The quartz, thus twice broken, next enters the second screen G, which takes out a certain proportion of the powdered ore, and that portion of the ore too large to pass through it is conveyed by the spout H to the crushing rolls J, which, in fact, perform an important part of the operation. These rolls have a smooth, hard surface, and the finely broken quartz is passed through them until it is reduced to a properly crushed and powdered condition. The product from the rolls is now taken by a small elevator K to the third or finishing screen L, which may have perforations of any desired fineness, and on leaving this third screen the ore is delivered into the large hopper M in a finely granulated condition ready for concentration or leaching by the cyanide or other process. Any product too coarse to go through the third screen is returned to the rolls and so crushed again, until sufficiently fine to be passed by this screen to the hopper M receiving the completely finished ore.

The whole of the machinery is driven by a compound steam engine of the undertype pattern, although, of course, the mill may be worked by water or any other power available. The plant illustrated is capable of dealing with a ton to a ton and a-half of quartz per hour, or, say, 25 to 35 tons per day of twenty-four hours, the finished product passing through 40 mesh, that is to say, a screen or sieve having 1600 holes to the square inch. It will be seen that manual labour is almost entirely dispensed with, from the time the rough quartz is fed into the stone breaker to the time it is delivered in a finished condition from the third screen. Larger plants are supplied with two or more sets of rolls, as also any other arrangement of machinery that may be necessary to suit special requirements.

The reduction mill we have described has been designed by Messrs. Julius Harvey and Co., 11, Queen Victoria-street, London, and has met with the approval of practical mining firms from the Colonies.

HORSELESS CARRIAGE NOTES.

ACCORDING to a recent report by the United States Consul at Havre, in a large number of communications from all parts of the United States asking for details of mechanically propelled vehicles, including bicycles and tricycles, in France a kind of "steam horse" is used for the propulsion of ordinary carriages, not constructed with permanent motors. It is joined to the carriage as an integral part of it. The front wheels of any carriage are removed and the fifth wheel—or turntable—is attached to the projecting platform of the "steam horse." These have tubular boilers, and coke is used for fuel. No noise is made or smoke or steam produced at any time. Prices vary according to size, from £375 to £521. There are the chaise, phæton, victoria, &c., which in all cases have the appearance of an ordinary carriage with the shafts removed, while in point of weight the excess is not very great over that of the type of carriage represented. For instance, a victoria to carry four persons, two inside and two on the box, weighs under 1500 lb. Most of the engines are of the petroleum—benzoline—type, and the gas is fired by one or more red-hot tubes in the same manner as a gas engine is fired. On the box there is a guiding lever, and another lever to disconnect the engine, releasing a clutch. The lever, when placed in other positions, gives four speeds. A handle is used for reversing. There is the usual brake lever, and a foot lever is employed to release the speed lever acting as a brake. The valve regulating the flow of the petroleum is also placed near the hand of the driver, but this does not require attention after it has once been set. To start the carriage it is necessary to stand at the back, light the burners which heat the ignition tubes, and turn the handle, and the motor starts. The driver then mounts his box, and by means of his lever clutches the engine to the carriage. Bicycles and tricycles are propelled by a small petroleum—benzolene—motor. The weight of the entire machine is considerably under 100 lb., and the price is about £52. The petroleum vapour is ignited by means of an electric spark. To set the machine in motion the rider mounts, turns a tap to admit the petroleum, which, at the same time, turns on the electric current that lights the fuel; he then propels the cycle with his feet in the usual manner until he feels the motor is working. Another handle is moved, which releases the treadles, and the cycle is then in full swing. On mounting a hill the rider can assess the speed by gearing up the pedals again and using the feet, thus obtaining an addition to the engine power. There is also in course of construction a somewhat similar machine to carry two persons. In France all carriages pay an annual tax. Those with one or two places pay £2; those with three places, £3; and those with four places, £4; bicycles and tricycles pay each 8s. These taxes are payable monthly in advance, and no vehicle can go on the road until the taxes are paid.

WE have yet another conviction for illegal use of a horseless carriage. At Solihull Police-court on the 4th inst., a carriage, belonging to a Birmingham and Maidstone firm of builders, was treated as a locomotive, and the owners were summoned for not carrying in front the necessary flag of warning. The defence was that the prosecution was an absurdity, as the Act was never meant to apply. The Bench, however, felt obliged to inflict a fine of 1s. and costs.

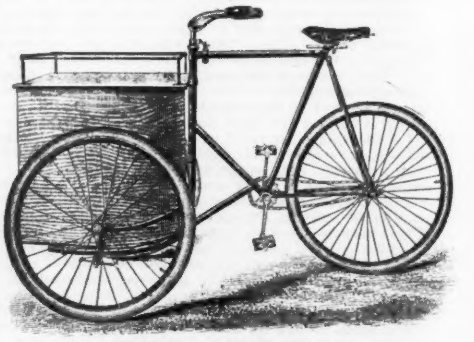
ARRANGEMENTS are being made for an International Exhibition of horseless carriages at the Imperial Institute. It is intended to comprise motor cycles and carriages and plant, and will open in May.

THE formation is announced of the Motor Car Club. It is a proprietors' club, and Mr. F. Simms, Billiter-buildings, Leadenhall-street, announces its formation.

WRITING on the recent horseless carriage competition in the United States, our American correspondent states that:—Among the important facts which have been illustrated by the practical test under very severe and unfavourable conditions, is that the carriages require greater power than has generally been supposed or provided for. Since a horse can exert very much more than a "horse-power" in emergency, as on a piece of bad road or a hill, and since, therefore, one or two "horse-power" is not the maximum power available for a one-horse or two-horse carriage, the motor or engine must be capable of exerting at least as much as the maximum effort available with animal traction. About 5-horse-power would therefore seem to be the minimum to be provided for a carriage intended for ordinary use. It has already been pointed out that makers who look for a foreign trade must adapt their gasoline motors to use high-test refined petroleum—or kerosene oil—since gasoline is an element of danger. Its danger is shown by the fact the amount of gasoline allowed to be held in the possession of any one person is regulated by law. There should, however, be little difficulty in making this change, and the change is certainly desirable in this country, while absolutely essential for European service. The carriages themselves should be of strong and substantial construction, with springs and engine attachments specially designed to ensure steadiness of motion and free from vibration. In two or three cases slight mishaps have caused the collapse of lightly built bicycle wire wheels, and it will be a matter for proof as to how far they will prove trustworthy especially on the driving axles.

OUR American correspondent on this subject writes concerning the article on American Motor Carriages in our impression of the 3rd ult., that there is some confusion regarding the light parcel tricycles and the heavy delivery wagon or parcel van referred to in paragraph No. 2. He says, "The parcels van is a large four-wheeled van such as would be drawn by one or two horses, and used for delivering goods from shops or stores, but fitted with a Bentz motor. The tricycle has a large basket or box slung between the two opposite wheels, and the machine is propelled by the driver in the same way as an ordinary bicycle, the third, or driving wheel, being sometimes behind and sometimes in front of the basket, as desired. The seventeenth paragraph should commence with a statement to the effect that machines of this kind, operated by the drivers, are in somewhat extensive use, and that experiments have been made with motor-driven machines of the same kind."

As to the name to be given to road vehicles having mechanical power, he says, "I think motor carriage is the best, and this may be divided into motor cab, motor trap, motor wagon, &c. It is not correct to say 'self-propelled' carriages, since they are not propelled by themselves but by an engine or motor which is independent of the carriage itself." One correspondent says that "no distinctive term is necessary, as persons do not now speak of a 'cable-drawn tramcar,' &c. As a matter of fact, however, the use of the term cable car, electric car, &c., is common, and in any case a distinctive term is required in discussing the subject, while in the case of a person owning several carriages, horses, motors, &c., he would have to give orders to have the 'motor phæton' brought round if he did not want his horses. In this connection it may be noted that about twenty of the De la Vergne carriages have been sold, many of them to wealthy men with extensive outfits of carriages and horses, so that a distinguishing name is necessary in their establishments. Again, as to the use of the term 'motor,' in electric railway practice the cars fitted with motors are termed 'motor cars,' and where trains of two or more cars are run, the train consists of a 'motor car' and 'trail cars,' the latter having no propelling power. An important outcome of the American trials has been the organisation of the American Motor League, to encourage the development and improvement of motor carriages, to encourage the use of such carriages on the public roads, and to protect their rights to such use, and also to encourage the present agitation for improved country roads."



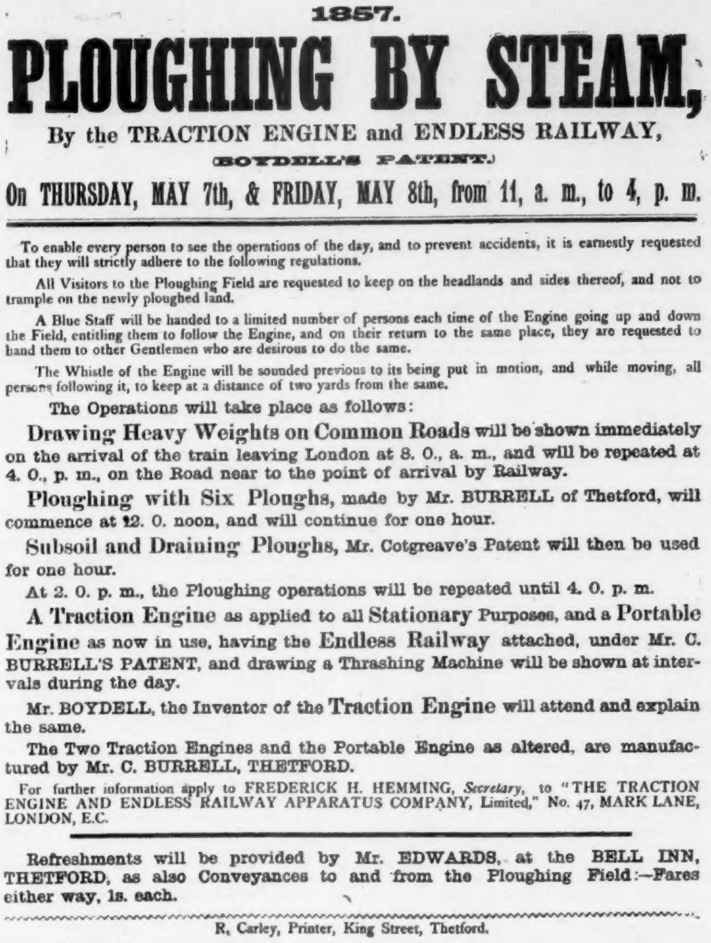
AMERICAN CARRIER TRICYCLE

Perhaps we may come in time to "motor car" and even to the hideous expression "motor trap," but let us hope that we value our language too well for that. In the case put by our correspondent, the owner of several kinds of vehicles and his servant especially, would be much more likely to speak of the "steam carriage," or the "steam brougham," or the "oil carriage," than the "motor carriage," or the "motor brougham." Imagine the "motor barouche!"

THE new dockyard at Sasebo was opened on December 5th with great ceremony. The work was begun in March, 1893, and the total cost has been 639,395 yen. The length of the dock is 443ft., and the breadth at the entrance 118ft., with a total capacity of 38,000 tons. The *Army and Navy Gazette* says that the dock can be filled with water in an hour and a-half, while five hours and a-half are required to drain it.

A LINK IN THE HISTORY OF STEAM PLOUGHING.

WE are indebted to Mr. F. Burrell, of Thetford, for the interesting programme which we reproduce in reduced *fac simile*. The original document is, we believe, unique, and was discovered by Mr. Burrell among some old papers. The Boydell engine drew a six-breast plough after it. The Boydell wheels acted admirably on soft ground, but the shoes slapped themselves to pieces on hard roads. This trial must have been one of the first public exhibitions of steam ploughing ever held, if not the first.



1857.

PLOUGHING BY STEAM,

By the TRACTION ENGINE and ENDLESS RAILWAY,

(BOYDELL'S PATENT.)

On THURSDAY, MAY 7th, & FRIDAY, MAY 8th, from 11, a. m., to 4, p. m.

To enable every person to see the operations of the day, and to prevent accidents, it is earnestly requested that they will strictly adhere to the following regulations.

All Visitors to the Ploughing Field are requested to keep on the headlands and sides thereof, and not to trample on the newly ploughed land.

A Blue Staff will be handed to a limited number of persons each time of the Engine going up and down the Field, entitling them to follow the Engine, and on their return to the same place, they are requested to hand them to other Gentlemen who are desirous to do the same.

The Whistle of the Engine will be sounded previous to its being put in motion, and while moving, all persons following it, to keep at a distance of two yards from the same.

The Operations will take place as follows:

Drawing Heavy Weights on Common Roads will be shown immediately on the arrival of the train leaving London at 8. 0., a. m., and will be repeated at 4. 0., p. m., on the Road near to the point of arrival by Railway.

Ploughing with Six Ploughs, made by Mr. BURRELL of Thetford, will commence at 12. 0. noon, and will continue for one hour.

Subsoil and Draining Ploughs, Mr. Cotgreave's Patent will then be used for one hour.

At 2. 0. p. m., the Ploughing operations will be repeated until 4. 0. p. m.

A Traction Engine as applied to all Stationary Purposes, and a Portable Engine as now in use, having the Endless Railway attached, under Mr. C. BURRELL'S PATENT, and drawing a Thrashing Machine will be shown at intervals during the day.

Mr. BOYDELL, the Inventor of the Traction Engine will attend and explain the same.

The Two Traction Engines and the Portable Engine as altered, are manufactured by Mr. C. BURRELL, THETFORD.

For further information apply to FREDERICK H. HEMMING, *Secretary*, to "THE TRACTION ENGINE AND ENDLESS RAILWAY APPARATUS COMPANY, Limited," No. 47, MARK LANE, LONDON, E.C.

Refreshments will be provided by Mr. EDWARDS, at the BELL INN, THETFORD, as also Conveyances to and from the Ploughing Field:—Fares either way, 1s. each.

R. Carley, Printer, King Street, Thetford.

BOILER EXPLOSIONS DURING THE YEAR ENDED JUNE 30, 1895.

THE annual report to the Secretary of the Board of Trade on boiler explosions has just been issued. From it we learn that the total number of explosions dealt with since the passing of the Acts, number of lives lost and number of persons injured, were as set forth in the following table:—

Year.	No. of explosions.	No. of lives lost.	No. of persons injured.
1882-83	45	35	33
1883-84	41	18	62
1884-85	43	40	62
1885-86	57	38	79
1886-87	37	24	44
1887-88	61	31	52
1888-89	67	33	79
1889-90	77	21	76
1890-91	72	32	61
1891-92	88	23	82
1892-93	72	20	37
1893-94	104	24	54
1894-95	114	43	85

Mr. Walter Murton, the Solicitor to the Board of Trade, reports as follows on formal investigations into boiler explosions during the year 1894-95:—Twenty-seven formal investigations were held into the circumstances attending boiler explosions which occurred during the year ending the 30th June, 1895. The investigations related to six vertical boilers, twenty-three land boilers—cylindrical, Lancashire, &c.—three locomotive boilers, two marine boilers, one steam pipe, one copper converter, one steam receiver, one heating apparatus, one esparto grass boiler. These explosions caused the death of thirty-nine persons, and fifty-six persons were more or less seriously injured.

I have again to observe, as in previous years, that in no case has the Court attributed the explosion to an unavoidable accident, although in five cases the Court did not attach blame to anyone, and in seven cases made no order as to costs. The first of these cases, No. 790, related to the blowing out of a joint in the piping made with an india-rubber ring, the india-rubber having perished. The second of these cases was No. 782. The Court found that the explosion was caused by over-heating from shortness of water, due to the defective feeding arrangement of the boiler. It was one of a group of three; neither of them was fitted with a feed check valve, and the internal pipe was carried to within 12½in. from the bottom of the boiler. Under certain conditions, therefore, the water could be blown out from one boiler into another, and in the absence of a glass water gauge, which, in the opinion of the Court, should have been fitted to each boiler, the attendant was misled. The third case, No. 791, relates to the explosion of a Cornish boiler, probably over twenty years old. The agent to the owner left the management of the boiler to a person who had worked it for sixteen years. As the steam gauge was graduated to 80 lb., he believed that the boiler could work at that pressure, and he placed an additional weight on the safety valve lever. In August, 1894, the boiler and engine were let to the user, and this gentleman was instructed as to working the boiler by the person who had managed it for sixteen years. The Court exonerated this person from blame, on the ground that he imparted to the user all the information he possessed, that he was not to blame for the unskilful manner in which it was worked at the time of the explosion, and that as the user had erred from want of skill no blame was attached to him. There was no evidence that the boiler had ever been inspected by any person.

The fourth case, No. 806, deals with the fracture of the flange of a cast iron manhole door in a vertical boiler used by a tramway company, caused by an unequal strain produced in screwing up the bolts. Until this explosion occurred there does not appear to have been any reason to suppose that cast iron doors were unsafe for the purpose. The Court was clearly of opinion that cast iron was not a suitable material for manhole doors to boilers, as the facts in this case conclusively proved. The fifth case, No. 861, refers to a water-tube boiler which was undergoing a series of tests before being fitted on board a torpedo boat catcher. For this purpose it was necessary to remove sixty-eight of the tubes connecting the headers, the apertures being plugged with nipples. One of these blew out, and the Court found that it had been irregularly and insufficiently expanded. This the Court held to be a faulty piece of workmanship, probably occasioned by the carelessness of a workman or by the peculiarity of his attitude when working in a confined space, which, in the circumstances, the makers of the boiler could not reasonably have discovered, and, moreover, that they had tested the boiler as plugged with these nipples by hydraulic pressure nearly 50 per cent. in excess of the steam pressure to which the boiler was subjected at the time of the explosion.

In nine cases explosions were due to the neglect of examination by competent persons, the boilers having been worked for periods varying from three to twenty-seven years without such examination. In one case the examination made was careless or perfunctory, and defects were not discovered. In one case the explosion was due to the screwing down of the nut on the spindle of the safety valve balance by a man who was not the boiler attendant, and in another the explosion was due to a defective safety valve, the spindle passing through and extending beyond a bush. In three cases boiler repairers were found to blame, and in another the patentees of an instrument used in filling their hot-water apparatus were found to blame for neglecting to advise clients of the necessity for using this particular instrument in filling the apparatus. In one case the vendor, a metal broker, was found to blame for selling a boiler which he knew was defective, the owner's friend, an engineer, was found to blame for advising him to purchase it, and the owner was also found to blame for neglecting to have it examined by a competent person. In eleven cases the Court found the owners or users of the boilers directly responsible for explosions, and in four cases they were held responsible for the neglect of their servants.

Report No. 816 relates to the explosion of a boiler used to supply steam to a pumping engine at a colliery, and three children playing in the vicinity of the boiler at the time of the explosion were killed. Under the Coal Mines Regulation Act, 1887, special rules are required to be established for the "conduct and guidance of persons acting in the management of such mine or employed in or about the mine as under the particular state and circumstances of such mine may appear best calculated to prevent dangerous accidents and to provide for the safety, convenience, and discipline of the persons employed in or about the mine." Special rules were duly established in respect of the mine in connection with which the boiler was used, and the Court observe that "although these rules provide in specific terms for the proper examination of the safety valves and the cleaning, firing, and feeding of the boilers, they do not specifically provide for the examination of the boilers," and they were clearly of opinion that these special rules should state in no uncertain terms that the boilers are to be thoroughly inspected, at what intervals of time they are to be inspected, and by whom this very important duty is to be performed.

Report No. 875 relates to the explosion of a boiler which was made at least thirty years ago. It had been used for supplying steam to pipes for the purpose of warming a mill, and at a later period of its history it was used to supply steam to an engine which helped a turbine when the water power was insufficient to drive the machinery at the mill. The boiler was never thoroughly examined by any competent person. After the explosion the plates in places were found to have been reduced from $\frac{5}{16}$in., their original thickness, to barely $\frac{1}{16}$in. No less than five persons were killed owing to this explosion, and the coroner's jury returned a verdict of manslaughter against the owner. He was tried at the Leeds Assizes and acquitted. Although the owner was acquitted of such culpable neglect as to render him criminally responsible, the Commissioners held that he was undoubtedly to blame for the explosion, as the boiler had not been examined by any competent person for seven years and the owner had taken no measures to ensure that it was being worked under safe conditions.

No. 874 refers to the explosion of a vertical boiler resulting in the loss of one life. The coroner's jury returned a verdict of manslaughter against one of the users. He was charged before the magistrates, and the charge was dismissed. He was then tried at the Staffordshire Assizes, and the judge directed the jury to acquit him. The users were carters, and they called in a person who held himself out as a boilermaker of some twenty-two years' experience, and when engaged by the users he was employed by a firm as an engineer and boilermaker. The Commissioners, finding that the users were justified in employing this person as a boilermaker, acquitted them of blame; but they found that the person employed was quite ignorant of the duties either of a boilermaker or of a boiler-repairer, and that he was to blame for the explosion.

Report No. 873 refers to an explosion more disastrous in its effects, both in regard to loss of life, injuries to persons, and destruction of property, than any case which has hitherto formed the subject of a formal investigation. Twelve boilers exploded, twelve persons were killed, and eight others were more or less seriously injured. These boilers formed part of a group of fifteen plain cylindrical externally-fired boilers, each of them about 66ft. in length, and were constructed in the years 1872, 1875.

Seam rips occurred from time to time in the boilers, and principally on this account four patches were fitted in 1887, four in 1888, four in 1889, one in 1892, and seven in 1894. The boilers were insured by an insurance company for a sum of £500 on the group, the object of the owners being to obtain regular inspections by the insurance company's inspectors, and reports as to the condition of the boilers from the insurance company. The boilers were duly inspected by the insurance company's inspectors, and in 1888 the insurance company, referring to the prevalence of seam rips, suggested that the boilers should be cut in two in the event of changes being made. In 1893 the insurance company again made suggestions as to cutting the boilers in two or substituting for them boilers of Lancashire type. The insurance company contended that, although the word "danger" was not used in their reports, it would be manifest to an engineer that the presence of danger was indicated, but in the opinion of the Court the advice given by the insurance company to the owners was conveyed in indistinct terms, and that they should have used language which would have admitted of no doubt that there was real and immediate danger of explosion. The Court found that the owner's engineer knew that the boilers were in a dangerous condition, and they found him to blame for not insisting on their condemnation. The Court found that the explosion was due to seam rip, and they were of opinion that in the interests of public safety the use of boilers of this type of extreme length should be discontinued.

The following amounts have been ordered to be paid towards the costs and expenses of the investigations, but these orders have not been invariably made according to the measure of blame attaching to the parties. The Court have in several instances taken the surrounding circumstances into consideration, and in making orders they have had due regard to the means of the parties, or the loss and injury suffered:—Boilermaker, £30; boiler repairer, £10 in two cases, and £5 in one case; vendor, £10; owner's friend, £5; insurance company, £50; owners or users—£5 in one case, £10 in five cases, £12 in one case, £15 in one case, £20 in three cases, £25 in two cases, £40 in one case, £42 in one case, £65 in one case, £90 in one case, and £200 in one case. Many of these explosions were due to ignorance, the owners or users personally attending to them, and considering that they were safe so long as they did not leak. One owner had worked a boiler for twenty-seven years without any examination, at a pressure of 60 lb. per square inch, and he thought that it would go on working at the same pressure for an indefinite time. Another steam user examined his boiler by tapping it with a hammer, and so long as the hammer did not go through the plates, he thought that the boiler was quite safe.

TRADE AND BUSINESS ANNOUNCEMENTS.—Lord Calthorpe, of Elvetham, has instructed Mr. G. Herbert Bayley, A.M. Inst. C.E., of Temple Chambers, Manchester, to design and carry out forthwith a scheme of sewage disposal, by precipitation and subsequent filtration, for his lordship's mansion and stables at Elvetham.—Messrs. Fleming, Birkby, and Goodall, Limited, mechanical leather, &c., manufacturers, of Halifax, Manchester, Liversedge, Brighouse, and elsewhere, have placed their London representation with Mr. J. E. Lawler, of 36, Lime-street, E.C.—On January 31st, the London offices of the Tredegar Iron and Coal Company, Limited, were removed from 28, Queen-street, Cheapside, E.C., to 7, Fenchurch-avenue, London, E.C.

INSTITUTION OF JUNIOR ENGINEERS.—The eleventh annual dinner of the Institution of Junior Engineers was held on Saturday, the 25th ult., at the Westminster Palace Hotel. Mr. Archibald Denny, the president, was in the chair. Among the guests present were Sir Donald Currie, M.P., Mr. J. M. Denny, M.P., Mr. James Dunn—Acting Director of Naval Construction—and Mr. A. J. Durston, C.B., Engineer-in-Chief of the Navy. Sir Donald Currie, in response to "The Mercantile Marine," said there was raiding and freebooting in the shipping trade as well as on land, and the dignity of the mercantile marine had sadly depreciated. Ships were not now sailed by the owners, as in the old days, and the competition under chartered rates did away with the personal interest of the owners. No industry had been so legislated against as the shipping industry, but in spite of the spasmodic bursts of humanitarian sentiment England still held her own on the seas. We were, however, behind other nations in valuing the mercantile marine as a serious adjunct to the Royal Navy. But just as in the days of Queen Elizabeth the mercantile marine went to the assistance of the Navy, so it would do now if occasion required. He regarded the present time as one of great difficulty in South Africa, but he wished that the people would understand and comprehend the question at issue and the history of the republics in Africa. He then gave his views on the subject, and made some most interesting statements on the affairs that had led up to the present complications.

YORKSHIRE COLLEGE ENGINEERING SOCIETY.—At a meeting held in the engineering lecture room of the College on Monday, February 3rd, the President, Mr. Henry McLaren, M.I. Mech. E. in the chair, Mr. J. H. Hamilton, B.Sc., read a paper on "Oil Engines," in which, after stating that the number and differences in design made a complete description of oil engines impossible within the compass of one paper, the lecturer said he should confine himself mainly to the "vaporiser" as the distinctive part of an oil engine, the other parts being all more or less like the better known gas engine. Oil engines may be divided into two great classes:—(1) Those which vaporise the oil in the cylinder or explosion chamber; (2) those with a distinct vessel as vaporiser, and as examples of each class, the Hornsby engine belongs entirely to the first, and the Priestman engine to the second; while between these two extremes are many others with features connecting the two. The vaporiser is the most important part of the oil engine, and upon it properly fulfilling its function depends the success or failure of the particular engine considered; and the great object to be attained is to keep the vaporiser at a constant temperature in order that the conversion of the oil into gas may go on regularly. The necessary heat is obtained in some cases from the waste gases of the exhaust; in others, directly from the heat of combustion; in some from the lamp heating the ignition tube, or again, in some cases a separate lamp is used, and in some engines two or more of these methods are used in conjunction, thus showing the great variety of this class of motor. The distinctive features of many different engines were explained by the lecturer with the aid of diagrams. He next went on to speak of the governing appliances, and explained that this was done in two ways, either by weakening the charge or else cutting out an explosion altogether, and here arose a difficulty in those engines which depended for their supply of heat for the vaporiser upon the burning of the oil in the engine itself. This is overcome by drawing back hot gases from the exhaust into the cylinder to keep up the temperature.

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

Railways as manufacturers.—A subject discussed at a recent railway club meeting was whether it is good policy for a railway to manufacture to any considerable extent, in its own shops, articles for repairs to cars or locomotives that can be purchased in the open market. The general opinion was that it is not good policy to do this, as manufacturers have usually better facilities, and more modern and complete machinery, and more skilled labour for their particular specialities, by which means they can supply these specialities cheaper than the railway company can make them. Where railways claim that they can manufacture cheaper than they can purchase, it is sometimes the case that they do not charge into the cost of the articles the freight charges on the raw material, or the use of cars in transporting the material. Certain articles, however, can be cheaply made from railway scrap, such as all kinds of small bolts, made over from damaged long bolts. Some roads even purchase their iron and brass castings, bolts, and nuts, journal bearings, forgings, &c. Thus in the matter of bolts, screws, handles, &c., a manufacturer makes large quantities of various styles and sizes, selling them to various railways, while railway shops make comparatively few of each of several sizes and styles, so that the cost of changing the machines for each kind of work increases the cost of the finished articles considerably. In some cases, however, where makers have charged very high prices, railways have gone into manufacturing for themselves, with the result of bringing prices down very quickly.

Charleston harbour.—The efficiency of jetties in improving harbours whose entrances are blocked by sand bars has been shown by the work recently completed at Charleston, which work has been in progress for several years, owing to the small and irregular appropriations allotted by Congress. The channel depth inside the bar was formerly 35ft. to 20ft., while on the bar it was only 12ft., the average depth of water on the bar being only 7ft. to 9ft. The material was a very fine sand, shifting considerably, but not easy to remove. The jetties practically form a funnel, with the opening towards the land, and so arranged as to intercept the ebb tides and concentrate them upon the bar at one point. The opening towards the land is 13,000ft. wide, and the jetties curve to an outlet 3000ft. wide on the crest of the bar. The inner end of each jetty is submerged for 6000ft., so as not to interfere with the entrance of the flood tide, while the momentum of the ebb tide carries a great volume of water so far down into the funnel that it cannot flow off to the sides, and must pass out through the apex opening, thus causing a scour over the bar. The north jetty is 15,000ft. long, comprising 291,000 tons of stone and 185,700 square yards of mattress. The south jetty is 18,000ft. long, and comprises 481,000 tons of stone and 143,400 square yards of mattress. One shoal has now moved out beyond the seaward end of the jetties, and is disappearing. There is a depth of 16ft. across the entire bar at low water, and a good 17ft. channel from the sea to the city wharves, while ships of 20ft. to 22ft. have safely entered. Between the limits of the jetties—including the channel scoured beyond them—593,000 cubic yards have been removed by dredging, and 471,000 cubic yards by scour during the past year. The project calls for a 21ft. low water channel. The work has been done under the engineer corps of the U.S. Army.

Colliery working.—The Nottingham colliery, in Pennsylvania, belonging to the Lehigh and Wilkes Barre Coal Company, has made a famous record in raising coal from one shaft, which is probably not excelled by any other mine in the world. There are two cages in the shaft, counterbalancing each other, carrying cars containing a little over two gross tons each. About 1200 cars, or 2600 gross tons, are hoisted per day of ten hours. The shaft is 300ft. deep below ground, or 405ft. in depth from the landing platform at the top of the breaker. The hoisting engine has a pair of cylinders, 26in. diameter and 5ft. stroke, and the hoisting rope winds on conical drums. To mine and handle this amount of coal requires about 700 men in the mines, 170 breaker boys in the breaker, and about 100 other men in various parts of the plant. From the bottom of the mine the entries extend over a 5 deg. slope for more than a mile underground, running under the Susquehanna River. The tailrope system of haulage is used in the mine. Pumping is done by compressed air, by which is avoided the great loss due to the condensation in long lines of steam pipe. The compressed air is furnished by a set of Ingersoll-Sergeant piston inlet air-compressors, with steam cylinders 28in. by 48in., with Corliss valve gear, and air cylinders 34½in. by 48in. The steam pressure is 110 lb. to 115 lb., and the air pressure 50 lb. The capacity is 10,500 cubic feet of air per minute. Steam is furnished to the compressors by four Babcock and Wilcox boilers of 250-horse power each.

Test of dynamite guns.—An official report has recently been made upon the test of three 15in. pnuematic dynamite guns, of 40 calibres length, installed in the fortifications at Fort Winfield Scott, California. In the course of the test eleven projectiles, three charged with 500 lb. of explosive gelatine, and eight charged with 100 lb. of the same, and fifteen dummy projectiles of full calibre and weight were fired. The projectiles were fired seaward. The official report says that the test for the capacity of the compressors of the guns developed the fact that they are fully capable of supplying air in sufficient quantity for firing continuously forty-five rounds an hour at extreme range, and fifty-four rounds were actually fired in 52½ minutes. At the beginning of the test the pressure in each gun was 1000 lb. per square inch, and in the storage reservoirs 2000 lb. Through the first part of the test the compressors had no difficulty in keeping this pressure in the reservoirs, the engines running under 87 lb. of steam. The last twenty rounds were fired at minute intervals, and no effort was made to keep up the storage pressure; it only fell to 1780 lb. at the fifty-fourth shot. Using one gun, twenty rounds—air shots—were fired in 7½ minutes, the pressure in the storage tanks falling from 1780 lb. to 1280 lb., the engines working under 93 lb. of steam. That the pressure of air was sufficient to produce extreme range was shown in the accuracy test, in which one gun, No. 3, with the same loss of air, produced a range of over 5000 yards. The traversing and elevating of the guns are done by electric power, and provision is made for the accomplishment of the work by hand if required. The flight of the 8in. sub-calibre shell charged with 100 lb. of explosive was steady. The full calibre 15in. shells charged with 500 lb. of gelatine were unsteady in flight. They had a gyrating motion, the tail revolving in a large circle about the line of flight, the head in a small circle. Members of the Board found it difficult to observe whether these shells always struck the water point first. There was no failure, however, to fire the fuse and explode the shell. The fuses used were mechanical and were set for instantaneous action, or for delays of half a second or two seconds. Those set for action on impact worked as desired. Two shells were fired with fuses set for two seconds' delay. One of these fell at such a range that the length of delay could not be obtained, though a delay was observed. The other fell at short range, and a delay of exactly two seconds was noticed. The valve mechanism of the gun and all the working parts of the system acted in a most satisfactory manner throughout the experiments. Five dummy projectiles were used in the test for rapidity of firing and loading. Four shells charged with 100 lb. of explosive were used to determine accuracy. The other projectiles served for trials for range, flight, &c. Shells charged with 100 lb. and 500 lb. of explosive were fired for range. The maximum distance attained with the 100 lb. shells was 5070 yards—about three miles—and with the 500 lb. shells 2170 yards—over one mile. The only test for accuracy which the limited supply of projectiles permitted, was made with four shells charged with 100 lb. of gelatine. The shell attained a mean range of 5031 yards, a mean dispersion in range of 23 yards, and an extreme dispersion of 70 yards. Using the line from the piece through the centre of impact as the line of fire, the mean deviation from that line was 16 yards, the extreme deviation was 32 yards to the left, and the extreme lateral dispersion was 52 yards. A summary of the shots fired shows that 75 per cent. of the shells fell within a rectangle 360ft. by 90ft. A range of 5030 yards and a rectangle of 21ft. by 156ft. would have contained all the hits. Two shells with 100 lb. of explosive were fired from different guns on different days at a hillside about 3700 yards distant from the guns. The shells struck 61ft. apart. The report says that the craters formed in the soft red rock by the explosion of the shells were bowl-shaped, 25ft. in diameter, and 4ft. in depth in one case, and 30ft. in diameter and 6ft. in depth in the other. These shells were provided with impact fuses. All shells fired for impact showed satisfactory action of the fuses. In the test for rapidity of loading and firing, five dummies, representing shells containing 500 lb. of gelatine, were fired in 8 min. 23 sec., the longest interval between shots being 2 min. The time of manœuvring the guns by electric power from extreme depression to extreme elevation and the reverse varied between 9 secs. and 13 secs. The time required for traversing through 360 deg. by power varied between 41 sec. and 1 min. 38 sec. By hand, one gun was traversed by the crew in 11 min. 12 sec., and elevated from zero to 35 deg. in 47 sec., and back in 44 sec.

An inclined plane gravity railway.—A railway whose two lines between the same terminal points differ in length by four miles is a curiosity which exists in Pennsylvania, extending between Carbondale and Honesdale, and the reason of this is that the motive power in each direction is mainly gravity. The distance from Carbondale to Honesdale is nineteen miles, and from Honesdale to Carbondale fifteen miles. This difference is due to the fact that the road goes by one route and returns by another. The road is 4ft. 3in. gauge. To connect with roads of standard gauge in the vicinity, a third rail is laid on the latter. Beginning at Carbondale, the road ascends to the top of Moosic Mountain by eight inclined planes operated by steam engines, and intervening "levels"—that is, slight down grades, from the head of one plane to the foot of the next. The summit level, between planes No. 8 and No. 9, 750ft. above the foot of plane No. 1, is about 1¾ miles long. Planes Nos. 9, 10, 11, and 12 descend the mountain, toward Honesdale, and they are operated without motive power other than gravity, the main drum being controlled by a fan and brake wheel geared from the drum shaft. The fan acts as a drag upon the drum. From the foot of No. 12 the road runs on a uniform grade of 1·2 per cent., or 1 in 120, for ten miles to Honesdale. Returning, there are eight elevating planes, Nos. 13 to 20, inclusive, the remainder of the distance being run by gravity. The "level" before reaching Carbondale is a continuous down grade of fourteen miles. Until 1877 the road was used for coal only, but since that date passenger trains have been run upon it. Six trains are now run each way daily.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

A SLIGHT falling off has taken place in the coal shipments during the past week, as compared with the large quantities sent away during the whole of January. Stems, however, are fairly well filled, and in a week or two's time we shall doubtless have another spurt again. At present there is a large amount of tonnage in the Alexandra Dock. The big steamer Imaum is expected to leave to-night. The price of pitwood is slightly weaker. There are better inquiries for manufactured iron and steel, and prices are advancing. With the general importations a fair amount of grain has been received. The river trade has been fairly brisk. The activity in the ship-repairing trade has been well maintained.

Prices ruling on 'Change to-day were as follows:—Coal: Best steam, 8s. 3d. to 8s. 9d.; seconds, 8s.; best house coal, 10s. 6d.; dock screenings, 5s. to 5s. 3d.; colliery small, 4s. 6d. to 4s. 9d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 47s. 3d.; hematite warrants, 48s. 11d., f.o.b. Cumberland; Middlesbrough, No. 3, 38s. 4d. prompt; Middlesbrough hematite, 46s. 2d. Iron ore: Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel rails: Heavy sections, £4 15s.; light ditto, £5 5s. Tin-plate bars, £4; Siemens tin-plate bars, best, £4 5s.; all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel coke, 9s. 3d.; Siemens (coke finish), 9s. 6d.; ternes, per double box, 28 by 20 C, 21s. to 22s. Pitwood, 15s. 6d. to 15s. 9d. Freights steady.

AUSTRALIAN NOTES.

New South Wales.—The Bills providing for the new taxation and the abolition of the Custom duties have at last become law; and it has been definitely decided that, with a few exceptions, the duties will cease on 31st December. All the *ad valorem* duties and the specific duties which were levied by the Dibbs Government cease on that date. The duties authorised to be levied by the Customs Duties Act of 1892 upon cement, plaster, hydraulic lime, iron, galvanised, in bars, sheet or corrugated; galvanised wire-netting, timber dressed and undressed, doors, sashes and shutters, and a few articles of food, cease on the 30th June, 1896. A few articles, the principal of which is oils, will bear diminishing duties until the year 1900 after that date all articles will be admitted free into New South Wales, with the exception of spirits, wines, beer, tobacco, cigars, and opium. To meet the loss of revenue in Custom duties the new taxation provides for a tax of one penny in the pound to be levied on the unimproved value of all lands, &c., subject to an exemption of £240, also an income tax of sixpence in the pound on the amount of all taxable incomes, subject to an exemption of £200.

Victoria.—Acting on the advice of the Railway Enquiry Board's report, the Victorian Minister for Railways is bringing in a Bill for the more efficient management of the railways in that Colony. It is proposed to create a Railway Trust, abolishing the office of Commissioners, the Railway Trust to consist of the Minister of Railways, *ex officio*, and four trustees; two of the trustees to hold office for three years and two for four years, and be eligible for re-appointment. The salary of the trustees to be £750 a year each, with £1 a day travelling expenses. The trust to have power to appoint a general menager—subject to the approval of the Governor in Council—who will be responsible to that body for the efficient working of the railways. An important innovation in the Bill is the method of meeting the loss occasioned by the opening of what are known as "political" lines. In future, whenever Parliament declares it is for the public policy of the country that certain works should be constructed, not because they would pay, but because they were in the interests of the whole community, any loss arising therefrom would have to be provided by Parliament in the ordinary estimates of the year. This proposal commends itself as a practical solution on the complex question between the commercial management of State railways and the country's requirements of State lines, and could be advantagously followed by the neighbouring Colonies. As the Minister for Railways stated: "What encouragement was there for the railway officials to make the railways pay, if new, costly, unpayable works were forced upon their management? They might be as careful and economical as possible, and bring the railways out of the present condition of annual deficits, but if Parliament threw additional burdens on the officers, and brought the finances again below the paying level, the officers would have to labour on again with a heavy burden on their shoulders." Owing to the alteration in the fiscal year, the Auditor-General has issued a report for the half-year ending June 30th last on the public accounts of New South Wales. The outstanding liabilities, as far as relates to the public debt, were on that date £56,457,499, on which the annual interest payable is computed at £2,149,251.

Reference has been made to the low cost of several lines of the West Australian railways. The following particulars, taken from the official reports shows how the items are made up on some sections:—

Northam-Yilgarn Railway—Southern Cross Contract.

170 miles long; gauge, 3ft. 6in.; 45 lb. and 46¼ lb. steel rails.

		Contract price per mile of line. Each item. £	Totals. £
Fencing, 60 miles, single fence—gates and cattle stops		34	34
Telephone		20	54
Grading		215	269
Culverts		28	297
Bridges		52	349
Ballast and platelaying — including 127 chain of sidings		208	557
Station buildings, (*a*) Passenger sheds, goods sheds, engine sheds, turntables, stationmasters' houses, latrines, platforms, loading banks, and approach roads	43	—	—
(*b*) Water services	32	—	—
(*c*) Palatelayers' cottages	14	89	646
Sleepers		209	855
Maintenance, three months		16	871

Amount of contract, £148,137 7s. 1d., which, exclusive of rails, fastenings, and rolling stock, per mile, £871; add cost of rails and fastenings, including £37 per mile railway freight to Northam, £501; add rolling stock, £240. Total cost per mile, £1612.

Southern Cross, Coolgardie Railway—Coolgardie Contract.

114 m. 50·75 ch., including terminal station at Coolgardie; gauge 3ft. 6in.; 45 lb. steel rails.

	Contract price per mile of line. Each item. £	Totals. £
Fencing—one mile single fence—gates and cattle stops	5	5
Telephone—labour only—erection of poles	4	9
Grading	85	94
Culverts	17	111
Bridges	3	114
Ballast and platelaying, including 217 chains of sidings	85	199
Station buildings	81	280
Sleepers	219	499
Maintenance, six months	61	560

Amount of contract, £64,125 13s. 7d.; making total cost, exclusive of rails and fastenings, materials for telephone line, and rolling stock, £560 per mile; add cost of rails and fastenings, including £78 per mile railway freight to Southern Cross, £466 per mile; add cost of telephone material, £60 per mile; add rolling stock, £315 per mile. Total cost per mile, £1401.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

THE second month of 1896 opens much more favourably than did January. The hindrances to business incidental to the beginning of a New Year are over, and there should be now nothing to seriously interfere with the development of demand. Alike in steel, in manufactured iron, and in pig iron, the works are all getting business, and values all round are gradually strengthening. Galvanised corrugated sheets are still quoted a minimum of £10 5s. by merchants, but makers quote £10 7s. 6d. to £10 10s. for 24-gauge in iron and £10 12s. 6d. to £10 15s. in steel. Some makers indeed ask £10 17s. 6d. to £11 for steel sheets of 24-gauge, but these top prices are hardly more than nominal except for first-class brands; the old difference of 10s. a ton between iron and steel having, in the case of ordinary qualities, been reduced to more reasonable proportions.

Information has reached the blast furnace owners of the Midlands that Messrs. Carnegie Brothers, of the United States, have lately been contemplating the erection of new blast furnaces capable of producing 500 tons of pig iron per day each, or 225,000 tons per annum. These would constitute the largest furnaces ever erected in the world's iron manufacture. The largest production hitherto obtained has been 400 tons per day per furnace, or 3000 tons per week, or 125,000 tons per year, including stoppages.

Engineers in the Midlands have perused with great interest the report on trade with Japan, which Mr. Ernest Satow, our Consul at Tokio, has sent home to the Foreign-office, in which he describes the remarkable expansion that has taken place in the commerce of that country during the past twelve months. The returns of the Tokio Stock Exchange show an immense advance in the quotations of the shares of all companies, and especially in the principal cotton spinning factories. Nearly 90,000 new spindles for factories already in existence in Japan have been ordered from England for delivery between March and August of 1896, through one Tokio firm alone. The last completed Japanese annual trade statistics—namely, those for 1894—show that of that country's whole foreign trade, 35 per cent. was with the British Empire, and nearly 18 per cent. with Great Britain; of the imports only, the value of those obtained from Great Britain was nearly 36 per cent. of the whole, from British India 11 per cent., and from the British Empire over 55 per cent. The Consul points out that hope for the immediate future of British trade lies principally in metals and machinery, and looking at the prospects of these trades in Japan, he believes that no fear need be entertained of any falling off in the aggregate value of British imports. What may be and yearly is more and more lost to Lancashire in the way of textiles, will, he declares, be fully recouped by gains to Sheffield and Birmingham, and by large contributions to the shipbuilding industries of the Thames, Tyne, and Clyde.

Alterations, extensions, and the purchase of new machinery and tools, the whole costing nearly £10,000, has been decided upon by the Electric Construction Company, of Bushbury, near Wolverhampton, which at present employs about 100 hands. A new provision stores, 180ft. long by 100ft., will be made, and the present stores room, which is 150ft. long by 100ft. wide, is to be converted into a machine shop, some heavy machinery and tools of novel type being already in hand by Lancashire firms.

The water pumped by the engines of the South Staffordshire Mines Drainage Commissioners remains at the same low figure at which it has stood for some time. It was reported on Wednesday last by Mr. E. Howl, the engineer to the Tipton district, that the rainfall during the six weeks ending the 31st ult. had been 2·55in., which was unusually low. There has been no necessity for employing auxiliary engines during the present winter.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The position generally continues to improve, and a very satisfactory tone prevails all through the iron and engineering trades of this district. Both makers and manufacturers of iron are not only well sold, but experience no difficulty whatever in getting their present full prices, which necessarily are showing a strong hardening tendency, forward contracts in most cases being only entertained at some advance upon current rates. There is also a good deal of work of one sort or another stirring amongst engineers, and the outlook for the future promises more or less general activity, many of the leading establishments being already fully supplied with orders for some time to come.

A steady business was reported generally on the Manchester Iron Exchange on Tuesday, with prices strong both for raw and manufactured material. In pig iron buyers were perhaps not quite so keen in placing orders as they were last week, many of the large users having covered their requirements, whilst the slight giving way in warrants tended to check the placing out of orders by consumers who have not already bought. Makers of pig iron, however, are all very firm, the tendency of prices being upward, if anything. For Lancashire brands of pig iron quotations were unchanged, but firm at recent full list rates. Lincolnshire makers, who at a meeting held in Leeds last week had under consideration the question of prices, were, with one exception, quoting an advance of 1s. per ton, and in some cases indifferent about selling at all. For delivery equal to Manchester, forge qualities are now being quoted at 42s. 6d. and foundry at 44s. 6d. net cash. Derbyshire foundry remain as last quoted. In outside brands offering here, Middlesbrough is steadily hardening, 46s. 4d. to 46s. 7d. net cash being the minimum for good foundry qualities, delivered equal to Manchester, with Scotch iron quoted on the basis of 47s. 6d. for Eglinton, delivered Lancashire ports, and 49s. 9d. delivered Dock Quay, Manchester.

In the finished iron trade new business is coming forward satisfactorily, both on home and foreign accounts, the recent sharp rise in Belgian bars having enabled orders to be booked here which might otherwise have gone to the Continent, and in hoops local makers are also booking a larger weight of shipping orders than they have been doing recently. For Lancashire bars delivered Manchester district, £5 10s. remains the quoted list rate, but most of the makers are very indifferent about selling at this figure, and only open to book orders for immediate specification from regular customers, declining to entertain anything like forward delivery, except at an advance. For Staffordshire bars quotations remain in some cases at £5 10s. for immediate delivery, up to £5 15s. For other descriptions of finished iron prices are as last quoted, averaging £7 10s. to £7 12s. 6d. for sheets; and £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths of hoops, delivered Manchester district, with 2s. 6d. less for shipment.

A steady improvement is noticeable as regards the condition of the steel trade. It is still exceptional where more than 56s., less 2½, is being got for ordinary foundry hematites, but steel billets are scarcely obtainable under £4 10s. to £4 15s., net cash, and boiler plates are now firm at £6 5s., with makers indifferent about booking at this figure. There is a considerable weight of business doing in steel forgings, with better prices obtainable.

In the metal market increasing activity is the general report. The demand does not now, as reported a week or so back, come forward upon any special class of goods, such as tubes, but upon all descriptions of manufactured material required, not only for locomotive building purposes, but for general engineering work, and on the Manchester Exchange on Tuesday an advance of ¼d. per pound upon all descriptions of tubes was announced, bringing them back to the prices ruling prior to the reduction about a month ago, whilst in other manufactured goods there is a similar upward move, owing to the advance in raw material. List rates, for delivery Manchester district, are now as under:—Solid-drawn brass boiler tubes, 6¼d.; solid-drawn brass surface condenser tubes, 7¾d.; solid-drawn copper tubes, 7½d.; brazed copper gas and steam tubes, 7¼d.; brazed brass gas tube, 7d.; brass wire, 5½d.; copper wire, 6¾d.; rolled brass, 5¼d. per lb.

I continue to receive very satisfactory reports with regard to the steady improvement in all branches of the engineering trade, and a good deal of work is coming to hand in some quarters owing to the keenness of foreign competition, evidently compelling English manufacturers to bestir themselves in improving their means of production. Re-construction of plant in various directions is just now going on, and I understand this is especially the case in the tin-plate trade, one or two of the Lancashire engineering firms being very busy with orders for re-construction of plant in the above branch of industry. Machine tool makers are almost without exception now full of work, some of them being quite pressed with orders, and one large firm is very busy with orders for Japan. There is a steadily increasing weight, of work coming through the hands of boilermakers, the locomotive building firms throughout Lancashire are now well supplied with orders, and one large railway establishment in the district, which has been quiet for the last three or four years, is now going full time. This improvement in the engineering trades is especially noticeable in the Gorton district, just outside Manchester, one of the largest industrial centres in the neighbourhood. In this district only twelve months ago the depression of trade was most keenly felt and special means of relief had to be adopted to meet the requirements of the large number of unemployed. Now there is generally full work, and many of the large establishments are running overtime.

The report which has just been issued by the delegates appointed by the British Iron Trades Association to visit continental iron works, with a view of investigating the position in connection with the increasing keenness of foreign competition, is regarded with anything but satisfaction by at any rate some of the representatives of the manufactured iron trade in Lancashire. The report is considered rather one-sided in the information the delegates have allowed to be published, the feeling being that the wages question on the Continent has not been fairly dealt with, in treating as a basis the wages paid in Westphalia, as they are higher in the above district than in any other part of Germany, whilst the lower-paid districts, such as Silesia, where skilled workmen are paid on an average fully £20 per annum less than in Westphalia, are none the less formidable competitors with English manufacturers. As to the question of carriage, this does not—except as it concerns the conveyance of raw material—affect Lancashire so much as other English manufacturing districts, but it is still a very serious item. The cost of carriage for pig iron from Lincolnshire to the forges in this district, a distance of about eighty miles, is 5s. 6d. to 6s. 2d. per ton, and if this could be brought down to the continental basis, which would necessitate a reduction of 2s. 6d. per ton, it would mean a decrease of 5s. per ton in the cost of finished iron, which would place local manufacturers in a very favourable position for competing with their rivals on the Continent.

The President of the Miners' Federation, in his recent address at the annual conference, made some capital out of the fact that notwithstanding the reported excessively depressed condition of the coal trade, large developments of mining operations were in contemplation, and the matter has also been further indirectly hinted at by the President of the Coalowners' Association. I may mention that the facts of the case are briefly that the Wigan Coal and Iron Company has acquired some 30,000 acres of coal in Nottinghamshire that has not yet been opened out. This coal, I understand, is similar in quality to that which is at present being got by the Shire Oaks Collieries, and the first pit, I am informed, is to be sunk at Bevercotes, where it is expected to reach the hard seam of coal at a depth of some 500 to 600 yards.

The annual meeting of the Manchester Coal Exchange was held on Tuesday, when the report and balance sheet, of which I have already given an abstract, was adopted, and Mr. John Tomlinson, of Darwen, was unanimously elected president for the ensuing year, Mr. Isaac Mosly, of Doncaster, vice-president, Mr. Ralph Peters, of Tyldesley, as treasurer—an office which he has filled since the establishment of the Exchange—and Messrs. James Bridge, of the Tyldesley Coal Company, Geo. Pearson, Ashton-under-Lyne, and James Carter, Blackburn, were elected by ballot members of the committee.

In the coal trade only a slow business is reported generally, with supplies too large for the demand, although many of the pits are only on four days per week. House coals continue in but very indifferent request for the season of the year, and prices are barely maintained at 10s. to 10s. 6d. for best Wigan Arley; 9s. to 9s. 6d. for Pemberton four-foot and seconds Arley; and 7s. to 7s. 6d. for common house coal at the pit mouth. The lower descriptions of round coal—suitable for ironmaking, steam, and general manufacturing requirements—are plentiful in the market, and very low in price, 6s. being about the average figure for ordinary steam and forge coals at the pit mouth. For engine fuel there is a moderate demand, but supplies are quite equal to requirements, with pit quotations remaining at 3s. to 3s. 6d. for common slack, and 4s. 6d. to 5s. for best qualities.

For shipment, a fair business comes forward, but prices remain at a very low level, ordinary descriptions of steam coal being still obtainable at 7s. to 7s. 6d. per ton, delivered at the ports on the Mersey.

Barrow.—The iron trade this week shows more life, and hematites are again in fuller demand. There is a brisk inquiry for Bessemer sorts, and prices have advanced in a marked way; 48s. 7½d. is the quotation for warrant iron sellers, 48s. 6½d. buyers, Makers on the other hand are quoting 50s. 6d. net, f.o.b., for mixed Bessemer numbers. The stocks of iron are very steady, varying only 15 tons, and that in the way of reduction during the past week. They now stand at 298,005 tons, or 8830 tons more than in the beginning of the year; 36 furnaces are in blast, compared with 29 in the corresponding week of last year.

Iron ore is steady, but not quotably higher, as so much Spanish and other foreign ores are now imported; 10s. is still the price net at mines for ordinary qualities.

The steel trade is brisk in almost all its departments, the exceptions being those of tin-plate bars, blooms, slabs, and wire rods, but rails and plates are in full demand, and orders are very well held. There is also considerable life in the steel casting trade, especially heavy patterns for shipbuilders. The hoop and billet trade is brisk, and the idle mills at Barrow which have been stopped through an accident will soon be again in full operation.

Shipbuilders and engineers are as busy as they can be in all branches of their trade, but there is an opening now for new orders on the building side, and these are expected as well from commercial as from other sources. The Clan liner Clan Menzies was launched at Barrow on Saturday last, and in a month her sister ship, the Clan Lindsey, will be launched. Other orders from the same owners are expected.

Coal and coke for iron at late rates. Deliveries are increasing, and so also is the demand, while prices are steady. Shipments do not show much life of trade. During the last week 4295 tons of pig iron and 8334 tons of steel have been exported from West Coast ports, compared with 9410 tons of pig iron and 4307 tons of steel in the corresponding week of last year, being a decrease of 5115 tons of pig iron and an increase of 4027 tons of steel. The total shipments to date this year represent 26,886 tons of pig iron and 43,471 tons of steel, compared with 24,828 tons of pig iron and 25,888 tons of steel in the correponding period of last year, an increase of 2058 tons of pig iron and 17,583 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

IN the South Yorkshire coal trade no improvement has taken place or is likely to do so while the present open weather continues. Four days are the most that is being worked per week, although, with the small number of days the men are employed, the output is more than sufficient to meet the demand. The metropolis is taking about an average amount of both Silkstone and Barnsley thick seam. The market is full of house coal, and the mildness of the season again militates against stocks being depleted. Not much business is transacted with the eastern markets in household fuel, although gas fuel is in excellent request. All descriptions of house coal make about last week's rates, with slight reductions when large quantities are taken. Silkstone remains at about 8s. 6d. to 9s. 3d. for best qualities, with secondary sorts at 7s. to 7s. 6d. The same value is universally obtained for Flockton. Short time is worked by the thin seam collieries, while the finest productions of these pits only realise 6s. to 6s. 6d. per ton.

Steam coal is usually very little called for in February, and this year the feeling seems more accentuated than a year ago. This is owing very largely to the immense output. Taken all round, however, the district pits are forwarding a good tonnage to Hull and Grimsby, the latter port taking a larger amount than before for steamboat and other purposes. The West Riding pits are doing a fair trade with Goole, although one or two South Yorkshire collieries send an average amount. Values still remain at 6s. 6d. to 7s. 3d. per ton at the pits, a slight advance on present contract quotations. Railway companies continue to take an average supply of locomotive coal, mainly on contract account. Gas coal is in fairly good demand, while quotations are rather lower than is usual at this season of the year. This is mainly due to the large production. A better state of affairs is reported in manufacturing fuel, although stocks are reported to be accumulating in some districts; 3s. 6d. to 4s. is the highest quotation for best qualities, while secondary sorts are obtainable at 2s. 3d. to 2s. 6d., with smudge at 1s. to 1s. 6d. at the pits. Coke is fairly well called for, and a better demand is expected now that the iron trade has improved. North Lincolnshire is taking a larger tonnage, owing to an advance in the production of pig iron there. The request from Derbyshire is about the same as usual. Values range from 8s. 6d. to 9s. 6d. per ton at the ovens.

The heavy industries, notwithstanding severe disadvantages which have taken place during the last few weeks, maintain a very firm appearance. It is generally felt that as the year advances business will increase also, and more so when the shipping season opens. Manufacturers, however, cannot overlook the fact that there are many political differences hovering about, and when these are settled—and not till then—will the iron, steel, and allied trades resume a healthy condition. Stocks in the hands of both makers and consumers are but small. Values are much the same as they were a month ago. Quotations are as follows:—Hematites, West Coast make, 57s., and East Coast 54s. in Sheffield; Lincolnshire forge, 39s.; foundry, 43s. Bessemer billets of guaranteed temper, £5 7s. 6d. to £6; with Siemens-Martin £7 and upwards. Makers of Bessemer and Siemens steel are well engaged upon orders, and Swedish Bessemer is actively called for. The rolling mills report an excellent trade, while a similar remark applies to wagon, carriage, and coach builders. The latter have secured a large amount of new work, with a prospect of a good deal more to follow shortly. The end of the strike on the Clyde and at Belfast has had a very beneficial effect already. Orders have come forward in amazing rapidity. Power, tramway, and other sorts of wheels are well called for, as well as every description of steel castings. Malleable iron founders are well off for work; cycle makers report an excellent business in cycle steel of the higher grades. Iron castings are rather quieter.

In the lighter industries the most prominent feature is the remarkable falling off in the demand for cutlery from the United States. Up to the end of 1895 the request was fully maintained, but with the advent of the present year orders have come in very slowly. This is the report of some of the largest and oldest established houses in this city, who have done an enormous American trade for a number of years. The silver and electro-plating branches are in a better condition. Consumers are ordering, freely and early, large quantities of agricultural implements such as scythes, sickles, spades, forks, and similar goods. Manufacturers in most cases, have heavy stocks, and these are being rapidly diminished. The remarkably fine open weather has interfered largely with the demand for chaff and turnip cutters, as well as other food preparing machines; on the whole, however, makers of knives and parts are very well employed. Much has been written of late in both English and foreign papers of the serious falling off in the weight of ivory sent to be sold in London. At the same time there has been a remarkable increase in the sales at Antwerp. Attention was directed to this important subject some little time ago in THE ENGINEER. The explanation is a very simple one. The majority of the ivory received at Antwerp comes from the Congo, which has become far richer in this material than was anticipated. Other causes too numerous to mention have also helped the Antwerp market. German, American, and French buyers attend the sales at that city in large numbers. Celluloid and other substitutes are being used in very large quantities. One of our leading cutlery makers stated not very long ago that his production of cutlery with celluloid handles had advanced some 50 per cent. during the last few years. With his enormous increase he cannot supply all his customers with the material. It is the same with other makers, best bone and horn have completely gone out of favour.

Mr. George H. Mills, after thirty-eight years' service with the Midland Railway Company, has now retired. On Saturday night, at Sheffield, he was presented with a gold watch by his colleagues, while Mrs. Mills was also handsomely remembered. Mr. A. S. Jarvis, the local goods manager, who presided, pointed out the remarkable development made by the Midland Company during the period covered by Mr. Mills' service. At that time—1857—the Midland had only 500 miles of railway; now it has 1375 miles, apart from other lines on which it works. In 1852 the company acquired twenty acres of land in London for the St. Pancras Station; two years later Manchester was reached, and later a more direct route was opened to that city. Barnsley was got to by 1862, and in 1864 began the struggle which ended in the Midland coming to Sheffield two years later. Mr. Jarvis mentioned the curious fact that at the time of the Great International Exhibition in London the passengers taking the journey from Barnsley to London only averaged 1¼ per day. In 1866 the company got to Scotland, and in 1870 the line from Chesterfield to Sheffield was opened. The growth of passenger traffic was amazing. In 1873 there were 21,994,048 passengers; in 1895 there were 40,498,318. The receipts in 1873 were £1,398,446; in 1895, £2,848,367.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

TRADE in this district is progressing very satisfactorily, and almost all branches are experiencing better times than they had last year. A good business is being done this week, and buyers are more numerous than sellers, as the expectation is that the spring will be a very busy season, and that if peace be maintained substantial advances will be realised in prices. The fact that at this period of the year, which is usually the slackest, advances in the value of iron and steel can be recorded, speaks well for higher rates when the navigation season arrives. The demand has been so good this week that plates and angles have been put up 2s. 6d. per ton, hematite pig iron 6d., and in some cases 1s.; No. 3 Cleveland pig iron 6d., and forge pigs 3d. at least. It might have been thought that the large excess of production over consumption during the past month, would have had a detrimental effect upon the market for pig iron, but as a matter of fact the prices are not affected, because heavy increases in stock are not unusual at this period of the year, and people believe that when the spring shipping season arrives the deliveries will be so large that the accumulations of the winter will quickly be absorbed. Last month the production of Cleveland pig iron exceeded the consumption by 26,528 tons, and this makes the increase in stocks over the last three months—they began to increase in November—no less that 64,927 tons. But the market becomes more favourable for the sellers, in spite of this.

The price of No. 3 Cleveland G.M.B. pig iron has this week been advanced to 37s. 9d. per ton for prompt f.o.b. delivery, and 37s. 6d. has been the lowest that has been accepted, but such a figure would not be looked at now, indeed some of the makers quote 38s. The season when the demand for No. 1 is at its best is near, and there is more disposition to buy among the continental people who are the chief consumers of it. Though it has risen in value, it is still relatively considerably cheaper than No. 3. It was formerly 2s. 6d. dearer than No. 3, now it is barely half that, and it can be had at 39s. No. 4 Cleveland foundry pig iron has been raised to 37s.; No. 4 forge to 36s. 3d.; and white to 35s. 6d. for early delivery, but the quantities of grey and white pig iron that can be obtained are very small. Basic pig iron is now fully 40s. per ton for No. 3. M. Nos. of Cleveland hematite pig iron have been advanced to 46s. 6d., and some of the producers quote 47s. for early deliveries.

The Cleveland Ironmasters' statistics for January were not more unsatisfactory than were expected, the increase in stocks of Cleveland pig being pretty near the estimate that was given in this column last week. The large increase did not surprise any one, for it is recognised that the make will exceed the consumption at this time of the year. The total stock of Cleveland pig iron is 332,197 tons, of which more than half is in Connal's stores, and less than one-third is unsold in the hands of makers. It is worthy of remark that the production of pig iron in January in the North of England was the largest that has been recorded in any month since the establishment of the trade—269,195 tons, of which about half was of ordinary Cleveland quality, the other being hematite, basic, and spiegel pig. It may also be noted that with the same number of furnaces in operation and the same number of days in the month, the production of January was 7726 tons more than that of December. Of the 134 furnaces built, 94 were in operation, 52 of them producing ordinary Cleveland iron—three more than in December—and 42 hematite, &c.—three fewer than in December. The Skinningrove Iron Company blew in a furnace to produce Cleveland iron, and Messrs. Bolckow, Vaughan, and Co. blew out one at their Middlesbrough works.

The Ironmasters' Association have now commenced to include in their statistics the record of shipments of pig iron from Skinningrove, in addition to those from Middlesbrough, and the table thus represents the exports of pig iron from the Cleveland district. Last month they were as under, as compared with the previous months, and those of the corresponding period of last year:—

	January, 1896. Tons.	December, 1895. Tons.	January, 1895. Tons.
Foreign	23,376	20,787	17,316
Coastwise	46,364	41,132	30,631
	69,740	61,919	47,947

Thus last month's exports were 7821 tons more than in December, and 21,793 tons more than in January last year. Included in the shipments last month were 8406 tons of hematite pig, against 6511 tons in December.

Last week was reported the sale of the Tees-side Iron and Engine Works, Middlesbrough, to a syndicate, headed by Sir Christopher Furness, of West Hartlepool. Further developments have since arisen, for already Sir Christopher and his colleagues have disposed of some of the property acquired to other persons. Thus the four furnaces have practically been sold to a well-known iron ore merchant in Middlesbrough, who is already the possessor of two pig iron works in the district, and associated with him is one of the leading blast furnace engineers and managers and a local timber merchant. The shipyard has been disposed of to Messrs. R. Craggs and Sons, who have been shipbuilders on the Tees for over sixty years, having yards both at Stockton and Middlesbrough. The yard which they have had almost ever since the establishment of Middlesbrough, and which adjoins the yard of Sir Raylton Dixon near the dock, has been sold to him by Messrs. Craggs. This leaves Sir Christopher Furness with engineering and bridgebuilding works, and these will be carried on in conjunction with the marine engine works of Messrs. Westgarth, English, and Co., also at Middlesbrough.

A considerable improvement is to be recorded in the finished iron and steel trades, and especially in the plate and angle departments, which are now fully employed, with good prospects of continuing so. The termination of the strikes on the Clyde and at Belfast has allowed of specifications being sent forward freely, and the openness of the weather permits of work being carried on regularly at the shipyards, so that there is not the curtailment of deliveries of plates and angles that is often experienced in the first few weeks of the year. Steel ship plates are firm at £5; steel strip angles at £4 17s. 6d., iron ship plates at £4 17s. 6d., and iron ship angles at £4 15s., all less 2½ per cent. and f.o.t. Common iron bars are steady at £4 17s. 6d., less 2½ f.o.t. Heavy steel rails continue in active demand, and £4 15s. net at works is the general quotation. For steel sleepers the inquiry is only moderate. Pipes and bridge work are ordered pretty freely, and engineers on the whole are doing well as regards the amount of work they secure, but as to increase of prices there is very little to record as yet.

A very ingenious and useful machine has recently been invented by Messrs. J. and W. Gee, of Middlesbrough, which is being introduced to the public by the Scrubbing Machine Syndicate, Middlesbrough. The inventors have struck out in an entirely new line, this being the first attempt to scrub floors by machinery, and so well have they succeeded in their endeavours that, as they have practically demonstrated at the Town Hall and various large halls in Middlesbrough and district, they can do the work with this machine in one-tenth the time that is required when it has to be done by hand, and besides this it is done more efficiently. A floor can be washed and wiped dry as fast as the operator can walk. The machine is something in appearance like a lawn mower. It runs on four wheels, and above the two front carrier wheels is a tank which contains the clean water, which may be as hot as the operator chooses. This water is supplied to rotary brushes at the bottom of the machine, and these, rotating in the opposite direction to the motion of the machine itself, scrub the floor. At the back of these brushes is another tank over the two back wheels, and into this tank the slop and dirt are collected. The wiping up apparatus consists of an endless band of absorbent material, made specially for the purpose, and this is pressed upon the floor by rotary brushes, the pressure of which can be regulated very exactly, and so the cloth accommodates itself to the inequalities of the floor. The cloth is then rinsed out mechanically as it leaves the floor, and passes through a wringer at the back. The machine is specially adapted for cleansing large areas of floors, which it is not necessary to sweep beforehand, and what with hand labour takes the whole day to clean can readily be done in an hour. All that the operator has to do is to keep the machine supplied with water and push it before him. Its efficiency and utility have been fully demonstrated in Tees-side.

The steam coal trade of Northumberland is very dull, and prices are unsatisfactory; in fact, it is difficult to see how, with so much irregular working, they can prove profitable to the coalowner. But 7s. 9d. f.o.b. is paid for best qualities now, whereas two or three years ago the same kind of coal realised between 12s. and 13s. House coal is in poor request for this period of the year. Deliveries of gas coal are heavy yet, but must shortly slacken. Coke is firm at 14s. to 15s. per ton f.o.b., and the consumption is large and increasing. The John Bowes, the first iron steam collier, is for sale. The vessel was built in 1854, at Jarrow-on-Tyne, and was the pioneer of a very large fleet of steamers employed in the coal trade between the Tyne and Wear and London.

The Tyne Engineering Company, which has two dry docks on the Thames and two at Swansea, has acquired Moralie's Dock, which adjoins its dock at South Shields, thus making six docks owned by the company. It will enlarge this newly-acquired dock.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Glasgow pig iron market was very strong at the end of last week, Scotch pig iron warrants having advanced about 1s. per ton. The prices of Cleveland iron and Cumberland hematite rose to a similar extent. A partial reaction has since taken place, but a great portion of the advance is still retained. Brokers report that the inquiry has been active from clients, and there has been a large speculative business. In addition to this, it appears that consumers have again come into the market in considerable numbers. The better outlook for trade and in a political sense has induced not a few to purchase iron in the expectation of a further advance. The monthly report of the Middlesbrough trade was certainly disappointing, but it did not produce much effect on the market. A large business has been done in the different sorts of iron for delivery a month hence. Scotch warrants were done at 47s. 3½d. at the end of last week, and this week they have sold from 47s. 3½d. to 46s. 10d. cash, and 47s. 5½d. to 47s. 0½d. one month. Business was done in Cleveland warrants from 38s. 4d. to 38s. 2d., and in Cumberland hematite from 48s. 8d. to 48s. 4d. cash.

The output of both ordinary and hematite pig iron has been somewhat increased, and as the stocks in Glasgow pig iron stores have increased by only 100 tons, it does not seem that the supply is too large. Indeed, there is a prospect of its being increased still further. Both the price of fuel and the rate of wages are in favour of an extended output, even although the makers should find it necessary to increase their private stocks. Messrs. William Baird and Co. are reported to have decided to erect three new furnaces for the production of their well-known Eglinton brand. One of the four furnaces that have been making basic pig iron at Glengarnock has been withdrawn from that iron, but over the whole country the furnaces are not reduced, but show an increase of one, the total in operation now being 77, of which 42 are making ordinary, 32 hematite, and 3 basic iron, compared with 74 at this time last year.

The prices of the special brands of makers' pig iron are dearer, in sympathy with warrants, the advances for the week varying from 3d. to 1s. per ton; G.M.B., f.o.b. at Glasgow, No. 1 is quoted 48s. per ton; No. 3, 46s. 6d.; Carnbroe, No. 1, 48s.; No. 3, 46s. 6d.; Clyde, No. 1, 50s.; No. 3, 47s.; Gartsherrie, Calder, and Summerlee, No. 1, 51s.; No. 3, 48s.; Coltness, No. 1, 53s. 6d.; No. 3, 49s. 6d.; Glengarnock, at Ardrossan, No. 1, 50s. 6d.; No. 3, 46s. 6d.; Eglinton, No. 1, 48s.; No. 3, 46s.; Dalmellington, at Ayr, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Shotts, at Leith, No. 1, 53s.; No. 3, 48s. 6d.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 49s.

There is no improvement in the pig iron shipments, which are on a very limited scale, especially as regards the quantity sent abroad. In the past week the clearances at the various Scottish ports make up a total of only 3181 tons, which compares with 5078 in the corresponding week of last year. Of the total there was sent to Holland 295 tons, United States 50, South America 100, Italy 50, France 100, Germany 70, Belgium 30, Spain and Portugal 20, other countries 25, the quantity despatched coastwise being 2441 tons, against 3599 in the same week of last year.

The manufactured iron and steel departments are favourably situated, the amount of employment being on the increase, with an encouraging number of inquiries in the market. Prices of both iron and steel are firmer, and if the advance in pig iron continues an increase may be expected.

A contract for seventeen large bogie passenger engines has been placed by the Highland Railway Company with Messrs. Dubs and Co., of the Glasgow Locomotive Works.

During the week there has been no improvement in the coal trade. The total shipments have been 128,121 tons, against 125,003 in the preceding week and 102,150 in the same week of last year. There is a decrease of 10,000 tons at the Firth ports, but the Fife shipments are 14,000 tons better than in the preceding week, and it is to be hoped this improvement may continue, as in some parts of Fife there is considerable distress among the colliers owing to long-continued want of employment. There is no change in coal prices.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE death roll of Tylorstown is now decided to be 57, and it is generally agreed that it was a most fortunate circumstance that it is so limited. Had the day men gone down—and many were on their way—the fatality would have been little short of the total of Cilfynydd, which nearly reached 300.

The week has witnessed the usual distressing scenes—the funerals of the sufferers, the sympathetic movements in every valley to relieve the widows and orphans, and while this has been going on, energetic means have been at work to clear the three pits and again start the output. Government contracts and those of other customers are pressing, and with all sorrow and consideration for the lost, it is but right to take note of the wants of the living.

Two of the three pits are reported ready for work. The Ferndale men in adjoining collieries have resumed work.

On Saturday notices were posted up at Park Slip, Tondu, No. 9 pit, Maesteg, and the Wyndam Colliery, Nantymoel, forming the group known as North's Navigation Collieries. The notice will mature in one month from date, and unless the decision now given be modified, all the collieries will be stopped.

In the Merthyr Valley the whole of Hill's Plymouth Collieries—over 3000 men—are stopped, and so far there appears no sign of any arrangement. Impartial authorities believe that the general manager is right in his contention, but regret that steps had not been taken by both parties to have the case adjudicated upon by the sliding scale committee.

The coal world is a little at unrest in several quarters. At Bwllfa the men are "locked out," and "grievances" are urged by the workmen at Llest and Ffaldau, which the agent of the Garw Miners' Association has been directed to investigate. Two collieries stopped in the Hirwain district remain so, though it is possible that one, eventually, may be worked from an adjacent property.

The Swansea Harbour report for 1895 has just been issued, and is in many ways satisfactory. For the first time the total trade exceeded three million tons. An increase is shown in coal exports, and in tin, terne, and black plates, but a slight falling off in patent fuel and in iron, steel castings, &c. Marked as the development has been, future prospects are still more satisfactory. The contract for the enlargement of the Prince of Wales dock has been given to Sir John Jackson, who will start operations shortly.

The prominent feature in the coal trade of late, especially noticeable at Cardiff, has been the irregular and insufficient supply of coal coming down, from the Rhondda collieries principally. This has led to a good deal of friction between coalowners and shippers, but every day yields a little improvement, and the week promises a substantial tonnage at Newport and Swansea. Coal business has been brisk, Swansea in particular showing an improved French trade. Prices are looking up, and are fully 3d. per ton better than last week. Cardiff quotations this week are as follows:—Best steam, 10s. 6d. to 10s. 9d.; seconds, 9s. 6d. to 10s.; drys, 9s. 3d. to 9s. 9d.; best Monmouthshire, 8s. 9d. to 9s.; second, 8s. to 8s. 3d.; best small, 4s. 6d. to 4s. 9d.; seconds, 4s. 3d.; drys, 4s.; house coal, best, 10s. 6d. to 11s. Monmouthshire coal is in very marked demand. No. 3 Rhondda, 9s. 6d. to 9s. 9d.; brush, 7s. 9d. to 8s.; small, 6s. 3d. to 6s. 6d.; No. 2 Rhondda, 8s.; through, 6s. 3d. to 6s. 6d.; small, 4s. 3d. to 4s. 6d. Swansea prices:—Best steam from 9s. 6d. to 10s. 6d.; seconds, 8s. 6d. to 9s. 6d.; No. 3 Rhondda, 10s. to 10s. 6d.; No. 2 Rhondda, 8s. 9d. to 9s. 6d.; anthracite, 8s. 9d. to 12s., according to quality. The Channel Islands are contracting largely for anthracite.

On 'Change, Cardiff, this week, pitwood ranged from 15s. to 15s. 6d., patent fuel 10s. to 10s. 6d., and coke as follows:—Furnace, 11s. 9d. to 13s. 6d.; foundry, 15s. 6d. to 16s. 6d.; special, 19s. 6d. Each industry is fairly active. At the end of last week some further good coal orders, from the Admiralty, came to the Cardiff district; one of 25,000 tons was placed at the Albion, and one of 65,000 tons was secured by the Ferndale collieries. The price is understood to be between 10s. and 10s. 3d.

In the iron and steel industry steel bar is still in a backward state, though a moderately large consignment continues to be sent from Cyfarthfa to the west of Wales. Business continues partial, and in some quarters rails are being turned out principally for foreign and colonial demand, while in others the rail make is limited to colliery sections for home requirements. Pig iron has been a little more in evidence of late, and prices are still going up. The advance since last week is about 1s. per ton. It was reported on 'Change, Swansea, this week that higher figures than the last market quotations for pig are likely to prevail, and that increased rail orders are tolerably certain from new developments in the Colonies. If to this a brighter outlook could be gained for the steel bar trade, spring trade would be regarded as more encouraging than it promised to be a month ago.

I note a decrease in stocks of pig iron locally, and a large bulk of pig coming in from Millom and other quarters, with scrap steel from Sheerness, and old rails from Southampton. Imports of iron ore to the principal ironworks have been large this week. The exports in iron and steel during the week included 430 tons for London; 50 tons rails, Sligo; and 20 tons rails, Carnarvon. Swansea Exchange was fairly attended midweek, and the following given as the latest quotations:—Glasgow pig, 46s. 10d.; Middlesbrough, No. 3, 37s. 11½d.; hematite, 45s. 8½d.; Welsh bars, £5 5s. to £5 10s.; sheet iron and steel £6 12s. 6d. to £6 17s. 6d.; steel rails, £4 10s. to £4 15s. for heavy, £4 17s. 6d. to £5 for light; Bessemer steel: Tin-plate bars, £3 17s. 6d.; Siemens, £4; all delivered in the district, cash.

Tin-plates: Bessemer cokes, 9s. 1½d. to 9s. 3d.; Siemens coke, 9s. 4½d. to 9s. 6d.; ternes, per double box, 28 by 20 c, 17s. 6d. to 22s.; best charcoal, 12s. 6d. to 13s. 6d.

The tin-plate trade continues to engage close attention, and local journals abound with comments upon the situation, reports from the States, and action of the men. The shipments of tin-plates have again been slightly in excess of make, but, as remarked on 'Change, this does not appear to have had any influence upon price, probably on account of the difference being slight. Last week the shipments amounted to 40,111 boxes; receipt from works, 35,409 boxes. Stocks in Swansea had amounted to 140,925 boxes, as compared with 145,627 boxes the preceding week, and 234,134 boxes this time last year. Last week sixteen mills were at work in the Briton Ferry district out of a possible twenty-one. Three of the mills out of six were at work at the Villiers, and four out of the six at Vernon.

A reduction of 10 per cent. from the 1874 list has been conceded by the workmen at the Western Works, Llanelly, and on Monday it was announced that the Old Castle men at the same place had agreed to a similar reduction.

The demand for tin-plates from Batoum continues; from the States it is still weak. It remains to be seen what the action of the men will bring about on the 1st of March.

The colliers have had another slight reverse, the sliding scale audit declaring a further reduction of 1¼. This was declared on Saturday last. The rate of wages is now 11¼ per cent. above the standard of 1879.

The strike in the Forest of Dean, at Speech House Hill Collieries, continues. This involves 240 men.

A beginning has taken place with the North Pembrokeshire Railway at Letterston. The contract for the work has been secured by Mesers. Holme and King, of London and Birmingham.

An important meeting of the Newport Chamber of Commerce was held last week, when, amongst other matters, the question of the Bute Bill for getting into Monmouthshire by the proposed new line to Bassalleg was fully discussed as one of extreme importance, and it was decided to refer its consideration to the executive committee.

On Wednesday the Plymouth colliers marched in procession, headed by their band, to the Union Workhouse at Merthyr. The object of the demonstration is said to be to awaken sympathy from the general public.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE market for iron and steel continues quiet on the whole, but there is a hardening tendency in prices, which shows that a healthy and improving tone prevails in the different departments.

In Silesia the situation of the iron business remains favourable; a hopeful feeling characterises the malleable as well as the steel trade, consumers coming forward pretty freely with their requirements, and the good reports that are being received from the Rhenish-Westphalian district also tend to increase the firm tone of the market. Pig iron makers are doing a fairly satisfactory business, and generally have realised higher prices; all the furnaces are actively engaged, as the malleable iron works, influenced by the generally rising tendency in prices, are becoming rather anxious to buy for forward delivery. There has been next to no business done in plates and rails during the past month, but an ample demand will probably be coming forward in spring.

The Austro-Hungarian iron market is still very weak, in spite of the slight improvement that was reported here and there. Prices are fluctuating; girders, for instance, met with an advance, 111fl p.t. being now the average quotation, against 106fl. p.t. in the preceding months. For tin sheets, on the other hand, a reduction in price was agreed upon. The demand for railway and structural material is tolerably satisfactory, though anything but brisk.

There is no alteration to be reported in connection with the French iron trade, transactions being on the whole limited.

The position of the iron and steel industry in Belgium may be regarded as pretty favourable. Pig iron is in improving request, and has been realising better prices. The railway department is in healthy employment, and prospects for the future are fair, the Belgian State Railways having invited tenders for the supply of sixty locomotives.

A good active trade is doing on the Rhenish-Westphalian iron market. The tone of prices is firm and generally tending upwards. Pig iron has been in lively request, and the blast furnace works are briskly engaged The strong demand that is coming in for all sorts of pig iron has caused makers to venture an advance in quotations, and spiegeleisen is now quoted M. 55 to 56 p.t., while forge pig, No. III., fetches M. 52 p.t. Scrap iron is very scarce and rising in quotation. Among the different sorts of finished iron, bars are, perhaps, the article that is best inquired for, and the mills continue in lively occupation. For girders some fair orders have lately been received, and the plate and sheet trade may be reported in a fairly good condition, with prices tending in an upward direction. Of the 11,000 wagons, which have recently been ordered by Government, a considerable lot has fallen to the Rhenish-Westphalian shops, securing employment for nearly a year. The tube foundries have hitherto remained in fair activity. Export trade leaves pretty much to be desired, especially with regard to the prices that have to be accepted.

Last week's quotations for the different articles of finished iron were as under:—Good merchant bars, M. 110; angles, M. 118; girders, M. 84; hoops, M. 112 to 117; billets in basic and Bessemer, M. 80 to 83; heavy plates for boilermaking purposes, M. 160; tank ditto, M. 135 to 140; steel plates, M. 125; tank ditto, M. 115 to 118; sheets, M. 140 to 145; iron wire rods, common quality, M. 118 to 125; drawn wire in iron and steel, M. 118 to 120; wire nails, M. 127 to 130; rivets, M. 150 to 155; complete sets of wheels and axles, M. 270 to 280; axles, M. 200; steel tires, M. 195 to 200; steel rails, M. 108 to 110; steel sleepers, M. 106; fish-plates, M. 112 to 120; light section rails, M. 95, all per ton at works.

Total production of pig iron in Germany, including Luxemburg, was for December, 1895, 510,405 t., of which 141,675 t. were forge pig and spiegeleisen, 27,458 t. Bessemer, 263,288 t. basic, and 77,984 t. foundry pig. Output in December, 1894, amounted to 498,233 t. only, while in November, 1895, 489,822 t. were produced. From January 1st to December 31st, 1895, 5,788,798 t. were produced, against 5,559,322 t. for the same period the year before.

The import of coal from England into Germany was for 1895 no less than 4,143,822 tons against 3,893,709 tons in the previous year.

According to the Berlin *Actionär*, the consumption of coal in Berlin was for 1895 1,426,725 tons pit coal and 797,100 tons brown coal and artificial coal. Supplies were:—From Upper Silesia, 883,583 tons; Lower Silesia, 201,257 tons; Westphalia, 100,909 tons; and England, 230,501 tons. Imports from England show an increase of 41,197 tons against 1894; indeed, they have never before been so high as in the year that is now past.

The following shows value of German trade in goods of all kinds to the Transvaal. In 1889 import from Transvaal to Germany amounted to M. 51,000, while export from Germany to Transvaal was M. 955,000; in 1893 value of import from Transvaal rose to M. 201,000; in 1894 it was 480,000; while value of export to Transvaal in the same year amounted to M. 3,154,000.

With regard to the German export in iron and steel to the Transvaal, a considerable improvement appears to have taken place of late. From 1892 to 1895, export was between 8000 and 9000 t. per annum, value of export amounting to about £50,000 per annum.

The iron industry in Russia has been steadily improving for some time past. There is now a large foundry and machine factory in course of erection at Saratow, which will employ more than 1500 men, a Warsaw firm, with a joint stock of 10 million roubles, being at the head of the affair. A Cologne firm is likewise said to have acquired large grounds near Ekaterinoslaw, for the purpose of building a plate and tube mill there. During the year now past the Russian wagon factories have received orders for more than 100,000 goods wagons; some years ago there were no factories of that description in Russia, and their requirements in wagons, &c., had to be covered from abroad.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, January 29th.

THERE is a very unsettled financial condition throughout the States, connected with, and in a measure attributable to, the effort of the Government to borrow 100,000,000 dols. The New York banks have gained 23,000,000 dols. since the Venezuelan message, and the Treasury lost 25,000,000 dols. The banks are now ready for the loan. Bank loans have been contracted in Boston, Philadelphia, and this city over 50,000,000 dols. within three weeks. As compared to same time 1893, our business throughout the country was 30 per cent. less. The industrial condition is not so favourable. Iron and steel production is in excess of market demands, and production must be curtailed. Prices of most staple products are now at their lowest probable limit. Ore and coke appear fixed, owing to centralised control. A sudden change may come over iron industries as soon as the Government loan is closed. The work of reorganisation of railroad properties is progressing, and the new president of the Baltimore and Ohio expects to create a blanket mortgage, taking up all others by the assistance of a collateral trust. Other properties are undergoing the same process. Rail makers are getting very little business, and while companies have voted to make large outlays, the placing of orders will be delayed until commercial and financial conditions are decidedly more favourable than at present. Steel makers have canvassed the market during the past two weeks, and they report buyers as having very little stock on hand and unwilling in the great majority of cases to buy in anticipation. Something like a crisis is immediately ahead of us, but the chances are it will pass without detriment. Enormous construction requirements are pigeon-holed until assured ease in monetary affairs warrants a different policy.

A "DOG CART" STEAM FIRE ENGINE.—In many places, especially abroad, it is often difficult to obtain a pair of horses for a steam fire engine when a fire occurs, and to meet the want of a one-horse machine, Messrs. Merryweather and Sons, of London, have just designed and constructed a novel "dog cart" fire engine. This has a quick steam raising boiler, gun-metal pump, and copper air vessels; it weighs only about 14 cwt. complete, and pumps over 100 gallons per minute. The machine carries three men, and has bunkers for hose and coal, while one horse can draw it easily at full trot.

LAUNCHES AND TRIAL TRIPS.

On **January 30th the s.s. Richmond**, recently built by **Messrs. Ropner and Son**, of Stockton-on-Tees, to the order of the Britain Steamship Company, Limited, London, left the river Tees on her trial trip. The steamer is an exact duplicate of the s.s. Chiswick, which made her trial trip on the 17th ult., and has also been built under the supervision of Mr. Spence, the company's inspector, who attended the trial trip, and who expressed himself highly pleased with the behaviour of the steamer, and also of the satisfactory working of her machinery during the trial run. After the compasses were duly adjusted in the bay, the steamer proceeded on her run round to Newport (Mon.), where she will load for Rio.

The other day the s.s. Holgate had her trial trip in Hartlepool Bay. The Holgate has been built by Messrs. Wm. Gray and Co. for the London and Northern Steamship Company—Messrs. Pyman Bros., London, managers. She is a fine steamer, built to Lloyd's highest class, and her dimensions are: Length over all, 329ft.; breadth, 44ft.; and depth, 23ft. 3in. She carries over 4100 tons deadweight, on a draught of about 19ft. Triple-expansion engines, having cylinders 23in., 36in., and 62in. in diameter by 39in. stroke, and two large steel boilers working at 160 lb. pressure per square inch, have been supplied by the Central Marine Engine Works of Wm. Gray and Co. Captain T. Pyman and Mr. Wm. Cromar have superintended the construction of the vessel and her machinery on behalf of the owners. The trial was in every respect a most successful one, Mr. Cromar being present on behalf of the owners, and Mr. Lindsay representing the engine builders. On its conclusion the vessel proceeded on her voyage to Cardiff, to load for the River Plate.

On Saturday last the large screw steamer Lisnacrieve, owned by Messrs. Hunting and Son, Newcastle-upon-Tyne, went for her official trial trip off the mouth of the Tyne. The vessel has had her machinery converted from the compound two-crank type to the three-cylinder three-crank type by the addition of new cylinders and a complete new high-pressure engine forward, together with new steel boilers for 160 lb. working pressure. The alterations have been made by the North-Eastern Marine Engineering Company, Limited, at the Wallsend Works, under the supervision of Captain Brunton and Mr. Taylor, the owners' representatives. The official trial over the measured mile—the vessel being fully laden—indicated an average speed of ten knots. Mr. Hunting, who was present at the trial, expressed great satisfaction at the results attained, as also at the expeditious and successful manner in which the work had been carried out. The North-Eastern Marine Engineering Company was represented on the trial by Mr. S. Hunter, manager, and Mr. D. Myles.

On the 31st inst. Messrs. Ropner and Son, Stockton-on-Tees, launched a steel screw steamer of the following dimensions:—Length between perpendiculars, 310ft.; breadth, extreme, 44ft.; depth moulded, 23ft. The steamer has been built to the order of a London firm, and is built off the two decked rule, with poop, bridge, and top-gallant forecastle. The saloon and cabins for captain and officers will be fitted up in the saloon house amidships, and the accommodation for engineers will be provided under the bridge deck, the crew being berthed in the forecastle, as usual. She has a double bottom, on the cellular principle, for W.B., and has been designed to carry a dead-weight cargo of over 4000 tons on Lloyd's summer freeboard; she will have all the most recent deck machinery for the expeditious loading and unloading of cargoes, has direct steam windlass, steam stearing gear amidships, with powerful screw gear aft. She will be fitted with a set of powerful triple-expansion engines by Messrs. Blair and Company. The ship was named Kingtor by Mrs. R. Ropner, jun.

On Thursday, January 30th, Sir Raylton Dixon and Co. launched from Cleveland Dockyard, Middlesbrough, a steel spar deck screw steamer, built to the order of Messrs. the Indo-China Steam Navigation Company, London. Her principal dimensions are:—Length, 300ft.; beam, 40ft.; depth moulded, 25ft.; with a dead-weight capacity of about 3300 tons on 20ft. The vessel has been built on the deep frame system, under Lloyd's special survey for their highest class, and specially designed for trading in the Eastern seas. The spar deck is of steel, sheathed with teak, and the bridge and forecastle decks of teak. The 'tween decks are also arranged for carrying Chinese passengers. Triple-expansion engines, 21in., 34in., 56in., by 42in. stroke, will be fitted by Messrs. the North-Eastern Marine Engineering Company, Sunderland, having boiler fitted with Howden's forced draught. The hull and machinery have been built under the supervision of Mr. Buchanan and Mr. Duncan. On leaving the ways she was named Chun Sang by Mrs. Alfred William Bulmer, of Great Ayton.

On Friday, January 31st, the steel screw spar deck steamer Rudelsburg, built by Sir Raylton Dixon and Co., Cleveland Dockyard, Middlesbrough, for Messrs. the Hansa Steamship Company, Bremen, was taken out to sea for her official trial trip under the command of Captain Zittlosen. Her dimensions are:—Length, 323ft.; beam, 42ft. 6in.; depth moulded, 25ft. Great care has been taken in the construction of the vessel, so as to meet the company's requirements for their River Plate trade. The poop, bridge and forecastle decks are of teak, and handsome accommodation is provided for captain, officers, and engineers in houses on bridge deck. Triple-expansion engines, built to German law requirements, have been fitted by Messrs. T. Richardson and Sons, Hartlepool, having cylinders 22½in., 36in., 62in. by 42in. stroke, with two large single-ended boilers, working at 200 lb. pressure. The hull and machinery have been constructed under the supervision of Mr. D. Wulff, superintendent engineer for the Hansa Company. During the trials everything worked most satisfactorily, and the vessel proceeded direct to Bremen.

On Saturday, February 1st, there was launched from the yard of the Tyne Iron Shipbuilding Company, of Willington Quay-on-Tyne, a steel screw steamer, built to the order of Mr. E. C. Thui, of Liverpool, for whom the builders have previously built several vessels, and of the following dimensions, viz.:—Length, 350ft.; breadth, 47ft.; depth, 28ft. 3in., moulded; and to class 100 A1 at Lloyds' on the spar deck rule. This vessel has water ballast fitted right fore and aft on the cellular system, and is also fitted with all modern improvements for the rapid loading and discharging of cargo, including a good outfit of large double-cylinder steam winches, direct-acting steam windlass, steam steering gear by Messrs. the Harrison Patent Steering Engine Company, and Hastie's screw gear aft. The engines, which are to be supplied by Messrs. the North-Eastern Marine Engineering Company, are of the triple-expansion type, having cylinders 25½in., 41in., and 68in. by 48in. stroke, and working at a pressure of 160 lb. On leaving the ways the vessel was named the Tropic by Miss Bone, of Tynemouth.

On Wednesday, the 29th ult., Messrs. Wigham, Richardson, and Co., launched from their Neptune Shipyard a screw steamer which they are constructing for the Indo-China Steam Navigation Company, of London. The steamer is finely modelled and built of steel. She is 290ft. in length by 40ft. beam by 25ft. in depth, and will be rigged as a two-masted schooner. She will have comfortable accommodation for a few passengers, and will be completely fitted for her special trade in the East, including the most modern and improved appliances for working both the cargo and the ship quickly and economically. The engines and boilers are also being constructed by Messrs. Wigham, Richardson, and Co., and they are designed to enable the vessel to maintain a good speed on her service. The construction of the steamer is proceeding under the superintendence of Mr. Colin Buchanan, the superintendent engineer for the Indo-China Steam Navigation Company, assisted by Mr. Duncan. As the vessel left the ways she was named the Fau-Sang by Mrs. T. Bulmer, of Middlesbrough, the wife of the agent for the Indo-China Company in the North of England.

On Friday last, January 31st, the official trial was made with the sea-going torpedo boat Viper, built for the Imperial and Royal Austro-Hungarian Government by Messrs. Yarrow and Co., Poplar, in the presence of Chevalier Leopold von Jedina, Naval Attaché to the Austro-Hungarian Government; Captain Padevit; Mr. Krainer, Engineer-in-Chief to the Austrian Navy; Lieutenant Schwarz, commander of the Viper; M. Thiel, naval architect; and Mr. Nitsch, engineer of the Viper. This vessel is 147ft. 6in. long by 14ft. 9in. beam, and was guaranteed to attain a speed of 24 knots when fully equipped and loaded, with 26 tons to represent armament. The Viper left Messrs. Yarrow and Co.'s yard at ten o'clock in the morning, and commenced her three hours' trial about noon at Thames Haven. During the middle of the three hours' trial six runs were made on the measured mile, during which the mean speed attained was 26·633 knots, and the mean speed for the three hours' continuous run was 26·638 knots—*i.e.*, 2·638 knots in excess of the contract speed. The vibration was practically *nil* at all speeds, the machinery being balanced on the system first introduced by this firm. After the run the usual manœuvring trials were carried out, all of which proved satisfactory. The boilers are of the Yarrow type, with straight tubes and no outside down pipes. The above result was obtained with an air pressure in the stokehold averaging ⅞in. of water.

On February 1st, 1896, Messrs. Furness, Withy, and Co. launched from their shipbuilding works at Hartlepool a large steel screw steamer built to the order of Messrs. the Lincluden Steamship Company—Messrs. Sivewright, Bacon, and Co., managers. The vessel is a very substantial type of a modern cargo boat, measuring over 340ft. in length, and built throughout of Siemens-Martin steel, with a large measurement and deadweight capacity, and built to the highest class under the British Corporation classification. Every care has been taken in designing this ship to construct her as substantially as possible for the heavy deadweight trade. She is built on the deep frame system, with cellular double bottom for water ballast, all fore and aft, and subdivided at intervals, the after peak being also available as a tank. To further ensure the safety of the vessel the main and fore holds are divided in the middle by steel water-tight bulkheads, these bulkheads being efficiently stiffened by an iron longitudinal division. It is anticipated that, with the extra amounts of subdivision in water ballast tanks and holds, and the efficient way the pumping gear is arranged, the vessel will be practically unsinkable by collision or stranding. To obtain as much strength as possible, the greater portion of the shell plating is in 24ft. lengths, this plating being efficiently backed up by strong deep framing carried up to the main deck, all fore and aft; the bottom plating is also thicker in way of all ballast tanks to permit the vessel to lie aground whilst taking in cargo. To allow for corrosion, the whole of the weather decks, tank tops, floor plates, &c., are of extra thickness, there being practically no thin steel in the ship. She has extra large-sized hatchways, which will take the bulkiest description of cargo, and would be specially suitable for carrying machinery, large guns, torpedo boats, &c. The auxiliary machinery for working and discharging cargo is of the most efficient description, six large winches to hatches, patent steam steering gear amidships, with hand gear aft, steam windlass, and the anchors being of the stockless pattern. The machinery has been constructed by Messrs. T. Richardson and Sons, the engines being of the triple-expansion type, with two large steel boilers. Every provision has been made in designing the machinery for economy of fuel and the minimum of cost of upkeep, all the parts being specially heavy, with large bearing surfaces. The extra fittings in the engine-room include Morison's evaporator and Geddes' water drainers, and the boilers are fitted with suspension furnaces and Geddes' protector doors. It is anticipated a good speed will be attained by this vessel, as she is finer lined than the ordinary run of cargo boats. On leaving the ways the vessel was named Lincluden by Miss Elsie Bacon, daughter of one of the owners.

A DISCOVERY of plumbago deposits is reported near Mandalay. Their extent and value as yet are unknown.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When patents have been "communicated" the name and address of the communicating party are printed in italics.

23rd January, 1896.

1641. Fastener for Boots, A. J. B. Bocquet, London.
1642. Pulleys, S. Straker, London.
1643. Collecting Deposit in Kettles, E. A. and C. J. Buck, London.
1644. Rubbing Apparatus, E. E. Dransfield and W. Tyree, London.
1645. Stable Double Salts of Chloride of Zinc, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
1646. Gasaliers, &c., Pendant Lights, H. Arnhold, London.
1647. Syphon Discharge Cisterns, W. A. G. Schönheyder, London.
1648. Gasifying Petroleum, D. Young.—(*F. Aschner, Germany.*)
1649. Water-closets, F. J. Reinisch, London.
1650. Strut-backs for Picture Frames, L. A. Marion, H. Guibout, G. and F. Bishop, and J. P. Kirk, London.
1651. One-trigger Double Gun, T. Southgate, London.
1652. Race Game, A. G. Evans, London.
1653. Pedals for Velocipedes, L. Bourzac, London.
1654. Straw Hats, S. Wingrave, London.
1655. Tobacco Pipes, F. Hopkins, London.
1656. Fasteners for Boots and Shoes, R. J. Clarke, London.
1657. Mechanical Toy, E. A. Hadley, London.
1658. Connecting Curtain Rings, R. H. Bishop and W. Down, London.
1659. Reefing Appliances for Sails, R. Turner, London.
1660. Device for Taps of Vessels, B. Hartley, Liverpool.
1661. Toy, T. Wignall, Liverpool.
1662. Showcards, W. and J. W. Devitt and E. A. Lees, Manchester.
1663. Winding Frame for Wool, J. Schott-Wautier, Liverpool.
1664. Velocipede Seats or Saddles, F. D. Chambers, London.
1665. Airing Cupboard, F. J. Bennett, London.
1666. Extractors, T. Fairley, London.
1667. Ammonium Nitrate, &c., Salts, T. Fairley, London.
1668. Manufacture of Sodium Salts, T. Fairley, London.
1669. Electric Batteries, W. Turner, London.
1670. Spindles for Locks, J. C. Hughes and J. Preece, London.
1671. Wagons for Coal, F. L. Lane and The Leeds Forge Co., London.
1672. Stop Valves, D. B. Morison, London.
1673. Drilling Rocks, R. and W. C. Stephens, London.
1674. Drilling Rocks, R. and W. C. Stephens, London.
1675. Velocipede Brakes, P. Dorigny, London.
1676. Cans and Canisters, S. Juhász, London.
1677. Disinfecting Water, W. Digby.—(*A. E. Woolf, United States.*)
1678. Electrodes, W. Digby.—(*A. E. Woolf, United States.*)
1679. Disinfecting Agents, W. Digby.—(*A. E. Woolf, United States.*)
1680. Fire-grates, W. Johnson, London.
1681. Incandescence Bodies, W. H. Wheatley.—(*F. Woernle, Germany.*)
1682. Incandescence Bodies, W. H. Wheatley.—(*C. Schmid, Belgium.*)

24th January, 1896.

1683. Curve Tracer, A. Monticolo and E. Scott, Wolverhampton.
1684. Pneumatic Tire Dust Cap, &c., R. Blacklock, Sunderland.
1685. Utilising Primary Electric Currents, T. Cooper, Walsall.
1686. Detachable Drain Pipe Socket, J. W. Martin, London.
1687. Isolator for Fastening Electric Wires, H. Rudolf, London.
1688. Securing the Safety of Railway Traffic, J. H. Hamilton, Belfast.
1689. Feed-tray for Dogs, W. Bauer, Manchester.
1690. Spindle Lubricating Device, J. Vaughan, Manchester.
1691. Glass Washer, J. Allison and W. Atherton, Leigh.
1692. Method of Packing Cycles, G. Wright, Nottingham.
1693. Securing Handles to Locks, G. A. Brookes, Manchester.
1694. Powder, E. J. T. Digby, Birmingham.
1695. Electric Tramways, T. Meacock, Birmingham.
1696. Cock or Tap, W. Barnes, Bristol.
1697. Reservoir Pen, G. Orford, Liverpool.
1698. Damping Warp Thread or Yarn, A. Brothers, Liverpool.
1699. Change Giving Apparatus, W. Dannenberg, London.
1700. Tobacco Pipe, H. H. Mayor, Liverpool.
1701. Syruping Aerated Beverages, D. Rylands and J. Bullen, Barnsley.
1702. Golf Club and Cricket Bat Grip, H. B. Barlow, Manchester.
1703. Banjos, H. and W. J. Riley and F. Baker, Birmingham.
1704. Shuttle-guard for Looms, J. T. and E. Cooper, Halifax.
1705. Coupling for Wagons, T. Locker and A. Schofield, Derby.
1706. Hand Drilling Machine, J. T. Blackett and W. Hutton, Guisborough.
1707. Thrust Blocks, A. C. Franklin, Shoreham.
1708. Boot Polishing Machine, R. L. Tapscott, Liverpool.
1709. Glass Bottle, E. G. Ward, London.
1710. Knee Grip for Saddles, A. S. Walker and T. H. Hooper, London.
1711. Machine for Cutting Turnips, S. Edwards, Sheffield.
1712. Urinal, T. Elliott, Manchester.
1713. Design for Woven Fabrics, R. J. C. Mitchell, Manchester.
1714. Cigar Holder, J. Edgar, Glasgow.
1715. Ships' Telegraphs, J. W. Ray and R. C. Saxby, Liverpool.
1716. Steering Gear, J. W. Ray and R. C. Saxby, Liverpool.
1717. Rubber Bit for Driving Horses, J. Connor, London.
1718. Chain for Cycle Gearing, &c., A. J. Caronni, London.
1719. Veterinary Bath, C. E. Roe and T. H. Rees, London.
1720. Money Detector and Changer, J. Stoddart, Woolwich.
1721. Car Wheel, L. L. Grouse, London.
1722. Permanent Way of Railways, S. Newton, London.
1723. Ventilator, R. B. Fuller, London.
1724. New Game, W. H. and G. F. Nicholls, Birmingham.
1725. Urethroscope, K. Schall, London.
1726. Flower-pot, J. Hall, Glasgow.
1727. Driving Gloves, R. M. Hogg, Glasgow.
1728. Washing Apparatus, A. J. Boult.—(*E. Féry, France.*)
1729. Salt, F. Perez, London.
1730. Flexible Harrow, W. Ogle, London.
1731. Teaching the Use of Numbers, A. J. Boult.—(*C. R. Jouve, France.*)
1732. Dovetail-cutting Machine, J. R. Rickard, London.
1733. Chain for Hub Cycle Wheels, A. Kotin, London.
1734. Elastic Boot and Shoe Heel, W. Noelle, London.
1735. Wool Dryer, M. Harding, London.
1736. Pneumatic Tires, D. W. Alexander, London.
1737. Mud Guard for Carriages, &c., W. Hewitt, London.
1738. Bicycle Support, F. A. Lucas, A. Salomon, and H. Franck, London.
1739. New Domestic Washing Machine, R. Felsche, London.
1740. Feed-water Heater, W. Schmidt, London.
1741. Manufacturing Gold-plated Wire, F. Kammerer, London.
1742. Candle Holder, J. Batchelor, London.
1743. Producing a Stage Illusion, W. B. Wood, London.
1744. Electric Traction, D. Korda, London.
1745. Syphon for Making Aerated Water, R. Prax, London.
1746. System of Communication for Vehicles, F. G Nettlefold and G. R. Jaggs, London.
1747. Cakes, &c., J. Latham, Liverpool.
1748. Penholder, M. Foran, London.
1749. Direct-acting Pumping Engine, W. H. Holehouse, Bradford.
1750. Fuel Blocks, J. C. Mewburn.—(*La Société Anonyme du Combustible Intensif, France.*)
1751. Packing or Lining for Forts, &c., R. Ellis, London.
1752. Paraffin Lamp, W. Reynolds and L. G. Astley, Coventry.
1753. Attaching Fittings to Boilers, J. Marshall, London.
1754. Delivering Tickets, &c., E. C. Beaumont, London.
1755. Envelope, A. J. Lely, London.
1756. Venetian Blinds, A. W. Glover, London.
1757. Removing Powder from Paper, W. B. Silverlock, London.
1758. Tobacco Pipe Cleaners, W. B. Silverlock London.
1759. Devices for Fixing Studs, &c., J. L. A. Aymard London.
1760. Cycle Construction, W. Graham, London.
1761. Sealing Bottles, C. Lambert, London.
1762. Cycle Saddle Construction, G. H. Trengove, London.
1763. Station Indicators, J. F. O'Brien, London.
1764. Defrosting of Dead Meat, &c., J. Atherton, London.
1765. Treatment of Dead Meat, &c., J. Atherton, London.
1766. Door Knockers, A. Culpin, London.
1767. Runner and Tip Cap for Umbrellas, J. Forbes, London.
1768. Gunpowders and Explosives, W. Hope, London.
1769. Pellets and Grains of Gunpowder, W. Hope, London.
1770. Means for Driving Cycles, H. B. Hopewell, London.
1771. Reducing Valves, J. W., T. T., and E. A. Boaz, London.
1772. Fire-arm Sights, E. Edwards.—(*V. Kjær, J. C. Johansen, and J. Zinn, Denmark.*)
1773. Mouthpieces for Cigarettes, P. H. Davis, London.
1774. Transposing Keyboard for Pianos, J. Hanauer, London.
1775. Dynamo Machines, A. I. Gravier, London.
1776. Milking Apparatus, P. Jensen.—(*C. G. P. de Laval, Sweden.*)
1777. Inkstands, B. C. Levy and F. S. and G. Carter, London.
1778. Brushes, C. H. Rouse, London.

25th January, 1896.

1779. Front Forks of Cycles, J. Goldschmidt, jur., London.
1780. Buckles or Fasteners for Belts, J. Foulds, Keighley.
1781. Fancy Boxes, D. N. Murdoch, Belfast.
1782. Testing Magnetic Quality, J. A. Ewing, Cambridge.
1783. Bath Glove, E. Barron, London.
1784. Pneumatic Tires, &c., L. O. Michael, Birmingham.
1785. Wastes of Baths, &c., S. L. Russell, Cheltenham.
1786. Cargo Vessels, W. Hök and H. Laing, Newcastle-on-Tyne.
1787. Automatic Self-opening Door, A. G. Pinfold, Bradford.
1788. Utilisation of Brewers' Mash-tun, R. D. Bailey, London.
1789. Oil Motive Power Engines, J. Söhnlein, Glasgow.
1790. Stopper for Jars, E. A. Matthias and W. H. Harrison, Manchester.
1791. Inflating Pneumatic Tires, W. Brookes, Manchester.
1792. Golf Tee Mould, A. Schultz, London.
1793. Electrical Photographic Lamp, J. M. Inglis, Edinburgh.
1794. Manufacture of Bricks, J. W. Ormrod, Keighley.
1795. Keeping Clean the Chains of Cycles, E. H. Harberd, London.
1796. Accumulators, W. G. Mulliner and W. H. Sturge, Birmingham.
1797. Furnace Door, L. Rushworth, and A. Fletcher, Ashton-under-Lyne.
1798. Water Level Indicator, G. Sumner, Manchester.
1799. Supporting Rods for Wood Piles, F. Krupper, Berlin.
1800. Shaping Golf Club Heads, &c., M. McDaid, Glasgow.
1801. Device for Opening Metal Cans, W. Haug, Glasgow.
1802. Metal Golf Putter Head, R. Hunter, Sandwich, Kent.
1803. Portable and Fixed Clothes Pegs, C. E. Hogg, London.
1804. Cigarette and Cigar Cases, J. D. Fawcett, Sheffield.
1805. Valve Mechanism for Engines, C. W. Thompson, London.
1806. Wooden Bedsteads, J. T. W. and R. G. Drake, Barnsley.
1807. Cycles, P. W. Brown, F. White, and P. A. F. Pratt, London.
1808. Crust Holder and Vent for Pies, C. E. Challis, London.
1809. Tubulous Steam Boilers, D. Purves, London.
1810. Incandescent Gas Lamps, H. Talbot, London.
1811. Boot Garters, W. Winans, London.
1812. Gas Stoves, W. P. Thompson.—(*R. G. Finlay, United States.*)
1813. Rowing Sculls or Oars, H. Ferns, Liverpool.
1814. Cellar Covers, T. G. Bond and R. R. Griffiths, Liverpool.
1815. Index Cutting and Printing Machine, W. Corfe, Liverpool.
1816. Screw Nut Making Machines, F. A. Meischner, London.
1817. Apparatus for Enriching Gas, C. C. Walker, London.
1818. Recording Temperatures, W. Fiddes and W. and B. Cowan, London.
1819. Washing Machines, J. Manning and J. R. S Hayes, London.
1820. Resonators for Stringed Instruments, D. Mayer, London.
1821. Decorative and Advertising Devices, E. Hockey, London.

1822. Photographic and other Prints, T. J. Foster, London.
1823. Razors, W. J. Sarjent and T. Merrill, London.
1824. Opening Oysters, G. H. L. Jammes and C. W. Lloyd, London.
1825. Closing Bung Holes of Casks, J. Schumacher, London.
1826. Varying the Speed of Crank Shafts, J. Grimme, London.
1827. Making Fat from Cocoa Oil, M. C. A. Ruffin, London.
1828. Lubricating Spinning Frames, A. D. Oates, London.
1829. Power Winches, A. E. Seaton, Sheffield.
1830. Affixing Kettles to their Stands, W. Soutter, Birmingham.
1831. Kneading and Mixing Machines, P. Pfleiderer, London.
1832. Baking, P. Pfleiderer, London.
1833. Chandeliers, A. C. Jones and J. Day, jun , London.
1834. Glass Articles, J. Jaques and W. E. McCalla, Manchester.
1835. Cowls for Chimneys and Shafts, K. B. McKenzie, London.
1836. Flush Bolt Locks, H. Piquet, London.
1837. Machine Gun and Carriage, W. H. FitzGerald, London.
1838. Shearing Machines, H. W. C. Cox and G. Bowmar, London.
1839. Superheaters, F. Clench and T. S. King, London.
1840. Fire Alarm, P. Stiens, London.
1841. Incandescent Mantles, P.Stiens, London.
1842. Holder for Glow Lamps, T. R. D. Kenny, London.
1843. Connecting Vehicles, D. Urquhart and F. Wynne, London.
1844. Carriage Windows, C. T. Sörensen, London.
1845. Rotary Motors and Pumps, H. H. Lake.—(*The "Société des Moteurs et Voitures Automobiles Sytèmes Filtz," France.*)

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1846. Tap Locks, W. T. J. Parkes, London.
1847. Union Connection, F. Offen, London.
1848. Electric Cycles, &c., C. Adams-Randall, London.
1849. Adjustable Spanners, R. F. Hall, Birmingham.
1850. Centre Pillars for Cruet Stands, W. H. Lucas, Birmingham.
1851. Lamps for the Use of Policemen, &c., J. Bryer, Derby.
1852. Falling Shuttle Boxes in Looms, G. Keighley, Halifax.
1853. Fastenings for Doors, F. W. and R. C. Averill, Birmingham.
1854. Admitting Air into Barrels, W. H. Duncan, Shropshire.
1855. Lubricating Carding Engines, J. McNeill, Manchester.
1856. Brakes for Perambulators, E. Framston, Manchester.
1857. A Pocket Scorer for Billiards, R. Niven, Glasgow.
1858. Boxes for Containing Matches, A. E. Box, Liverpool.
1859. Manufacture of Cycles, G. and K. E. S. Walker, London.
1860. Protecting Electric Lamp Fittings, J. L. Kendal, Manchester.
1861. Opening of Mineral Liquid Bottles, J. Bowden, Dukinfield.
1862. Starting Hydrocarbon Oil Engines, S. Griffin, Bath.
1863. Rotary Engines, J. Burgermeister, Glasgow.
1864. Loom Pickers, J. Greenwood, Manchester.
1865. Pneumatic Tires, R. Blacklock and F. Turvey, Sunderland.
1866. Fumeless Gas Iron Gas and Air Mixer, G. E. Berry, Colchester.
1867. Straining Electrical Conductors, S. W. Baynes, London.
1868. The Royal Triple Grip Stud, T. Clarke, Leicester.
1869. Practice of the Strokes of Golf, D. Anderson, Coventry.
1870. Finger Board Zither, A. Minder, Cologne.
1871. Eye-glass Cord Winder, F. G. Davis, Birmingham.
1872. A Parlour Game, J. W. Waddell, Ontario, Canada.
1873. Signalling, W. Johnson and J. Potter, Birmingham.
1874. Receiving Box for Garden Shears, J. Lee, Penarth.
1875. Rendering Leather Waterproof, B. A. von Mansberg, Berlin.
1876. Files and Rasps, T. Osol, London.
1877. Balloons and Flying Machines, T. Fraser, London.
1878. Mechanism for Measuring Liquids, H. Galopin, London.
1879. Advertising Signs, B. Doyle, London.
1880. Fluid-pressure Motors, T. McCarter and T. Cooper, London.
1881. Sprinkler Installations, R. Wilding, London.
1882. Edge Tools, J. A. Innocent, Sheffield.
1883. Cycles, F. and T. Berry, London.
1884. Appliances for Holding String, H. Cardwell, Manchester.
1885. Plug Box, T. Morley, London.
1886. Parlour Game and Puzzles, W. Dench, Horsham.
1887. Domestic or other Cisterns, T. J. Smith, London.
1888. Dynamo-electric Machines, S. Z. de Ferranti, London.
1889. Composing Machinery, T. Hewitt, London.
1890. Railway Signals, Sir F. H. Sykes, Bart., London.
1891. Cameras and Accessories, C. E. Peczenik, London.
1892. Anti-corrosive, J. Ockermüller, London.
1893. Neckties, A. Strauss-Collin and L. Kronenberger, London.
1894. Fire Grates, P. Benham and E. J. Eason, London.
1895. Ventilators, A. C. Stevenson, London.
1896. Pen Nib Extracting Device, G. H. Light, London.
1897. Reservoir Penholders, W. Gunson, London.
1898. India-rubber Cutting Apparatus, W. Symington, London.
1899. Calculating Machines, C. V. Boys, London.
1900. Making of Cyanides, J. J. Holden and H. Baum, Liverpool.
1901. Tea-pots, Coffee-pots, &c., A. Adams, Birmingham.
1902. Oil Lamp and Oil Stove Wicks, C. S. Stemp, London.
1903. Butter Boxes, B. Haughton, London.
1904. Distress Signalling Apparatus, E. T. L. Bryers, London.
1905. Furnace Blasts for Treating Metals, H. Maxim, London.
1906. Pressure Recording Devices, J. F. Batchelor, Brooklyn, U.S.A.
1907. Photographic Cameras, E. H. P. Humphreys, London.
1908. Boilers, Furnaces, &c., G. S. G. de Livet, London.
1909. Roundabouts, T. Axtell, London.
1910. Butter Holder, E. Gamban, London.
1911. Chairs, L. Samuel, London.
1912. Production of Grinding Materials, J. Killer, London.
1913. Perforated Hygienic Shoulder Pad, L. Vidal, London.
1914. Apparatus for Cooling Air, T. B. Lightfoot, London.
1915. Skating Rinks with Natural Ice, T. B. Lightfoot, London.
1916 Frames for Inserting Photographs, G. Butes, London.
1917. Fire-extinguishing Apparatus, J. C. Hudson, London.
1918. Cardboard Box, H. Wollheim, London.
1919. Florentine Blind and Fittings, A. Darling, London.
1920. Engine Governor, G. Flett.—(*G. Dawson, India.*)
1921. Tool-cutting Blade, F. Grah and H. Heuscr, London.
1922. Carriage for Common Roads, J. Fog, London.
1923. Water-closet Syphon Cistern, H. Thomson, London.
1924. Driving Chain for Cycle Wheels, T. Grace, London.
1925. Boots, &c., J. Marquitz and B. Felber, London.
1926. Hand Trolley, S. A. Perceval, London.
1927. Electric Railway System, M. L. Wood, London.
1928. Adjusting Bedstead Heads, F. E. J. Bruhn, London.
1929. Tube and Funnel Enema, A. P. Barrett, London.
1930. Lock-nut, E. A. Goddin, London.
1931. New Medicinal Compound, J. Y. Johnson.—(*Vereinigte Chininfabriken, Zimmer and Co., Germany.*)

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1932. Clothes-horse and Screen, G. W. Clark, Sheffield.
1933. Magazine Camera, J. W. Smith and F. Eveleigh, Derby.
1934. Machinery for Cleaning Lamps, C. B. Walker, Ulverston.
1935. Fastening Pneumatic Cover on Wheels, J. W. Sadler, York.
1936. Hydrocarbon, &c., Engine, W. E. Gibbon, Colchester.
1937. Naval Signal Flashing Lamp, W. T. Douglass, London.
1938. Match-box, W. E. Phillips, Chester.
1939. Aiding Combustion in Furnaces, J. Sculthorpe, Liverpool.
1940. Golf Club, J. P. Cochrane, Leith.
1941. Kitchen Range Appliance, &c., J. Renwick, Manchester.
1942. Vehicle Spring, S. W. Gillett.—(*G. T. Glover, United States.*)
1943. Taking Up Slack of Tow Lines, L. H. Curtois, Lincoln.
1944. Derrick for Ship Decks, T. G. Barron, Stockton-on-Tees.
1945. Roller for Photographic Mounting, J. Harkness, Handsworth.
1946. Stick Holder, O. B. Hatch and J. W. Dougal, Glasgow.
1947. Arrangement for Invalids in Bed, T. E. Cooke, Glasgow.
1948. Casting Starch Confectionery, J. C. Robins, Glasgow.
1949. Water-closet Bowl, L. M. Rumsey, Glasgow.
1950. Centrifugal Machine, J. Laidlaw and C. A. Matthey, Glasgow.
1951. Parting Thread for Shuttles, A. G. Brookes.—(*W. F. Draper and J. H. Northrop, United States.*)
1952. Compensating Contraction of Wires, A. Honeybourne, London.
1953. Reflecting Mirrors, L. Ellison, Manchester.
1954. Permanent Way of Railways, T. Keeling, Glasgow.
1955. Pneumatic Tire, J. Linley and J. T. B. Bennett, Birmingham.
1956. Orthosulphobenzoic Acid, G. W. Johnson.—(*Chemische Fabrik vormals Goldenburg Geromont and Co., Germany.*)
1957. Photographic Cameras, T. P. Brown, Huddersfield.
1958. Electric Gaslighters, J. T. Armstrong and C. G. G. Braunerhjelm, London.
1959. Wool Combing Machinery, J. E. Bur, Derby.
1960. Boiling Sugar and other Syrups, E. Shaw, Bristol.
1961. Window Panels for Doors, W. M. Trousdale, Manchester.
1962. High-pressure Flexible Hose, F. Reddaway, Manchester.
1963. Improved Electrical Switch, S. Glover, Manchester.
1964. Portable Camera Stand, J. Russell, Kingstown, Dublin.
1965. Game, A. E. Mellor and W. H. Callingham, Brighton.
1966. Roller Skate Wheels, T. L. Mitchelmore, Southampton.
1967. Shedding Mechanism of Looms, J. and E. Hill, Keighley.
1968. Valve Tap, G. A. Crawford and M. Crawford, Belfast.
1969. Scarf and Tie Holder, A. J. Pickworth, London.
1970. Inlaying of Metal or Alloys, R. B. Boulton, Cardiff.
1971. Controlling Slide Valves, W. E. Drake, Weymouth.
1972. Bottle Stoppers, J. Creasy and J. Bree, London.
1973. Plane Iron for Wood-working Planes, T. E. Tubbs, London.
1974. Gun Boats, H. S. Atkinson, Birmingham.
1975. Loom Shuttle Guards, J. Leigh and P. Oakes, London.
1976. Device for Pie Dishes, &c., C. E. Challis, London.
1977. Adaptable Electro-plated Dish Rim, J. J. Rope London.
1978. Manufacture of Detergent, S. Wohle and A. C. Irwin, London.
1979. Conduits for Electricity, &c., W. H. Lane, London.
1980. Making Ferrate of Soda, H. R. Angel, London.
1981. Stand for Exhibiting Fruit, &c., G. Johnson, London.
1982. Watch Holder, G. Roach, London.
1983. Breech-loading Ordnance, H. Schneider, London.
1984. Gloves, O. Kaufman, London.
1985. Curling Irons, R. Hacking, London.
1986. Binding Books, W. E. Coleman and F. G. Fender, London.
1987. Firing Guns by a Single Trigger, W. Mansfield, jun., London.
1988. Forming Tubes, P. M. Justice.—(*A. Brainard, United States.*)
1989. Package Charging Apparatus, E. Friedman, Glasgow.
1990. Sliding Windows, H. Hutchinson and J. W. Green, Manchester.
1991. Curving Sheet Iron for Barrels, J. Scheibe, London.
1992. Electric Arc Lamps, E. J. Bagnall and G. Arnold, London.
1993. Automatic Apparatus for Gas Meters, T. A. Greene, London.
1994. Locks, W. J. Holman, London.
1995. Fastenings for Securing Straps, &c., C. H. Stanbury, London.
1996. Laces for Boots and Shoes, A. W. Glover, London.
1997. Centre-bits, A. von Kunowsky, London.
1998. Fastening Cabinets of Drawers, T. B. Vernon, London.
1999. Charging Vessels, F. Rossbach-Roussett, London.
2000. Glow Bodies for Incandescent Gas Lighting, C. Kortwich, London.
2001. Chains and Driving Gear for Bicycles, &c., T. Hewett, London.
2002. Swivels for Railway Cars, J. C. Mitchell, London.
2003. Telegraph Repeaters, H. H. Lake.—(*B. F. Merritt, United States.*)
2004. Hand Trucks, W. and H. J. Richman, W. H. Stehle, and S. L. Doughty, London.
2005. Ice-making Machines, C. A. Künzel, jun., London.
2006. Button-hole Attachments for Sewing Machines, E. O. Bennett, London.
2007. Expansion or Telescopic Joints, J. P. Burnham, London.
2008. Steam Boilers, J. A. Fish, London.
2009. Compressible Spaces for Types, C. F. Hilder, London.
2010. Compound Asbestos, A. E. H. Field, London.
2011. Change-giving Apparatus, H. D. Booth, London.
2012. Skirt Protectors, H. Feder, London.
2013. Metal Blocks for Printing Purposes, C. Hentschel, London.
2014. Remedial Serum, G. B. Ellis.-(*F. Niemann, Switzerland.*)
2015. Water-closets, S. S. Hellyer, London.
2016. Photographic Cameras, D. H. T. Peploe, London.
2017. Bicycles, S. Drzewiecki, London.
2018. Music Stools, F. R. Bennett and S. Mounter, London.
2019. Stencil Printing Machines, H. Joféh, London.
2020. Preparation of Food, I. A. Timmis, London.
2021. Nitric Acid, R. J. Friswell and Brooke, Simpson, and Spiller, London.
2022. Incandescent Oil Lamps, A. J. Boult.—(*Société Dubois Frères, France.*)
2023. Gear Cases for Cycles, F. Easom and Humber and Co., London.
2024. Motors, C. T. Crowden, London.
2025. Boxes for Postal Transmission, F. Ulrich, London.
2026. Boxes, F. Ulrich, London.
2027. Manufacture of Graphite Blocks, F. Ulrich, London.
2028. Making Artificial Dentures, A. L. and B. F. Gilmer, London.
2029. Lamps, R. B. Roxby, London.
2030. Infusing Hops, W. Wrentmore, London.
2031. Pedals, F. D. Owen, London.
2032. Corsets, J. C. Gilroy, London.
2033. Gas Burners, W. H. Wheatley.—(*T. Verstraeten, Belgium.*)
2034. Burner, W. P. Thompson.—(*The Continental Gas Gluhlicht-Actien-Gesellschaft "Meteor" vormals Kroll, Berger and Co., Germany.*)
2035. Velocipedes, W. P. Thompson.—(*E. L. Evens, Australia.*)
2036. Chains of Stentering Machines, J. Mason, Manchester.
2037. Pneumatic Tires for Cycles, D. Davies, Liverpool.
2038. Fire-lighters, C. Davies, Liverpool.
2039. Metallic Screens, J. Lightbound and J. Greenslade, Liverpool.
2040. Machines for Making Cigarettes, W. C. Briggs, London.
2041. Book Protector, W. L. Wise.—(*G. Barnes, Australia.*)
2042. Boot Attachments, T. Woodbridge and B. J. Hale, London.
2043. Telegraphy, T. B. Dixon, London.
2044. Permutation Locks, J. W. Packard and A. M. Ellis, London.
2045. Steam Pipes for Heating Purposes, G. F. Gautier, London.
2046. Kilns, S. Bridgwood and Son, London.
2047. Twining and Doubling Yarn, G. Salefsky, jun., London.
2048. Superheated Dry Air Inhaler, L. A. Tallerman, London.

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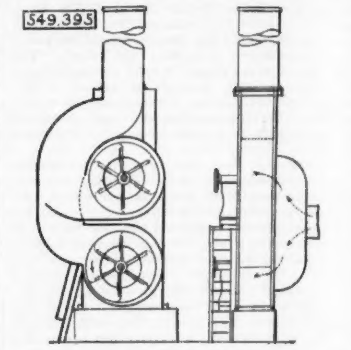
2049. Extracting Gold from Ores, J. B. Torres, London.
2050. Water Waste Preventers, T. J. Evans, London.
2051. Thermometers, H. R. J. and H. F. W. Burstall, London.
2052. Cigars, Cigarettes, and the like, P. W. Bramwell, London.
2053. Dynamos, L. W. Heath, Manchester.
2054. Calendar for Glazing Collars, H. Bury, Manchester.
2055. Ball Castor, H. R. Presser, Birmingham.
2056. Magneto-electric Machines, R. Bryan-Hames, H. E. C. Walcott, J. B. Collier, and E. G. Bryant, Bournemouth.
2057. Forming Cops, J. D. Whyte and Whyte's Patents, Ld., Bradford.
2058. Creels, J. D. Whyte and Whyte's Patents, Ld., Bradford.
2059. Yarn Winding Machinery, J. D. Whyte and Whyte's Patents, Ld., Bradford.
2060. Bicycle Attachment, H. L. Davis, London.
2061. Vice, S. Harrison, Ripon.
2062. Conveyor Belts, N. Greening and N. Greening and Sons, Ld., Manchester.
2063. Treating Sewage, J. Hamer, Manchester.
2064. Axle-boxes, A. J. Charlton, Manchester.
2065. Roller Blind Mountings, T. H. Stevens, Glasgow.
2066. Horse Bits, J. L. Young.—(*C. Thomas, United States.*)
2067. Holding and Heating Irons, F. I. Groves, Leeds.
2068. Winding-on Motions, J. Pye and J Connell, Halifax.
2069. Shuttle Guards of Looms, F. Baynes, Halifax.
2070. Indicating Signals, J. R. Johnson, Stockton-on-Tees.
2071. Time and Date Indicators, J. C. Sellars, Liverpool.
2072. Motors, M. B. Wild, Manchester.
2073. Gauge Glasses, J. F. McIntosh, D. M'Callum, and R. Watson, Dundee.
2074. Lamp and Bracket Reflectors, J. Parker, Bradford.
2075. Gas Burners, J. Warry and G. N. and E. A. Arculus, Birmingham.
2076. Belts and Buoys, J. P. Bayly.—(*E. M. Robert, France.*)
2077. Preparing Bread and Biscuits, W. Jago, Brighton.
2078. Wearing Apparel, J. Ténenbaum, Liverpool.
2079. Stacking Sacks of Flour, G. P. Templeton, Glasgow.
2080. Treating Potatoes, H. D. Fitzpatrick.—(*F. Wieland, Germany.*)
2081. Condensed Milk Products, W. F. Maclaren and A. S. Fleming, London.
2082. Perforation and Water Mark Finder, W. J. Cave, Eastbourne.
2083. Fire Extinguishing Apparatus, J. Tombeur, Brussels.
2084. Mechanical and Detachable Go-cart, L. Sertet, Brussels.
2085. Coupling, J. Villard and J. Bonnaffous, Brussels.
2086. Fishing-rods, A. C. MacLeod, London.
2087. Tricycles and other Vehicles, J. Browne, London.
2088. Power-driven Road Vehicles, J. C. Windover, London.
2089. Mounting Photographic Cameras, J. H. Fay, London.
2090. Whalebone Substitute, G. L. A. Kuhlemann and J. Baier, London.
2091. Working Chaff Cutters, &c., C. Hammond, Pilgrim's Hatch.
2092. Water-tight Joint, C. Dummer, Portsmouth.
2093. Extracting the Fibre of Plants, C. Legrand, London.
2094. Stiffening Suspenders, F. W. and A. A. Brooks, Newport, Mon.
2095. Cycle Brake, W. Marsh, London.
2096. Rotary Engine, J. Gill, London.
2097. Meat Stand, S. Cohen, London.
2098. Preventing Vehicles Overturning, D. Cremmen, London.
2099. Hydrocarbon Burner, A. S. Elliott, London.
2100. Furnaces, &c., J. C. Love and J. E. Hodges, London.
2101. Utilising Waste Heat, J. Horrocks, Manchester.
2102. Separating Apparatus, E. T. Hughes.—(*G. W. Fitts, United States.*)
2103. Partitioned Enamel, H. Cintrat.—(*A. Navarein, France.*)
2104. Boot Protector, A. V. Campbell and J. Lambert, London.
2105. Fastening Covers of Hampers, G. A. Askew, London.
2106. Lightning Discharger, Siemens Bros. and Co.—(*Siemens and Halske, Germany.*)
2107. Telephone, J. Imray.—(*La Société Anonyme pour la transmission de la force par L'electricité, France.*)
2108. Manhole for Sewer Drain, &c., J. Neave, London.

SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

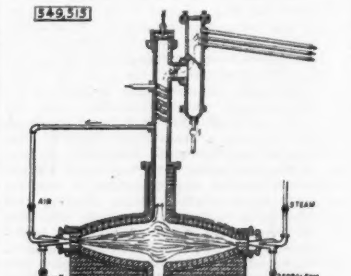
549,395. Induced Draught Apparatus, *W. R. Roney, Brookline, Mass.—Filed March 25th*, 1895.

Claim.—(1) An induced draught apparatus comprising in its construction two fan casings located at different heights and each containing an exhaust fan and having their outlet ports in close proximity to each other, a stack located above said casings, and a single flue connecting the stack with both outlet ports. (2) An induced draught apparatus comprising in its construction two fan casings located at different heights and each containing an exhaust fan, a stack located above said casings, a single flue connecting the stack with the outlet ports or passage-ways of both casings, and a hinged plate or deflector located in the flue between said outlet ports and having a length or diameter less than the size of the passage-ways or ports, whereby a complete closing of either passage-way is prevented.


549.395

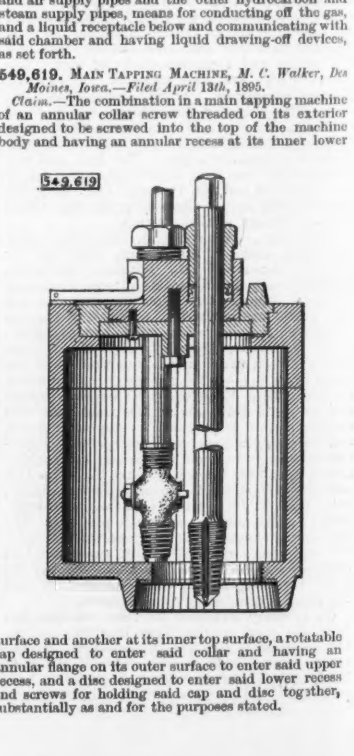
549,515. Process of and Apparatus for Manufacture of Gas, *E. D. Kendall, Sewaren, N.J.—Filed September 8th*, 1894.

Claim.—(1) The herein described process for the manufacture of gas consisting in directing immediately against each other a flame in the form of a blast or jet, and a blast or jet of hydrocarbon vapour, and conveying off the resultant gases. (2) The combination of a chamber, opposing injecting devices delivering thereinto, one of which comprises hydrocarbon and air supply pipes and the other hydrocarbon and steam supply pipes, means for conducting off the gas, and a liquid receptacle below and communicating with said chamber and having liquid drawing-off devices, as set forth.


549,515

549,619. Main Tapping Machine, *M. C. Walker, Des Moines, Iowa.—Filed April 13th*, 1895.

Claim.—The combination in a main tapping machine of an annular collar screw threaded on its exterior designed to be screwed into the top of the machine body and having an annular recess at its inner lower surface and another at its inner top surface, a rotatable cap designed to enter said collar and having an annular flange on its outer surface to enter said upper recess, and a disc designed to enter said lower recess and screws for holding said cap and disc together, substantially as and for the purposes stated.


549,619

PARKHEAD FORGE, ROLLING MILLS AND STEEL WORKS.

(*Concluded from page* 131.)

FROM the furnaces, which have an output capacity of 150 tons in the twelve hours, this highly serviceable crane lifts the slabs and rapidly transports its load to the plate mills, the roughing and finishing rolls of which are served by one live-roller table in front and one in the rear of the mill, a cross-sliding motion being imparted by a special engine of Messrs. Miller and Co.'s make. These tables of live rollers are capable of carrying plates up to 25 tons weight, an example of this being the stupendous gun-shield plate which is shown being operated upon in our view of the planing machine on page 166.

The largest of the plate mills—one of the most powerful and complete plate mills in Scotland—is driven by a set of coupled reversing steam engines with 46in. cylinders, 5ft. stroke, geared 2½ to 1, and having a working pressure of 120 lb. These engines, which are also by Messrs. D. Stewart and Co., are illustrated on page 154. The mill rolls are 32in. diameter, 10½ft. long, and weigh 15 tons each. A small pair of 6in. cylinder engines on the housing work the screw gear, raising or lowering the top roll, which is also balanced by hydraulic pressure.

This mill is capable of turning out over 100 tons of finished plates every twelve hours, from ⅜in. upwards in thickness and of all sizes and dimensions. The very largest and heaviest plates ever put into a marine boiler have been produced here; amongst others being those supplied to Messrs. J. and G. Thomson for the boilers of the International steamship Kensington built two years ago. These plates were 32ft. 11in. by 7ft. 7¼in. by $1\frac{9}{16}$in. thick, and weighed each 7 tons 10 cwt. 3 qr. The other plate mills, of which there are two—the larger having rolls 24in. diameter by 6½ft. long—are principally devoted to ship and bridge plates and thin plates, including sheets of all sizes down to $\frac{1}{16}$in. thick.

For shearing plates after they are rolled there are several powerful steam shears at a convenient distance in the rear of the mills. The two largest of these are by Messrs. Joshua Buckton and Co., Leeds, and deal with plates up to 1½in. thick. Messrs. Beardmore, however, impressed with the greater suitability of shears actuated by hydraulic power over those driven by steam for the heaviest class of work, are now constructing for this purpose a powerful hydraulic shearing machine. It is of massive design, capable of shearing mild steel plates up to 2½in. thick, and as it embodies some interesting novelties in this class of machine, may be referred to with some detail. The cheeks or standards each consist of two steel plates 14ft. by 9½ft. by 6in., which are separated by a cast steel distance piece, so as to stand about 13½ft. apart from centre to centre. The gap is 37in. wide from the edge of the bolster, and is quite open at both ends of the machine, so that a 2½in. plate, 6ft. broad, and of any length, can be split from end to end with ease. The motive power is supplied by two cast steel hydraulic cylinders, 20½in. internal diameter by 4½ft. stroke, firmly snugged and bolted to the back of the cheeks. The ram of each cylinder is in the form of a trunk piston, to which is secured a mild steel connecting-rod. The water, under a pressure of 700 lb. per square inch, acts on an area of 330 square inches on the underside of each ram, while there is a constant back pressure of 700 lb. per square inch on an annular area of 47 square inches on the upper side of the ram, thereby enabling the blade to be lifted when the pressure on the lower side of the ram is relieved. The effective pressure on the lower side of each ram is thus 88¼ tons. The hydraulic pressure is transmitted from each ram to the blade or apron through a lever having a mechanical advantage of 3 to 1. Both levers are rigidly keyed to one common shaft, 18in. diameter and 18ft. long, which passes from end to end of the machine, and is supported by cast steel brass-lined bearings passing through the cheeks and bolted firmly to them. Any tendency to thrust the blade endwise will be resisted by the torsional rigidity of the main shaft. The total pressure, therefore, transmitted to the blade at any instant is upwards of 530 tons; and as the cutting edge has an inclination of 1 in 9, the intensity of pressure per square inch on the section of, say, a 2in. plate in the process of being sheared will be approximately thirty tons, which allows an ample margin for friction in the working parts. While the plate is being sheared, it is held steadily against the bolster by three small hydraulic cylinders, which together exert a pressure of ten tons, and are bolted firmly to the front guide of the machine.

When equipped with this massive appliance, Messrs. Beardmore have it under consideration whether arrangements cannot be made whereby a mild steel plate of any dimensions and of thickness up to 2in. may be taken from the mill floor, sheared on all four edges, and deposited again on the floor, with the aid of only one man and a boy

There are two principal bar mills at Parkhead. One is a 22in. mill, with three-high roughing rolls, and lifting tables at front and rear, and two-high finishing rolls. Coupled direct to mill is the driving tandem engine, having cylinders 40in. and 30in. diameter, the working pressure being 60 lb. In this mill are rolled angles up to 7in. by 7in., bulb angles up to 8½in. by 3½in., channels up to 10in. by 3½in., girders 9in. by 3in., tees 6in. by 5in., bulbs 10in., rounds and squares 6¼in., &c. The mill is served by six coal-fired heating furnaces. The other is a 10in. merchant mill with three-high roughing and finishing rolls and necessary guide rollers, driven by horizontal engine, 24in. cylinders and 22in. stroke, coupled direct to mill. This mill rolls angles with 1in. flanges up to 3in. by 2½in., also rounds and squares, flats, channels, cop steel, nail strips, &c., of a like range of scantling, including Z-bars. 2in. by 1¼in. by ¼in. by ⅛in., as supplied for the construction of the torpedo-boat destroyers.

At the present time Messrs. Beardmore are laying down a tire mill which, it is anticipated, will soon be in operation, and supplying a felt want in the Glasgow district where locomotive works abound. In connection with this class of manufacture, the steam hammer "Samson," as already stated, is being altered to serve for punching out the centre of the tires.

Coming now to speak of the production of armour-plates by the Harvey process, Parkhead has already been employed in their manufacture for some considerable time. Plates of this class, as well as plates of nickel steel, have been turned out in large numbers for many of the vessels now building or fitting out for our own and foreign navies. Casemate plates for H.M.S. cruiser Terrible and battleship Jupiter, and protective engine hatchway armour-plates for H.M.S. Venus, Diana, Juno, and Doris, have all been turned out. One of the complete casemates for H.M.S. Terrible is shown, as erected in the finishing-shop of Parkhead prior to despatching it to the builders, by Fig. 5. At the present time Messrs. Beardmore are engaged, amongst other "lines," upon the armoured casemates for the new first-class cruisers Europa and Diadem, being laid down at Fairfield and Clydebank.

The Harvey process, as carried out at Parkhead, may be briefly outlined before treating of any features in detail. A special ingot of the necessary weight—20 tons or 25 tons it may be—is cast from one of the open-hearth Siemen's furnaces. Never allowed to get positively cold, it is transported to the reheating furnace, situated alike near the cogging mill and the hydraulic press. To the latter it is conveyed on rails by steel bogie carriages. Supported in slings from an overhead crane serving the press, the ingot is rapidly, bit by bit, compressed in thickness. By bogie again it is then transferred to the reheating furnaces in connection with the plate rolling mill, where the mass is rolled out so as to allow of a clear plate being cut of the dimensions and thickness required.

From the plate mill the plate is again taken to the hydraulic press and perfectly flattened, from whence it is taken to the machine shop, and when cool, stripped of its rough surplus sides and ends. One of the surfaces of the plate is planed smooth preparatory to its being treated in the carburising furnace. There are four of these furnaces, charged from the top, and served by an overhead crane. Two plates are treated at once, being deposited with their planed surfaces facing each other, but with the bone and charcoal carbonising medium between. From a moderate temperature the heat is gradually increased until at a suitable degree it is maintained for a length of time—seventeen days, or perhaps twenty days—sufficient for the carbon to thoroughly penetrate the surface to a suitable depth. From the carburising furnace the plate is taken once more—if it should have to be bent—to the reheating furnace and press where the appropriate curvature is given, and thence to the machine shop to be planed and bevelled on sides and ends to something near its finished dimensions, and to have the necessary slotting done—if it be part of a gun casemate—and the holes bored and tapped for attaching it in its situation on boardship. Again subjected to a moderate heat, for a period probably of twelve hours or so, the plate is thereafter taken to the sprinkler or spray bath where its carbonised surface is chilled to the desired temper. The result is a surface of such hardness as to resist the cutting power of the hardest tools. The plate is afterwards trimmed to its correct dimensions and bevel by grinding under a special grinding machine. This and all the other machining operations are carried out in the machine shops which we describe further on.

The chilling bath, the reheating furnace from which the plates are taken prior to the chilling process, and the hydraulic forging press referred to in the foregoing, are all contiguous to each other, and have facilities in common for working them. The furnace has a draw-out bogie-built bottom on which the plates repose in the furnace, and are borne out to under the crane serving either the hydraulic press or the chilling bath. The hydraulic press is of 4000 tons capability, and was entirely constructed of Parkhead steel within the works. The gap admits of a 12ft. plate, and there are three hydraulic cylinders of 24in. diameter, the pressure in which—3 tons per inch—is supplied from large direct-acting pumping engines of Messrs. Duncan Stewart and Co.'s make. For serving the press, and at the same time so placed as to be capable of changing the rolls of the cogging mill, is an overhead travelling crane of 20 tons capacity of Messrs. Grieve and Co.'s make. Behind the press is a similar but heavier crane—40 tons capacity—by the same makers, which aids in the delivery side of the press, but whose principal duties consist in lifting the plates from the bogie in connection with the furnace for the reheating of the carbonised plates and depositing them in position on the supporting bars of the chilling bath.

The chilling bath proper is a shallow pit, brick encased and surrounded, bogie height, about 20ft. long by 10ft. in width. Across it, about ground level, are deep solid iron bearers for supporting the plate or plates to be operated upon. Below the level of these bearers is a bed of jet nozzles, pitched about 3in. apart each way. This bed occupies the entire space, but is fitted in sections of about 5ft. square, each section being controlled, as regards the ejection of water, by a separate valve so that the force and supply of water are concentrated through the particular section or sections above which the plate to be sprayed may happen to be placed. About head level, and running the whole length of bath, are side girders on which are carried two movable spray sections with nozzles similar to those underneath, also means for slinging the plate to be heated. The movable top spray sections or roses are supplied through flexible piping. The plate is deposited on the bearers with the carbonised side uppermost, and the spraying process is directed to both top and bottom surfaces simultaneously. The water supply to both top and bottom nozzles is from a storage tank of great capacity, supported on standards about 30ft. or 35ft. in height near the bath, and the water after use is pumped back into the tank by a powerful centrifugal pump of Drysdale's "Bon Accord" type.

Eclipsing all existing armour-plate plant, however, in interest and capability, is the hydraulic forging press of no less than 12,000 tons capacity which is now in course of erection in the works. This, it is believed, will be the most powerful press in existence, the one recently laid down by Messrs. John Brown and Co., of Atlas Works, Sheffield, being 10,000 tons. Mostly all the parts are being prepared by Messrs. Beardmore and Co. themselves, and in our issue for August 9th last, in connection with Mr. Riley's paper read before the Institution of Mechanical Engineers, we were enabled to give an illustration of the great cylinder pertaining to the press. This special casting of nickel steel by Messrs. Beardmore weighed in the rough sixty-four tons, and is probably the heaviest single piece ever cast of this material and afterwards machined to form part of an engineering production. Fig. 1 on page 140 shows this huge cylinder being cut to proper length in turning lathe. Finished, the cylinder will weigh forty-two tons, being 72in. diameter by 5ft. stroke. The height of the entire press above the ground level will be 33ft. 6in., the height under cross-beam will be 7ft., and the width between columns 15ft. The working pressure in the cylinder will be three tons per square inch, and there will be two return rams 14in. diameter, worked with a pressure of 750 lb. per square inch.

Power for this Titanic press will be provided by four double horizontal compound hydraulic pumping engines, by Duncan Stewart and Co., which will occupy a space 48ft. by 42ft. The cylinders will be 25in. and 43in. diameter, and the stroke 18in., the steam pressure being 100 lb. per square inch. The engines will run at 100 revolutions per minute, and work sixty-four single-acting pumps with rams $1\frac{1}{8}$in. diameter, made of Delta metal. For serving this mammoth press an overhead travelling crane of 100 tons capacity and 65ft. span has been prepared by Messrs. Shanks and Co., Johnstone. It will run on girders supported on massive steel built columns. The driving shafting is square, planed to gauge, and with a special scarph connection of new design. The crane is fitted with various special details for rotating the heavy ingots with which this stupendous press will be called upon to deal. A view of this crane temporarily erected is shown by Fig. 6, page 154.

For machining and finishing the various heavy items produced the Parkhead establishment, as has already been stated at the outset of this notice, is magnificently equipped; the re-arrangements and additions recently carried out, and still being made, being such as will fully cope with any likely further development of the system of supplying shipbuilders and engineers with completely finished items.

Apart from the older machine-shop, known in the works as the turning-shop, and which we briefly noticed in treating of the older forge department, to which it is contiguous, there are two new machine-shops parallel to each other, 200ft. long by 50ft. wide. They are lofty and are lined with white enamel bricks and copiously lighted from above. The first and older shop is served by a 40-ton square shaft-driven overhead crane by Shanks and Co., and the other by a 30-ton crane, with engine and boiler on the crab, by Messrs. Booth Bros., Leeds. At present we have only space to describe and illustrate some of the more powerful and interesting of the machine tools which the enterprise of Mr. Beardmore has successfully called into action.

The machines and plant recently, and at present, being laid down in connection with armour-plate production, embraces some of the heaviest and most perfect machinery of the kind yet made. To obviate needless iteration of the name, we may say in a sentence that almost the whole of the machines involved have been made by Messrs. Thomas Shanks and Co., of Johnstone. This firm were the original makers of the very massive armour-plate planing machine ordered by the Sheffield firms twenty years ago, but we are assured that this plant is entirely new, the machines having been designed and manufactured as the outcome of recent experience in France and America. While specially designed with a view to overtaking armour-plate work, the provision of heavy tools is, of course, adapted for general and lighter purposes. It will, therefore, be convenient to treat of the whole of the machines in the shops just as they occur in discharging the varied work they are called upon to undertake.

For dealing with plain shafting there are two heavy double lathes, 27in. centres, on one bed 84ft. long, and another over 60ft. long, fitted with two lathes in the same manner. These lathes—each with four cutting tools, and respectively capable of dealing with lengths 70ft. and 46ft.—were originally used, and are still, of course, capable of doing so if required, to centre-bore the long straight shafts, as well as turn them, until the special boring machine about to be described was designed for the purpose, and which has been a great success.

This special machine, which is constantly employed on shafts for the British and other navies, has two boring tools one working from each end, and by special arrangement progressing towards each other to meet in the mid-length of the shaft with the most absolute truth and exactness. This machine is capable of boring, at one cut, any sized hole up to 10in. diameter through the longest shaft ever yet designed. Amongst recent work overtaken by this machine is the propeller shafting for the Russian Imperial yacht Standart. This was in lengths of 60½ft., and the hole bored through the centre was 9in. diameter. Inspection of the centre disc resulting from the operations of this machine tool affords striking proof of the marvellously exact work of which it is capable.

For dealing with crank shafts—articles of manufacture for which, as is well-known, Parkhead has long been celebrated—three of the heaviest patent quadruple geared double-bed lathes are used, fitted with special balancing details and Barrow's patent incutting slides. The smallest of these lathes, with 57in. height of centres, has a bed

9ft. 6in. wide and 42ft. long, the weight being over 60 tons. The largest lathe weighs over 100 tons, and has a bed 45ft. long. The middle lathe, Fig. 7, of 69in. centres—which we illustrate on page 166—has a double bed, 10ft. 6in. wide and 57ft. long, and is fitted with four massive saddles and rests, two working at the back by guide screw, independent of the two swivel compound rests at the front, which are worked by separate guide screws and shaft for surfacing. All these saddles are supplied with power movement, so that any or all may be moved either way at the rate of 10ft. per minute. A special feature in this trio of lathes is the width of the loose headstock, which in the particular lathe now under notice is 9ft. wide. This feature has been found of great value in securing round bearings, which in other lathes not steady in this respect are oval, owing mostly to the swing of the crank. The driving power is very great, and four heavy cuts are easily taken at the same time. Barrow's in-cutting slide is a massive steel casting overhanging between the crank webs, and self-acting either way, and reduces the time of finishing a crank-pin considerably. Still another feature is the ready mode of attaching L-shaped balance weights to the face-plate for balancing purposes.

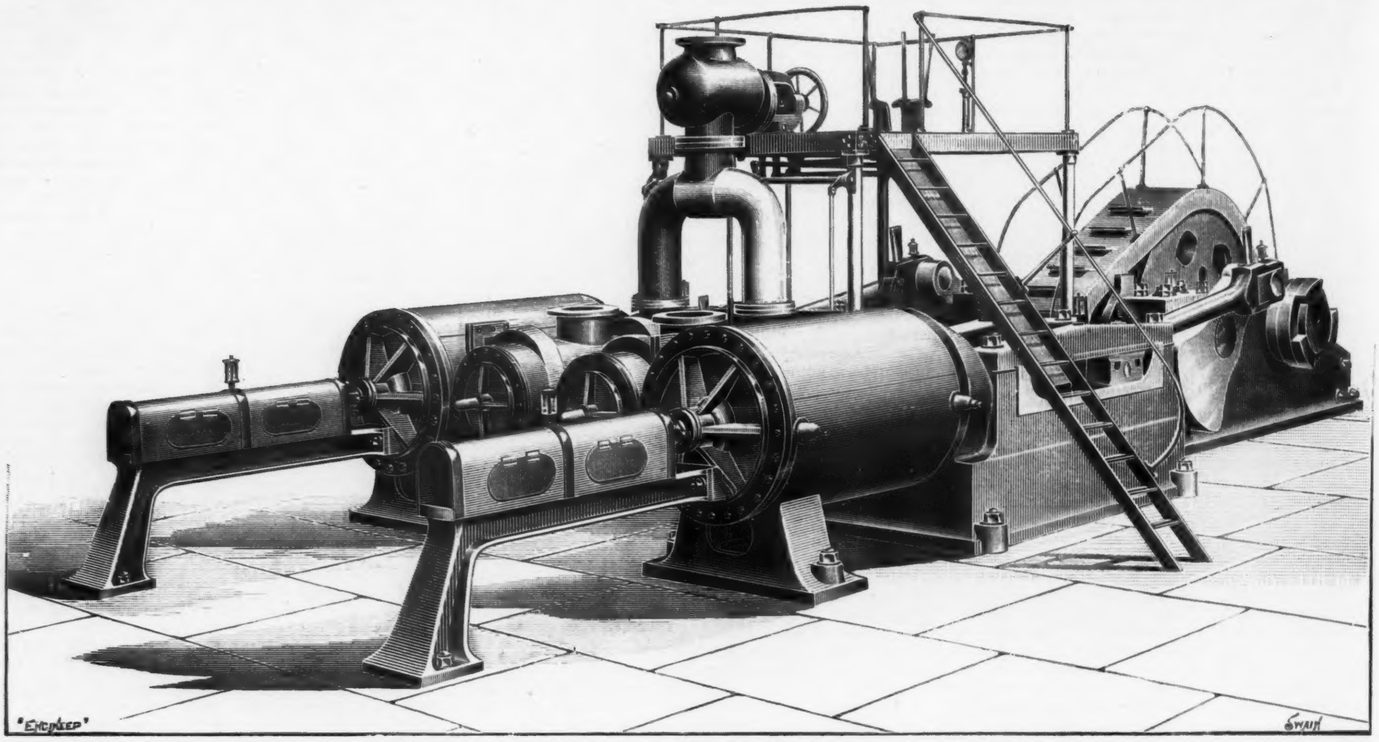


Fig. 4—REVERSING ROLLING MILL ENGINES, PLATE MILLS, PARKHEAD FORGE

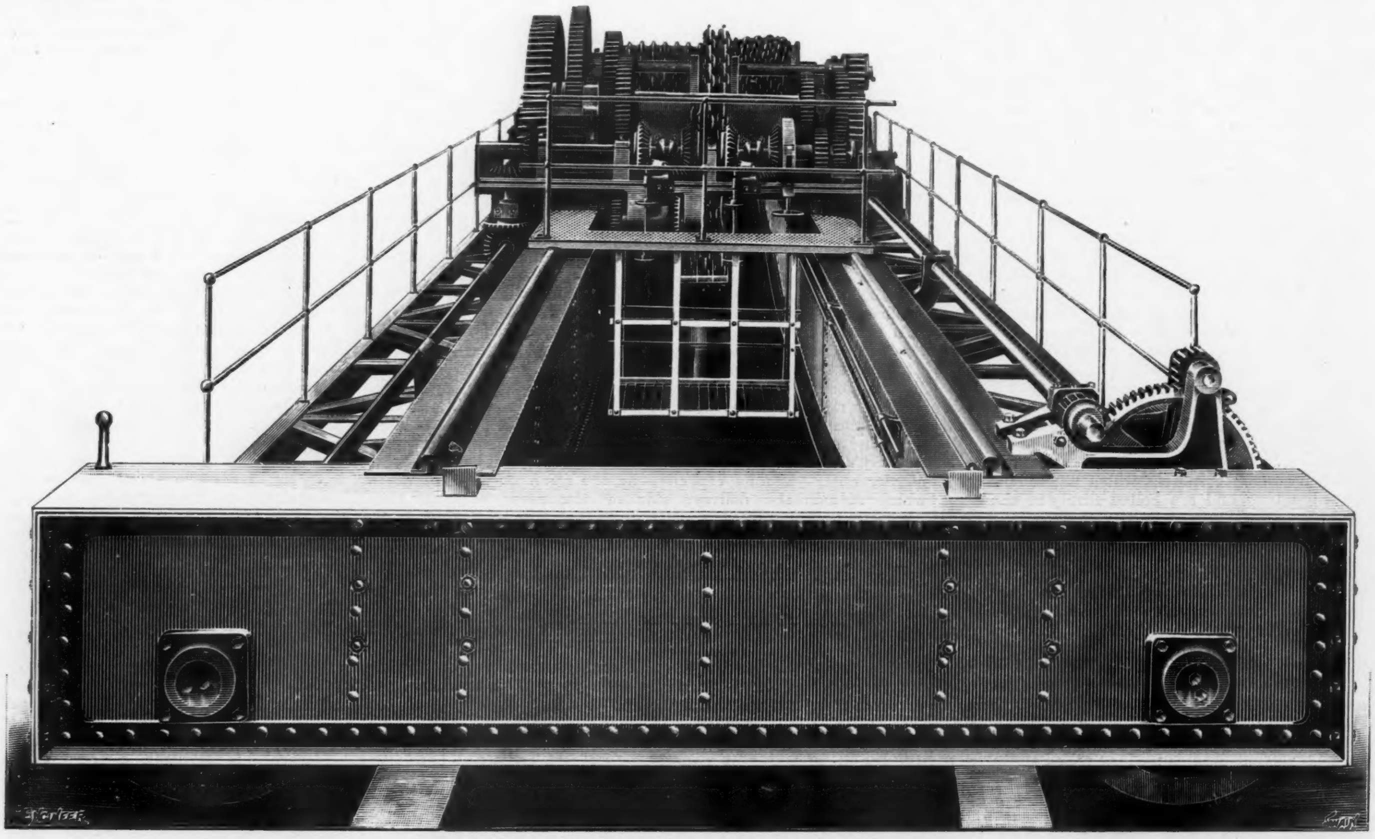


Fig. 6—100-TON TRAVELLING CRANE FOR SERVING FORGING PRESS

This magnificent tool is capable of turning cranks and other shafts of the largest dimensions up to 40ft. in length. Our illustration on page 166, Fig. 7, shows this lathe dealing with a section of the double crank shafting for the Chilian cruiser Ministro Lenteno, now building by Sir William Armstrong, Mitchell, and Co., 19ft. 6in. in length, 15½in. diameter, having an 8in. hole through centre. It is of interest to state further that on the occasion of one of our visits to Parkhead, this lathe was engaged upon a length of the heavy shafting for H.M.S. Powerful, of 20in. to 21in. diameter. The crank shaft for this vessel as finished and lying in the engine-shops at Barrow is shown by Fig. 8 on page 166. From this it will be seen that there are four similar and interchangeable lengths forming the complete shaft to each of the two separate sets of twin engines. The finished weight of each such sectional length was 6¼ tons, the rough forging from which they were made weighing 15¼ tons, while the ingots from which they were each originally fashioned weighed as much as 48 tons. The total length of shaft was 46ft. 8in., and a 10in. diameter hole ran through the centre. The finished weight of the complete shaft was 25¼ tons, while the total weight of ingots was 192 tons.

For slotting crank-webs there is employed one of the largest size of Barrow's combined slotting and planing machines hitherto made. The slotting stroke of this heavy tool is 6ft. and the vertical bed upon which it slides has an adjustment of some 4ft., so that the overhang of the tool in slotting and planing is brought to the least possible limit. The planing movement is 10ft., and the total weight of the machine is over 50 tons. The two ripping tools are of section 9in. by 1in., and two grooving cuts are taken at one operation. This machine has proved of such great use in dealing with the peculiar form of the "tongue" in the casemate plates with which Parkhead has been engaged, that another and larger machine is nearly finished from the same patent and by the same makers. This immense machine has a 10ft. slotting stroke and a 12ft. planing stroke. The table is 10ft. in diameter, and the total weight 70 tons.

In planing machinery the shops are richly equipped. There are two of an exceptionally powerful description, which plane surfaces 10ft. 6in. square by 20ft. long, each having three tools. The side tool is balanced, and is moved up and down as easily as a 100 lb. weight. There are two grades of speed, and the total weight of each machine is over 90 tons. Another of these massive tools is in progress at the works of Messrs. Shanks and Co., Johnstone, 2ft. wider and weighing over 100 tons. One of these large planers is illustrated by Fig. 3 dealing with a truly stupendous item, a gun shield for H.M.S. Terrible, the rolled plate from which it was cut weighing no less than 25 tons. The bending of this plate to its conical shape with a different radius at top and bottom was done in the 4000-ton forging press, and is a striking illustration of what may be done in this direction. Besides these massive planers there is a smaller planing machine 7ft. between the uprights, and having four tools, one on each upright, and balanced as in the case of the larger planers. Sunk into the ground are massive guides, upon which two other guides are placed to receive the armour plates, while a very powerful standard and tool upon the bed is engaged in dovetail grooving, angling, and finishing the ends of the armour plates. A smaller planing machine with two tools and admitting work 6ft. square is used for planing crank webs. For boring out the holes in crank webs and the bolt holes in shaft couplings a double heavy boring machine with 5in. steel spindles is used, while for drilling and tapping the innumerable holes in armour plates a double boring machine with Barrow's patent driving gear is used, the range of the spindles being 20ft. by 10ft. high. This latter detail, it may be mentioned, has been found most effective as applied to radial drills by the same makers, and the rapidity with which these holes can be drilled may be judged from the fact that three of these machines have overtaken the whole work.

Any distortion that may be caused in the process of chilling the armour plates, or any fulness in size or shape that may remain, must afterwards be rectified by grinding machines. When it is considered that this must be done on a surface which is not only as hard as steel, but much harder, and that in some cases as much as ⅜ths of an inch of this adamantine surface must be grooved away, the conditions to be met with will be understood. In accomplishing this the work is stationary, and a grindstone revolving at a high velocity moves over the surface to be ground. In addition to this there are parts to be ground away which can only be slowly done by emery wheels. The two armour grinding machines employed are of special design by the Johnstone firm. In the one for plain surfaces, the grindstone travels over 20ft. either way whilst rotating at a great velocity. The recesses and difficult parts are ground by emery grinders upon a second special machine with 30ft. bed, fitted with two work plates. The grinders are vertical and horizontal, and revolve at over 1000 revolutions per minute.

In the flanging shop, situated beyond the bar and the tire mills, there is another of the departments of Parkhead Works, in which every provision is made for dealing with the material of modern shipbuilding and engineering practice in ways which modern progress demands. For heavy plates, either for armour or for boiler building, there are to be found here a series of four ripping machines of powerful make. For dealing with the heavy plates which now enter into the construction of cylindrical marine boilers there is a set of massive vertical rolls of Craig and Donald's make. These are capable of dealing with steel plates, cold, 12ft. in width by 1¾in. thick. For flanging boiler fronts, and ends, and furnace mouths there are two of the heaviest make of Tweddell's hydraulic flanging machines. For planing the flanged ends of boiler plates there is a very capable machine, with an immense circular table, 22ft. diameter. On each side of the flanging machines here alluded to are heating fires of the most approved kind, the blast for which is provided by Root's blowers conveniently placed. The flangers and fires are served by hydraulic cranes of three tons capacity, while for serving the shop generally is an overhead travelling crane of 20 tons capability. The hydraulic power actuating the flanging machines here—the pressure being 1500 lb. per square inch—is provided for by engine pumps and accumulator in a power house adjacent to the flanging shop, the plant being of Messrs. Fielding and Platt's providing.

In addition to the branches of manufacture already indicated may be mentioned an extensive rivet works where large quantities of rivets, both iron and steel, are being turned out, of all the various sizes required in the construction of ships, boilers, and bridges, by a complete range of modern machines. There are also in the forge section special hammers and other requisite appliances for the manufacture of railway carriage axles and crank axles for locomotives, in both of which lines Parkhead does a large trade. There is an output capacity per hammer of twenty axles per day.

In the mechanical testing department, a necessity in all important modern steel works, are two of Buckton's testing machines of modern type constantly requisitioned in the determination of the qualities and characteristics of the materials produced in the works. Here also is arranged in intelligent series a most interesting and instructive collection of test pieces of various kinds, showing the wide possibility of high-class manufactured Siemens steel. One item conspicuous both for size and interest shown here is the wrecked connecting-rod taken from the engine-room of the s.s. City of Paris after the disastrous accident of August, 1893. This rod, from the extraordinary manner in which it is bent and twisted without showing the slightest sign of fracture, affords eloquent testimony not only to the severe ordeal through which it had passed, but to the high-class quality of the forgings then, as now, produced at the Parkhead works.

Needless to add, the works are lighted throughout by electricity, both on the arc and incandescent principle. The boiler power for the works is supplied by groups of boilers at various convenient situations. In all there are some 45 boilers, chiefly of the Lancashire type, of working pressures ranging from 120 lb. to 50 lb. Included in this number are two water-tube boilers of the Babcock and Wilcox type of 100 lb. working pressure.

Institution of Naval Architects.—The annual meetings of the Institution will take place on Wednesday, March 25th, and the two following days, in the hall of the Society of Arts, John-street, Adelphi, W.C., by kind permission of the Council. The Right Hon. the Earl of Hopetoun, G.C.M.G., President, will occupy the chair. The annual dinner will be given on Wednesday, March 25th, at the Holborn Restaurant, High Holborn, W.C., at 7.15 p.m. The King's Hall has been engaged, which will afford ample accommodation. Evening dress will be worn.

CARBORUNDUM.

The material discovered in 1890 by Mr. E. G. Acheson, and named carborundum, is now being made in quantity as a rapid-cutting, exceedingly hard abrasive. An interesting paper on the subject of its formation in the electric furnace was read some time since before the Franklin Institute, describing the discovery and the method of manufacture of this artificial material of diamond-like hardness. On October 19th last the largest electric furnace in the world was put into operation in the works of the Carborundum Company at Niagara Falls, N.Y. One thousand horse-power was at that time turned into their furnace from the power station of the Niagara Falls Power Company. The whole of the electricity produced by this power is caused to operate for twenty-four consecutive hours upon the crude materials contained in the furnace, or a total expenditure of 24,000-horse power hours. This is expended in operating on carbon and silicon. Less than two tons of carborundum is produced with the above energy, but the product is a material which will grind anything, and is now being used in diamond cutting. The production of this material was announced two or three years ago, and the Committee on Science and the Arts of the Franklin Institute, after careful and exhaustive tests on the merits of carborundum, concluded a report to the Institute as follows:—

"The results of these practical trials may fairly be summarised in the statements that the new material possesses remarkable properties as an abrasive, being the first artificial substance thus far produced which compares favourably with bort—diamond—in hardness, and which is capable of being used as a substitute for it; that when its peculiarities are better understood it should be capable of yielding cutting wheels of high efficiency to take the place of abrasives in common use; and that it should find general application in the arts wherever its price is not prohibitory. In consideration of the facts set forth, the Institute recommends the award of the John Scott Legacy Premium and Medal to Edward G. Acheson, for his discovery of a new and valuable artificial abrasive material.'

In his first experiment to find a means by which carbon could be crystallised, Mr. Acheson used an iron bowl lined with carbon, and filled with a mixture of carbon and clay. Into the centre of this mixture a carbon rod was introduced, and to it one of the wires supplying an electric current was attached, while the other wire was connected with the iron bowl. When the current was turned on the mixture was fused, and a violent chemical reaction appeared to have taken place. When the mass had cooled down it was opened and examined, with the result that a few very small crystals of a bright blue colour were found. In later experiments the iron bowl furnace was replaced with one constructed of refractory bricks, into each end of which extended a carbon rod, an electric apparatus was arranged for supplying and regulating a current of from 100 to 200 ampères, an alternating current being used. Mr. Acheson soon discovered that the crystals were not what he expected to obtain; they were not pure carbon. In colour they were usually blue, with a hardness sufficiently great to abrade the diamond. He was led to believe, from the materials, together with the colour, hardness, and general form, that the product was composed of carbon and alumina, so he coined the name carborundum from the words carbon and corundum. It was afterwards found that carborundum is a compound of carbon and silicon.

Carborundum is now manufactured from a mixture or fusion of sand, salt, coke, and sawdust, and the electric current is supplied to the furnaces of the company from the great power-houses at Niagara Falls and at Monongahela City, Pa. The furnaces are made of brick, four-sided; at the centre of each end wall there is a large bronze plate, to which four copper cables are connected. These cables convey the current. Through the centre of the mixture of sand, salt, and sawdust, a core of grains of coke is built which serves to make an electrical connection between the two terminals. When the current is turned on it soon raises this core to an enormous temperature, and a chemical change takes place, which produces carborundum. The current is kept on for twenty-four hours, and then allowed to cool down. On opening the furnace a ring of very beautiful crystals is found round the core, varying in colour from yellow to violet, and these crystals are called carborundum.

Being formed at an enormously high temperature, it is stable at all temperatures below that of its formation, and it appears to be capable of resisting many of the more powerful chemical re-agents. The only re-agents that appear to be capable of decomposing it readily are the caustic and carbonated alkalies in the state of fusion. In hardness, the substance approaches, if indeed it does not equal, the diamond, the hardest of known substances. The crystals are brittle, and are broken up into various sizes, numbered the same as emery; the numbers indicating the threads per lineal inch in the sieves through which they pass. When properly used, these grains are said to abrade any hard surface more than four times as rapidly as emery.

Where it is intended to glue the grains on belts, finer numbers are used than in the case of emery, as its sharpness causes it to cut so deeply into the metal that it may be pulled from the belt. Carborundum powder is graded by floating in water, and designated by the number of minutes it floats. It is used for glass grinding, brass valve and stop-cock grinding. For the latter it is said that one-eighth of an ounce of powder, mixed with oil or soap, is all that is required by one workman for a day's work. Carborundum wheels are made with either a vitrified or cement bond.

THE ELECTRIC DRILL FOR NAVAL CONSTRUCTION.

For some time mechanicians have turned their attention to the possibility of applying the power generated by electrical apparatus to tools, for the purpose of rapid drilling. Messrs. Siemens have constructed portable electric motors, running at various speeds from 900 to 1200 revolutions per minute; these motors being connected up to long flexible cables, associated with a powerful current form a dynamo, and being capable of rapid application to a vertical drill, which can be worked in any position within the radius provided by the length of the cables, and moved about from spot to spot as required.

This system has been very considerably developed within the past six months, having been adopted with remarkable success in the Royal Dockyards, and its application to the exigencies of warship construction seems likely to affect in a very material degree, the rate of speed at which vessels may be completed. Of course it is very well known that the main portion of the bolt holes in the skin plating of an iron or steel vessel are punched out by suitable machines in the machine shop where the plates are prepared; but there are bolt holes whose number is countless, the precise position of which cannot be ascertained until the frames, skin and bulkheads, &c., are put together, and it is the rapid piercing of these apertures that the electric drill is eminently suited to deal with. Hitherto the old clumsy system of drilling such holes with the ordinary brace and ratchet drill has been employed. This is a most laborious and tiresome process, involving the waste of many hours in the piercing of a few holes, if the plate is at all thick, and one of the most familiar sights upon a ship in course of construction is the patient driller, in some dark, almost inaccessible corner, doubled up over his brace, whilst he painfully scratches his way through the hard steel with his inefficient tool.

By the employment of the electric portable drill, however, all this difficulty is obviated. For ordinary work, when the plate to be bored can be detached for this purpose, the electric motor is suspended by a rope from a pulley attached to a convenient beam or temporary pole above, and the rope, which runs through the pulley, has a counterweight, consisting of a few pieces of pig iron at the opposite end. This enables the artificer to lift the motor up and let it down upon his work as he proceeds. In order to steady the motor over the plate to be drilled, it is passed under a standard, which screws up and down upon an upright, and this upright is fixed to a small portable bed upon which the plate is laid. The drill works at the rate of about 200 or 300 revolutions if put at full speed, but a far lower rate of working is generally employed, we understand about 70 or 100 revolutions. The same kind of electric motor drill is also employed for piercing vertical plates which cannot be detached from their position, should there be any suitable adjoining vertical wall which can be made use of as a purchase, a special tightening-up screw being provided; only in this case the motor is suspended from the side to the pulley above, and works of course horizontally instead of vertically. The standard and bed-plate are, moreover, not required.

But by far the most ingenious and practical application of the electric motor, as now in process of development for driving the drilling tool, is in the boring of a series of many consecutive holes, one after another, for the laying of deck plating, and in the cutting out of the butterfly-shaped pieces of plating, for ports for small quick-firing guns in the sides of a vessel. In neither of these cases can any "purchase" be obtained by the ordinary means to press the drill home. Even in the case of deck drilling, the tightening screw would have to be cast loose over and over again, and shifted from spot to spot, which would neutralise the value of the speed gained by the rapid working of the electric drill. One of the dockyard electricians has adopted a most satisfactory means for overcoming the difficulty in regard to "purchase." A portion of the electric current from the generating dynamo is diverted to powerful electro-magnets attached to the electric motor, and, by making the body of the vessel itself earth, the motor is made to cling to the deck or ship's side with such tenacity that the drilling tool works away just as though it had a tightening screw at its back, only much more steadily. For the pressure of the motor with its magnets is constant, as it is associated with elastic springs acting upon the drill, whereas a tightening screw presents a pressure which is always varying. For the vertical deck-drilling electric motor a sort of truck is provided to shift it from place to place, and when required to work, a small handle is turned which switches on the current, making the magnets—which are short stumpy legs—adhere to the plate required to be pierced. Another small handle switches the current on to the drill, which starts at once. The drill is stopped and the motor detached with similar ease. For drilling holes in the vertical walls of a ship outside, the motor with magnets is suspended from a pole alongside, a rope being merely passed over the pole to support it. The leg magnets in this case are, of course, directed horizontally, and the drill works horizontally between them. The motor is pulled along the pole with a pulley and another rope, as the work advances.

But one of the cleverest features of the magnet system remains to be described. Until recently two magnet poles were employed for the two short legs, one being positive and the other negative. But it was found that the purchase was an unsteady one, as the electric motor vibrated and wobbled a good deal, and the drilling was unsatisfactory. The idea was conceived that if three legs were employed, a steady base for the drill would be obtained. But how could one pole be used without the other for the third leg? Three legs were, therefore, contrived, each having the two poles complete in itself. Thus each of the three legs of the electric drilling motor is now an independent magnet, having a positive and a negative pole. The face of each leg has three concentric spaces. The inner circle composes the negative pole, the outer ring the positive pole, a concentric portion between the two being filled with insulating material. Thus a perfectly steady tripod is afforded, and there is no danger of the drill breaking by its cutting unevenly through the plate.

All these processes are as yet practically in their infancy, but it would seem as though the electric drill had a most important future. The system might be extended, with the aid of the tripod electro-magnetic contact, to slotting and planing, and we have little doubt that this will yet be accomplished.

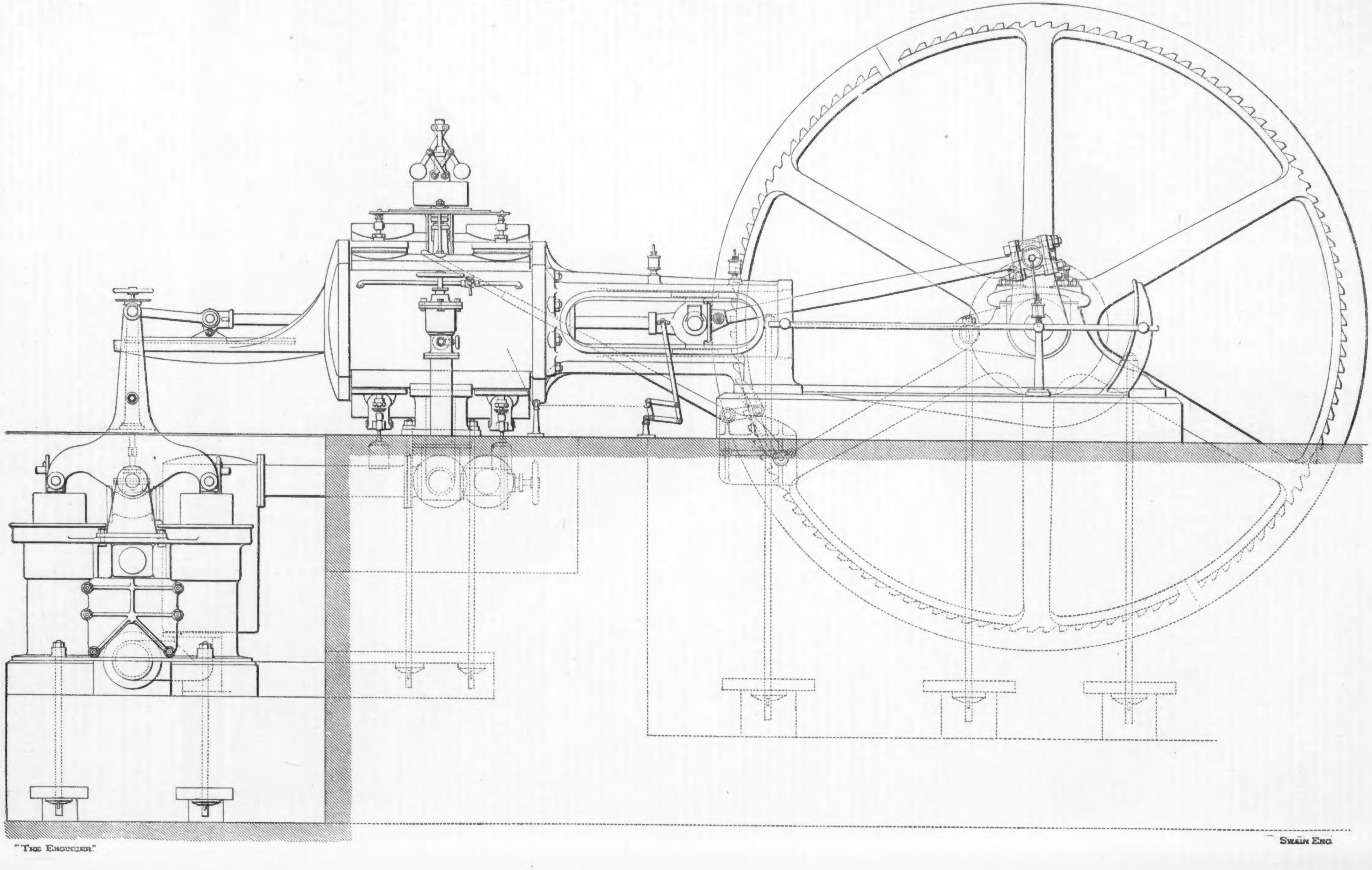
"The New Light and the New Photography" is the title of a special issue of the *Photogram*, giving articles on "Early Work on Invisible Rays," by E. J. Wall and H. Snowden Ward; "The X Rays," from an article by Prof. Roentgen; and on the work of Mr. A. Campbell Swinton and of J. W. Gifford. It is published by Messrs. Dawbarn and Ward.

The Erie Canal.—Mr. George W. Aldridge, Superintendent of Public Works of New York State, in his annual report on the canals of the State, recommends that the rights of millowners to use the surplus waters along the canal be not renewed when their present leases expire, as the custom leads to great waste of water, endangering navigation, while the revenue derived from this source is infinitesimal. The gross tonnage of the State canals for 1895 was 3,500,134, of which 2,327,481 tons were toward tide-water, and 1,172,833 westward; 1,762,663 tons were through freight, the remaining 1,797,651 tons being for way points. The Erie Canal alone carried 2,356,084 tons, and the Champlain 966,335, the remainder being carried by the three smaller canals. Electrician Barnes, in his report to Mr. Aldridge on the electrical towing experiments of last fall, states his belief in the practicability of this system of towing, but considers the overhead trolley system too cumbersome and costly, and recommends a direct towing motor running on a track on the towpath, the power to be applied direct to the boats, and boat owners to be charged a stated sum for the motor service, thus relieving them of all responsibility, with the exception of turning on and off the service at their needs.

COMPOUND HORIZONTAL ENGINE WITH COLLMANN VALVE GEAR AT MONSTED'S MARGARINE FACTORY, SOUTHALL

MESSRS. JESSOP AND SON, LEICESTER, ENGINEERS

(*For description see page* 158)


"THE ENGINEER"
SWAIN ENG.

THE LIFE OF IRON RAILWAY BRIDGES.

Is the statement which has been frequently advanced, that the life of iron railway bridges does not exceed the brief span of twenty-five years true? For a certain class of bridges, under certain conditions, the answer must unquestionably be in the affirmative. For another class of bridges, under different conditions, we are not disposed to accept this very restricted limit of longevity, and shall, we trust, be able to demonstrate that in this instance the reply must be in the negative. In order better to explain our meaning, we shall divide the structures under consideration into three classes. In the first will be included all those bridges which were faulty and defective in design, built of poor material, badly constructed, of very inferior workmanship, and maintained—if at all—in the most careless and perfunctory manner, or as frequently occurred, totally neglected. Those bridges, of which there are more remaining in a tinkered and patched-up condition than the public are fortunately aware of, were erected in the early days of railways; and although we must all plead guilty, both at home and abroad, through sheer ignorance at that time, to the first allegation, yet the others do not hold, or certainly not with the same force, for the people of different countries.

It is to this class of railway bridges that the American engineers, who admit, candidly enough, how numerous they formerly were in the States, apply the phrase "flimsy construction." On the Baltimore and Ohio line, all the iron bridges erected prior to 1878 have either been strengthened by additional metal, by extra girders, or temporarily supported by scaffolding pending reconstruction. Without claiming any undue or especial merit for the English bridge builder of bye-gone days, we think we may fairly refer to our article "The Cutter Bridge at Ely," in a recent number of THE ENGINEER, as a proof that so far back as half a century ago we did not build iron railway bridges of "flimsy construction." Foreign experience has also proved that in structures of the class referred to, an existence of twenty-five years, short as it appears, was a very fair life, for as often as not bridges succumbed before the full score was attained. We may now leave any further consideration of class one, and pass on to number two.

In the second category are included all bridges which are free from the defects belonging to their predecessors of the former class, have been designed in accordance with the most approved engineering practice at the time of their erection, well and substantially built, and adequately and efficiently maintained. There remains one more condition, and a very important one, that is, that the ultimate stresses upon the bridge should not exceed—beyond a fairly reasonable limit—in character or intensity those which it has been calculated to support without detriment to itself and without danger to the public. Could all these conditions be rigorously and faithfully enforced, a very considerably longer life might be expected to attend iron and steel railway bridges than a mere quarter of a century. Unfortunately a result so desirable is impossible of achievement, though we might certainly do more than is done, especially in the matter of maintenance, to bring about a closer approximation. In addition to ordinary wear and tear, which cannot be altogether eliminated, there is the inexorable *tempus edax rerum* to be reckoned with, which denies immortality to bridges as well as to mankind. The wear and tear of iron must not be judged by that of timber or other equally perishable material. Iron and steel do not carry within themselves the germs of self destruction. They are not like timber, the production of a natural growth, and thereby subject to a natural decay, which, although it may not seriously impair the absolute strength of the material for some years, yet causes it to become deficient in fibre, and consequently less able to resist the effect of impact. Iron and steel, on the contrary, when in the form suitable for construction, are the production partly of a chemical and partly of a mechanical process, and their subsequent deterioration, and possibly ultimate destruction, are due to influences from without and not from within. If the joints of a cellular flange are all carefully riveted up and well caulked, the ends similarly closed up, and the whole box, so to speak, made completely air-tight, corrosion will not ensue. In other words, the ordinary external influences are kept at bay, and prevented from exercising their usual mordacious powers. A remarkable illustration of this immunity on the part of iron from deterioration under these conditions was afforded by the removal of an old bowstring girder over Commercial-road. The inside plates, which had not even been given a protective coat of paint, tar, or any other preservative, were as sound, both in appearance and in reality, as when they were first built up. What would be the life of a bridge under the supposed favourable conditions we have assigned to class two there are no existing examples to determine. Another condition inseparably attached to all railway bridges past, present, and in all probability future ones also, upsets all calculation. It would nevertheless exceed the limit already referred to.

The third category, which is the most general, comprises those bridges which fulfil all the conditions belonging to those of the second class, with, perhaps, a larger margin for contingencies, but which are habitually subjected to stresses considerably in excess of those for which they were designed. It may be said that, without being guilty of a waste of material, an engineer cannot help this, and there is considerable truth in the remark. Every few years a notable increase takes place in both engine and train loads; and though it may be presumed that the absolute available cross section must ultimately put a limit to the engine load, no one could take upon himself to say what that limit might be, and when it would be reached. There can be very little doubt but that all railway bridges designed within the last fifteen years, although free from all avoidable defects, are daily and hourly exposed to stresses far exceeding their original limits. About this time—that is in 1880—the consolidation engines on one of the principal American lines weighed 54 tons. The present weight of the same type of locomotive is 80 tons, and it is proposed to use on the same railway an electric motor weighing 95 tons; if it is not already running over the tracks. A similar progressive increase, though not to quite the same extent, has attended the engine or live loads of the railways of every country. It is obvious that it is not fair to estimate the death rate of bridges, designed with a margin of reasonable proportions to carry 54 tons upon the results which are obtained when those same bridges are subsequently subjected to stresses amounting to 80 tons and upwards. As well might a registrar of the public health base his bills of mortality for the inhabitants of a district blessed with all the advantages of modern hygiene, upon the data procured from a locality notoriously deficient in the very first principles of sanitary science. To some degree, the engineer is placed upon the horns of a dilemma so far as railway bridges are concerned. If he does not allow a very wide margin for future contingencies in the shape of greatly increased live loads, he lays himself open to the accusation, when these contingencies do arise, of having made his bridges too weak. If, again, he recognises the necessity, or at any rate the advisability, of providing largely for future additional demands upon his bridges, he is equally liable to the charge of incurring a great waste of material. Is it any wonder that under such circumstances, bridges were designed with either low units of stress, or with a certain margin of extra strength and redundancy of metal, and then allowed to take their chance of being able to support the 50, 60, or more per cent. of additional stress that finally was brought upon them?

It is comparatively a very simple matter to ascertain if a bridge is quite safe, and equally so to discover if it is quite dangerous, but to determine the line of demarcation exactly where safety terminates and danger commences is frequently a difficult, delicate, and anxious investigation. It is moreover one which cannot be left altogether, as a rule, to the judgment of any one particular character or class of mind. The pure theorist would point to his calculations and figures, and unhesitatingly predict the certain collapse of the structure, if the actual stresses exceeded those he had allowed and provided for. As a matter of fact, experience and practice belie this theoretical assertion on nearly every railway in the world. Again, a simple practical man in the capacity of an inspector might detect some slight deformation in some one member of a truss, and honestly conclude that the bridge was in a dangerous condition; whereas the defect might be of no consequence whatever, and the bridge in a perfectly secure state. In order to arrive at a competent opinion respecting this apparently evenly-balanced question, a searching and rigorous inspection and examination of the existing structure is, in the first place, imperative. Secondly, the ultimate decision must be founded, in addition, upon an accurate knowledge of the amount and character of the stresses upon it originally provided for, and of those subsequently imposed. Thirdly, these two sources of information must be supplemented by a perfect acquaintance with the particular type of girder or truss under investigation, with the quality of the material and workmanship, and with the amount of the maintenance or negligence, as it may happen to be, which has attended the bridge since its erection. A certain amount of practical experience and ability in dealing with the subject must also be possessed by the official upon whose fiat depends the possibly fatal prolongation of the life of an already dangerous structure, or the condemnation of one which has still some years of useful duty before it.

It is a matter for regret in connection with the subject of our article that tubular bridges are now obsolete; box girders, except under especial conditions, are in the same category; and plate girders rarely available beyond the moderate span of a couple of hundred feet. All these varieties of the continuous web type have afforded the best record for longevity, and to them may be added riveted lattice girders with several, but not too many, systems or series of triangulations. There are numerous examples of bridges belonging to one or other of these examples in our own country which have far surpassed the quarter of a century allotted to them—the Menai Bridge, for instance. One reason assigned for their superior durability is, that the stresses due to both the dead and live loads, as well as to that inseparable but indeterminate function of the latter, termed impact, are more uniformly diffused over a larger portion of the main girders, instead of being concentrated, or, perhaps, preferably speaking, located over a comparatively few points. In the former case, the whole bridge resists *en masse*, as it were, the impact of the rapidly moving load, while in the latter, the effect of the shock has to be counteracted by a very short length of the girders, for it is an axiom that the dynamical effect of a moving load decreases as the separate members of the girders are more remote from those which constitute the locus of its application. In a continuously riveted web girder there are in this sense no separate members, any more than there are in a rolled joist. In estimating the life of a railway bridge, repairs and reinforcements, such as additional plates and rivets, are not to be regarded as terminating its existence, unless they are of such a character as to destroy the peculiar type to which it originally belonged. If a bridge built with pin connections be converted into one with rivets, we hold, as in the case of the Crumlin Viaduct, that its life terminates at the time of the conversion. The patching, however, of the lattice girder bridge carrying the London, Chatham, and Dover Railway over the Thames at Blackfriars, we cannot regard as a renewal, or as an interruption of the process of decay. While it is no doubt both the duty and interest of the engineer to prolong the life of his bridges, that is, to make them last as long as possible, the safety of the public is paramount to all other considerations. Iron and steel are cheap in comparison with human limbs and lives.

LOCOMOTIVE SERVICE.*

By J. H. M'CONNELL, Superintendent of Motive Power, Union Pacific System.

TWENTY-FIVE years ago a large portion of the freight and passenger traffic in the United States was handled with 16in. × 24in. cylinder engines. On a few roads with heavy grades 45-ton 10-wheel engines and 50-ton consolidation engines were used. The maximum load in a freight car was 20,000 lb., and to prevent loading cars beyond that limit a charge of double first-class was added to the excess. With an increase of freight traffic came the 28,000 lb. capacity car; this was very shortly followed by the 32,000 lb. capacity car. As new equipment was needed the 40,000 lb. capacity car was introduced, which for a time was considered as having reached the limit for freight cars. The 50,000 lb. capacity car followed; then the 60,000 lb. capacity car, while to-day we see occasionally a car with a capacity of 80,000 lb. The modern refrigerator car with its load and ice weighs about 100,000 lb.

The 20,000 lb. capacity car carried 300 bushels of grain; the modern box-car carries 1000 bushels of grain. Every part of the railroad equipment, the track and bridges, has been increased to keep up with the advance in the freight car. The same is true of the passenger equipment. With the 20,000 lb. car we had the sleeping car weighing 60,000 lb., and considered by many people entirely too heavy for the track. It is quite common now to see coaches weighing 80,000 lb. and sleepers weighing 100,000 lb. The 56 lb. rail was followed by the 60, 67, 70, 75, 80, 90 lb. rail, and 100 lb. rail is being laid on some of the Eastern roads. The locomotive, to meet the increased service, has grown from a 30-ton 8-wheel engine to a 60-ton 8-wheel engine; the 10-wheel engine from 45 tons to 70 tons, and the consolidation engine from 50 tons to 80 tons.

Notwithstanding the greater carrying capacity of the present equipment, the constant decrease in rates made by active competition causes less revenue to be derived from hauling a car containing 60,000 lb. of freight than was received in 1870 for hauling a car containing 20,000 lb. of freight. From 1870 to 1880 there was a decrease in amount of revenue per ton per mile of 48 per cent.; between 1880 and 1894 a further decrease of 50 per cent. Comparing the rate per ton per mile earned in 1870 with 1894, there has been a decrease of 74 per cent. The revenue derived from hauling a car containing 60,000 lb. of freight in 1894 was 22 per cent. less than that obtained from hauling a car containing 20,000 lb. of freight in 1870. The train expense is greater, the general expenses greater, and the entire cost of operating a railroad is greater than in 1870. A railroad of any importance that shows operating expenses less than 65 per cent. of earnings is accused of failing to maintain the property. The ratio of operating expenses to earnings of six railroads running into Chicago shows the following percentages:—65·86 per cent., 68·37 per cent., 72·80 per cent., 62·35 per cent., 57 per cent., 74·59 per cent.

Work done by locomotives.—The question is often asked if the modern locomotive moves as much tonnage in proportion as the smaller engine did twenty-five years ago. Old engineers frequently remark that the engines of to-day do not do the work in proportion to their size that the smaller ones did twenty-five years ago. Facts show that we are getting better work with the modern engine. Every condition is more favourable to the modern engine; we have greater weight on driving wheels, larger heating surface and increased steam pressure. Some records show a consolidation engine built in 1870 to have had 20in. by 24in. cylinders, a total weight of engine of 100,000 lb., with 85,000 lb. on driving wheels, 1500ft. heating surface in the boiler, and 140 lb. steam. A consolidation engine built in 1895 shows a great difference in everything except the cylinders, which are the same. The total weight of engine now is 150,000 lb., weight on drivers 137,000 lb., heating surface in boiler 2200ft., steam pressure 180 lb. The engine of 1870 hauled 24 loads weighing 528 tons, while the 1895 engine hauled a train of 35 loads weighing 1120 tons over the same division. The increase in passenger service is almost as marked. Twenty-five years ago, with a time schedule of 22 miles an hour, it would have been considered an impossibility to make an engine haul ten cars on a schedule of 40 miles an hour, yet it is now done every day, and these engines maintain a speed of 55 miles per hour between stations with ten cars. Have we reached the limit with the modern engine, and have we determined how much a locomotive can be made to earn for the company?

Tonnage rates.—The question should only be considered from one standpoint, that is, how much can we make the engine earn? To accomplish this—that is, make it earn all it can—the idea must be given up that an engine should run from 75,000 to 100,000 miles before it is taken in the shop. When freight engines are kept in service until they have made that mileage, the company is not getting the revenue the engines could earn. An engine in freight service should haul every ton of freight it is capable of doing, regardless of cost for repairs and fuel. When the performance is considered on a mileage basis, or with reference to how cheap it can be run, and how many miles it will make between general repairs, there will be frequent complaints made by the mechanical department of overloading, and an effort will be made to have the train reduced in order to favour the engine, so there can be a better average made on repairs and coal. After four years' experience with tonnage rating on grades ranging from 40ft. to 96ft. to the mile, it has resulted in a general increase in average number of cars per train. Where 22 loads was a train over some of the heavy grades, by the tonnage system frequently 26 cars are hauled with the same engine that hauled 22 cars for a full train. In another case, where 28 cars was a full train, a tonnage rating has increased the train to 35 loads with the same engine. It was supposed that 28 loads was a full train, and trainmen were of the opinion that the engine could not pull 35 loads, but after several tests it was demonstrated that the engine was capable of doing this, and no further trouble was experienced in hauling a train of 1100 tons.

When we consider the service of a locomotive from the standpoint of what it can earn, and not what it costs per mile to run it, we will then begin to increase the number of freight cars per train and arrive at the question affecting the revenue of the company, and that is, the cost of hauling a loaded car per mile or cost of hauling a ton of freight one mile. There are very few roads in the West on which the train haul could not be increased on some of the districts. An increase of one car containing 20 tons of freight in each train will increase the earnings of a locomotive in one year 7200 dols., and the only additional expense would be 90 tons of coal. Taking the average of a locomotive at 3000 miles per month, or 36,000 miles per year, we have the revenue of 20 tons of freight hauled the same mileage at one cent per ton per mile, or 20 cents per mile per car. There has been no increase in the wages of the engineer, firemen, or trainmen, or for repairs. The only extra expense has been 5 lb. of coal per train mile. Taking the average tonnage per car for the year on six Western roads, which is 11·44 tons per car, the locomotive can earn on this basis 4118·40 dols. per year for the company more than it did before. By keeping the engine in first-class condition at all times, I believe every locomotive in freight service on our Western roads can be made to earn at least 4000 dols. more for the company per year than at present; and the expense will not be increased except for fuel at the average rate of five pounds of coal per car mile.

Reports of performance and cost.—The monthly statements of locomotive performances sent out by railroads, when compared, show a wide difference in cost, and unless the conditions of making them up are known the comparisons are unsatisfactory. Some roads allow engines only actual mileage between terminals, regardless of length of time making the trip. Should the train be delayed several hours by switching or meeting trains, no mileage is allowed. In helping service the engine is only credited with

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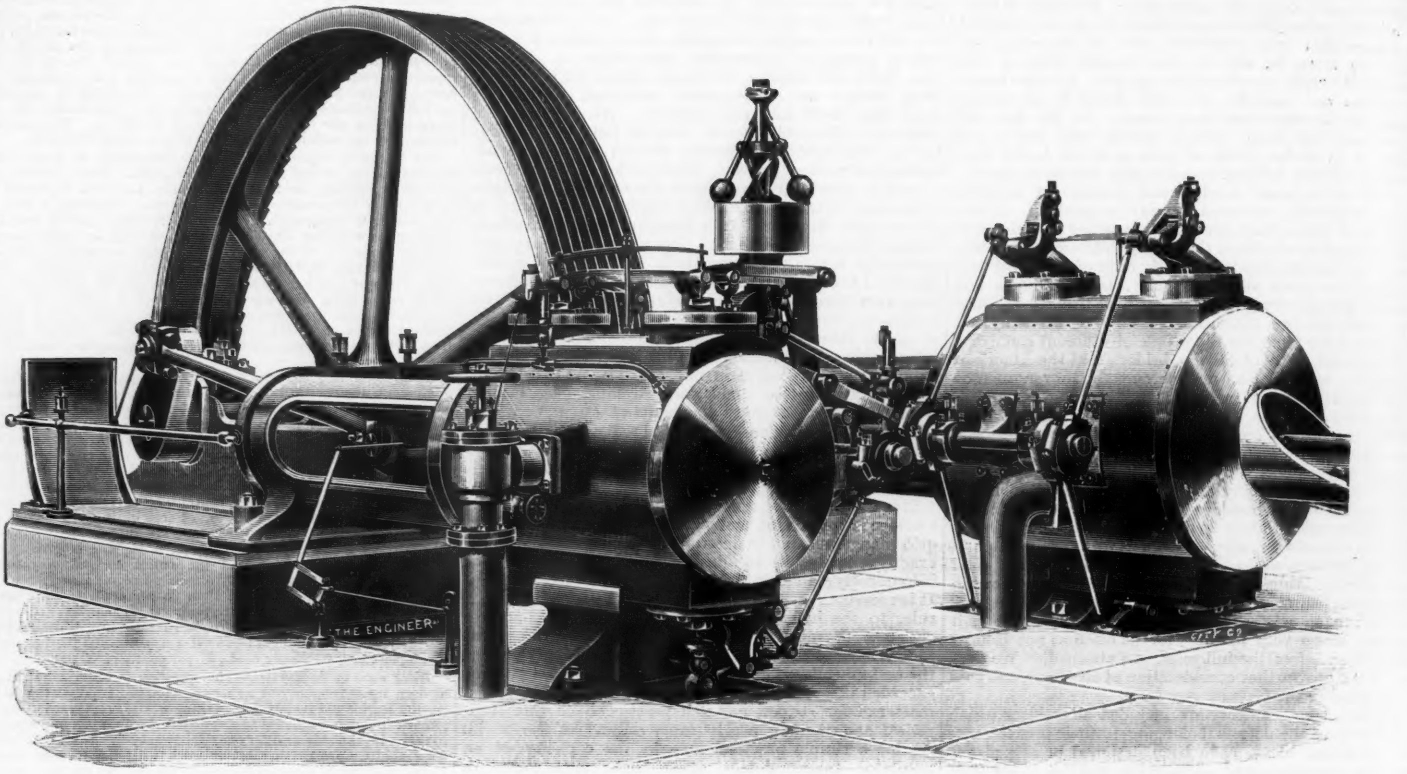
* A paper read before the Western Railway Club.

COMPOUND HORIZONTAL ENGINE, WITH COLLMANN VALVE GEAR

MESSRS. JESSOP AND SON, LEICESTER ENGINEERS



actual mileage. While the crew will receive a day's pay, the engine may make but thirty miles in twelve hours.

It is the practice of a number of roads to allow constructive mileage to all engines in passenger and freight service. Some roads add 10 per cent. to the mileage, as it is claimed to make up for the coal and oil used in taking the engines from the roundhouse to the train and in leaving the train and being put in the roundhouse. In addition to this they are allowed ten miles per hour for switching or lay-outs on the road. Where overtime is paid the engineer, the engine is given mileage to make up for it. By this system of watering mileage a locomotive report is made to show a good average on coal and oil and low cost for repairs and a large individual engine mileage, when the actual cost is 10 per cent. to 15 per cent. greater than that shown by the report.

Taking the annual reports of some Western roads, considering the freight engine mileage with freight car mileage, they show the following percentages of freight engine mileage to freight car mileage:—

4·06 per cent.	4·24 per cent.
4·76 ,,	5·35 ,,
4·37 ,,	5·32 ,,

The combined mileage of passenger and freight trains compared with the engine mileage in same service shows following percentages of engine to car mileage:—

8·78 per cent.	7·76 per cent.
7·57 ,,	11·29 ,,
7·44 ,,	6·48 ,,

The following gives number of cars per train when figured on same basis for all the roads:—

18·80	20·09
18·66	17·73
23·60	24·66
22·86	

There is no uniformity in rating trains. One road rates two empties as one load, others three empties two loads, and others five empties three loads. A train of 10 loads and 20 empties under these systems would be called respectively 20 loads, 22 loads, and 24 loads. But the showing on paper would convey the impression that one road was hauling a greater number of cars per train than another, when there is a probability that the road showing the smaller train was moving the same tonnage.

Following this matter still further, the average tonnage for a loaded car for the year on the five roads shows:—

12·87 tons.	14·40 tons.
9·09 ,,	12·26 ,,
9·84 ,,	

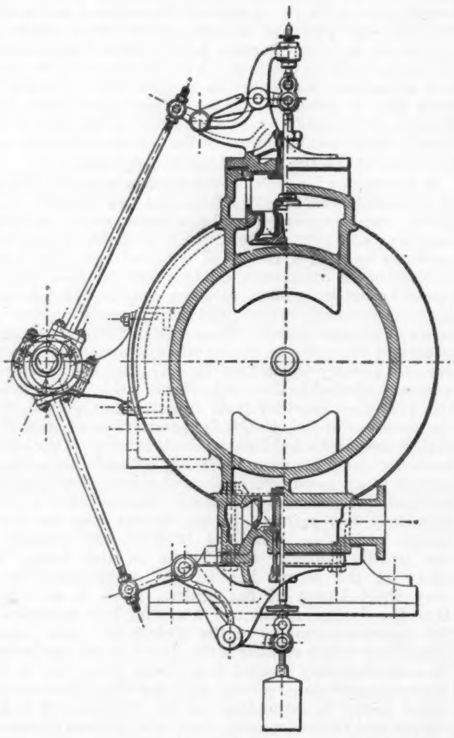
With such a variation in the manner of allowing mileage and rating trains, no satisfactory comparison can be made, and until all roads show the cost of moving a loaded passenger and freight car one mile, locomotive performance sheets will be of little value for comparison.

How to increase revenue.—The problem of to-day with decreased rates is to haul greater tonnage in each car and reduce the cost of doing it. The revenue of a railroad is derived from the service rendered by its locomotives. To increase the revenue the locomotives must do more work. The tendency is to increase their weight and size, and there is not enough attention paid to getting increased service of those now owned. The freight earnings largely exceed the passenger earnings, and by directing efforts to hauling increased tonnage the revenue is increased without any great increase in operating expenses. The weight of a train over a division is usually determined by the amount of tonnage an engine can haul over certain grades. In nearly every case increased tonnage can be hauled if the mechanical and transportation departments work together. An increase in the steam pressure of 5 lb. will, in many cases, take one more car over the grade.

When the mechanical departments of our railroads give the same attention to increasing the train haul that they do to making a showing of how cheap they can run the locomotives per mile, they will find they have obtained increased service from the locomotive, decreased the cost of hauling a ton of freight, and increased the revenue of the company. The problem of to-day is, how much does it cost to haul a ton of freight one mile, not what it costs per mile to run your locomotives.

MONSTED'S MARGARINE MANUFACTORY, SOUTHALL.

WE commence this week the illustration of the engineering features of the fine new margarine factory of Mr. Otto Monsted at Southall. The manufactory comprises many features of interest in connection with the steam and refrigerating machinery, and we commence with the illustration of the steam engines by the engravings herewith and on page 156. The engines were built by Messrs. J. Jessop and Son, of Leicester, and consist of two pairs of horizontal compound condensing engines, with high-pressure cylinders 15in. diameter; low-pressure, 28in. diameter; with a stroke of 36in. They are designed for 120 lb. boiler pressure, and run at a speed of 70 revolutions per minute, each pair indicating with an economical load 200-horse power. The cylinders are steam-jacketed with protected end covers. The air pumps for each pair have double plungers working vertically, as shown on page 156, and driven by rocking lever from tail rods of low-pressure cylinders; the plungers are 14in. diameter, and have a stroke of 16in. The condensers are jet condensers, placed vertically, and the outflow or delivery from air pumps is received in tanks placed a few feet above, whence it flows by gravity to the cooling pond some distance away. Suitable valves are fitted for working the engines high pressure when desired. The fly-wheels are 14ft. diameter by 1ft. 9in. wide, grooved for eight 1¾in. diameter ropes. The cranks and crank shafts are steel, and the crank pins of Whitworth's fluid compressed steel, with phosphor bronze steps in connecting rods. The connecting rods are 7ft. 6in. centres, and the cranks are set at 90 deg.



Transverse Section of Cylinder with Colman Valve Gear

The valve motion is the well-known Collmann patent valve gear, previously described and illustrated in our pages, and of which Messrs. J. Jessop and Son are the sole licensees in England. The arrangement of the valve gear is shown on the longitudinal elevation, page 156, and by the transverse section annexed, which is taken through the valves of the high-pressure cylinder. The action of the folding levers, the lower one of which opens the valve under the resistance of a spring, is exceedingly quiet, and in every way satisfactory. The steam valves are double-beat equilibrium valves, and are placed on top of cylinders with exhaust valves underneath. The governor is high-speed type, the automatic expansion being variable within very wide limits. The cut-off in low-pressure cylinder is variable by hand while the engine is running, and the valve gear gives excellent results in working. The wearing parts are very strong and of large area, and similar engines to those under notice have been running for many years with very little attention. Over a thousand engines fitted with Collmann patent valve gear are at work on the Continent and in England.

KING'S COLLEGE ENGINEERING SOCIETY.—On Friday, January 31st, Mr. Mowat gave his presidential address, Mr. Herroun, F.I.C., in the chair. Commencing with a few remarks as to the advantage of regularly attending the Society's meeting, the author passed on to the consideration of railways. The methods of acquiring land for railway purposes, and the requirements of the Board of Trade, was followed by a description of the permanent way, in which the different appliances, such as rails, sleepers, chairs, check-rails, fish-plates, &c., were described in detail. Passing on to the subject of signalling, the author described the working of a semaphore and the use of auxiliary and fog signals, and then dealt with the block system, taking the train staff and ticket systems as an example of the working of a single line. With regard to the rolling stock, he referred to the coupling of the wheels of the locomotive and to passenger carriages and goods trucks, pointing out the advantage of bogies and describing the carriage wheels and continuous brakes. Before bringing his remarks to a close, the author referred to the extraordinary growth of traffic on British lines, which necessitates the adoption of many precautions, often insufficiently appreciated by the public.

ENGLAND LEADS IN THIS ONLY.—"There is not perhaps a larger market for any mechanical device of which a need is felt than for a small gas and gasoline engine. The mechanic, says the *Scientific Machinist*, who will build a 1-H.P. fairly efficient gas engine, and sell it at about the cost of a 1-H.P. steam engine, will secure a trade of very large proportions. If he should be able to realize a fair profit on each sale—and otherwise it would be dangerous to engage in that or any other business—a large fortune could undoubtedly be built up in a few years. The question is often asked, why are Americans, who in most matters of enterprise generally have no superiors, so backward in the use of gas and gasoline engines? And it is a pertinent question which no one can answer. The English lead us in this line of work, and perhaps this only. They adopt our steam engine and boiler designs, machine tool designs, and have modified much of their engineering work in various branches along the line of American ideas, but they are our masters, in the design of gas engines. Not only this, but our manufacturers are either so egotistical or fossilised that they see nothing of the kind, admit no part of the truth, and apparently care nothing about doing their plain duty by their customers and to maintain America's reputation. They are even lacking in Yankee adroitness, or they would at least copy some of the good English designs." The writer of this might have added just one thing more, namely, the oil engine, and by that one point be more correct, for the American gas engines will work.

STEAM ENGINE MAKERS' SOCIETY.

THE seventy-first annual report of the Steam Engine Makers' Society is being issued this week, and Mr. James Swift, the general secretary, in his introductory address, congratulates the members on the very satisfactory results of the past year's operations. The number of admissions had exceeded those of any previous year, the total increase of members had shown a like result, and notwithstanding a depression in trade, with an extended unemployed list, several extensive disputes, and a heavier list of sickness than in any previous year, the capital value was a record that had never been attained before. All this had been achieved without any excessive tax upon its contributors; and if proof were wanted upon this point, it was to be found in the limited number who had lapsed their membership, or given up their connection with the Society.

The compilation of the report is on similar lines to those of previous years, the income and expenditure of each branch being given in detail, and carried forward to abstract tables, from which is compiled the summary balance of the Society's entire work. These show that the balance at the end of 1894 stood at £28,826, and that the expenditure for 1895 had been £17,366, leaving the Society with a cash balance on December 31st, 1895, amounting to £30,478, or an average of of £4 6s. 1d. per member. The total number of members at the close of the year was 7085, and the number of branches 101, of which 98 are in the United Kingdom, one in the United States, one in Canada, and one in Queensland. The net result of the year's work was, an increase of two branches, 405 additional members, after allowing for deaths and exclusions, and an increase of capital amounting to £1651, without taking into account the arrears owing, or any valuation of the Society's stocks, or goods, or other property. In comparing this year's report with its predecessor, the total income of £19,018 is more by £1443 than that of 1894, and this increased income has been due chiefly to the lesser number out of employment, who, not being in receipt of donation, became contributors for the time being.

Turning to the expenditure, Mr. Swift remarks that while there are points for pleasant reflection, there are others that cause matter for serious consideration for some time to come. The most satisfactory feature in the expenditure is the reduction in the amount paid for donation to unemployed. In 1894 it was £8250, or £1 4s. 8½d. per member; but this year's report only shows £6009, or 16s. 11½d. per member, being £2240 of a decrease, and Mr. Swift is sanguine that the year on which we have now entered will be even more satisfactory, as, apart from present signs that the average period of bad trade had spent itself, they might look forward with less anxiety as to employment for members than has been the case for the past three years. The total payment for sick benefit had, however, been larger than in any former year, being £4068, as against £3324 in 1894. The greater part of this sum was paid in the spring of the year, and in a great measure appeared to have been the result of the long frost, as in March the number of members in receipt of sick benefit went up to double the normal number. Fortunately the advent of milder weather restored the great majority, and death did not claim more than the average number, the sum paid for funeral allowance being £1170, or only £72 in excess of 1894.

Superannuation again showed an increase, and to such an amount that should tell them they did not take up this matter any too soon, and that if they were to be true to themselves they would have to do even more in the future. The payments last year had amounted to £3208, as compared with £2830 in 1894, and the present worth of the superannuation fund now stood at £11,648, having increased by interest £350 during the year. The payment for miscellaneous or working expenses had amounted to £12,036, being equal to 5s. 9d. per member, or 11¾ per cent. of the total expenditure, a smaller average than on any former occasion.

In former reports Mr. Swift has alluded to the suggestion by some that trade societies should confine their work to combatting the capitalist, leaving the providing of benefits for sickness, old age, funerals, &c., to the friendly societies. Turning to this question again, he says, that "although it is but some five years since this theory was advocated, its being put into practice has not shown lasting results. Few, if any, who have adopted this principle, have shown any staying power, but so soon as the first excitement appears to have passed, and contributions had to be paid with no immediate return, the membership lapsed. As evidence of this, and what may be called the rise and fall of new unionism, as run upon these lines, we may say that in 1890 there were five societies who then made returns of membership, giving a total of 266,000. By the latest returns the same five societies have fallen to a membership of 54,700, and trade unionism is weaker by over 211,000 in these cases than it was five years ago. Had, however, in our opinion these societies been financed to provide some benefits, however small, other than strike pay or management expenses alone, we believe they would still have been a power in their separate industries. Societies like our own were derided for attaching benefits of a friendly nature, but events have proved that our forefathers were wise in their generation when they adopted the principle which we of the present generation have done our best to extend and consolidate. Whilst we are prepared for peace, we are, at the same time, prepared for war. We have capital to meet our con-combatant members' claims, whilst we have it to defend our position if the capitalists become the aggressors, or causes arise that call for action to be taken."

Referring to the recent dispute in the shipbuilding industry, Mr. Swift remarks that "Much has been written within the past four months in relation to this strike and lock-out, and much of it might have been left unsaid. The statement that the action of the employers was for the purpose of stamping out trades unions is an old cry, but almost out of date. We do not think that there is more than a very limited number of employers who have even the desire to do so, much less the thought that such a result is possible. There may be exceptions in single cases, and the exception may be made in that of the Belfast employers, who arrogantly refused any return of previous reductions in wages. To this no exception could be made had they stood alone, but the Clyde employers, figuratively speaking, did not stay to inquire whether it was a free fight or a family quarrel, but rushed into the fray by closing their works in sympathy with the wealthy firms in Belfast. Having done so they can now at their leisure count the cost. Their private ledger showing the loss on production will certainly be a sealed book to themselves, but to the public it will be known that the Clyde workmen secured an advance that would most likely not have been at present asked for, seeing that only a short time before they had accepted a compromise on wages, and this had not even been paid before they were locked out. Having locked out their own men, other centres were asked to federate and make common cause with them in their own rash policy. Fortunately the other centres were more rational, and although it was understood they were full of sympathy, their inaction showed they were at least human, and would not turn adrift old employés to cover the rash action of the Clyde employers, who in the long run had to concede an advance beyond what the men had previously agreed to accept. After this experience it is doubtful if the Scotch Employers' Federation will resort to such an expensive experiment again. The disputes named have been an object lesson in other than the disaffected districts, as our list of admissions fully proves. It has had the effect of recommending combination, as the action might have been taken in any other locality; hence the desire to be prepared. The newspapers giving prominence to the question, young men have been anxious to be part of an organisation, offered themselves as candidates, paid the entrance fees, not waiting for a conflict, and then looked to trade unionists to support them. This desire is still manifest, and it rests with present members as to how far they will assist in securing a benefit to the Society by the many who are now open to be canvassed and initiated."

WATER IN HERTFORDSHIRE.

THE water supply of districts round London opens many questions of considerable difficulty, and as a contribution to the problem of the supply by wells the following letter by Professor W. Boyd Dawkins, F.R.S., F.G.S., Assoc. Inst. C.E., will be read with some interest:—

The feeling that the wells proposed to be constructed by the New River Company, and for which they are applying to Parliament for powers, will do injury to the surface in the upper valley of the Lea, is so general among the inhabitants of Hertfordshire that it will not be out of place for me to discuss the question as to whether it be well founded or not. I propose, therefore, to lay before your readers (1) what has been done in the area under consideration, (2) what it is proposed to do in the future, and, lastly, to see from the experience of other similar areas of chalk from which large quantities of water have been obtained, whether the surface has been damaged by the deep wells. For this inquiry the report of the Royal Commission on the Water Supply of the Metropolis (1893) offers a convenient basis.

(1) The daily average amount of water pumped during 1891 by the New River and East London Companies from deep wells sunk into the chalk in the area of the Lea to the south of Ware, irrespective of the supply from the river Lea itself, which does not concern us, as it cannot affect in any way the surface waters above the intakes, amounted to about 11 million gallons per day. Does this abstraction of water, coupled with the quantity drawn from private wells, affect the surface waters of the district? On this point the divergence of opinion among the witnesses examined before the Commission was so great that an assistant commissioner was sent, in company with the engineer to the Hertfordshire County Council, to collect independent evidence, and to verify the alleged facts on the spot. The result of his inquiry, as embodied in the report of the Royal Commission dated September, 1893, are as follows, viz.:—"I am unable to find in the whole of the evidence, and in the arguments produced, a single item which is at all strongly in favour of the theory of permanent depletion; while there are many most convincing arguments in support of the theory of seasonal change. Taking the oral evidence as a whole, it is shown that the source of no river which has been examined is at the present time, or was in 1891, at a point lower down in the valley than it had been at some previous period before 1875, and Mr. Topley says there was a belief in the depletion of the rivers, &c., in or about 1868, a time of great drought, and, it may be added, a time longer anterior to the date at which the Lea Valley Companies began to pump any material quantity of water. For the reasons recorded above, with the information derived from the tables of rainfall and percolation, and from the river gaugings, along with the general evidence, I am of opinion that there is no proof of any permanent depletion of any river, well, or spring, except from local causes; while there is conclusive evidence that the changes recorded, where not produced by local pumping or the undue extension of watercress beds, are seasonal; that they have occurred to at least as marked a degree in years gone by, and before 1875, and that they will occur again."

This conclusion was accepted by the Commissioners in the following terms:—"We are of opinion that we are not justified in believing that the pumping by the New River and East London Companies has actually and in fact produced as yet a permanent appreciable depression of the water levels in Hertfordshire and the upper part of the Lea Valley, although such pumping may temporarily affect to some extent the height of water in wells in the immediate neighbourhood of the companies' works. That these companies can continue to increase the quantity pumped from the chalk with equal immunity until it has reached five times the present 'take' we are not prepared to say, as will be seen later on. We think there can be no doubt, although Sir John Evans does not agree, that water is constantly passing in considerable volume from the north and north-west to the south-east under the pumping stations in the Lea Valley, and ultimately finding its way into the bed of the Thames some distance below London." It is obvious, therefore, that no mischief has been done as yet to the surface waters of the Upper Lea by pumping from the existing deep wells, and that the current idea that the general level of the water in the district has been lowered by pumping is without foundation in fact.

(2) The New River Company's Bill makes provision for obtaining a further supply of 12 million gallons from six wells in the sparsely populated area around Hertford and Ware. Will these wells injure the surface? The first point to be noted is the fact proved before the Commission, that the deep subterranean water in the chalk finds its way ultimately into the lower reaches of the Thames, and into the sea, in vast volume through the general mass of the chalk underneath the valleys and without touching the surface, and that therefore the quantity pumped out of a given deep well does not represent the number of gallons abstracted from the nearest surface stream, but that obtained from the general body of water in the chalk, of which the surface streams form a small fraction. Within the limits of a letter it is impossible to carry this line of inquiry further. It is sufficient for our purpose to quote the following conclusions from the report of the Commissioners, viz., that "During a succession of wet years no doubt more than 56 millions will be available," and that, "An average daily supply of 40 million gallons can be obtained from wells and springs in the chalk of the Lea Valley without affecting any material interests." The additional 12 millions sought for brings up the total yield to about 23 millions, leaving a margin of from 17 millions in dry seasons to 33 millions in wet years for further requirements should they arise.

(3) The last point to be considered is the effect of heavy pumping from deep wells on the surface in other districts in which the conditions are the same as in the area of the Lea. It may be measured by the effect of pumping on the valleys of the Cray and the Darenth, and the wells of the Croydon area on the surface waters. The area of chalk available for the supply of the Kent Waterworks amounts to about 132 square miles, and the actual amount pumped from it in 1891 was 13½ millions, without counting the numerous private wells established on the banks of the Thames, some of which yield as much as 1,800,000 gallons a day. The only result has been to lower the water level close to the pumps. The general effect on the agriculture of the district is nil, and Kent still remains the garden of England. The chalk area of the Lea is more than twice as great as this area, and, consequently, the percolation into it is more than twice as great. In the light of this experience, it is idle to suppose that the addition of 12 million gallons to the yield of the existing wells would affect the surface in the Upper Lea, except by lowering the water-line close to the wells during pumping.

In the case of Croydon the experience is practically the same. In that small district the amount of water obtained from deep wells has been steadily increasing during the last twenty years without any effect in lowering the general level of the water in the chalk. The observations of Mr. Walker, ranging over a period from 1883 to 1892, prove that there is only a seasonal fluctuation without permanent depression. There is no reason to believe that the sinking of the proposed wells in the valley of the Lea will cause other effects that those experienced in the two above-cited cases, and if local damage of any sort be done, it will no doubt be fairly met by the New River Company. There is, in my opinion, water in abundance, both for the local needs and for the deep wells in question. If anyone doubts this, let him refer to the report of the Royal Commission, and the evidence upon which it is based.

LEGAL INTELLIGENCE.

AT THE ROYAL COURTS OF JUSTICE, CHANCERY DIVISION.

4th February, 1896.

(*Before Mr. Justice* STIRLING.)

THE BLACKPOOL GREAT WHEEL.

GRAYDON V. BASSETT.

IN this case the plaintiff was described by his counsel as an American gentleman, who had served in the United States cavalry, and had devoted a great portion of his life to applied science. He had, in September, 1893, taken out a patent in this country for a gigantic wheel or vertical "roundabout," and was also the inventor of a dynamite gun, which, it was alleged, was a great success. It was under a licence from him that the Great Wheel at Earl's Court was erected, in accordance with his patent, in 1894 and 1895, and which was worked during the summer of 1895 and very extensively patronised. The work of erection was carried out by Lieutenant Bassett, R.N., the defendant, who was connected with the firm of Maudslay, Sons, and Field, the well-known engineers. Under an agreement of date 10th August, 1895, defendant acquired the sole right of constructing these wheels in the United Kingdom and France, on terms to be settled, from time to time, between himself and the patentee, provision being made for reference to arbitration in the event of dispute.

The plaintiff's case was that in the autumn of 1895 he found that the defendant Bassett had negotiated with a company who were owners or lessees of certain pleasure grounds at Blackpool, and had entered into a contract for the erection of a great wheel there. There had been previous communications with a view to an agreement, according to which Lieutenant Graydon was to get £5000 for his licence for the Blackpool Wheel, but those negotiations came to nothing.

Mr. BUTCHER, who with Mr. BOUSFIELD, Q.C., and Mr. KIMBER, appeared for the plaintiff, stated that investigations that had been made with regard to the Blackpool Wheel disclosed the fact that it was in all substantial respects similar to the Great Wheel at Earl's Court, and that if it were constructed it would be in violation of the plaintiff's patent. He, therefore, claimed an injunction restraining the defendant Bassett and the Blackpool Company from erecting the wheel, except in accordance with the licence of August 10th. Defendant had admitted that he had entered into the contract for the erection of a Great Wheel at Blackpool, but suggested that it was not being constructed in accordance with the plaintiff's patent; but upon comparison of the designs, as well as on the testimony of experts, it appeared to be absolutely identical with the patented design. The defendant further suggested that the plaintiff's patent was not valid, but he—Mr. Butcher—submitted that a licensee was estopped from raising a question of that kind.

Mr. JUSTICE STIRLING observed that if the plaintiff's case rested on a grant to the defendant of an absolute licence there could be no injunction, the only question being what was to be paid for the use of the licence.

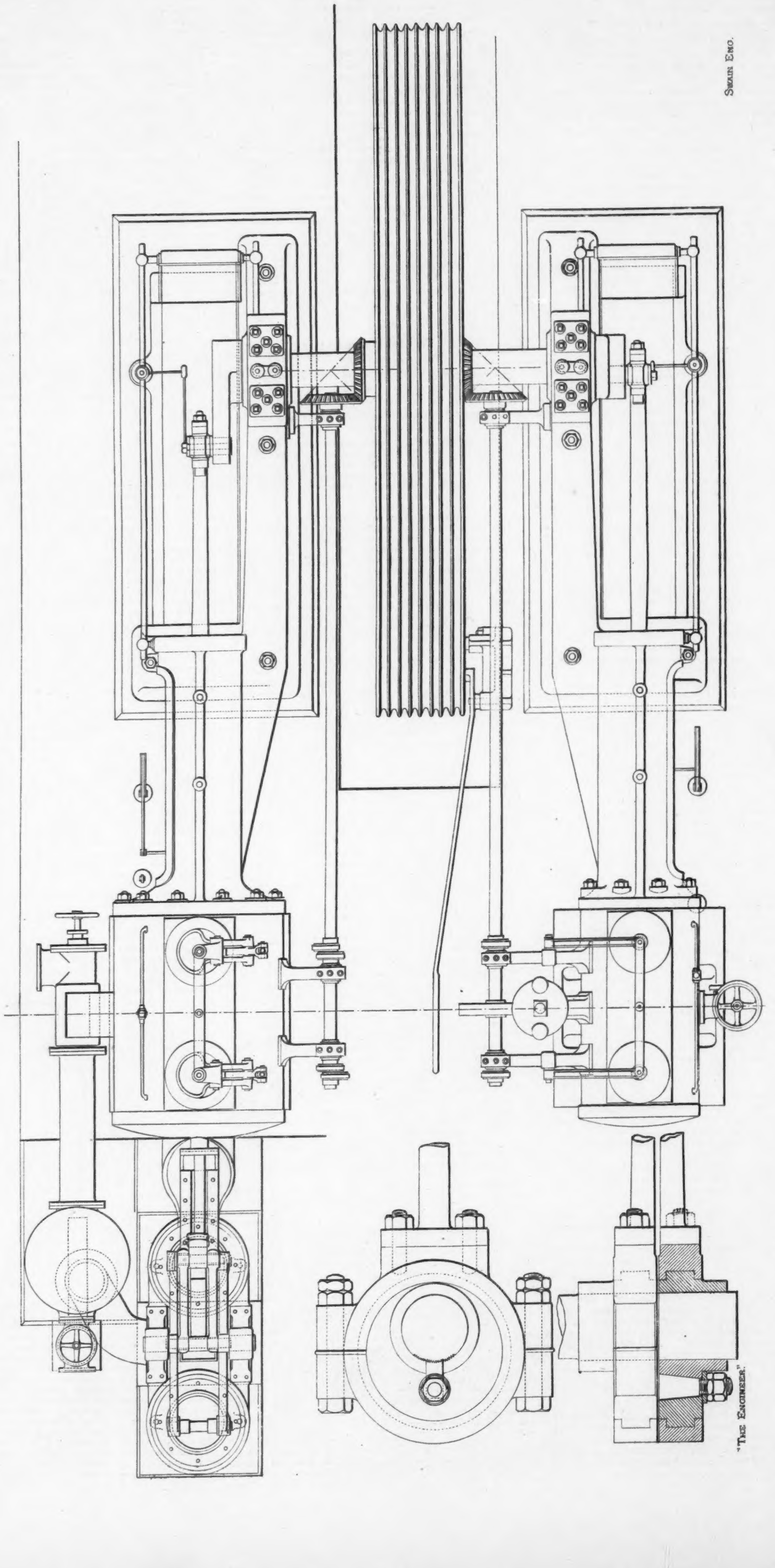
The case occupied the whole day, and was adjourned to the next day, and at the conclusion of the arguments Mr. Justice Stirling postponed his decision.

On the 6th Mr. JUSTICE STIRLING delivered judgment. He said the action was brought by the owner of a patent for improvements in revolving vertical wheels for amusement and other purposes, and was brought to restrain alleged infringement, or, in the alternative, to restrain breach of an agreement between the parties, dated August 10th, 1895. In October, 1893, there had been an agreement by which Bassett, who was a partner in the firm of Maudslay, Sons, and Field, the engineers, by which Bassett was to have sole right of manufacture in the United Kingdom and France of wheels and towers, in accordance with Graydon's inventions, and on the 4th November a similar right was given through Bassett to the Gigantic Wheel and Recreation Towers Company, within the district under the control of the London County Council. That company erected the Great Wheel at Earl's Court. In August, 1895, disputes arose between Graydon and Bassett, and cross-actions were brought which led to the agreement in question, by which Bassett was to have, subject to the agreement with the Great Wheel Company, the sole right of constructing in the United Kingdom and France, wheels, towers, and other works, in accordance with plaintiff's patent. In September, 1895, negotiations took place between plaintiff and Bassett with relation to the Great Wheel at Blackpool, but the parties were unable to come to terms. Then Bassett appeared to have entered into negotiations with the Blackpool Winter Gardens, Limited, for the construction of a wheel on land of which they were owners, and after an exchange of letters this action was instituted to restrain the defendant from erecting the wheel except in accordance with the agreement of 10th August. The defendant denied that the intended wheel was to be constructed in accordance with the plaintiff's patent, and he also disputed the validity of the patent on the ground of want of utility and want of novelty. It was contended that the defendant, being a licensee, was not entitled to question the validity of the patent, and the argument had been limited by the Court to the question of construction. In his—the Judge's—judgment, the plaintiff was right in his view that the agreement gave Bassett the sole right of using the invention for the purpose of construction only; but it seemed to him that no case had been made out for the interference of the Court. The defendant had, according to the plaintiff's admission, a licence to construct wheels according to the patent; but there was no evidence that Bassett intended to use this wheel when it had been constructed—and, indeed, it seemed that he intended to get up a company to work it. The case, therefore, on the present materials failed. This issue determined but a very small item of the controversy that had arisen, and he should be glad to give favourable consideration to any suggestion for facilitating the trial of the more serious question of the validity of the patent. He dismissed the action without costs as regarded Bassett, but with costs as regarded the Company.

COMPOUND HORIZONTAL ENGINE WITH COLLMANN VALVE GEAR AT MONSTED'S MARGARINE FACTORY, SOUTHALL

MESSRS. JESSOP AND SON, LEICESTER, ENGINEERS

(For description see page 158)


Swain Eng.
"The Engineer"

RAILWAY MATTERS.

A deputation, under the auspices of the Light Railways Association, waited upon Mr. C. T. Ritchie, M.P., President of the Board of Trade yesterday—Thursday—at noon, to advocate the promotion of legislation for the construction of light railways under an improved system of procedure and regulations, and with the assistance, in certain cases, of financial aid from the Government.

Messrs. Ruchonnet and Dumur, representing the Jura-Simplon Company, have arrived in Rome, to discuss with the representatives of the Italian Government some points which remain to be settled in the conventions for the definitive construction of the line through the Simplon, which is to be carried out by the Governments of Italy and Switzerland, each on its own territory.

Mr. Thomas Robertson, general manager of the Great Northern Railway of Ireland, has been appointed to the chairmanship of the Irish Board of Works in place of Lieutenant-General Sir R. H. Sankey, K.C.B., who retires under the sixty-fifth year rule. Mr. Robertson took up the general managership of the Great Northern Railway of Ireland in April, 1890, and the railway has since advanced with signal success, and now occupies a position of great prosperity.

An extraordinary if not unique accident happened on the 10th inst. to William Stevens, an engine-driver on the North British Railway, while driving an express train from Carlisle to Riccarton. As the train was approaching Longtown at high speed, the lid of the sand-box was blown off, and, rising in the air, was shot through the spectacles of the engine, and struck Stevens on the head with great force. He was seriously injured, and is now in the infirmary at Carlisle.

The London and North-Western fast train leaving Carlisle at 5.38 p.m. had a narrow escape on Wednesday from being wrecked in a cutting between Grayrigg and Oxenholme. As the train was running through the cutting a huge boulder was rolled over the edge of the rocks above, and it smashed against the side of the train, two carriages being badly damaged. No passengers appear to have been hurt, but the affair caused much consternation. Detectives are investigating the matter.

At the annual general meeting of the shareholders of the London Street Tramways Company, held at the Cannon-street Hotel on the 6th inst., the chairman Mr. A. F. Fry, said they had carried 13,987,820 passengers during the year, showing an increase over the previous year of 1,370,037, while the percentage of working expenses to receipts showed a decrease of 2·10 compared with 1894—an altogether satisfactory return. The miles run by their cars during the year totalled 1,314,711, or an increase of 50,464 miles over the miles run during the previous year. The amount earned per mile run had beeen 12·67d., or an increase of 0·08 over 1894. The cost of forage showed a decrease of £615, and they recommended a dividend of 4 per cent.

An official notice has been given by the Bute Docks Company of their intention to withdraw the deposited Bill for next session. The Bill, which was regarded as the great Bill of the coming session, sought powers to enable the Bute Docks Company to construct over forty-nine miles of railways in connection with their docks at Cardiff. These railways were to be constructed principally along the beds of the Glamorganshire and Monmouthshire canals, and would thus have enabled the dock company to enter into direct railway competition with the Taff Vale Railway. The amount of share and loan capital required for this scheme was £1,330,000. The withdrawal of the Bill is understood to have been decided upon in order to facilitate the passing of the Bill for the amalgamation of the undertakings of the Bute Docks Company and the Rhymney Railway Company

In the report to the Board of Trade on the accident which occurred on the 5th December last at Ballynahinch junction, on the Belfast and County Down Railway, Major Marindin says:—"Now the collision under consideration would not have occurred had the automatic vacuum brake been operative on the passenger vehicles at the tail of the train, and the inquiry has elicited the fact that the Belfast and County Down Railway Company are not only ignoring the order in regard to the proportion of brake vans in their mixed trains, but are deliberately acting in direct contravention of their undertaking (quoted). This is a matter deserving the Board's serious attention, for although such undertakings, the acceptance of which enables the Board at times to make certain valuable concessions to railway companies, are, to the best of my belief, honestly acted up to as a rule, it becomes a question, in view of this case, how far they should be accepted in the future." The undertaking referred to was given under the seal of this Irish company; no wonder at the unequivocal remarks by Major Marindin.

A Board of Trade report by Major F. A. Marindin, R.E., has been published on an accident which occurred on December 26th, near St. Pinnocks Viaduct, between Doublebois and Bodmin-road, on the Cornwall section of the Great Western Railway. In this case, as the down mail train which left London for Penzance at 9 p.m. on December 25th was running down the incline between Doublebois and Bodmin-road at about 5.44 a.m., the engine, tender, and the leading carriage left the rails, the engine, after running across the 6ft. way and along the side of the longitudinal timbers of the up line, coming to a stand in a distance of 170 yards from the point where it left the rails. No person was injured, and there was not very much damage done to the rolling stock. Major Marindin says that the accident, which would probably have been a serious one if it had not been for the excellent service done by the continuous brake promptly applied by the driver, and stopping the train about 107 yards short of a high viaduct, was due to a portion of the rocky slope on the south side of the line slipping down on to the line shortly before the train passed.

At the fourth half-yearly meeting of the Waterloo and City Railway Company on the 6th inst., held in the Board-room at Waterloo terminus, the directors' report showed that the expenditure during the half-year amounted to £62,321, making the total outlay £122,736 at the close of December last. Since the report was issued they had received a statement from the engineers which gave a most interesting account of the progress that had been made. It stated that towards the City the tunnels on July 22nd last were about 100 yards Citywards of the river Thames. They had now reached a point in Queen Victoria-street, nearly opposite St. Nicholas Church, the distance driven in six months being 530 yards of double tunnel. These tunnels had been driven under the low-level sewer, the Metropolitan Railway, and Queen Victoria-street, without mishap, in the solid London clay, and the rate of progress was 73ft. per week. The smaller, or railway, tunnels were now 400 yards distant from the commencement of the City station, which would probably be reached in June, 1896. Towards Waterloo the tunnels were, in July last, entering Stamford-street, but as they had encountered ballast and water, and had to work under compressed air, the progress was much slower. Average distance of tunnels from the crossing of the Waterloo-road, about 120 yards; present rate of progress, only about 23ft. per week; length of double tunnel driven in this direction since the last half-yearly report, 300 yards. The contracts for the Waterloo low level station had been let at the engineer's estimate, and the works had been commenced. Total length of single tunnel driven since the commencement of the works, 3036 yards, being 69 per cent. out of the total length between the Waterloo station and the City station.

NOTES AND MEMORANDA.

At the last meeting of the Berlin Physical Society Professor Des Coudres made a communication on kathodic radiation, and demonstrated its sensitiveness to magnetic lines of force.

According to the *Mittheilungen* of the Verein Deutscher Eisen and Stahl-Industrieller, the total outturn of pig iron in Germany, including spiegeleisen, forge, Bessemer, basic, and foundry pig, and also castings run directly from the blast furnace. amounted last year to 5,788,798 tons against 5,559,332 tons in 1894, showing an increase of 229,476 tons.

One of the first surgical operations in which the diagnosis has been made by means of the Röntgen rays was performed in Berlin last Sunday. The patient got a piece of needle into her hand two months ago, and suffered very severe pain. With the help of a Röntgen photograph the exact position of the fragment was ascertained, and the operation was perfectly successful.

In a paper on "Dark Light," before the Paris Academy of Sciences, by M. Gustave Le Bon, it is described how an ordinary photographic dry plate, placed under a negative in a printing frame, and the negative closely covered with a thin plate of iron, was exposed to the light of a paraffin lamp for three hours, and after prolonged development brought out a faint but well-defined image. If a plate of lead was wrapped round the back of the frame, and bent over the edges of the iron plate so as to enclose the printing frame in a metallic box, after three hours' exposure to the same source of light, an image was obtained "which was nearly as vigorous as if no obstacle had been interposed between the light and the plate." M. Le Bon proposes to continue the study of the properties of light after its passage through opaque bodies.

There are about sixty-three cement works in the whole of Germany. The Rhine is the principal centre for this manufacture, but in the neighbourhood of Hamburg there are three or four in operation for the production of the article. The annual production of Germany amounts to nearly 11,000,000 barrels, giving employment to some 1800 hands, whose annual earnings amount to some £698,780. The largest customers for this article in Europe are Russia and Norway, and of transatlantic countries, the United States, Brazil, Chili, and Venezuela. The exportation to Great Britain and British Possessions is comparatively small. The following table gives approximately the quantity and value exported to European and other countries:—Norway, 58,500 cwt., £6700; Russia, 34,353 cwt., £2900: United States, 1,386,872 cwt., £168,000; Brazil, 446,340 cwt., £40,200; Chili, 131,000 cwt., £13,000; Venezuela, 103,000 cwt., £9800.

Professor Neesen described recently to the Berlin Physical Society two interesting strokes of lightning, one of which pierced the roof of a church tower unprovided with a conductor, and stopped short at the organ. Its effects were characterised by the rents it made in the inside of the church above the organ, similar to those observed in a tree when struck. The second struck a petroleum store, whose four tanks were each protected by five-pointed conductors adequately put to earth. Two of the tanks were completely shattered by a violent explosion, the other two burnt out by fire. The speaker was of opinion that the petroleum vapours above the tanks had been ignited by small sparks during the discharge, and he had verified this view by experiment; he therefore proposed that, for the purpose of adequate protection, all openings, more particularly manholes, should be guarded by wire netting, on the principle of the Davy lamp.

Great Britain is still the largest producing country of tin ore in Europe, although her ore only contains on an average about 2½ per cent. of metal, requiring much washing and concentration. As regards Europe, observes the report for 1895 of the Liège Chamber of Commerce:—"For a long while past tin has only been worked to a profit in the mines of Cornwall, Saxony, and Bohemia; and latterly new lodes have been proved, some of which already make considerable additions to the general production. Some deposits have been found in Spain, in Gallicia, and especially in Orense, these deposits continuing into Portugal; and, during the last few years, tin has been mined near Oporto and Braganza. France possesses a few tin mines, but their ore is poor, and the Montebras mines in La Creuse are no longer worked for tin ore." If the other countries make no more profit from the working of tin ores than is now made in Cornwall they will soon close some of their workings.

In one of the Fine Art Society's galleries Professor Herkomer is exhibiting a series of some thirty specimens of a new process of his own invention, by means of which autograph sketches by an artist can be indefinitely reproduced by copper-plate printing. The process is simple. According to a description published in the *St. James's Gazette*, the design to be reproduced is painted by the artist upon a plate of copper surfaced with silver; the pigment used is black and oleaginous; its composition a secret of Professor Herkomer's; the painting is transparent, the silver ground being left for the high lights, and only semi-obscured in the half-tones. When completed the design is granulated by sprinkling it with a powder which adheres to the plate in varying densities corresponding with the tones of the design. From the plate so granulated in relief a matrix in intaglio is obtained by electrotyping, and this can be put into the press and printed like an ordinary copper-plate.

According to the latest returns for the year 1893-94 regarding the expenditure of the highway authorities in rural districts in England upon main roads and ordinary highways, the sum spent was £1,992,786. The amount raised by rates to meet this outlay was slightly higher than it has been since the whole cost of maintenance was thrown on the County Councils in 1888-1889, although it is less than the old rate. The rateable value of the highway districts and separate highway parishes was £52,683,540, and as the amount raised was £1,520,510, the average charge was equivalent 6·9d. in the pound. The aggregate length of the roads under the supervision of highway boards and surveyors of highways in England and Wales—excluding 14,697 miles of main roads repaired by the County Councils themselves—was 105,330 miles. Main roads cost on an average from £45 6s. to £72 16s. per mile to keep in repair every year, and ordinary highways from £14 6s. to £19 10s. a mile.

The topographic and hydrographic survey of Chatham county, Georgia, which was started in 1890, and afterwards discontinued, has, *Engineering News* says, recently been resumed by placing a large corps of engineers in the field. The object of the survey is to establish a basis from which the work of draining large areas of swamp land can be carried on. The whole of the county lies but little above water level—the highest point being but 60ft. above mean low water, as established by the U.S. Coast and Geodetic Survey—and with proper ditching and the construction of tide-water gates much land now valueless might be used for farming purposes, and particularly for rice growing. As a basis of operations a principal meridian and parallel were run, crossing each other at the City Exchange, of Savannah, Ga., and dividing the county into four unequal parts. From the intersection as a zero point meridians every 3000ft., and parallels every 2000ft. run, with a transit, and then levels taken. Meander lines are then run along roads, streams and swamp lines. The surveys being transferred to topographic sheets, give lines of drainage with great accuracy, and enable the location of the tidal gates. A part of the county has already been ditched and drained and further and quite extensive work will follow the present surveys. The work is done by the County Commissioners, who use convict labour mostly. M. Geo. W. Brown is chief engineer, and Mr. Hayward Ranuel is assistant engineer.

MISCELLANEA.

The Administration of the Province of Amur is adopting measures for the development of steam navigation between the port of Vladivostock and the ports of China and Japan.

The British Association of Waterworks Engineers has been formed, and the address of the Association is, we are informed by the secretary, Palace-chambers, 9, Bridge-street, Westminster, S.W.

The Sheffield Gas Company has intimated a reduction in the price of gas of 2d. per 1000 cubic feet to all classes of customers. The benefit to the consumers of gas will be £15,029 per annum, and to the Corporation for public lamps £1241 per annum.

Among the measures which have been prepared, and will be submitted by the Government this session, is one for facilitating the construction of light railways in the United Kingdom, and for amending the law with respect to the supply of water to the metropolis.

The death took place, on Saturday, of Mr. John Gunter, of Middlesbrough, who was at one time works manager of Messrs Dorman, Long, and Co.'s Britannia and West Marsh Iron and Steel Works, Middlesbrough, and afterwards of Sir Theodore Fry and Co.'s Rise Carr Ironworks, Darlington.

The *Gazette* of the 11th inst. publishes an Order in Council, dated the 8th inst., rescinding the regulations of January, 1893, relating to the screening of ships' side-lights at sea, and reviving in its original form Article 3 of the regulations contained in the schedule of the Order of August 11th, 1894.

We are requested to state that the arrangements are now complete for lighting in the evening the "Southern Galleries" of the South Kensington Museum on the west side of Exhibition-road, which contain the collections of machinery and naval models. These galleries will be open free to the public from 17th February on three evenings a week—Mondays, Tuesdays, and Saturdays, till ten p.m.—in the same manner as the main building.

It is stated that the Niagara Falls Power Company, on January 14th, accepted the grant approved by Mayor Jewett, and that it may be expected that within a year or so, electric current, generated by the Niagara Falls, will be transmitted to Buffalo for lighting and power purposes. The contract entered into, which covers a term of sixty-six years, requires 10,000-horse power to be furnished on or before June 17th, 1897, and an additional 10,000-horse power per year for four years thereafter.

The librarian of the Patent-office of the United States of America is making a collection of illustrated and other trade catalogues, price-lists, circulars, and other similar publications for reference by those instituting inquiries in regard to patents, designs, and trade marks, or making use of the Patent-office library. In reply to a letter from the London Chamber of Commerce, urging that a collection of illustrated and other trade catalogues, price-lists, and similar publications should be made and filed in our Patent-office library, Sir H. Reader Lack, the Comptroller, has written that the nucleus of such a collection was formed some twenty years ago, and has since that date been gradually extended. In view, however, of the suggestion of the London Chamber of Commerce, he will be happy to consider how far it may be possible to render this collection more complete, and to make it more easily accessible for public reference.

The economy of electricity as a means of power in connection with mining engineering was well illustrated at a meeting a few days ago, at Mason's College, Birmingham, of the South Staffordshire and East Worcestershire Institute of Mining Engineers, when Mr. L. Meachen, jun., supplemented his paper, read at a former meeting, on the new electric power plant at Haden Hill Colliery. This plant has now been at work about six months. The total cost of the installation was £2289, while a steam plant would cost £1089 less; but, on the other hand, they had the advantage of light, and a saving of £73 per annum in candles, and a saving of £30 per annum in lights on the bank. Altogether there was a saving of £102 per annum. Taking other considerations into account, the result of the change was a net reduction of cost equal to 3¼d. per ton, or on the output £40 per week. The cost of abour in connection with the installation was ·47d. per ton.

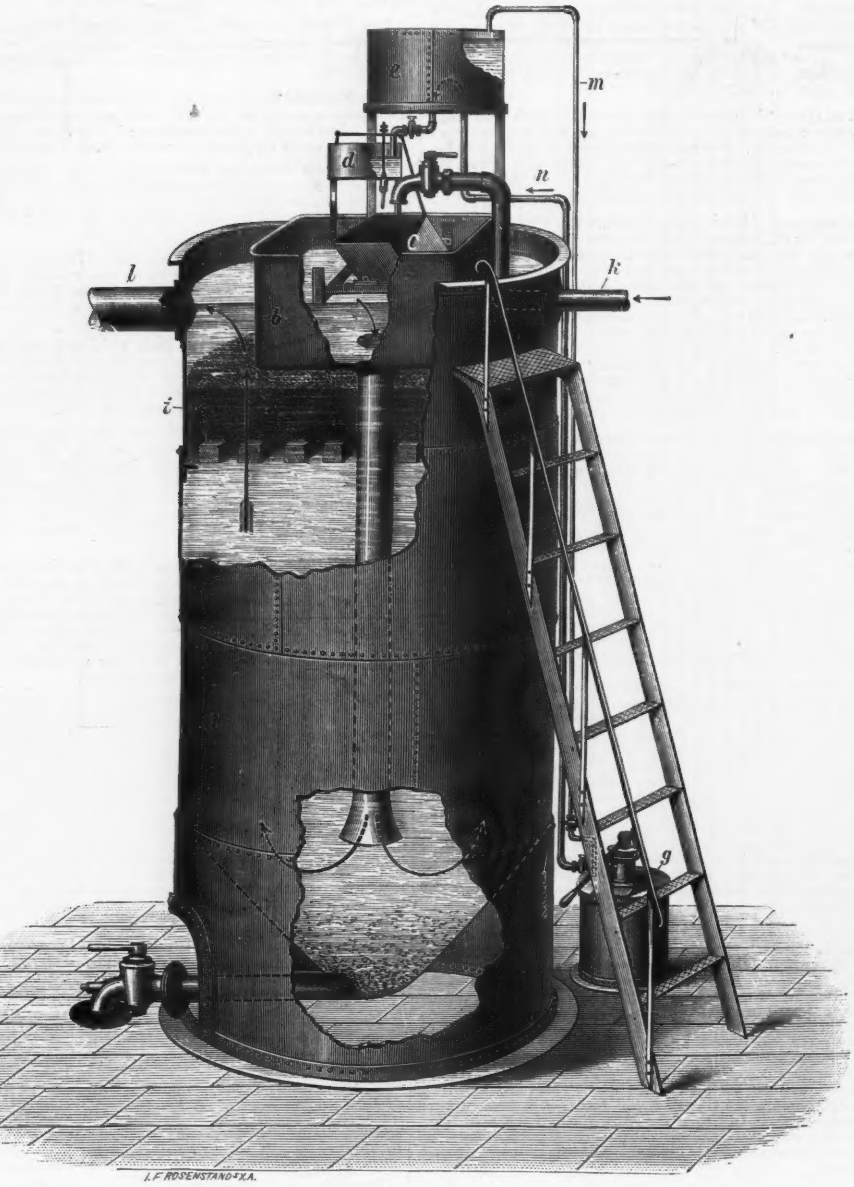
Speaking of the "marking" mania, the *Journal* of the London Chamber of Commerce says, "The Merchandise Marks Act of 1887 was passed with the object of protecting the purchasing public from fraud through false representations and descriptions, and it provides that any representation or description must be true. Hereupon the conclusion was hastily jumped at that the Act compelled the marking of all imported goods capable of being marked with the name of the country of origin. The Act compels nothing of the kind. The Customs have no power, because the Act does not confer it, to interfere with imports of 'blank' goods, whether these be textile stuffs, hardware, or what not. Where no marks appear, therefore, there is no room for qualification, and Parliament has not yet considered it desirable or necessary to introduce wholesale and all-round compulsory marking. So far, therefore, as trade has been lost to German houses by unnecessary disclosures of origin, the loss is due to the over-anxiety either of the producing house or of the agent here."

In concluding an article on the late so-called "water famine," the *St. James's Gazette* says:—"The Progressives threaten to reopen the question in the House of Commons. No course could give greater satisfaction to the other side, for the more the facts are investigated the more uncompromising will they appear. If a dozen inquiries were held they could lead to no other conclusion. But in the House of Commons there would be an opportunity of going into a point which is lightly passed over by the Government inspectors, which came out at the inquiry. A most damning indictment, to which no answer was attempted, was laid against the County Council for its share in this business. It was proved, point by point, that this public body not only opposed the necessary works, which would have averted the scarcity of water, but in doing so acted with deliberate dishonesty. It concealed a certain important document from its own engineer, who must otherwise have materially modified his own expert opinion on the question. This will be a very pretty story to air in the House of Commons, and it is to be hoped that the Progressive threat will be carried out and the requisite opportunity given."

The Swansea Corporation has decided to adopt a scheme of refuse destruction, electric lighting, and tramcar propulsion. It was decided, before the work was begun, to take the opinion of Mr. Preece, C.B., and he has reported:—"I have carefully considered all that has been said against the proposals of the town council, but I have come to the conclusion that the corporation would be quite safe in adopting Mr. Manville's several recommendations on their own individual, intrinsic merits. Each part of the so-called triple scheme is practical and promising. They mutually support each other for the benefit of the ratepayers. The price charged for the light could be reduced to a figure below that of any other town in the United Kingdom. The demand for the light must consequently increase and the number of lamps fixed would soon exceed the comparatively small number proposed to be installed by the town council. Swansea would become a pioneer town. Its inhabitants would benefit by having better transit, purer air, and cheaper light. Its finances would be improved by the profits that would arise from the successful administration of those purely local and municipal industries which the Legislature has decreed should be in the hands or under the control of the ratepayers themselves."

BRUNN'S AUTOMATIC FEED-WATER SOFTENER

MR. P. SCHAU, MANCHESTER, ENGINEER



AUTOMATIC FEED-WATER SOFTENER.

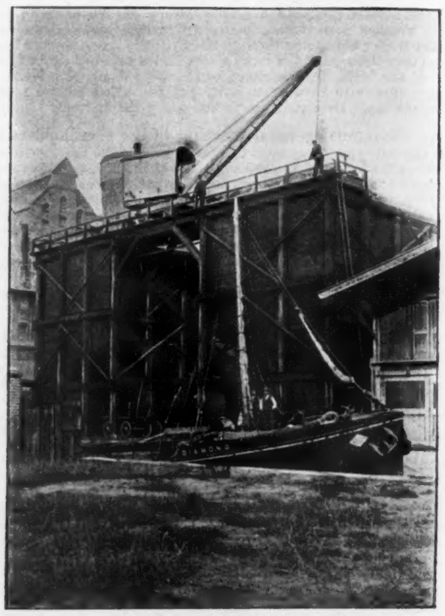
The accompanying engraving illustrates a form of water softener, with automatic arrangements for delivering and mixing the softening materials in the water to be treated. The water to be treated is led through the pipe *k*, into one of the chambers of the oscillating receiver *c*, and when this chamber is filled the centre of gravity is removed, and the receiver tips over in such a manner as to pour its contents into the mixing tank *o* below, bringing the other chamber of the receiver below the orifice of pipe *k*. To the receiver is fixed a system of levers, which at every oscillation actuates a valve fixed on the bottom of the holder *d* in which the chemicals are contained. As the movement of the valve at *d* can be regulated, any given quantity of chemicals is by this arrangement mixed with the water. The impurities are precipitated to the bottom of the tank *a*, while the pure water ascends through an intermediate filter *i*, consisting of wood-wool, and leaves the apparatus through the pipe *l*. The precipitated impurities are removed by the cock *f* every four to six weeks, and the filter material is taken out at the same intervals to be cleansed, and can be used repeatedly. The chemicals are, by means of the pump *g*, pumped to the top of the apparatus, thus saving time and labour. The apparatus is also made in a smaller form by the manufacturer, Mr. Paul Schou, 6, St. Mary's-gate, Manchester, and they are made under Brunn's patent.

STORAGE OF COAL IN HOPPERS AT BATTERSEA.

The coal storage hoppers illustrated by the engravings on page 163, and by the engraving annexed, have been erected from the designs and under the superintendence of Mr. Percy W. Symmons, Assoc. M. Inst. C.E., London, for the Sea Coal Company, at Ransomes Dock, Battersea, for the purpose of receiving and discharging house coal brought from canal-side collieries by sea-going lighters. The lighters are constructed to carry about 350 tons, and are capable of navigating canal or river as well as putting out to sea. The widening of locks in the Aire and Calder Navigation, West Yorkshire, has made it possible for the lighters to be berthed alongside the colliery staiths or screen-shoots to receive their cargoes, thereby saving the serious breakage made at the ports of shipment by steamers. When loaded the lighters are towed back to sea to be picked up by a steam collier bound for London. The disadvantages in the use of sea-borne coal are, that owing to the four trans-shipments it receives from the pit's mouth to the consumer's cellar, the size is much reduced, and the condition altogether deteriorated. By direct shipment into sea-going lighters these drawbacks are avoided, and river-side merchants are able to deliver to the consumer coal equal in size to that conveyed by rail. The past twelve months' working of the lighters proves that there is a great future before them, that their adoption was no reckless venture, but a bold attempt to solve a difficulty which has troubled the seaborne traders and rendered it hard for them to compete with their railway rivals when the size of coal was the chief factor in the business. It must, however, be borne in mind that the successful working of the lighters depends entirely upon a sufficient number of quick steamers fitted with towing apparatus to take them to and fro. A powerful steam tug was employed to bring the lighters round the coast when they were first started, but the towing colliers were found to be superior. Another fact worthy of mention is that it is hazardous to bring coals from the Durham collieries by lighter during the winter months owing to the exceptionally rough weather experienced north of Spurnhead.

The hoppers.—They are wooden structures made up of 12in. by 12in., 12in. by 6in., and 14in. by 7in. creosoted pitch pine timbers for the framework, which stands on forty-four cast iron columns 10ft. high from the ground, the bottom and sides being made up of 4in. and 3in. planking. The hoppers have three divisions 33ft. 6in., 23ft. 6in., and 16ft. in length, with a uniform breadth of 29ft. and are capable of holding 1000 tons of coal. The columns stand on brick piers, which are built of London stock bricks set in cement, and are secured by four 1¼in. bolts 2ft. 3in. long attached to cross bearers built into the brickwork of the piers. These piers stand on a bed of concrete 5ft. square and 3ft. deep, consisting of eight parts of ballast to one of Portland cement. The framework of the hoppers is braced together with old iron rails, and the inside receives additional support from two tiers of angle iron stays, which are bent round and securely bolted to the uprights. The bottoms of the hoppers slope down to a point from the sides at an angle of 30 deg. one side and 20 deg. on the other, and are supported by two 14in. by 7in timbers, to which the 4in. planking is secured. These timbers are fastened to the 12in. by 12in. uprights, and they also rest on a bracket made out of a 14in. by 7in. timber, which is secured by bolts to the uprights. This sheet iron is fastened along the bottom of the hoppers to enable the coal to run with freedom, thus doing away with any trimming of the coal towards the mouths of the shoots by the aid of men inside the hoppers. There is a crane road running along the top of the hoppers parallel with the dock frontage, upon which is placed a steam locomotive crane, which unloads the coal from the lighters and discharges into hoppers. Openings, ten in all, are constructed at the bottom of the hoppers, and a combined shoot and screen is fixed below each. The screens—which were specially designed by Mr. Symmons—are fixed underneath the shoots, being 5ft. long by 2ft. 6in. wide, and can be altered as required from ⅜in. to ⅝in. mesh. A loading bench in two tiers is constructed beneath the hoppers, the back bench being closed with match-boarding to keep the coal dust from spreading. Underneath the mouths of the shoots is a bench for the scales, and the lower bench is for the man who takes the sack from the scales into the carts, which are backed up to this bench in between the columns. There is a space for thirteen carts to be loaded at a time, and this can be done at the rate of 120 tons per hour. The loading into the hoppers from the lighters—by the aid of the one crane—can be done at the rate of 30 tons per hour. The actual saving per ton by using these hoppers is small, but they have the advantage of turning out five times as much work, and work can be carried out in any state of weather.

Steam crane.—This crane was constructed by Messrs. Grafton and Co., of Bedford, and is nominally of five tons power. The carriage—which is built up of rolled steel girders—is mounted upon four steel tired wheels, 2ft. 4in. diameter, spaced for 7ft. gauge, and the centres of axles are also 7ft. apart, so that the crane is equally stable in all four directions. The superstructure or revolving portion is of a new type, inasmuch as it has no central pillar, but revolves on four friction rollers placed on axles radiating from the centre. The centre pivot is a massive steel bolt 5in. diameter, provided with a steel nut and gun-metal washer under the head, which anchors down the revolving portion to the under carriage. The engines have two cylinders 7in. diameter by 10in. stroke, placed horizontally and driving on to a steel double-throw crank; they are fitted with link motion and gun-metal straps. The crane has four motions, namely, hoisting, slewing, derricking, and travelling; they can all be worked simultaneously, although it is very seldom required to do this, as the crane is usually placed in such a position that it will plumb both the lighter and the hopper in some portion of the circumference of the circle described by the jib. The jib—which measures 33ft. long—is made of light steel girders, trussed and braced, and is arranged for working at a radius of 30ft., or any shorter radius that may be found convenient. The boiler is of the vertical cross water-tube type, 7ft. 6in. high by 3ft. 6in. diameter. Placed beneath it is a tank which contains about five hours' supply of water, the boiler being fed by a pump driven direct from the crosshead of one of the engines; there is also a donkey pump as a standby or auxiliary, when the engines are not being worked; the exhaust steam is taken into the chimney. The working pressure of the boiler is 80 lb. The whole of the levers controlling the various motions of the crane are brought into a convenient position immediately in front of the driver, so that he can, without taking his eye off the load, move any lever in any direction required and with the least amount of effort. All the shafts of the crane are steel, the derrick and travelling gear wheels are also of steel, as well as the pinions for the hoisting and slewing gear. The speed of lift is 200ft. per minute, and the speed of slewing 600ft. per minute, and by a special arrangement of loose frictional roller path, the crane can be stopped or started without any surge or jerk. The total net weight of the crane itself is 18 tons, coal and water about 2 tons, and receptacles are provided for ballast of scrap iron to the extent of 4 tons or 5 tons, or 25 tons in working order.


COAL STORAGE HOPPERS, BATTERSEA

THE MAINTENANCE OF ROADS AND STREETS IN SUBURBAN TOWNS.

In a recent paper read before the Township of East Orange, U.S.A., Improvement Society, Mr. W. S. Bacot, C.E., called attention to the great expense and poor results of the present system of cleaning and maintaining the roads of suburban districts, and described a systematic plan for efficient and economical work, which he recommended for adoption by the East Orange Township.

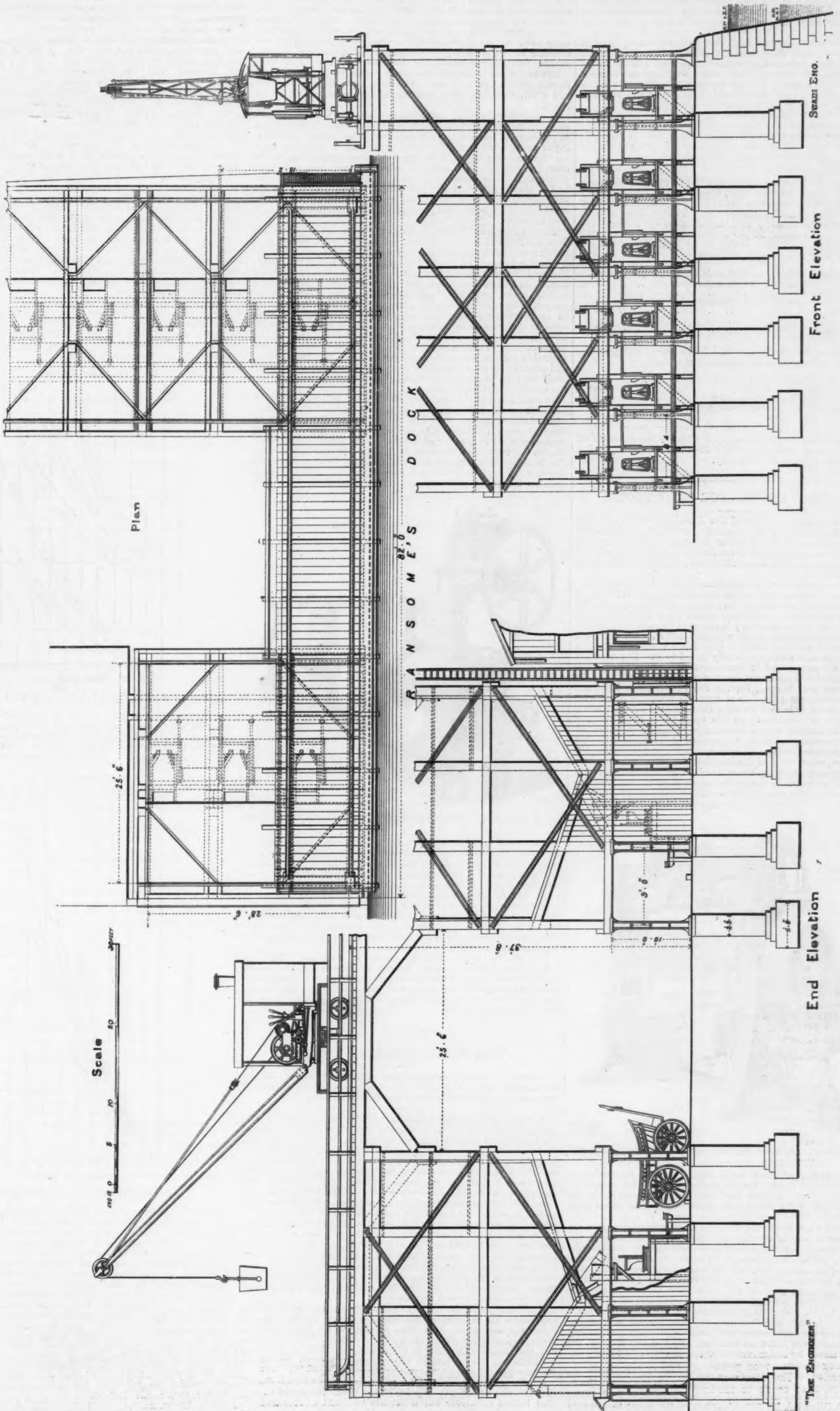
There should first of all be an energetic man and a good engineer appointed as commissioner of streets and sewers, with full power and ample means, and he should be held responsible for the expenditure of the money and the work done therewith, but he should not be hampered by political considerations. No breaking up of the street to excavate for sewers, gas pipes, water pipes, &c., would be allowed except upon his permit, and the permit would only be granted upon a deposit being made to ensure the proper restoration of the road and the road surface. He would have under him an assistant engineer to do the engineering and surveying work of the department, and an inspector of roads who would supervise the repair and construction work, inspect the condition of the entire system of roads, direct the work of the block men, and generally supervise the outdoor work of maintenance, cleaning and renewal, besides keeping the necessary records and making periodical reports to the commissioner.

The township authorities are charged with the maintenance of 30 miles of improved streets and roads with Macadam and Telford paving, and it is recommended that 10 miles should be maintained

COAL STORAGE HOPPERS, RANSOME'S DOCK, BATTERSEA

MR. P. W. SYMMONS, ASSOC. M. INST. C.E., LONDON, ENGINEER

(For description see page 162)


Plan
RANSOME'S DOCK
Front Elevation
End Elevation
Scale
25.6
28.6
82.0
37.6
9.6
10.6
SHARP ENG.
"THE ENGINEER"

on the block system, while a central force—divided into small gangs for street cleaning and light repairs, and into larger gangs for reconstruction work—would attend to the maintenance of the other 20 miles, and to the periodical renewal of road paving on the entire 30 miles.

There would be fifteen block men, each having a beat or section of two-thirds of a mile, which he would patrol, keeping it clean and in order, making continual light repairs to prevent ruts or holes, &c. Each man would be equipped with a wheelbarrow or push-cart, a short square shovel, a street broom, a large hoe, a rake, a pickaxe, and an iron tamp or rammer. The annual cost would be as follows:—

	£
Fifteen men at £72	1080
250 cubic yards stone at 6s. 5½d.	80
Incidentals	40
Total per year	1200
Total per mile per year	120

The average width of the paved part of the roads is 24 yards, giving 15,000 square yards per mile, which must be renewed every five years, the wear being estimated at ½in. per year, and the limit of wear not being allowed to exceed 2½in. As the 2½in. of wear would require to be renewed with 3in. of stone—as rolling compresses the loose material 20 per cent.—the amount of material required per mile for reconstruction would be 1250 cubic yards. The cost may then be estimated as follows:—

	£
1250 cubic yards of stone delivered, at 6s. 5d.	400
Picking or "stocking" the surface, 15,000 yards	15
Rolling 15,000 yards, at ½d.	30
Spreading stone, screenings, and binding material, at ½d. ..	30
Incidentals	25
Total for repairs for five years	500
Total for repairs per mile..	50

In addition to this, the cost would be increased £120 per mile for ten miles, so that the total estimate is as follows:—

	£
10 miles cleaned and repaired at £220	2200
20 miles general repairs at £100	2000
20 miles cleaning by central force at £20..	400
Incidentals: Gutters, basins, ditching, drains, &c.	400
Total	5000

The central force would be equipped with the proper outfit of tools for the men, and also with a 10-ton steam roller, and a sprinkling cart of 600 gallons capacity.

ELECTRIC MOTORS FOR SHOP TOOLS.

DURING the annual meeting of the American Society of Civil Engineers, held in New York in January, a visit was paid to the new works of the Crocker-Wheeler Electric Company, on the Delaware Lackawanna and Western Railroad, where the tools and machines are driven by independent motors, thus eliminating shafting and long belts.

As described in the society's programme, the principal engineering feature is the electrical power transmission system which is employed throughout, whereby the power required to operate the works proper is reduced to 25-horse power from 100-horse power estimated. All of the machinery is operated by individual motors built into each machine, or by separate motors, each driving a single length of shafting, which in turn drives as many of the old-style machines as can be conveniently belted to it. The result is, first, that all power used in connection with these machines is stopped whenever the machine is out of use; and second, that the works are free from belting, leaving them remarkably light and clear for handling material. As most of the tools are fitted with their own motors, it is easy to shift them from place to place if required, as it is unnecessary to line them up to any system of shafting. In addition to the remarkable reduction in power required for operating the plant, this method of driving gives a shop system of great flexibility. This was well illustrated during the past summer, when many of the company's machines were operated in their original positions in the ruins of the old works which were burned, under temporary covers, by means of temporary wires run to the motors built in them. The machines were afterward, from time to time, moved from one position to another, as the work on the new buildings required, being kept, however, in continuous operation day and night. By this means the company turned out 20 per cent. more product last year than ever before in its history, in spite of the fact that for three months the entire plant was in ruins.

FIG. 1.

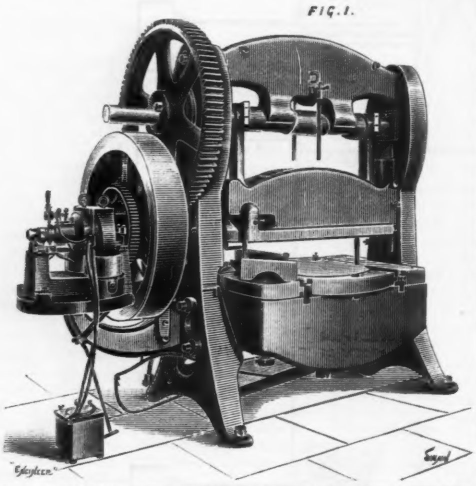


Fig. 1—HEAVY PUNCH PRESS, WITH ELECTRIC MOTOR

The lighting and power for the plant are supplied by a 150-horse power Corliss engine driving an 80-kilowatt dynamo in the detached power-house. The current is conducted from the power-house by a pair of cables through an underground tunnel—which also carries the heating pipe and the cables for experimental work—through the cellar of the office building, thence rising from a manhole under the floor of the main shop and running along under the roof on ordinary trolley line insulators to about the centre of the shop, where they terminate on suitable slate panels. From these branch out four sets of wires carried in a similar manner along the roof trusses, and extending through and feeding the four quarters of the main building. By this arrangement the supply of power for either section of the shop can be readily discontinued by opening a small switch.

From the switchboard run also the circuits for supplying the other buildings. The branch connections from the main circuits are carried down the inside of the cast iron columns of the building to a point about 6in. below the surface of the floor; thence they are carried along through small wooden troughs, which were laid for this purpose in the concrete, straight across the shop close to the bases of each pair of columns, or 10ft. apart. The wires are brought up from the troughs through the floor wherever connections are desired, through 1in. holes bored through the flooring. The wires pass into and out of the centres of the columns through small hand holes cast in them near the top and bottom. The columns are supported on cast iron bases resting on suitable masonry foundations, but the joints between the columns and their bases are about 1ft. above the shop floor, to facilitate the levelling of the columns by wedging, if it should ever become necessary to preserve the level of the overhead crane track.

The king posts of the roof trusses are extended upward so as to furnish posts for the roof sign. The main building is 100ft. wide, and 450ft. long, the office building adding another 50ft. to the length.

In the construction of the buildings it was decided to use a floor heavy enough for the foundations of any machinery it was desired to put down at any part, and which would also permit the carrying of heavy loads on roller trucks, rather than to introduce hand car or industrial railway tracks, since this would greatly cut up the floor, and could not be arranged to reach every part and avoid interference of two cars on one track. The floor consists of 4in. by 6in. chestnut sleepers laid in Portland cement concrete, with a finishing coat laid on by trowel and treated on top with tar. On this is laid 2in. spruce planking, and on this 1½in. finished maple floor boarding.

The ordinary construction for the side trusses of a roof was also departed from, in order to furnish trusses the lower members of which would be strong enough to support trolleys for travelling hoists of a capacity up to four tons, and it was found by Messrs. Post and McCord, the engineers of the building, that by the use of 15in. light I beams—or rolled joists—for the under members of the lean-to trusses, and a very light angle iron for the upper members supported by vertical pieces of angle iron, the roof trusses could be made with very little increase of weight, and with a lower member that would easily carry a large and powerful hand hoist. These roof trusses are 10ft. apart. The same principle was applied to the roof of the engine-room in the power-house, where it was desired to support a six-ton travelling crane on the roof trusses, and extend over a stretch of 45ft., or four trusses, as this would avoid the presence of any columns. The main shop has a fifteen-ton electric travelling crane.

The office building is designed with special reference to facilitating the work of the engineering department and the management of the company. The general offices and the office of the chief engineer and assistants are on the main floor, with connection directly to the floor of the shop. The workmen's entrance, also on this floor, is so arranged as to make the men pass through the book-keeper's department. The second floor contains the drawing office, blue print and photographers' rooms, library, and the toilet and locker rooms. The third floor will be for assistants and storage. One-half of the basement is arranged for a laboratory for such experimental work as it is desired to carry on without disturbing the shop; the other half is for bicycles used by the employés. Up through all of the floors extends a fire-proof vault about 10ft. square, with arched brick floors and air spaces on all sides for the reception of the records on each department.

FIG 2

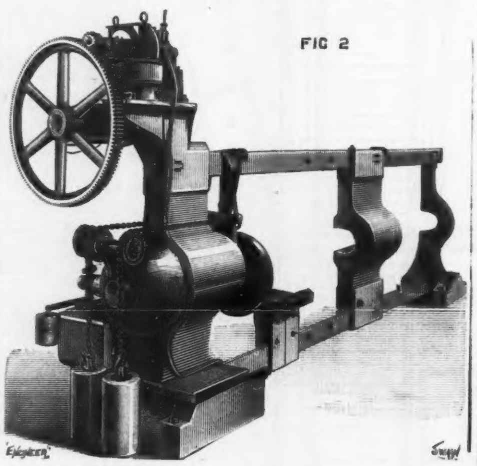


Fig. 2, HYDRAULIC ARMATURE PRESS, WITH ELECTRIC MOTOR

The entire plant is new, having been rebuilt last summer on the site of the old works occupied by this company. The new buildings are of the modern "slow-burning mill construction," and have been erected practically in accordance with the plans of the New England Mutual Insurance Companies.

Two of the larger machine tools we illustrate. Fig. 1 is a heavy punch press, with the electric motor mounted at the side, the controller being shown on the floor. Fig. 2 is a hydraulic press for forcing together the plates of armatures, and the pump is driven by the motor mounted on top of the machine and geared to the spur wheel as shown.

HORSELESS CARRIAGE NOTES.

A DISPLAY of motor carriages and other road vehicles will be made in the North Gallery of the Imperial Institute to-morrow afternoon, under the auspices of the Motor Car Club.

A DEPUTATION, including members of the Self-propelled Traffic Association and others, on Wednesday waited on the President of the Local Government Board in a room at the House of Commons. Their object was to urge upon the right hon. gentleman the desirability of amending the Locomotive Act, or of introducing a new Bill to facilitate locomotion on highways, and it is satisfactory to find that the deputation adopted and supported the suggestions we have made as to the form the Bill should take.

Sir David Salomons, in introducing the deputation, said that they wished to amend the Acts which had been framed with a view to restricting the traffic of traction engines in the country roads, There had recently arisen on the Continent a system of horseless carriages. Such vehicles, it was believed, would be of great advantage in this country, particularly in agricultural districts, where they might be used to convey produce to the railways. The restrictions of the existing law prevented the development of this trade. He pointed out also the large industry which would grow up in the making of such carriages.

Mr. Thornton, of the County Council, stated that the Highways Committee was in favour of the proposed reform, and said that if there was one place more than another where these horseless carriages might be tried, it was in the metropolis. The Committee felt that some controlling power should be vested in the local authorities as far as London was concerned, though that might not be necessary outside the metropolis.

Mr. Shaw Lefevre said that his presence on that occasion showed that this was not a party question of any kind. He should be very glad indeed to render any assistance he could in forwarding a measure such as the one suggested. He believed that they were much behindhand in this important industry, and that continental towns were much ahead of them. The parts of the country most concerned in the matter were undoubtedly the rural districts. One must consider this a branch of the light railway question. Anything which would facilitate transit in and out of the country and the supply of the towns could not fail to be of enormous importance and value to the agricultural labourers.

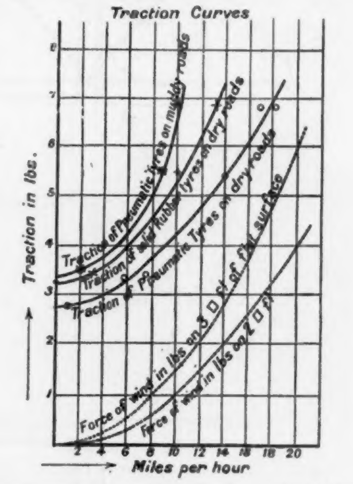
Mr. Chaplin in reply said, with regard to the object of the deputation he would not detain them long. He was in sympathy with everything which had been said. A Bill on the subject was now in an advanced stage, and he was quite in sympathy with it, and intended, with the assistance of Mr. Russell, to carry it through the House during the present session. With regard to the statement made as to the advantage these vehicles would be to agriculturists, he quite agreed. The Bill suggested possessed certain advantages which did not exist for the light railways. For instance, the vehicles referred to could go to every farmer's door, and this would be a decided advantage not only to agriculturists, but to other classes of the community. He hoped at an early period to introduce a measure which would meet the views of all the gentlemen who had been good enough to wait upon him.

The deputation withdrew after thanking Mr. Chaplin.

THE computation of the power necessary for working motor carriages will occupy the attention of some of our readers just now, and the following account of experiments sent us by Mr. Louis Barrow, of 61, Stirling Road, Edgbaston, will interest them:—

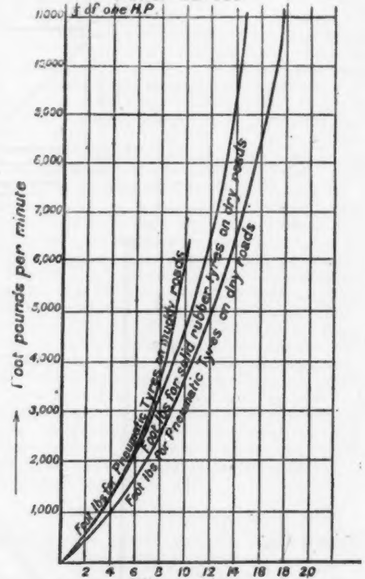
The curves shown herewith are derived from some experiments made a year ago upon half-a-dozen bicycles fitted with pneumatic, solid, and cushion tires, each weighing with their rider about 200 lb. The machines were run "free" down hill with feet on rests at a constant speed, and the traction was found by multiplying the gradient by the weight.

The method of conducting the experiments was as follows:—Suburban roads of even gradient were chosen having bench marks at convenient positions. Now if the incline is a long one, and the machine is started from rest, the velocity will accelerate until the resistances exactly balance the traction, after this point the revolutions of the crank were duly noted.



Curves showing Cycle Traction and Wind Resistance

In the next experiment, instead of the machine being started from rest, a flying start was made with the cranks revolving at the same number of revolutions as was attained in the previous experiment, the hill would then be descended at a constant speed. The time was now taken by stop watch for a certain distance.



Curves showing Cycle Propelling Power

General experiments were made on the same incline and the mean time taken—differences of more than 5 per cent. were rare. Distances and gradients were found from the new 6in. Ordnance maps. A second machine of the same kind of tires has sometimes given slightly different results. These points have been duly marked on the above curve. All the roads had a uniform gradient. Each point on the traction curves is the result of at least three separate tests on the same machine. Cushion tires were not perceptibly faster than solid, but the difference between these and pneumatics is considerable. Two curves for wind pressures—from Molesworth—for 2 and 3 square feet of flat surface are also shown, for the purpose of comparison with the traction curves.

If the traction is proportional to the weight, it would appear from the curves that the power required to drive a motor carriage of one ton—including passengers—along level roads at ten miles an hour would be 1·2-horse power if fitted with pneumatic tires, 1·6-horse power for solid rbbuer tires, and 2-horse power where a pneumatic tired vehicle is used on muddy roads. If it is required to ascend gradients of 1 in 20 at the same speed, the horse-power required is respectively 4·2-horse power, 4·6-horse power, and 5-horse power. The power required to drive the mechanism would have to be added to these results to obtain the total horse-power wanted.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

BULLHEAD RAILS AND FLANGE RAILS.

SIR,—I hope before long to present some new and interesting information on the comparative merits of the bullhead and flange section for rails, but in the meantime will answer one or two remarks in the correspondence column of THE ENGINEER of January 17th. It is, of course, true that deficiency in rail stiffness cannot be compensated for by close spacing of sleepers; but as even heavy rails will and do deflect, it is well to have such comparatively close spacing. As already noted, the modern type of American standard section is designed for a combination of stiffness and durability. As to the question of colonial railways, the traffic and the finances should enter into consideration; and it would be economically and morally wrong to expend money on the elaborate construction of a short length of railway that would have better served the interests of the community by being spent in opening up the country by greater lengths of railway. It is not right to impose an unnecessary capital cost for work whose benefit will be reaped only by "posterity," while the originators and first-comers have to pay the interest on this cost. It would certainly be wrong, for instance, to build the Mombasa Railway suitable for express trains and heavy traffic. As Sir Arthur Cotton says, in his "Public Works in India:"—"What is most wanted is speed; not in travelling on the railways or canals when executed, but in executing them." In other words, the underlying principle of colonial railways should be the construction of the greatest mileage at the least cost, and in the least time; "least cost" being, of course, considered in relation to the prospects of immediate or delayed increase in traffic. It is simply a matter of economics—not economies.

As to the remarks of "Railbed," if he will read my former letter on the rail question he will see that it is distinctly pointed out that the tie-plate is entirely different from a chair. The tie-plate is simply to protect the tie, and may be considered in the same light as creosoting or other preservative methods. It is not necessary with light traffic or with hard ties, but with the bullhead rail a chair is required in any case to support the rail, the rail having no stability in itself. Thus the standard track of the South Australian Government Railways consists of 80 lb. flange rails, on wooden sleepers so hard as to require the boring of the spike holes, and rendering tie-plates unnecessary.

In regard to the reference of "Sextus" to the question of stiffness, I may say that while the London and North-Western Railway 90 lb. bullhead rail is 5¾in. high, there are here in use 80 lb. rails 5⅝in. high, and 100 lb. rails 6in high. Height, however, is, of course, only one consideration, but I have not yet had time to more closely compare actual sections. I may say, however, that with a somewhat extensive observation of railway track, I have never found any track—certainly not in England—to compare with the remarkably smooth and easy riding track having 100 lb. American flange rails. It is, as one engineer has said, like riding on a billiard table. Your correspondent says that flange rails have been tried in England and have failed. That, however, judging from the sections, has been due to the fact that the sections were not of such good design as to give the best results. The same is true of many of the older American sections, but in this discussion I have been dealing with the modern sections.

E. E. RUSSELL TRATMAN, C.E.

New York, January 31st.

SEWAGE DISPOSAL AT SALFORD.

SIR,—Having read the article in your issue of the 17th ult., upon "Sewage Disposal at Salford" and Mr. Corbett's scheme for the purification of the sewage of the borough, and having studied the question of sewage purification for a number of years, permit me to make a few observations upon the mode intended to be pursued in the proposed new works at Salford.

First, Mr. Corbett proposes to use chemical precipitants which will cost 31s. 5d. per million gallons. This is a very serious item, and in addition there is the cost of the washing machinery, and the working expenses attached thereto, used for the purpose of cleansing the filtering media, &c. The effluent he will get from this costly chemical and mechanical mode of working will, I venture to say, be far from satisfactory, either to himself or the Corporation.

Let us here examine the question of precipitants. In all sewage there is an ever-varying amount of matter in suspension, and which it is important to get rid of; in order to do this he proposes to add so many grains of a precipitant costing, as before stated, 31s. 5d. per million gallons; but in doing this he not only adds to the weight and bulk of the sludge to be dealt with, but makes it worse to deal with than if it were left alone, and also destroys any manurial value that may be in the sludge.

Secondly, Mr. Corbett proposes in his filters to use a material that would need constant attention, and when foul require to be washed in the sand-washing machines, and thus all foul matter that has been arrested by filtration he gets back again; it is working in a circle. Mr. Editor, what becomes of the "washings" from the filters? Do they not go back again into the sewage tanks, and thus the sewage becomes worse and harder to treat than before?

Mr. Corbett is right when he throws cold water upon filtering media, such as polarite, magnetic carbide, magnetite, and the like; but why not carry this reasoning a little further, and do away with chemical precipitants as well as the other "media"? I will endeavour to point out a material made from town's refuse that will obviate all this washing, and at the same time deodorise and decolorise the sewage without any precipitant whatever. I refer to the "carbonised refuse system of sewage purification, combining therewith the disposal of town's refuse." This is a method of purification unequalled by any other as yet devised, and consists in making the town's refuse purify the town's sewage; or in other words, using one nuisance to abate another. At first sight this would appear to be well-nigh impossible; but it is well known that all town's ashpit refuse contains a large percentage of animal and vegetable matter, to carbonise which is to convert it into charcoal, and thus not only is a cheap and efficient filtering medium obtained, but the first and annual cost of destructors and such-like methods of disposing of refuse is entirely obviated.

The process may be briefly described as follows:—The refuse is deposited in specially-constructed carbonisers and brought to a red heat, so that no matter how foul the material may previously have been, it will by this process not only become thoroughly purified, but be converted into the most valuable filtering material that can be produced. It is screened into four grades, the second, third, and fourth sizes—consisting principally of small, medium, and large cinders—are used in two ways, viz., (1) as preliminary filters or screens, by means of which the sewage is deprived of the bulk of its suspended matter; (2) as the under-layers of filter beds supporting a top one of the first screenings, being the carbon powder used in the filtering—deodorising and decolorising—medium, and in, to, and through which the previously clarified sewage is run; a clear and inodorous effluent issuing therefrom, capable of sustaining fish life.

The filters are capable of dealing with every description of polluted fluids, domestic or factory. As no lime or other precipitating agents are employed, the sewage is not robbed of any of its fertilising properties, nor is the effluent poisoned by noxious chemicals, and what is of still greater importance, there is no increase in the volume of sludge, which consists of settlings only. The impurities in the sewage are arrested either in the preliminary filters, or on the surface of the filter bed, and when the former become choked they are allowed to drain, and the contents re-carbonised. When the filter bed becomes choked, the flow is diverted, the bed drained, the impurities deposited are scraped off, and after resting awhile a fresh layer of carbon powder is laid on, and there is practically a new filter ready again for use. The scrapings are in a comparatively dry and portable condition, and can be either used for fertilising purposes or re-carbonised and used over again.

In conclusion, I put works down on the above system for the—then—Baildon, near Bradford, Local Board, and the results obtained cannot be surpassed for efficiency and economy.

Leeds, February 6th. W. SHAW DUNCAN, Civil Engineer.

SLIDE VALVE FRICTION.

SIR,—Referring to my letter on the above subject in your last issue, and your remarks with reference to the presence of steam between the slide valve face and its seating, I beg to thank you for honouring me by an editorial note to my letter.

I was aware at the time I wrote that steam does insinuate itself between the valve and steam chest facing, but considered that such steam would be squeezed out owing to the superincumbent pressure and the motion of the slide; in fact, Professor Unwin in his 1877 edition of "Machine Design," page 266, refers to this question as follows:—"But it is possible that the steam may insinuate itself partially or over the whole extent of the faces of the valve which are in contact with the surface of the valve chest; and in that case the downward pressure of the steam on the back of the valve at those parts would be neutralised by the upward pressure of the layer of steam between the surfaces, and the friction would be due to the pressure on the remainder of the valve only. According to some experiments of Mr. Thomas Adams, steam does so insinuate itself so long as the intensity of pressure between the valve and steam chest faces is less than the steam pressure, but when the pressure is greater, as must be the case with ordinary slide valves, this layer of steam is squeezed out, and then the coefficient of friction is found to have a much higher value, so that in the formula above we ought to take $\mu = 0{\cdot}2$ to 0·35, the value being greater as the pressure and temperature of the steam is greater." The formula referred to by Professor Unwin was $F = \mu\, p\, a$, where $\mu = 0{\cdot}15$ for smooth surfaces, such as slide valve surfaces not well lubricated. In his latest edition, Professor Unwin does not mention anything with reference to the presence of steam between the valve and steam chest faces, only quoting the preceding formula, but substituting for the value of μ, 0·10 instead of 0·15 as given above. He also refers to Mr. Aspinall's experiments, as stated in my previous letter. From this I concluded that the presence of steam between the valve and steam-chest faces might be ignored, and therefore based my calculation on this assumption.

It may be of interest to mention that a method of lubricating slide valves with water has been proposed by Herr C. von Lüde, and was published in the *Organ für die Forschritte des Eisenbahnwesens*, 1884, page 4. His proposition was to use as a lubricant water taken direct from the boiler and forced under the steam pressure between the valve and steam-chest faces. It would then be distributed over the whole surface, so that the valve would roll, as it were, on drops of water, which are themselves subject to the boiler pressure, and thus in the simplest way equalise the pressure on both the upper and lower faces of the valve. The claim put forward on its behalf was that the lubrication would be independent of the driver, and, therefore, require no attention; it would also be independent of the working of any lubricating gear; the lubricant would always be present in unlimited quantity, and would always be distributed automatically over the surfaces by the steam pressure. Diagrams were given showing the application of the arrangement to both passenger and goods engines. A small stop-cock fixed in the side of the fire-box admits water through a copper pipe to the valve chest, and is only closed when the engine is standing. The water passes through small holes in the slide valve to narrow grooves cut in its face; these are alternately emptied and filled as the slide valve passes to and fro, four times during each double stroke, and this takes place, whether the regulator is open or closed, without any possibility of interruption. It was also claimed for the arrangement that it was simpler than other lubricating devices in use. EDWARD J. M. DAVIES.

24, Harrington-square, London, N.W.,
February 8th.

SIR,—In commenting on Mr. Davies' letter in your issue of the 7th, you state, as far as I can gather, that in the case of a slide valve, no matter how well fitting, the steam pressure acts not only on its back but also underneath the valve, so that the only pressure holding it on to its seat is that due to its weight. Now what puzzles me here is the inconsistency between this theory and such facts as scored and worn slide valve faces and seats, and the advantageous use of balanced slide valves and piston valves. Surely its weight alone cannot be enough to cause the deep scores and heavy wear of pretty well every slide valve? I should be very glad if you could explain this inconsistency, and so enlighten a puzzled reader. E. A. G.

2, Willes-terrace, Leamington,
February 10th.

[The total area of the back of the valve on which the pressure acts is very much larger than that of the faces in contact.—ED. E.]

SIR,—If your correspondent will take two plates of cast iron, and plane up the surfaces carefully, and then put one plate on the other, and squeeze them hard together, he will find that he cannot exclude the air from between the two, and they will fall apart. This they ought not to do if they fitted air-tight on each other. A properly made surface plate, however, will float on the film of air between it and its fellows, but the air may be excluded by sliding. No such conditions can occur in a slide valve, the surface being comparatively rough. FRITTOIR.

Paris, February 10th.

THE TRUSTY GAS ENGINE.

SIR,—In reply to a letter in your issue of the 7th inst., signed J. A. Drake, it is true this gentleman was in the service of Weyman and Hitchcock, Ld., from 1890 to 1895, as works foreman or manager, and in that capacity was employed both on the gas and oil engine. There is no need for other comment.

J. E. WEYMAN.

Cheltenham, February 8th.

[This correspondence must now close.—ED. E.]

THE INSTITUTION OF CIVIL ENGINEERS.

MANUFACTURE OF ALUMINIUM.

AT the ordinary meeting on Tuesday, February 11th, Sir Benjamin Baker, K.C.M.G., the President, in the chair, the paper read was on "The Manufacture of Aluminium by Electrolysis, and the Plant at Niagara for its Extraction," by Mr. Alfred E. Hunt, M. Inst. C.E.

The author, after briefly stating the situation of the Pittsburgh Reduction Company's works, and of those of the Niagara Falls Power Company, described the ores of aluminium best fitted for electrolytic reduction to the metallic state, and gave an account of the general principles governing the extraction of the metal from its compounds.

The Hall process, which was that adopted by the Pittsburgh Reduction Company, involved the direct electrolysis of the sesqui-oxide, alumina, dissolved in a molten bath of the mixed fluorides of aluminium, calcium, and sodium. One cubic foot of the solvent would serve for an hourly production of one pound of metallic aluminium, the bath used being capable of dissolving one-third of its own weight of alumina. The electrical energy required for extracting this amount of metal was 3730 watt hours for the decomposition of the alumina, with a further supply to maintain the bath at the temperature necessary for the molten condition. The fluorides remained unchanged, so that the operation was continuous. The bath was made either from a mixture of fluorspar and cryolite, or from the artificial fluorides; and it might be fused in a separate vessel when starting work, or in the bath by the current itself. Alumina was added at frequent intervals to prevent too great a variation in the resistance of the bath, and the aluminium, as it was produced, was siphoned from beneath the layer of fluoride, where it collected without interference with the progress of the operations. The oxygen of the alumina was liberated at the carbon anode, which at the temperature of the bath—980 deg. C.—oxidised to carbon monoxide. Outside the bath this was burnt at once to carbon dioxide, and was allowed to escape into the working apartment. The carbon anodes were consumed at nearly the same rate as the aluminium was produced, the amount being about two-thirds of the quantity actually used. The difference of potentials theoretically necessary for the separation of the constituents of alumina was about 2·8 volts, but a greater difference was due to the resistance of the bath. The pots employed were of iron with carbon linings, but these could be dispensed with if a high degree of purity was not required.

The chief impurities in the finished product were silicon and iron. These were derived from the alumina as well as from the carbon anodes. Aluminium could be produced containing 99¾ per cent. of the pure metal, and was regularly delivered with 99 per cent. The electrolytic baths were joined in series, the positive bar of the switchboard being joined to the carbon anode of one of the baths, and the last pot of the series being joined to the negative bar of the switchboard. All the copper connections were necessarily very heavy, on account of the large currents employed. The sources of the loss of energy were enumerated, as well as the requirements to be met by a suitable solvent and the ore for use in the Hall process.

The electrical energy was generated at the works of the Niagara Falls Power Company, and was conveyed, without the intervention of transformers, over a distance of about half a mile by stranded copper cables 1¼in. in diameter. The loss in transmission was about 1½ per cent. of the energy conveyed. The cables were carried in a subway, 5ft. 6in. high and 3ft. 10in. wide, formed of concrete with masonry protection, and with a wooden floor. The two circuits were kept distinct, and were connected at the further end by a switchboard to step-down transformers. These were arranged in sets of two, of which the secondary coils were in circuit with one commutating machine or motor generator, the entire set of three machines dealing with 500-horse power. The transformers were of the ordinary type, with closed magnetic circuit, and gave an efficiency of 97 per cent. on full load. They reduced the potential of the secondary circuit to 115 volts. The conductors from the low potential side of the transformers were formed of 4in. by ½in. copper bars, insulated on slate slabs. They connected the two transformers with the twenty-pole motor generator, driven by the two quarter-phase currents at 150 revolutions per minute and producing a continuous current of 2500 ampères, by means of a second and independent winding and commutator on its armature. The currents from the motor generators were joined in parallel to large "omnibus" bars passing directly from a switchboard to the reduction pots. The author discussed the several methods of measurement for a basis of charge for the energy supplied.

At the New Kensington works of the Pittsburgh Reduction Company the dynamos were driven by steam power. The best steam coal cost only 5s. 3d. per ton at the stokeholds, and evaporated 10 lb. of water per lb. of coal at 100 deg. C. in actual practice. Natural gas was obtainable at even a lower equivalent rate during part of the year, when it was used instead of coal.

At the works of the Niagara Falls Power Company water was taken through a canal, 188ft. wide and 12ft. deep, from the Niagara River, on the United States side, and at a point about half a mile above the celebrated Falls. It was then conducted by vertical iron pipes, 7ft. 6in. in diameter, to the turbines, at present three in number, of 5000-horse power each. These were placed at the bottom of a pit, which it was intended ultimately to enlarge so as to accommodate ten turbines. The flow of the water was controlled by gates and penstocks, placed at the top of the vertical pipes. The turbines were of the Fourneyron type, with two wheels each, and with buckets divided into three tiers. The axes were vertical, and the centre line of the case, midway between the two wheels, was 136ft. below the level of the water in the canal. The speed was controlled by external annular gates, by which the buckets could be partially or wholly throttled. The turbines discharged into a tunnel of horseshoe section, 21ft. high, 18ft. 10in. wide at its upper portion, and 14ft. 9in. on the floor. It was about 9500ft. in length, the average gradient being 36ft. per mile, and it was expected to give a velocity of discharge of 26ft. 6in. per second, and to have a capacity as a tail-race to turbines developing 100,000-horse power.

The 5000-horse power turbines had vertical shafts, carried up to the surface without the intervention of gearing between the bucket-wheels and the dynamos. The weight of each of the shafts and of the machinery attached to it amounted to about 152,000 lb. The load was supported as far as possible upon the disc of the upper bucket-wheel by arranging it as the top cover to the case of the guide-wheels, the disc of the lower bucket-wheel being at the same time shielded from the pressure of the water. The resultant end pressure, when the load was light, therefore, amounted to about 2000 lb. upwards; but when the load was increased the upward pressure diminished slightly and became a downward one of the same amount at full load. These variable resultant pressures were taken up by water-cooled thrust blocks, arranged on the shaft. The latter was 11in. in diameter at its journals, where it was solid, and 3ft. 2in. at its intermediate portions, where it consisted of a steel tube. The turbines were arranged to deal with 430 cubic feet of water per second, and to develope 5000-horse power, with an efficiency of 75 per cent. Their normal speed was 250 revolutions per minute. Each turbine drove a single dynamo, built upon a heavy masonry arch thrown across the top of the turbine-pit. The field magnets revolved, and the armature was arranged wholly within the revolving field-magnet system. There were twelve pole-pieces mounted within a nickel steel ring $4\frac{7}{16}$in. thick, 4ft. 3in. high, and 11ft. 6in. in diameter. The field magnets were excited by a continuous current, representing 0·2 per cent. of the energy developed by the machine. The armature was built on the outside of a large annular foundation casting, and was entirely wound with $\frac{5}{16}$in. by 1¼in. copper strips placed in pairs in grooves made in the core, and insulated by mica. The winding was arranged to give two separate but similar alternating currents, each with twenty-five complete cycles per second, and with a maximum difference of potential of 2500 volts. The two currents differed in phase by an angle of 90 deg. The efficiency of the machines was 97½ per cent.

In an appendix a detailed account was given of the several ores of aluminium.

SPEAKING of the construction of H.M.S. Andromeda, the Pembroke correspondent of the *Naval and Military Record* says:—"A noticeable feature of the frames at the two ends are the bracket plates to receive the beams of the various flats, which were all riveted in place before the frames were erected. Such a proceeding, which is perfectly safe when the frames are treated on the scrive board, would not be so if resorted to under other circumstances. It has, therefore, never been attempted on any previous ship."

THE PARKHEAD FORGE

(For description see page 153)

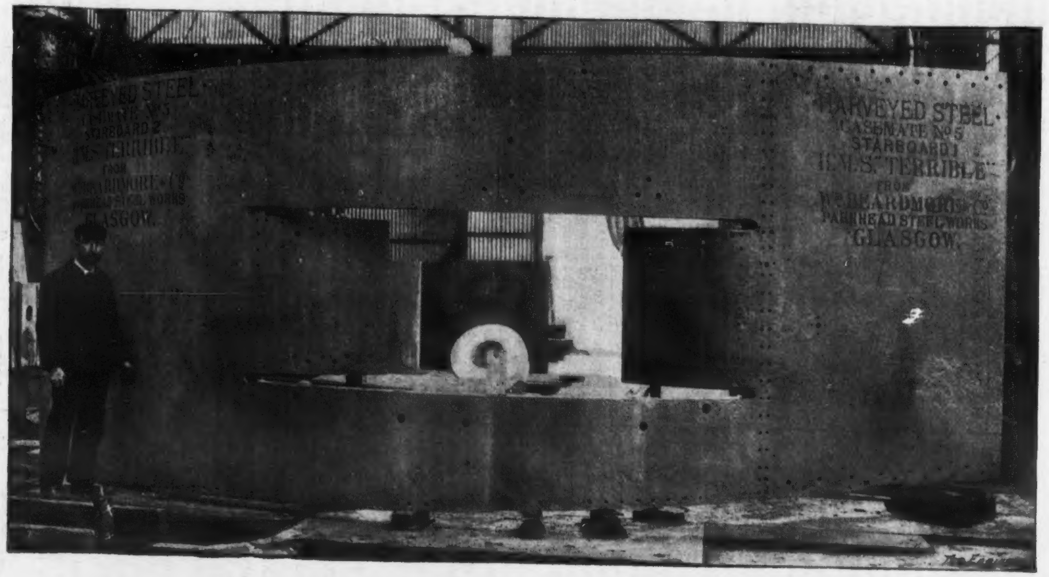

HARVEYED STEEL
CASEMATE No 5
STARBOARD 1
H.M.S. "TERRIBLE"
FROM
WM BEARDMORE & Co
PARKHEAD STEEL WORKS
GLASGOW.

Fig. 5—HARVEYED STEEL CASEMATE, 6in. THICK, FOR H.M.S. TERRIBLE

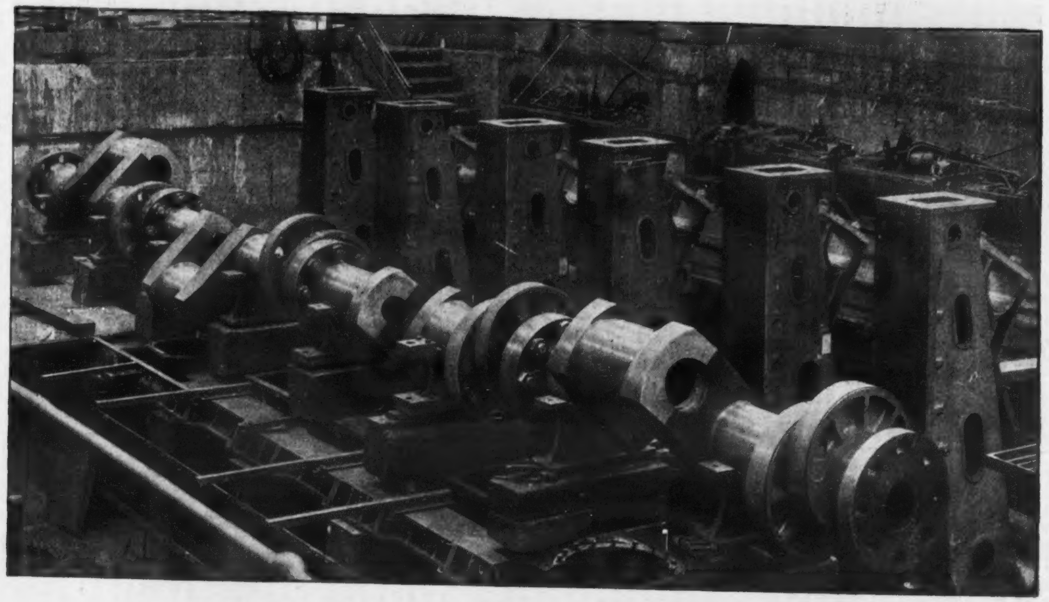


Fig. 8—CRANK-SHAFT OF H.M.S. POWERFUL IN BARROW ENGINE WORKS

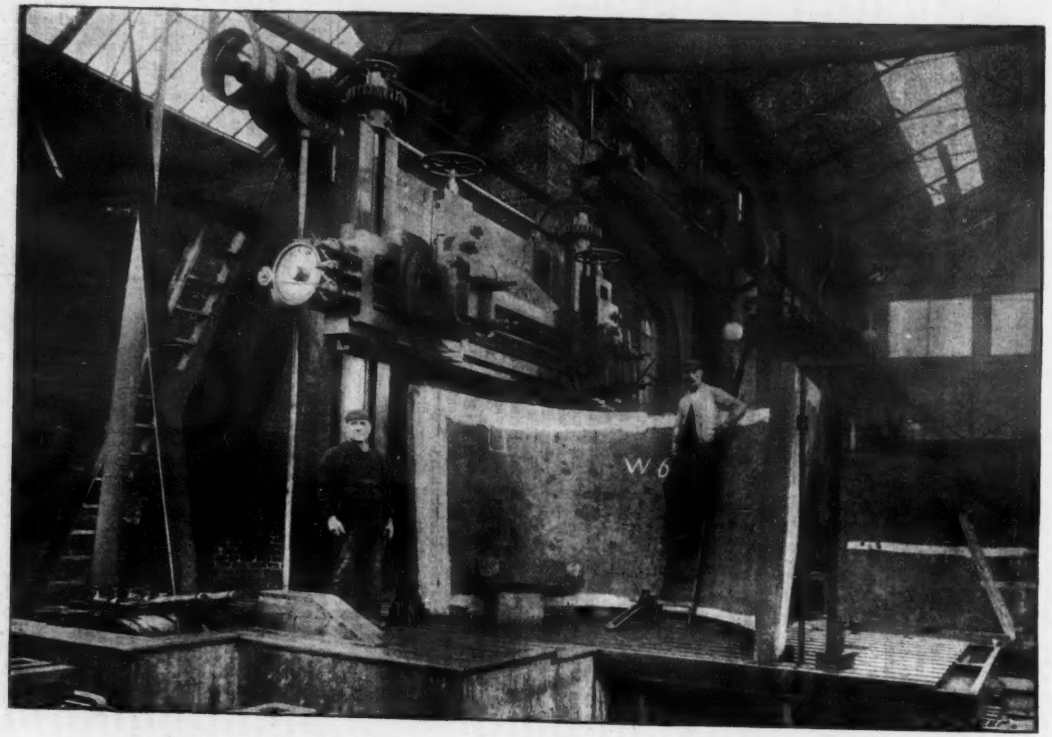


Fig. 3—PLANING MACHINE OPERATING UPON GUN SHIELD, 6in. THICK, FOR H.M.S. TERRIBLE

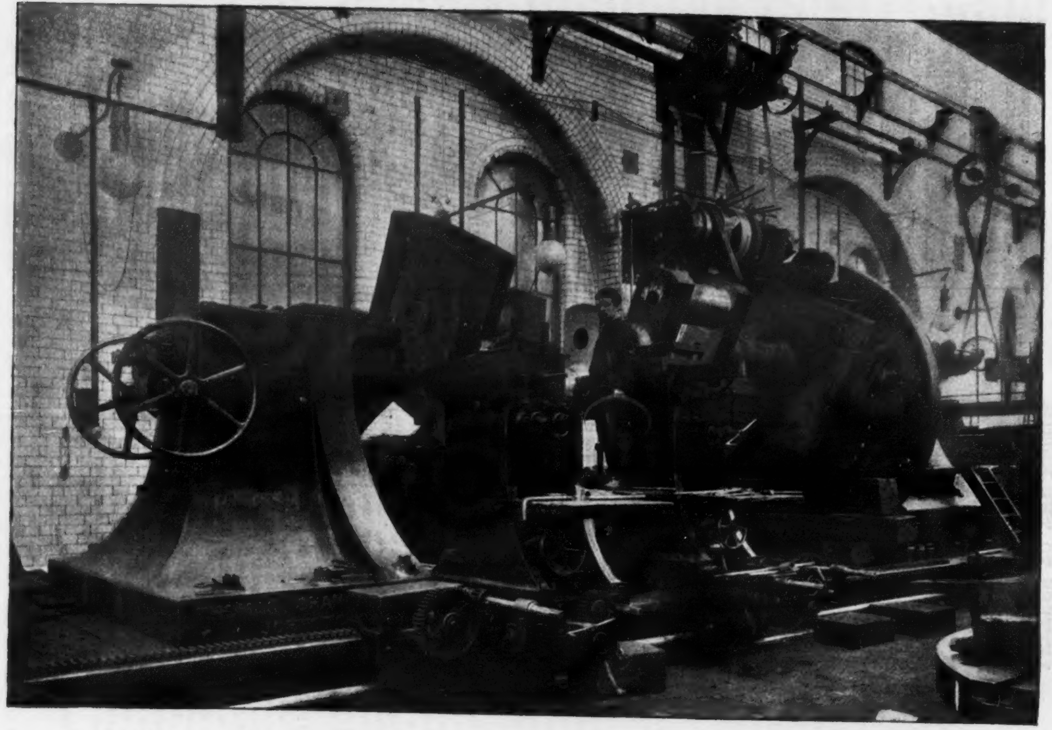


Fig. 7—LATHE, 69in. CENTRES, WITH DOUBLE CRANK-SHAFT OF CHILIAN CRUISER MINISTERO LENTENO

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THE COST OF LOCKS AND WEIRS.

(*To the Editor of The Engineer.*)

Sir,—Can any reader give me a rough estimate of the cost of a lock and weir across a river about 60 yards wide with a rocky bed?

Monmouth, February 8th. E. P. J.

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of The Engineer.

MEETINGS NEXT WEEK.

The Institution of Civil Engineers.—Tuesday, February 18th, at 8 p.m. Paper to be discussed: "The Manufacture of Aluminium by Electrolysis, and the Plant at Niagara for its Extraction," by Mr. Alfred Ephraim Hunt, M. Inst. C.E.

The Institution of Junior Engineers.—Monday, February 17th, at 7.30 p.m. Lecture II. of special course on Marine Engineering Design, by Mr. H. M. Rounthwaite, M.I. Mech. E., M.I.N.A.

The Institution of Mining and Metallurgy, London.—Wednesday, February 19th, at 8 p.m. Paper: "Mining in the Wollastonite Ore Deposits of the Santa Fé Mine, State of Chiapas, Mexico," by Mr. E. T. McCarthy, Member.

Royal Institution of Great Britain.—Tuesday, February 18th, at 3 p.m. Lecture: "The External Covering of Plants and Animals: Its Structures and Functions," by Professor Charles Stewart, M.R.C.S., F.L.S. Thursday, February 20th, at 3 p.m. Lecture: "Some Aspects of Modern Botany," by Professor H. Marshall Ward, D.Sc., F.R.S., F.L.S., Professor of Botany in the University of Cambridge. Friday, February 21st, at 9 p.m. Discourse: "The Past, Present, and Future Water Supply of London," by Edward Frankland, Esq., D.C.L., LL.D., F.R.S., M.R.I. Saturday, February 22nd, at 3 p.m. Lecture: "Light," by the Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., M.R.I., Professor of Natural Philosophy, R.I.

Royal Meteorological Society.—Wednesday, February 19th, at 7.30 p.m. Papers: "Report on the Phenological Observations for 1895," by Edward Mawley, F.R.H.S., President. "Notes on the Recent Unusually High Barometer Readings in the British Isles," by Robert H. Scott, M.A., F.R.S. "Turner's Representations of Lightning," by Richard Inwards, F.R. Met. Soc., F.R.A.S.

Society of Arts.—Monday, February 17th, at 8 p.m. Cantor lecture: "The Chemistry of Certain Metals and their Compounds used in Building, and the Changes Produced in them by Air, Moisture, and Noxious Gases, &c.," by Professor J. M. Thompson, F.R.S.E. Tuesday, February 18th, at 8 p.m. Foreign and Colonial Section. Paper: "The Development of Electrical Traction Apparatus," by H. F. Parshall, General Electric Company, U.S.A. W. H. Preece, C.B., F.R.S., Vice-president of the Society, will preside. Wednesday, February 19th, at 8 p.m. Paper: "Report of the Royal Commission on Secondary Education," by H. Macan. Sir Owen Roberts, M.A., will preside.

DEATHS.

On the 7th inst., at 32, Carleton-road, Tufnell-park, suddenly, of syncope, Francis Pickersgill Cockshott, late Superintendent of the Great Northern Railway, in his 72nd year.

On February 7th, at 35, Cambridge-gardens, North Kensington, George Robertson, M.I.C.E., F.R.S.E.

THE ENGINEER.

FEBRUARY 14, 1896.

COAST DEFENCE SHIPS.

A very large addition will be made, no doubt, to our naval strength. We shall have line-of-battle ships, cruisers, and torpedo catchers, but we fear that a special type will find no favour with the Admiralty. At all events, no hint has been dropped, no sign has been made that coast defence ships will be built; indeed, the term coast defence ship is regarded as a term almost of opprobrium. When a ship is held to have gone out of fashion, instead of being broken up she is used as a coast defence vessel. One would imagine that the part which such ships might have to play was wholly insignificant. In this respect Great Britain does not pursue the policy of other countries; Germany and the United States, for example, attach great importance to vessels for coast defence. It seems to us that it is impossible to consider the problems of modern naval warfare without seeing that the coast defence ship might on occasion prove simply invaluable; but the coast defence ship, to be of the greatest utility, must be specially constructed for the purpose. The battleship is in all cases a thing of compromise, and in the craft we have in view certain things indispensable in a sea-going vessel or a cruiser would be absent. Indeed, any attempt to combine a number of qualities all good in themselves would prevent the attainment of the intended object.

The coast defence ship whose construction we suggest would have for headquarters any suitable port; as for instance, Liverpool, Leith, or the Tyne. The number of ships appertaining to each port could be easily settled, probably on a basis of length of coast line to be protected. In war time the duties of the vessels would be that of patrols. Each would be attended by scouts in the shape of torpedo catchers. Only under the most exceptional circumstances would any one of them be withdrawn far from the base of operations. The ranges or beats of them would overlap, so that a constant chain of intercommunication might exist round our shores. It will be seen that ships working under such conditions can dispense with much that is essential in sea-going craft which may be for days, if not weeks, out of sight of land, or at least far from any port where coal, stores, ammunition, &c., can be obtained. Consequently on a reasonable tonnage very great opportunities for providing armour and guns become available. But, on the other hand, the draught of water must be moderate; we shall go so far as to say that the ships must be built each with more or less regard for the particular station on which she is to be employed. It is probable, however, that a draught of 18ft. is about the most that could be allowed; certainly the most on the east coast, and in many places in the Channel. The speed of the ship should be considerable, but we do not think that in this class of craft a very high speed is at all essential. As a rule 17 knots would do very well. The object of such a ship is neither to run away nor to chase, and she could always traverse the distance covered by her beat in sufficient time to be useful if she could steam 17 knots. The attempt to make her faster would defeat the object in view, by overloading her with machinery. It would not be of the smallest use for such a ship to arrive in a hurry where she was wanted, and then find that she was wholly overmatched. Our coast defence ship would have comparatively moderate engine and boiler power. Her boilers would be of the "express" type. Her machinery light, and adapted for running at a high speed. A breakdown would be a matter of secondary importance, because the vessel would never be far from her base; and for the same reason, the quantity of coal carried would be small—enough for a couple of days' hard steaming at most would suffice. Special arrangements, would, however, be made for taking in coal quickly, and coal derricks could be provided either in the river, in the case of the Mersey, let us say, or on shore. In Portsmouth the arrangements for coaling would be such that she could always fill her bunkers in a couple of hours. There is no mechanical difficulty in the way of doing this, all that is needed are special coaling appliances. Thus, then, the ship when short of coal would be able to run into harbour, fill her bunkers, and go out again in an exceedingly short time. Her utility would largely depend on the power of doing this.

While we are at peace, it would be unnecessary to maintain a full crew on board the coast defence ship, and even when she was in fighting trim, it would not be necessary, perhaps, to carry a crew for more than three days at a time without a day on shore. But, in any case, it is clear that the accommodation to be provided on board for the crew might be much less complete and comfortable, not to say luxurious, than that to be found in modern battleships and cruisers. The great mass of superstructure, in the shape of deck-houses, which are more or less necessary in regular sea-going ships, would not be needed in a vessel working near home. In peace times there would be plenty of room for the very small crew, and in war times the men would have to rough it a little. In no case, however, would wooden deck-houses and a multitude of wind trunks and cowls be tolerated. Our man-of-war is intended for fighting, not as a residence. It will be seen that by carrying small quantities of coal, and providing very light boilers and machinery, sacrificing deck-houses, and so on, a very considerable weight is rendered available for other purposes, and our coast defence ship may be at once heavily armed and well protected by armour. The first essential is that she should not be sunk at all, or sunk with difficulty; the second is that her crew should not be killed nor her guns disabled by the fire of the enemy. The first end would be attained as far as may be by bulkheads, the second by disposing the whole of her armament in a central citadel over an armour deck running fore and aft, and a belt along the water-line of such a thickness as would keep out the shells of quick-fire guns. This would not be difficult, because hard-faced armour is capable of great things in this way. We hear of plates being punched, and projectiles going through almost uninjured; but the damage which even a 6in. solid shot can do inside a large ship is quite trifling compared to the havoc which can be wrought by a shell bursting between decks. The United States pin their faith to a large extent on their monitors for coast defence—and properly so. They would, no doubt, prove extremely formidable craft, especially in fair weather, or in inland waters or sheltered bays. They present a very small mark to shoot at, and there is very little to damage even if they are hit; but they are too low in the water, and carry their guns too near the sea, to be really dangerous in a breeze, and they are, besides, very, very slow. It would not be at all a difficult task for such a ship as our own Empress of India to run right over and sink an American turret ship. Our coast defence ship would have to carry her guns well above water; the more so as a light forecastle would be necessary for steaming head to sea. But in all this there is no insurmountable difficulty so long as too much is not attempted. Her armament would consist of quick-fire guns of moderate weight and dimensions, and we are disposed to think that it would be better to use only a single size of gun throughout, say 8in. Elswick quick-fire. This would very greatly simplify all the ammunition arrangements, and avoid a source of confusion. The number of guns to be carried would depend on the tonnage available. Half a dozen such guns, carried two to fire ahead and two on each broadside, would constitute a most powerful armament. Of course there would be provided a considerable number of small machine guns intended to repel torpedo attacks, and the ship would be fitted with a couple of torpedo tubes; but her guns would be her strong point.

It is of not the smallest use to provide a great number of guns—the crews of which would be destroyed by shell fire in a few minutes—or even shielded guns, which could be carried away shield and all; nor guns on a deck which would be choked with the ruins of boats and deck-houses, all in flames in five minutes. It needs no magical perspicacity to see that a ship with two guns, which she can continue to use as long as her ammunition holds out, must in the long run beat a ship with a dozen guns, none of which can be fired ten minutes or less after a battle begins. If we have a given amount of tonnage allowed us, it is better to use that up partly in armour and partly in guns, than all in guns. Very great protection can be afforded to guns and gunners in a central citadel with suitable traverses. Of course we shall be told that we propose to sacrifice we know not how many good qualities, but this is precisely what we intend to do; and we answer that in every warship something must be given up, and that it is unwise—most unwise—to crowd a coast defence ship with things which, even in sea-going ships, are of doubtful necessity.

We shall have, then, in the ship whose description we have sketched a more or less impregnable floating fort rather than a ship of war in the ordinary sense in which the word ship is employed, and it will be seen at a glance, we trust, that this floating fort would be a thing about which the captain of even a first-class battleship might think twice before he attacked it. In the first place, our ship could manœuvre in water that the battleship dare not enter. The French Navy could do nothing with the German Navy in 1870-71 because the French ships drew seven or eight feet more water than did those of their foes. The well-directed fire of a few 8in. quick-firers would play havoc with the upper works of the warship, and in return the warship could do little unless she succeeded in landing a heavy shell inside the citadel of the coast defence ship. The principal duty, however, of our suggested craft would be to prevent the making of raids on our coasts by armed cruisers. Numerous examples of these raids were supplied a few years ago during the Naval Manœuvres. It would be an extremely audacious cruiser, for example, that attempted to loot Brighton, let us say, while there was one of our coast defence ships within fifty miles of that town. In a fair fight there are not half a-dozen cruisers afloat that would not have to seek safety in flight, and the cruisers that would not are in the British Navy. It is, of course, extremely difficult to convey anything like an accurate idea of details within the limits of an article like this, we can but suggest the outlines. Our programme after all comes to this, that a number of ships should be constructed specially to defend our coasts and those of our Colonies and our coaling stations; that they should abandon a number of qualities needed in a cruiser or a battleship, on much the same principle that policemen do not carry knapsacks; and that availing ourselves of the sacrifice of certain characteristics, we should secure in their place a very powerful battery, which could be fought behind armour to the very best advantage. There is much in such craft to recommend them; something worth consideration, we think, in the proposal that they should be built.

LOCOMOTIVE GRATES.

PERHAPS our American railroad contemporaries will pardon us for saying that their pages present us with an endless series of puzzles, some of them amusing, all interesting. The puzzle sometimes lies in a direct statement of fact; sometimes in the difficulty of reconciling contradictory arguments or assertions; sometimes in the apparent impossibility of explaining an event on any rational scientific basis. The last number of *The American Engineer and Car Builder* contains an article which presents us with a very favourable example of the second type of puzzle. Of course all our readers know that railway men in the United States, far from having anything to learn from English engineers, are in a position to impart very valuable instruction. If we were to venture to assert anything to the contrary we should be called very hard names, yet we find the following passage in our contemporary. He advocates the carrying out of a series of experiments by some intelligent person to ascertain the relative value of large and small grates in locomotive engines, and then goes on to say:—"Unfortunately most of our railroad managers seem to be wedded, or at least in love, with ignorance. They are always ready to spend any amount of money in contention or litigation, to protect themselves and advance their interests, but if it could be known, it is believed that the amount of money which is expended annually for the advancement of knowledge is very small." We tremble when we think of the chastisement we should receive if we had written and printed and published such a statement. Fancy an English journal daring to say that American railway managers were in love with ignorance, not even wedded to it; the delicate significance of the distinction will be generally appreciated, we think. As a puzzle, the query how came such a passage to appear in an American railroad journal is excellent. We pass on to the consideration of another.

Tremendous speeds have been attained in the United States. We have admired, wondered, and not unnaturally asked how the thing was done. We cannot do it at this side of the Atlantic, or at least we do not do it, and we seek for explanation and information. In reply, we are told by one railway engineer that he has no fast engines, but that he can provide "some first-class liars." This statement does not advance matters much, and may be regarded as beside the question. But as an explanation is seen to be necessary, our contemporaries tell us that the resistance of rolling stock on American railways is quite trifling, 15 lb. or so per ton at 73 miles an hour. If this be so, it is easy to see that no very extraordinary power is required, and so we find that a locomotive developing 600 to 700-horse power is quite competent to do the work said to be done. Here we may do a little sum. Let us assume that the rate of combustion is 30 lb. a mile. In an hour there was burned 73 × 30 = 2190 lb. of coal, and, dividing this by 700-horse power, we have 3·1 lb. of coal per horse-power per hour. This is just what we should expect with an English engine. If we suppose, further, that the grate area was twenty square feet, then coal would have to be burned at the rate of about 109 lb. per square foot per hour. That is a very high rate of combustion, much higher than rates usual in this country; but, on the other hand, no English locomotive has ever run 86 miles at the rate of 73 miles an hour. The engine which, in the United States, made the run in question had, we understand, about 28 square feet of grate surface for 700-horse power. At the 30 lb. a mile rate, this would represent a consumption of 78 lb. per square foot per hour. We would be content to accept this figure as representing what took place, but for the article which we are considering. From this we learn that the maximum rate of combustion in the United States locomotives is 200 lb. per square foot of grate per hour. We may say here at once that we do not believe that it is possible under any conditions obtaining in a locomotive boiler to *burn* coal at this rate. It may be put through the fire-door, but it is not all burned, a large proportion being carried up the chimney by a draught which is of necessity so strong that the fireman "has to keep tight hold of his shovel lest it should be pulled into the fire." It is, perhaps, not unfair to assume that coal was burned during the run on the Lake Shore line at 40 per cent. less than the maximum rate. This would give us 120 lb. per square foot of grate per hour, an estimate which is probably not far from the truth. Another simple little sum tells us that under these circumstances the total weight burned per hour on a 28ft. grate was 33,600 lb. Now, if we divide this by 3, we have 1120-horse power, in which case the theory that the resistance of the train was only 15 lb. per ton collapses; and if we divide by 700 we find that the engine used 4·8 lb. of coal per horse per hour; if by 73 that the consumption per mile was 44·6 lb. We must leave our friends at the other side of the Atlantic to take their choice. Probably the truth lies somewhere between the two. At all events, it is a perplexing puzzle to reconcile the statements made on the one hand concerning train resistance, and on the other about the rate at which coal is burned by American locomotives. We need scarcely say that it is a matter of extreme importance to decide whether the resistance of American rolling stock on American roads is or is not really less than that to be overcome on English daily practice. Mr. Tratman, in his letter which will be found in another column, more than implies that it is very much less. It is a difficult matter, no doubt, to carry out any really useful direct test of the stress on a drawbar at high speeds, and to get diagrams from the engine cylinders would be yet more difficult. But there ought to be no trouble in ascertaining within a little what was the total weight of coal burned during the 86 miles "record" run, and with this before us we should be able to form a good idea as to what the train resistance was.

The reason why our contemporary has written about grates is that a paper was read by Mr. J. Snowden Bell on "Wide Fire-box Locomotive Boilers" before the Western Railway Club last November. *The American Engineer and Car Builder* tells us that the discussion which followed was by "No means conclusive with reference to the primary question whether a large locomotive grate and fire-box is better than a small one. In fact, this debate reminds one of a boy's composition on the seasons, in which he said that 'Some loves Spring, some loves Summer, others Autumn, and others Winter; but as for me give me Liberty or give me Death.' That is, the participants in the discussion seemed to desire most to maintain a non-committal attitude with reference to the question under consideration, so as to be free to use big or little fire-boxes as they might choose." Our contemporary manifests some surprise that there should be any difference of opinion on the subject. But there is really nothing surprising about the matter. To use the words of the late Charles Beyer: "Anything will do for a locomotive;" and it is well known that engines manage to get along somehow, and do their work under very various conditions. In this country locomotive superintendents are so tied up for width that the grates of express locomotives at all events are nearly all the same size; the minimum dimension is about 18 square feet, and the maximum seldom touches 21 square feet. If we could use larger grates we would, and the reason why is obvious. The smaller the grate the less is the area through which air can find its way for combustion, and the sharper must be the draught to pull it in. Furthermore, a small grate always means a thick fire when the engine is fully loaded, and a thick fire requires a smart draught to force air through it. But this entails a contracted blast pipe, and a contracted blast pipe is contrary to all the best traditions of English practice, and is an offence to drivers and locomotive superintendents alike. It is sometimes argued that the size of the grate is of the less consequence, because so much air can be admitted through the fire-door. This may be right in theory, but not in practice. It is well known that when there is a difficulty in keeping steam, it is often due to too large an air admission over the fire. It seems to check the rate of combustion. In the United States coal is burned under very different conditions from that which obtains here, and the scoop is not used to anything like the extent it is employed in this country. Our contemporary does not supply much information as to the results obtained with grates of varying size. He argues in favour of a large fire-box, no matter what the grate area; and in this we think he is right, but it must not be forgotten that some locomotives built many years ago by Mr. McConnell, for the London and North-Western Railway, with very large and lofty fire-boxes, could not be made to steam satisfactorily until the grates were raised nearly a foot. Radiant heat is a very peculiar thing, and seems to lose itself in an inexplicable fashion, if it has to travel very far.

THE HARBOURS OF INDIA.

THE question of the present insufficiency of harbour accommodation throughout the coast line of India appears likely shortly to receive the consideration it undoubtedly demands. The importance of this matter will certainly receive accentuation owing to the construction now progressing of the coast line railway between Madras and Calcutta along the western shore of the Bay of Bengal. Up to the present time all the inland districts of India have been practically shut off from the numerous towns—many of them important—situate on that coast. To all intents and purposes the only ports available for the shipment of the produce of such of those districts as lie north of Madras on the eastern side of India have been Madras and Calcutta. Nearly 800 miles of surf-beaten coast stretch between these two ports. In the absence of all railway communication with the interior, this gap in the harbour accommodation of the Bay of Bengal has not been so seriously felt as to make it imperative on the Government of India to incur the expense of constructing a midway harbour. But as the coast line progresses it is sure to become linked up at various points throughout its length with the great interior system of railways. Through this connection a large amount of freight-seeking traffic will ask a readier outlet than is now available for it. This chance of adding to the expected revenue of the new line must, however, be sacrificed if there be no port at which that freight can be obtained. This fact must render it imperative upon the Indian Government to stir in the matter, even if there existed no other reasons for its doing so.

To deny that such other reasons exist would, however, be to concede too much. The total harbour accommodation of India is, and has long been, quite insufficient for its needs. Representation on this point has been urgent for very many years past. Nor have such representations failed of a considerable amount of effect. We have within the last few decades seen Karachi, Colombo, and Madras converted at a vast outlay into safe harbours; all of these, prior to such a term, having been but open roadsteads. As to the two ports first named, we hear nothing but satisfaction expressed. Unfortunately, however, this is not the case as regards the third, Madras. The writer of a letter to the *Times* recently described this port as being yet one from which all prudent shipmasters must fly on the first threatening presage of one of those cyclonic storms which are so frequent and so disastrous in the Bay of Bengal. If this assertion may be accepted, it remains therefrom that between Colombo, in Ceylon, and Calcutta at the head of this "storm-vexed" bay, a distance of about 1400 miles, there exists no safe shelter for shipping. This fact, coupled with the approaching facilities of railway communication that we have named, must surely induce the Government of India to adopt remedial measures; and there have not been wanting suggestions in this direction to which attention might well be given. It is, however, not to be denied that there is hardly a coast line in the world that is so bare of facilities for the construction of a harbour as that which is now under particular reference. South of Madras these disabilities are not so severely felt. In both Tuticorin and Negapatam the traffic of Southern India possesses outlets the natural advantages of which might, perhaps, lend themselves without difficulty to improvement. But both of these ports lie relatively adjacent to the magnificent harbour of Colombo before referred to, and it is confidently anticipated that when union shall have been effected between that place and the railway system of Southern India, it will become the port of export for all the districts of that Indian region.

We need, therefore, primarily only to consider the question as it affects the 800 miles of coast between Madras and Calcutta—the efficiency of the port first named being assumed. Doubtless the Government at Calcutta has in its possession surveys and reports upon all such localities along this coast line as may possess features for safe harbourage. But if so the public has not been taken into confidence respecting them. Nor must the fact, perhaps, be too readily assumed, for a harbour on the east coast of Ceylon now used as a safe resort for shipping during the height of the north-east monsoon, was only accidentally discovered a few years back by a member of the Public Works Department of the island. It is, therefore, possible that there may remain undiscovered possibilities along the 800 miles of unsheltering coast line that we have named. But this is merely conjecture. What we have heard asserted is that at Vizagapatam, a town on the coast situated about midway between the ports of Madras and Calcutta, an outlay of some £300,000 would construct a harbour ample for the accommodation required for the shipping plying in the Bay of Bengal. We do not understand that this estimate has been made professionally, or as the result of any detailed survey of the marine features of the locality. Consequently it is not pretended that the suggestion can be anything more than barely tentative. Still, the information has been made upon information locally acquired, and may therefore be possessed of material value. Vizagapatam is, as we have said, centrally situate in the sense of our discussion. It is one of the points that will not only be directly served by the coast railway now in progress, but it is one that, from its importance, must become one of the ports of debouchment for the trade of the interior, from which it is now shut off by the want of railway communication. In our foregoing remarks we have abstained from mention of the needs of the Western coast of India. The Indian Ocean, however, is relatively free from the cyclones that are almost seasonal in the Bay of Bengal. The demands of the West Coast, therefore, for extended harbour accommodation, do not in the least degree approach in gravity those of the coast to which we have confined our notice, and its claims may be held over without prejudice to the needs of the present generation.

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A FEATURE OF THE NEW NAVAL PROGRAMME.

THE most remarkable feature in the new naval programme, if the forecasts of it are in any degree correct, is the proposed construction of a large fleet of torpedo boat destroyers. It seems not improbable that between a fifth and a sixth of the entire sum voted to the Naval Estimates of the ensuing financial year will be appropriated to the construction of a large number of these vessels. The cost of each may be estimated at between £60,000 and £70,000. The speed aimed at is 30 knots, and in some cases, from makers who are prepared and able to undertake the task, 33 knots will be asked. There is no doubt whatever that such a speed can be obtained; there are at least three makers who will willingly undertake to give it, but in fairness to themselves they will probably insist on being allowed a comparatively free hand in the matter. Fortunately, the British Admiralty, though faulty and misguided on several points, is wise enough, as a rule, to leave the design and construction of highly-specialised types in the hands of those most competent to deal with them, and to slacken, though not infrequently under pressure, the government trammels. In the coming orders it is sincerely to be hoped that the Admiralty will deal wisely and generously with the builders. In doing so they will certainly have the approval and sympathy of the public, for in this way can they alone realise their ambition. To those who have watched with attention the gradual change of opinion on naval matters, this large order for high speed, lightly armed, and totally unprotected craft will come with little surprise. When, a few years ago, a revulsion of feeling against huge unwieldy fighting platforms set in, it might have been foreseen that as our knowledge and capability increased, a smaller, high speed, readily manœuvred vessel would replace the old and massive form, just as surely as the lighter quick-firing, high velocity guns would replace the cumbrous 110 tonners when science had made it possible. There will doubtless be various opinions about the wisdom of the order, there will be some who will contend that unarmoured vessels are useless in these days of quick, accurate fire and penetrating projectiles; there will be others who consider it impossible to keep vessels intended for such high speed permanently efficient; others perhaps who will see no place for them in warfare, and not comprehend their method of attack; and finally, and amongst them ourselves, those who foresee great things from the torpedo boat destroyer, as it is now called—a name which will need revision—and believe that, as in the days of the Great Armada the small handy vessels of the British fleet were able to swarm round and rout the great Spanish ships, so in the future the little boats that can come and go with swiftness and precision will have an immense power over more unwieldy craft. We do not underrate by a fraction the value of battleships of a size not exceeding that of the new ships, magnificent fighting machines in all respects, nor of the first-class cruisers—both these elements are exceedingly necessary to an efficient navy—

but we expect when the trial comes to see great things done by the skilful combination of the smaller vessels. From one point of view, an order for such a large quantity of a particular type, and a great expenditure of money, require the most careful consideration. The whole difficulty appears in the question, Has finality, or an approach to finality, been reached in the construction and design of torpedo boat destroyers? We can very safely answer No, and that gives the pause to a statement of opinion. We are, it must be understood, firm in our belief that a large fleet of small ships is greatly to be desired; but we think that to construct it too rapidly would be a fatal error. Unfortunately wars and rumours of wars make it imperative that the country should be expeditious in her movements. If the country were more settled, we should like to see the construction of this fleet of torpedo destroyers spread over several years, to the constructions of each new year the experience of the previous year being added. There are very many points that require improving. Chief of them, steering qualities, both in men and machines. Perhaps the men have been quite as much to blame as the machinery in the many petty collisions and mishaps which have marred our naval manœuvres. It is very much to be deplored that men should be at fault, but that can and must be corrected by drill, discipline, and knowledge. That the machinery should go wrong is also to be deplored; that also can be and must be put right. The whole machinery of warships, of all sorts, for the future must be simplified. A completely fitted vessel now-a-days is as intricate in its internal arrangements as a spinning jenny. This should not be, and will not be. Means and methods of simplifying can and will be found. Many have appeared in the last few years, and there are men ready and able to make many more. We do not think we are unreasonably optimistic in this. Our experience has always been that where simplicity has been demanded it has been found, and that only where unnecessary complications have been tolerated they continued to exist. Might we prophesy of the craft of the future the direct lineal descendant of the torpedo destroyer, we should say it will attain a speed approaching 40 knots, will have a thin but very resisting armoured deck and whaleback, will be armed with two or three torpedo tubes, and one quick-fire automatic 4·7in. or 6in. gun, protected. Steering gear will be perfected, and the vessel will have magnificent possibilities in manœuvring. Such things we may hope to see while the twentieth century is still young; what our children may see, and foresee, we do not dare to anticipate. We leave untouched the subject of the tactics of the new flotilla. It is the province of the admiral, not of the engineer. It is the engineer's duty to produce the handiest, swiftest, most dangerous craft he can, and in the present instance we may say it is the duty of the Admiralty to break the remaining shackles and leave him quite free to do his utmost.

IRISH RAILWAY WORKING.

THE railway companies of Ireland seem to have had some of the benefits in working that have been common here in the last half-year. Companies such as the Great Northern of Ireland have had increased receipts throughout most of the sections of the revenue, but passengers exhibit the largest recovery; and they have the benefit which is not so common here of a moderate expenditure on new works, so that there is only a limited additional interest to pay. The Great Northern, for instance, last half-year, expended £32,286 only. Out of this sum, £9812 was spent on the new line to Ardee, in course of formation—a short branch on which £16,409 have been spent up to the end of last year, and which is expected to take the further sum of £19,500 to complete it. Beyond that amount already alluded to the expenditure on the capital account in the past half-year has been £9256 on new working stock, and £13,217 on new works at many parts of the line; and when it is remembered that the line owned and worked by the company is over 500 miles, it will be seen that the additional capital expenditure is very limited. The cost of working the traffic, too, is moderate—the receipts for the past half-year being £420,000, and the expenses in the total only £202,251, so that the proportion is below that of most of the arterial lines of this country. In the case of another of the Irish lines of a different type, the Cork, Blackrock, and Passage Railway, the past half-year seems to have brought about a decision that is rather unusual—a Bill is to be promoted in Parliament to enable the company, amongst other things, to convert the existing line to one of 3ft. gauge; and to make a line of that gauge from Passage to Crookhaven. The little line from Cork has been one that has attempted to introduce the "zone" system of railway fares, but with only limited success; and it is now intended to alter the gauge of the line to a narrower one. Apart from such variations, the working of the Irish railways seems to proceed smoothly, and yields on the whole better results as the years pass on, though some of the items of expenditure show that growth which is very familiar on this side of the Channel.

LITERATURE.

Gas Manufacture: The Chemistry of. A Practical Handbook on the Production, Purification, and Testing of Illuminating Gas, and the Assay of the Bye-Products of Gas Manufacture. For the use of Students, Chemists, and Gas Engineers. By W. J. ATKINSON BUTTERFIELD, M.A., F.C.S., Head Chemist, Gasworks, Becton. London: Charles Griffin and Co., Limited. 1896. Large 8vo., pp. 375.

IT has always been a matter of surprise that this particular and vast chemical industry has not attracted greater attention among chemists, and that its exposition and development has been left almost entirely to engineers; it is therefore gratifying to record a move in the right direction in the appearance of a volume emanating from a chemical source. Therefore, we welcome the present handbook, and have perused it with interest, and our only cause for regret is that it is not more chemical, and even exclusively chemical. The matter is treated in eleven chapters. The first chapter deals with the raw materials of gas manufacture, which are considered under the following heads:—(1) For the production of coal gas; (2) for the production of water gas; (3) for the production of oil gas; (4) for enriching gas of low illuminating power. It is one of the best chapters in the book. Various coals and oils are described, their chemical characters set forth, and methods of examining them recorded. The next two chapters treat of coal gas, and contain some of the worst matter in the book, where the author enters very superficially into the engineering department of the gasworks and leaves chemical problems of high technical interest unsolved, and this is all the more regrettable because the chemical matter that fortunately does form the preponderating proportion of these two chapters is good. The next four chapters treat of water gas, oil gas, gas enrichment, station gas meters, station governors, and the gasholder. Again we feel that more might have been said chemically; for instance, about oil gas processes that are before the public at the present day.

The next two chapters treat of gas analysis and photometry very completely, and although much is old and much contained in another book recently published, and mentioned by the author, yet it forms an appropriate part of the present volume. In the gas apparatus, we are surprised to find the old Frankland and Ward apparatus with the old steel facets still holding its own at Becton. In Chapter X. we come to the application of gas, with which the manager of a gasworks should be acquainted in order to produce a suitable material; to burners, including the incandescent gas burner, which the author considers one of the greatest triumphs of chemical research of the century; gas fires and gas engines are briefly treated. Bye-products and methods of examining them form the subject of the concluding chapter. An incomplete bibliography and an excellent index complete the book, which should prove of use to those connected with the gas industry.

The defects of this book are the poorness of the engineering portions, which anyway seem somewhat superfluous in a chemical handbook, and the lack of diagnosis in many chemical points. This want of confidence on the part of the author seems quite unwarranted when the character of the more complete portions of the book is considered. We should think, too, that, holding the high position he does, he cannot be new to the work, and therefore we suppose his reticence is due to his modesty; for instance, he tells us gas engineers are by no means united in opinion as to the best variety of brick to use for retort stacks; and, again, that gas engineers are not unanimous in opinion as to the most economical carbonising temperature; and further, that they are not decided as to the correct dimensions, shape, position, and material for retorts, nor quite at one as to the relative merits of various scrubbers and washers. This does not surprise us in the least, but we think readers of the book would like to know what the author's chemical erudition would lead him to say on these matters. So, too, in the paragraphs treating of the quality and quantity of gas produced, we notice no mention of the effect of the size and shape of the retort, of the effect of the size of the coal charged in, the effect of packing, or the effect of quantity of coal. Then it is pointed out that the carbonic oxide burns at the top of the shaft when the furnaces are not working properly, but that this is not sufficient to form the sole guide to the engineer on the proper amount of primary and secondary air to admit to the furnace. The introduction of a little of the chemistry of regenerative firing would, in this case, help matters through better than the abrupt suggestion of an analysis, and the subsequent comments on the composition of the gases. We may, however, in conclusion, remark that as an addition to the literature of the gas industry, this volume is decidedly valuable, and that with a few judicious expurgations on one hand and amplifications on the other, its value will be very greatly increased.

The Law Relating to Factories and Workshops, including Laundries and Docks. By MAY E. ABRAHAM and ARTHUR LLEWELLYN DAVIES. London: Eyre and Spottiswoode. 1896.

IN books which are the result of collaboration it is sometimes rather difficult to determine the point at which one author begins and the other leaves off. No such difficulty exists, however, with regard to this work, as it is divided clearly into two parts, the first of which is written by Miss May E. Abraham, and has for sub-title "A Practical Guide to the Law and its Administration;" while Part II. is styled, "The Act with Notes," and is from the pen of Mr. A. L. Davies. The book is wound up with an appendix dealing with the special rules laid down for dangerous employments, and containing copious indices. Miss Abraham is a lady Government factory inspector under the Act, and her portion of the book extends to some eighty pages. It consists of a very business-like and readable *résumé* of the various Acts of Parliament which control the inspection of factories at the present day.

The average owner of a factory or workshop has but a hazy notion of the law on the subject, and when it is borne in mind that no less than fifteen Acts, passed at various dates, must be studied and sifted by him if he wishes to master the details, his ignorance may be excused. Hitherto he has known that at odd times the factory inspector will make his appearance on his premises, and that if this latter gentleman is not treated with civility and his suggestions carried out, he can make things very unpleasant for the unfortunate proprietor. Miss Abrahams simplifies matters for him by pointing out clearly what the factory inspector has a right to do, and what he has not, so that any one armed with her book might, after a couple of days' study of it, be in a position to judge as to whether or not the inspector with whom he has to do is exceeding his legal powers.

The various chapters of Part I. deal with a general view of the Acts, sanitary provisions, means of safety from machinery and fire, employment, alterations of hours, overtime, periods of employment for men, women, and children, certificates of fitness for employment, education of children employed, holidays, accidents, special rules for dangerous occupations, laundries, docks and building operations, bakehouses, tenement factories, outworkers, particulars of work and wages, the Truck Act and its administration, and legal proceedings and penalties. The whole may be said to give a very fair outline of the law as it stands at present, and forms, so to speak, a suitable introduction to the statistics and legal technicalities which follow. The impression it leaves on the reader is that the existing Factory Acts, while, like all other laws, may be open to improvement, yet are not so terribly unreasonable as is usually imagined by those whose knowledge of them is merely superficial.

The hard reading, however, comes in in Part II., where the text of the fifteen Acts relating to the subject since 1878 is given. Mr. Davies, who is a barrister-at-law, has amplified the Acts and facilitated their comprehension by very full foot-notes. Not only is the law laid down, but its carrying into effect is demonstrated by reference to no less than thirty-seven cases which have been fought out legally under these Acts.

The subject is not altogether of an inviting nature to the ordinary reader, but it is emphatically one in which a great many industrial people are bound to take an active interest from time to time. To such this book is to be recommended, as it will greatly facilitate a grasp of the matter. The dimensions of the book, too, are not such as to alarm the business man who is short of time. This may be looked on as a distinct advantage.

SHORT NOTICES.

Laxton's Builders' Price Book for 1896. *Containing above* 72,000 *prices.* Originally compiled by William Laxton. Seventy-ninth edition. London: Kelly and Co., Ld. Price 4s.—This well-tried price-book has lately been growing much in bulk with each revision of prices. A new feature in this edition is the rule of procedure in cases to be brought before the Tribunal of Appeal appointed under the London Building Act, 1894; also a new form of "agreement and schedule of conditions for building contracts" lately issued by the Royal Institute of British Architects, which supersedes a form of "heads of conditions of builders' contract" originally agreed to between the Institute and the Builders' Society, but now withdrawn from general use.

Gleanings from Patent Laws of all Countries. With Information as to Points of Practice, Area, Population, Production, &c. By W. Lloyd Wise, J.P. London: Cassell and Co. 1895. Small 8vo, 208 pp.—This is the first portion of the "Gleanings," and comprises information concerning patent laws in twenty-two countries, beginning with the Argentine Republic and ending with Germany. The quantity of information given concerning each country varies, but the heads are much the same. For Germany they are: Application, procedure, grant, area, population, production, assignment and transfer, date of law, fees, international arrangements, kinds of patents, miscellaneous, remarks, revocation, subject matter, who may obtain, and working. It is a useful little book and systematic in arrangement.

BOOKS RECEIVED.

Traité Théorique et Pratique des Courants Alternatifs Industriels. Par F. Loppé and R. Bouquet. Ouvrage en deux volumes. Deuxième volume. Partie Pratique. Paris: E. Bernard et Cie. 1896. Price 15f.

Life and Letters of the late Admiral Sir Bartholomew James Sulivan, K.C.B., 1810-1890. Edited by his son, Henry Norton Sulivan. With an introduction by Admiral Sir G. H. Richards, K.C.B., F.R.S. With portrait, map, plans, and illustrations. London: John Murray. 1896. Price 16s.

THE VALUE OF INLAND WATERWAYS for the conveyance of goods is, perhaps, not fully realised outside of Germany. By the waterways of the Upper Elbe, nearly 2,000,000 tons of merchandise are transported inland, and a similar quantity, and some 20,000 tons of timber in rafts are brought into Hamburg from the interior. The principal articles conveyed to the interior over these waterways are grain in the proportion of 26 per cent. of the whole volume; manures, 15 per cent.; coal, 5 per cent.; raw iron, 4 per cent.; and petroleum, oils, and colonial produce. Those brought into Hamburg consist principally of sugar, 43 per cent. of the total volume; manures, 13 per cent.; and stone, grain, salt, and flour. Similarly large quantities of goods find their way into Berlin, amounting to close upon 3,000,000 tons, and several thousands of tons of timber in rafts inwards in the course of the year. Of this traffic stone forms 65 per cent.; fuel, 14 per cent.; articles of consumption, 9 per cent.; timber, 6 per cent.; and merchandise, 6 per cent. Another centre of this water traffic is Mannheim, into which nearly 2,500,000 tons of goods enter in the course of the year, but as in the case of Berlin the return trade is not nearly so considerable. The principal articles thus imported into Mannheim are coal, in the proportion of 53 per cent. of the total volume, grain, petroleum, oil-seeds, raw and worked iron. The return trade consists of salt, timber and cement.

DURHAM SEWERAGE DISPOSAL SCHEME.—On Thursday, February 6th, a Local Government Board inquiry was opened in the Town Hall, Durham, into the sewage disposal scheme of the Durham City Corporation. The inquiry was held before Major-General Crozier, one of the inspectors of the Local Government Board, and there were in attendance others interested either in promoting or opposing the scheme. The Town Clerk, Mr. Fred Marshall, and Mr. Charles J. Lomax, A.M.I.C.E., represented the Corporation. The Dean and Chapter of Durham, the Master of University College, the Principal of Hatfield Hall, Durham, and the Ratepayers' Committee were also represented. In opening the inquiry, Mr. Marshall said that the scheme had for its object the prevention of sewage entering the river Wear. The corporation were compelled to prevent this pollution owing to an action brought against them by the County Council. In consequence they advertised for schemes to be sent in, for which premiums were awarded. The scheme sent in by "Valves," the *nom de plume* of Messrs. Lomax and Lomax, engineers, Manchester, was the scheme awarded the premium, and, with a slight exception, was the one which would be laid before the inspector. In the original scheme there was no destructor. The corporation took this matter into consideration, and, having regard to the great difficulty of dealing with the refuse from the city, they instructed Messrs. Lomax to add a destructor to their schemes. The estimated cost of the proposed works amounted to, exclusive of land, £25,222. In addition to that, there was the estimated expenditure of £1500 for the land. The Local Government Board were asked to sanction the borrowing of £30,000. Mr. Lomax then explained the details of the scheme, which included main concentrating sewers following the course of the river Wear to the outfall site near Kepier, at which point the sewage will be elevated 32ft. high, and treated first in precipitation tanks, and afterwards through polarite filter beds, the effluent being passed over prepared land filtration areas. The estimated cost of the precipitation tanks and filter beds was stated to be £4453. The destructor, engines, and pumps, together with the buildings, £6257. Mr. Coldwell, the city surveyor, was called, and said that the amount of refuse collected from the city, as stated by Mr. Lomax, was correct. He stated that the existing sewers were all laid with pipes. There was great difficulty in obtaining refuse pits in Durham, and no other method of disposing of the refuse would be advantageous. The inquiry was then closed. The inspector will report to the Local Government Board in due course.

THE WESTINGHOUSE ELECTRIC TRAMWAY.

The overhead wire system for tramways has been to the present time far more widely adopted than any other, although conduit systems have been successfully used in a few places. The former system has manifold disadvantages, and objection on the score of cost chiefly is urged against the latter.

The report of Dr. Hopkinson on the Leeds electric tramway proposals calls attention to the system in use in Washington, as described in The Engineer, December 7th, 1894, and as now shown by the Westinghouse Electric Company, in Victoria-street. In this new system the ordinary electric car such as used in either of the other systems is employed. This car carries a small battery the poles of which are connected to bars placed under the car, which make contact with cast iron, flat, bun-shaped projections or buttons standing about ¼in. to ¾in. above the roadway. These bars are approximately the length of the car, so that as long as the car covers a set of buttons they are connected to the battery above referred to. These buttons form the terminals of the wires of a small electro-magnetic switch, placed in a box buried at the side of the roadway in the case of a single track, and between the tracks in a double line system. When the current from the small battery carried by the car passes through one of these switches, its armature is attracted, and the current from the main is then switched on to the third contact point, forming part of the group of three in the roadway. This third contact point is rubbed by a corresponding bar, carried by the car, which thereupon becoming charged from the main, conveys current to connections from the motor on the car in the usual manner.

It will thus be seen that this third point is only connected with the main as long as current is flowing through the other two contact points from the battery carried by the car, so that when the car has passed over them the current ceases in the electro-magnetic switch, and leaves the three contact points "dead," so that traffic can pass over them without the possibility of a shock to either passengers or horses. In other words the entire system is insulated except at those points which are covered by the car.

Each button is about 4in. in diameter, and presents a convex face to the traffic, the edge being level with the road and the centre about ½in. above. They are corrugated on the surface so as to lessen the chance of horses slipping on them. They are placed somewhat closer together than the total length of the car, in order that the bars carried by the car make a contact with one set before they leave the previous set, and thus a continuous supply of current is obtained. The number of buttons, or points as they are for some reason called, in a group may be reduced to two by using the rails as a return, which in no sense lessens the safety of the system.

The construction of the electro-magnetic switch is novel. An electro-magnet is used having two coils, one of fine wire, which receives the current from the small battery carried by the car, the other of larger wire, which takes the current from the main required to supply the motor on the car. The action of this second coil is simply to reinforce that of the first coil, and to strengthen the pull of the electro-magnet in order to secure a firmer contact. On this electro-magnet being excited by the battery in the car its armature is attracted, thereby bringing into contact two sets of double carbon blocks.

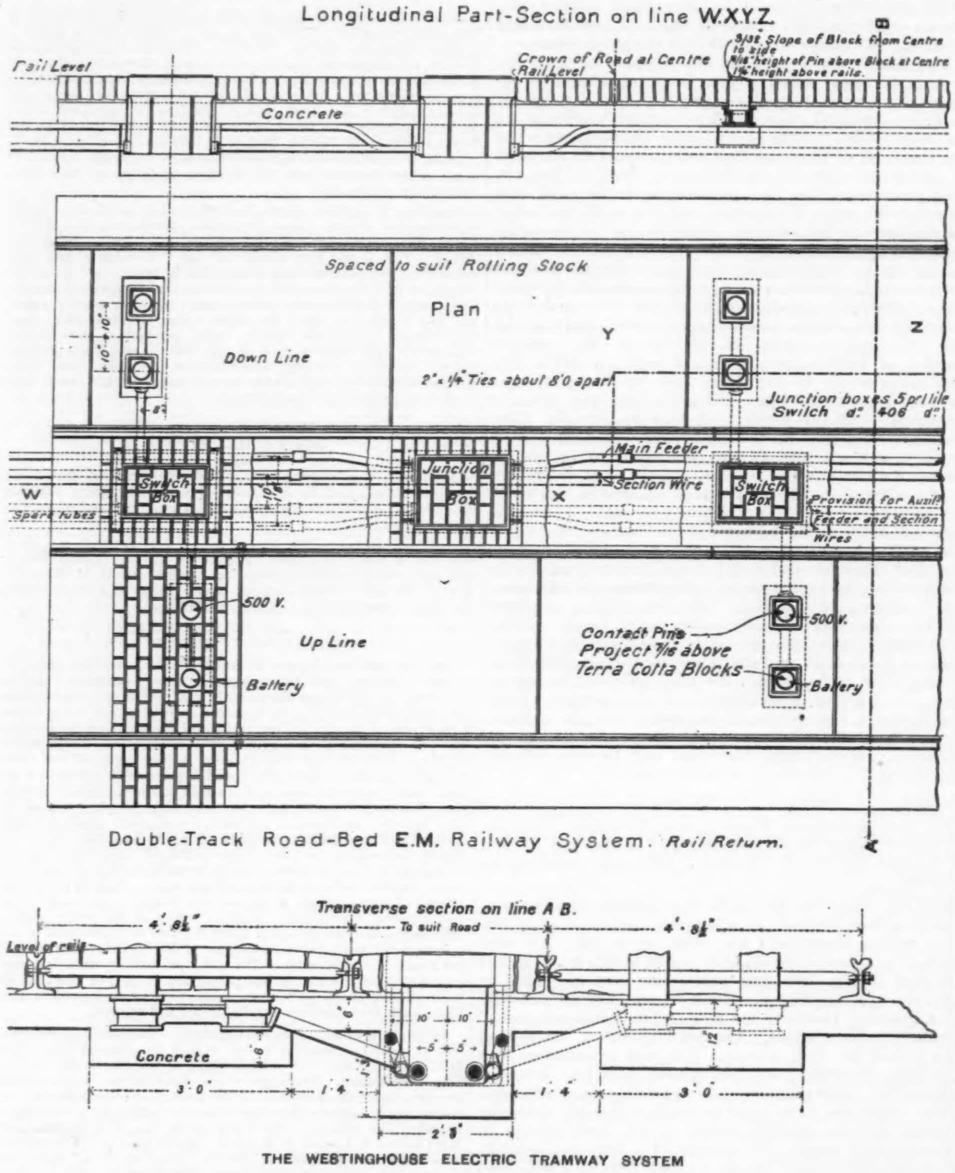
The carbon blocks in one of these sets are connected together, while those in the other set are separately insulated. In the latter case one of the carbons is connected to one of the points in the road, through the thick wire of the coil, and the other is connected to the main. It will thus be seen that when the four carbon blocks go together the connection is made between the main wire and the third contact point. Carbon contacts are used because they will not stick together by the action of the current. This switch, as will be seen in the engravings, is mounted in a bell, similar to a diving bell. The base on which this diving bell fits has a circular groove, which is filled with oil. The construction of these boxes and the switches will be seen in the engraving, page 171.

The mouth of the bell itself contains a somewhat smaller groove, so that when the two are placed together an S-shaped channel is formed, and a complete oil seal is obtained, which prevents the entrance of dirt or moisture. The base has knobs on it carrying insulated pins, which are permanently connected to the various wires on the surface of the road and the main wires.

The pins have their heads split and fit into holes, the openings of which are tapered, so that the mere effect of placing the bell into position on its base will make all the contacts necessary for the switch, and in the event of the switch becoming defective the bell can easily be lifted off and a new one placed in its position, the operation occupying but a minute or two.

The diving bell construction and oil seal make an absolutely water-tight case for the switch, which will remain dry even if the whole surface of the road is covered with water. Two of these bell switches are generally placed in one manhole in a 6ft. way, one controlling the up-line, and the other the down-line. It can therefore be readily seen that the chances of leakage and accident to the wires is very much reduced, as by the construction of the switch shown the insulation of the mains can be practically made as high as may be desired, and everything being buried underground, no accidental damage can be done to the wires.

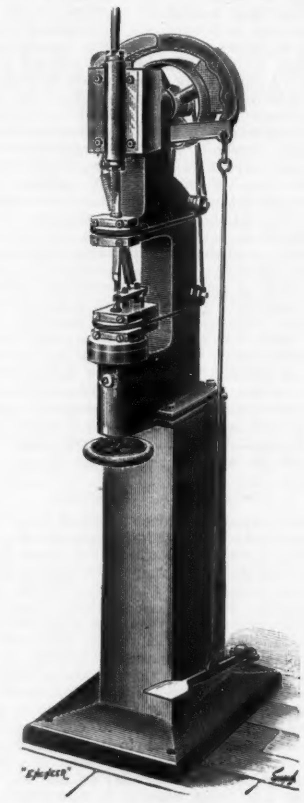
There is conduit to maintain, and the safety of the public is absolutely ensured. This system is well adapted for use on railways, where the length of trains enables very much fewer contact points to be used, and the much larger surface offered for contact makes it much easier to carry a far larger current than has been hitherto done; and as the contacts are only active at the time that the train is on them, the danger to workmen in tunnels or cuttings is reduced to a minimum.


Longitudinal Part-Section on line W.X.Y.Z.
Rail Level
Concrete
Crown of Road at Centre
Rail Level
3/32 Slope of Block from Centre to side
7/16 height of Pin above Block at Centre
1⅛ height above rails.
Spaced to suit Rolling Stock
Plan
Y
Z
Down Line
10"
10"
8"
2" × 1/4" Ties about 8'0 apart
Junction boxes 5 pr. Mile
Switch do. 406 do.
Main Feeder
Section Wire
W
X
Switch Box
Junction Box
Switch Box
Spare tubes
Provision for Auxil. Feeder and Section Wires
500 V.
Up Line
Battery
Contact Pins Project 7/16 above Terra Cotta Blocks
500 V.
Battery
Double-Track Road-Bed E.M. Railway System. Rail Return.
Transverse section on line A B.
4' 8½"
To suit Road
4' 8½"
Level of rails
Concrete
6"
6"
10"
10"
5"
5"
12"
1' 3"
3' 0"
1' 4"
1' 4"
3' 0"
2' 3"

THE WESTINGHOUSE ELECTRIC TRAMWAY SYSTEM

A BICYCLE CHAIN RIVETING MACHINE.

Builders of bicycles have adopted, for the manufacture of their chains, machines for hammering the heads of rivets over instead of spinning them. By spinning, the *Scientific American* says, the friction of the spinners against the rivets causes the metal to adhere to the spinner, thus marring and tearing the heads of the rivets. Also, with the spinning machine, it is a very difficult matter to spin over the hardened rivets which most of the bicycle dealers require to be used in their chains. The rivets are hammered by means of a reciprocating rotating hammer, also by a rotating anvil held against endwise movement, in an anvil carrier bolted to the table or support between which the chain passes. The illustration represents an improvement in that class of riveting machines designed to simultaneously head the opposite ends of the rivet, the object being to produce a simple, convenient, and effective machine, containing few parts, having a large capacity for accurate work, and not liable to derangement, at a small cost. The machine shown in the illustration, made by John Adt and Son, New Haven, Conn., is arranged for heading the rivets of bicycle chains. By removing the lower revolving fixture it is adaptable for the riveting of articles which require riveting. The distance between the revolving hammer and the table is sufficient to allow the placing of fixtures thereon for the purpose of holding the work, thus expediting its manufacture. The largest chain manufacturers in the United States are now using this machine, which has had several years' prior use as a plain riveting machine,



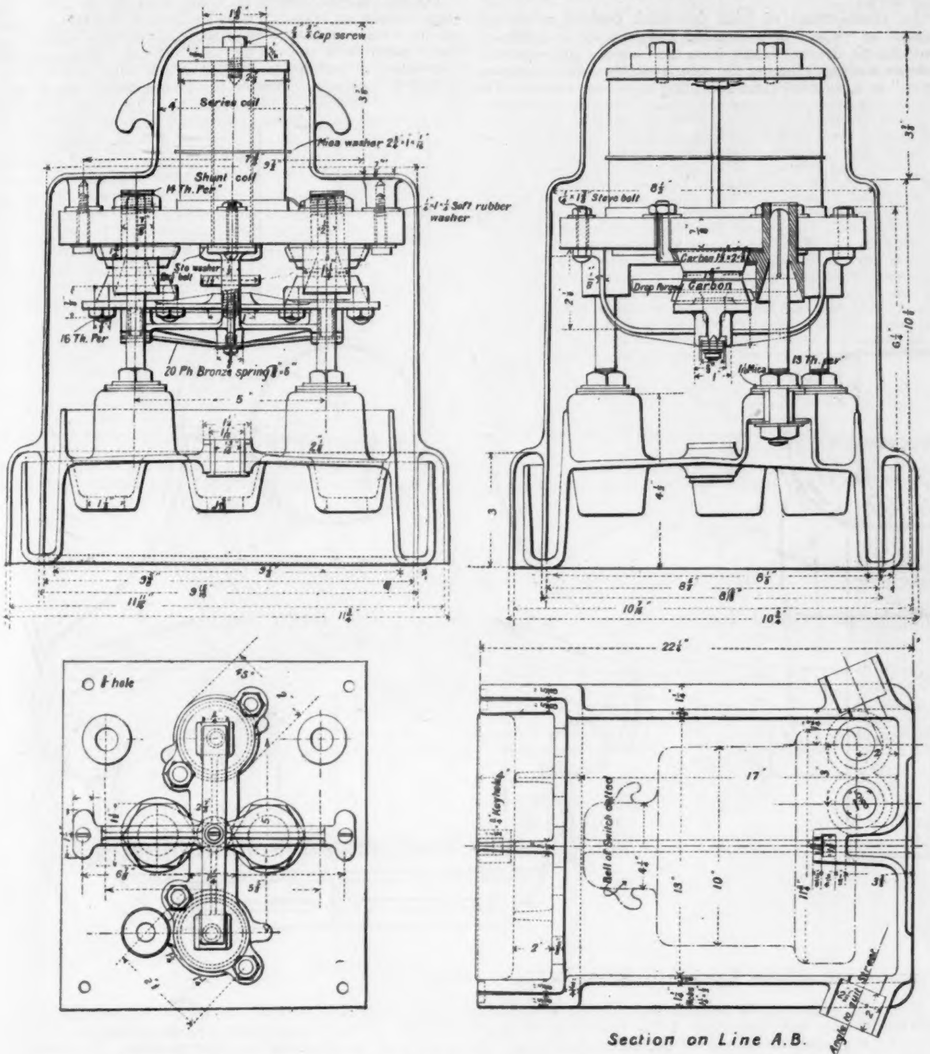
i.e., without lower revolving fixture. It is also largely used by skate manufacturers to rivet the runners of skates to the foot pieces. Messrs. John Adt and Son—F. B. Shuster, proprietor—also make an automatic wire straightening and cutting machine a large one of which has just been completed, weighing nearly six tons and being about 32ft. in length. It is capable of cutting and straightening wire from ⅞in. diameter and under, and 21ft. lengths down to 1in. in length.

MANCHESTER ASSOCIATION OF ENGINEERS.

On Saturday last the members of the above Association held their fortieth anniversary dinner at the Grand Hotel, Manchester, Mr. Joseph Nasmith, the president, occupying the chair. The loyal toasts having been duly honoured, Mr. M. Ingram proposed "Our Municipal Corporations." Whilst complimenting the corporate authorities on the important works and improvements which had already been accomplished, he urged that much remained to be done—especially in sanitary matters—before an ideal condition would be attained. Alderman Hoy, who responded, spoke at length of the important work accomplished by the Manchester Corporation in the direction of improved means for technical instruction, and remarked that the engineering and electrical students were the backbone of their technical school. There was no doubt we needed all the advantages that could be got from scientific training, and such training would become a more and more important part of the education of any person who was going to any one of the staple trades of the district. Mr. Frank Hazelton, the secretary, next read the annual report, which stated that to the membership roll during the year had been added thirteen honorary annual members, and thirteen ordinary members; and after taking into account the loss by death, resignation, and erasure, the total number of names of all classes on the roll amounted to 368, as against 360 in the previous year, viz., twenty-seven honorary life members, 126 honorary annual, and 215 ordinary members. From the financial statement it would be seen that the balance standing to the credit of the Association, after payment of all accounts due up to December 31st, 1895, was £3645 15s. 1d., as against £3469 3s. 6d. the previous year, thus showing a surplus of £176 11s. 7d. on the year's working. The payment to the superannuation members had been at the rate of 7s. per week, and during the coming year this allowance would be increased to 8s. 6d. per week. It was with profound regret, the report added, the Council had to record that during the year death had removed the following members:—Messrs. L. Burnet, Glasgow; C. Farmer, Salford; James Hall, Salford; Robert Kilgour, London; F. Meixner, Manchester; and George Vickers, of Salford. Mr. E. Windsor Richards, President of the Institution of Mechanical Engineers, proposed "Prosperity to the Association." It was, he said, very gratifying to know from the report just read that their Association was in so sound and healthy a condition, and another gratifying circumstance was the reform just brought about in the Institution of Civil Engineers, to whom a supplementary charter had been granted, largely through the efforts of their late president, Sir E. Leader Williams. A great deal had been said of late as to foreign competition and technical education, and it had been the fashion for some time to decry our own

THE WESTINGHOUSE ELECTRIC TRAMWAY SYSTEM

THE WESTINGHOUSE ELECTRIC COMPANY, LONDON, ENGINEERS



SECTIONS AND PLANS OF ELECTRO-MAGNETIC SWITCH AND BOX

industries. It was frequently said that our right hand had lost its cunning, that in technical education we were behind our continental neighbours, who were taking our trade from us, and that England would soon be left high and dry amongst the nations of the earth. Some gentlemen who lately went out to Germany and Belgium, and had a run through some of the works there, had come to the conclusion that we were not so fit to manage our business as our friends on the Continent. Many of them, however, would remember the visit paid by members of the Iron and Steel Institute to Belgium, where they had an opportunity of inspecting the principal works. They certainly found the works exceedingly well and carefully managed, but that they were better managed than English works he was not prepared for a single instant to admit. Our continental friends had no doubt taken away a great deal of our trade; this, however, was not because we were less skilful than they, but because of their large tariffs, which prevented us sending our manufactures into their countries, whilst they could send their manufactures into England without paying any tariff whatever. If the foreigners would withdraw their tariffs they would soon find that we were able to hold our own with them. The President, in responding, remarked that the Manchester Association of Engineers might be said to represent the democracy, as the larger associations, with their headquarters in London, represented the aristocracy of the profession. He thought, however, that their Association did quite as important a work as the larger associations in London—of which they were proud to be members—and was doing much to advance the prosperity of the profession, and thereby to advance the prosperity of the country generally. Mr. W. H. Hunter, M.I.M.E., engineer to the Manchester Ship Canal, proposed "Our Guests," which was responded to by Mr. Oscar Hall and Mr. James Platt. "The Trade of the District" was next proposed by Mr. T. Daniels, and responded to by Mr. Elijah Helm, secretary of the Manchester Chamber of Commerce, and the toast of the "Chairman" concluded the proceedings.

CANALS AND NAVIGABLE RIVERS.

The following is an abstract of a paper read by Mr. L. B. Wells, M. Inst. C.E., before the Manchester Geographical Society, on the 3rd inst.:—

"The writer considers that the inland waterways question is a serious one which has to be faced, for whereas from the middle of the 18th to the middle of the 19th centuries the average cost of transportation was cheaper in England than abroad, the reverse is now the case.

"In 1850 the ordinary cost of land carriage for goods in Europe was 8d. per ton per mile; the railway rates were now:—United States, 0·40d.; Germany, 0·82d.; Italy, 1·25d.; Holland, 0·78d.; France, 1·10d.; Great Britain, 1·40d.; Belgium, 0·80d.; Russia, 1·20d.; and the average 0·97d. per ton per mile, showing that the rates on English railways are 350 per cent. higher than those of the United States, and 75 per cent. higher than those of Belgium. Railway companies do not compete in rates; the only genuine competition is from independent waterways and the sea. As shown by the canal map prepared by the writer and more clearly seen as enlarged for the purpose of this paper from York southwards there is a network of canals, the total length of which approximates 4000 miles. 2550 miles are owned by independent companies; 1400 miles are owned by railway companies; 140 miles have been converted into railways; 300 miles are derelict or abandoned. Many of the navigations have been used for centuries. The majority are, however, of comparatively modern date, traffic not being of sufficient importance to warrant an expenditure of £8000 to £10,000 per mile.

"The opening of the Bridgwater Canal in 1762 may be said to have inaugurated the canal era. The writer groups the canals into six groups, viz.:—The Humber, Mersey, Birmingham, Severn, Thames, and Wash groups. The Humber and Mersey groups are nearly all barge canals suitable to vessels of 13ft. to 14ft. beam, carrying 40 tons to 60 tons. They are connected by canals owned by several different companies. The shortest route passes over four companies. The Birmingham group are all narrow canals, and the most important of them are in the hands of railway companies. The canals connected with the Severn are barge canals; one of the most important, the Kennett and Avon, which ought to provide a through route to London, is in the hands of the Great Western Railway Company. The canals around London are barge canals, and so are those connected with the Wash.

"Having regard to their dimensions, the canals of England and Wales may be divided into five classes:

	Miles
(1) Narrow boat canals aggregating about	1240
(2) Shallow barge canals	2040
(3) Improved barge canals 6½ft. deep and upwards ..	230
(4) Ship canals 13ft. to 18ft. deep	23
(5) Manchester Ship Canal..	35½
Total..	3568½

The narrow canals provide for boats carrying from 18 tons to 30 tons; the small barge from 40 tons to 60 tons; improved barge canals 90 tons to 350 tons; ship canals are short and of no present importance.

"The map shows that railway controlled canals are well situated for traffic, yet, out of a tonnage of 34,000,000 tons, they only get 6,500,000, less than one-fifth. Of the barge canals the most important ones are the Weaver, Aire and Calder, and the Severn, all of which are independent. The improved sections of these three waterways aggregate 107 miles, and the united traffic in 1888 amounted to upwards of 4,000,000 tons, the tonnage carried being one-eighth of the total carried by the remainder of the canals, and five-eighths of the total carried by railway controlled canals. The latter on nine and a-half times the length of waterway carried only 65 per cent. more traffic. Certain of the narrow canals, especially around Birmingham, are largely used. The Birmingham and Warwick Junction, which has six locks in a total length of 2½ miles, carries 195,000 tons per annum. In many of the canals the sills are well below the navigable draught of the canal, so that an additional load could be carried without structural alteration. The same horse will haul a narrow boat loaded with 20 tons on a narrow canal, a barge loaded with 40 tons to 50 tons on a small barge canal, and one loaded with 100 tons on a 10ft. waterway at the same speed. Two horses haul 200 tons and upwards on the Weaver, and on the Continent barges carrying 250 tons to 300 tons are hauled by two horses. When railways were first made the canals were handed over to them wholesale. In the year 1846 seventeen Acts of Parliament were obtained transferring 776 miles of canals to railway companies. This was one of the great mistakes in canal legislation. In France the Government bought the canals at a cheap rate and afterwards made them toll free.

"We now have forty-three navigable waterways controlled by thirteen different railway companies, including some of the main routes north and south, east and west. The railways have secured their positions by amalgamation. Nothing comparable with this has been attempted by canal companies; they remain isolated, and in many instances amalgamation is rendered impossible owing to the interposition of a railway owned canal. To proceed from London to Birmingham the canals of five different companies must be traversed. The importance which attaches to freedom of movement of material in the kingdom is seldom realised. The weight annually transported within the United Kingdom by railways equals 309,596,000 tons; by canals and navigable rivers, 36,300,000 tons; or for internal transport, 345,896,000 tons; shipped coastwise, 25,000,000 tons; total for home tranportation, 370,896,000 tons. This compared with 84,000,000 tons of cargo moved in ships trading to the Colonies and foreign ports. The coastwise and oversea traffic together reach 109,000,000 tons. Thus we find the weight transported by railway and canals is more than three times the united volume of our boasted oversea and coasting trade.

"The ocean tonnage of the world has been estimated at 140,000,000 tons; the railway tonnage carried 100 miles at ten times that amount. The average cost of railways in the United Kingdom has reached £47,000 a mile, but throughout the world it is only £15,500 per mile. The United States affords the cheapest railway carriage, having reduced their rate of late years on seven of their trunk lines from 1·40d. in 1865 to 0·32d. in 1890, but the carriage by water is 0·20 1/16d. per ton per mile, and the agitation for increasing the length and enlarging the capacity of the waterways with greater rapidity is growing year by year. The railways on which reductions were first made competed with water carriage through the Great Lakes, and these have proved among the most prosperous of the railways. It has been found impossible to regulate railway rates by law in America, and we have recently learnt a somewhat similar lesson. The Belgian railways are State owned, and the charges are made to cover the cost of maintenance and bare interest on the capital. It is reported by the Minister to require ·488d. per ton per mile to enable this to be done. Sir G. Findlay stated that the cost of full train loads of coal, and returning empties between Wigan and London, was 0·21d. in 1870, and had risen to 0·24d. per ton per mile in 1875. This rise, together with the charge of 0·4d. quoted from America, gives ground for taking 0·5d. as the lowest possible rate for general goods traffic by rail. The rate of freight from Liége to Antwerp is from 1s. 9½d. to 1s. 11d., or less than 0·25d. per ton per mile, and the canal carries 570,000 tons a year in spite of two competing lines of railway. Of the traffic into Paris by rail and water 41 per cent. is waterborne. At Berlin one-half of its imports is carried by water, and in both France and Germany the percentage carried by water has increased in much greater proportion than by railway of late years. German iron and hardware is carried by rail to Antwerp at one-half the price similar goods are carried from Wolverhampton to London, the distance being about equal. In the United States 27½ per cent. is waterborne, notwithstanding cheap railway rates. In France, 30 per cent.; in Germany, 23 per cent.; whereas in the United Kingdom it is less than 11 per cent.

"The cheap cost of conveyance by improved canals such as the Aire and Calder was given before the Committee on Canals in 188?. The question of haulage is a most important one. From the Midland brickworks in the Midlands to Brentford-on-the-Thames is 149 miles.

	£	s.	d.
Taking 24 tons as a boat load, the toll on 24 tons at 2s. 6d. amounts to	3	0	0
Haulage and navigation cost 0·33d. per ton per mile for 149 miles..	4	19	4
	£7	19	4

If the haulage be taken at the rate of steam haulage ruling on the Aire and Calder thirteen years ago, the account would stand as follows:—

	£	s.	d.
Toll	3	0	0
Haulage cost 0·33d. per ton per mile for 149 miles.. ..	0	8	9
Total cost of steam haulage	£3	8	9

A difference of £4 10s. 7d. per trip. Canals with few exceptions remain what they were before railways were made, and are still worked by horses, and we have only to compare the neglect with which they have been treated with the efforts so successfully made to develope railways to see one great reason for the decay of canals in England. Most of them require to be enlarged. Between 1887 and 1891 the number of barges 126ft. long suitable for the first class of French canals increased from 933 to 2016, or 216 per cent. At the latter period 7500 barges were in use capable of carrying 200 tons and upwards.

"The writer then quoted the Report of the Joint Committee of Parliament, 1872, which stated that canal competition with railways had been defeated and the canal system discouraged by the purchase of important lengths by railway companies. That facilities should be given for the amalgamation of adjoining canals. That no canal should be henceforth placed directly or indirectly in the control of any railway company, and pointed out that except in one or two instances these recommendations had not been acted upon. If the canal system was to take its proper place as a factor in the prosperity of the country by some means or other it must be placed on a new footing. Either the whole system must be joined into one great public trust or canals must be grouped, so as to obtain the means and benefit of organisation. Without good organisation no business could be carried on successfully in the face of the severe competition of the age. Whether any movement of real value could be made without the financial aid of Government or Corporations is a question which could only be decided after full inquiry by a Royal Commission. The writer hoped he had convinced the meeting that there was need for both inquiry and action."

King's College Engineering Society.—On Friday, the 7th inst., Mr. C. F. Mott read a paper on "Petroleum." He commenced with a sketch of the rise of the petroleum industry, and described earlier attempts at obtaining oil from wells. He next outlined the geological distribution of petroleum deposits, and indicated various theories as to the origin of the oil, also giving probable explanations of its tendency to "spout" violently from new wells. He then proceeded to describe the crude material, and the methods of obtaining, storing, and refining it. Finally, he touched upon the present uses for petroleum products, describing in some detail the legal method of testing lamp oil. At this meeting Mr. Wolfe Barry, C.B., and Mr. Walter Smith, were elected patrons of the Society.

Trade and Business Announcements.—The prospectus has been issued of the Greig Roadways, Limited, formed with a capital of £25,000 to acquire and work the patent of A. Burness Greig for improvements in the construction of paving, a new roadway material constructed chiefly of wood and asphalte made into bricks. The offices are at St. Dunstan House, Idol-lane.—The prospectus has been issued of the Daimler Motor Company, with a capital of £100,000, formed to work the patents of the Daimler motors and carriages, and to construct these motors in England. The offices of the company are Billiter-buildings, Leadenhall-street.—Messrs. Samuel Fisher and Co. inform us that owing to the lapse of lease of their premises, Nile Foundry, Birmingham, they have dissolved partnership by mutual consent as from the 31st December last. All liabilities will be discharged by Mr. C. J. Dore and Mr. R. W. Deacon, who will also receive all accounts owing to the partnership. The business and goodwill, together with all patterns, drawings, and books, have been transferred under an amalgamation agreement to Messrs. E. Humphries and Co, of Pershore, who will in future manufacture all the specialities that have for so many years been associated with the Nile Foundry.—Messrs. Fell and James give notice that the practice as patent agents and the business as consulting engineers, which have been carried on for the last seven years by them, under the titles of Fell and Wilding and Fell and James respectively, will be carried on from this date under the one style of Fell and James.

THE REED WATER-TUBE BOILER.

HER MAJESTY'S torpedo boat destroyer Lightning, delivered last year at Chatham by Palmer's Shipbuilding Company, Jarrow, went through her official trials in a remarkably creditable manner. The contract called for a speed of 27 knots per hour, maintained for three consecutive hours, and this the builders have exceeded by practically one knot per hour. The average for the three hours gave 27·944 knots per hour. In the best of the runs over the Maplin, the Lightning ran the mile in 1 min. 55 sec., being equal to 31·3 knots, or over 36 miles per hour. She had all her weights on board, being loaded down to contract conditions. The entire absence of flame from the funnels, and the absolute freedom from vibration which made her sister ship the Janus—also Palmer's build—so conspicuous, were just as marked in the case of the Lightning.

Fig. 1.

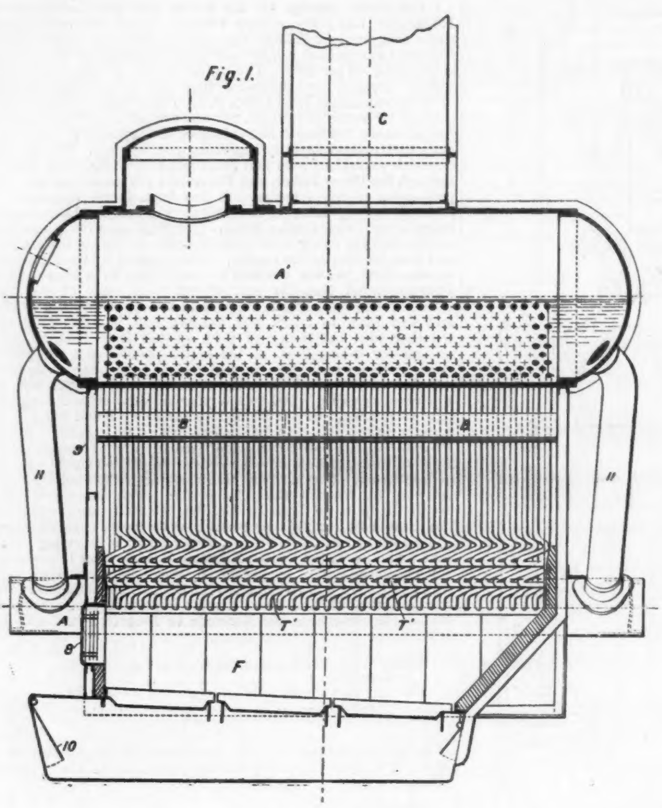
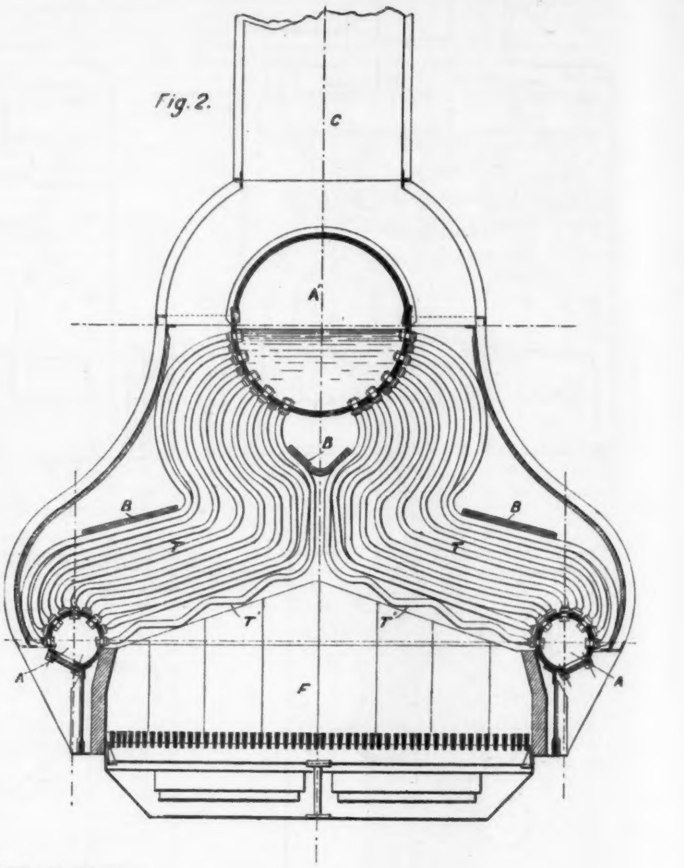


Fig. 2.



REED'S WATER-TUBE BOILER, H.M.S. LIGHTNING

The Lightning is a duplicate of the Janus, the propelling machinery consisting of two sets of three-cylinder triple-expansion engines driving aluminium bronze propellers, and supplied with steam by four of Mr. Reed's patent water-tube boilers. The whole result was obtained with the greatest ease, and the working of the machinery, also the steaming of the boilers, was all that could be desired. The amount of coal consumed during the three hours was 14 tons. The steam pressure during the trial averaged 195 lb. per square inch, and the average revolutions 368 per minute.

After the three hours' speed trials had ended the vessel was put through an elaborate series of other trials, including full speed circles in both directions, circles astern at a little under full speed, also circles and general steering by hand gear. The handling of the engines with regard to stopping and starting was very severely tried, and seeing that with the hand gear only about seven seconds were necessary to go from full speed ahead to full speed astern, nothing better could be desired. The vessel was in command of Lord Charles Beresford. Mr. Welch and Mr. Emdin watched the trial on behalf of the Admiralty. The trial was conducted on behalf of the contractors by Mr. J. W. Reed, their engine works manager. Mr. W. J. Anstey represented the interests of the Engineer's Department of the Dockyard, and Mr. E. Cornish that of the Steam Reserve. It may also be stated that the Lightning on her run round from the Tyne occupied only about 13½ hours in covering the distance, running about 20 to 21 knots, practically under natural draught. This is probably the greatest speed at which a vessel has gone from the Tyne to the Thames. Altogether the builders are to be congratulated on the successful results.

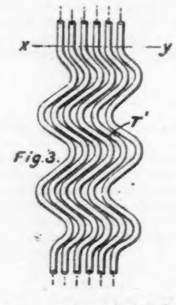
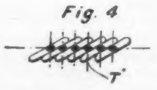


Fig. 3.

Fig. 4



We illustrate the boilers of the Lightning, which are of the three chamber class, with four large external downcast pipes. Probably Mr. Reed will find that these are superfluous after some further experience. Fig. 1 is a longitudinal section; Fig. 2 a cross section; Figs. 3 and 4 are details showing the particular arrangements of the tubes; Fig. 5 shows the method of fixing the tubes. A more or less semi-spherical screwed washer or ferrule 3 with a canted surface 3ª thereon is screwed tightly on to the tube 4, and the tube-plate 5 is dished as shown to a radius corresponding with that of the ferrule. By screwing up the nut N the ferrule can thus be drawn into close contact with the tube-plate, so as to make good the joint.

The arrangement of joint described enables a certain amount of "play" or movement to take place in a tube or the tube to diverge slightly from the correct line in the first instance without effecting the security of the joint, which can "give" to a certain extent according to circumstances. The hole in the plate will be large enough to give a clearance between its sides and the outside of the tube so as to afford space for any small movement of the tube at its joint. In the figures, 8 are the fire doors, 9 the cleaning doors, 10 the ashpan doors, and 11 the circulating pipes connecting the lower chambers A with the upper chambers A¹.

The downcomers were arranged primarily to give a certain supply of water to the bottom ends of the tubes, but at the same time they form a substantial part of the framework of the boiler. The tubes are of solid drawn steel galvanised externally by electro-deposition. The lower chamber is of cylindrical cross section with a flattened lower side, and provided with handholes for access; a manhole is provided in the upper chamber. The tubes are readily secured, and in the event of damage can be removed and replaced in a very short time; at the same time a very secure joint is made, for in the vessels referred to there are in all upwards of 30,000 joints, and though they have been many times under steam, not a single leak has occurred. Baffle plates B are provided, as shown, to assist in directing the flow of the gases. The furnace and tube casings are double, with an air space between, the fire side being lined in an effective manner with an asbestos composition, the outer casing being quite cool; even when under heavy forced draught, the hand can be borne comfortably on the boiler front. The lower part, near the grate, is lined with fire quarls. The furnace has three doors arranged to close and fasten automatically. The arrangements are such that all air supply to the furnace passes through automatic doors, all precautions being taken to prevent flame being forced into the stokehold, in the event of an accident to a tube. These precautions were considered desirable at the time of designing the work, owing to the unfortunate accidents that had then occurred in some other parts of the country. In this case the necessity for such precautions has never arisen, for although the twelve boilers in these three vessels, the Janus, Lightning, and Porcupine, have been many times under steam under forced draught, some up to as far as 5½in. of water, there has not been a single accident or leak of any kind.

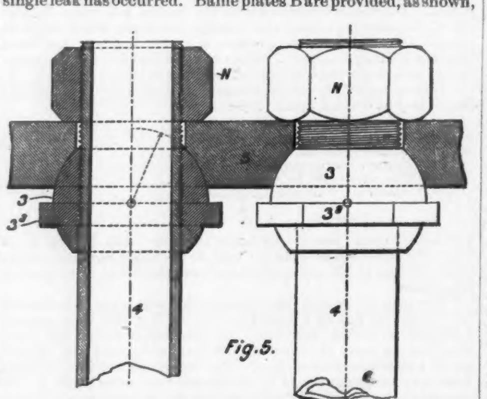


Fig. 5.

There are four boilers in each vessel, each having its separate main feed pump, the feeding being controlled by Reed's automatic feed regulator. In the upper chamber and dome a simple but effective form of separator is fitted, which ensured freedom from priming even at the highest rates of evaporation.

During the experiments on shore with the first boiler of these vessels, an evaporation at the rate of 28,300 lb. of water per hour was obtained. The boilers are capable of supplying more steam than the engines can take, and an opportunity was taken to try the Porcupine at sea with only half her boilers in operation. Under these conditions a mean speed of 23·79 knots was obtained, and the two boilers supplied steam for 2800 indicated horse-power, or 1400 indicated horse-power each, with less than 4in. of water pressure. The boiler is of substantial design throughout, but the weight complete, with furnace gear, clothing, mountings, &c., is only 13¾ tons. On an evaporative trial of six hours with one of the boilers on board the Lightning, an evaporation of 12 lb. of water per pound of coal was obtained, we understand, using Welsh coal.

GENERAL OWEN ON "DRIFT."

ON Thursday, February 6th, General C. H. Owen, R.A., best known as the author of "Modern Artillery," read a paper at the Royal Artillery Institution on the question of "Drift," which he considered had been allowed to lapse into a less satisfactory condition than when he left the service. He dwelt on the doubtful and casual treatment of it in recent artillery works, such as the official treatise of gunnery by Major Mackinlay. He went through the records of the experiments on which his conclusions had been based, and invited discussion. His main position was that pointed projectiles with a right-handed twist carried to the right under most service conditions, and flat-headed ones to the left. This he attributed to the position of the resultant of the air pressure, and illustrated it by the gyroscope, as he had previously done by the flight of a model projectile.

The audience, as might be expected, consisted of such artillery officers as were interested in mathematical questions affecting the flight of shot, but while it included several well known specialists it was much larger than might have been expected. Major MacMahon, in the discussion which followed, abstained from any application of high mathematics to the treatment of the question, but urged the use of photography to determine the actual position of projectiles towards the end of the trajectory. Professor Greenhill followed very much the same line, urging that there are forces acting on the shot that require investigation in addition to those dealt with by General Owen; for this reason he supported Major Mackinlay's treatment of the question in the present state of our knowledge. Captain Cooper exhibited a curious effect by means of a model devised by himself and Mr. Greenhill. By this it was shown that a spinning gyroscope, enclosed in a card box running over a switchback course, turned towards the right on a concave part of the track and to the left on a convex. As the gyroscope was protected from the action of the air, this was not the effect dealt with by General Owen; moreover, its action was in the opposite direction. Altogether it was generally felt that while General Owen had investigated and dealt with the action of certain forces with great ability, there were others of which account must be taken, and that the most hopeful means of pursuing the question lay in the application of photography to a well arranged programme of firing.

THE Students of the City and Guilds' Technical College, Leonard-street, Finsbury, are holding their biennial conversazione on Thursday, February 20th, for which Professor Silvanus P. Thompson, D.Sc., F.R.S., has been induced to prepare a lecture on "Invisible Light and its Photography," a subject suggestive of recent discoveries and current scientific topics. The lighter portion of the programme consists of a concert and dance, while the whole of the College not used in the entertainment is to be given up to exhibits of model machinery, electrical appliances, and chemical manufactures.

RIVER PARRETT IMPROVEMENT SCHEME.

IN THE ENGINEER of November 1st, 1895, we published the report which accompanied the first prize designs by Mr. E. D. Stoney for proposed scheme for the improvement of the navigation of the river Parrett by the formation of a ship canal to Bridgwater. We now give the report which accompanied the scheme, of Mr. H. G. Foster Barham, Assoc. M. Inst. C.E., to which was awarded the second prize by the Bridgwater Port and Navigation Board. It was suggested that the first and second prizes should be divided between these two competitors, but Mr. Barham felt so strongly that the river improvement rather than a canal was the proper course to pursue, that he preferred to take the separate prize for a separate thing. Subsequent events have proved the correctness of thit view, as the Bridgwater Port and Navigation Board have now abandoned all ideas of carrying out a ship canal, and have consulted Mr. W. H. Wheeler, of Boston, as to the advisability of carrying out improvements to the river Parrett:—

In compiling this scheme for the improvement of the Parrett Navigation, I have been influenced not only by a desire to advise the best from an engineering point of view, but also to study the interests of Bridgwater. There appear to be two alternatives:—(1) To cut a canal between Bridgwater and Combwich Reach; (2) to improve the present river course. I shall advocate the second of these because I consider a canal inadvisable, and unsuitable for reasons which I here give:—(*a*) It would not be a financial success, and I doubt whether the trade and prospects of Bridgwater warrant the expense that would be incurred. (*b*) There would be considerable difficulty in obtaining an adequate water supply. (*c*) Certain difficulties connected with the making, use, and maintenance of the canal, which I shall deal with hereafter.

In my opinion the canal would not pay, because I believe it would be quite the exception for vessels to use it. Ships of 300 tons and over might, it is true, prefer not to run the risks of the present channel, and smaller vessels might use it in order to avoid the neap tides, but large vessels and neap tides are the exception, not the rule at Bridgwater. I have assumed that the existing docks owned by the Great Western Railway Company will be connected with the canal, and that no fresh ones would be made. Co-operation with this company is, I consider, an essential in any canal scheme. In my estimate I have allowed no sum for the use of the docks or of the present canal as a conduit for the water supply.

Dealing next with the quantity of water necessary for the proper working of the canal, and assuming its top water level to be at 26·0 O.D., which is about 1ft. higher than the highest flood since 1883—that there are two locks, one at each end of the canal, each 230ft. long, by 35ft. broad, with an average drop in water level of 12ft. at the Combwich end, and 6ft. at the Bridgwater end, the former to be opened for calculating purposes at the most, say, five times, and the latter four times daily. Then I estimate the quantity of water necessary for the maintenance of the canal will be as follows:—

At the Combwich end	483,000	cubic feet per day.
At the Bridgwater end..	193,200	,, ,,
Which makes	676,200	,, ,,
To this I add 25 per cent. for waste, leakage, and evaporation	169,050	,, ,,
Making a total of	845,250	,, ,,
Or	5,282,812	gallons per day.

Such a demand would be very exceptional under present conditions, but provision ought to be made for its supply. There appear to be three available sources of supply:—The Cannington Brook, the Durleigh Brook, the river Tone.

The drainage area of Cannington Brook is approximately 12,032 acres. Calculating on a minimum dry weather discharge of 0·25 cubic feet per second per 1000 acres, which I believe the streams in this neighbourhood might well fall to, then the minimum dry weather discharge would be 1,624,320 gallons per day. Of this I consider a quantity of 1,120,000 gallons ought to be retained as a drinking supply to Bridgwater, assuming that the population might be trebled during the next hundred years. This leaves a surplus of 504,320 gallons per day for the canal. I understand, however, that Lord de Mauley has the right to pump water from the brook outfall, in order to irrigate the Pawlett Hams, which are 3050 acres in extent. Indeed, his agent told me that during dry weather the whole available discharge is used for this purpose. In order to utilise this supply, the stream would have to be dammed back for a considerable distance, and the banks raised from 4ft. to 5ft. at the outlet end. A bye-wash would also have to be provided for the storm water. From gaugings I have taken, I should say that during the summer months there would be a present average discharge of about 2,500,000 gallons per day at the mouth of this stream, not reckoning any deduction for pumping on to the Pawlett Hams.

The drainage area of Durleigh Brook is approximately 4480 acres. Calculating as before, there is a minimum discharge of 603,348 gallons per day. Of this the Bridgwater Swimming Baths take a weekly supply of 133,000 gallons, and in addition a daily supply of 4000 gallons to keep them fresh. We may, therefore, reckon on a minimum available quantity of water from this stream at, say, 570,000 gallons, and an average summer supply of, say, 1,400,000 gallons per day. I understand from Mr. J. H. Waddon, of Bridgwater, that he has the absolute mill rights over the Durleigh Brook, but that he would relinquish such rights for the sum of £100, and an annuity of about £7 for seventeen years, at the end of which time his lease expires. It is probable that the freeholders would also have to be compensated. There is from this brook an available fall for gravitation of 18in., assuming that the water was taken along the towing path of the present canal. I should recommend the laying of an 18in. cast iron pipe, with spigot and socket joints. This, at a cost of 33s. per yard in the ground, would amount to £2200.

The Patnell Rhine and Hamp Brook are both small streams and do not permit of the water being gravitated into the proposed canal, and for practical purposes are not worth considering. It appears, then, that if the water rights were purchased on the Cannington and Durleigh brooks, there would be a sufficient water supply for the locks for ordinary purposes, but a totally inadequate supply during times of extreme drought, combined with heavy traffic through the locks. The only certain source seems to be the river Tone. If arrangements could be come to with the Great Western Railway Company to use the present Bridgwater and Taunton canal as a conduit, and either to buy up the water rights, or to do as is done now and pump water when necessary from the Tone at Creech St. Michael, where there is a lift of 26ft., and again from the present canal into the proposed canal at Bridgwater, a rise of about 5ft., then I consider a canal is quite feasible as far as its water supply is concerned.

I am of opinion that the subsoil is not very favourable for cutting a canal. Clay with layers of sand and peat intermixed, although easy to excavate, are about the worst materials to stand at a slope. During construction water permeates through the most pervious beds, acts as a lubricant, and allows the stiff clay and top soil to slide down the slope, while the peat and lower silt squeeze laterally into the cutting, with the result that the whole mass settles down. I have had considerable experience in this class of work, and know only too well that as a rule the lower one excavates through the alluvial deposits of this district, the softer and milder the clays become. Near the Bridgwater end, the bottom of the canal would be in peat, and sheet piling would probably have to be driven in order to keep the banks up. I do not believe anybody could say to what extent this might not be necessary without making trial pits along the canal. Bore holes are notably misleading, and my opinion is that in many places the banks would not stand at a slope of 3 to 1 without considerable support, either from stone pitching or by means of stakes or piles. The brown clay and the top of the blue clay at the Bridgwater end of the canal would be worth something to the brick and tile yards of the neighbourhood. It could probably be sold at 7d. a cubic yard, but it would take many years to get rid of it. I have deducted £4600 for the sale of the clay in my estimate of the cost of a canal. The clearing away of the silt which would accumulate at the bottom of the canal at the Combwich end would be a constant cause of expense, just as it is in the present Bridgwater Dock. It is impossible to avoid the silt entering the canal, as the salt water charged with sediment is of considerably greater specific gravity than the canal water, and fills up the lower part of the lock immediately the gates are open.

The question of vessels entering canal is a matter which wants some attention. The flood tide passes up Combwich reach at a rate of from three to four miles an hour. If, therefore, ships leave Burnham much before three-quarter flood, they will reach the lock gates at a time when the current is so strong as to make entering those gates most difficult. Waiting for the fuller tide would involve serious delay in reaching Bridgwater, and would make the captain of any vessel hesitate before adopting such a course.

I estimate the cost of constructing a canal 19ft. deep, 50ft. wide at the bottom, with slopes averaging 2½ to 1, as follows:—

	£	s.	d.
Excavation and embankment	44,605	0	0
Land	9400	0	0
Locks	13,410	0	0
18in. pipe from Durleigh Brook	2200	0	0
Parliamentary expenses	4000	0	0
Buying water right, Durleigh Brook	300	0	0
Pumping station at Creech	1000	0	0
,, ,, ,, Bridgwater	1000	0	0
Two lock keepers' cottages	500	0	0
One pumping station cottage	250	0	0
Sheet piling in canal	1458	0	0
Pitching slopes	5000	0	0
Bye waste, outlet works, and raising banks at outlet of Cannington Brook	200	0	0
Ditch each side of canal	565	0	0
Towing path ,, ,, ,, ...	1807	0	0
Mooring posts, lighting, &c.	80	0	0
Superintendence	2000	0	0
Highway Board, easements, compensation ..	1000	0	0
Sundry charges	500	0	0
Unforeseen expenses	2000	0	0
	91,255	0	0
Less value of clay	4600	0	0
Making total of	86,655	0	0

This estimate takes no account of compensation to the Great Western Railway Company for the use of their docks, or of their canal as a conduit. Neither does it reckon in any compensation to Lord de Mauley for interfering with his rights, if any, to the water of the Cannington Brook. All things considered, I do not believe a canal would be constructed under a cost of £100,000. Assuming this sum was borrowed at 3½ per cent., and had to be repaid in fifty years, then the annual sum of money required to pay off this debt would amount to £4266, or approximately 4¼ per cent. on the borrowed sum.

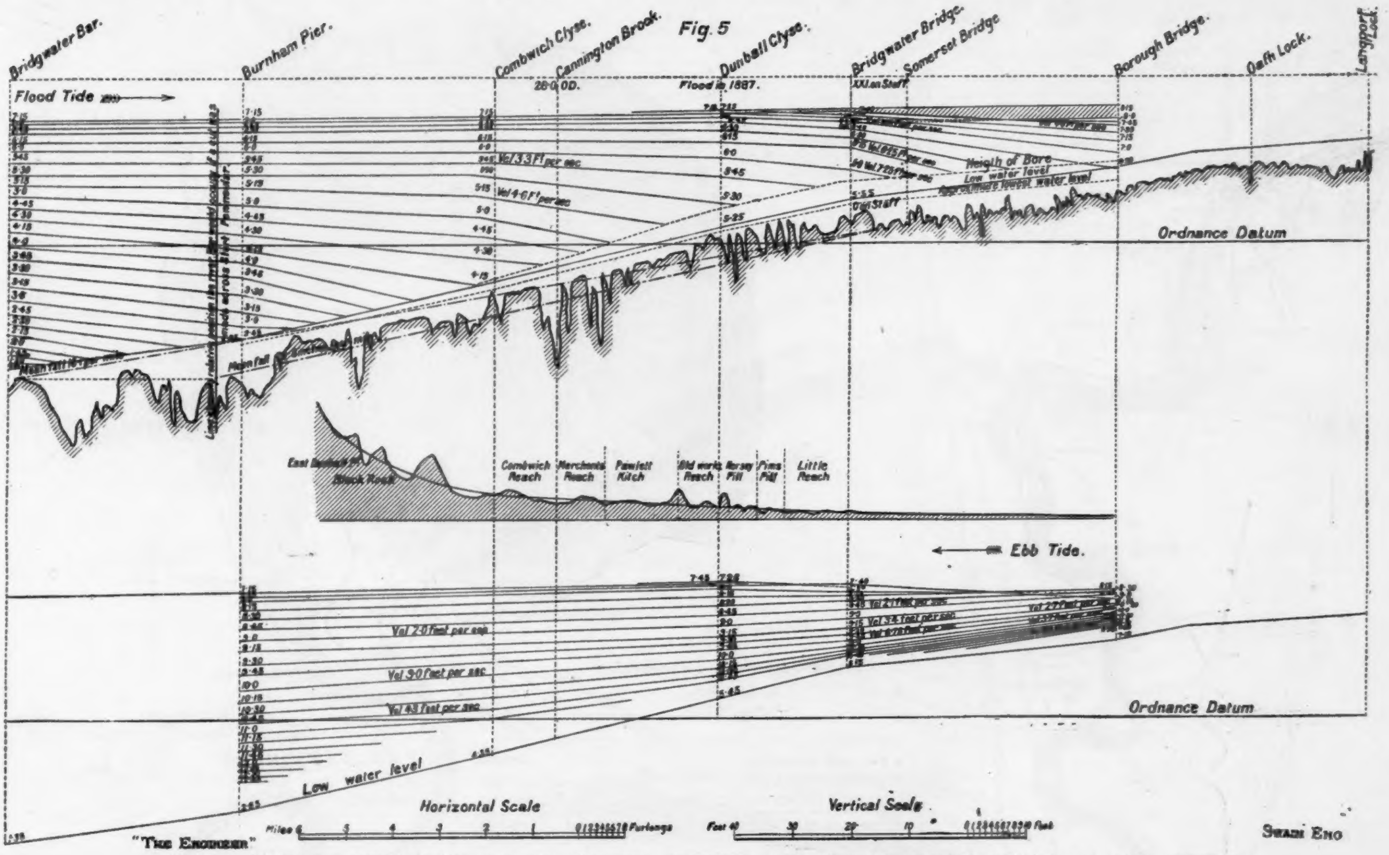
The rateable value of Bridgwater is £41,353, and a rate of 1d. in the pound produces £150 per annum. Thus if the borough alone had to pay for the canal there would have to be an extra rate of 2s. 4½d. in the pound in order to pay off £4266 annually—an increase of more than one-third on the present rate. The annual cost of maintenance of the canal I should reckon at about £600 per annum.

Having now shown my reasons against the construction of a canal, I will proceed to set out what I consider to be the best scheme to adopt. I have made a most careful inspection of the river Parrett, from Burnham to Langport, and also of the rivers Tone and Brue. I have taken tide readings—Fig. 5—of the Parrett, without which it is impossible to thoroughly investigate a tidal river, and I have also taken samples of water, and velocity gaugings at different points along the channel. I attach special importance to the tidal diagrams, as they demonstrate the peculiarities of the river, which if not taken into account would tend to lead to wrong conclusions. The peculiarities of the Parrett are mainly due to the geological formation through which it flows; the great rise of tide, combined with a wide-mouthed entrance channel; and to the sand banks at the mouth of the river. The effect of these last is so to retard the tidal wave, that on a high spring tide such as that of September 30th, 1894, there was a difference of level on the rising tide between Burnham and Combwich, immediately before the tide reached the latter place, of 7ft. 6in. in a distance of five miles. Between Combwich and Dunball this amount was 9ft. in five miles, and between Dunball and Bridgwater 6ft. 3in. in two and three-quarter miles. This great difference in level gives rise to the "bore," which is largest where the contraction of the channel is greatest, *i.e.*, between Dunball and Bridgwater. The velocity of the tidal wave was as follows:—

Between	Bridgwater Bar	and	Burnham	5ft. per second.
,,	Burnham	,,	Combwich	4·5 ,, ,,
,,	Combwich	,,	Dunball	6·4 ,, ,,
,,	Dunball	,,	Bridgwater ..	8·0 ,, ,,
,,	Bridgwater	,,	Borough Bridge	9·1 ,, ,,

High water level at Combwich was 7in. higher than at Burnham.
,, ,, ,, ,, Dunball 1ft. 4in. ,, ,, ,, ,,
,, ,, ,, ,, Bridgwater 1ft. 1in. ,, ,, ,, ,,
,, ,, ,, ,, Borough Bridge 2in. ,, ,, ,, ,,

A study of a map of the district shows what a wandering course the tidal rivers have carved out, through the estuary deposits they have built up. These wanderings give rise to tidal oscillations, which when once set up are most difficult to stop, and their tendency seems ever to make the channel less and less straight, as may be



PLAN No. 1—DIAGRAM SHOWING FLOOD AND EBB TIDE 30th SEPTEMBER, AND DIAGRAM SHOWING BREADTH OF RIVER PARRETT seen by following the old flood banks along the river, which appear to trace out a much more direct course than the present ones do. The result is that the fall of the river per mile of its course gradually diminishes, and tends to the deterioration of the channel. The mouths of the Parrett, Brue, and Axe, each demonstrate the influence of the south-westerly gales, which beat up a bar across their outlets, causing them to take first a north-easterly and then a south-westerly course. Thus there is little doubt in my mind that Stert peninsula is the old bar of the Parrett, which long caused it to take a north-easterly direction. The time is even within the recollection of some of the pilots, when ships could pass in and out between Stert Island and this peninsula, and although this is now impossible, there is at the present day an exactly corresponding channel immediately north of this island, and called the "westerly course," through which there is still a sufficient depth of water for ships of moderate draught to pass. This only shows how the channel has tended further and further to the north-east, until at last the hillocks raised by the wind blowing across the Gore sand became a formidable enough barrier to effectually turn the channel, which is now well on its south-westerly tack, which it will probably continue until turned once more by the limestone cliffs west of Stolford. The Gore sands will accumulate, and in twenty or thirty years, perhaps less, there will be, I believe, an island a mile west of Berrow, where there are now very few feet of water even at the highest tides. These facts are impressed upon one by a study of Fig. 3, which is reproduced from the Admiralty sheet.

I have dealt rather fully with the conditions at the mouth of the Parrett, because they have considerable bearing upon a portion of my scheme. The part of the river between "Nine Streams" reach and "Little" reach is the portion which gives the chief difficulty to navigation owing to the sharp bends. The depth of water between Combwich reach and Bridgwater wants if possible increasing, so that ships of ordinary draught may reach the latter place at all tides. The present low-water channel may be described as a series of pools called "Bights," varying from 5ft. to 15ft. deep, which occur at the outer side of the bends, and which are connected by rapids of shallow water, often not more than 6in. deep. The irregularities of the river bed are shown on Fig. 5. Between two opposite curves, the flood and ebb channels take different sides of the river, leaving a shoal or sandbank between them, and in a rapid river this is well nigh impossible to prevent.

There is only one way of increasing the available depth of water in the channel, and that is by deepening the river bed, and thus lowering the low water line. This can be accomplished permanently by shortening the length of the present channel, so as to increase the fall per mile, or it can be done temporarily by scouring out a deeper channel, and giving a more uniform fall to the river bed. My scheme is to deepen the present channel of the river, and to make it follow better lines. I also suggest the making of a channel across Stert Peninsular.

I recommend the purchase of a steel-hulled steam launch for the purpose of carrying out the improvements proposed in this scheme. The requirements of this launch may be stated as follows:—It must be capable of steaming up against the ebb tide, and while so doing of stirring up, scouring, or eroding such portions of the bed of the river as lie high, of clearing out ships' berths, washing away sandbanks lying above water level, and cutting if possible through bends of the river. Its manager would conduct such training works as shall hereafter be described, and would superintend the carrying out of such operations as from time to time would be required for the improvement of the navigation. Several systems might be adopted for scouring the bed of the river. I may mention those of forcing water or air, by means of jets, into the silt, of eroding the bed of the river by means of revolving cutters, mounted on a vertical shaft, or of raking up the bed of the river by drawing a harrow along the bottom. I shall recommend a combination of the first and last of these methods. Plan Fig. 1 shows a launch 60ft. long, 14ft. beam, and drawing 4ft. of water. She will be fitted with a compound surface condensing engine of sufficient power to drive the boats 8 knots, with a locomotive marine type boiler, capable of supplying steam to the above engine, and also to the following:—Two auxiliary donkey engines for purposes of working the air, circulating, bilge, and feed pumps: one pair of compound coupled surface condensing engines, for purposes of working, and connected directly with two 8in. centrifugal pumps, to work at 300 revolutions per minute, with an outlet pressure of 20 lb. per square inch, and capable of discharging together 2400 gallons per minute. These pumps will be able to deliver water either to the stern or to the bow of the launch as required, by means of 8in. diameter cast iron pipes passing along and under each side of the deck.

For scouring and deepening the bed of the river, I propose to pump water to the stern of the boat, and round a U shaped 8in. diameter wrought iron pipe, pivoted as shown near its top ends, and connected by means of hose pipes with the two pumps. The bottom of this U bend will be of square section, and to its lower side will be screwed eight 2in. diameter discharge nozzles, through which water will project against the bed of the river. I propose also to fix rakes along this pipe, in front and in line with the jets, to assist them in their work. The lower end of this U bend will be suspended by ropes with pulleys from davits as shown, so that the jets can be lowered to the required depth, or when not in use, lifted up into a horizontal position when the U bend will fit the stern of the boat. This method has the advantage that it automatically adjusts itself to any depth less than that to which it is set. It will also be desirable to direct jets of water from the bow of the launch, for the purpose of cutting into and through sandbanks, clearing out ships' berths, and generally for scouring into such places as are difficult to deal with from the stern. The drawing shows the arrangement of these jets. Two vertical 8in. diameter cast iron pipes, capable of being removed when not in use, are fixed on each side of the bow of the launch. Both are capable of being turned round on their vertical axis by means of handles at their tops. At the bottom of each pipe is a curved nozzle, with a 3in. diameter outlet, which will be bolted to the bottom of the vertical pipes, by flanges cast at an angle of 60 deg. to the vertical axis. By so doing it will be possible to set the nozzle at any angle to the vertical axis as shall in practice be found most effective. The connection with the 8in. pipes from the pumps will be made by short lengths of hose pipe. One person at the bow of the launch will thus be able to direct the jets in any required direction.

A considerable annual expense might, I think, be saved by adopting a more economical method of removing the silt from East Quay. At present this is done by men throwing it out into the middle of the channel. A method I propose is to lay a 15in. cast iron pipe along the quay wall. At every 40 yards of this pipe there would be a 12in. diameter branch pipe, with a sluice valve to control it, which pipe would lead downwards and be connected with a 12in. diameter pipe 40 yards long, running at the bottom of the quay wall on the graving bank. Each length of such pipe would have 120 small ¾in. diameter holes placed along it. Water would be pumped from the river by the steam launch into the 15in. pipe at any convenient point, say near the bridge. All that would then have to be done would be to open and close each 12in. sluice valve in turn. I believe the whole graving bank could by this means be cleared of mud by two men in less than a day, and if this could be done, it would certainly save Bridgwater £120 per annum. I should recommend giving this system a trial for a short length to see how it answers. I have not estimated the cost of laying these pipes in my scheme, and, indeed, only offer the suggestion as a possible use to which the steam launch might be put.

None of the large bends above Combwich can be cut off without interfering with existing works, such, for instance, as those at Dunball, Pawlett, and Combwich. The one cut which would, I believe, be beneficial to all concerned, would be that across Stert Peninsula. The effect of making such a channel would be of enormous benefit to Bridgwater. Not only would it shorten the distance from the bar to the town by 4¼ miles, or nearly a quarter, but what is even of greater importance, it would increase the time of flood tide at Bridgwater by a full hour, allowing ships to get up from twenty minutes to half an hour earlier than at present, and permitting them to leave later. High water at Bridgwater would be some fifteen minutes earlier, and from 3in. to 6in. higher than at present, and at Borough Bridge it would be as much as half an hour earlier, and about 2ft. higher. The mean fall in the bed of the river from a point half a mile above Bridgwater Bridge to the bar of the river would be increased from 16·1in. to 20·8in. per mile. I have no hesitation in saying that the result of increasing the fall by this amount would alone materially improve the depth of water at all times, and with the aid of mechanical scouring as already described, I believe sufficient depth of water could be obtained for ships to reach Bridgwater at all tides.

Another important result of making this channel would be that the tidal volume passing up and down the river would be much increased. This would result not only owing to the extra depth of water at the bottom of the river which the tide would fill, due to the deepening of the channel, but what is of far more importance, because the tide would reach and fill the upper part of the river, which at present it has not time to do. Unfortunately, I did not at first realise the importance of this point, so that my tidal readings did not extend above Borough Bridge, and I am, therefore, unable to calculate what quantity of water this would represent; but assuming a mean width at high water between Bridgwater and Borough Bridge of 35 yards, then the extra quantity of tidal water passing Bridgwater four times daily, on such a tide as that on September 30th, and when the quantity of fresh water coming down was small, would be nearly 40 million gallons for that length alone, and if the river above Borough Bridge were reckoned in, this quantity would probably be increased to something like 150 million gallons. I have shown hatched on the flood diagram Fig. 5 the area of water between Dunball and Borough Bridge which is not filled by the tide. The reason of this is not very difficult to explain. The tidal wave on September 30th took 5 hours 35 minutes to travel from Bridgwater bar to Borough Bridge. High water at the latter place was just an hour later than it was in the Bristol Channel, and at that time the water at Burnham had already sunk 3ft. 3in. It will be thus seen that the water at Borough Bridge never had time to rise to its proper level, consequently all the beneficial scour of this quantity of water, which would have passed nearly the whole tidal length of the river, was lost. No doubt the tide of which I took the readings was an exceptionally high one, but the same thing occurs every day, only on a smaller scale.

While on this subject I should like to point out how intimately the interests of the Port and Navigation and of the Somerset Drainage Boards are connected, and of the benefits that would accrue if they could work more in conjunction. I am indebted to Mr. F. Lowry, A.M.I.C.E., the engineer to the latter Board, for that part of my tidal diagram showing the river bed between Bridgwater and Langport. This section shows a large deposit above Borough Bridge, due no doubt to the fact that the energy of the flood tide is here exhausted in damming back the fresh water; the result is slack water, and a deposition of the coarser particles held in suspension. I here give the results of samples of water taken at different points along the river, showing the proportion of sediment by weight and by volume in a gallon of water. The volume was measured by allowing the sediment to settle in a gauged glass, and to obtain the weights I dried the deposit and had it accurately weighed. Samples were taken at half flood and half ebb at each of the places:—

River Parrett Water.—Proportion of Sediment, September 30th, 1894.

		Proportion by volume.	Quantity in 1 gal. of water. lb.
Burnham Pier	Half flood	1/123	·034
	Half ebb	1/172	·0242
Combwich Clyse	Half flood	1/34	·1213
	Half ebb	1/43	·0971
Dunball Clyse	Half flood	1/16	·2621
	Half ebb	1/78	·0534
Bridgwater Bridge	Half flood	1/57	·0728
	Half ebb	1/20	·2087
Borough Bridge	Half flood	1/172	·0242
	Half ebb	1/191	·0225

I do not think there is a great deal to be deduced from these samples, as the amount of sediment is much influenced by local circumstances. The muddiest sample, that taken at half flood at Dunball, is chiefly due to the rough water immediately below that place in "Old Works" Reach. The extremely muddy sample taken at half ebb Bridgwater Bridge, I can only account for by the river being contracted above the bridge, and hence the current more rapid at this point.

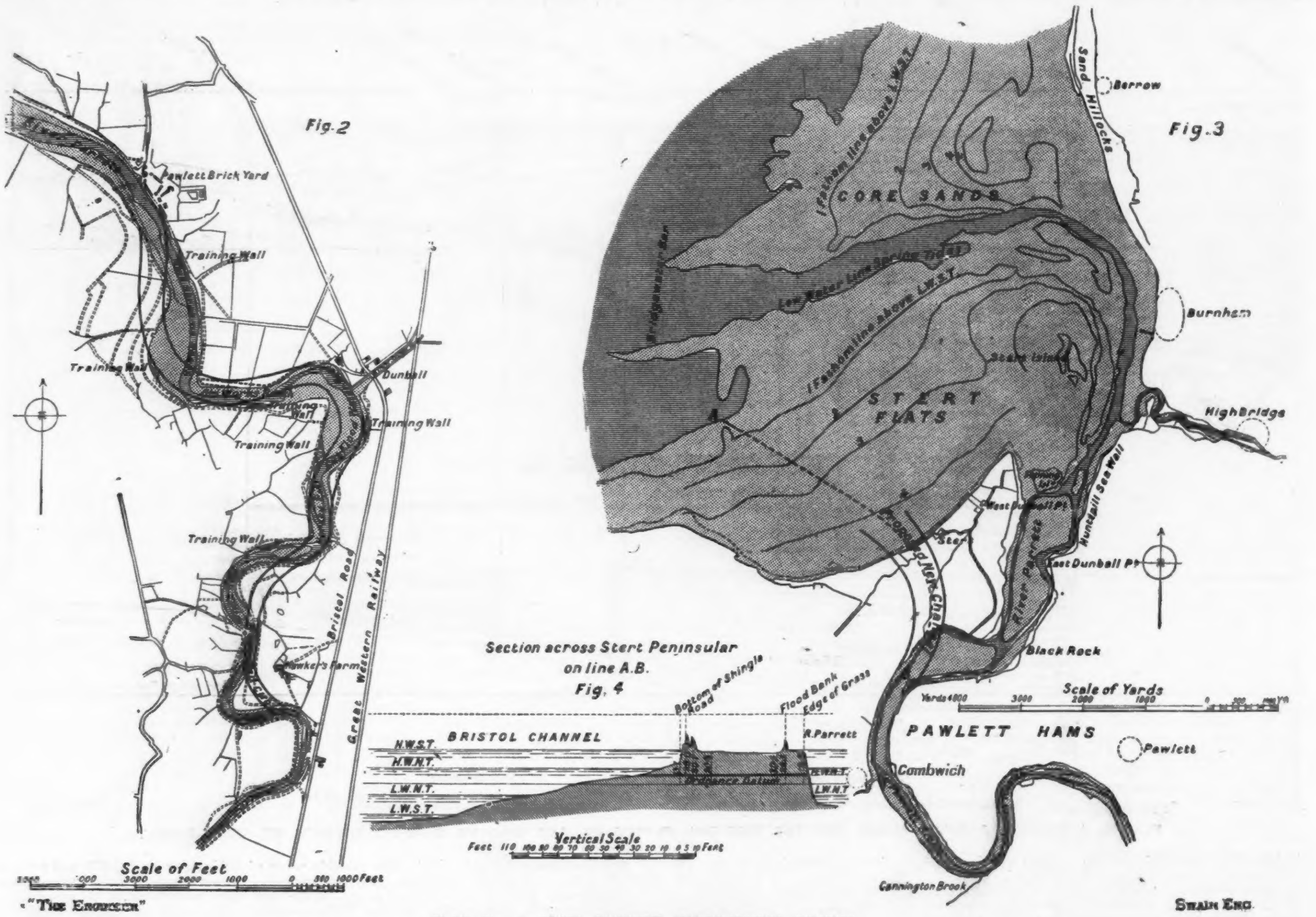


Fig. 2

Fig. 3

Section across Stert Peninsular on line A.B.
Fig. 4

"THE ENGINEER" SWAIN ENG.

PLAN No. 2—RIVER PARRETT IMPROVEMENT SCHEME

The brickyard rubbish above Bridgwater and Somerset Bridge wants removing, so as to permit the bed of the river being lowered at these points. This could easily be done by barge men, paid piece-work. There are a few other places below Bridgwater where the bed of the river will want lowering by other means than by scouring, notably, a ridge of limestone rock which crosses the river bed immediately opposite Combwich. Improvements in a tidal river are mainly to be looked for by a free access of the tide, assisted in the case of a sluggish river by dredging, or in a river such as the Parrett, by mechanical scouring or eroding.

Locks and sluice gates especially in a muddy river are an absolute mistake, and only lead to the silting up of the channel above and below them. There is not a single example in the neighbourhood where this is not the case. The flood gates on the Brue at Highbridge I consider the greatest mistake. The banks above them are constantly having to be raised to prevent the land being flooded, because the river is now so sluggish that it cannot carry the sediment it brings down to the sea. The Somerset and Dorset Railway Company spend hundreds of pounds annually in clearing out the tidal deposit from Highbridge Clyse. The river Brue has a drainage area of 207 square miles, and instead of being navigable, and a source of prosperity to the district, it does not even answer the purpose of a canal, nor of a really efficient drain. There are hopes that with the new sluice gates now nearly completed, the free run of the tide will once more be admitted. From a perusal of Mr. Grantham's report in 1872-73, I understand that the land between Crip's Corner and Yarsdale lies between 4ft. and 5ft. below the highest flood tide level. The river banks for these seven miles would have to be specially seen to, but I have no doubt that if the tide was admitted to-morrow, this river from that day with a little help would gradually improve and deepen its channel. I lay some stress upon this point, because should such a cut across Stert Peninsular as I have suggested be contemplated, it would be of considerable importance both to Burnham and Highbridge, that as large an amount of tidal water as possible should be admitted up the river Brue.

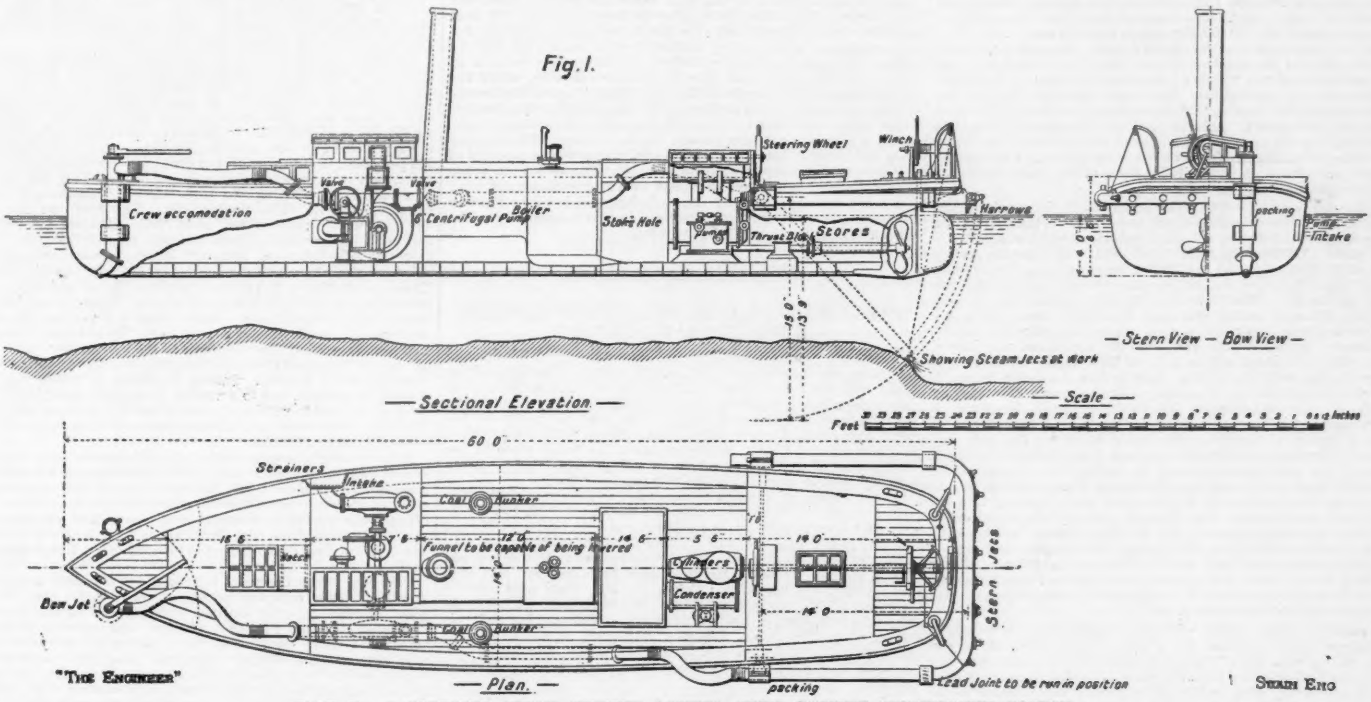


Fig. 1.

PLAN No. 3—PROPOSED STEAM DREDGER LAUNCH, RIVER PARRETT IMPROVEMENT SCHEME

It may no doubt be said that the effect of shortening the course of the Parrett would be to materially alter the present conditions between Combwich Reach and Burnham. No doubt the low-water channel would suffer, and in time perhaps some of the present estuary would silt up, but this would not matter in the upper estuary, and as far as Burnham and Highbridge are concerned, I believe their conditions would be improved. There is 40ft. of water opposite Burnham Pier on a high tide, enough and to spare for the largest man-of-war, and although this depth might, and probably would not always be maintained, there would with such a tide, and with the water flowing up the river Brue, always be sufficient water. It must not be lost sight of that the sand and mud banks of Bridgwater bay are due to the deposits brought down by the Parrett, and that Burnham is gradually losing its sea front. Its water now so muddy would be clearer, and in many respects would be placed more under conditions similar to those of Weston-super-Mare.

It may be said that the Bath brick trade would suffer through the shortening of the river. I have given this matter a good deal of consideration, and do not believe that such would be the result. The effect of the cut would no doubt diminish the size of the "bore," and by allowing the tide to penetrate up the river more easily and sooner, would at the same time render the water slightly less turbid. On the other hand, there would be more water passing up the river, so that the rise of tide though less quick, would be considerably longer; and moreover the duration of high water would be lengthened, which is the time when the greatest deposit takes place. As to the peculiar nature of the slime, I do not believe that this would be altered to an appreciable extent. Bath bricks can be made anywhere between Dunball and Borough Bridge, a distance of 8½ miles, and there is far from a dearth in the present quantity of slime, which settles on the slime "batches" as much as 12ft. thick in the year.

Fig. 3 shows the course I should suggest for this cut. It is set out approximately to a radius of one mile. It is found in practice that a river follows a slightly curved course better than a straight one, as the low-water channel follows the outer bank instead of wandering from side to side. Stert would thus be on an island, and it would be necessary to provide a ferry to the mainland. There would be no difficulty in doing this, and in every respect this place would be immensely benefited. I have put forward this part of my scheme with some hesitation, owing to the magnitude of the change and the interests at stake. There has not been time to investigate the subject as thoroughly as it deserves, and I have kept it separate in my estimate of the cost.

Should it be held worthy of consideration, I should suggest the making of a working model of the river Parrett from Bridgwater to the river bar, on a horizontal scale of 2ft. to the mile, and a vertical scale of 8ft. to an inch, in which the conditions are as nearly as possible those actually existing. Up this model the tide would be made to ebb and flow, at intervals of a few minutes, by means of a rocking shutter at the sea end. When the conditions had become similar to those now existing a cut would be made as proposed, and its effect on the lower part of the river thus experimentally determined. I had on a former occasion to deal with such a model in connection with the Mersey estuary, and know that very valuable results may be so obtained.

I shall now deal with that part of the river which wants most attention, and which it is part of my scheme to rectify. "Little" reach—see Fig. 2—has undoubtedly the worst bend in the river for ships to get round. This bend has a radius of only 300ft., which is far too small, in fact no curve in a navigable river of this size ought to have a less radius than 1000ft. The other bad curves appear to be those at "Nine Streams" reach, with a flood channel bend of 350ft. radius; "Horsey Pill," with a radius of 400ft.; and "Pims Pill," with a radius of 450ft. Nobody knowing the river Parrett would ever attempt to dredge any material in order to improve the waterway. Such a proceeding would be absolutely futile, as the channel changes with every tide. Sandbanks weighing thousands of tons are removed at a single "spring" or freshet, and deposited elsewhere. The only chance is to humour the river, to train it gradually to maintain, if possible, one low-water channel only, and to follow a course which, while gradually easing the sharp bends, shall at the same time be in accordance with the inclinations of the river. The oscillations of the water from one bend to the next are like the swing of a pendulum. If the water is checked suddenly, as occurs in a sharp corner, the result is that the energy of the tide is expended in eroding the bank. In this lies the secret of the cure. Training walls, either of timber, fascine work, brickyard rubbish, or better still, a combination of these to suit the particular conditions, should be placed at points above and below the curve to be dealt with, which shall so deflect the current as to make it impinge on the point to be removed, and in time wash it away. Hitherto all that has been done has been to strengthen the banks at such points as were being eroded. This, although it may answer for a time, will effect no cure. It is like attempting to stop a swing in the middle of its oscillation, it requires a lot of doing, whereas if it is taken in time at the extremes of its course there is no difficulty. In the same way I propose to deal with the worst places in the river, they must be taken above and below, not at the spot itself. The curve at "Little" reach is so sharp, and the channel so narrow, that I shall recommend cutting across it, and I have shown on Fig. 2 the new course set out at a radius of 1000ft., and striking the two adjoining curves at a tangent. The length of this cut will be about 350 yards. I should propose at first to make a cut 21ft. broad and 12ft. deep by manual labour. Into this the steam launch would float, and I should expect to be able to complete the rest of the work by its means alone. Assuming the excavation could be done at 10d. per cubic yard, the first cut would cost £392. As, however, I feel a little uncertainty whether the launch will be able to do this work, I have allowed in my estimate £2500 for cutting across the bend. Spring tides bring up more deposit than they take down, and the balance is only maintained by the fresh water floods. Thus in the summer months when there is an absence of rain, the river becomes very much more choked than during the winter. The flood tide takes a more direct course than the ebb, and to it I chiefly look for training purposes, it rises very much more rapidly, and has to do the double work of damming back the fresh water, and working its way uphill. The ebb tide assists the low-water channel, and it acts longer and more uniformly than the flood tide. These differences will assist a little in determining how and where to place training barriers.

I have shown on Fig. 2, by means of black lines, the ultimate course to which I should aim at training the river. Of course many years would elapse before it would flow in anything like the course shown. In "Nine Streams Reach" the flood tide will be directed on to the left bank, by a barrier placed on the right bank, 300 yards south of Pawlett brick-yard, and again by another barrier on the left bank higher up the reach, so as to direct the force of the current on to the point at the corner. I have shown the positions at which I should propose to place these barriers. In "Cut flood way" reach, the flood water should, if possible, be made to hug the right bank, which is also the side of the river the ebb tide takes. This will best be accomplished by fixing and filling out the right bank immediately south of Dunball Clyse, as shown in Fig. 1, where serious erosion is now taking place. At the same time a barrier may be gradually projected from the left bank where shown. Other reaches will be dealt with in the same way. The most difficult, Pim's Pill, coming in the middle, must be taken last. I am quite confident as to the success of this training, and have no doubt that in time the river could be made to take any desired course.

A little experience will soon show the form of training wall or barrier best suited for the particular conditions. In a few cases it might be advisable to drive small piles 10ft. to 15ft. apart, between which a fencing of copse oak poles would be nailed, or a training wall could be made by laying layers of fascines side by side, broom end towards the channel, with intermediate layers of brickbats. In places where the bank has to be projected and strengthened, which as a rule would be all that would be done, I should recommend the present system being continued, *i.e.*, of driving in stakes, pinning bushwood, and tipping down the banks stones and brickbats, anything, in fact, heavy enough not to be carried away by the force of the current. This training would be done under supervision from the steam launch. I estimate that the expenses incurred, apart from the maintenance of the launch, or the cutting through of "Little Reach," might amount to £200 annually during the first ten years, after which, and when the river had begun to flow in better lines, the expenses ought to be less, and certainly nothing like what is now expended annually by the Drainage Commissioners in maintaining the banks. The making of a channel across Stert Peninsular would not in my opinion be a very expensive undertaking. A small passage if once cut through would, I believe, be soon enlarged by the action of the tides. I show a section of the ground on Fig. 4, the thick line showing the depth I should propose to make the first cutting. It will be observed how remarkably flat the ground is, being in fact below the highest spring tide level, except at the north end, where it rises for a short distance to a maximum of 10ft. above the average ground level. The subsoil is no doubt mild blue clay with layers of sand intervening, and at the north end the high ground will probably be composed of sand and shore pebbles. The work might be let to a dredging contractor, and from inquiries I have made from such, I believe it could be excavated at 1s. per cubic yard. Assuming a channel 50ft. wide by 15ft. deep was made, then the cost at this price would amount to £9500. Such a channel once cut, could, I have little doubt, be enlarged by the steam launch, assisted by the tide.

It is impossible for me to estimate the total cost of this undertaking without knowing how the proposal would be viewed by such places as Burnham, Highbridge, and Stert itself, but as far as the engineering is concerned, the work seems very straightforward. I estimate the initial expenses of my scheme as follows:—

	£	s.	d.
Making cut across "Little Reach"	2500	0	0
Land at "Little Reach," ten acres at £80 per acre ..	800	0	0
Steam launch complete	2000	0	0
Unforeseen expenses, sundry charges, &c.	200	0	0
	£5500	0	0

Assuming this sum was borrowed at 3½ per cent., and had to be repaid in fifty years' time, then the annual amount to be paid would be £235. I estimate the annual expenses as follows:—

	£	s.	d.
Maintenance of launch — crew and fuel — at say £6 10s. per week	338	0	0
Training operations, say £200 for the first ten years	200	0	0
Repairs, wear and tear of launch	80	0	0
Superintendence	200	0	0
Interest on borrowed sum, and sinking fund to clear off debt	235	0	0
Sundry charges, say	37	0	0
Total	£1090	0	0

This sum on the rateable value of the borough amounts to 7¼d. in the pound. The above estimate is, I believe, full. The present bend at "Little Reach" would, after the making of the new cut, in time fill up, and the land could be put into cultivation. In other places, where training operations were conducted, as much land would, I consider, be reclaimed as was taken. I have deducted nothing in my estimate for the value of the clay excavated in cutting through "Little Reach." This, although it would be of a "mild" nature, would no doubt be worth sixpence per cubic yard for the first 9ft., and its value at this price would amount to £184.

Before concluding I should like to acknowledge my indebtedness to Mr. F. Wills, whose experience in connection with scouring the bed of the Upper Parrett with his launch, the Pioneer, has been of considerable assistance to me. I would even suggest that before trying a new launch he should be asked to experiment in the lower portion of the Parrett. I do not, however, consider his boat is powerful enough to carry out my scheme, even if arrangements could be made with the Drainage Commissioners. I am also indebted to Captain Jobson, who has given me every assistance; and last but not least to Mr. Thomas Griffith, without whose experience as a pilot of the Parrett I should have been at a great loss.

I have the honour to remain, Gentlemen,
Your most obedient servant,
H. G. Foster-Barham, A.M.I.C.E.
Dated this 29th day of October, 1894.

Referring to the armament of the new cruisers of the Spencer programme, the *Army and Navy Gazette* says:—"It does seem a little risky to give them nothing heavier than a 6in. quick-firer. The Severn class were said to be overarmed with 8in. guns, the present First Sea Lord, among others, condemning them in this respect, although Lord Hood overruled the objection. The Aurora class also carries guns of 9·2in. calibre, while in the Talbot and other modern ships of equal tonnage with the Aurora there are only 6in. and 4·7in. guns. It may be, of course, that increased rapidity of fire is held to be a compensation, and it is also an advantage, doubtless, to lessen the number of different types of ordnance a ship carries." Which last sentiment we thoroughly endorse, and consider that such an advantage is well worth some sacrifice.

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

The acetylene gas controversy.—There is at present much interested discussion in scientific circles as to the possibilities of the manufacture of calcium carbide and acetylene gas, certain parties having been publicly exploiting the industry by disposing of stock in companies owning the Wilson patents. Dr. Birchmore, in a recently published article, says that no carbide has been made commercially by the system shown in the Wilson patents, which is a modification of the Siemens furnace. In laboratory experiments he has made carbide by five different methods—(1) the Wilson patent method; (2) the Morehead practical unpatented method; (3) the Cowles method; (4) the Clarke patent method; (5) the Moissan unpatented method. Some alleged carbide which came into his hands would yield neither ethine, methane, nor hydrogen. He states that it is perfectly well known to all who have examined the question that the Wilson patents are valueless as far as protecting the monopoly of the manufacture and the use of carbide are concerned. He is of opinion that when a burner is produced which will burn ethine properly, numerous carbide industries will spring up without any professional promotion. As to the use of ethine for illuminating purposes, he did not think it commercially practicable to distribute the gas through street mains on account of the great percentage of leakage that would occur, and suggested the use of steel "bottles" or cylinders as now used for other gases, the gas being compressed under such pressure as to be liquefied. One such cylinder has already exploded, however, killing three persons, and there would be continual disastrous accidents from the handling of these cylinders by individual consumers, especially in connecting them up to the gas pipes.

The New York State canals.—In the annual report of the Superintendent of Public Works it is stated that silting up of the canals has been going on for twenty-five years, and in the absence of sufficient appropriations for thorough cleaning, the only cleaning done during this time has been the removal of bars formed by inflowing streams. The result has been the gradual accumulation of about 2,250,000 cubic yards in the Erie Canal alone, or sufficient to reduce the draught of boats from 6ft. to 5ft. 4in. if it were uniformly distributed over the bed. Proportionately large deposits exist in the other canals. The superintendent favours such means of improvement as will enable the speed of the boats to be materially increased, considering this as being more beneficial than any attempt to increase the size or carrying capacity of individual boats. The traffic on the New York State canals in 1895, amounted to 3,500,314 tons, of which 2,327,481 tons were moved eastward, or to tide-water, and 1,172,835 tons were moved westward. Of these amounts 1,762,663 tons were through freight, and the balance local freight. The State of New York has voted an appropriation of £1,800,000 for canal improvement, not for a general enlargement, but for cleaning out, deepening, widening narrow portions to standard width, improving the locks, and replacing some of the "flights" of successive locks by hydraulic balance locks of vertical lift. The main object is to increase the depth, and to give the standard dimensions of section for the entire length of the canals. A large number of engineers have been employed to make complete and detailed surveys and levels during the winter, when the canals are closed to navigation, so that it may be seen just what work is required. Some of the rock excavation will be begun in the spring.

Water supply tunnel.—The water supply from the great Nashua reservoir, fifty miles from Boston, will be conveyed to the distributing reservoirs near the city by a large aqueduct, of which one part will be a tunnel 11,319ft. long, with a grade of 1 in 5000 for the greater part of the distance, and 1 in 2500 for the remainder. The sections are of varied design, to suit the varying character of material met with, but the clear dimensions are 10ft. 10in. high at the middle, and 12ft. 2in. wide at the springing line of the roof, which is a semicircular arch of 6ft. 1in. radius. Below the springing line the sides have a radius of 14ft. 4in., and the invert has a radius of 14ft. The brick lining will be 12in. or 16in. thick—three or four rings—for the roof, 8in. to 16in.—two to four rings—for the walls, and 4in. to 12in.—one to three rings—for the invert. The backing will be of concrete, brickwork or dry rubble. At the lower end of the tunnel part will be built in open trench, and here the work will be largely of concrete, with brick lining for the walls and invert. The concrete arch will be about 14in. thick at the crown. Some of the working shafts used in driving the tunnel will be closed by brick arches and stone and earth filling. Others will be only partly filled in, leaving a brick-lined shaft opening into one side of the tunnel roof. The concrete masonry will consist of five parts of clean stone or gravel—¼in. to 2½in. largest diameter—two parts of sand, and one part of cement. The concrete must be laid rapidly, and rammed until water flushes to the surface. Mortar for brick masonry will be composed of one part of cement to one, one and a-half, or two parts of sand, and for stone masonry it will be one part of cement to two of sand.

Automatic telephone system.—In the ordinary system of telephone exchanges, each subscriber has a wire to the central office, and must call up that office in order to have his wire connected with that of any other subscriber with whom he wishes to communicate. This involves very complicated and expensive switchboards at the central station, with an army of operators to attend to the connections. In most of the automatic telephone exchange systems which have been invented, each subscriber would have an individual switching mechanism at the central office or exchange, and his line would connect with the lines of every other subscriber, involving very complicated connections, and complicated special apparatus for each subscriber. In the Callender system, however, the apparatus is very simple, and the costly outfit of switchboards and operators is avoided. The subscriber's apparatus consists of the usual telephone transmitter, receiver and call bell, and also a special signalling transmitter consisting of two graduated indicator dials, and numbered from 0 to 9. For a larger exchange, having any number of telephones not exceeding 999, a third dial is used, while the addition of a fourth dial would increase the capacity to 9999 telephones. A subscriber desiring to put himself in communication with another subscriber, say No. 36, places the indicator arms or pointers over the proper numbers on the plates; that is to say, the left-hand pointers over 3 and the right-hand pointer over 6. He then pulls down the lever at the right-hand side of the box and releases it. This completes the operation, as the signalling transmitter automatically turns in the proper signal, and in less than twelve seconds the call bell rings. If the desired communication is effected, one long ring is given. Two rings indicate a "busy" call, if the telephone signalled for is already in use. The signal-receiving mechanism is made capable of storing a call, so that should a call arrive during a busy hour when the system is in full use, this call will be stored or held for a few seconds, long enough to allow some part of the system to become inoperative, and thus enable the stored call to be operative. When the telephone already in use is released, the stored call becomes effective, and a "connected" signal is sent over the lines of both parties to the new connection then made. The mechanism connects the "caller" and "called," if the latter's line is not in use. The call bells of both subscribers are then rung through the movement of the circuit closing agent along the signalling track. Finally both subscribers are left in undisturbed communication, all of the apparatus having passed out of their control, with the exception of the progressive switch seized and individualised for the "caller," and the connector element connecting the "called" with the "caller." The other parts of the apparatus revert to common use as soon as each has served its independent function.

Irrigation.—The State of Illinois has a fertile soil for agricultural purposes, but even here irrigation has been found advantageous in increasing crop products. In 1894 the crops on the farm of the Eastern Illinois State Hospital for the Insane, 1000 acres, were ruined by drought, and the management had to expend 15,000 dols. for vegetables, fruit, &c. In consequence of this an irrigation system was installed, and during the dry season of 1895 the farm produced all the fruit and vegetables required, including 2000 bushels of turnips fed to the cattle. In the spring of 1895 plans were adopted to supply water for the irrigation of 150 acres of garden and orchard. Pipes were laid from the Kaukakee River, and ditches dug across the land. Two pumps, of 2½ and 3 million gallons daily capacity, furnish the water for the entire institution and for the irrigating system of 100 acres of vegetable garden and 50 acres of orchard. A 10in. main leads from the pumps to the building, and from this there is a 6in. pipe 1200ft. long to the highest point of the farm, about 25ft. above the river. From this summit 2000ft. of 4in. and 800ft. of 3in. pipe extend to various parts of the land, and hydrants are placed at intervals, short lengths of hose leading from the hydrants to the furrows made by a ditching plough. The depth of water in the ditches does not exceed about 3in. or 4in. The onion bed, and certain other portions, were flooded instead of ditched. By means of portable dams of sheet iron the streams in the furrows are kept under control and the water is directed to any desired point. Seven crops of peas were raised. The cost of such a system, using oil, steam, or wind engines and pumps, for an ordinary farm is estimated at £3 to £4 per acre irrigated—this being for the first year only, the subsequent expense being merely for fuel and labour.

Air compressors driven by water-wheels.—A compressed air power plant has been installed by the North Star Mining Company, of California, in which the compressors are driven by the largest Pelton "impulse" water-wheels ever built. The wheel is 18ft. 6in. diameter, with rod spokes, mounted on a 10in. shaft, and has a series of buckets on the rim, which receive the impulse from a 1½in. jet nozzle in a pit below the wheel. An automatic device regulates the amount of water according to the power required, thus maintaining a uniform speed and a uniform pressure in the receiver. The water is conveyed to the plant through five miles of 20in. riveted steel pipe, with a head of 775ft., or a static pressure of 335 lb. per square inch. The wheel is guaranteed to give 85 per cent. efficiency, running at 110 revolutions per minute, and the great size of the wheel was adopted in order to give proper piston speed to the compressors under the high head available, the piston speed being 400ft. per minute. The wheel shaft is connected direct to two compound air compressors, with cylinders 10in. and 18in. diameter and 24in. stroke. The air is compressed to 30 lb. pressure in the initial cylinders at 160 deg. Fah., then passes through a cooler consisting of fifty copper pipes 1in. in diameter and 18ft. long, placed in the wheel pit, and thence to the second cylinders, in which it is compressed to 90 lb. It then passes through 1000ft. of 6in. pipe to a receiver at the shaft, and then through a reheater—increasing its temperature to 350 deg. and its volume 43 per cent.—to the high-pressure cylinder of a cross-compound direct-acting Corliss engine, built with slightly enlarged ports and jacketed cylinders. It leaves this cylinder at about 130 deg. Fah., and goes to another reheater, where the temperature is raised again to 350 deg. Fah. Thence it passes to the low-pressure cylinder of the engine, from which it is exhausted into a brick flue, which conveys it to the offices and change-house, where it is discharged to warm and dry the miners. For pumping from the mine, a compound differential pump with a capacity of 600 gals. per minute at 500ft. lift is used. The air for the pump is reheated and sent down the shaft in a magnesia-covered pipe, but is not reheated between the cylinders, which allows it to be discharged into the shaft at a comfortably cool temperature. The air is also used for the drills in the mine.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

THERE was a large attendance on 'Change to-day. A fair demand for steam coal prevailed at last week's prices. The demand for house coal was not so good. If anything, a slight reduction has taken place in the price of pitwood. A buoyant tone prevails in the manufactured iron and steel trades. The coal shipments for the week have reached nearly 70,000 tons. Stems with the principal shippers are well filled. An improvement has taken place in the importation of iron ore, as compared with previous weeks. Great activity prevails all round in the ship repairing trade.

Prices ruling on 'Change to-day were as follows:—Coal: Best steam, 8s. 3d. to 8s. 6d.; seconds, 8s.; best house coal, 10s. 3d. to 10s. 6d.; dock screenings, 5s.; colliery, small, 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 47s. 3d.; hematite warrants, 48s. 8d., f.o.b. Cumberland; Middlesbrough, No. 3, 38s. 5d., prompt; Middlesbrough hematite, 46s. 6d. Iron ore: Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel rails: Heavy sections, £4 15s.; light ditto, £5 5s. Tin-plate bars, £4; Siemens tin-plate bars, best, £4 5s.; all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel coke, 9s. 0½d. to 9s. 3d.; Siemens (coke finish), 9s. 4½d. to 9s. 6d.; ternes, per double box, 28 by 20 C, 21s. to 22s. Pitwood, 15s. 6d. to 15. 9d. Freights steady.

LAUNCH.—On the 4th inst. a large petroleum tank steamer Cowrie was taken for trial off the Tyne. The weather was very hazy, but an excellent trial of the machinery was made, and it gave every satisfaction to those on board. The Cowrie is one of two vessels built by Sir W. G. Armstrong and Co., at their Walker shipyard, for Messrs. M. Samuel and Co.'s Shell Line of steamers. The vessel has been built of steel, under Lloyd's special survey for their highest requirements. Her chief dimensions are:—Length, 387ft. 6in.; breadth, 48ft.; depth, 31ft. 6in. She has a deadweight capacity of 7000 tons, which she carries on her statutory draught of water. Like the rest of the same fleet, she has been specially constructed under the supervision of Messrs. Flannery, Baggallay, and Johnson, of London and Liverpool, for the double duty of carrying oil in bulk to the East and returning to European ports with general cargoes of fine goods. She is fitted with ample engine and boiler power, her engines having cylinders 27½in., 43½in., and 73in. by 48in. stroke, and on her trial trip these developed about 2000-horse power. It is a source of great satisfaction to Messrs. Samuel that the vessels of their existing fleet carry out this exacting service in the most efficient manner. The space set apart for oil in the Cowrie is, as in her sister ship Nerite, divided longitudinally and transversely into sixteen separate oil-tight compartments, with special trunk-ways to allow for the expansion of the oil under variations of temperature. The pumping arrangements are most complete, so as to enable the oil cargoes to be discharged with the utmost rapidity. When this work is done the tanks are all properly and efficiently cleansed and ventilated by means of special appliances fitted on board for this purpose. For dealing with the general cargoes of the vessel a large installation of deck machinery has been fitted, so that the cargo may be worked from all the hatches simultaneously. The accommodation for the captain and officers is in the bridge, the engineers in a deck house aft in the poop, and the crew in the forecastle. The propelling machinery is of the triple expansion type, manufactured by the Wallsend Slipway and Engineering Company. Electric light, including search light for use in the Suez Canal, has been fitted. The speed attained on the trial trip was over 11½ knots, and everything about the engines and boilers worked without a hitch, and steam was easily kept. A feature of the trials was the thorough testing of all the auxiliary gear, which was found to work to the satisfaction of the company's superintendent, Captain Coundon, and the superintending engineers. Immediately after the trial the Cowrie proceeded on a voyage to Batoum, under the command of Captain Parsons.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

ALTHOUGH wages for engineering work at home and on the Continent are not so widely different as are those paid in iron and steel manufacturing proper, yet ample evidence is forthcoming that even in the structural departments there is quite sufficient divergence to act deleteriously to British interests, and to deepen the conviction at present entertained by many British engineers that in their sphere of trade, no less than in the production of material, there is urgent need for practical steps of some sort to be taken to lessen the gulf in the matter of establishment charges which now separates the engineers and machinists of Great Britain from their competitors across the English Channel. Statistics just available give the following comparative statement of the rates of wages per day paid in the engineering shops of England and Belgium respectively, together with the amount of difference, which it will be seen is, in each case, against the English engineer:—Roll turners, England 4s. 8d., Belgium 3s. 1½d., difference 1s. 6½d.; smiths, 4s. 8d., 2s. 10d., 1s. 10d.; fitters, 4s. 8d., 3s., 1s. 8d.; labourers, 3s. 5d., 2s. 7d., 10d. These differences, although considerable, are not, as we have previously intimated, by any means so great as in the case of ironmakers, which is shown by the following comparison of the wages rates at the celebrated Seraing Works of the Cockerill Company and those at one of the largest establishments in England, employing, like the Cockerill Company, close on ten thousand workmen:—Rolls, first roller, England 9s. 6d., Belgium 5s. 5d., difference against England 4s. 1d.; second roller, 5s. 8d., 3s. 9d., 1s. 11d.; third, 5s., 2s. 11d., 2s. 1d.; first heater, 15s. 1d., 6s. 3d., 8s. 10d.; second heater, 5s. 6d., 3s. 6d., 2s.; third heater, 4s. 6d., 3s. 2d., 1s. 4d., men at open-hearth furnaces, smelters, 12s. 11d., 4s. 6d., 8s. 5d.; assistant smelters, 7s. 5d., 2s. 11d., 4s. 6d.; other labour—average—6s. 3d., 2s. 4d., 3s. 11d. The foregoing statistics appear to emphasise what is the prevailing opinion in the iron and steel and engineering trades, namely, that in the recent report upon foreign competition the British Iron Trade Association scarcely gave sufficient emphasis to the manner in which British manufacturers are handicapped in this respect.

On 'Change to-day, Thursday, in Birmingham a fair amount of business was transacted, and prices were well sustained at last week's level. The revival since its resumption is not going forward with the leaps and bounds that characterised the last few months of 1895, but there is a healthy tone generally about business, and if progress is rather slow, it is held to be sure. Prices are unchanged on the week. The Gospel Oak Ironworks, Tipton, are to be restarted after being idle some time. When in full work they should employ 200 workpeople. Some time ago they turned out 300 and 400 tons of bars and sheets per week.

Confidence in the stability of the current trade improvement is inspired in Midland engineering and iron circles by the Board of Trade returns for January. The increase under metals and metal-wares amounts to £525,236, or more than 25 per cent. compared with a year ago. The value of iron and steel has risen from £1,351,086 to £1,716,072. In pig and puddled iron the rise in value is 64 per cent., in bars and angles 30 per cent., in railroad iron 106 per cent., in iron wire 17 per cent., in telegraphic wire 62 per cent., and in galvanised sheets 49 per cent. This last advance is especially gratifying to this district, galvanised sheets being one of its chief productions. The trade in this class of iron with Australia has risen from £36,860 to £52,391; and with South Africa from £17,360 to £50,625. Our third best market—India—is, however, slightly under last year, the value of the shipments thither being £32,003, against £33,023. There is a decline of 20 per cent. in plain sheets and hoops to all countries, and of 22 per cent. in tin-plates. There is an improvement of 32 per cent. in steam engines and of 13 per cent. in general machinery. South America and India have taken locomotive engines, the value of the shipments to India upon this time a year ago having increased from £2749 to £29,695; and to South America from £16,685 to £23,005. Mining machinery to Africa rose from £30,007 to £49,693, and to Australia from £3811 to £21,245. The value of the textile machinery sent to India rose from £53,231 to £94,766; and of miscellaneous descriptions of machinery to Europe from £87,550 to £131,543.

A very satisfactory gathering in all respects was the sixth annual dinner, on the 9th inst., of the Birmingham Association of Mechanical Engineers. The members number 161, or an increase of 27 on the year, and the finances are in a sound condition. The Mayor, who presided, observed that mechanical engineers had been closely associated with Birmingham for upwards of 100 years. The city had long been celebrated for machinery, tool making, and engineering.

The Star Tube Company has been formed with a capital of £100,000. This company purchases for £38,000 the premises, plant, machinery, stock-in-trade, and goodwill of the Star Tube Company, established in 1891, who are manufacturers of weldless steel tubes, which are used in the construction of cycles, marine and other boilers, heating apparatus, condensers, superheaters, boring and mining apparatus, axles, guns, carriages, &c. After the purchase of the Star Tube Works, in November, 1891, from the former owners, the vendors reconstructed the tube mill, and laid down new plant. These alterations and extensions were not completed until 1894. The profits for the thirteen months ended July 31st, 1895, are certified at a sum sufficient to pay interest on the contemplated debentures, the dividend on the preference shares, and a dividend on the ordinary shares at the rate of 8 per cent. per annum.

The new coalfield about to be developed between Retford and Tuxford is creating much interest, and the first sod of the new colliery is to be turned this month. The shaft is to be sunk between Haughton and Walesby, and will not affect the famous dukeries. As the Duke of Newcastle has, however, sold the minerals underlying a very large area, it is possible that several other shafts will be sunk ere long, and, indeed, it is said that there will be five in all.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—A strong tone characterised the iron market at Manchester on Tuesday, and there was a full attendance, with a considerable weight of business offering, buyers being prepared to place orders for fairly large quantities whenever they could get some slight concession upon present quoted rates. Makers, however, who in most cases have been selling pretty heavily recently, are not only very firm at their full rates, but in some cases disposed to harden further upon these, and amongst merchants and dealers there are now very few low sellers, the strong position of makers naturally operating as a decided deterrent against underquoting, unless the iron is already held in second hands. For local brands of pig iron makers are still quoting about 46s., less 2½, for No. 3 foundry, delivered Manchester, but are very chary about selling beyond small quantities at these figures, For district brands higher prices are ruling, Lincolnshire being now generally quoted 42s. 6d. for forge to 44s. 6d. for foundry, net cash, with ready buyers at 6d. under these figures; and foundry Derbyshire averages 46s. 6d. to 47s. 6d., net cash delivered Manchester. Outside brands offering here have also shown an upward move, and could scarcely now be bought within 6d. of last week's prices, 46s. 10d., net cash, being the minimum for foundry Middlesbrough, delivered Manchester, whilst Eglinton is quoted from 47s. 6d. and 48s. net prompt cash, delivered Lancashire ports, to 49s. 9d. and 50s., delivered Dock Quays, Manchester.

In the finished iron trade, makers, who in bars have been selling freely at their recent full rates, have made an advance of 2s. 6d.

per ton, £5 12s. 6d. for Lancashire and £5 12s. 6d. to £5 15s. for North Staffordshire qualities, being now the minimum figures. Prices for other descriptions of finished iron are without alteration, sheets remaining at £7 10s. to £7 12s. 6d.; and hoops at £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths, delivered Manchester district, with 2s. 6d. less for shipment.

In the steel trade there is a decided upward move as regards hematites, in which some large transactions have been put through, one Sheffield firm, it is reported, having during the past week placed orders for no less than 50,000 tons, and makers have generally advanced their prices quite 1s. per ton upon those which were being taken a week ago, 56s. 6d. to 57s. 6d., less 2½, being now the minimum for No. 3 foundry, delivered equal to Manchester. Steel boiler plates, however, do not yet show any very appreciable improvement, and can still be brought from Scotland at £6 5s., with Lancashire makers asking £6 5s. to £6 7s. 6d. per ton, delivered in this district.

Generally, a fairly good business is reported in the metal market, and except that there are perhaps not the large contracts that just before the rise were being placed, the recent advance has had no appreciable effect in checking the ordinary run of orders coming forward. Considerable quantities of brass and copper tubes and sheets are being taken for all branches of engineering; electrical engineers are also very busy, and their requirements are considerable for miscellaneous goods.

I understand that at last a method of making an aluminium joint without alloy, and which. without either being soldered, brazed, or keyed, is rendered homogeneous, and practically nubreakable, has been perfected. This joint has been tested by the leading cycle manufacturers for the manufacture of cycle frames entirely of aluminium, which, with equal strength, will be 50 per cent. lighter than steel. Mr. Wm. Pearson, of Birmingham, is the inventor of this new process, which is being taken up by the Cramp Manganese Bronze Company, of Nottingham, who will, I am informed, make the metal tubes and fittings, and supply them to three of the leading English firms of cycle manufacturers.

Steadily increasing activity continues to be reported throughout the engineering trades of this district. Boiler makers during the last few weeks have booked a large number of orders, no less than 150 boilers, I understand, having been placed with different Lancashire firms, about 70 of these having gone into the hands of one large maker. Stationary engine builders are also fully engaged, and in the above branch of industry a number of additional men have been put on during the last few weeks. Other branches of engineering are in much the same satisfactory position as I have reported recently.

The returns of the engineering trades unions are this month of a very encouraging character. With the return to employment of the men affected by the recent shipbuilding dispute, and the general improved condition of trade, the out-of-work list of the various societies shows a considerable reduction. In the Amalgamated Society of Engineers, there are now only about 5 per cent. of the total membership on donation benefit, whilst in this immediate district less than 4 per cent. of the local membership are on out-of-work support, the improvement in trade being such that the local secretary is unable to meet the demand for certain classes of workmen. The Steam Engine Makers' Society reports a decrease of 1 per cent. in the number of unemployed members, only about 2 per cent. of the membership being now in receipt of donation. The reports from the different districts as to the state of trade indicate a decided steady improvement, although in some of the marine centres trade does not seem to become any better.

The compilation of the comprehensive annual reports which are now issued by some of the principal trades union organisations must not only be a very laborious task to the officials, but involve a great deal of careful research into outside matters of special interest to the members. I have been furnished with a few details with regard to the compilation of the just-issued report of the Steam Engine Makers' Society, an abstract of which appears in another column, which are certainly interesting, and afford some idea of the work involved. The report, which is a bulky volume of 416 pages, is filled with branches' financial returns, abstract statements, detailed balance-sheets, statistics, and Government returns on various questions appertaining to the working classes. The Society has 101 branches in different parts, and the report gives the name of every member, a summary as to those who have removed to other towns, any members who have gone abroad, and of those who have left the engineering trade, and gone into some other business. Following this are records of the amounts paid to members for superannuation, sickness, or unemployed benefit, and as the names, amount, and number of weeks are given separately, each member practically becomes his own auditor of the report. A balance sheet is also given of the working expenses of each branch. Much space is devoted to the payments, past and present, in superannuation to aged members, from which it is evident that the Executive Council are making a strenuous effort to provide for future claims, and of late years a special fund for this purpose has been raised and invested with corporate bodies, so that it may be separate and distinct from the general funds of the Society. Amongst the tables in the report are a number of statistics extracted from the reports issued by the Labour Department of the Board of Trade. Other tables are given of an educational character, which no doubt will be studied by the more thoughtful members, and give them some idea of foreign trade. These tables include the exports of engines and machinery, the production of pig iron in the United States, the continent of Europe, and the United Kingdom, from 1854 to 1894, the production of steel rails, coal and tonnage of ships launched, whilst casualties amongst the working classes are given in tabular form, as compiled from H.M. Inspectors of Factories, Mines, Railways, and Board of Trade returns, each year since the passing of the Boiler Explosions Act. Taken on the whole, Mr. Swift, the general secretary, has compiled a report that not only shows his society's finances to be capable of bearing criticism, but also includes instructive information that will, no doubt, be fully appreciated by the members.

The paper read before the Manchester Geological Society on Tuesday by Messrs. J. Barnes and W. F. Holroyd, on the rocks and fossils of the Yoredale series of the Marsden and Saddleworth valleys, raised an interesting point as to the correctness of present accepted theories with regard to the strata in which such fossils as the authors exhibited are only to be found. The observations were chiefly made in the new section recently exposed by the making of the London and North-Western Railway tunnel from Diggle to Marsden, and very interesting finds of anthracosia and other allied forms were made in the same set of shales at Marsden, from the end of the tunnel, and from material brought out by sinking the new shaft at Flint pits. Side by side they had in the same beds goniatites of at least a dozen different shapes, some of which were not yet determined, and at least four species of nautili, with descites; three species of othoceras; two species of producta; one of gervillia, evidently marine forms, along with such fossils as anthracosia of several species, posidonia, and a number of small gasteropoda, and occasional fish remains—fish teeth, small fish scales of small ganoid forms, and large scales, mostly detached and preserved singly in small ferrous carbonate nodules, and evidently belonging to some large fish, such as the megalichthys, holoptichthys, saurichthys, &c. In the discussion which followed, the hope was expressed that the sections given might be entered in the Society's transactions, as they opened out some very important new questions; and Mr. Bolton expressed the opinion that the positions in which the fossils had been found by Messrs. Barnes and Holroyd tended to alter their ideas of the lower coal measure series, and went to prove that the Yoredale, millstone grit, and the lower coal measures were part and parcel of the same series. He added that at Owens College, Professor Dawkins had placed together the collections of Yoredale shells and fossils in the coal series, so that visitors could see the genesis of the Yoredale fossils, and contrast them with the adjacent coal measure fossils, this having been done chiefly to warn people from supposing that whenever they found these particular fossils they would also find coal.

In the coal trade no improvement can be reported, the position being weaker, if anything, and although collieries are working less time, four days per week being a very general average, supplies are plentiful. House-fire coals continue in but slow demand, with a want of firmness in prices, although there is no actually quotable giving away. Best Wigan Arley is now only in exceptional cases fetching more than 10s.; Pemberton 4ft. and seconds Arley, 8s. up to 9s.; and common house coals about 7s. per ton at the pit mouth. In the lower qualities of round coal suitable for iron making, steam, and general manufacturing purposes, supplies are in excess of requirements, with prices extremely low, 6s. being still about an average figure for ordinary steam and forge coals at the pit mouth, with 5s. 3d. to 5s. 6d. taken for common steam coal for shipment. At some collieries supplies of engine fuel are short to meet requirements, whilst at others slack is accumulating in stock, and there is consequently rather a wide margin in prices, common sorts ranging from 2s. 9d. to 3s. 6d., and better qualities from 4s. 3d. and 4s. 6d. up to 5s. at the pit mouth.

Business remains quiet in the shipping trade, with ordinary steam coal still not averaging more than 7s. and 7s. 6d., and better qualities about 8s. per ton, delivered at the Garston Docks, or the High Level, Liverpool.

Barrow.—There is a generally improved tone in the hematite pig iron market, and business is growing week by week as the season advances. The make of iron is increasing. At Barrow this week another furnace has been lighted, and other furnaces are being prepared for blast in the Cumberland district. Thirty-seven furnaces are now in blast in the district, compared with twenty-three in the corresponding week of last year. Prices are firmer at 48s. 9d. net cash sellers of warrant iron, and 48s. 8d. buyers. Makers' iron is quoted at 50s. 6d. net f.o.b. Stocks during the week, owing to bulling operations, have increased by 5700 tons to 303,705 tons, being 14,530 tons more than in the beginning of the year.

There is not a corresponding improvement in the iron ore trade, as Spanish iron ore is now seriously competing with the native product. Prices are firm at 10s. for ordinary sorts, and a fuller demand is looked for.

Steel makers are well off for rail orders, and for orders for plates for shipbuilding and boilermaking purposes. There is also a good business in hoops and billets, and the mills at Barrow, which were stopped owing to an accident, are now again in full swing. Heavy steel castings are in demand, and a good business is doing in steel sleepers at the West Cumberland works.

Shipbuilders and engineers are very busy, and expect to be more so in the immediate future.

The coal and coke trades are brisk, and fuller deliveries are coming to hand. The consumption is increasing, and prices are firmer, though not quotably higher.

The shipping trade is showing new life. The exports of pig iron from West Coast ports during last week, 8136 tons, and of steel 8224 tons, compared with 1900 tons and 5607 tons respectively in the corresponding week of last year, an increase of 6236 tons of pig iron and 2617 tons of steel. The aggregate shipments this year to date represent 30,727 tons of pig iron and 43,361 tons of steel, as compared with 26,728 tons of pig iron and 31,495 tons of steel in the corresponding period of last year, an increase of 3999 tons of pig iron and 11,866 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

BUSINESS in the South Yorkshire coal district still continues in the same unsatisfactory condition. Pits are working but four days a week, while a few are only employed three days. Even with these few working days stocks are reported to be accumulating, and production is far in excess of the current demand. Household fuel is only moderately asked for, and a further decrease in working hours will have to take place, unless a sharp spell of cold weather sets in immediately. There is only a slight quantity of household fuel taken over both the Midland and Great Northern Railways, while reports from London are very discouraging. The request from other markets is slight, although the Eastern Counties are taking a larger tonnage of gas coal. Quotations have not changed very much. Silkstone, which is eagerly sought after in London, is sold at 8s. to 9s. 3d. for best qualities, and 6s. 9d. to 7s. for secondary sorts. Barnsley "softs" in good demand at 7s. 3d. to 8s. per ton.

Flockton coal is obtainable at about the same prices. Thin seam coal, however, can be procured at 6s. to 6s. 3d. per ton at the pits in quantities. A fair trade is transacted in steam coal, considering the season of the year. Since the opening of 1896 business has been very good, and about on an average compared with the beginning of 1895. Grimsby has done a fairly average trade, although values are small and competition keen. The largest district coalowners in South Yorkshire have forwarded a good tonnage to Hull, and with one or two exceptions have improved their positions slightly since the year began. Railway companies are taking a large tonnage out of the district, mainly on contract account. Quotations in the open market range from 6s. 6d. to 7s. per ton for best steam coal, with secondary qualities at 6s. per ton at the pits. Gas coal continues in excellent demand, taking into consideration the small consumption of gas for heating and other purposes. Values are from 6s. to 7s. per ton in company's own wagons at the pits. Manufacturing fuel is in slightly better request. All descriptions are plentiful, and prices rule very low. Small nuts are in moderate request at 4s. 9d. to 5s. 6d. per ton. Good screened slack is obtainable at 3s. 6d. to 4s. 6d., and ordinary pit slack at 2s. 6d. to 2s. 9d. per ton. Smudge is plentiful at low rates. Coke is in a slightly better condition, and North Lincolnshire is taking an increased tonnage, while a similar remark applies to Derbyshire and Northamptonshire. Values range from 8s. to 9s. 6d. per ton at works.

The Yorkshire collieries sent to Hull last month 150,944 tons, as compared with 142,576 tons in January of 1895. The exports to foreign countries reached a total of 56,452 tons, as compared with 53,733 tons in the opening month of 1895. The principal foreign customers were Germany, 13,842 tons, against 10,466 tons; Sweden and Norway, 18,833 tons, against 11,342 tons; and Holland, 17,802 tons, against 3514 tons.; while Russia showed a considerable decrease. A significant fact is shown in the January returns; 133 collieries appear on the list sending coals to Hull, against 172 last year. This means that 39 collieries have dropped out of the competition, these being presumably those working the expensive seams or doing a small turnover, for it has been already and repeatedly stated in THE ENGINEER, this is the day of the great producer.

In the heavy industries business has improved of late. After the war material departments the most actively employed are those engaged in the production of railway tires, axles, springs, buffers, &c. Many of the home railway companies have placed some very extensive orders, and these will take some little time to execute. A similar state of things is reported from abroad, foreign companies having given out several most satisfactory orders to English makers. The Penistone Steel Works are busier this month than they have been for a year. The carriage and wagon builders report an excellent business doing.

It was anticipated that a settlement of the shipbuilding strikes on the Clyde and at Belfast would immediately result in a rush of orders being placed for marine work. This has not been the case, however, but a healthy continuous demand has sprung up, and is far more acceptable than a "boom." The carrying business is in rather a poor way, with freights at a very low ebb; and this is not calculated to encourage the marine industry. Siemens-Martin and Bessemer steel are in excellent request. Hematites have dropped 2s. to 3s. recently, and quotations are as follows:—Bessemer billets, £5 12s. 6d. to £6; hematites, 56s. to 57s. for West Coast; and 54s. to 55s. for East Coast; Lincolnshire forge iron, 39s. and 40s.; ditto foundry, 40s. to 41s.; with bar iron at £5 10s.

The Board of Trade returns for January show a value of hardware and cutlery exported amounting to £181,519, compared with £149,617 in January of 1895, the principal increasing markets having been the British Possessions in South Africa and the East Indies, as well as Australasia and British North America. Foreign West Indies and Brazil have shown a considerable falling-off. In steel, unwrought, the value exported was £191,763, as compared with £107,648 for January of 1895. The chief increasing markets were Russia, Sweden and Norway, Denmark, Germany—from £16,106 to £38,990; Holland—from £5546 to £12,112; the United States —from £18,296 to £26,399; British East Indies—from £3998 to £17,153; Australasia—from £6138 to £11,243; and British North America—from £2533 to £6308. Not a single market showed a decrease.

The lighter trades are not in so good a condition as they were just before Christmas. Orders have kept the men well employed up to the present time, but it is somewhat discouraging to note that orders are not coming in, and the future outlook not very promising. Contracts for both table and pocket cutlery have been placed by the Government for the army and navy. These orders, which will furnish a good amount of employment for many months to come, have been placed at very low rates, and several leading firms have not taken any part in the competition. Skate makers are almost without hope of clearing off their stocks, but they rarely anticipate two good years in succession.

The annual report of Messrs. Vickers, Sons, and Co., River Don Works, Sheffield, shows that the company has had a most prosperous year. After the payment in August of the interim dividend on the preferred stock, there remained for distribution the sum of £156,267 10s. 4d. After paying the balance of the 5 per cent. on the preferred stock, and 15 per cent. on the ordinary shares, requiring for both £118,625, there remains to carry forward £25,642 10s. 4d. The directors add that they have paid off during the year 2895 debentures to the amount of £28,000, and intend to pay off the remainder of the debentures as they fall due. The company has been, and is now, very busy on military, marine, and railway material.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE state of trade becomes more favourable as the year progresses, and in almost all branches of the iron and allied industries a substantial improvement in demand has been recorded this month, with some increase in prices. It is very satisfactory to note some revival in the finished iron trade, for that has been very backward in experiencing any upward movement, and consumers in the iron trade generally were reluctant to believe in the genuine character of the revival, while finished iron continued depressed. Not only has there sprung up a brisker demand for iron plates, bars and angles, but some advances in prices have been secured, and so promising are the prospects that one of the leading iron plate manufactories in this district, which has been idle for over five years, is likely to be reopened shortly; indeed, negotiations with that end in view are now in progress. There is also a probability of another small iron manufactory being reopened. On the whole business in the iron and steel trades generally is more active than it was at any time last year, for though there may not be quite so much doing in the pig iron trade as there was in the autumn, yet both the finished iron and steel trades are decidedly brisker, as are also the allied industries, more particularly the engineering, shipbuilding, and pipe founding branches. Prices both of finished iron and steel have touched as high figures as were attained at any time last year, there having been advances in a good many departments. Thus Cleveland hematite pig iron has been raised 6d. per ton; hematite iron ore, 3d.; Cleveland, No. 3, and grey forge, 3d.; iron and steel plates, angles, and bars, 2s. 6d.; and producers are in no hurry about selling, as everything tends to strengthen their position, and to lead them to expect still better prices.

Makers of Cleveland pig iron have no reason to complain of the amount of business they have done either this or last week, and they could have done more if they had been prepared to commit themselves to deliveries over next quarter. This they are naturally loth to do, because that will be almost the busiest period of the year, when they may expect to sell to more advantage than they can at present. No. 3 this week has been sold chiefly at 38s. for early f.o.b. delivery, but 38s. 3d. is now the general rate, and it is difficult to meet with anyone, either maker or merchant, who will let his iron go at 38s. There have been a few sales of No. 3 for delivery over the second quarter at 38s. 6d., but 38s. 9d. is now the figure that is being asked. The Consett Iron Company has restarted a furnace which has been idle for a year, and it will produce hematite pig iron, as will a furnace which Messrs. William Whitwell and Co. are to blow in at the Thornaby Ironworks, but to counterbalance these two furnaces at other works producing Cleveland pig and a third producing hematite are likely to be blown out very shortly in order to be relined. Cleveland warrants have advanced to 38s. 7d. cash. The stock of Cleveland pig iron in Connal's warrant stores on Wednesday night was 181,181 tons, the increase for the month being only 388 tons. This is a much better record than has been known for some months, for the average daily increase has been only 32 tons, whereas last month it was 300 tons, and in December 500 tons. The exports of pig iron from the Cleveland district have shown considerable improvement this month; up to Wednesday night they reached 27,372 tons, against 23,237 tons in January, and 20,044 tons in February last year; but it must be remembered that trade in this month last year was greatly hampered by the very severe weather, which seriously curtailed the deliveries both to Scotland and the Continent. Inland consumers have also had larger quantities, so that there is no doubt the next statistics of the Ironmasters' Association will be more favourable than have been those of the last three months.

No. 4 Cleveland foundry pig iron is realising 37s., and grey forge has been advanced to 36s. 6d., with white at 35s. 6d. Mixed numbers of Cleveland hematite pig iron have been sold at 47s. per ton, and that is the regular quotation now—a rise of 6d. this week, and this is as high as was obtained at any time last year. Thus all that was lost through the collapse has been regained. The price of average quality Rubio ore has been advanced to 12s. 9d. per ton, delivered at wharves on the Tees.

Mr. Walter Hill, who was manager of the Claylane Ironworks, Southbank, for some years, has been appointed manager of Messrs. Walker, Maynard and Co.'s Redcar Ironworks. Mr. William Bulmer, who for forty-seven years has been connected with the North-Eastern Railway Company's dock at Middlesbrough, for many years as superintendent, has resigned. Mr. Bulmer received his early training with Messrs. Fossick and Hackworth, engineers. He is to be succeeded by Mr. A. E. Bullan, who was at one time at Hull Docks, but for the last five years has been manager of the Corporation Wharf at Stockton. Mr. Charles Steel, of the North-Eastern Railway, has been appointed general manager of the Highland Railway, in succession to Mr. Andrew Dougall.

A good trade is at last being done in finished iron, which has hitherto shown little recovery from the depression, and prospects may be considered encouraging. The steel industry is showing excellent features, works being well employed and orders numerous, with consumers willing to pay advanced prices. Thus steel plates have been raised to £5 2s. 6d.; steel boiler plates to £6 2s. 6d.; steel ship angles to £5; iron ship angles to £4 15s.; steel girder plates to £5 7s. 6d., all less 2½ per cent. and f.o.t. Common bars have been advanced to £5, less 2½ per cent. f.o.t.

The rail trade continues as active as ever. There is no slackening in the inquiry, and manufacturers are well situated, with very satisfactory prospects. Heavy steel rails are firm at £4 15s. net at works. The exports of rails from the Tees are heavy this month, especially to India, but there does not appear to be much doing in the steel sleeper or the cast iron chair trades, certainly nothing like so much as the activity in the steel rail trade would lead one to expect.

A considerable improvement can be reported in the engineering industry, all branches sharing in this, but particularly the locomotive branch. As yet, however, the improvement has been chiefly in demand, and very little upward movement in prices has been noticeable. At the shipyards work is actively carried on, and there is nothing like the interruption that there was in February last year caused by the severe weather. Outdoor operations have this winter not been interfered with by the weather; in fact, such a favourable winter season on this score has never been experienced within the memory of the present generation. This has allowed of the plate and angle mills being kept fully employed. Bolts, nuts, and rivets are in good request.

Business in the coal trade shows no sign of revival, and lower prices than even those of last year have to be accepted. Thus the contracts for the supply of Durham coal to the Swedish State Railways have just been renewed, but at a price 6d. below those of last year, which themselves were 1s. 4d. below those at which the 1894 contracts were placed. The latest prices vary between 11s. 10d. and 12s. 1d. delivered c.i.f. Stockholm. House coal is in small request, but the mildness of the season is not favourable to a good demand. Last month's coal shipments from North-Eastern ports amounted to 1,571,467 tons, or 309,142 tons more than in January, 1895. Coke is in excellent request, and the production is increasing, as more is called for, as well in this district as on the West Coast, which receives large supplies from Durham. The present price of coke is 13s. 9d. delivered Middlesbro' for the best qualities, and 13s. for average sorts. At Craghead on Saturday the officials and workmen presented to Mr. James Fairley an illuminated address and a gold watch on the completion of his twenty-fifth year of service as manager and agent of the Craghead and Holmside Collieries.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Glasgow pig iron market has been rather unsettled, but a considerable business has been done in the principal classes of iron. Scotch warrants have sold from 47s. 3½d. to 47s. 5d. cash, and 47s. 6d. to 47s. 8d., one month. The general improvement in trade, the favourable Board of Trade returns, and the proposal to make further important additions to the Navy have all exercised an encouraging effect, and there has been a renewed disposition in the last few days to invest in iron. Cleveland warrants have sold from 38s. 3½d. to 38s. 5½d., cash, while Cumberland hematite has brought 48s. 8½d. to 49s. 0½d. cash, and up to 49s. 2½d. one month.

It is rumoured that a considerable increase may shortly be made in the number of furnaces in blast. Pig iron can, it is understood, be produced at present at very moderate cost, labour and fuel being cheap, and the idea seems to prevail that additions might well be made to stocks now in the expectation of making a future profit out of the adventure. Since last week an additional furnace has been put in blast, and there are now 78 in operation, compared with 74 at this time last year. The output of hematite pigs has been reduced about 600 tons per week, while that of ordinary pigs has been increased 800 to 900 tons. The consumption of Scotch-made pig iron at home is on the increase, and the imports of English pigs into Scotland are considerably larger than at this time last year.

The prices of Scotch makers' iron are as follow:—G.M.B., f.o.b. at Glasgow, No. 1, 48s.; No. 3, 46s. 6d.; Carnbroe, No. 1, 48s. 6d.; No. 3, 47s.; Clyde, No. 1, 50s.; No. 3, 47s.; Gartsherrie, Calder, and Summerlee, No. 1, 51s.; No. 3, 48s. 6d.; Coltness, No. 1, 53s. 6d.; No. 3, 49s. 6d.; Glengarnock, at Ardrossan, No. 1, 50s. 6d.; No. 3, 47s.; Eglinton, No. 1, 48s.; No. 3, 46s.; Dalmellington, at Ayr, No. 1, 48s.; No. 3, 46s.; Shotts, at Leith, No. 1, 53s. 6d.; No. 3, 49s. 6d.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 49s.

Foreign shipments of Scotch pig iron are still small, the clearances of the past week showing no improvement. The total shipments, coastwise and foreign, were only 3414 tons, against 4678 tons in the corresponding week of last year. There was dispatched to the United States 80 tons, South America 120, Canada 30, India 132, Australia 160, France 40, Germany 65, Belgium 60, Spain and Portugal 185, China and Japan 200, other countries 230, the coastwise shipments being 2112 against 3336 tons in the same week of last year.

A fair business is being done in manufactured iron at comparatively firm prices, and the steel market is very active, the current inquiries being on an extensive scale, and the orders actually placed such as will keep the works well employed for a considerable period. The foundry trade is improving, and the different branches of the engineering trade are sharing in the general revival. Locomotive engineers are in a specially favourable position, most, if not the whole, of the makers of these engines in the West of Scotland being in possession of contracts that will keep them going throughout the year.

A considerable number of shipbuilding contracts have been intimated in the course of the last few days.

There is no improvement in the tone of the coal trade as a whole. For certain classes of coal used in manufactures the demand is steadily expanding, but the output more than keeps pace with the inquiry, the result being that an easy feeling characterises the market and prices remain low. Main coal is quoted, f.o.b. at Glasgow, 5s. 10d.; splint, 6s. 3d. to 6s. 6d; ell, 6s. 9d.; and steam, 7s. 6d. per ton. At Ayrshire ports prices are, for house coal, 6s. 6d. to 7s.; steam and main, 6s. to 6s. 3d.; triping, 5s. 3d.; dross, 3s. to 3s. 6d. The total coal shipments from Scottish ports in the past week were 116,246 tons, against 128,121 in the preceding week and 107,680 in the corresponding week of last year. The trade continues backward in Fifeshire.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE iron and steel trades have been much more active of late, and if the old average despatch of steel bar were only going on, there would be little cause for complaint. The demand for steel rails has improved, and prospects in that branch are becoming brighter. It is expected that substantial orders are coming from the colonies and foreign countries.

Last week Cardiff shipped 1000 tons to Trinidad, and Newport despatched 2200 tons to Savona. Rumours are about that rails to Japan and South Africa are likely to figure on some of our ironmasters' books. In addition, home demands are certain to increase. A local authority calls attention to the fact, that the estimate of the engineers of the Port Talbot Dock, and various lines of rail, amounts to £673,297, of which the Ogmore Valley extension lines are likely to cost £557,875, and the South Wales Mineral Railway £115,421. Then, in addition, there are the Great Western Railway promotions, to which I have called attention of late. These are expected to run over £100,000, and some say considerably more so. For a long time expansions and extensions have been rumoured, and now it would appear they are close at hand. Many are in the Cardiff district.

The first month in the year has figured well in respect of coal export. The total dispatch from the chief ports of Wales during January was 1,771,632 tons, as against 1,487,621 tons for January, 1895. Cardiff figured particularly well, dispatching 1,082,853 tons coal to foreign destination, and 192,849 tons coastwise; Newport, 237,341 foreign, and 99,640 coastwise; Swansea, 99,479 foreign, and 49,747 coastwise; Llanelly, 10,615 foreign, and 6108 coastwise. Cardiff shipment of iron and steel during January was larger than it has been for a long time—8949 tons, coke 9559 tons, and 26,573 tons patent fuel. Swansea sent 2460 tons coke, and 18,470 tons patent fuel.

I should add that Cardiff total coal exports for January is a record one. In round numbers it represents close upon a million and a-half, and, as discussed on 'Change, if maintained at that rate would represent 18 million tons a year, a figure which is expected some day in the near future to be reached. The previous record month was May, 1895, when 1493 tons were shipped.

Last week, with the partial stoppages of some of the Ferndale group and the Plymouth difficulty in front, showed a lessened despatch, but I note that up to mid-week heavy tonnages have figured—several between 4000 and 5000 tons for Port Said and Buenos Ayres, and over 3000 tons to Colombo, Marseilles, &c.

The award of the umpire in the Mardy dispute leaves the men slightly benefited.

I regret to state that a serious accident occurred at the Mardy Colliery—Locketts—on Tuesday. The cage was being lowered with twelve men, when it came in collision 150 yards down with a temporary platform, and the result was that the poor fellows were all more or less badly injured, though fortunately, not one was thrown out. Most of them have broken limbs, and the injuries of some are regarded as serious, though not fatal.

Coal shipments during last week at Swansea exceeded the corresponding week last year by 10,000 tons. Newport, Mon., also indicated a good brisk trade.

The Tylerstown pits are again at work. I am glad to record the settlement of the North's Navigation collieries dispute. Concessions have been made on both sides, and at a large meeting on Saturday night last the ratification was finally given that brought about a peaceful arrangement.

The Plymouth Hill collieries remain quiet. Meetings are constantly held, and end without leading to resumption. It has been intimated that the colliers of neighbouring districts are helping the "lock out," yet it can only be at starvation figures, compared with the 25s. and 30s. the men would earn on ordinary employment. The help of other colliers rarely exceeds 6d. or 1s. per man per week.

Coal prices mid-week at Cardiff were not quite so firm as one could wish. For best the market was slightly weaker, and inferior kinds were cleared at lower prices. Latest quotations are:—Best steam, 10s. 3d. to 10s. 6d.; seconds, 9s. 6d. to 9s. 9d.; drys, 9s. 3d. to 9s. 6d.; best Monmouthshire, 8s. 6d. to 8s. 9d.; and seconds, 8s. For best small steam prices are 5s. to 5s. 3d.; slightly inferior, 4s. 6d.; inferior, 3s. 6d. to 4s. 3d. The mildness of the season continues to tell upon house coal. Cardiff prices are 10s. 6d. to 11s. for best; No. 3 Rhondda, 9s. 7½d. to 9s. 9d.; No. 2, 7s. 9d. to 8s.; through, 6s. 3d.; small, 4s. 3d. to 4s. 6d. Swansea prices:—Steam, 9s. 6d. to 10s. 6d.; seconds, 8s. 9d. to 9s. 6d.; No. 3 Rhondda, 10s. to 10s. 6d.; No. 2 from 8s. 9d.; anthracite best, 11s. to 12s.; seconds, 10s. to 10s. 6d.; ordinary large, 8s. 9d. to 9s. 6d.; small, 3s. 9d. to 4s.

On 'Change, Swansea, this week pig iron was regarded as 6d. per ton better than last week, and the improving character of that trade was stated to be satisfactory. No improvement was recorded in Bessemer bars, for which the demand continues to decline. This in part was due to the preference shown for Siemens, with shorter carriage, and prices, as will be seen, are little different: block tin at £60 10s. to £61. The latest quotations, Swansea, are as follows:—Pig iron, Glasgow, 47s. 4d.; Middlesbrough, No. 3, 38s. 5d.; hematite, 46s. 3d.; Welsh bars, £5 5s. to £5 10s.; sheet iron and steel, £6 12s. 6d. to £6 17s. 6d.; steel rails, heavy, £4 10s. to £4 15s.; light, £4 17s. 6d. to £5 5s.; Bessemer steel, tin-plate bars, £3 17s. 6d.; Siemens, £3 18s.; tin-plates: Bessemer steel cokes, 9s. 1½d. to 9s. 3d.; Siemens, 9s. 4½d. to 9s. 6d.; ternes per double box, 28 by 20 C, 17s. 6d., 18s. 6d., to 22s. 6d.; best charcoal, 12s. 6d. to 13s. 6d.; wasters, 6d. to 1s. less; odd sizes, usual extras. Briton Ferry hematites 1, 2, 3, 49s. 6d. to 50s. There is no brightening up of the tin-plate industry, and, in fact, prospects are getting more gloomy than ever. It was announced this week that one of the most important tin-plate works of the district—the Beaufort Morriston—is to close temporarily, and others are likely to be laid by until times improve. One large failure was announced on 'Change this week, and it is stated that the movement to open up new markets is to be abandoned. These are rather alarmist views, and may suggest more serious times than will happen, as the tin-plate is often quick in rallying from grave depression. Probably it is necessary that the lowest deep should be reached, as often happens in the coal trade, before a rebound. Briton Ferry outlook is quite as bad as that of others. Closed works or partial employment are common features. All the mills at Earlswood were quiet last week for want of orders. At the Vernon four were kept on, and at the Villiers three mills. Raglan Bay and Gwalia, on the other hand, were full of work. Last week the total shipments from Swansea amounted only to 27,628 boxes, while the receipt from the works totalled 46,106 boxes. Total stock at present consists of 159,405 boxes.

Patent fuel is moderately brisk at Cardiff and Swansea, at last figures; coke is also in fair demand, without change of quotations. Pitwood, Cardiff, 15s. 3d. to 15s. 6d., downward tendency, principally on account of heavy arrivals. In iron ore prices are advancing, and a fair business is being done. This week heavy consignments have come in for Blaenavon, Cyfarthfa, Dowlais, and Ebbw Vale. Cardiff last prices were:—Rubio, 12s.; Tafna, 11s. 3d. to 11s. 6d.; Garucha, 10s. 9d. to 11s. c.i.f. Swansea imported 1653 tons pig iron last week, 639 tons scrap steel, and 60 tons tin bars.

I regret to announce the death of Major Bell, general manager of Nixon's Collieries in the Merthyr Vale and Mountain Ash districts. He succeeded Col. Gray in this post, and had the satisfaction of enjoying the entire confidence of the company and of the men. His immunity from accident was in a great measure due to the excellent provision of Mr. Nixon, who, in the laying out of his collieries, was particularly attentive to ventilation and general means for safety.

The great topic of the day is the Bute and Rhymney fusion, which in the light of the full agreement of the shareholders is understood as almost certain to be a successful enterprise on the part of the promoter, Sir W. T. Lewis, Bart.

There is a rumoured hitch in the Swansea Corporation arrangement with their threefold scheme, and some discussion is going on as to whether the tramway part will be adopted. In local circles the wish is strongly expressed that it should not be allowed to drop.

The miners' eight hours per day argument is again to the front. The opinion conveyed to the deputation hinting at the suggestion that such matters are more for individual settlement and agreement than for enactment is held strongly in many parts of the coalfield. One doubter points out that the next subject for legislation will be the time of the dinner hour.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

A FAIR account can be given of last week's trade in iron and steel. Specifications come in pretty freely, and work has been secured for a considerable time ahead; prices continue firm, on the whole, but are favouring buyers rather than sellers.

Quite a satisfactory business is done on the Silesian iron market, both makers and manufacturers reporting their order books well filled; especially the pig iron trade may be considered in a favourable position. There is a good business done in bars and girders, and also for plates a regular demand is being experienced, and an advance in quotations is looked forward to.

There is no novel feature to be noticed on the Austro-Hungarian iron market, business transactions generally being limited. Here and there better prices have been obtainable, especially for plates of all descriptions, which is due, not only to the rising home demand, but also to the continually improving condition of the German iron industry, the pressing offers from that quarter having almost entirely ceased of late. The railway department is looking forward to being busily occupied; the rails required for the Vienna Railway amounting to 6322 t., of which, however, only a small lot—1652 t.—is to be delivered in 1896, the remaining 4670 t. falling on 1897. Hitherto the shipbuilding and engineering line has been but moderately employed, but spring is likely to bring more orders, the Austrian Lloyd having resolved the building of a large steamer. Austrian total import in iron and steel was for 1895, 229,883 t., worth 18,014,745 fl., against 178,566 t., worth 15,287,235 fl., in 1894. The greater part of import falls to Germany—114,463 t.—of which 70,206 t. were pig and scrap iron. Great Britain comes next with 993 t., of which 826 t. were foundry pig. A considerable decrease in import may be perceived for wire, axles, and tools, while almost all other articles show an increase. Total export in iron and steel was for 1895, 38,667 t., worth 15,004,892 fl., against 43,368 t., worth 12,528,671 fl., in the year 1894 There were exported to Italy 9676 t.; Russia, 6914 t.; Germany, 6717 t.; Servia, 3555 t.; Roumania, 2808 t.; France, 652 t.; England, 507 t.; Switzerland 502 t.; and to other countries, 7335 t.

As a result of the languid and irregular demand which has been coming forward on the French iron market during the past weeks, a dull tone prevails in almost all departments. The majority of the works are kept going pretty regularly, but there is not much gained at the present quotations, which are generally less firm than in late autumn.

In Belgium the iron and steel trades are, on the whole, favourably situated, and a fair account is given by makers, as well as manufacturers, of the current demand. A specially good inquiry is coming forward in the steel trade, and structural iron is also in very healthy request. Prices are the same as before, but they show much firmness, and are likely to improve soon.

There is little change to note in the condition of the Rhenish-Westphalian iron industry, which continues altogether satisfactory, though no large amount of business has been done, but makers are pretty hopeful with regard to the future, and if prices do not rise as rapidly as some wish, it certainly is a prudent measure on the part of producers to wait for a further increase in demand, ere quotations are universally advanced. Pig iron is in very lively request, and inclined to advance; in the Siegerland makers are said to have sold their total output for the second quarter. Production of the German blast-furnace works was for 1895 as under:—

	Forge pig. Tons.	Bessemer. Tons.	Basic. Tons.	Foundry pig. Tons.
January	153,950	38,166	226,649	75,810
February	131,330	26,141	206,999	70,234
March	138,160	37,388	230,464	75,132
April	120,763	51,236	227,891	70,530
May	123,042	42,870	250,673	73,044
June	115,577	41,704	242,245	70,366
July	120,290	36,131	236,555	79,027
August	116,866	36,608	259,952	77,559
September	116,913	36,591	242,662	82,789
October	113,967	38,494	267,247	91,556
November	131,801	36,708	243,851	77,462
December	141,675	27,458	263,288	77,984
	1,524,334	444,495	2,898,476	921,493

Total output in pig iron was for 1895 5,788,798 t., against 5,559,322 t. in 1894.

The malleable iron department has not met with any perceptible improvement, the mills being regularly but not satisfactorily occupied, as prices are too low to allow of a profit, especially when quotations for raw material are decidedly rising. A good activity is going on in the railway and engineering departments; besides large orders that have been given out by the Prussian State Railways, contracts have also been secured from the Wurtemberg Railways, one being for 800 load wagons.

The requirements of the Prussian State Railways are estimated to amount for 1896-97 to 113,811 t. rails—M. 12,495,000; 39,301 t. small articles—M. 5,750,000; and 53,875 t. sleepers—M. 5,437,000. Average prices, per ton, have been fixed on M. 109·8, M. 146·3, and M. 100·9. The requirements in pit coal have been estimated on 3,571,214 t., worth M. 29,791,500, or M. 8·34 p.t.; of these, 1,740,336 t. are to be supplied by the Westphalian district at M. 8·41 p.t.; 1,299,164 t. at M. 7·71 p.t., from Upper Silesia; 291,064 t. at M. 9·58 p.t., from Lower Silesia; and 136,920 t. at M. 10·51 p.t., from the Saar district. The consumption in artificial coal, which is to come from Westphalia, has been estimated at 305,005 t., for which M. 2,851,000 have been fixed. The coke required will be partly supplied by the Westphalian district—48,776 t.—and partly by the Lower Silesian district—26,287 t.—M. 12·63 and 12·65 p.t. having been fixed as average quotation. For brown coal and artificial coal—29,931 t.—M. 172,400 has been fixed, which is equal to about M. 5·76 per ton. The consumption of pit coal on the Prussian State Railways rose in 1894-95 from 2,946,000 t. on 2,984,533 t.; total expenses, on the other hand, having decreased from M. 37,169,788 on M. 37,157,701. The consumption of pit coal briquettes amounted to 246,309 t., worth M. 3,327,398, for 1894-95, against 241,170 t.—M. 3,455,441—in the preceding year; in coke 65,248 t. were consumed in 1894-95, for which M. 1,213,370 were paid, against 62,776 t. at M. 1,276,809 in the year before. Of the total quantity of fuel consumed in 1894-95, 90·55 per cent. were pit coal, against 90·7 per cent. in 1893-94; briquettes, 7·47 per cent., against 7·4 per cent.; and coke, 1·98 per cent., against 1·9 per cent. in the year before. From the Upper Silesian district 1,059,938 t. pit coal, 2621 t. artificial coal, and 1500 t. coke were ordered; from Lower Silesia, 230,660 t. pit coal, and 26,864 t. coke; from Westphalia, 1,520,219 t. pit coal, 241,688 t. briquettes, and 36,581 t. coke; from the Aachen district, 54,382 t. pit coal; from the Saar mines, 117,150 t. pit coal; from other districts, 2178 t. pit coal; and from different gasworks, 303 t. coke.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, February 5th.

THE industrial situation is still disturbed by the effects of the movement of the Government to take one hundred and ten million dollars out of the pockets of the people to make up for what should have come through the Custom Houses. There is a general holding back and an unwillingness to enter into large contracts. A great deal of material is wanted for railroads, lake boats, agricultural and manufacturing requirements. The restriction of production during the past few weeks has been a matter of prudence only. The present producing capacity will probably be needed as soon as spring opens. Railroad companies will begin ordering rails about March 1st. Bridge builders have inquiries out for nine thousand tons of plates and shapes this week. Rods have sold freely, billets have advanced at tide water to 21 dols. asked. There is greater activity at all interior points, but it is measured by near requirements. A few large consumers have thought the conditions of the market to be such as to warrant placing orders for the delivery of pig, Bessemer, and billets up to June. The greater number of consumers do not feel willing to bind themselves, so far, yet they recognise the danger of an advance. If certain conditions came, there would be a rush of buyers. Lake ores are high. Coke promises to stay at 2·00 dols. Anthracite coal will sell 25 cents a ton higher than last year. Billets are up, and so are bars, sheets, and structural shapes, but only to a fractional extent. The conditions on this side are favourable to stronger quotations. Producing interests have demonstrated their ability to restrict production promptly and sufficiently to control prices. The manufacturing interests everywhere look for early and greatly increased activity, and the rush to anticipate an advance in prices will soon set in.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

29th January, 1896

2109. Fastening Doors, Windows, &c., G. Inman, London.
2110. Door Springs, J. Coffin, London.
2111. Candles, W. B. Fitch, London.
2112. Boats, W. B. Fitch, London.
2113. Rotary Motion, G. Howard and E. T. Bousfield, London.
2114. Manufacture of Porcelain Bricks, P. Chapuy, London.
2115. Joining Up Tubes, H. T. Turnor and J. Watkins, London.
2116. Bottle Stopper, H. S, Jones.—(*C. Kemper, Belgium.*)
2117. Dark Chambers, G. C. Dymond.—(*H. Hofmann, Germany.*)
2118. Stand, G. C. Dymond.—(*The Firm of W. Ullrich, and Co., Germany.*)
2119. Apparatus for Planking Felt Hats, H. Sutton, Manchester.
2120. Needle Threaders, A. J. Mills, Liverpool.
2121. Labels or Tickets in Rolls, A. Williamson, Manchester.
2122. Collapsible Paper Boxes, E. P. Lehmann, Liverpool.
2123. Machine for Making Paper Bags, F. Hesser, Liverpool.
2124. Filling Cartridge Belts, H. Borchardt, London.
2125. Opening Sheets, J. Williams and G. H. White, London.
2126. Steam Utilising Apparatus, C. Garver, London.
2127. Gas Burners, A. J. Boult.—(*The Continental Gas Glühlicht Aktiengesellschaft "Meteor" vormals Kroll, Berger and Co., Germany.*)
2128. Motor or Traction Vehicles, C. T. Crowden, London.
2129. Impressions of Type, F. R. and H. S. Spark, and J. B. Ellis, London
2130. Handles, G. Walters, London.
2131. Bottle, W. Barnett, London.
2132. Portable Exhibiting Notices, W. Dixon, Bedford.

30th January, 1896.

2133. Securing Safety of Traffic, J. H. Hamilton, Belfast.
2134. Shape for Glazed Bricks, T. H. Brown, Liverpool.
2135. Tobacco Pipes and Cigar Holders, C. Merington, Penge.
2136. Stoves, F. J. Reinisch and S. Osiecimski, London.
2137. Piston-rod Lubricator for Engines, E. Reilly, Grimsby.
2138. Internal Combustion Engines, J. Roots, London.
2139. A New Game, H. O. and J. O. Roberts, Gloucester.
2140. Watches, H. Heilmann, Manchester.
2141. Speed Gear for Cycles, E. Deeley, Birmingham.
2142. Clip for Fixing Lockets, E. Warrilow, Birmingham.
2143. Oil Lamps, J. McNaughton, Glasgow.
2144. Applying Plastic Materials, J. E. and C. S. Bedford, Leeds.
2145. Construction of Ships, J. Rowland, Sunderland.
2146. Puzzles, J. Walker, Birmingham.
2147. Handles of Umbrellas, G. Huxley, Manchester.
2148. Penholder, W. Fletcher, Scotland.
2149. Riveting, A. and J. Stewart and Clydesdale, Ld., and J. Wotherspoon, Glasgow.
2150. Drying Brewers' Refuse, R. Cunliffe, Manchester.
2151. Packing for Pumps, J. Weir, Cathcart, near Glasgow.
2152. Closing Water-tight Doors, J. H. Boolds, Middlesbrough.
2153. Adapting Handles to Boxes, M. Holt, Staffordshire.
2154. Dough-kneading Machines, S. H. Hodges, Mass., U.S.A.
2155. Lavatories, J. Shanks, Glasgow.
2156. Apparatus for Gasifying Petroleum, F. H. Aschner, London.
2157. Window Sashes, W. Thomson, Glasgow.
2158. Tea-pot J. Gullery, Belfast.
2159. Dominoes, Draughtsmen, &c., H. B. Simpson, Westmoreland.
2160. Bridles, W. Farn and T. U. Clarke, Leamington.
2161. Conveying Electric Current, P. Dawson, London.
2162. Ruler and Guard, J. Coker, Twickenham.
2163. Cycle Saddle, W. H. Hillsdon, London.
2164. Cycle Lamp, R. F. R. Conder and W. H. Hillsdon, London.
2165. Tray for Photographic Purposes, J. Airs, London.
2166. Musical Instruments, A. C. Pope, Tunbridge Wells,
2167. Agitators for Condensers, T. N. Cretney, London.
2168. Manufacture of Aerated Waters, T. N. Cretney, London.
2169. Corsets, J. S. Metcalfe, London.
2170. Transmission of Heat, S. E. Morley, London.
2171. Cylinders, J. Lewis, Birmingham.
2172. Brake Apparatus for Tramways, C. L. Schroder, Birmingham.
2173. Pipes, Ames, Crosta, and Co., and R. Ames, London.
2174. Opening Sliding Windows, G. Jones, London.
2175. Adjustable Doors for Wardrobes, J. Barber, London.
2176. Preserving Meat, A. B. Pinto, London.
2177. Stud, F. W. Payne, London.
2178. Corks, P. Boyd, London.
2179. Mountings, G. Wyatt and The Henry Rifled Barrel Engineering and Small Arms Company, London.
2180. Tables, F. Weiss, London.
2181. Floating Tablet of Soap, C. W. Lucas, London.
2182. Envelope, C. W. Lucas, London.
2183. Utilising the Heat of Gas, A. G. Glasgow, London.
2184. Mills, P. Hesse, London.
2185. Construction of Lifts, S. G. Bennet, Staffordshire.
2186. Construction of Lifts, S. G. Bennet, Staffordshire.
2187. Candle, R. F. R. Conder, London.
2188. Dental Forceps, G. C. Dymond.—(*F. Stepin, Austria.*)
2189. Penholders, I. Golwer, Liverpool.
2190. Lifts, E. Kiebitz, Liverpool.
2191. Erasers, Cleaners, &c., J. H. L. Ewen, Liverpool.
2192. Water Heating Apparatus, W. J. Woosey, Liverpool.
2193. Article in Connection with Cycles, M. G. Noble, Liverpool.
2194. Electric Arc Lighting, O. Bondy and A. Jordan, London.
2195. Tobacco Pipes, E. W. Thurgar, London.
2196. Colouring Matters, C. D. Abel.—(*The Actien Gesellschaft fur Anilin Fabrikation, Germany.*)

Chloride Solutions, E. Hermite, E. J. Paterson, and C. F. Cooper, London.

2198. Feeding of Steam Boilers, A. F. Yarrow, London.
2199. Electrical Currents, J. Imray.—(*La Société Anonyme pour la transmission de la force par l'electricité, France.*)
2200 Hot-water Receptacle for Foods, F. W. Taylor, London.
2201. Materials for Fabrics, A. J. Boult.—(*L. P. Converse, United States.*)
2202. Brick-making, J. Berry, G. Beardsall, and The Ideal Brick Press Syndicate Ld., London.
2203. Splicing for Knitting Machines, W. James, London.
2204. Clips, A. J. Boult.—(*L. P. Converse, United States.*)
2205. A New Acid, J. W. Mackenzie.—(*C. Schmid, Belgium.*)
2206. Rotary Steam Engines, &c., W. J. H. Dalton, London.
2207. Valves for Tires, E. Marshall and T. Hands, London.
2208. Telescopic Joint for Tubes, E. J. Shaw, London.
2209. Pointing Skewers, J. Lemon and W. Jackson, London.
2210. Miners' Coal Box, A. Morris, London.
2211. Railway Wagon, J. Angus, London.
2212. Bottles, &c., R. D. Bradford, London.
2213. Process of Treating Wool, J. C. Anderson, London.
2214. Clip, W. Purchase, London.
2215. New Game and Appliances therefor, W. Roden, London.
2216. Violin Support, W. Purchase, London.
2217. Jewellery, F. W. White, London.
2218. Decorative Article, A. E. and E. M. Saunders, London.
2219. Paint, C. Sullivan, London.
2220. Clip for Cuffs, J. T. M. and G. W. Farrier, London.
2221. New Safety Device for Cycles, J. P. Miller, London.
2222. Raisin-seeding Machine, C. Bristow, London.
2223. Cement or Artificial Stone, F. Turner, London.
2224. Prepayment Mechanism for Meters, C. O. Bastian and H. C. Hodges, London.
2225. Extracting Metal from Ore, H. H. Bush and J. J. Shedlock, London.
2226. Cornice Pole Joints, W. A. Hudson, London.
2227. Steam Motor Governor, F. Clench and T. S. King, London.

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2228. Aerial Military Apparatus, B. F. S. Baden-Powell, London.
2229. Corset Attachment, A. Wardroper, London.
2230. Shirt Sleeve Clip, G. H. McKay, Glasgow.
2231. Propelling Small Boats, D. Champion, Shepperton-on-Thames.
2232. Folding Table, R. Schmidt and J. N. Rasp, London.
2233. Writing Tubes and Incandescent Lamp, C. Baker, London.
2234. Collapsible Boat, J. Fanstone, Brighton.
2235. Golfing Appliance, G. Lewis, Manchester.
2236. Cycle Cranks, D. Gray, Dundee.
2237. Spinning Yarns, J. T. Ainsworth and J. Arkinstall, Keighley.
2238. Pulley Block, W. Dargue, Halifax.
2239. Lamp Pendant, J. Harper and Co. and C. Retallack, Wolverhampton.
2240. Gate and Door Stop, H. R. J. Denton and J. R. Cartwright, Wolverhampton.
2241. Anchors, J. McCain, Newcastle-on-Tyne.
2242. Tramcar Seats, E. J. Drysdale and J. S. Macgregor, Glasgow.
2243. Machine for Raking Hay, F. S. Cocks, Peterborough.
2244. India-rubber Capsule for Bottles, E. Cumming, Guildford.
2245. Looms, W. Sutcliffe, Burnley.
2246. Rubber-tired Wheels with Wire Spokes, G. W. Lomas, Manchester.
2247. Recovering Oil from Fish, &c., J. Jack, Glasgow.
2248. Electrial Cut-outs, H. Hirst, London.
2249. Fuses for Electrical Cut-outs, H. Hirst, London.
2250. Marker for Leaves of Books, &c., G. W. Coe, London.
2251. Fanlight Opener, C. F. Gray and H. Wilson, Birmingham.
2252. Oil Lamps and Stoves, E. F. Hulse, Manchester.
2253. Submarine Vessels, S. Lake, Manchester.
2254. Bore Holes, F. Walker and W. C. Sanderson, Barnsley.
2255. Cycles, C. F. Winch, London.
2256. Cooking Range, P. J. Ekstrand and L. E. Waterman, London.
2257. Cans, A. J. Tolley.—(*F. T. Tolley, Australia.*)
2258. Indicating Vacant Seats in Vehicles, D. H. Bruins, London.
2259. Pianofortes and Pianettes, J. Strong, London.
2260. Hygienic Movable Barrel Head, W. Norris, Middlesex.
2261. Spades, J. Lee, Birmingham.
2262. Sunshade, A. S. Walker and T. H. Hooper, London.
2263. Plate Attachments to Horses' Hoofs, A. S. Walker, London.
2264. Hot Water Circulating Pipes, C. P. Kinnell, London.
2265. Braces, S. A. White, London.
2266. Mortar Mills, C. J. Williams and J. Hollick, London.
2267. Roller Mills, C. J. Williams and J. Hollick, London.
2268. Riding Saddles, S. O'Connor, London.
2269. Incandescent Gas Lights, J. Moeller, London.
2270. Multiple Shuttle Power Looms, G. Schwabe, London.
2271. Chloride of Magnesium Solutions, F. T. B. Dupré, London.
2272. Gloves, W. L. Pierce, London.
2273. Puzzle Apparatus, G. C. Dymond.—(*W. H. Bailey, United States.*)
2274. System of Aqueous Navigation, J. Fraser, Liverpool.
2275. Benches, W. T., G., J., and E. Evans, Manchester.
2276. Separating Husk from Cotyledons, P. C. D. Castle, Liverpool.
2277. Boat, R. W. Ray, London.
2278. Chain Gearing for Velocipedes, C. F. G. Low, London.
2279. Water Space Deflector, J. P. O'Donnell.—(*J. King, C. Downs, and J. Waddington, South Africa.*)
2280. Bicycle Cranks, C. W. Wilson, London.
2281. Lamps for Burning Hydrocarbon Oil, A. Kiesow, London.
2282. Attachment for Pianoforte Actions, A. Lexow, London.
2283. Surgical Trusses, J. H. Haywood, London.
2284. Stands, H. C. Phillips, J. Palmer, jun., and P. R. Plass, London.
2285. Bitumen for Asphalte, C. W. Bradshaw and H. A. H. Moore, London.
2286. Forceps, C. Barber, London.
2287. Brakes for Velocipedes, &c., J. D. Derry, London.
2288. Advertising, H. J. Haddan.—(*M. Salinas, Spain.*)
2289. Mechanically Propelled Vehicles, H. Lane, London.
2290. Gas or Petroleum Engines, &c., H. Lane, London.
2291. Apparatus for Seasoning Casks, J. Metcalfe, London.
2292. Carvings, S. Willner and W. P. Thompson.—(*Wesse and Co., Germany.*)
2293. Velocipedes and other Vehicles, L. Boulay and E. Staes, London.
2294. Fuses for Explosive Projectiles, J. C. Thompson, London.
2295. Consuming Smoke, A. M. Kitchen and T. Pfister, London.
2296. Machine for Painting Ships' Bottoms, A. Simey, London.
2297. Machinery for Drying Tea Leaf, W. Jackson, London.
2298. Incandescent Gas Lamps, J. W. Lea and J. H. Perrins, London.
2299. Ice-making Machines, W. T. Whiteman.—(*A. McVicar and W. K. White, New Zealand.*)
2300. Desk Rulers, J. Walton, London.
2301. Wheel Tires, E. G. Wood and E. Armitage, London.
2302. Timekeepers, F. L. Hancock, London.
2303. "Rising" Safety Vesta Box, W. T. Rising, London.
2304. Locomotives, P. Purcell and J. J. Dunne, Liverpool.

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2305. Lamp Burners, D. C. Defries, London.
2306. Drawing Pins, A. W. Bevis, Birmingham.
2307. Manufacture of Cups and Saucers, C. F. Bilson, London.
2308. Superheating of Steam, C. D. Holmes, London.
2309. Golf Putter, W. McIldowie, Belfast.
2310. Connecting Taps, J. Phillips and F. J. Howard, Coventry.
2311. Oil Lamps, J. M. L. Whitfield, near Huddersfield.
2312. Slides for Braces, Belts, &c., A. C. Twigg, Birmingham.
2313. Riding Saddles, J. A. Barnsby, Birmingham.
2314. Means for Finishing Metals, &c., T. Weir, Dublin.
2315. Tobacco Pipes, T. A. Naughton, Newcastle-on-Tyne.
2316. Closing Water-tight Doors, A. Heine, Newcastle-on-Tyne.
2317. Purses, E. Erlanger, London.
2318. Lathes, S. H. Wright and G. Webb, Herefordshire.
2319. Blast Furnaces, G. L. Scott and J. G. Sanderson, Salford.
2320. Knife Cleaning Machines, E. K. Dutton, Harrogate.
2321. Driving Brickmaking Machines, W. Johnson, Leeds.
2322. Venetian or Louvre Ventilators, B. Waldron, Birmingham.
2323. Hand-actuated Cranes, A. Menzies, Glasgow.
2324. Improved Electric Coupling, J. H. Tucker, Birmingham.
2325. Tea Kettles, J. W. Hancock, Leicester.
2326. Delivery Machines, F. Lamplough and F. H. E. Shipton, London.
2327. Metal Plating, T. M. Ash and H. N. Weldon, Birmingham.
2328. Hanging Gas and Oil Lamps, J. B. Bruce, Birmingham.
2329. Letter Box Thief Preventer, J. Carpenter, Southampton.
2330. Cycle Padlocks, W. Arnold and G. J. Minors, Wolverhampton.
2331. Paraffin Lamps, W. Macadam, London.
2332. Making Acetylene Gas, G. Holdsworth and G. S. Wilkinson, Huddersfield.
2333. Joints of Driving Belts, E. Clarke, Birmingham.
2334. Metal Polishers' Brushes, J. E. and H. E. Hartley, Birmingham.
2335. Electric Meters, W. McWhirter, Glasgow.
2336. Looms, J. Clayton and J. Payne, Burnley.
2337. Electric Apparatus, G. E. Sautter and H. Harlé, London.
2338. Stretching Fabrics, R. Gemmell and F. Buxton, Manchester.
2339. Heating Air, J. Langfield and G. H. Kenworthy, Manchester.
2340. Spinning and Doubling Frames, W. Bodden, Manchester.
2341. Loose Reeds for Looms, J. J. Dearden, Manchester.
2342. Fire-lighters, M. Firth, Manchester.
2343. Extinguishing Lamps, M. McCleary, Sawbridgeworth.
2344. Dress Protector, &c., E. H. Smith, Northallerton.
2345. Cap for Cycle and Vehicle Pedals, E. W. Settle, Coventry.
2346. Tires for Cycles, J. Lindsay, Dublin.
2347. Muzzle for Dogs, T. Marples, Reddish.
2348. Electric Switch, J. M. Huisman and H. C. Gover, Glasgow.
2349. Heating Smoothing Irons, &c., G. R. Hislop, Glasgow.
2350. Tool for Shaping Bosses, &c., E. Wilson, London.
2351. Shirt Ironing Machine, C. and F. Townend, London.
2352. Raising Blinds, J. H. Nitzsche, London.
2353. Machine Belting, C. H. Gray, London.
2354. Safety Device for Pockets, J. Wood, London.
2355. Railway Brake Apparatus, W. and H. Bormann, London.
2356. Christmas, &c., Cards, H. C. Hall, Brownswood Park.
2357. Candle Shade, C. E. Green, London.
2358. Single-acting, &c., Engines, J. W. Restler, London.
2359. Photo-mechanical Reproductions, C. F. E. Fenske, London.
2360. Machinery and Propellers for Vessels, J. Huber, London.
2361. Device for Holding, &c., Small-arms, M. and P. Reilly, London.
2362. Inflating Tires and Footballs, E. A. Bellow, Liverpool.
2363. Fastening for Corsets, W. M. Perry, Manchester.
2364. Bags, J. W. Duxbury, Liverpool.
2365. Respirator, J. W. Towers, Liverpool.
2366. Street Gully, G. M. Reed and W. H. Knight, London.
2367. Cleansing Printing Blankets, J. Platt and J. Holgate, London.
2368. Lessening Conduction of Heat, H. P. Ibbotson and G. W. Giles, London.
2369. Ashpan, R. W. Green, London.
2370. Hot-air Engine, H. Clifford and A. J. L. Glidden, London.
2371. Shield for Rubber Wheel Tires, F. J. Money, London.
2372. Floating Metallic Packing, E. T. Ferrier, Cardiff.
2373. Letter-card, G. Dowie and J. M. Morton, Glasgow.
2374. Glass Cloths, F. J. Robinson and A. A. Attree, London.
2375. Lamp Glass Cleaner, F. J. Robinson and A. A. Attree, London.
2376. Tracheotomy Tubes, J. Fenigstein, London.
2377. Treeing Machine, B. Ladds and G. H. Gardner, London.
2378. Traces or Driving Reins, J. Schmitz, Aix-la-Chapelle, Germany.
2379. Engine Governors, A. S. F. Robinson, London.
2380. Fire Indicating Apparatus, W. H. Trimble, London.
2381. Cutting and Shaping Machines, P. P. Huré, London.
2382. Dynamometers, H. H. Lake.—(*G. W. Lewin, United States.*)
2383. Driving Gear for Cycles, &c., T. Shepherd, London.
2384. Book Protectors, W. A. Stanfield, Belfast.

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2385. Window Blind Cord Pulleys, E. J. Field, Norwich.
2386. Hook, J. Mullin, Dublin.
2387. Hand Irons, C. Kirby, Leeds.
2388. Straining Paper Pulp and the like, F. W. Hall, Derby.
2389. Stand or Support for Wash-tubs, J. Driver, Keighley.
2390. Lamp Igniters, W. H. Coops, G. A. Crighton, and R. Tatham, Liverpool.
2391. Roller Skates, R. Thomson, Buckden.
2392. Game, J. Gazard and H. O. and J. O. Roberts, Gloucester.
2393. Motor-driven Vehicles or Autocars, J. J. H. Sturmey, Coventry.
2394. Velocipedes and Motors, J. J. H. Sturmey, Coventry.
2395. Boxes, W. Strain, Belfast.
2396. Oil Duct, A. Snow, Bristol.
2397. Memorandum, B. A. Tarbès, Bognor.
2398. Cycle Cleaning Stand, C. P. Watson, Leeds.
2399. Seats or Saddles for Velocipedes, J. C. Walker, London.
2400. Washing and Wringing Machines, H. C. Longsdon, Keighley.
2401. Protecting Ships' Hulls, C. and G. K. Craig, Newcastle-on-Tyne.
2402. Waterproofing Velwood, R. Rose and E. Bayspoole, London.
2403. Humidifying Air, D. Hall and J. H. Kay, Manchester.
2404. Shanking Flat Buttons, J. Brown, Manchester.
2405. Rail Chair, H. von Gersdorff, Liverpool.
2406. Candle Burner, J. C. Brown, Higham Ferrers.
2407. Wire Drawing Apparatus, W. Frese, Barmen, Germany.
2408. Corrugated Metal Sheeting, J. A. Main, Glasgow.
2409. Tanks, W. Orr, Glasgow.
2410. Roundabout carrying Balloons, W. Jackson, Nottingham.
2411. Stop Cock, W. McCaig, Glasgow.
2412. Self-acting Spring Apron, W. J. B. Woodrow, London.
2413. Muzzles, T. Marples, Stockport.
2414. Ventilating Waterproof Garments, H. Markus, Manchester.
2415. Photographic Films, T. A. Garrett and W. Lucas, London.
2416. Flanged Building Blocks, M. M. Gueldenstein, London.
2417. Umbrella Closer, S. Fader, London.
2418. Pocket Tablets for Almanacks, A. Gauld, London.
2419. Electric Pendulum Indicators, F. Jones, London.
2420. Heating Apparatus, R. S. Calef, London.
2421. Perambulators, F. Cohn, London.
2422. One-trigger Double-barrel Gun, T. Southgate, London.
2423. Dyeing Browns, J. Sanders and T. H. Sanders, London.
2424. Using Disinfectants, T. Grimstone, London.
2425. Ornamenting Waterproof Fabrics, T. Birnbaum, London.
2426. Pneumatic Seats for Chairs, H. Fairfax, London.
2427. Measuring Electrical Resistances, E. H. Griffiths, London.
2428. Water-tube Boilers, F. E. Rainey and the Mirrlees, Watson, and Yaryan Company, Limited, London.
2429. Bicycle Propelling Apparatus, R. Westall, London.
2430. Portable Seats, E. Jordan, London.
2431. Tobacco Pouches, H. W. Elworthy, Birmingham.
2432. Cycles, T. W. Burley, A. C. McG. Hogg, and J. C. T. Murray, London.
2433. Carriers for Exposing Tea, S. C. Davidson, London.
2434. Removing Paraffin from Articles, J. S. Beeman, London.
2435. Decomposing Salts, C. Buderus and J. Merz, London.
2436. Producing, &c., Motive Power, H. Maxim, London.
2437. Electric Heat for Welding, &c., A. Hirsch, London.
2438. Filling Boxes with Matches, V. Carassale, London.
2439. Door Bolt, Evered and Co. and G. Clarke, London.
2440. Velocipede Wheel, J. Y. Johnson.—(*E. Joubert, France.*)
2441. Ice Skating Rink, A. H. Tyler and J. S. E. de Vesian, London.
2442. Straw Hats and Bonnets, G. Larousse and E. Mermilliod, London.
2443. Cash Recorder for Tills, T. O'Brien, Manchester.
2444. Recording Mechanism for Musical Instruments, W. Neale, London.
2445. Treatment of Waste Products, W. H. Deaville, Manchester.
2446. Azo Dyes, S. Pitt.—(*L. Cassella and Co., Germany.*)
2447. Telephones, Muirhead and Co. and F. L. Muirhead, London.
2448. Plough, S. D. Poole, London.
2449. Safety Apparatus for Lifts, J. Botterill, London.
2450. Tobacco Pipe, R. Hornby, London.
2451. Treatment of Marble, &c., D. J. J. Froment, London.
2452. Burners for Gas Lighting, J. Lehmann, London.
2453. Leaf-turner for Books, H. H. Lake.—(*E. Drisaldi, Italy.*)
2454. Knife-cleaning Machine, C. Macdonald and A. Baker, London.
2455. Bicycle Tandem Attachment, M. Jakobson, London.
2456. Knitted Goods, J. H. Cooper and J. A. and A. Corah, London.
2457. Casting Printing Plates, E. Oldroyd and Co., E. Oldroyd, and H. H. Jennins, London.
2458. Shirts, &c., A. Weil, London.
2459. Electric Welding Apparatus, A. Hirsch, London.
2460. Non-fillable Bottle, J. S. L'Hommedieu, London.
2461. Skates, S. L. Schwartz, London.
2462. Pen Extractor, G. C. Baker, London.
2463. Railway Brake, W. S. Whitney, London.
2464. Music Leaf-turner, L. Carter and E. Kemble, London.
2465. Car Coupler, H. G. Wesemann, London.
2466. Automatic Railroad Track, H. G. Wesemann, London.
2467. Decorticator, R. Little.—(*E. Mathieu, East Indies.*)
2468. Cans, &c., F. W. Durham, jun., New Barnet.
2469. Bicycles, J. Etcheber, London.
2470. Door Spring, J. Coffin, London.
2471. Sighting Telescopes, F. R. von Voigtländer, London.
2472. Lenses for Terrestial Telescopes, F. R. von Voigtländer, London.
2473. Nut and Washer for Screw-bolts, J. B. Gunning, Sydney, N.S.W.

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2474. Hydraulic Cartridge, W. G. Gass, J. Tonge, J Nicholson, and T. Eastham, Bolton.
2475. Chimney Cowl, J. McLaren, Dersingham.
2476. Invoice and Letter File, &c., G. Osborn, Croydon.
2477. Match-box, J. R. Robinson, Leeds.
2478. Preventing Foxes Entering Fowlhouses, H. Procter, Ripley.
2479. Roarer for Soldering Purposes, A. Ford-Slayd Southampton.

2480. Stand and Cigar Ash Tray, &c., S. P. Ming, Liverpool.
2481. Foot Warmer, C. Phillips, Leeds.
2482. Washing Minerals, W. C. Blackett and H. Palmer, Newcastle-on-Tyne.
2483. Vehicle Skid, T. Crooke, London.
2484. Inserting Wire in Boots, A. G. Brookes.—(*S. W. Robinson, United States.*)
2485. Builders' Scaffolding, A. G. Brookes.—(*F. B. Gilbreth, United States.*)
2486. Driving Rotary Sifters, &c., W. W. Willis, Ipswich.
2487. Door Guard, R. Parkinson, A. Hartfield, and T. Helme, Preston.
2488. Pencils, T. Turner, Longport.
2489. Sodium Silicate and Nitric Acid, W. Garroway, Glasgow.
2490. Puzzle, G. Barrett, London.
2491. Screw Propellers, H. Sidebottom, Manchester.
2492. Velocipede, W. Bown and G. E. Aston, Birmingham.
2493. Shirts, J. H. Gibbs, Bristol.
2494. Developing Negatives, J. Lewis, Birmingham.
2495. Preventing Boiler Corrosion, W. J. Tranter and O. Howl, Birmingham.
2496. Steam Condenser, L. F. Gjers and J. H. Harrison, Middlesbrough.
2497. Vegetable Kettle, J. Quarton, Birmingham.
2498. Inspection Junction for Drains, E. Codling, Manchester.
2499. Ventilator, G. W. Knowles, Bristol.
2500. Knitting Machine Mechanism, R. Wallis, Middlesbrough.
2501. Conveying Electricity to Cars, A. S. Krotz, W. P. Allen, and O. S. Kelly, Manchester.
2502. Screw Propellers, A. W. Case, London.
2503. Preventing Fibre Accumulating, B. and J. Booth, Halifax.
2504. Calico Printing Machine, F. D Haddon and A. A. Kuenemann, Manchester.
2505. Buckles, A. Caulkin, Birmingham.
2506. Cycle Tires, The Double-Arch Tire Company and D. Crowther, Huddersfield.
2507. Making Riding Saddle Trees, A. C. Russell, Walsall.
2508. Fireworks, &c., J. Nisbet and J. B. Nisbet, Glasgow.
2509. Adjustable Baby Chairs, J. P. McPhun, Glasgow.
2510. Governing Engines, D. Johnston and W. McAdam, Glasgow.
2511. Extracting Oil from Fish, J. Jack and M. Blake, Glasgow.
2512. Drip Collecting Attachment, L. K. A. Ehlers, Glasgow.
2513. Cycle Driving Mechanism, G. Beekman, Glasgow.
2514. Bicycle and other Vehicle Tires, A. Graff, Glasgow.
2515. Nursing Bottles, W. Fairweather.—(*The Dorothy Nursing Bottle Company, United States.*)
2516. Chaff Cutting Machines, W. S. Richmond, Suffolk.
2517. The "B." Tandem, H. Benson, Belfast.
2518. Waterproof Table and Wall Covers, M. Lavy, Berlin.
2519. Treating Coat Fronts, W. H. Sladdin, Brighouse.
2520. Domestic Fireplaces, J. Dawber, London.
2521. Game, E. W. Hopkins, London.
2522. Saucepans, H. B. Doughty and C. T. Barlow, London.
2523. Electric Railway System, A. Casazza, London.
2524. Cutting Metal Pipes, D. G. Brighton and E. M. Venning, London.
2525. Disjointing Iron Pipes, D. G. Brighton and E. M. Venning, London.
2526. Keys of Typewriting Machines, A. Hodgson, London.
2527. Chucks, E. Schmidtmann, Cologne.
2528. Heat Preserving Covering for Pipes, A. Zingen and O. Beckmann, Cologne.
2529. Stop Valves, J. Robinson, London.
2530. Buttons Made in Two Parts, C. Bordes, London.
2531. Apparatus for Making Suppositories, D. Genese, London.
2532. Collapsible Boxes, E. M. Fuller, London.
2533. Tap Holes of Stoneware Bottles, H. J. Ansell, London.
2534. Finger Stalls, E. Nash, London.
2535. Railway Chair, J. Jackson, H. T. Porter, and A. W. Lusby, Oxfordshire.
2536. Device for Use with Penholders, A. O. Joynson, London.
2537. Sole Laying Machines, J. G. Lorrain.—(*E. E. Winkley and B. Phillips, United States.*)
2538. Varnish and Oil Cans, &c., J. G. Heywood, London.
2539. Levelling Metal Plates, &c., J. F. Golding, London.
2540. Cycle Brake and Alarm, C. E. Johnson and L. A. Kinsey, London.
2541. Extension Feet, Lilley and Skinner, Ld., and W. G. Dell and P. J. M. Gunthorp.—(*E. L. O'Connor, United States.*)
2542. Nitrogenous Substances, J. S. Wallace and J. Castell-Evans, London.
2543. Dry Kilns, H. H. Lake.—(*A. S. Nichols, United States.*)
2544. Sole Levelling Machines, E. C. Judd and H. E. Cilley, London.
2545. Current Regulators, H. H. Lake.—(*S. C. C. Currie, United States.*)
2546. Clasps for Chains, H. H. Lake.—(*J. V. Washburne, United States.*)
2547. Travelling Trunks, E. King, London.
2548. Buffer Attachment for Brooms, &c., E. King, London.
2549. Typewriter Counting Attachment, A. H. Kinder, London.
2550. Watering Appliances, A. A. Champion and F. S. Perkins, London.
2551. Bottles, J. J. Walsh, London.
2552. Ash Sifters, A. Belot, London.
2553. Pneumatic Tires, F. L. Woodhouse, London.
2554. Focussing Scales for Cameras, T. M. Clark, London.
2555. Stair Carpet Holders, L. Humphreys, London.
2556. Cycles, The Trengrove Improved Cycle Frame Company and W. H. Trengrove, London.
2557. Type Cutting Machines, T. T. Heath, London.
2558. Type Writers, T. T. Heath, London.
2559. Typographic Machines, T. T. Heath and A. N. Verdin, London.
2560. Means for the Manufacture of Bottles, W. Dunham, London.
2561. Apparatus for Cleaning Knives, E. A. Attwood, London.
2562. Incandescent Gas Lights, T. W. Kellet, Liverpool.
2563. Producing Fuel from Turf, &c., W. Schöning, London.
2564. Manufacture of Iron Sheets, W. Roberts, London.
2565. Metallic Cots, S. J. Hoadly, London.
2566. Removing Foil, H. J. Haddan.—(*G. Wiedeman, jun., United States.*)
2567. Artificial Straw Hats, &c., J. L. Pollock, London.
2568. Air and Waterproofing Varnishes, J. L. Pollock, London.
2569. Motor Carriages, E. J. Clubbe and A. W. Southey, London.
2570. Telephone Systems, W. A. Houts, London.
2571. Feeding Cups for Invalids, A. J. Lely, London.
2572. Rapid Tanning of Hides, &c., H. L. J. Roy, London.
2573. Cigarette Boxes or Cases, J. Plenderleith, London.
2574. Breech-loading Ordnance, R. Matthews and J. Horne, London.
2575. Explosives, H. H. Lake.—(*The firm of Fried. Krupp, Grusonwerk, Germany.*)
2576. Incandescent Oil or Spirit Lamp, H. Hempel, London.
2577. Removing Dust, J. E. Howard and J. C. Taite, London.
2578. Manufacture of Casks, C. Wittkowsky, London.
2579. Nut Lock, S. Stevens, London.
2580. Feeding Fuel to Furnaces, A. O. Müller, London.
2581. Telephonic Apparatus, E. W. Smith and The New Phonopore Telephone Co., London.
2582. Rests for Two-wheeled Machines, T. P. Wood, London.
2583. Flues and Manhole Covers, W. Jordan.—(*The Hogan Boiler Co., United States.*)
2584. Feeding Water, W. Jordan.—(*The Hogan Boiler Co., United States.*)
2585. Coin-freed Delivery Machines, R. J. Moser and H. W. Phipps, London.
2586. Grease Separator, E. F. W. Wilkinson and A. A. Smith, London.
2587. Processes of Fermented Liquors, A. Myers, London.
2588. Adjustable Handle for Bicycles, G. A. Wheeler, London.
2589. Steam Generators, A. J. Boult.—(*J. B. Granjon, France.*)
2590. Marine Velocipedes, G. F. Cremer, London.
2591. Stoves, A. J. Boult.—(*C. M. Hess, ——.*)
2592. Sheet-metal Bends or Elbows, C. Carduck, London.
2593. Lamps, E. L. Williams, London.
2594. Extraction of Caustic Alkali, A. J. Boult.—(*G. Villani, Italy.*)
2595. Embroideries, The "Lehner" Artificial Silk Co., London.
2596. Stoppers, W. A. Landau, London.
2597. Boot Spikes, W. A. Landau, London.
2598. Spout for Discharging Liquids, W. A. Landau, London.
2599. Neckties, A. B. Davey, London.
2600. Bearing Reins for Horses, J. Parks, London.
2601. Slides for Photographic Cameras, E. Pocknell, London.
2602. Finger Shield, A. Thorpe, London.
2603. Tobacco Pipe, J. Fitchie, London.
2604. Bottles, J. Fitchie, London.
2605. Construction of Moulds, &c., J. Lewthwaite, London.
2606. Damp Proof Tobacco Wrapper, E. M. Harley, Surrey.

5th February, 1896.

2607. Photographic Cameras, &c., S. P. Hyatt, London.
2608. Looms to Weave Without Healds, J. Taylor, Waterfoot, near Manchester.
2609. Stopper, G. MacDuff, London.
2610. Dynamo-electric Machines, E. S. G. Rees, Wolverhampton.
2611. Curtain Hooks and Eyes, A. F. East, Winchester.
2612. Cooking Jams and Confectionery, G. Sara, Truro.
2613. Artificial Marble, W. Beer.—(*H. Lüschen, Germany.*)
2614. Artificial Stone, F. W. Maxwell and W. Beer, Manchester.
2615. Hopper Feeders, W. Lord and F. Woodhead, Manchester.
2616. Water-tube Boilers, W. R. Cummins, Fifeshire.
2617. Patent Slide for Scarf, J. G. Rolason, Birmingham.
2618. Handles for Cycles, &c., H. Stone, Birmingham.
2619. Tires for Cabs, Buses, &c., J. Watt, Glasgow.
2620. Detaching Devices, &c., H. L. Offerman, London.
2621. Safety Pins, G. Browning, Manchester.
2622. Controlling Corves on Tramways, J. McBean and J. Eaton, Sheffield.
2623. Electric Targets, &c., W. W. McLauchlan, Manchester.
2624. Safety of Ships, G. Russell, London.
2625. Boilers for Heating Water, J. Waugh.—(*H. Bolze, Germany.*)
2626. Bobbins, C. A. Rickards, Bradford.
2627. Machines for Dressing Stone, J. Spencer, Keighley.
2628. Engine Governors, J. Mallinson and W. P. Gibbs, Cardiff.
2629. Furnaces, J. Harper and Co., Ld., and H. Devonport, Wolverhampton.
2630. Disconnecting Ventilating Trap, A. Harkess, Leith.
2631. Aluminium Splice, S. H. Levi, Shepperton.
2632. Ranges, G. Ashton, Manchester.
2633. Stone Sawing Machinery, G. Anderson, Dundee.
2634. Ruler, T. T. Greenwood, Darwen.
2635. Hose Pipe Couplings, W. Cornish and A. Smart, Bristol.
2636. Devices for Doors, P. R. J. Willis.—(*L. Depp, United States.*)
2637. Connecting Tires to Wheel Rims, J. McConechy, Glasgow.
2638. Footballs, F. Sugg, H. Collins, and J. J. Warry, Liverpool.
2639. Ornamental Letters and the like, B. Bradford, Liverpool.
2640. Chessboard, A. Scott, London.
2641. Card Games and Markers, A. D. Musson, Grantham.
2642. Absorbing Vibration in Spindles, P. Fyfe, Glasgow.
2643. Tilting Barrels or Casks, T. Williams, Stockton-on-Tees.
2644. Gas Governors, A. Hallett, Huntingdon.
2645. Oil Lamps, J. Davidson and the Tourtel Gas and General Engineering Company, Ld., London.
2646. Baths, J. A. Hollem, London.
2647. Index File, C. W. Northrop, London.
2648. Folding Box, A. R. Buckton, R. W. Brumby, and S. Clarke, Sheffield.
2649. Cycle Bell Alarm, A. de Courcy, Birmingham.
2650. Envelope and Book-post Wrapper, H. B. Tucker, Bath.
2651. Velocipede Driving Gear Case, H. Bate, London.
2652. Swivel Rasp for Horses' Teeth, F. Swales, London.
2653. Treatment of Paper Pulp, A. H. Harrison, London.
2654. Umbrella Frame, J. Murphy, London.
2655. Tobacco Pipe, W. H. Humphreys, London.
2656. Cycles, &c., R. Bright, London.
2657. Driving Gear of Bicycles, &c., H. Comyns, London.
2658. Simplex Apparatus, R. J. Eke, London.
2659. Rolling Machine, R. J. Eke, London.
2660. Fumigator, W. E. Darlington, London.
2661. Producing Incandescent Lighting, T. Landi, London.
2662. Cutting Hair or Wool, A. Gray.—(*J. W. Newall, Australia.*)
2663. Milling Cutter for Iron, &c., W. D. Marshall, London.
2664. Automatic Scales, H. Clifford and A. J. L. Gliddon, London.
2665. Adjustable Carbon Resistance, S. P. Blackmore, London.
2666. Fluid for Galvanic Batteries, J. E. Preston, London.
2667. Apparatus for Receiving Messages, J. E. Preston, London.
2668. Spinning Top, I. Shulman and S. Mechlowitz, London.
2669. Detachable Hoof Pads, T. Cloke, London.
2670. Wheeled Vehicles, J. A. Mays, London.
2671. Magic-lantern Slides, W. C. Pexton, London
2672. Boot and Shoe Stretchers, E. E. H. Wade, London.
2673 Drawing-off Frothy Liquids, A. E. Occleston, London.
2674. Armatures, P. R. Jackson and Co. and J. S. Lewis, London.
2675. Carrying Shafts of Lorries, J. Rawlinson, Liverpool.
2676. Machinery for Making Cigars, J. Lacoste, London.
2677. Vulcanite, H. Birkbeck.—(*P. W. Wierdsma and J. Kuipers, Holland.*)
2678. Treatment of Apatite, &c., J. G. Wiborgh, London.
2679. Machinery for Washing Grain, G. Daverio, London.
2680. Turbines, L. Benze and E. Bachmayr, London.
2681. Manufacture of Pigments, H. and S. H. Hawkins, London.
2682. Valves for the Supply of Liquids, W. B. H. Drayson, London.
2683. Electricity Meters, G. Hookham, London.
2684. Producing Crushed Malt, B. Rothenbucher, London.
2685. Fibrous Substances, I. A. F. Wallberg and J. D. Ullgren, London.
2686. Locking Shutters, A. J. Boult.—(*A. Lagarigue, France.*)
2687. Cutters, G. Brunton and W. A. Thornton, London.
2688. Shaft Tugs, W. Tyree.—(*F. N. Jones, New Zealand.*)
2689. Apparatus for Mixing Concrete, W. H. Baxter, London.
2690. Alarm Apparatus, A. J. Boult.—(*J. P. Dutilch, France.*)
2691. Filling Bottles, C. W. Clayton and R. J. White, London.
2692. A New Stud and Tie Clip, W. Heeley, London.

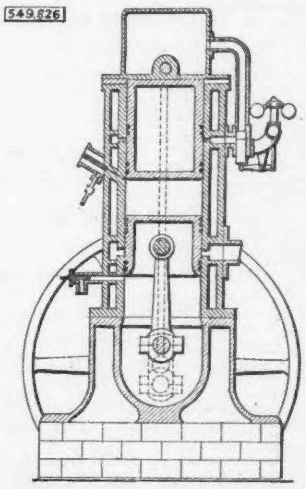
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

549,626. Balanced Gas Engine, *F. Burger, Fort Wayne, Ind.—Filed August 1st*, 1894.

Claim.—(1) In a gas engine, a cylinder, two working pistons, a crank shaft having cranks connected with said pistons, a closed crank shaft chamber, a cross-head chamber, and passages connecting the two chambers, substantially as described. (2) In a gas engine, the combination with the enclosing case forming a chamber, of a cylinder mounted therein, two working pistons mounted in the cylinder, a shaft in the chamber, connections between the working pistons and shaft enclosed within the case, inlet and outlet ports controlled by the pistons, an inlet port to the chamber controlled by one of the pistons, an igniter connected to the combustion chamber, and a governor controlling the passage of the gases from the chamber to the cylinder, substantially as described. (3) In a gas engine, the combination with the cylinder having a water jacket and provided with inlet and outlet ports, of two pistons mounted in said cylinder, a crank shaft connected to said pistons, a crank shaft chamber and a crosshead chamber having communicating passages, and connections between said chambers and the inlet ports, substantially as described.

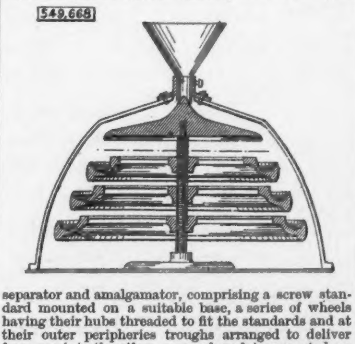
549,626



549,668. Separator and Amalgamator, *F. L. Fisher, Granger, Oreg.—Filed November 6th*, 1894.

Claim.—(1) In a separator and amalgamator, the combination of a screw-threaded standard and a series of wheels having threaded hubs fitting said standard and having troughs of progressively increasing diameters adapted to deliver into one another from the top to the bottom of the series, and means for supplying the upper trough, substantially as set forth. (2) A separator and amalgamator, comprising a screw standard mounted on a suitable base, a series of wheels having their hubs threaded to fit the standards and at their outer peripheries troughs arranged to deliver from one into the other, a spreader plate mounted on the top of the standard to deliver into the upper trough, the plate having a conical top, and a feed hopper delivering on the top of the cone, substantially as described.

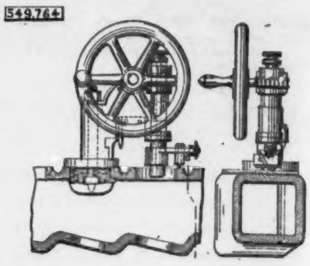
549,668



549,764. Machine for Re-facing Surfaces of Hand-holes, *J. J. Cain, Bayonne, N.J.—Filed February 11th*, 1895.

Claim.—(1) A re-facing machine consisting of a body adapted to be secured in a fixed position, and having a shaft mounted to rotate therein, which is provided with a tool-carrying arm; means for rotating said shaft; means for adjusting said arm longitudinally on said shaft; a tool block mounted to slide on said arm to and from the shaft, and means for moving the tool block step by step across the work at each revolution of the shaft, substantially as and for the purposes specified. (2) The combination with the machine body of a tool shaft furnished with gear; a worm for turning said gear, and means for rotating said worm; a tool arm mounted to slide on said shaft; a screw for adjusting the position of the arm on the shaft; a tool block mounted to slide on said arm; a screw provided with a wheel for adjusting the tool block on the arm; and a pin located in the path of revolution of said wheel for engaging the same, substantially as and for the purposes specified.

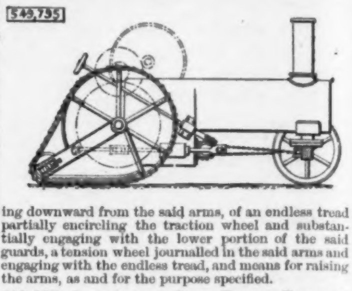
549,764



549,795. Traction Engine, *E. Ingleton, Pottstown Pa.—Filed March 13th*, 1895.

Claim.—(1) In a traction engine, an endless tread for the traction wheels, and means, substantially as described, for raising and lowering a section of the tread from the steering gear of the engine, as and for the purpose specified. (2) In a traction engine, the combination, with the traction wheel, upwardly swinging arms fulcrumed upon the axle of the wheel and extending beyond said wheel, and guards extending downward from the said arms, of an endless tread partially encircling the traction wheel and substantially engaging with the lower portion of the said guards, a tension wheel journalled in the said arms and engaging with the endless tread, and means for raising the arms, as and for the purpose specified.

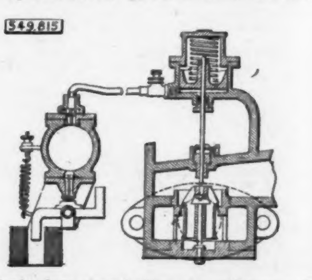
549,795



549,815. Governor for Steam Turbine Valves, *C. A. Parsons, Ryton, England.—Filed September 26th*, 1891.

Claim.—(1) The combination with a cut-off valve for a steam turbine, of a spring pressed piston or diaphragm connected to said valve, a fluid compressing pump communicating with said piston or diaphragm, a valve admitting fluid to said pump, and means for controlling or governing said admission valve, substantially as described. (2) The combination with a cut-off valve for a steam turbine, of a spring pressed piston or diaphragm connected to said valve, a fluid compressing pump communicating with said piston or diaphragm, a valve admitting fluid to said pump, a solenoid, a core and a cam carried by said core and adapted to engage said admission valve, substantially as described.

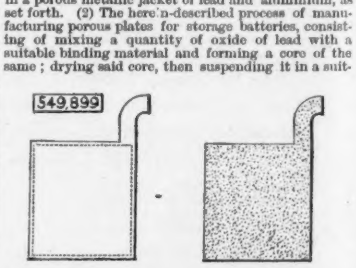
549,815



549,899. Plate for Storage Batteries and Process of Making It, *F. J. Clamer, Philadelphia, Pa.—Filed December 20th*, 1895.

Claim.—(1) A plate for electric storage batteries consisting of a central core of oxide of lead enveloped in a porous metallic jacket of lead and aluminium, as set forth. (2) The herein-described process of manufacturing porous plates for storage batteries, consisting of mixing a quantity of oxide of lead with a suitable binding material and forming a core of the same; drying said core, then suspending it in a suitable mould and pouring therein a melted alloy of lead and zinc to form a metallic jacket or envelope around the core; afterward immersing the plate thus formed in a suitable acid, allowing it to remain therein until the zinc in the jacket has been eaten out, leaving a porous lead jacket enveloping the central core, substantially as described. (3) The herein-described metallic blank for making plates for electric storage batteries, consisting of a central core of oxide of lead enveloped in a metallic jacket composed of an alloy of lead, zinc, and aluminium, as set forth.

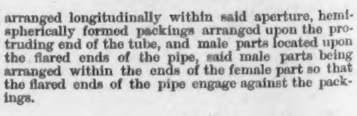
549,899



549,902. Combination Soft-metal Pipe Coupling, *J. B. Dockery, St. Louis, Mo.—Filed August 12th*, 1895.

Claim.—In a pipe coupling of the class described, a female part constructed with a centrally-arranged diaphragm in which is formed an aperture, a tube arranged longitudinally within said aperture, hemispherically formed packings arranged upon the protruding end of the tube, and male parts located upon the flared ends of the pipe, said male parts being arranged within the ends of the female part so that the flared ends of the pipe engage against the packings.

549,902



THE TWO NEW DOCKS AT PORTSMOUTH.

IN the year 1540 the Royal Dockyard at Portsmouth embraced an extent of only about eight acres. At the present day, with all its accessories, it covers an acreage nearly thirty times as great. It was during the session of 1864 that Parliamentary powers were obtained for the construction of the basins, wharves, and docks which form what is known at Portsmouth as the "Dockyard Extension;" and the site of the two great docks, which form the subject of the present paper, was then so far established that entrances to both of them were built, and even suction-culverts leading to the main pumping engines were provided, whilst the docks themselves were still *in nubibus*. It is a remarkable instance of the foresight of those who were in authority at the time that they should have designed these dock entrances with a width of 82ft., although they can have had but very dim visions of the future 15,000-ton monsters which should eventually occupy the docks.

It was not until the commencement of the Powerful and Terrible, however, with their length of 530ft. over all, that the Admiralty authorities found it necessary to build two new docks of extraordinary length, as without them the great cruisers, when completed, could not have been received for overhaul into any of our Government dockyards. It was then at once decided to construct two suitable graving docks within the entrances already provided, to be called respectively Numbers 14 and 15. Designs were accordingly prepared, under the direction of the department of the Director of Works at the Admiralty; the work of construction being carried out by Mr. J. Price, of 15, Great George-street, Westminster, under the direction of Major Pilkington, C.B., R.E., and Mr. C. Colson, M.I.C.E., of the naval civil engineers' department. The representatives of this department upon the spot were, in the first instance, Major Raban, R.E., until his appointment as Director of Works at the Admiralty, and, subsequently Major Exham, R.E.; Mr. C. H. Colson, A.M.I.C.E., being the Admiralty Engineer in immediate charge of the works, and Mr. A. W. Manton, A.M.I.C.E., the contractor's agent.

By the courtesy of the department of the Naval Civil Engineers we have been permitted to view the works of the new docks now in course of construction, and have been afforded many interesting particulars as regards their constructive features. Photographs and sketches have also been courteously supplied for reproduction.

The main dimensions of the two docks are as follows:—

	No. 14 Dock. ft.	No. 14 Dock. in.	No. 15 Dock. ft.	No. 15 Dock. in.
Length, extreme, at copings	563	6*	563	6*
,, ,, on floors	550	0	550	0
Width, extreme, at copings	120	0	120	0
,, ,, on floors...	75	0	75	0
Depth, extreme	43	6	43	6
Width of entrances	82	0	94	0
Depth of water over sills when full...	33	10	33	10
Total capacity of each dock, including that of entrance	gals. 12,621,000		gals. 12,698,000	

Since the introduction of deep bilge-keels for war vessels has taken place, difficulties have been found in docking those of very large displacement and corresponding breadth of beam, even in docks whose entrances were 82ft. wide; although it has been done, by a little adjustment, in the cases of the Majestic and Magnificent, the largest war ships afloat. Hence, in order to provide sufficient room for modern ships, under all conditions, with their bilge-keels, it was decided to widen the entrance of one of the new docks—Number 15—to 94ft., and to complete the other dock in such a manner that its entrance could be widened hereafter without trouble.

The mode of construction of the new docks has differed very materially from that employed for the "extension" works, begun in 1868. Beech and fir piles had at that time formed the foundations for walls and docks. In the present instance these have been entirely done away with, and the preliminary coating of concrete for the bottoms was laid upon the undisturbed soil, the precaution being observed of not removing the last foot of material until the moment of concreting. The excavation of the new docks was carried out by working off the entire surface area to begin with, leaving a "dumpling" or ridge of earth between each dock, the floors being finished before the walls. As, however, when the entrances were originally constructed a space had been excavated inside them, and this, of course, was always full of water, in order to get on with the excavation of the docks before the cofferdam was completed — which we shall presently describe—it was necessary to leave a bank across both docks to serve as a temporary dam, and to confine operations as much as possible to the space behind it.

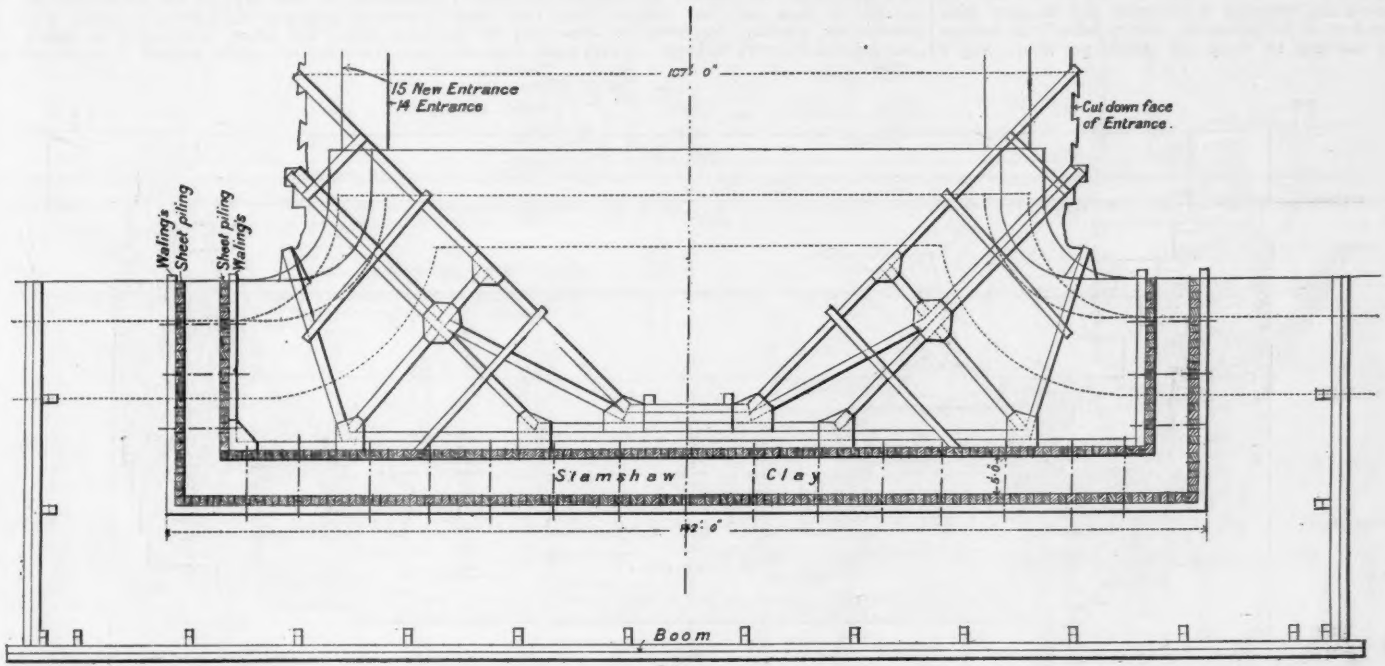
The work of excavation was carried out by running a gantry across the heads of both docks, and hoisting the spoil in skips by small 3-ton cranes standing upon the gantry. Piles were driven at distances from 15ft. to 20ft., and queen-trussed 12in. by 12in. timbers, with two 1¼in. wrought iron tie rods, were placed spanning the piles. Across these were placed decking timbers of 8in. by 4in. stuff, and on this decking ran two lines of rails, one for the hoisting cranes, and the other for the wagons of spoil which were run away to Whale Island. The iron skips were lowered down to be placed on small trolleys, on rails running about the excavations, and as each of these, when full, weighed about one ton, care was taken to obtain always a slight gradient towards the gantry, so that the trolleys only required hand pushing to reach the face of the excavations when empty and light. When filled, they ran down by themselves to the gantries. As the spoil came up, it was tipped direct into wagons and run off to its destination. It may be mentioned, in parentheses, that Whale Island, which is now the site of commodious naval barracks and a school of gunnery is practically the result of spoil raised from dock yard excavations since the year 1864.

Whilst working at dock Number 15 the workmen came upon an interesting old culvert, of excellent cut stone and brick, which was employed in ancient days for the flooding of the moat running around the north-east of the original dockyard. Almost the whole of the excavation was in the London clay strata, and showed very clearly the beds of black pebbles and layers of septaria. A thick bed of hard brown sandy clay was interspersed with large boulders of limestone, that gave some trouble in driving the piles for the large cofferdam, as we shall see presently. Considerable trouble was also experienced during the progress of the works by the liability of the clay to swell, expand, and crack when exposed to the weather. Several very heavy falls of material took place, not slips, in the ordinary sense of the word, but rather caused by the whole mass swelling, and then caving out at the bottom. The total quantity of material got out during the excavation of the docks was 310,000 cubic yards.

The amount of water found in the excavations as they proceeded—independently of that before alluded to which was the result of earthwork begun in 1864 — was fortunately very small, and one 6in. Tangye's special pump in each dock has sufficed to keep down all the leakage, although two extra pumps were provided for use in emergencies.

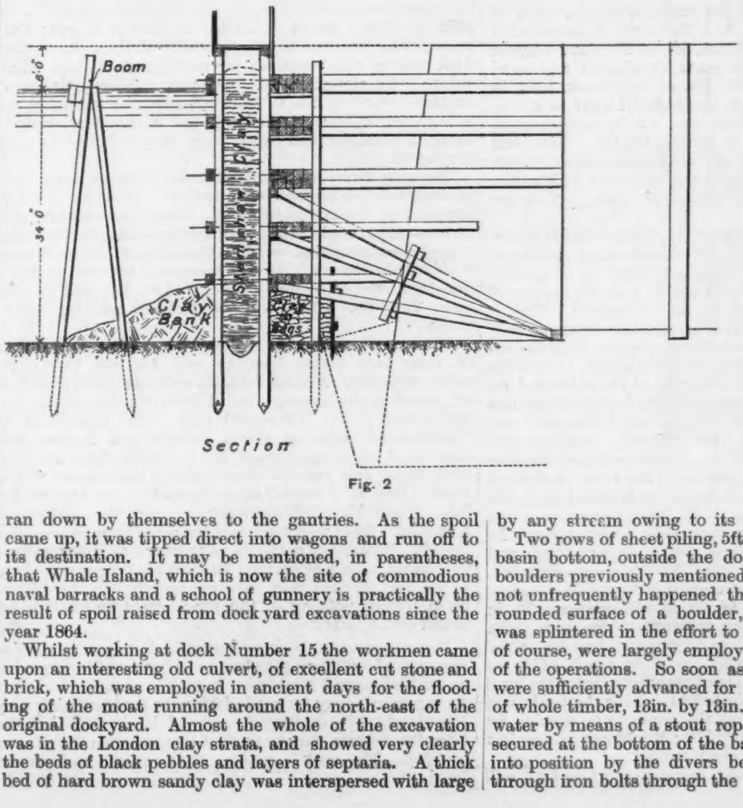
We must now describe the cofferdam — Figs. 1, 2, 3, and 8—which was constructed across the entrance to dock No. 15. As this entrance opened into the "basin," and had to be enlarged from 82ft. to 94ft., it was necessary to provide a dam strong enough to hold up a constant head of water of about 34ft., across a space of 107ft., whilst the old sides and stops at the entrance were being cut away and re-faced right down to the sills at the bottom. At first a circular dam was proposed, but, after all the circumstances had been considered, it was decided to construct a square-faced trussed dam, as being more simply built up, and taking up less room in the repairing basin, into which the dock opened. This was a point of great importance, in view of the limited space available in the basin for moving about ships. The adequate strength of the dam, moreover, was a matter of much moment, as, the basin being constantly full of ships, an accident which should result in a failure of the dam to keep back the head of water, would mean very great damage to them. The pressure against the dam when the water behind was pumped out was about 3000 tons. Hence it was made very strong, and more timber was put in than was actually necessary to take up the strain. The plan of the trusses of the dam is shown in illustration Fig. 1, and Fig. 2 is a section showing the rakers butting against the outer stop of the dock entrance. The dam stands on a sandy clay, which is almost impervious to water when *in situ*, but which is very quickly cut away by any stream owing to its composite character.

Two rows of sheet piling, 5ft. apart, were driven into the basin bottom, outside the dock entrance, the limestone boulders previously mentioned giving some trouble, as it not unfrequently happened that a pile, meeting with the rounded surface of a boulder, took a wrong direction, or was splintered in the effort to drive it through. Divers, of course, were largely employed during the whole course of the operations. So soon as the two rows of sheeting were sufficiently advanced for walings to be added, pieces of whole timber, 13in. by 13in. square, were hauled under water by means of a stout rope running through a block secured at the bottom of the basin, and were then levered into position by the divers below. The putting of the through iron bolts through the outer waling, the two rows



Plan

Fig. 1



Section

Fig. 2

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*An extra length of 15ft. can be obtained for each of the docks by putting the caisson in the outer stop of the entrance. This would give an extreme length, if required, of 578ft. 6in.

of sheet piling, and the inner waling, was a troublesome job, but was successfully accomplished, and then the space between the two rows of sheeting piles was filled up with puddled clay. The top rows of raking struts, as seen in the engraving, were then secured behind the sheet piling, and the pumping out of the water behind the dam commenced. As on several occasions small leaks which existed near the bottom of the dam suddenly assumed importance, and quantities of sand were washed in under the sheet piling, it was decided, before pumping out all the water, to carry a wall of bags of clay and loose bags right round inside the dam, and to cover the exposed sand on the outside of the dam with a layer of clay for about 15ft. from the dam. The strength of the dam was finally reinforced by another inner row of short lengths of sheeting, of 9in. by 3in. material, driven some 10ft. within the original dam at its bottom, the space inside being packed with clay. This treatment was found quite successful, as, if any little leak was started, the sand was screened from the water by the bag-work, and the leak was quickly stopped by the clay from above settling down into it. At the present time, after the dam has been standing for fourteen months, with a pressure of 3000 tons against it, and the operation of removal and renewing of brickwork and masonry been carried on in its immediate vicinity behind, the leakage only amounts to about 700 gallons per hour. Fig. 4 shows the dock entrance in process of alteration behind the dam.

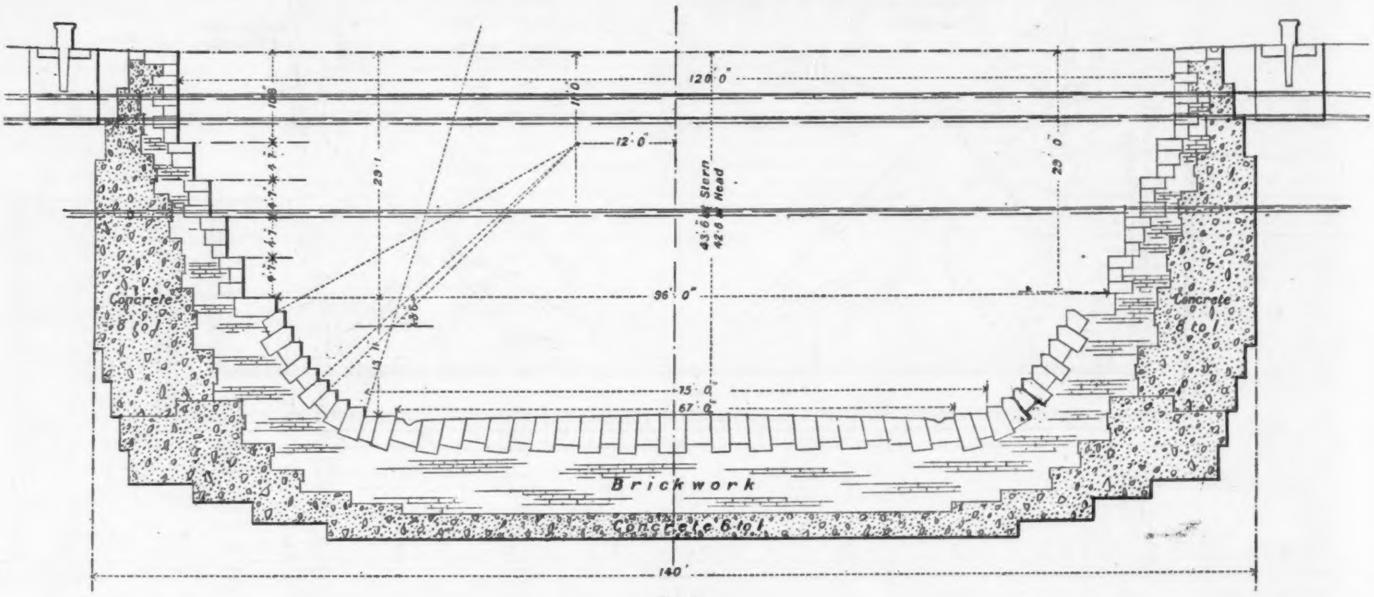


Fig. 3

Let us now turn to the construction of the dock linings. An enormous quantity of materials has been and is yet to be employed in their completion. No less than 15,000,000 of bricks were required, which have been obtained from the contractors' own works at Copnor, from Poole, Chandlersford, Hamworthy Junction, &c. The 600,000 cubic feet of granite wanted is all being supplied ready dressed and fitted, block to block, by Messrs. J. Freeman and Sons, from Cornwall. The cement used has been supplied by Messrs. Francis and Co., J. Bazley White and Co., Tunnel Cement Company, Trechman, Weeks and Co., and other contractors.

A cross section of one of the docks—representative of either—is given in Fig. 3. The floor is constructed of the following layers:—First, 3ft. of Portland cement concrete, composed of six parts of shingle and sand to one of cement; secondly, 7ft. of brickwork, built in cement mortar, composed of two parts of sand to one of cement; and lastly, 4ft. of granite, set in neat cement, making a total thickness of about 14ft. 6in. The total water pressure from below upwards against the concrete base, were the surrounding strata saturated with water, would be about 3392 lb., or a ton and a-half, per square foot.

The sides are lined very similarly, except that they are surmounted by two courses of Portland stone at the top and a little at the heads. They are built up of granite blocks, backed with brickwork, which is set in mortar of two and three parts of sand to one of cement. This is supported at the bottom with concrete of six to one proportions, higher up with concrete of eight to one proportions. The thickness of granite at the sides is less than that of the floor. The concrete at the springing of the sides and on the walls is considerably thickened. The bricks are not laid as in ordinary building brickwork, but are laid loose in wet cement mortar. They are then "drawn" together and the mortar is forced into all the joints, so that no air hole exists. As seen in the engraving of the cross section of dock, the lining comprises in reality an inverted arch, the granite blocks being cut so as to form voussoirs in the floor, and the side blocks corresponding with them. In making the concrete for these docks, two of Carey and Latham's mixing machines, size No. 2, were employed. Wooden shoots were at first employed to run the concrete to the bottom of the docks for the first floor layer of 3ft. in thickness; but owing to the cement hanging up in these shoots, it was found advisable to use circular iron tubes. These were made in lengths, so as to admit of being shortened when used to shoot concrete into the wall linings as these increased in height. Near the top it was found more convenient to set the concrete in moulds for the backing, and then to build the brickwork up against it, throwing in a filling of earth behind.

When completed, the two docks, Nos. 14 and 15, will be connected up with the existing pumping station by means of the old suction culverts, and each of them can be emptied of water—when full—in three hours, the pumps having a working capacity of 70,000 gallons per minute.

Four slides for lowering timber and three flights of steps are being provided on each side of the new docks, as well as an additional set of slides and steps at the heads. Six 7-ton compressed air capstans are to be fixed round each dock, and these are supplied with motive power from the air compressors in the main pumping house. Subways are laid beneath the surface on both sides of the docks to contain the necessary pipes, &c. A steel ship caisson is provided for each dock entrance. These have oak keels bearing against a granite face, in order to make a water-tight joint when the dock is empty.

Fig. 5 shows the head of No. 14 Dock in its present condition, January, 1896. The gantry which spans the head is visible in the back ground, together with one of the lifts subsequently employed for getting out and lowering materials as the dock progressed in depth. It will be, of course, understood that as the surface was cut away beneath the gantries, the piles of these had to be removed, and the work underpinned with fresh supports. The engraving shows very clearly the progress of the dock sides. The bottoms have been completed where the temporary lines of rail are shown.

Fig. 6 exhibits the construction of the bottom and laying of the granite blocks. These blocks are quarried, prepared, and trimmed at the works in Cornwall, full sized drawings of the dock sections showing each stone being laid out on a smooth prepared floor; so when the stones arrive they have only to be pieced together and joined by neat cement. The radiating shapes of the several blocks of granite is well shown in the engraving.

Fig. 7 shows the whole of No. 14 Dock in its present condition, looking towards the entrance. It will be remembered that this is the original entrance, of 82ft. in width, which is not to be altered as yet; this accounts for the extraordinary width of the sides of the dock within the entrance, as seen in engraving. The entrance is closed by the ordinary caisson; the new entrance of dock No. 15 will not only be extended to 94ft., but will be very much squarer in the floor section, to make room for the exceedingly deep bilge-keels now employed.

The new docks were commenced in August, 1893, but, of course, a considerable time was exhausted in preparing approaches, lines of railway, &c., before the actual work of excavation could begin, and this preliminary work was a good deal hampered owing to the necessity for enclosing it all within fencing. It is proposed at present to have one dock completed and opened before the end of this year, and the other will be finished shortly afterwards.

The importance to the British Navy of the completion of these two docks, Nos. 14 and 15, can hardly be over-estimated. A most valuable epitome of the question of naval docks appears in *Whitaker's Almanack* for the current year. It is stated that "only two docks in Government yards of Great Britain and Ireland are capable of receiving ships of the Powerful class, and that even these two are not docks in the strict sense of the word. One is a combination formed of the two docks, Nos. 7 and 10, at Portsmouth, so that the docking of a Powerful there might prevent the docking of two smaller vessels. The other is the basin entrance at Haulbowline. Of course, such a place *may* be used for the purpose, but, as its use in that way involves the shutting up of the basin within, nothing of the kind would be likely to be risked during war."

It is earnestly to be hoped that, not only may a series of new docks of large size be put in hand at Devonport—as we understand now to be in contemplation—but that arrangements may be made forthwith for increasing very considerably the docking capacity of Malta, and that the Gibraltar scheme may be pushed forward with the utmost rapidity. The cost is nothing to the enormous interests involved.

THE MIDLAND RAILWAY COMPANY'S AUTOMATIC STEAM AND VACUUM BRAKE.

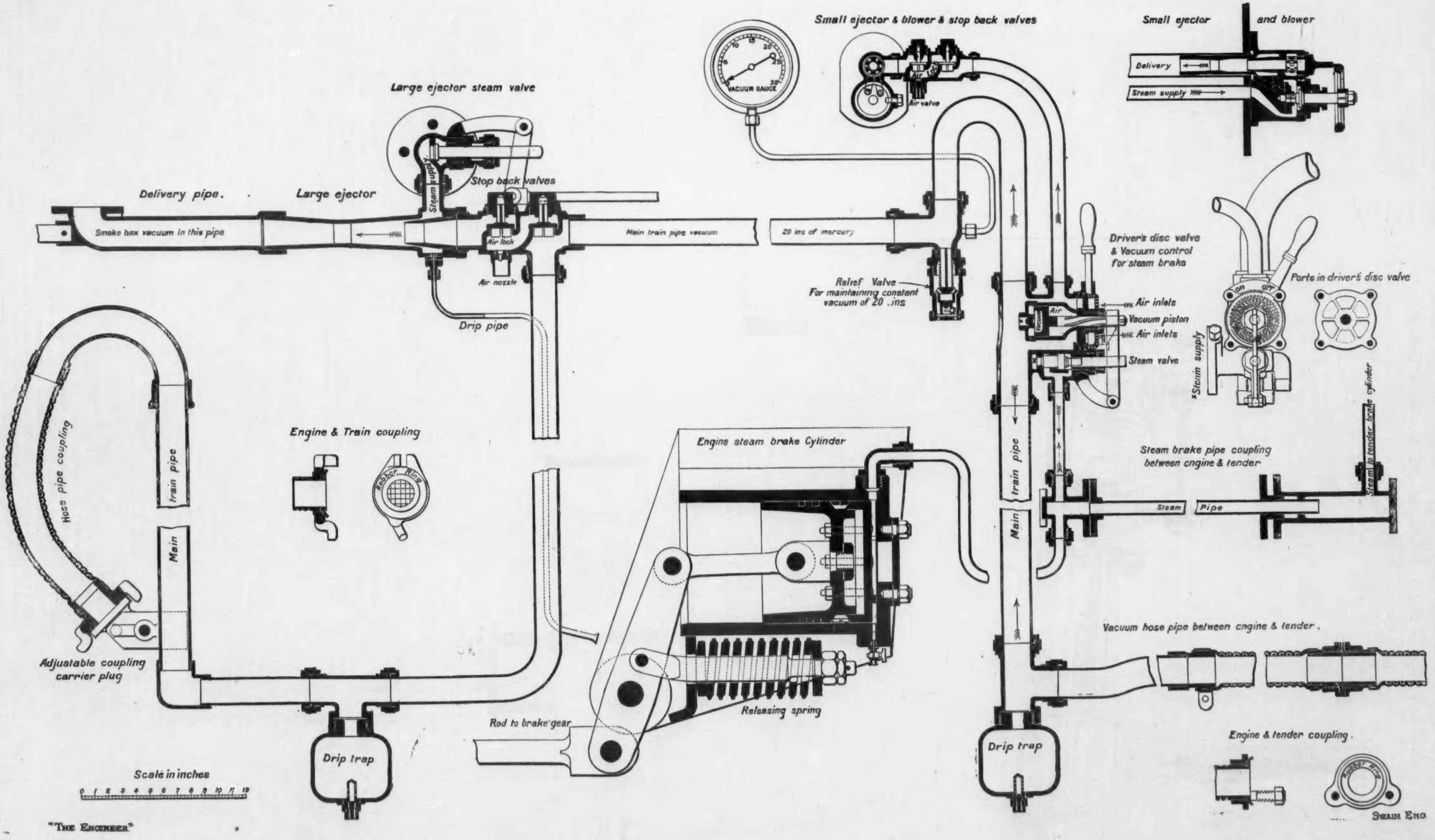
In the description of the Midland Railway Company's locomotive works, which we published in our issue of the 13th December last, we made brief reference to the vacuum brake, which is exclusively employed with excellent results on this company's stock. Through the courtesy of Mr. Johnson we are now enabled to present to our readers a very interesting illustration, representing diagrammatically a section of the complete apparatus on the engine. Apart from the steam and vacuum cylinders and intermediate gear for actuating the brake blocks, it will be seen that the apparatus comprises essentially a small ejector, with which is combined a blower, a driver's disc valve and vacuum control for the steam brake, and a large ejector. There are also drip traps for allowing of the escape of water accidentally introduced into the train pipe, a relief valve for maintaining a constant vacuum of 20in., a pair of stop-back valves behind each ejector, and a steam valve for the large ejector. Of this apparatus only the small ejector and blower and the driver's disc valve and vacuum control for steam brake are placed in the cab.

Before going into the details of the mechanism above enumerated, it may be found not out of place briefly to describe the principles which govern the action of this combined brake. The steam brake which is applied to the engines and tenders may be disposed of in very few words, comprising as it does a cylinder 9in. diameter, fitted with a piston, which is forced out by the admission of steam, in opposition to a stout helical spring. The piston is connected to the brake gear by means of a lever and rod as shown, so that its outward movement applies the brake, and its inward movement, due to the expansion of the spring, releases the blocks. The automatic vacuum brake, which, in the case of passenger traffic, is applied to every vehicle of the train, depends for its proper action upon the maintenance of a vacuum in each of the brake cylinders and throughout the whole length of the train pipe. The destruction or partial destruction of this vacuum by the admission of air into the train pipe operates an extremely sensitive ball valve fitted on each brake cylinder so as to close the passage communicating with the space above the piston, and leaving open the passage communicating the lower side of the piston through which the air finds its way, raising the piston and applying the brakes. To release the brakes again the admission of air to the pipe is arrested, and the normal vacuum restored in the train pipe and below the brake pistons, which, being in equilibrium, fall by gravity. From this brief description, then, it will be seen that the power stored up in the space above the piston is not reduced by the repeated applications of the brakes.

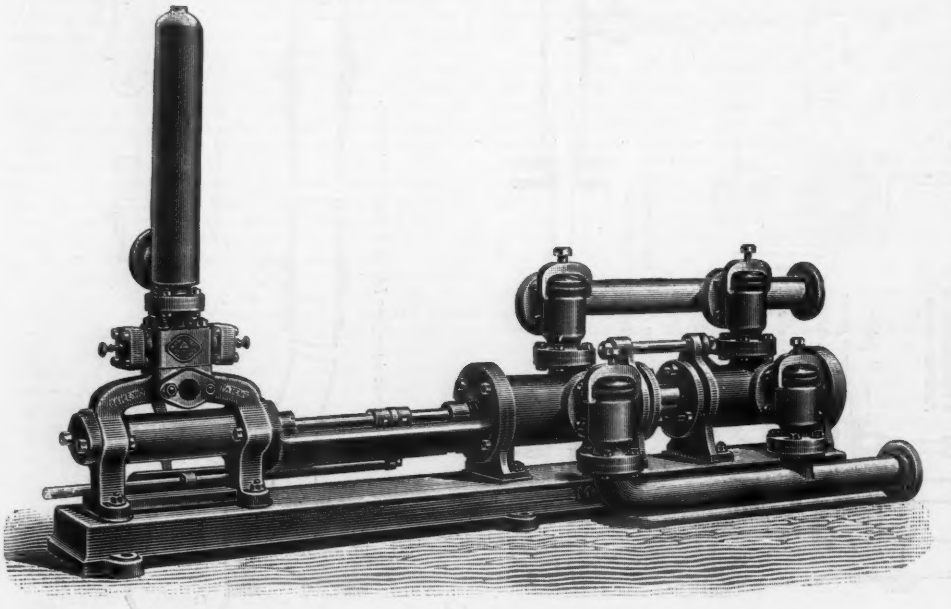
Referring now to the diagram, the first appliance which claims attention is the small ejector, since upon this devolves the duty of maintaining the vacuum throughout the entire system. As previously stated, this is fitted in the cab, and derives steam from the dome, the supply pipe passing through the steam space in the boiler, through which also the exhaust pipe is led to the blast pipe in the smoke-box. The supply of steam to either this ejector or blower is regulated by a disc valve actuated by the hand wheel and spindle shown. The ejector communicates with the main train pipe through the driver's disc valve and vacuum control for steam brake, and is provided with a device called an "air lock," consisting of two stop-back valves, between which is inserted an air valve. The movable part of this valve is a ball which is held against its seating only when a vacuum is maintained in the train pipe, but falls when the vacuum is destroyed, thereby allowing any accumulated water to escape. The driver's disc valve and vacuum control for steam brake in reality comprise three distinct devices which operate conjointly to give simultaneity of action of the two brakes—steam and vacuum. In distinct parts of the same casting two pistons are arranged. The larger of these is in connection with the train pipe, and the smaller controls the steam to the brake cylinder, while a third device is an air disc by means of which air may be admitted to the train pipe by the simple movement of a handle from right to left. When this is done the vacuum behind the larger piston is destroyed, and leaves it in equilibrium. As the rod of this piston is connected with the steam valve rod by means of a lever pivoted as shown, and as steam at boiler pressure is always acting on the end of this valve, the latter is then released and admits steam to the brake cylinder on the engine. When the vacuum is restored in the train pipe, thereby releasing the vacuum brakes, the ratio of the areas of the two pistons is such that the atmospheric pressure on the larger one, aided by the extra purchase on the lever connecting the two, is sufficient to overcome the steam pressure on

THE VACUUM BRAKE ON THE MIDLAND RAILWAY

(*For description see page* 182)


Small ejector & blower & stop back valves
Air lock
Air valve
Vacuum gauge
Small ejector and blower
Delivery
Steam supply
Large ejector steam valve
Steam supply
Stop back valves
Delivery pipe.
Large ejector
Smoke box vacuum in this pipe
Air lock
Air nozzle
Main train pipe vacuum
20 ins of mercury
Relief Valve
For maintaining constant vacuum of 20 ins
Drip pipe
Driver's disc valve & Vacuum control for steam brake
Air
Vacuum
Air inlets
Vacuum piston
Air inlets
Steam valve
Steam supply
On
Off
Ports in driver's disc valve
Steam brake pipe coupling between engine & tender
Steam
Pipe
Steam to tender brake cylinder
Hose pipe coupling
train pipe
Main
Adjustable coupling carrier plug
Engine & Train coupling
Rubber Ring
Engine steam brake Cylinder
Releasing spring
Rod to brake gear
Drip trap
Main
train pipe
Drip trap
Vacuum hose pipe between engine & tender.
Engine & tender coupling.
Rubber Ring
Scale in inches
0 1 2 3 4 5 6 7 8 9 10 11 12
"The Engineer"
Swain Eng

BAILEY'S HYDRAULIC SEWAGE PUMP



the smaller one, which is closed, again shutting off the steam supply, and opening the exhaust port. It will thus be seen that the driver can, by one slight operation, viz., the movement of a handle from right to left, apply and release the vacuum brake throughout the whole of the train, and also the steam brakes on the engine and tender.

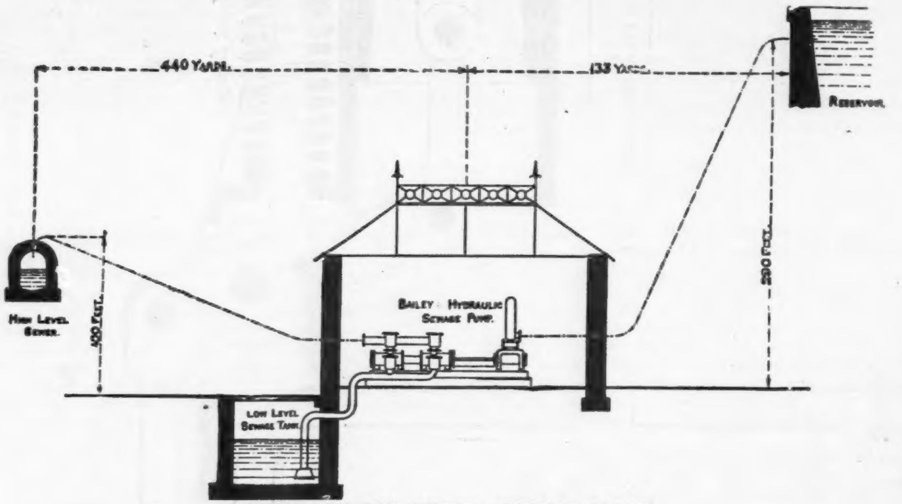
The large ejector, which is intended for emergencies only when it is required to create a vacuum quickly in the train pipe, is fixed on the side of the boiler near the smoke-box, and is provided with its own steam valve operated from within the cab by means of a rod and lever. Steam is derived from the dome as in the case of the small ejector, and the exhaust takes place in the blast pipe. Behind the ejector are placed two stop-back valves, one of these being necessary to prevent the small ejector drawing air into the train pipe through the large ejector when the latter is not working. Between the two valves the space provided forms an air lock, a nozzle with a very small outlet being arranged to allow any water of condensation which may accumulate in the space to escape. When the large ejector is out of action a vacuum is maintained in the barrel equal to that in the smoke-box, so that any steam leaking through the steam cock will travel with the air current in the direction indicated by the arrow, or pass as water through the drip pipe. Any leakage past the valve situated between the air lock and the train pipe will be air entering through the small air nozzle alluded to above. Since the adoption of this arrangement of air lock behind the ejectors the brake system employed by the Midland Company has enjoyed complete immunity from water accumulating in the train pipe; nevertheless, further precaution is taken by the provision of drip traps in suitable positions in which any water which may get into the pipes can accumulate, the discharge taking place by means of a ball valve when the vacuum is destroyed throughout the train. Another small device shown on the diagram is a relief valve intended to maintain a constant vacuum of 20in. in the train pipe. This valve is controlled by a sensitive helical spring arranged around its stem, so that when an excessive vacuum is attained the valve rises and admits air to the pipe.

The apparatus is considerably more split up than is necessary, since the two ejectors, the driver's disc valve and vacuum control for steam brake, and relief valve might be all combined in one instrument, but we have no doubt Mr. Johnson has good reasons for adopting this arrangement, and the annual Board of Trade reports on brake failures prove unmistakably that this combined brake enjoys a very high reputation amongst the continuous brakes in use in this country.

Messrs. Sydney Smith and Sons, of Nottingham, have fitted one of their largest syrens with organ whistle combined for signalling purposes to the Czar's yacht Standart.

BAILEY'S HYDRAULIC SEWAGE PUMP.

Messrs. W. H. Bailey and Co., of the Albion Ironworks, Salford, Manchester, have just completed for the Blackrod Urban District Council, a specially designed hydraulic pumping engine, of which we give illustrations. This pump is to be employed for lifting sewage from a low-level collecting tank into the main sewer, which is 100ft. above the tank, and the motive power is obtained from the water main serving the district. There are 62 houses, with a population of 310 in the district, whose sewage has to be dealt with by the pump, and the quantity raised is about 600 gallons per hour, the available water pressure being 290ft. head. The sectional illustration will give an idea of the arrangement of the pumping engine, sewer, and reservoir. The pump, which is fitted with 4½in. rams, with 12in. stroke, the water cylinder being 4in. diameter, works noiselessly, and has no dead centre, and provision is made for adjusting the speed to suit requirements. The valves are of special design, and of a type which the firm has found best applicable to the class of work for which this pump is to be used. Messrs. Bailey have designed modifications of this pump for use in connection with water supplies for towns, and for raising water to the sump from dip workings in mines.



BLACKROD DISTRICT COUNCIL SEWERAGE SCHEME

COAL DUST AND HIGH EXPLOSIVES.

With a view to increasing our knowledge of the safe working of coal mines, the North of England Mining Institute appointed a committee on flameless explosives to experiment and report on a large number of so-called high explosives. The committee have been at work for nearly a year, and their second report dealing with the action of flameless explosives in mixtures of coal dust and air, and coal dust, air, and pit gas, was read on Saturday, the 15th inst. A former report gave the results of experiments conducted in mixtures of gases and air alone, but the investigations are far less important than those conducted since, particularly as it has now been finally demonstrated that an exceedingly small quantity of coal dust is sufficient to cause an explosion, and the contention that it only constituted a danger when present in large quantities is proved to be entirely unfounded, so that it is not impossible that many explosions which up to the present have been attributed to the ignition of inflammable gases should now be ascribed to this cause. This inquiry has revealed the fact that the presence of coal dust in quantities varying from 32 parts to 1 produced almost identical results, a point which deserves and we trust will receive the fullest recognition and attention, now that it is demonstrated to a certainty. Another point of almost equal importance, particularly when regarded simultaneously with the above fact, is that all the so-called flameless explosives produce on detonation "evident flame," and are liable to cause explosion under certain conditions, though undoubtedly less dangerous than ordinary blasting powder.

The results of these experiments are so valuable and instructive, and appear to have been conducted with so much thoroughness and knowledge, that it is to be hoped that the Institute will find it possible to appoint another committee, now that the present one has concluded its programme, to make further investigations in the same field. Much, very much, has still to be learnt about the commencement and propagation of explosions in mines, not only as due to the presence of coal dust, which in the future must be considered a more weighty factor than it has been in the past, and as produced by the use of blasting charges of whatever nature and constitution, but also from causes more obscure, less easy of investigation and detection, and therefore more to be feared. The conditions of an explosion frequently preclude the possibility of a satisfactory inquiry, and results have to be, or are, attributed to causes which are readily conceivable, if certain allowances are made, when, if the true facts of the case could be ascertained, it is not impossible that causes far less common and less understood, if understood at all, have produced the disaster. We need only remind our readers again that up till now it was held that only when coal dust was present in such quantities as to prevent the practical working of the mine was it liable to that sudden ignition. The conclusions of the committee have been drawn up as follows:—

(1) The high explosives—ammonite, ardeer powder, bellite, carbonite, roburite, securite, and westfalit—on detonation, produce evident flame.

(2) The high explosives are liable to ignite either inflammable mixtures of air and fire-damp, or air and coal dust, or air, fire-damp, and coal dust, and, therefore, cannot be relied upon as ensuring absolute safety when used in places where such mixtures are present.

(3) The explosives are less liable than blasting powder to ignite inflammable mixtures of air and fire-damp, air and coal dust, and air, fire-damp, and coal-dust.

(4) The experiments have shown that ignitions of mixtures of air and coal dust, with or without the presence of fire-damp, can be obtained when there is present a much smaller quantity of coal dust than has been previously supposed to be necessary.

(5) It is essential that similar examinations of the working places and precautions which are in force in mines where blasting powder is used, should be rigidly observed when a high explosive is employed.

(6) In selecting a high explosive for use in a mine, it should not be forgotten that the risk of explosion is only lessened, and not abolished, by its use.

(7) In view of the changes from time to time made in the proportions and constituents of high explosives, it is desirable that the name of the explosive should be printed on the wrapper of each cartridge, and that the date of manufacture and the proportion of the ingredients used in the manufacture of the explosive should be printed on the case of each packet of cartridges.

(8) As these explosives alter in character if improperly kept, it is necessary that every care should be taken in the storage to ensure their being maintained in good condition.

The Institution of Junior Engineers.—At the meeting of this Institution, held at the Westminster Palace Hotel on 14th February, the Chairman, Mr. H. J. Young, presiding, the paper read was on "The Stability of Tall Chimneys," by Mr. F. J. Bancroft, B.Sc., member. Having drawn attention to the danger to life, destruction of property, and loss of business which often ensued from the fall of a tall shaft, the author enumerated the characteristics exhibited by chimneys that had fallen. Such shafts had usually been observed to "sway" or "rock," which movement, although a source of alarm to some people, had by others been regarded as an essential condition of safety, and showed the admirable elasticity possessed by the structure; cracks had also been traceable starting on the windward side, and descending obliquely to the leeward side of the shaft, which had finally collapsed by the crushing of the material through the concentration of the pressure on one side. No reliance should be placed on the tenacity of the mortar, since the erection might have to withstand a gale while the work was new; pressure should therefore be present over the whole of the bed joint, and in no case be less than zero, so as to become a tensile stress. It was thus necessary to limit the position of the centre of pressure, so that the maximum stress should not exceed twice the mean, and that no tensile stress be caused. The determination of the limiting position of the centre of pressure for square and circular shafts having regard to the thickness of brickwork in each case was then considered, and it was shown that it was only where the brickwork became infinitely thin that it was permissible to be at one-sixth of the diameter from the leeward side for square shafts, and to be at one-fourth of the diameter from the side for round shafts, these being the values given by Rankine, and copied into many works without reference to the relative thickness of the brickwork to the outside measurement of the shaft. This was shown to be an important point, causing an error of 58 per cent. in the calculations of the safe wind pressure in a square shaft, the thickness of brickwork being taken at a quarter of the diameter. Calculations of a shaft that had actually fallen were then made, from which it was seen that a wind pressure of about 16 lb. per square foot would be sufficient to cause tensional stress, and that the weak place was at the second set-off, where the shaft ultimately failed. The author combated the idea of rocking being indicative of safety, and showed that separation must take place at the joints; the swaying, with its concomitant pressure and relief, promoted disintegration, and caused the shaft to be still less capable of resisting the recurring wind pressure. The heavier the material of which a shaft was built, the greater would be its stability, the foundations being good, and thus less probability would there be of its swaying. It was frequently stated in treatises on chimney design that the diameter at the base should be one-tenth to one-twelfth the height, but having regard to the paramount importance of width of base, the width obtained by this rule was insufficient. A shaft was instanced 200ft. high, the outside diameter of which at ground was only 18ft., giving the chimney an attenuated appearance neither pleasing nor suggestive of security. The need for periodical examination of tall chimneys was discussed, and emphasised by reference to the recent disastrous fall of a shaft at Burnley. In conclusion, attention was directed to the danger attending the practice of increasing the height of a shaft in order to obtain more draught. The velocity of gases up the chimney being proportional to the square root of the height, increased duty was better obtained by larger diameter than by greater height. It was, therefore, advisable to have ample area in designing a chimney—a provision which would obviate the inconveniences often leading to increasing the height, and would result satisfactorily in every particular. A discussion followed the paper.

NEW GRAVING DOCKS AT PORTSMOUTH

MR. J. PRICE, WESTMINSTER, CONTRACTOR

(*For description see page* 181)

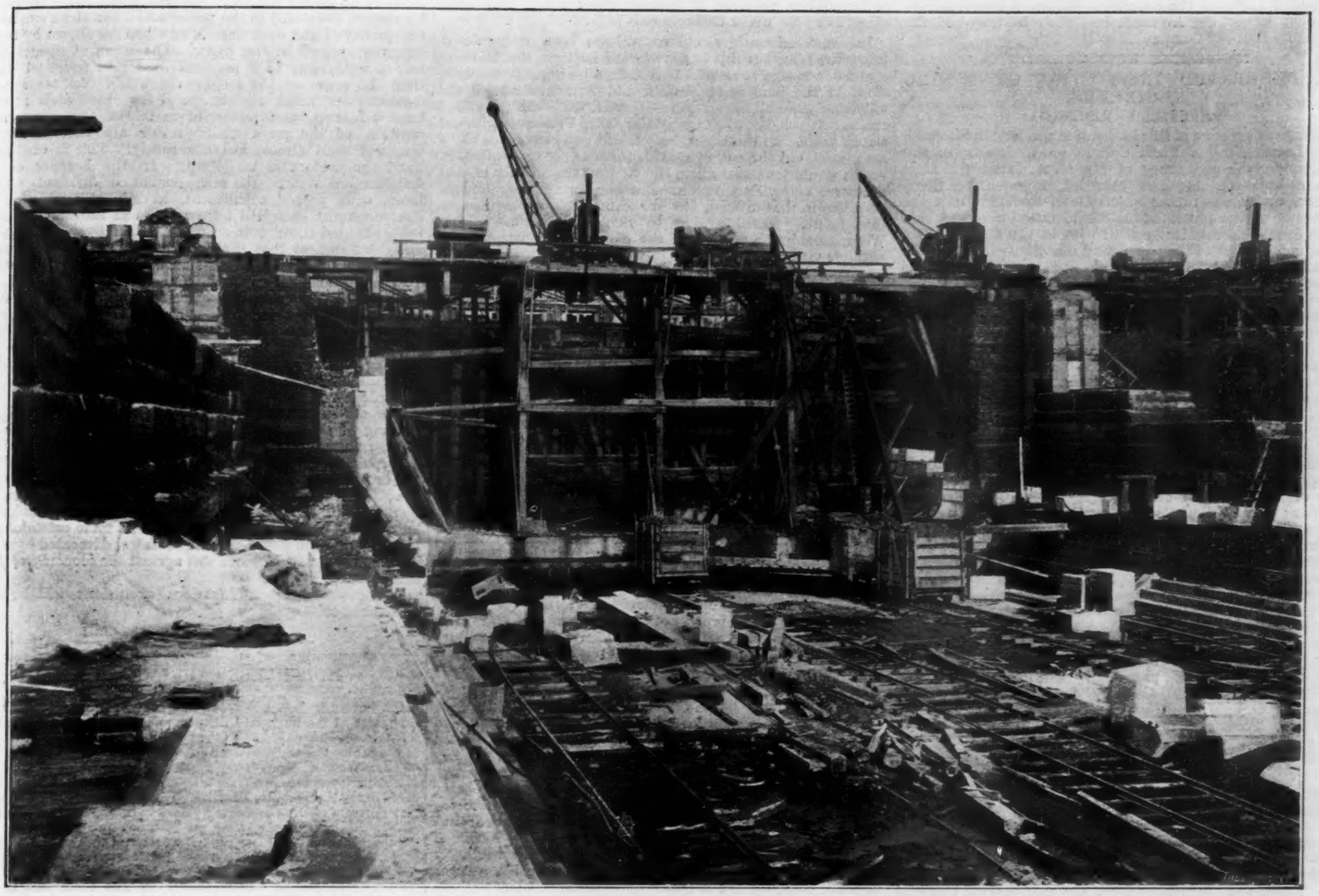


Fig. 4—ENTRANCE TO No. 15 DOCK

THE STRUGGLE FOR THE SCOTTISH SOUTHERN COAL-FIELDS.

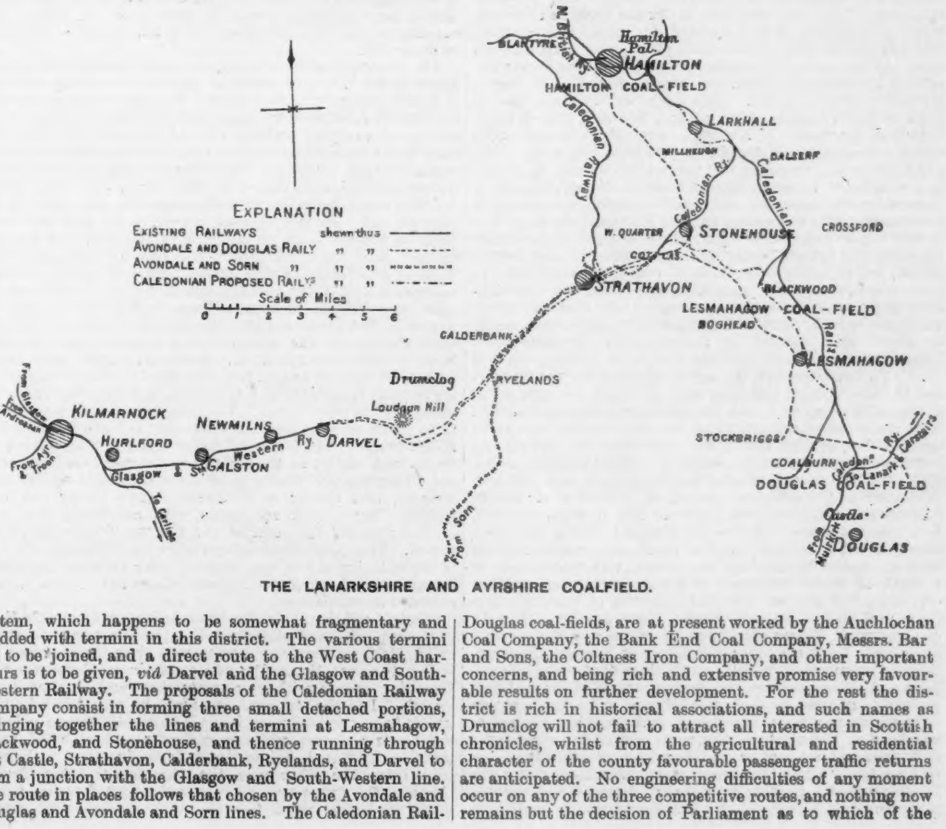
IN a recent number—THE ENGINEER, December 20th, 1895, page 610—we laid before our readers a short account of the Private Bills in Scotland for the session of 1896, and alluded, in enumerating the various projects seeking parliamentary powers, to the forthcoming struggle for the Lanarkshire and Ayrshire coal-fields. We are now enabled to lay before our readers full particulars of the great fight pending, and to give in detail the leading features of each of the three powerful rivals who seek to acquire this valuable district.

Hitherto spectators of the rivalries of Scottish lines have been accustomed to a more northern field of battle, recent fights more especially having centred around Inverness and the Highlands; and the struggle now pending carries with it, therefore, not only importance, but also novelty of locality. The three competitors for the Lesmahagow and Douglas coal fields are :—(1) The Avondale and Douglas Railway; (2) the Avondale and Sorn Railway; (3) the Caledonian Railway. A brief glance at the accompanying map will at once show the route by which each line proposes to annex the district under consideration.

(1) *The Avondale and Douglas Railway.*—Two objects are sought by this scheme, viz., the access to the west coast, ports of Ayrshire, Irvine, Ayr, Troon, &c., and also the formation of direct connection between Douglas and Glasgow. Starting from a point a little to the north of the town of Douglas, and near to Douglas Castle, the seat of the Earl of Home, the proposed Avondale and Douglas Railway runs in a north-westerly direction past Stockbriggs, Lesmahagow, and Boghead, until Stonehouse is reached. Here the line divides, one route continuing in a north-westerly direction until junction is made with the North British Railway Company's Hamilton and Glasgow branch near Hamilton; the other route running in a south-westerly direction, passes Cot Castle and Strathavon, and still continuing in the same direction, reaches Calderbank and Ryelands, finally terminating at Darvel by forming a junction with the Glasgow and South-Western Railway Company's system, a connection which it will at once be noted gives direct access to Ardrossan, Irvine, Ayr, Troon, and other important shipping ports. The engineers of the Avondale and Douglas Railway are Messrs. Simpson and Wilson, of Glasgow, who place the cost of the 35 miles of line involved in their proposal at £660,000. The project has been abandoned for the present. Passing now to the second competitor for the coal-fields under consideration—the Avondale and Sorn Railway—we find a very similar route traversed.

(2) *The Avondale and Sorn Railway* commences at Cot Castle, and, leaving the Caledonian Railway, at once runs to Strathavon, and, passing Calderbank, still follows the route selected by the Avondale and Douglas line until Ryelands is reached. Here the line takes a southerly course, and, following the valley of Glengavel Water, follows a similar route until a junction is made near Sorn with the proposed Mauchline, Muirkirk, and Dalmellington Railway, a scheme, our readers will remember, which passed the House of Commons last year, but was subsequently hung up owing to the dissolution. The Avondale and Sorn Railway will, in combination with the Mauchline, Muirkirk, and Dalmellington route, give a through line from Dalmellington to Glasgow, passing through Cumnock, Sorn, and Strathavon, and thence onwards by the Caledonian Railway Company's system. The engineers for the Avondale and Sorn Railway are Messrs. Formans and McCall, of Glasgow. An independent company is backing the undertaking, Mr. Somervell, of Sorn, a leading inhabitant, being one of the principal promoters. The total length is sixteen miles, and the estimate is placed at £188,000.

(3) *The Caledonian Railway scheme.*—Turning, in conclusion, to the last proposal seeking Parliamentary powers, viz., that of the Caledonian Railway Company itself, we find a route laid down with the obvious intention of resisting invasion, whilst at the same time improving the existing system, which happens to be somewhat fragmentary and studded with termini in this district. The various termini are to be joined, and a direct route to the West Coast harbours is to be given, *vià* Darvel and the Glasgow and South-Western Railway. The proposals of the Caledonian Railway Company consist in forming three small detached portions, stringing together the lines and termini at Lesmahagow, Blackwood, and Stonehouse, and thence running through Cot Castle, Strathavon, Calderbank, Ryelands, and Darvel to form a junction with the Glasgow and South-Western line. The route in places follows that chosen by the Avondale and Douglas and Avondale and Sorn lines. The Caledonian Railway Company also seeks powers for a short loop line past Larkhall, joining Ayr-road Junction with this same branch near Dikehead. The total length of line for which the Caledonian Railway Company seeks powers in this connection is about thirty miles, the estimate for which is £600,000. The engineer is Mr. George Graham, of the Caledonian Railway, with Mr. J. Wolfe Barry, C.B., as consulting engineer.



THE LANARKSHIRE AND AYRSHIRE COALFIELD.

A word may be added, in conclusion, as to the country so keenly sought after at the present moment, after a long period of somewhat unaccountable neglect. The Lesmahagow, Stonehouse, and Strathavon coal-fields, known more generally under the name of the "Lesmahagow coal-field," and the Douglas coal-fields, are at present worked by the Auchlochan Coal Company, the Bank End Coal Company, Messrs. Bar and Sons, the Coltness Iron Company, and other important concerns, and being rich and extensive promise very favourable results on further development. For the rest the district is rich in historical associations, and such names as Drumclog will not fail to attract all interested in Scottish chronicles, whilst from the agricultural and residential character of the county favourable passenger traffic returns are anticipated. No engineering difficulties of any moment occur on any of the three competitive routes, and nothing now remains but the decision of Parliament as to which of the three rivals is to have this much coveted, and we may add in anticipation, hardly contested, portion of Scotland.

Since the above was written, we understand that further developments have just occurred in connection with the proposed Avondale and Douglas Railway by which negotiations are pending which may lead to this route falling into abeyance, at all events for the current session, and thus leaving the district, so far as the immediate contest is concerned, to be fought for by the Avondale and Sorn Railway and the Caledonian Railway Company.

THE FEDERATED INSTITUTION OF MINING ENGINEERS.

SHEFFIELD MEETING.

A GENERAL meeting of this Institution was held in Sheffield, in the Lecture Hall of Firth College, on Wednesday of this week, under the presidency of Mr. G. A. Mitchell. More than a hundred members attended, representing many districts, and it was rather unfortunate, therefore, that the amount of matter presented for consideration exceeded that which could be conveniently dealt with in the time allotted, consequently most of the papers and the discussion generally had to be curtailed. The discussions, it is true, are adjourned to the next meeting, when, however, the pressure of time will probably also be felt, and anyway, they will lose in spontaneousness and brightness. Of course there is the alternative of writing one's views, but such contributions lack the freeness and generalness of the spoken statements, and sometimes lose considerably in value in consequence.

The following were the papers read at the meeting:—"The Eastern Limits of the Midland Coalfield," by Professor Ed. Hull, F.R.S.; "Electric Welding," by Mr. T. Scott-Anderson; "The Vibromotor as applied to the Screening of Small Coal," by Mr. Emerson Bainbridge, M.P.; "The Matabele Goldfields," by Mr. F. G. Shaw; "Photography in the Technology of Explosives," by Mr. Alfred Siersch; "Lead and Lap of Winding and other Engines," by Mr. Hargrave Walters; "The Elliott Coal Washer," by Mr. J. Platt.

The following having appeared in the "Transactions" of the Institution were open for discussion:—"The Depth to Productive Coal Measures between the Warwickshire and Lancashire Coalfields," by Mr. Charles E. De Rance, F.G.S. ("Transactions," vol. x., page 244); "The Blasting Efficiency of Explosives," by Bergassessor Winkhaus ("Transactions," vol. x., page 264); "The Use of Steel Girders in Mines," by Mr. E. Thompson ("Transactions," vol. x., page 272); "Gold Mining in Nova Scotia," by Mr. F. H. Mason, ("Transactions," vol. x., page 281); "Economic Minerals of the Province of Ontario, Canada," by Mr. Wm. Hamilton Merritt, F.G.S., M. Am. Inst. M.E. ("Transactions," vol. x., page 288). Some of these were, however, not discussed. The first paper was

On the Eastern Limits of the Midland Coal-field, by Professor Edward Hall, LL.D., F.R.S., F.G.S. This paper attracted considerable attention; it had been prepared at the request of the Council. The author regards the term Midland coal-field as intended to designate a group of coal-fields, including those of North and South Staffordshire, Leicestershire, and Warwickshire, which lie in the centre of England, for the most part south of the river Trent, and are isolated from the coal-bearing tracts of the North of England either by considerable areas of Triassic strata or by the uprising of the Lower Carboniferous. The Leicestershire and Warwickshire fields are those which concern the present inquiry, and are regarded as the outward and visible signs of extensive sheets of concealed coal measures connecting them more or less with the North and South Staffordshire fields. The geological map of England, it is pointed out, would seem to indicate that the two coal-fields in question might be supposed to extend indefinitely under the Triassic and more recent secondary strata, which form the whole surface eastward, notwithstanding the uprise of old pre-carboniferous rocks within the area, which, in fact, have been regarded as having formed islands in the carboniferous age. This agreeable supposition would give a concealed coal area far exceeding in extent that at present visible at the surface. But recent investigations do not tend to confirm this view. Casting a look backward, Sir Roderick Murchison expressed an opinion against the probable extension of the coal measures under the Eastern Counties, whereas Professor Jukes inclined to think that certain Silurian uprises were islands during the earlier carboniferous ages, but subsequently became submerged in time to participate in the deposits of the coal measures, and so he entertained the idea that coal strata might exist to the east of these Silurian islands. The author, however, viewed these islands as the margin of a ridge of ancient Palæozoic rocks which separated the Midland coal-field from any other to the south and west; he called it "the central barrier of land," and regarded it as never having been wholly submerged or covered by coal measures, and, like Murchison, considered it as extending into and embracing the Eastern Counties. The author is now inclined to regard these ancient rock masses not merely as islands bordering the mainland of that distant period, but in reality as the borders of the mainland itself. In other words, the eastern parts of Leicestershire and Warwickshire and the adjoining tracts extending into East Anglia are underlain by rocks more ancient than the coal measures, which remained unsubmerged in Carboniferous, Permian, and Triassic times. Strong evidence is adduced in support of this view. In Leicestershire, boring undertaken by the Netherseal Colliery Company at a distance of about one mile south of the existing colliery, gave the following generalised result: New red sandstone, 262ft.; coal measures, above the main seam, 514ft.; middle and lower coal measures, and all the lower carboniferous strata, wanting; older Palæozoic rocks, 19ft. The latter, consisting of reddish, purple, and grey grit, sandstone and micaceous quartz, is destitute of fossils, whereas the coal measures above are full of plant remains. A similar result was obtained in a second boring put down about a mile further to the south-east, where reddish vitreous quartzite, slightly micaceous, was penetrated at a depth of 760ft. However, it seems that a ridge of these very old rocks cuts off the coal measures of the Leicestershire coal-field to the south-west, just as the old rocks of Charnwood Forest determine their limit in the opposite direction. There are other indications of Eastern Leicestershire being underlain by rocks much older than carboniferous. As regards Warwickshire, the eastern margin of the coal-field is clearly indicated by the Lower Silurian or Upper Cambrian beds, which rise from Atherstone on the north to the neighbourhood of Bedworth on the south. Coal is worked as far as Wyken, but the author considers it improbable that coal will be found under the tract about Hinckley, under the Triassic strata. Further borings are desirable to establish this point with certainty. In Northamptonshire borings in two cases have proved the Palæozoic rocks beneath those of Mesozoic age, but in one case carboniferous limestone was encountered at a depth of 800ft., near the town of Northampton. Mr. Etheridge thinks that this is an indication of "an extended coal-field" in the tract between Northampton and the exposed coal-field of Warwickshire. The author is not of this opinion, as there are evidences of an extended period of denudation previous to Triassic times which may have swept away the upper carboniferous beds.

In Buckinghamshire old rocks have been encountered below the Lias, but this is anyway too far from the Midland coal-fields to signify much. In Suffolk, a boring near Statton, close to the borders of Norfolk and Suffolk, disclosed the following generalised section:—Gravel, &c., 16ft.; tertiary strata, 54ft.; chalks, 874ft.; gault clay, 50ft.; Palæozoic grits and slates, 534ft. In the latter, both fossils and calcareous rocks are absent, but the author regards them as pre-carboniferous, which would tend to confirm the view of the absence of coal measures under East Anglia. Further borings may produce surprises in that district, but the author is not sanguine on this point. Turning now to South Staffordshire and Worcestershire, a section of the district demonstrated the author's views on the manner in which the coal measures and overlying Permian beds terminate towards the south in a concealed bank of Silurian rocks. The success at Sandwell Park is recognised by the author as showing that the Silurian ridge keeps well to the east at that spot, and in discussion pointed out that probably a Silurian ridge from the south will be encountered between Sandwell and Birmingham. The actual course of the Silurian ridge, however, can only be defined by further boring.

In conclusion, it was inferred that the old Cambro-Silurian rocks formed a ridge trending from Salop and Worcestershire eastwards into the eastern parts of the counties of Warwick and Leicester, which was very irregular in its outline, and sent out ridges in a northerly direction separated by intervening bays. Against the shelving sides of these ridges the coal-measures were deposited, filling up the bays as the region gradually subsided under the carboniferous waters, and in consequence the upper coal-measures cover a more extended area than the productive middle beds, and these than the lower carboniferous, which are altogether absent in South Staffordshire and Warwickshire. The author had been encouraged by a well-known geologist and former colleague to hammer away at the process of extending the coal areas eastward. He fears the result of his hammering has not been, as in the case of a piece of beaten gold, to extend its surface, but rather to cause it to assume smaller dimensions.

In discussion, Mr. De Rance's paper was also considered. It was pointed out that the very regular succession of the beds of coal and ironstone, which in the pitted beds corresponded exactly with the beds that had not been disturbed, tended to indicate an upheaval in the neighbourhood of Dudley rather than the Silurian ridges suggested in the paper. Professor Hull pointed out that the upheaval was probably subsequent to the depositions of the beds, and therefore the ridges suffered as well as the coal measures. Coal was acknowledged to be too deep down in Cheshire—4000ft. or so—to be considered for working, anyway while shallower coal can be obtained. The probable extension of the Midland coal-field to the Forest of Wye was mooted. It was also stated that, encouraged by their previous boring, and taking cognisance of the dip, the East Anglians intended putting down a boring near Clacton-on-Sea. Some members doubted the separation of the South Staffordshire coal-field frcm Warwickshire; others regarded the Derbyshire and Nottinghamshire as part of the Midland field. The author explained that he took a London view of the last matter.

The vibromotor applied to coal screening.—Mr. Bainbridge stated that the vibromotor had been applied with considerable success to the separation of fine from coarser coal, and proved so effective that the separation took place within the first foot or so of the screen. The vibromotor may be attached to any convenient part of the screen, but in the example referred was attached to the end of the screen, and was of the character well known to our readers. Mr. Platt, in a subsequent paper, also alluded to the use of the vibromotor for this purpose, but as neither paper contained any practical details it was suggested in discussion that details as to the construction of the vibromotor screen, its dimensions, its weight, its capacity, the power required to work it, &c., should be included in the papers.

The Goldfields of Matabeleland formed the subject of a long paper by Mr. Shaw, in which he gave an interesting account of investigations in that country. The paper was, moreover, abundantly illustrated by slides, showing character of scenery, section of working, position of gold deposits, &c. All the work so far done seems to have been directed entirely by the remains of old workings. These seem to be of astonishing extent, and although they were none much over 30ft. deep, yet they made up in length and numerical strength. It is pointed out that the ancient searchers for gold did not abandon these because of the lack of richness, but simply because they knew no means and had no appliances for working at a depth. In the author's opinion there is a vast amount of gold in the country, but that it will be difficult to mine and difficult to treat. There is, however, abundant power in the Victoria Falls, very beautiful views of which were thrown on the screen, and a company has already been formed to exploit it. Seven or eight gold belts have been noticed, and, in fact, one-third of the whole area of the country is stated to be gold-bearing, and there was mention made of 1800 miles of reef. The reefs, however, do not appear to be of the true fissure vein character, but are interbedded in the country, which are said to be "mud" rocks, altered to shales and schists in the vicinity of the reefs, the latter are not all auriferous. Coal and iron ore are also found in the country, and timber is plentiful; native labour not too willing. Some rich specimens were exhibited, and ore *in situ* running into ounces per ton was frequently mentioned. The mining regulations allow for following the dip of the reefs, instead of the perpendicular lines ruling in the Transvaal, and many other places where the dip line is not regarded as satisfactory.

Electric welding.—Mr. T. Scott-Anderson drew attention to the application of electric welding in the neighbourhood of Sheffield, and an opportunity was given the members of seeing it in operation. The two methods employed are the Benardos system without accumulators, and Dr. Zerener's system. In the former, it may be remembered, the article to be operated upon is made to constitute one pole of the electric circuit, while a carbon pencil attached to a portable insulated holder, and held by the workman, constitutes the other pole, the electric arc being struck between the two poles thus formed; actual fusion takes place, and the weld becomes very strong. Excentric rods, a slot link of a reversing engine, a 50 cwt. roughing roll, a cast steel helical pinion weighing over 6 tons had its shrouded ends electrically welded, boilers have been patched, metals may be cut and bored; in fact, holes may be pierced in steel and iron or other plate with great rapidity, and by gradually moving the arc holes may be elongated into slits, so that the application of the electric arc is by no means limited. Various precautions necessary for success are stated in the paper, and when these are taken the quality of the work done is excellent, as shown by many examples quoted in the paper. The mean of electrically-heated welds was 18·5 per cent. better in figure of merit than the mean of the hand-made welds. In large work cavities are filled up by applying the carbon; the heat is intense, and pieces of metal of the same composition of the piece under repair are thrown in the arc, and melt almost instantaneously. This is continued until the surface is made up. In the Zerener or the deflector arc system, the arrangement is different, an arc lamp, with proper adjustment, having on each side an electro-magnet energised by a portion of the main current being shunted through it. This in action draws and spreads out the flame, so that the extent of this deflection can be adjusted. Lamps of various sizes are used to suit the work. This is suitable for making seam and lap welds, and for brazing and soldering purposes, for which the Benardos system, with its concentration of heat in a small area, is not suited. Various examples of the successful working of the deflector system are quoted, but unfortunately there was nothing at the works visited under treatment, although a deflector lamp was shown and some scrap melted by it. The Benardos system was shown in operation.

The author pointed out that these systems of electric arc welding are not proposed as a substitute in all cases for the ordinary methods of welding now in use, nor are they proposed as a substitute for riveting in high-pressure boilers, but rather as an addition capable of very extensive application, under conditions where the ordinary methods are inapplicable. The simplicity of the process and the portability of the plant are good reasons for its more extended use. In discussion the use of accumulators was advocated by some, but the author's experience was against the economy of their introduction.

The other papers and various excursions will be duly considered subsequently.

HORSELESS CARRIAGE NOTES.

ON Saturday last a large number of ladies and gentlemen assembled at the Imperial Institute to inspect some specimens of self-propelled carriages and to see them at work, at the invitation of the Motor Car Club. Among those present were Prince Edward of Saxe-Weimar, Sir William Harcourt, M.P., Dr. Rentoul, M.P., Mr. Atherley-Jones, M.P., Sir Frederick Abel, Sir J. Somers Vine, Mr. Hiram Maxim, Mr. H. H. Cunynghame, Mr. H. J. Lawson, Mr. Bertram van Praagh, Mr. Frederick R. Simms, and the Hon. Evelyn Ellis. The exhibition on Saturday was held in the west garden and the north gallery; the latter, being over 230 yards long, afforded considerable scope for displaying the different machines on view. Of these there were four. The first was driven by a Daimler motor, similar to that illustrated in THE ENGINEER of the 20th December last; the second was by the Acme Motor Carriage Company, and was driven by a Benz motor; the third was the Kane-Pennington carriage, illustrated in THE ENGINEER of the 3rd ult.; and the fourth was the electrically-propelled carriage, illustrated in THE ENGINEER, 27th July, 1874. Three of these were shown in operation, and trials as to speed, starting, and steering were carried out. The first two machines were also subjected to grade tests in the west garden, where they surmounted easily enough a short slope with a gradient of 1 in 10. The steering in all of them appeared to be quite certain and easily controlled on the smooth surfaces on which the running took place, but the steering arrangement of the Kane-Pennington carriage, as illustrated in our impression of the 3rd ult., has some advantages and gives a feeling of full command not felt with the other carriages. It consists of a long handle bar stretching right across the car, worked by either of the persons sitting on the front seat, this bar operating two forks as in bicycles. The means of control of the speed and of stopping and starting are not in any of them such as an unskilled person can readily learn to use, but they are better in the Daimler carriage and in the Benz carriage than in the Kane-Pennington. Learning to use them is necessary in all, but these carriages as now made by the Daimler Company and those fitted with the Benz motor, and those using belt driving gear and toothed gear instead of chains, may be looked upon as carriages which can be used in regular work and with some pleasure by those who wish to travel long distances and prefer a mechanically propelled vehicle working at small cost. There yet remains considerable room for improvement.

SINCE the meeting in the Agricultural Hall, as reported in our impression of December 13th last, the Traction Engine Owners' Association has followed up the resolutions then carried. Mr. A. Griffith-Boscawen, M.P., President of the Association, has given notice to introduce a Bill to amend the Acts at present governing the use of steam road locomotives. The Parliamentary Committee of the Association has been very busily engaged of late in drafting a Bill to embody the wishes of those engaged in the industry, and in ascertaining the views of M.P.'s. These proposals have been received with very general approval, and to bring matters to a definite conclusion a conference was held on Wednesday afternoon at the House of Commons, in which the following members of Parliament and members of the Association's committee took part:—Mr. Griffith-Boscawen, M.P., Mr. C. Bill, M.P., Mr. A. Baldwin, M.P., Mr. F. Gorell-Barnes, M.P., Mr. A. Brassey, M.P., Mr. J. H. Morrell, M.P., Viscount Valentia, M.P., Captain J. F. Bagot, and Sir J. E. Dorington, M.P., and Mr. H. Hobhouse, M.P., representing the County Councils; Mr. E. B. Chittenden (chairman), Mr. Aveling, Rochester; Mr. C. Burrell, jun., Thetford; Mr. Eddison, Leeds; Mr. Arnold, East Peckham; Mr. Jesse Ellis, Maidstone; Mr. Allen, Oxford; Mr. Constable-Curtis, Micheldean; Mr. Summers, secretary; Mr. R. Capper, Parliamentary agent.

The clauses of the draft Bill are so very similar to those required in a Bill with regard to light road locomotives or horseless carriages, that we refer to the matter here. The first object of the Bill is to ensure universal licences and uniformity of bye-laws in regulating steam road locomotive traffic. This is the first necessity in any Bill, and is the requisite to which we have again and again drawn attention as of the utmost importance. The further object of the Bill, of which notice has been given by Mr. Boscawen, is to amend the Road Locomotive Acts, which were passed in 1878, and it is contended that the regulations for licences, hours of travelling, the maximum of speed, and other matters are altogether unsuited to the present time, and are preventing the further progress of steam road locomotion, in which it is estimated that already ten million pounds of capital have been invested. It was decided on the suggestion of Mr. Hobhouse, who cordially supported the object of the Bill, that an effort should be made to get it read a second time and referred to a Select Committee. Other "backers" of the Bill who could not be present at the Conference are Colonel Kenyon Slaney, M.P., and Lord Alwyne Compton.

RAILWAY MATTERS.

The Austrian Minister of Commerce will introduce into the Lower House a Bill for the construction of a railway connecting the Transylvanian with the Roumanian lines, by way of the Rothenthurm Pass.

Information has reached Sheffield that the Norwegian Main Railway desire to receive tenders for delivery during the present year of 8000 British tons of Shireoaks or Kiveton Park large locomotive coal to be delivered at Christiania.

It is stated with reference to the Bechuanaland Railway, which is being pushed forward to Buluwayo from the south, that the extension from Mafeking to Gaberones, will, it is hoped, be opened for traffic in July, and the survey for 200 miles further to Palapye is almost completed. Palapye is distant from Buluwayo only about 160 miles.

Some American railways have introduced electric power on their branch lines. On these the average consumption of coal is given as 1 lb. per ton mile. If the train weighs 50 tons the consumption of coal then will be 50 lb. per mile. The average mileage per hour is only 7·4, including stops, so perhaps this is not much more than a good locomotive would consume.

Mr. George Abbott, the district superintendent of the South-Eastern Railway at Charing-cross and Cannon-street, has just entered on his fiftieth year of service. When the Cannon-street terminus was opened in September, 1866, he was appointed station-master, and has ever since occupied that position. In February, 1890, the charge of Charing-cross terminus was added to his duties.

The working expenses of the London and South-Western Railway in 1885 were 58 per cent., and in 1895 they were 54 per cent. In 1885 the South-Western carried 34,700,000 passengers, in 1895 it carried close upon 53,000,000 passengers. In 1885 the company paid a dividend of 5 per cent., in 1895 it paid a dividend of 6½ per cent. In 1885 the Ordinary Stock stood in the market at 129½, in 1895 it reached 204.

Mr. A. Holt has again brought before the Liverpool Chamber of Commerce a scheme for carrying goods along the high roads between Liverpool, Manchester, and other places, by means of road locomotives working on a plateway level with the ordinary roads, in competition with the railways. He urges the oft made claims for this system that the terminal charges would be reduced, the breakage of bulk obviated, and transit costs reduced.

It is announced by the *Ironmonger* that a new combination has been formed amongst the leading British manufacturers of steel rails, with the object of maintaining prices and regulating sales. The mills are pretty well employed, but for some years past profits have been poor. Under the new arrangement it is held that better profits will be secured, even in the face of Continental competition. In a former combination the German makers were included, but that is not the case in the present instance.

The Liverpool Overhead Electric Railway receipts for the past half-year amount to £31,590, and expenses to £18,893. The number of passengers carried were 3,460,060 against 3,780,375. The works in connection with the southern extension are making good progress, and it is hoped that the additional line will be open for traffic in the autumn. The directors recommend the declaration of dividends at the rate of 5 per cent. on preference shares, and 3½ per cent. on the ordinary shares (£6825), leaving £2074 to be carried forward.

The boiler of a locomotive of the Pennsylvania Railroad exploded January 16th, while the engine was hauling a freight train near Camden, N.J. The crown sheet collapsed, and the engineman was fatally scalded, but the fireman, though blown out of the cab, was not much hurt. The boiler of a locomotive on the Delaware, Lackawanna and Western Railroad exploded January 17th, while the engine was hauling a freight train near Halstead, Pa. The fireman was seriously injured. Low water is said to have caused the collapse of the crown sheet. A similar accident to the above occurred January 9th near Rushville, O., on the Toledo and Ohio Central Railroad, while the engine was climbing a heavy grade. The fireman was seriously injured. Another locomotive boiler explosion has since occurred, so that is four in about one month. This looks like evidence of pushing the theory of Mr. McConnell—page 111, col. 1—a little too far.

The record of train accidents in the United States in December last includes 72 collisions, 79 derailments, and six other accidents, a total of 157 accidents, in which 48 persons were killed, and 199 injured. These accidents are classified by the *Railroad Gazette* as follows:—Collisions: Trains breaking in two, 9; misplaced switch, 3; failure to give or observe signal, 6; mistake in giving or understanding orders, 10; miscellaneous, 10; unexplained, 34; total, 72. Derailments: Broken rail, 3; loose or spread rail, 3; defective bridge, 3; defective switch, 1; defective frog, 1; broken wheel, 4; broken axle, 7; broken truck, 2; fallen brakebeam, 2; broken car, 1; boiler explosion, 1; misplaced switch, 2; careless running, 1; bad loading, 1; bad switching, 1; snow on track, 1; landslide, 4; wind, 1; malicious obstruction, 4; accidental obstruction, 2; unexplained, 34; total, 79. Other accidents: Boiler explosion, 1; explosion, 1; broken side rod, 1; cars burned while running, 1; other causes, 2. Total number of accidents, 157.

The net loss to the State on the Indian railways for 1894-95 is expected to be 197 lakhs, including the usual contribution to sinking funds, which for that year amounted to 44¾ lakhs. On this subject the report says:—"If interest on lines under construction were also excluded from the above figures, the gains and losses to the State in its connection with the entire Indian railway system in 1893-94 would be a net loss of about 72¾ lakhs, and in 1894-95 the results would show a net loss of about 148¼ lakhs of rupees. The loss on guaranteed railways is attributable to the high rate of the interest guaranteed; to the increased cost, as compared with previous years, of remitting the interest at the very low rate obtained, and estimated to be obtained, for Council bills on India; and to the fact that the companies' share of surplus profits is, under the contracts, calculated on the supposition that earnings could be remitted in payment of interest at a rate of 1s. 10d. the rupee. The State has to continue to pay interest at the guaranteed rates until the contracts terminate."

A collision between two trains occurred just outside London Bridge station on Tuesday evening. The South-Eastern Ostend mail, bound for Dover, was due to leave at 5.30. There were about a hundred passengers in the train, which was made up of four carriages and general baggage vans. The mail started according to signal. In making its way along a fork line to its point about 200 yards distant in the rails whence both the through and the local trains run on their respective journeys, the mail, it would appear, had just put on steam, when a Blackheath train ran in on the opposite side. The driver, it is said, overshot his mark, and, in so doing, "grazed" the side of the Ostend carriages. The result was disastrous for the Blackheath train. The engine and a couple of carriages were thrown off the line. The steps and some woodwork of the mail were stripped off, but otherwise it suffered nothing to speak of, though it was not exactly in a fit condition to proceed on its journey. Fortunately there happened to be in the station what is called a depôt train, or a train going back to quarters, and this in a very few minutes was brought into requisition by the station master. The passengers and their luggage were promptly transferred, and the Ostend mail sent on its way not so late after all. The mishap caused great delay to the local traffic.

NOTES AND MEMORANDA.

A red pot glass is now being made by Messrs. Putzler Brothers, Penzig, Germany, which is very clear and bright, but is opaque to the whole of the blue side of the spectrum all the way down to the line D ½ d of the wave length 628. There has hitherto been great trouble in obtaining good samples of red glass for optical-testing work, and for obtaining non-actinic illumination.

In a paper recently read before the Paris Academy of Sciences on "Some Properties of the Röntgen Rays," by M. Jean Perrin, the conclusion is drawn that these rays are not identical with the kathodic rays, since the latter cannot pass out through vacuum tube walls of 1 mm. in thickness. The propagation of the Röntgen rays is shown experimentally to be linear; they are not reflected either by a mirror of polished steel or of glass, neither are they refracted by prisms of paraffin or wax. Unsuccessful attempts to form diffraction fringes showed that if the phenomenon is periodic, the period is much below that of green light. M. Poincaré, pointed out that Professor Röntgen had already shown that the X rays are not refracted.

A device for deodorising gas engine exhausts is described in the *Chemical Trades Journal* as consisting of a box, divided into two compartments by a perforated partition, on which bone black is spread in a moderately thick layer. The exhaust gases from the engine enter into the lower compartment at the extreme left, pass through the perforated dividing wall and superimposed layer of absorbent in the upper compartment, and thence escape into the open air through a pipe at the upper right-hand side. Thus the ammonia and fœtid hydrocarbon gases are absorbed by the bone black, and what ever liquid offensive particles may be in the products of combustion are retained by it mechanically. Water of condensation collecting in the lower compartment may be drained off through a drip pipe.

In a recent number of the *Comptes Rendus* is a paper "On the Equilibrium of an Ellipsoidal Envelope," by M. L. Lecornu. The problem of a flexible inextensible surface submitted to a given system of forces gives rise to a system of partial linear equations, the integration of which, in general, is not possible. The particular case, however, of an ellipsoidal membrane, which is of considerable practical value on account of its application to the theory of aerostats, can be dealt with by the use of elliptical co-ordinates, and the results of the integration are given.—"The Measurement of a Section of the Paris Base Line with the Apparatus of Jäderin," by M. d'Abbadie. By the use of wires of steel and of bronze, of known co-efficients of expansion, a base line can be measured at the rate of 2500 metres per diem, as against 400 metres when bars are used as the standards of length.

In a recent Chemical Society paper on "An Examination of the Products Obtained by the Dry Distillation of Bran with Lime," by Mr. W. F. Laycock, the author says:—Considerable quantities of bran and unslaked lime, in the proportions of 1 : 2 by weight, were subjected to dry distillation. The resulting distillate consisted of a black oil floating on an aqueous solution. The solution contained considerable quantities of ammonia, chiefly as bicarbonate, also amines and pyrrols, together with small amounts of ketones, and ethyl alcohol. The oil after redistilling was treated with dilute hydrochloric acid and the pyridine bases thus separated were afterwards purified. The unchanged oil was freed from small amounts of ketones by shaking with sodium bisulphite solution. The residual oil consisted of a mixture of hydrocarbons and pyrrol homologues with small quantities of furfuranes, and an indole.

There seems to be no doubt of the truth of the statement as to the gradual sliding of the mountain called Puy du Gouffre in the South of France. That enormous mass, of about 10,000,000 cubic metres, has moved as much as 1·20 metre. The cause of this phenomenon has not yet been ascertained, but the damage already done, especially to the mines in the vicinity, is very considerable. The water-pipes of the Grand Combe have been broken, and the inundation of the mines is feared. A factory deriving its water from the mountain has been suddenly deprived of its supply and been obliged to close its doors. Three hundred workmen are occupied in constructing a loop line for the railway from Alais to Paris. At the present moment passengers have to alight and walk about half a mile. There will be some fine examples of "glacial" action some day when this movement is completed.

At a recent meeting of the Berlin Meteorological Society, Professor Kremson spoke of the duration of sunshine over Europe, basing his remarks on the data available from the various stations. The mean duration increases from the north towards the south, being least in Scotland and greatest in Spain. There is also a distinct increase from the west eastwards. It is less on mountains than over open plains, except at very high stations which are frequently above the level of the clouds and mist. All stations show a yearly minimum in the winter solstice, and a maximum in the summer; the latter occurs as early as May in Scotland, in June over Germany, and in July over Spain. There is no such annual variation observable at the highest stations. The amplitude of the annual curve is less when based on the percentage of observed to possible duration of sunshine. The curve of daily variation rises sharply in the morning, is then steady for some time, and falls again sharply towards the evening. At high stations, says *Nature*, the daily maximum occurs in the afternoon.

At a meeting of the North of England Institute of Mining and Mechanical Engineers held at Newcastle on Saturday, the report of the proceedings of the Flameless Explosives Committee was presented. It recorded experiments conducted in mixtures of coal dust and air, and mixtures of coal dust, air, and pit gas. The explosives tested were bellite, securite, ammonite, roburite, carbonite, ardeer powder, and westfalit. The committee have been carrying on their experiments since March, 1892, and the results point very conclusively to the unreliability of all the safety explosives. It is proved that no explosive is flameless, and that all are capable of igniting gaseous and coal dust mixtures. The experiments have also shown that ignitions of mixtures of air and coal dust, with or without the presence of firedamp, can be obtained when there is present a much smaller quantity of coal dust than has been previously supposed to be necessary. It is stated that in selecting high explosives for use in a mine, it should not be forgotten that the risk of explosion is only lessened, and not abolished, by its uses.

The following new regulations are in force in Belgium relative to the manufacture of matches:—It is not sufficient in the future that the dipping plates of white phosphorus matches should be covered with hoods connecting with a strong draught chimney; a suction tube connected with a mechanical ventilation must be established on the level of the dipping plates and vessels which contain the paste. Respecting the composition of the pastes, they must not contain more than 80 per cent. of white phosphorus, without counting the water; the least infringement will not be tolerated, as it is satisfactorily proven that an excellent match paste can be manufactured from this consistency. The dryers, except the tunnels in which workmen must remain, must, after June 1st, 1895, be aired by mechanical ventilators. Permanent Committees exist which are to fix the amount of air. The working tables upon which white phosphorus matches are filled must likewise be ventilated, so that the phosphorus vapours may be immediately drawn off to the lower part of the workshop and thrown out. This ventilation must be such that, combined with the other causes of removal of the air in the workshops, the expulsion of air per hour and per workman in each room where white phosphorus matches are handled shall be at least 2119 cubic feet. The removal of air in the rooms where Swedish matches are handled must be 1060 cubic feet per hour and per workman; and further, each workman must dispose of at least 353 cubic feet of air.

MISCELLANEA.

Owing to the serious competition of other districts and the low price of coal in Sheffield, Messrs. John Brown and Co. have found themselves compelled to close all the steam coal seams at their Carhouse Colliery. Nothing but an absolute loss on the pits working would have led the directors to take this step. About 400 men and boys are affected.

At the annual meeting of the Cleveland Mine Owners' Association Sir Lowthian Bell, Bart., has been re-elected chairman, and Sir David Dale, Bart., vice-chairman. This is the twenty-fourth year in succession that the respective offices have been filled by the same gentlemen. Sir Lowthian Bell entered his eighty-first year on Saturday, and the meeting desired that its congratulations should be conveyed to him that he was in the enjoyment of health and vigour.

The general meeting of the Federated Institution of Mining Engineers, opened at Sheffield on Wednesday, under the presidency of Mr. G. A. Mitchell. Professor Edward Hull read a paper on "The Eastern Limits of the Midland Coalfield;" Mr. Emerson Bainbridge, M.P., contributed another on "The Vibromotor, as applied to the Screening of Small Coal;" other papers were read, and visits made to various works in the Sheffield district. The next meeting is to be held in London on the 4th, 5th, and 6th of June next.

Great activity continues to prevail in Portsmouth Dockyard, where upwards of a thousand men are working overtime, including all engaged upon the Eclipse, second-class cruiser. The Sultan, battleship, which sank in the Comino Channel when flying the flag of the Duke of Coburg, and after being raised was sent to Portsmouth, where she has undergone thorough renovation, and being fitted with new engines and boilers, is to be ready for the pennant by the 29th inst. The *Standard* says she is to relieve the Penelope as guardship of reserves at Simon's Bay.

The feasibility and cost of sand filtration for purifying the water supply of Pittsburg, Pa., is to be investigated by a Commission, consisting of the Mayor, the President of the East Branch of the City Council, and "eight representative citizens and taxpayers," two of whom shall be physicians, all of the eight to be appointed by the Mayor. English waterworks' engineers have carried out sand filtration for generations; and as the chemists and biologists and outside scientific teachers have at last learned and admitted that this is an effective system, the above reads curiously.

On the 8th inst. the engineers of the s.s. Mara, of the Demerara and Berbice Steamship Company, were presented, by owners and underwriters, with a substantial gratuity in recognition of their repairing a broken thrust shaft at sea in May, 1895. The gratuity was suggested by the superintendent engineers, Messrs. Flannery, Baggallay, and Johnson, and it may act as an inducement to others who may one day be in a similar fix to do their best in trying to avoid, as far as possible, the towing of their ship into port when the machinery breaks down, thereby saving owners and underwriters large sums of money.

Among the Private Bills shortly to be introduced in the House of Commons this session is the Plumbers' Registration Bill, which is backed by Mr. Lees Knowles, Earl Compton, Mr. Dixon, Dr. Farquharson, and Mr. Sexton, and has the support of some of the principal municipalities of the United Kingdom. The measure is calculated to have a beneficial effect, as its chief object is to enable people to select properly qualified plumbers, and to provide that plumbers convicted of practices injurious to the public health may be dealt with in the same way as dentists convicted of malpractices under the Dentists' Act, 1878.

Her Majesty's Secretary of State for Foreign Affairs has received a despatch from her Majesty's Acting Consul-General at Christiania, stating that the Norwegian Main Railway—Norsk Hoved Iernbane—desire to receive tenders for delivery during the present year of 8000 British tons of Shireoaks or Kineton Park best large locomotive coal, to be delivered at Christiania. Price to be specified separately for each kind of coal. The tenders in sealed envelopes, marked "Locomotive Coal"—Lokomotiv Kul—will be received at Hovedbanens Kontor, Christiania, until March 6th, next at 11 a.m. Further particulars may be seen on application to the Commercial Department, Foreign-office, between the hours of eleven and six.

The Bath and West and Southern Counties Agricultural Society will this year hold its annual exhibition at St. Albans, from May 27th to June 1st. The money prizes for stock, produce, &c., amount to £3241, in addition to medals and plate. No prizes, either with or without trials, are offered by the Society for implements, although the Society expects and announces that "there will also be a large display of implements, machinery, and articles of general utility." A special prize of £50 is offered by the proprietors of the *Ironmonger* London newspaper, for the best machine for drying fruit and vegetables, and the competition for this is likely to excite much interest. It is strange that this Society should leave its duties in these matters to be performed by voluntary help from without.

The Rivers Committee presented a report on Tuesday in which they stated that they had come to the conclusion that the first step towards providing London with an efficient steamboat service and restoring the Thames to its old service as a highway was to free the piers from toll and to provide improved landing-stages with better approaches. As to the question of the Council's providing a steamboat service, they thought that the question should be deferred until it had been ascertained whether private enterprise was prepared to meet the requirements of the passenger service of the river. The consideration of the matter was adjourned for further information. Does the County Council or anyone else think the river steamboat traffic will ever again be worth considering so long as penny omnibuses run, and quicker underground lines are available.

A few days ago the American liner Paris had entered the Southampton Dock on her voyage from New York, and was swinging in the centre of the basin to her berth, when the pilot gave the order for the engines to be reversed, but it is thought there was a temporary flaw in the telegraph apparatus which failed to act, and the Paris struck one of the Isle of Wight steam packets, named Her Majesty, which was lying at moorings at the transport quay. The fore compartments of the steam packet commenced to fill with water, and the captain and crew who were on board, finding their vessel sinking, saved their lives by climbing up the dock walls, but they lost all their belongings which were on board, and the vessel eventually sank. This appears to have been an accident which would not have occurred if reversing screw propellers controlled from the bridge had been in use on the Paris.

An interesting trial was made on the 12th inst., at Liverpool, before the committee of the Marine Salvage Association, to determine the value of a new flexible metallic tube for use in place of the india-rubber tubes, which experience has proved are not always reliable under high steam pressure. In front of the Salvage Association sheds on the pier head a Gwynne's centrifugal pump was connected by a 30ft. length of the metallic flexible tubing to one of the portable boilers generally used for marine salvage work, steam being raised to 60 lb. and afterwards to 80 lb. pressure. The metallic tubing was perfectly steam-tight. The manufacturers of this—the Flexible Metallic Tubing Company—were represented at the trial by their managing director, Mr. W. Bowley, and their senior country representative, Mr. Morris Ansell. Mr. Bowley explained that their success was due to their new interlocking section, enabling them to wind their metal strips spirally into a flexible metallic tubing that could not be untwisted.

THE NEW YORK BICYCLE SHOW.

(*From our Correspondent.*)

The bicycle show held in New York in January was one of the largest and most successful of these in America, and gave a comprehensive idea of the great extent and importance of the bicycle industry, and the numerous special industries involved, such as the manufacture of pneumatic tires, lamps, saddles, tools, and the thousand-and-one items of fittings and equipment.

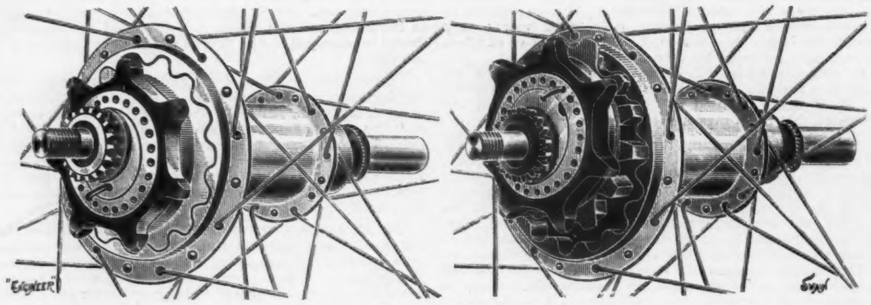


Fig. 1—THE BICYCLE BI-GEAR

In regard to driving gear, the sprocket wheel and chain are, of course, practically universal, but one machine exhibited had two coupling rods instead of the chain. The pedals drove a wheel gearing with a smaller wheel—the gears being spur gear, enclosed in a steel box, and running in oil—the axle of which carried two crank arms, set at an angle and connected by round steel coupling rods to similar crank arms on the axle of the rear wheel. Three or four systems of change gear are now on the market, the object of these being to give a high gear for fast riding on good roads under favourable conditions, and a low gear for use in crowded streets, on sandy roads, or on uphill work, while an intermediate position throws the gearing out so that the rider can coast down hill with his feet on the pedals, the pedals being stationary. The change is effected by a push-and-pull handle at the side of the saddle, or by a trigger handle on the handle-bar, the change being effected at any speed. The two positions of the "Bi-Gear" device for this purpose are shown in Figs. 1 and 1a, and the particulars of the "Racycle" change gear are given in the table at the end of this article.

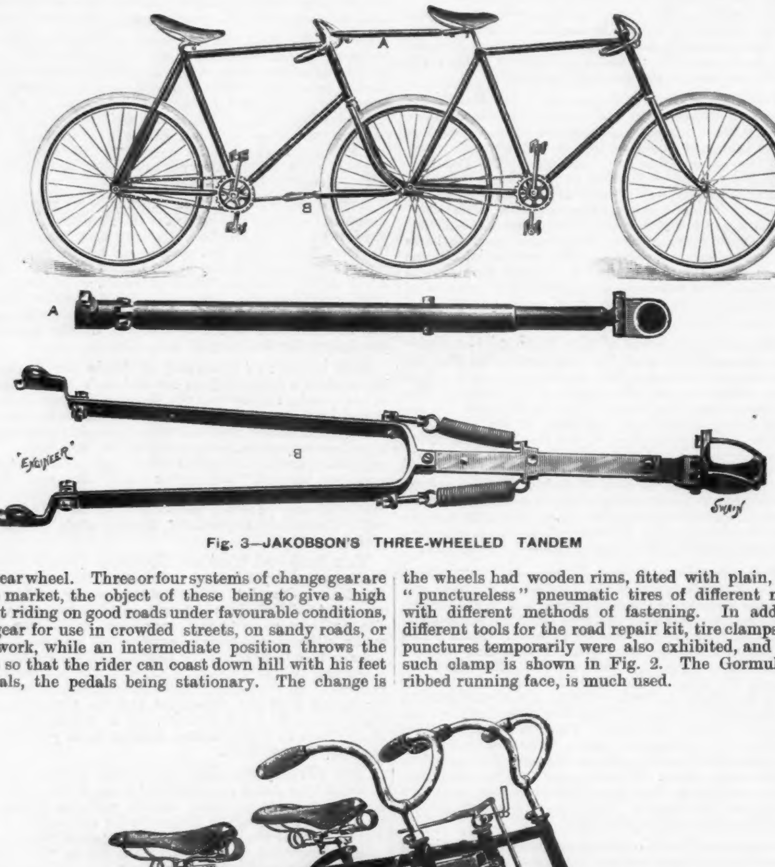


Fig. 3—JAKOBSON'S THREE-WHEELED TANDEM

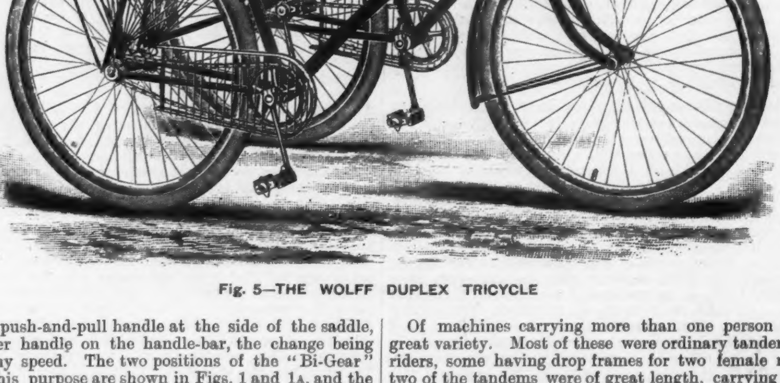


Fig. 5—THE WOLFF DUPLEX TRICYCLE

The Phillips bicycle has two radius beams fulcrumed—one on either side—to the rear of the frame. From the forward ends of these beams arms extend downward, to which the pedals are attached. At the angles formed by the radius beams and the pedal arms, driving rods connect with the cranks. The cranks are placed, as in an ordinary bicycle, diametrically opposite to each other. All the bearings are ball-bearings. The pedals, therefore, move vertically instead of in a circular path, giving a long direct push on the down stroke, and a quick return up stroke. The inventor claims for this mechanism that it enables the rider to exert a more uniform effective pressure through a greater angle of revolution of the crank shaft, and consequently to ascend steeper grades with the same gear, or the same grades with a higher gear, than can be done by means of the ordinary crank.

Practically, all the machines were of the modern safety pattern, and not a single one of the older and more picturesque type, with one very large wheel and one small rear wheel, was to be seen. The later development of this older type, having the small wheel in front, was also absent. The majority of the wheels had wooden rims, fitted with plain, armoured or "punctureless" pneumatic tires of different material, and with different methods of fastening. In addition to the different tools for the road repair kit, tire clamps for repairing punctures temporarily were also exhibited, and one form of such clamp is shown in Fig. 2. The Gormully tire, with ribbed running face, is much used.

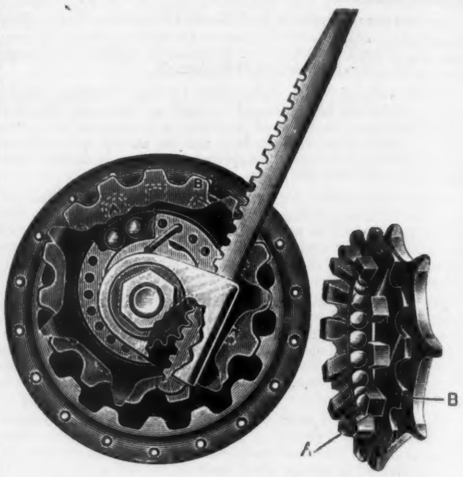


Fig. 1a—BICYCLE BI-GEAR

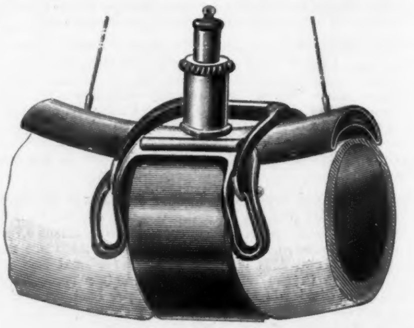


Fig. 2—TIRE CLIP

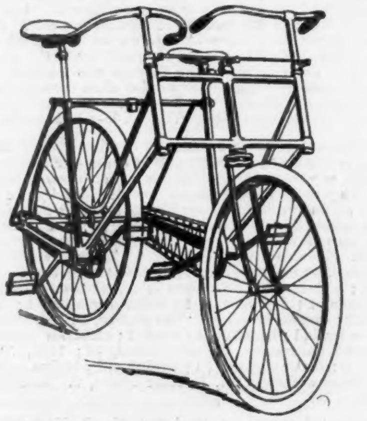


Fig. 4—THE "COMPANION" BICYCLE

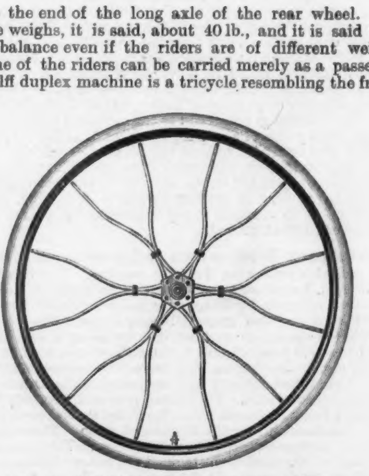


Fig. 7—STEVENS' WOOD SPOKE WHEEL

Of machines carrying more than one person there was great variety. Most of these were ordinary tandems for two riders, some having drop frames for two female riders, but two of the tandems were of great length, carrying six riders each. One of these was a Fowler machine, 13ft. long over all, weighing 137½ lb., and having a wheel base of 10ft. 5in., with wheels 30in. diameter fitted with tires 2½in. diameter. It had four driving sprockets, with 28, 23, 14, and 9 teeth. The product of the two large sprockets, multiplied by wheel diameter and divided by the product of the two small sprockets, gives a gear compounded to 153. The other was a Stearns machine, weighing 137 lb., and having a gear of 120. It differed from the others in having all the riders between the wheels, instead of the rear rider sitting over the rear wheel. The Jakobson three-wheeled tandem, Fig. 3, is formed by removing the front wheel of one bicycle and attaching the fork to the rear of another bicycle, a detachable telescopic tube A connecting the saddle post of the front bicycle with the handle-bar stem of the other, and a forked removable rod B—provided with spring—connecting the rear axle of the front with the bottom bracket of the rear bicycle. A departure from the tandem is the "companion," or side-seat bicycle, Fig. 4, in which the two riders ride on either side of the rear wheel, each set of pedals driving a sprocket chain fitted to the end of the long axle of the rear wheel. This machine weighs, it is said, about 40 lb., and it is said to be easy to balance even if the riders are of different weights, while one of the riders can be carried merely as a passenger. The Wolff duplex machine is a tricycle resembling the frames and rear wheels of two bicycles, with the front ends of the frames connected by cross bars carrying the fork of a single leading wheel, as shown in Fig. 5. One or both riders can operate the machine. This machine, with 26in. wheels, and

59 or 63 gear, weighs 42 lb. Two of these machines were shown fitted for military use, as noted below.

The frames are generally constructed after the general designs of the English Humber machines, but there were also two designs of upright or pyramid frames, one of which is shown in Fig. 6, and which is said to be easier to ride than the diamond-frame machine, while effecting a saving in weight. A novelty in wheels is the Stevens wheel, with curved double spokes of light tough hickory, bent to a variety of patterns. Each spoke is secured to the hub by two bolts—as shown in Fig. 7—these bolts passing through a steel plate, which hold the spokes firmly together.

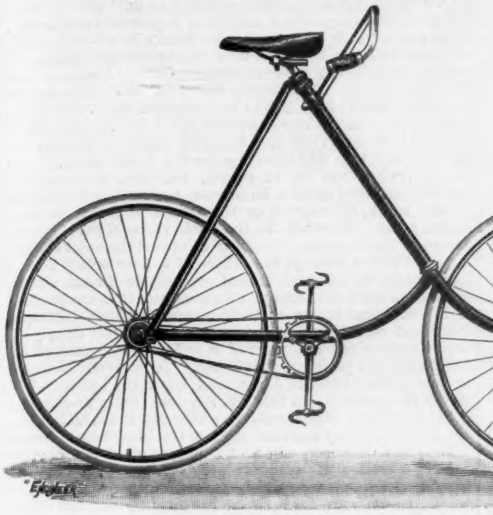


Fig. 6—THE DURYEA PYRAMID BICYCLE

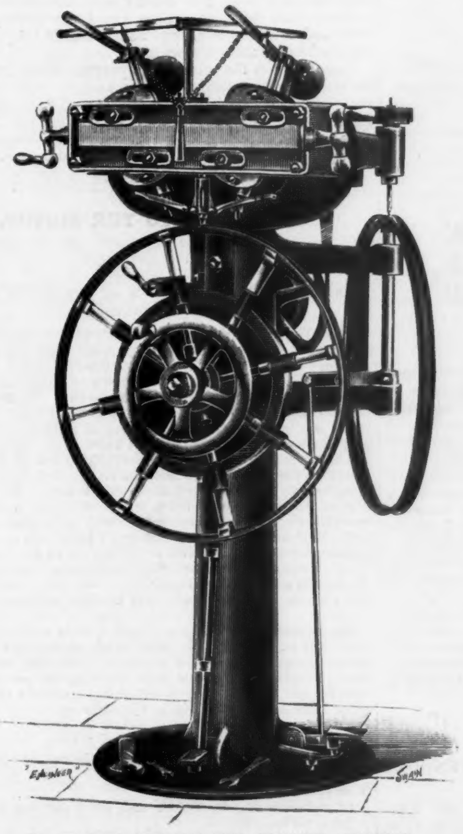


Fig. 10—TWO SPINDLE RIM DRILLING MACHINE

The introduction of the bicycle into military service, for the use of carriers, &c., has called the attention of makers to the possibilities in this direction, but there was not much display of such machines. Two Wolff duplex machines, above mentioned, were shown, fitted with guns, one having a small breech-loader—of very little use apparently—and the other a small Maxim rapid-fire gun. A Columbia tandem was shown fitted with hangers and straps for conveniently carrying two Colt twelve-shot repeating magazine rifles, two Colt six-shot revolvers in holsters, a jointed signal staff, two army overcoats on the front handle bar, and two army blankets on the rear handle bar. This appeared to be an excellent and practicable arrangement. Another Columbia machine—Fig. 8—had a 40-pound Colt automatic gun, of the type recently adopted in the United States Navy, attached to a turntable on the front handle bar, the gun being capable of being moved in any direction, vertically or horizontally. It is a single-barrel gun, with a "pistol" handle attached to a breech casing, containing the mechanism for feeding, firing, and ejecting the cartridges, which are contained in belts stored in a box on the machine, the boxes containing 250 or 500 cartridges each. Single shots may be fired, or the gun will automatically fire all the cartridges on the belt at one pull of the trigger, firing 100 shots in 16 seconds. The recoil is very light, and does not affect the frame of the machine.

The "Racycle" Two-speed Gear.

28in. wheel.		Teeth on rear sprocket.					
		8		9		10	
Teeth on front sprocket.		Combination of gears produced and ground distance covered.					
		Gear.	Ground covered.	Gear.	Ground covered.	Gear.	Ground covered.
			feet.		feet.		feet.
15	.. low	52	13	48	12	42	10
	.. high	68	17	63	16	54	14
17	.. low	59	15	52	13	47	12
	.. high	77	19	68	17	61	15
18	.. low	63	16	56	14	50	13
	.. high	82	21	73	18	65	17
19	.. low	66	17	59	15	53	14
	.. high	86	22	77	19	69	18
21	.. low	73	18	66	17	59	15
	.. high	95	24	86	22	77	19

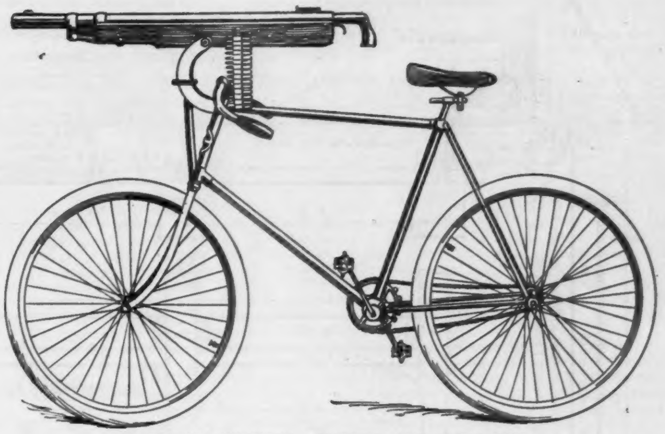


Fig. 8—THE COLUMBIA MACHINE AND COLT GUN

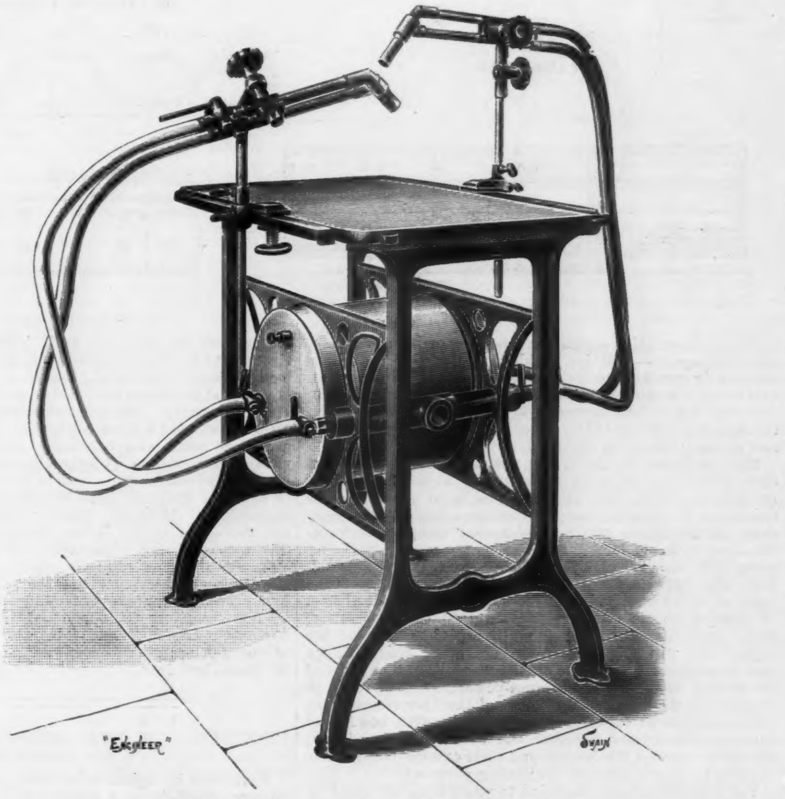


Fig. 9—BRAZING STAND FOR REPAIR WORK

Various forms of parcel-carrying and passenger-carrying machines were shown, these being usually tricycles, with a basket for parcels, a box of groceries, &c., or a small carriage body seat for children or an adult, mounted over the rear axle, while the driver sits upon the saddle behind the front wheel, as in an ordinary bicycle. A number of these machines are already in use.

A small but interesting part of the exhibition was that devoted to bicycle machinery, and a brazing stand for repair work and a two-spindle Fox rim drill are shown in Figs. 9 and 10. Their main features explain themselves.

LAUNCHES OF H.M.S. PELORUS AND DESPERATE.

THESE two new warships were successfully launched last Saturday afternoon; the Pelorus from No. 1 slip in Sheerness Dockyard, and the Desperate from the shipyard of Messrs. John I. Thornycroft and Co., at Chiswick.

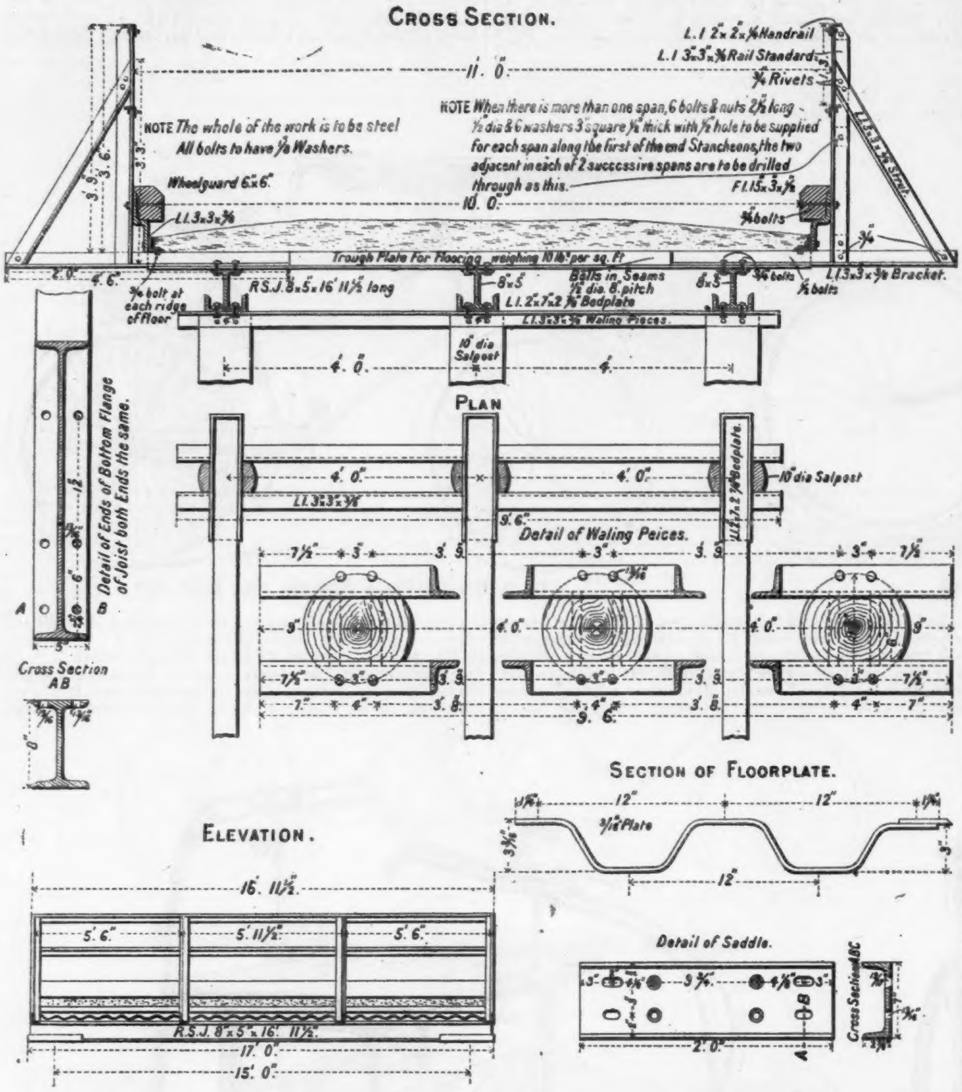
The Pelorus is the first of a new type of third class protected fast cruiser—of which several are intended to be built—designed by Sir W. H. White, C.B., and is of the following principal dimensions:—Length, 300ft.; breadth, 36ft. 6in.; and displacement, 2135 tons. The hull is of steel throughout, the stern and rudder posts, shaft brackets, &c., being of cast steel. The vessel has no side armour, but her vital parts are shielded by a protective deck of 2in. steel plating, which extends her whole length. Unlike some other ships of her class, the Pelorus has poop and forecastle decks, and between them a waist extending to about half her length; the officers' cabins being under the poop, and on the lower deck aft, and the crew quarters forward under the forecastle.

The propelling machinery of the Pelorus—which is to be supplied and fitted by Messrs. J. and G. Thomson, of Clydebank, Glasgow—consists of two independent sets of twin screw triple-expansion engines, having three inverted cylinders, steam for which is to be supplied by eight water-tube boilers of the Normand type, the engines being designed to develope 7000 indicated horse-power with forced draught to the boilers, and to drive the ship when at full speed at 20 knots an hour. The ship will carry sufficient coal to give her a radius of action—at 10 knots—of about 7000 miles; part of the coal being stowed above the protective deck over the engine and boiler rooms, and the remainder in the side bunkers below it.

The Pelorus will be armed throughout with quick-firing guns, of which she will carry eight 4in., eight 3-pounders, and three Maxims; two of the 4in. guns will be mounted on either side of the conning tower on the forecastle and two on the poop, the remaining ones being placed on the upper deck and at the bows and stern. There will also be fitted two torpedo tubes. The ship will have two wooden masts, with lowering topmasts, and will carry on them four fore and aft jib headed sails. There will be the usual complement of boats, which will include one 27ft. steam cutter, and she will be lighted throughout by electricity, the current being generated by two dynamos. She will also be supplied with the usual steam steering gear for actuating her balance rudder, air compressing machinery, &c.

The construction of the Pelorus has been a record one in Sheerness Dockyard, her keel plate having only been laid on the 21st of last May, but as it is desired by the Admiralty authorities that she shall take part in this year's tactical exercises, the dockyard officials were given *carte blanche* in the matter of the employment of labour and overtime, so as to have her ready by the end of the coming June. There are several other ships of her size and class to be built, but orders

CONTRACTS OPEN—ROAD BRIDGES


Cross Section.
L. I 2" x 2" x ¼ Handrail
L. I 3" x 3" x ⅜ Rail Standard
¾ Rivets
11. 0"
NOTE The whole of the work is to be steel All bolts to have ⅛ Washers.
NOTE When there is more than one span, 6 bolts & nuts 2½" long ½" dia & 6 washers 3" square ⅛" thick with ½" hole to be supplied for each span along the first of the end Stanchions, the two adjacent in each of 2 successive spans are to be drilled through as this.
Wheelguard 6" x 6"
10. 0"
Fl. 15" x 3" x ⅜
L.I. 3 x 3 x ⅜
⅜ bolts
Trough Plate For Flooring weighing 10 lb. per sq. ft
2. 0"
4. 6"
⅜ bolt at each ridge of floor
R.S.J. 8 x 5 x 16' 11½ long
8" x 5"
Bolts in Seams ½ dia. 8" pitch
L.I. 2" x 7" x 2 ⅜ Bedplate
L.I. 3" x 3" x ⅜ Waling Pieces.
10" dia Salpost
4. 0"
L.I. 3 x 3 x ⅜ Bracket.
Plan
4'. 0"
10" dia Salpost
L.I. 3" x 3" x ⅜
9'. 6"
Detail of Waling Peices.
Detail of Ends of Bottom Flange of Joist both Ends the same.
Cross Section AB
Section of Floorplate.
12"
⅛" Plate
Elevation.
16'. 11½"
5'. 6"
5'. 11½"
R.S.J. 8" x 5" x 16'. 11½"
17'. 0"
15'. 0"
Detail of Saddle.
2'. 0"
Cross Section ABC

for their construction—with the exception of her sister ship, the Proserpine — will be withheld until she has been thoroughly tested. The Pelorus was named by Mrs. Burnell, wife of the Captain-Superintendent of Sheerness Dockyard, and her launch was attended by Vice-Admiral R. Wells, Commander-in-Chief at the Nore, and all the principal naval and military officers of the district.

The Desperate is one of the new class of torpedo boat destroyers—the first of six ordered to be built for the Navy by Messrs. Thornycroft and Co.—and is in general design similar to the Daring, the first destroyer built by the same firm, but having to attain a guaranteed speed of 30 knots an hour. She is larger, and has more engine and boiler power than that vessel. She is 210ft. long, 19ft. 6in. broad, and 13ft. 6in. deep. The weight of her hull has been reduced where possible by the employment of a special steel of greater tensile strength—by some 10 tons per square inch—than the mild steel generally used in vessels of her type. She will be propelled by engines of similar design and arrangement to those of the Daring, but capable of developing 5400 indicated horse-power. Steam will be supplied by three water-tube boilers of the Thornycroft type, two being placed forward—back to back—with one funnel common to both, and the after one with a funnel to itself; the space between the funnels and their casings being made to serve as upcast shaft for ventilating purposes.

The Desperate being intended to attain a higher speed by three knots an hour than previous destroyers constructed by her builders, a modification has been made in the form of her bow and stem so as to render her a drier vessel when travelling fast; the bow has been made to flare, and the stem above water, instead of raking aft, rakes forward. The vessel will be armed with six quick-firing guns, four of which will be on the broadsides and one at either end; she will also be fitted with two torpedo tubes. The naming of the Desperate was performed by Miss Hemming, daughter of Mr. G. W. Hemming, Q.C., and the launch was witnessed by a large number of spectators. The company on the launching platform included Lord Robert Montague, Admiral Bowden Smith, Mr. Deadman, of the Constructive Department of the Admiralty, with Messrs. Thornycroft, Donaldson, Bedbrook, and others.

CONTRACTS OPEN.

PUBLIC WORKS, LOWER ASSAM DIVISION.

The Secretary of State for India is inviting tenders for a number of road bridges in which the designs for the ironwork seem to have brought it down to the smallest requirements. The following are the road bridges required:—Nine spans of 15ft.; thirty-two spans of 20ft., including all bolts, &c., required to complete the erection of the work in India, together with an allowance for waste, &c., of 10 per cent. in the net quantity required. Bolts, nuts, and washers for connections between spans and fir timber bracings in thirty piers, are also to be supplied as follows:—297 bolts, 1ft. 8in. long by ¾in. diameter; 594 washers for ditto, 3in. square by ⅛in.; 198 bolts, 2½in. long by ½in. diameter; 198 washers for ditto, 3in. square by ⅛in. The work, including bolts, nuts, and rivets, is to be of steel, except the washers, which may be of wrought iron if preferred. Names of makers from whom it is proposed to obtain the steel, and character of steel, to be stated in tender. Open-hearth acid is preferred; no basic steel of any kind will be accepted. All corresponding parts are to be made exactly similar and interchangeable. All riveting is to be done by hydraulic, steam, or other machines of approved construction, and in no case must the diameter of the rivet under the head be more than $\frac{1}{32}$in. less than the diameter of the hole. Tests, conditions of contract, &c., are the same as for Indian State Railway requirements. The accompanying illustrations are of the 15ft. spans, the 20ft. spans are of precisely similar construction, and the scantlings are the same except the rolled joists, which are 8in. by 5in., weighing 27 lb. per foot in the 15ft. spans, and 10in. by 5in., weighing 30 lb. per foot in the 20ft. spans. The computed weight of one 15ft. span is 2 tons 5 cwt. 2 qr.; of one 20ft. span is 2 tons 18 cwt. 3 qr. Tenders are to be in by March 3rd, 1896.

PROGRESS OF THE SHEFFIELD EXTENSION TO LONDON.

Favoured by splendid weather, the works of the Manchester, Sheffield, and Lincolnshire Railway Extension to London have made great progress since we noticed them in The Engineer of August 30th last. At Broadhurst-gardens, on the west side of the Finchley-road Station of the Metropolitan Railway, the excavation forming the commencement of the tunnel is well in hand. Here there will be four lines of rail, judging from the width between the retaining walls, nor is it, perhaps, likely the new line will have less accommodation than Robert Stephenson provided on the Euston incline sixty years ago. These retaining walls are in Staffordshire blue brick. A shaft has just been opened close to the road, where Fitzolm's Parade formerly stood, and another is going to be begun nearer the Hampstead Baths. Reaching Fairfax-road, we were glad to observe "the Navvy Mission Shelter and Coffee Rooms," as affording evidence that someone is looking after the welfare of the large number of men, nearly all strangers in London, who are engaged upon this great work. From here to Hilgrove-road the work done consists mainly of clearing the surface, and the two cranes at work six months ago have been removed, leaving huge heaps of clay around the tops of the shafts. At Hilgrove-road corner it is now clear that the London and North-Western will be spanned at the eastern end of its Loudoun-road Station. The bridge will be close against the mouths of the two parallel Primrose Hill tunnels, the northern of which is the celebrated one of 1837. To compensate for the shortening of the station, the London and North-Western Company is extending it westwards, and have provided a new and much wider bridge to carry Loudoun-road over the railway. South of it, the Manchester, Sheffield, and Lincolnshire line will go under Alexandra-road, where a couple of houses on each side will have to be removed. A shaft is being sunk at this place. The same applies to Boundary-road, but the shaft at the latter is not now being worked. Going on between Loudoun-road and Marlborough-hill, most of the gardens of the houses have been swallowed up, or rather obliterated, under vast mounds of clay. The line must be in tunnel here, but how it will be executed remains to be seen. At Waverley-place, just behind the Eyre Arms, the ground begins to fall southwards, and at St. John's Wood the new railway comes into daylight. It is at this point that the greatest activity is at present being shown. Widening out as it comes under St. John's Wood-road, heavy retaining walls are being put in, and preparations making for getting out the soil between them. Only the eastern wall will separate the Manchester, Sheffield, and Lincolnshire from the Swiss Cottage line of the Metropolitan at this point. Lodge-road is temporarily diverted, no doubt to construct a bridge for it, and then the Regent's Canal is reached, the crossing of which will involve some fine bridge work. Temporary bridges are up, of course, and over the canal the line extends itself upon a large area, bounded by Alpha-road on the south, Grove-road on the west, and the canal itself on the north. Here will be the goods and coal yard, but the passenger line keeps to the east of it, nearer the Swiss Cottage line, and passes through the centre of a narrow lane termed Lorne-gardens. A single line of ordinary gauge has already been made from the Metropolitan nearly up to Lorne-gardens A thoroughfare known as Grove-gardens, which connected Park-road and Grove-road on the south of the Canal, has been simply wiped out, most of it going to form part of the goods and coal yard just mentioned. At present, Boscobel-terrace, a little south of Alpha-road, forms the barrier which blocks the advance, but this will not long prove an obstacle, if Blandford and Harewood-squares behind it are to form the site for the coming terminus close to the Marylebone-road.

No steps, however, can be taken towards beginning the passenger station till adequate provision has been made for housing the people who will be turned out by it. These will be fairly numerous, for between Boscobel-terrace and Blandford-square lie several densely-populated streets of decidedly low social standing. To provide for these people five or six huge blocks of dwellings are under construction north of the canal, between Grove-road and Cunningham-place. They are of the "improved dwellings" type, with play grounds railed round on the top, and open staircases. Red brick is used for the outside work, at any rate on the front nearest the street; and from their state of forwardness, they will be ready for occupation by this summer. We should say the inhabitants of them will benefit considerably by the change, as the ground lies higher than the Blandford-square neighbourhood, and the dwellings are not only lofty, but are not hemmed in by other houses.

Judging from the remarkable progress made during the last six months, there seems every reason to feel confident that two years at farthest will see the Manchester, Sheffield, and Lincolnshire Company securely established in London, and within sight of seeing some return upon the immense amount of capital it has invested in this great enterprise.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

AN APPROXIMATE RELATION OF POWER TO SPEED IN BICYCLES.

Sir,—The popularity of the bicycle is such that any scientific information concerning it, or high-speed road traction, must be welcome to the public. It was with interest that I examined the traction and power curves in your issue of the 14th inst., contributed by Mr. Louis Barrow, and, so far as they concern the bicycle, I have worked on the same subject but on different lines. I have based my inquiry on the resistance to railway traction, as the nearest comparative system that I know of in which an estimate can be fairly deduced from the direct operation of the amount of power on the crank of the machine on the dry level track. There is uniformity for comparison there that is not on the roads generally, as their varying condition would not permit a reliable result; nevertheless, the track estimate would be a good guide for the road. In carrying out my inquiry, I have kept in view that the resistance to railway traction is taken from D. K. Clark's edition of 1884. The experiments recorded there may not probably be so favourable as the present railway system may now give, but in the absence of more recent data in that particular I must abide by it.

My estimate is for a bicycle weighing 28 lb. with pneumatic tires, rider 150 lb. in all 178 lb., 6½in. crank, and a calm wind. I have taken the coefficient of the bicycle at 0·25, and on that basis I have constructed the rule here following to get at the higher speeds, and I think that it will fairly represent the result, until more absolute proof is given to the contrary:—

$$R = \frac{v^2}{100} + 7{\cdot}75$$

R = total resistance to bicycle traction in ounces; add 50 per cent. above 5 miles per hour.

V = speed in miles per hour.

In reducing engine, tender and train per ton to per 178 lb. weight, we have then—

Miles per hour	5	10	15	20	25	30
Resistance to railway traction per 178 lb. weight, in ounces	15·3	16·4	17·7	19·2	—	24
Resistance to bicycle traction per 178 lb. weight, in ounces	8	13·12	14·99	17·62	20·99	25·12

In estimating the power of the rider on the bicycle up to 30 miles an hour, that is, for a bicycle with 72in. gear, having a radius of crank toothed wheel of 2·87in., and radius of the small hind toothed wheel 1·12in., we have the following:—

Miles per hour	5	10	15	20	25	30
Tractive force on chain, in lb.	6·25	10·25	11·71	13·76	16·39	19·62
Pressure on crank, in lb...	2·75	4·52	5·17	6·07	7·23	8·66
*Exertion of rider on crank per mile, in lb. ..	1310	2154	2464	2893	3446	4128

* Half of the revolutions of the crank is estimated here, also, in connection with the increasing resistance of the bicycle, as shown by the rule over the railway resistance, in consequence of the curve of the track.

From the above any person may gear up for the higher speeds and ascertain the crank pressure for such gear, that being only a matter of arithmetical calculation.

Robert Wilcox.

London, February 19th.

SLIDE VALVE FRICTION.

Sir,—Referring to the letter from Mr. E. I. M. Davis on the above subject, in your issue of February 7th, I see that he, in calculating the pressure on the back of a slide valve, still adheres to the method of taking the whole area of the slide valve multiplied by steam pressure, and brings such heavy metal as Professor

Unwin and Mr. Aspinall to back him. I can only say that I think he errs in excellent company.

In calculating the pressure on the back of a slide valve, I have always considered that part of the surface of a valve that was in contact with the face of the cylinder was in equilibrium, and that only the port area had to be considered. My object in taking part in this discussion was to have that point made clear, knowing that very many adopt the method Mr. Davies has taken. I consider that your editorial footnote to Mr. Davies' letter settles conclusively that the method I had taken was right; and it involves an important point, that the surface of a slide valve may be increased without increasing friction, thereby making a better working valve.

I will give from actual practice an approximate estimate of the power required to drive slide valves in two engines, showing how greatly the percentage differs in engines of the same power. In these two engines the cylinders are 12in. diameter, piston speed 450ft., steam-chest pressure 75 lb., travel of slide valve 5½in., power about 80-horse power, and unbalanced area of slide valve 76 S.I. are all practically the same; but one has a stroke of 36in. with 75 revolutions, and the other 15in. with 180 revolutions. I will take the average pressure on the slide valve—allowing for back-pressure—at 65 lb. × 76 S.I. = 4940 lb., the coefficient of friction $\frac{1}{8}$ makes the pull on the valve spindle = 617·5 lb.; travel of valve $\frac{5\frac{1}{2}\text{in.} \times 2 \times 617{\cdot}5\text{ lb.}}{12}$ = say 566 units of power per revolution; a rough calculation gives me about 234 units for the excentric and spindle friction, say about 800 units of power per revolution expended in working the slide valve. For the long-stroke engine 800 × 75 revolutions = 60,000 units = 1·82 H.P., and for the short-stroke engine 800 × 180 revolutions = 144,000 units = 4·36 H.P., or on 80-horse power a percentage of 2·27 and 5·45 respectively = 3·15 per cent. in favour of the long-stroke engine.

I may remark that the long-stroke engine drives a flour mill; its efficiency is tested by the amount of flour ground. The short-stroke drives a steamboat; its efficiency is tested by the indicator—in the latter case friction not being taken into account. I may also remark that the clearance in the engines is 6 and 13 per cent. respectively—another point in favour of a long-stroke engine.

February 16th. C. D.

SIR,—Referring to the letter from "Frottoir," of Paris, on the above subject in your last issue, in which he refers to two planed surfaces of cast iron, your correspondent raises a new point in the discussion, viz., the difference between the English and American mode of preparing slide valve and steam chest faces. In this country the faces are carefully scraped up by means of a scraper, after being planed, and are compared with a standard surface plate with the aid of red lead or a little oil; whereas in America the surfaces are considered fit for service after simply being planed. It is evident that in the former case approximately true plane surfaces are obtained, so that there will be little, if any, leakage when they commence work. This uniformity of surface is, however, impaired after they have been in work some time, owing to the tendency of slide valve and steam chest faces to score and wear on the ribs between the ports.

The advocates for the American system claim that although there is some leakage at the commencement when they are newly placed in position, yet they rapidly wear and adjust their surfaces the same as when they are scraped, so that all the extra time and work expended in the latter process is practically thrown away, the only advantage accruing being that a little nicer approximation is obtained between the surfaces when they are first put to work, with a consequent less leakage at the commencement.

This question was discussed, so far as I can remember, at the summer meeting of the Institution of Mechanical Engineers, held in Bristol in 1877. when a slide valve of circular form was exhibited by Mr. F. W. Webb, of Crewe, and had been especially designed by him to minimise the tendency to score and groove of slide valve surfaces. It consisted of a circular shaped valve, as already stated, the back of the valve and the strap forming part of the valve rod being also of similar shape, so that if the valve tended to seize, it would turn about its axis in the valve rod strap, and so adjust itself. The ports were, of course, also of circular form, so that the action of the valve was not interfered with when it so turned. I believe that the surface of the slide valve exhibited showed no signs of undue wear, although it had been running and in service some considerable time.

It is quite evident that the preparation of slide valve and steam chest faces forms an important factor when considering the approximation between such surfaces, and the possible insinuation and exclusion of steam, for it is quite possible to obtain such a nicety between the respective surfaces and the standard surface plate that they are approximately true planes. I have myself seen such highly finished surfaces, so that it would be not so far wrong to consider them as true planes. On the other hand, however, when the surfaces are simply planed, as according to the American practice pointed out above, the approximation between such surfaces would be very rough indeed; nevertheless, nearly, if not all, American locomotive slide valves are balanced. I apologise for again troubling you. EDWARD J. M. DAVIES.

24, Harrington-square, London, N.W.,
February 15th.

COAST DEFENCE SHIPS.

SIR,—May I be permitted to note that the suggestion in your admirable article, that a number of ships should be constructed specially to defend our coasts, and those of our Colonies and coaling stations, &c., should include — in addition to all you suggest—accompanying patrol "ram-torpedo" vessels, say two or three to each fifty-mile or so "beat" of coast line; one as a reserve. These could be made almost invulnerable, could lead the advance, could ram or torpedo—the latter solely from under water if preferred; the crews would be in comparative safety relatively to those of torpedo boats or "catchers" making the same class of attack, wherein they run a very fair chance of being blown out of the water by the quick-firers; they could have the simplest of engines, and twin reversing propellers operated from practically impregnable conning towers. Such part of the hull as was not in the water would be a hardened "shellback," which would not be hurt by any sweep of the quick-firers at the angle at which it could be reached, and such a vessel could plant a torpedo with relative certainty; and if more were needed, could ram besides. One or two patrolling from each end of a beat could make short work—in our channels—of any enemy in between them. The other craft are all necessary, but these would make extraordinarily effective and remunerative Uhlans. They need not go very far from their base, and they could, if desired, burn oil fuel. In this connection I would mention that reversing propellers can be so controlled from the conning tower, as to automatically and simultaneously regulate the power employed to their developed propulsive action.

I need hardly repeat that all ships in the Government service or elsewhere would benefit by the application of a system which permits the utmost simplification of the engines, gives the possibility of the most direct and effective manipulation of the vessel, and ensures the highest of running, cruising, or hovering economy in every way. In the shaft of the Powerful, which you have just illustrated, there is a 10in. hole, which engineering common sense will, I trust, in this or in other ships, shortly make use of as a means by which to apply the materials to reverse, &c., the direction of motion of nothing but the ship.

In adequately furnishing Great Britain and her Colonies with all necessary craft, shall we add, say, for every fifty miles of coastline here and abroad, two or three coast defence ships of the description I—roughly—take the liberty of suggesting, in addition to the others?

It is a comfort to know that our Government now appears to recognise our Imperial responsibilities; and it is only to be hoped that nothing will be allowed to stand in the way of its doing the thing thoroughly. Britannia can, at any rate, tolerate no arbitration between herself and Neptune. Like the Doges of old, on the Adriatic, let us "marry the sea," for it is our very life. If necessary, we must suspend the Sinking Fund to provide the dowry. By doing so we should make the Consols of Greater Britain the best assured and secured investment in the world, and all foreigners who wanted real security would put their money in them. Better suspend a Sinking Fund than have to replace sunken ships, or risk the hopes, commerce, and the very life of Greater Britain. ROBERT MCGLASSON.

Selhurst, S.E., February 15th.

UNITED STATES PATENT LAW.

SIR,—It will probably be of interest to those of your readers who have been relying upon the patent law at present existing in the United States, under which they can as first and true inventor at any time apply for protection for inventions already published in Great Britain by specifications or otherwise, to know that certain radical changes are now pending before Congress in the United States as to a revision of their patent laws.

One of the most important of the proposed changes in the United States law is to limit the time in which a valid United States application must be made to seven months from the date of filing of the first foreign application which has matured into a patent, thus conforming and limiting the privileges of alien inventors to those granted by other nations in the International Convention. The new law as it now stands makes no provision for postponing the date on which the same would go into effect, except that it shall not refer to applications pending in the United States Patent-office at the time the law is approved. The new law might be passed and approved by the President at any time within the next few months, and after such law goes into effect British or other foreign inventors would find themselves at once barred from applying in the United States for valid protection under patent for such of their inventions as might be over seven months old from the date of original application in Great Britain or in a country other than in the United States.

At present the privilege to the inventor still holds, that he can obtain a valid patent in the United States at any time after their first application elsewhere, in spite of publication, provided the invention has not been in public use in the United States for more than two years prior to the date of making application in the United States. FELL AND JAMES.

1, Queen Victoria-street, London, E.C.,
February 17th.

THE INSTITUTION OF CIVIL ENGINEERS.

SIR,—As certain alterations in the constitution of the Institution of Civil Engineers are now proposed to be effected, it appears to me to be a favourable opportunity for a thorough ventilation of the entire subject. There is doubtless a reason why the greater bulk of members join not only this, but other professional institutions and societies. Take the Institute of Patent Agents, for example, which received its charter of incorporation only the other day, and yet many members of this institute—even those of good professional repute—dub themselves Chartered Patent Agents. Why any more a chartered patent agent than a chartered civil engineer, chartered architect, or chartered surveyor, or chartered anybody else who happens to be a member of a chartered institute or society?

If my view, therefore, is correct, the chief value of the Institution of Civil Engineers to the larger majority of the members is the standing which membership either does actually or is supposed by the greater majority of people to convey. Consequently, in my opinion, whilst using every exertion to secure practical papers covering a wide field so as to meet the wants as far as possible of the members in various branches of the profession, the chief aim should be to maintain, and if possible to increase, the prestige of the Institution, and every care should be exercised to see that any alterations in the constitution will have this effect at least.

What is wanted in the civil engineering profession is a compulsory registration of properly qualified practitioners under the control of the Institution of Civil Engineers, to whom—as established for nearly 80 years, and incorporated by Royal Charter for nearly 70 years, and possessing over 6000 members, and a large income—the privilege should of right belong.

124, Chancery-lane, W.C., ALEX. J. WALLIS-TAYLER.
February 17th.

THE RESISTANCE OF AMERICAN ROLLING STOCK.

SIR,—A good deal of attention has been given lately in your columns to this important matter. There can be no doubt that American rolling stock is very much easier to haul weight for weight than ours, and there are several reasons for this beyond the fact that it is all on bogies, and the chief of all is, of course, that it is universally fitted with centre buffers. Our side buffers have no redeeming feature, and their chief use would seem to be to give as much extra work to the locomotive as possible. I have for a considerable time done my utmost to show the officers of our leading lines the great absorption of power in side buffers, and I hope you will shortly see some fruit from my persistent efforts.

Advocates' Library, Edinburgh, NORMAN D. MACDONALD.
February 17th.

PRIOR PUBLICATION OR NOT.

SIR,—I am interested in the purchasing of a patent, the model of which was shown to one or two persons before it was protected, with a view of selling the invention; but the patent was applied for immediately afterwards.

I am now told by a patent agent that the mere showing the model constitutes "prior publication," and invalidates the patent, although nothing in the shape of a drawing or written description had been made; whilst a second patent agent tells me that this is all nonsense, and that the only risk the inventor ran was that, if the model had been shown to an unscrupulous person, he might have made an application for a patent or manufactured a machine before the inventor applied for his patent.

This last opinion appears to me to be the most reasonable way of looking at it; but if the law is really so stringent on this point, it is right inventors should know it, and I feel sure some of your readers will be able to enlighten me on the matter. J. H.

[Our correspondent omits to state whether the model was shown in confidence or not. If it was, we should be of opinion that there was no such publication as would invalidate the subsequently granted patent. It would be reasonable to suppose that there was some such confidence, inasmuch as the purpose of showing the model was to invite a purchase of an invention which presumably the purchaser would patent.—ED. E.]

MR. RITCHIE ON THE LIGHT RAILWAYS BILL.

AN influential deputation from the Light Railways Association waited upon Mr. C. T. Ritchie, the President of the Board of Trade, at his offices on the 14th inst., to lay before him their views on the subject of light railways. The deputation was introduced by Sir Albert Rollit, M.P.

Sir Albert Rollit, M.P., in introducing the deputation, said that the demand for light railways was general, and was based on the belief that agriculture, trade, and industry would be benefited. The deputation came to urge the necessity of improved legislation for light railways and tramways. In Ireland and on the Continent light railways had been found to be of the greatest advantage to agricultural and trade interests. They felt that the want of such railways in Great Britain was due to the fact that our laws and the regulations of the Board of Trade, and the cost of delay of Parliamentary proceedings had been practically prohibitive. They urged that the conditions of circumstances of each part of the country ought to be considered. In many cases financial help on the part of the State was absolutely necessary in aid of private enterprise and local effort. They proposed that a permissive power should be given to the Treasury, subject to the approval of the Board of Trade, and to local authorities, subject to that of the Local Government Board, to help such undertakings by loans at a low rate of interest. The present Chancellor of the Exchequer had spoken strongly in favour of the necessity of some State aid. The deputation were glad to think that the representations already made had perhaps contributed to the mention of a Light Railways Bill in the Queen's Speech. Sir A. Rollit then referred to the report of the Board of Trade conference and to the Bill of the late Government, both of which they generally approved.

Sir William Hart Dyke alluded to the disastrous state of agriculture. He did not urge that the construction of light railways throughout England would relieve agriculture, but he submitted that, combined with the other efforts which might be put forward by her Majesty's Government, they would be of enormous advantage. He thought that the local authorities should be the county councils, because upon them the landowning classes were represented. They were desirous that simplicity should be the watchword in the machinery of the Government Bill, and that the numberless restrictions and regulations now put forward by the Board of Trade should be reduced to the lowest possible level.

The Duke of Sutherland pointed out the great necessity for light railways in the Highlands.

The Earl of Warwick, speaking as an Essex landowner, referred to the difficulties which had been experienced in the county in getting light railways by private effort, which had shown the necessity of State assistance.

Other members of the deputation having spoken,

Mr. Ritchie, in reply, said he regarded that extremely representative deputation as likely to be of great assistance to the Government in pushing forward their scheme of light railways. Light railways, even if they were made in the way the deputation wished, would not of themselves convert agriculture from a state of depression to one of prosperity. The question was not a party one. He hoped that the present Government would profit by the criticism passed on the Bill of last session, and endeavour to make their Bill more effective. He had himself taken considerable interest in the question, and along with his colleagues, Lord Dudley and Sir Courtenay Boyle, he had paid a visit to France and Belgium with the view of seeing how the light railways were constructed there, and how they were worked. They came back convinced of the great value of these light railways in France and Belgium to the agricultural community; and more than ever resolved to do their best to encourage legislation which would have a similar effect in this country. The Government hoped to be able to put before Parliament proposals which would insure the co-operation of private enterprise, local enterprise, and State assistance. The experience in Belgium was that the average light railway lines paid 3 per cent. There were one or two provinces where there was a slight burden upon the rates, and where the dividend did not come up to 3 per cent. But it was a remarkable fact in connection with these provinces, that so great had been the benefit conferred by light railways that more were being asked for; and he thought this showed that these provinces thought that, notwithstanding any claim upon the rates, light railways were worth this burden. This seemed to indicate that where there was local assistance it did not necessarily imply a burden upon the rates. But, of course, a burden upon the ratepayers had to be contemplated. In some poor districts there could be no local contributions at all. He hoped that when the members of the deputation saw the Bill they would find that some provision had been made as regards difficulties of the kind, and that a distinction would be drawn between certain districts which might be able to contribute locally and others which could not. The Government recognised that there were some districts where it was hardly possible to expect very great local aid, and they had endeavoured to provide moderately for districts of the kind. He hoped their Bill would provide for the making of light railways all over the country, and then they could call them anything they liked. He hoped that the road authorities and landowners and all interested would co-operate and not raise unnecessary objections to the use of the main roads. If they were to have any extensive system of light railways they must be constructed cheaply, for if not they would not be of much use. And if they were to be made cheaply considerable use must be made of the main roads. He thought that they would find in the Bill provisions for the co-operation, not only of municipal and rural authorities, but of two or more rural councils if necessary, or of rural and urban district councils. Their endeavour had been to make the Bill as elastic as possible with regard to the many matters which had been alluded to. With regard to the question of relaxing the present requirements of the Board of Trade, that was one of the necessary conditions of the Bill. They would provide that it should not be necessary to go to Parliament at all, for the expenses of going to Parliament would be prohibitive. At the same time care must be taken that no important railway scheme should take advantage of the Bill, and so escape the proper and necessary control of the Board of Trade. As to stations, signals, and conditions of safety, the requirements must and would be carefully considered. The conditions of fencing would also have to be carefully modified. As to gauge, the Government felt that they could not lay down any hard-and-fast line in the Bill. Whether the line was of a narrow gauge, as it ought properly to be in many cases, whether it was of a broad gauge, as in some cases it might very properly be where junction was made with an existing railway, no case would be shut out from the scheme of the Bill. The Bill was drafted with a view to simplifying matters as much as possible, although those who would have a right to raise objection to schemes before the Board of Trade would have opportunity of being heard.

Mr. Tomlinson asked if the right hon. gentleman would deal with the question of large railways imposing impossible conditions on a light railway.

Mr. Ritchie said the Bill would make provision for the consideration of all matters connected with the railways. He was afraid that if they were to complicate the measure by legislating as to the powers of the existing railway companies they would never be able to pass it at all. He wanted the co-operation of existing railways. He believed that in many parts of the country the success of light railways would depend on the way in which the existing railway companies assisted in the making and the working of the new lines. He trusted it would be found that in almost every single case the Government had endeavoured to meet the points which had been raised by the deputation. The suggestions made would receive the fullest consideration. Their object in framing the Bill and in passing it through the House of Commons would be to meet the legitimate requirements of the local authorities and the community generally. He trusted that in this work the Government would be doing something, even though it might be very little, towards meeting the agricultural depression which unhappily existed.

On the motion of Mr. Laurence Hardy, M.P., seconded by Colonel Foster, M.P., a vote of thanks was accorded to Mr. Ritchie, and the proceedings terminated.—*Times.*

THE Admiralty have ordered the torpedo gunboat Spider to be commissioned at Devonport on March 1st, by Lieutenant A. Whitehouse, for the instruction of engineer students in the practical working of a ship's engines and boilers. The Spider will remain in commission until November, and her engines and boilers are to be worked entirely by students, a few stokers only being allowed for coal-trimming.

NEW GRAVING DOCKS AT PORTSMOUTH

MAJOR PILKINGTON, R.E., AND MR. C. COLSON, M. INST. C.E., ENGINEERS

(For description see page 181)

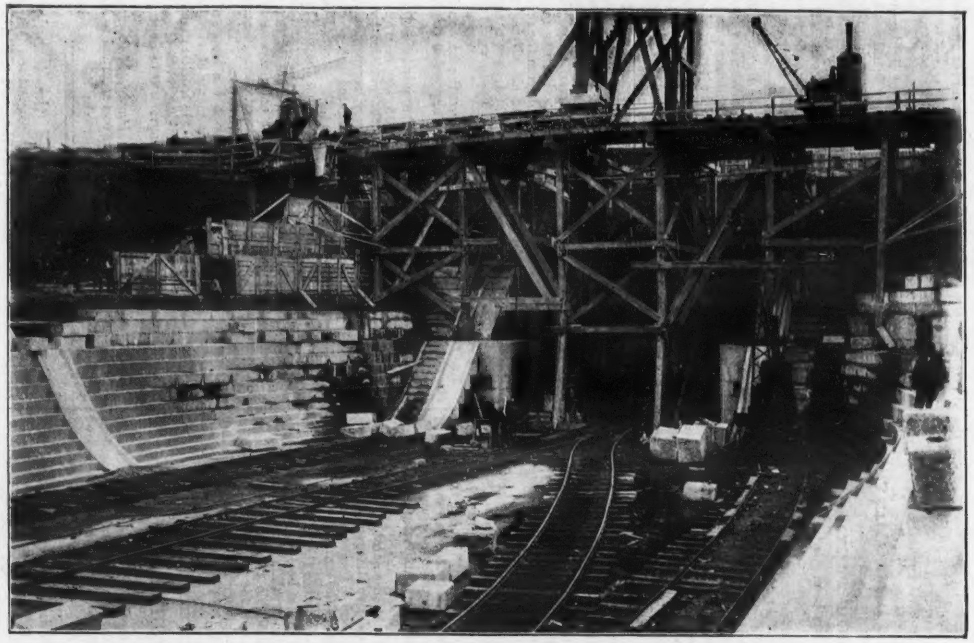


Fig. 5—HEAD OF No. 14 DOCK, FROM WEST SIDE

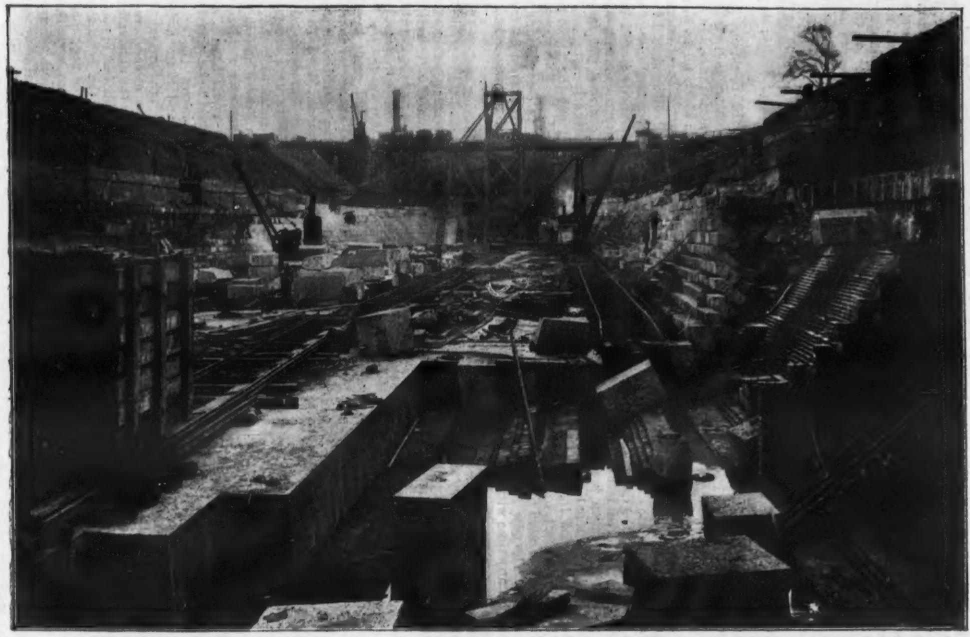


Fig. 6 - No. 15 DOCK, FROM ENTRANCE

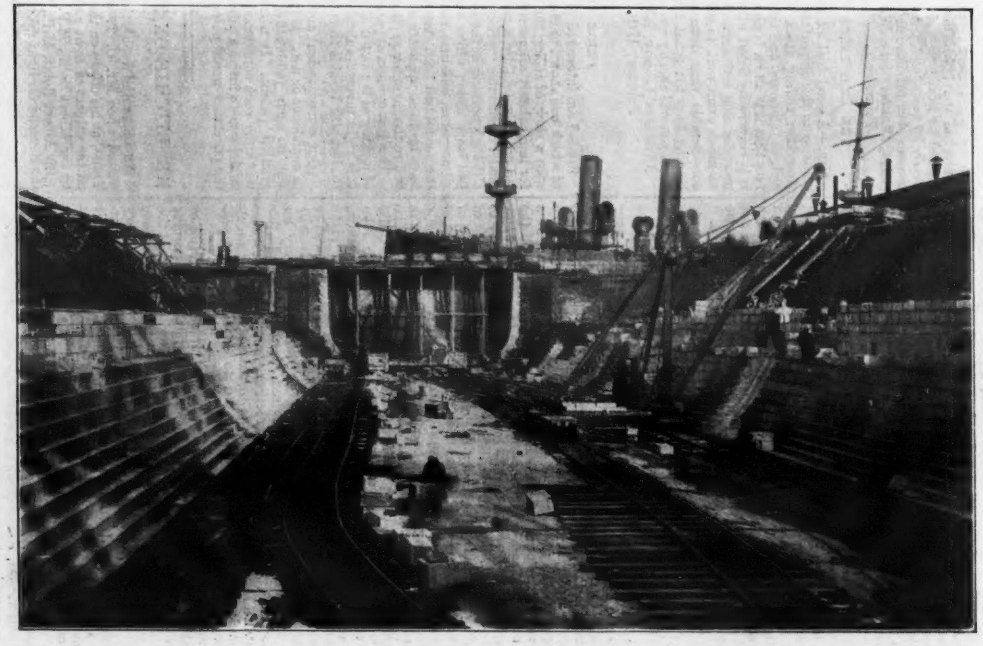


Fig. 7—No. 14 DOCK, FROM HEAD

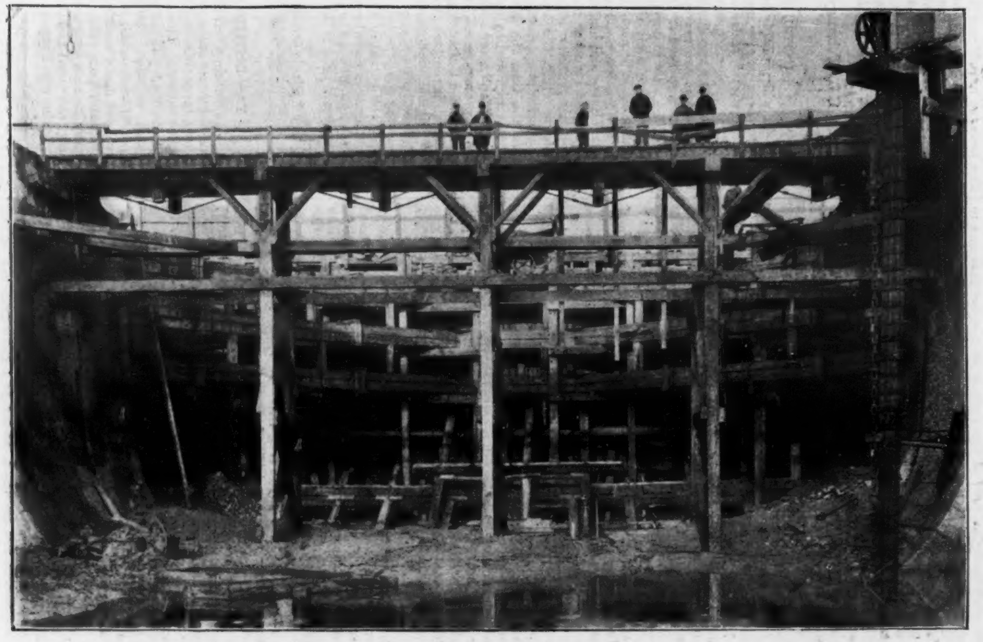


Fig. 8—DAM AT ENTRANCE OF No. 15 DOCK, AT INSIDE

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TO CORRESPONDENTS.

Registered Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and bearing a penny postage stamp, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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D. F. (Crewe).—*There would be no difficulty in building a locomotive with 19in. by 26in. cylinders and 8ft. drivers coupled, but coupling is unnecessary with so large a wheel. Coupling large wheels has never given satisfactory results. You may run the flanges within an inch of each other if you like. You will find dimensions given on a large number of drawings of locomotives published from time to time in our pages. About 5in. deep, with a web 1in. thick and 2½in. over the flanges, in steel, would probably answer very well for a coupling rod, but there is a considerable diversity of practice.*

HORN COMB MAKING MACHINERY.

(*To the Editor of The Engineer.*)

SIR,—Can any correspondent favour us with the name of manufacturers of horn comb making machines? J. H. H.

London, February 18th.

ANGUS SMITH'S COMPOSITION.

(*To the Editor of The Engineer.*)

SIR,—I should feel greatly obliged if you could furnish me with the names of any makers of Dr. Angus Smith's solution, which is used for coating cast iron water pipes. J. P.

London, February 4th.

A QUESTION OF SCREW PROPULSION.

(*To the Editor of The Engineer.*)

SIR,—I shall be obliged if any of your readers will let me know the percentage of power wasted in the thrust block or blocks of a large screw steamer of the total indicated horse-power, say, for instance, the Paris. Also the thrust in pounds to propel the ship at her normal speed *en route.* THRUST.

West Kensington, February 19th.

LIME.

(*To the Editor of The Engineer.*)

SIR,—I am anxious to get reliable information with regard to the economic production of lime, and especially on the following points:—(1) The best construction of kilns, with approximate cost; (2) the actual cost of burning the lime per ton, consumption of coal; and (3) any figures relating to the matter. I find Mr. Burnett's book of little assistance on these points. I can find no publication which will help me, and shall be glad of any assistance. G. G. S.

February 16th.

DISPOSAL OF TOWN REFUSE.

(*To the Editor of The Engineer.*)

SIR,—I am desirous of receiving information on the subject of garbage disposal in England and other countries. Reports, price lists, catalogues, and other pamphlets, and data as to cost of installation and operation are especially desired.

Please announce through the columns of your valued paper that receipt of such information will be acknowledged, and that patentees, controllers of patents, and officials of municipalities, can do me a service by forwarding data in their possession.

ERNEST MCCULLOUGH,
Consulting Engineer, Merchants' Association.
Mills-building, San Francisco, February 1st.

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, February 25th, at 8 p.m. Discussion on paper: "The Electric Street Railway System of Montreal, Canada," by Mr. Granville Carlyle Cuningham, M. Inst. C.E. Friday, February 28th, at 8 p.m. Students' meeting. Paper: "Loughborough Sewage Disposal Works," by Mr. Arthur S. Butterworth, Stud. Inst. C.E. Mr. Alexr. R. Binnie, Member of Council, will preside.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, February 27th, at 8 p.m. Discussion on papers: "The Electric Wiring Question," by F. Bathurst, Associate. "Concentric Wiring," by Sam Mavor, Member. Paper: "High-voltage Lamps and their Influence on Central Station Practice," by G. L. Addenbrooke, Member.

INSTITUTE OF MARINE ENGINEERS.—Monday, February 24th, at 7.30 p.m. Papers: "Liquid Fuel," by H. C. Wilson. "The Engineers of the Royal Naval Reserve," by F. Cooper.

THE INSTITUTION OF JUNIOR ENGINEERS.—Saturday, February 29th, at 5 p.m. Visit to inspect the engineering features of the National Skating Palace, Hengler's Circus.

THE SOUTH STAFFORDSHIRE INSTITUTE OF IRON AND STEEL WORKS' MANAGERS.—Saturday, February 29th, at 7 p.m., at the Institute, Dudley. Paper: "Chain Cables," by Mr. Wm. B. Rubery, President. There will be a large collection of specimens on view.

SOCIETY OF ARTS.—Monday, February 24th, at 8 p.m. Cantor lecture: "The Chemistry of Certain Metals and their Compounds used in Building, and the Changes Produced in them by Air, Moisture, and Noxious Gases, &c.," by Professor J. M. Thomson, F.R.S.E. Tuesday, February 25th, at 8 p.m. Applied Art Section. Paper: "The Palette of the Potter," by William Burton, F.C.S. Walter Crane, R.I., will preside. Wednesday, February 26th, at 8 p.m. Paper: "The Standard of Musical Pitch," by A. J. Hipkins. Sir Alexander C. Mackenzie, Mus. Doc., will preside. Thursday, February 27th, at 4.30 p.m., at the Imperial Institute, South Kensington. Paper: "The Tobacco Industry of India and the Far East," by C. Tripp, formerly of Sumatra. The Marquis of Lorne, K.T., M.P., will preside.

THE ENGINEER.

FEBRUARY 21, 1896.

ADMIRALTY CONTRACTS.

THE questions put by Mr. Holland to the Government on Tuesday night possess to a considerable extent only an academical interest. His inquiries referred, as will be seen from our Parliamentary Notes, to transactions which took place long since, and with which we dealt very fully at the time. Mr. Holland, no doubt, raised the subject in order to obtain some assurance from the present Government that an acknowledged error committed by the late Government should not be repeated. Mr. Goschen was quite within his rights when he said that "the question deals with facts long past, and should have been addressed to our predecessors in office in the last Parliament;" but, a reference to Hansard would have told him that similar questions were put, and replies were elicited from Mr. Goschen's predecessor, which admitted that the Admiralty were in the wrong. On two other matters of fact, moreover, Mr. Goschen has obviously been misinformed, or he has fallen into an error, and it is worth while to explain what these are.

Mr. Goschen stated that in accordance with long-established practice, certain working drawings of machinery were communicated to firms who had entered into contracts with the Admiralty for later vessels. This is not strictly true. In the first place, the Admiralty had up to the time mentioned only communicated drawings which were their property. In the second place, the firms who received the Yarrow drawings had not at the time entered into contracts for the construction of vessels similar to those shown in the drawings. The facts were that Messrs. Yarrow submitted certain drawings to the Admiralty, retaining possession of them. They neither gave them nor sold them to the Government, but sent them in as suggestions. These drawings were copied by the Admiralty and sent out to firms who had never before constructed any torpedo destroyers of the kind. It must be remembered that the Havock was the first of her class. It may be conceded that if the Admiralty had given an order to Messrs. Yarrow for, let us say, the Havock, that they would subsequently have had a right to use that vessel as a model, and either build copies for themselves in the Royal Dockyards, or have them built in private yards. We do not say that this would have been good policy, or a policy worthy of the Admiralty; but that is not the point at issue at this moment. In like manner the Government would have been clearly within their right in making any use they thought proper of Messrs. Yarrow's drawings, if they had acquired property in them. The true onus of the charge is that the Admiralty used documents confidingly submitted to them as though they were their own. We believe that the Admiralty laboured under a misapprehension, and considered that they were entitled to make use of all or any information they possessed. It is highly desirable that steps should be taken to prevent anything of the kind occurring again. The second mistake made by Mr. Goschen lay in the assumption that the designs submitted by Messrs. Yarrow were practically duplicates of machinery supplied to the Admiralty seven years before. Engineers are aware that during seven years the construction of machinery for torpedo boats has not stood still; and the difference between the engines of the Havock and that of boats built seven years before were radical, although they might very well appear the same to the untrained eye. To a man unskilled in such matters, all triple-expansion engines are alike, except in size; but to those who have had experience, it is well known that the success or failure of the high-speed machinery in torpedo boats depends on proportions and methods of construction which are all important, and have been arrived at only by a long course of trial and error.

If we concede that the Government were strictly within their rights when they used Messrs. Yarrow's drawings as these were used, the expediency of pressing their rights remains to be considered; and on this point we have no doubt whatever. No argument is needed to prove that the Admiralty ought to be supplied continually with the latest useful information. It ought to be apprised of every invention and improvement effected by the leading firms of the country. But it is impossible that it can be placed in this position unless it is content to regard valuable information as confidential. There can be no doubt that in this respect the practice of the War-office has been far better than that of the Admiralty. The former continually receives and regards as confidential most useful information. More than once fault has been found with it for official reticence, but the error, if such it can be called, is in the right direction. If Messrs. Thornycroft, or Yarrow, or any other eminent authority on high-speed war vessels, arrive as the result of their experiments at certain facts, which may almost be regarded as discoveries, the Admiralty ought to be told all about these facts at once. If, however, the department is to be regarded as a sieve through which everything leaks, the engineers and shipbuilders interested will keep their information to themselves, and leave the department to find out what it can. More than one very serious breakdown has occurred at sea, simply because of the ignorance of the Admiralty authorities concerning apparently small matters of detail. It is above and beyond all things necessary that the country should have the best of everything. We do not think that the policy hitherto pursued by the Admiralty is calculated to secure that result. Mr. Holland's questions appear at first sight to be superfluous. But they will have done good if they clear up the relations of the Admiralty and contractors. It should, for example, be clearly understood once for all, that designs submitted to the Admiralty are to be regarded as confidential, unless it is expressly stated in writing that they will be made public if the authorities think fit. It is, of course, well understood that once a contract is signed and the Admiralty have practically bought a set of drawings, they can do what they please with them, unless there is an agreement to the contrary. But until the drawings of the Havock were distributed over the country, it was taken as certain that suggested designs should be regarded as confidential. Mr. Goschen can settle the whole question for the future by establishing a very simple rule, so obvious that it is unnecessary to state it here in set terms; and if he will do this as a result of Mr. Holland's inquiries, then the member for Bow will not have lifted up his voice in vain.

SUPERHEATED STEAM.

WE publish this week the full text of Mr. Patchell's paper on "Steam Superheating," read before the Institution of Mechanical Engineers on the 31st of January. The literature of the subject is very scanty, and Mr. Patchell's paper is proportionately valuable. His own experience has been confined, however, to one form of apparatus, that of Messrs. McPhail and Simpson, which has already been very fully described in our columns. It is a very special form of superheater, and is open to the charge that it is not really a superheater at all, but virtually an extension of boiler surface. This is, however, not strictly true, save in the sense that nearly all superheaters can be regarded as extensions of boiler surface. It would be waste of space to repeat here what Mr. Patchell said, and it will answer a better purpose if we consider what others have said and written on the subject. Superheating is an extremely indefinite term, or, at all events, it admits of being treated as though it were vague. On the one hand, we may say that superheated steam is steam gas, and deal with its nature and properties as Rankine did. On the other, we may say that a superheater really does nothing more than dry steam that would otherwise be very wet. An apparatus may be fitted to one boiler or set of boilers and produce a marked economy. A similar apparatus may be fitted to another set of boilers and do little good. There is, therefore, an uncertainty about superheating which has done much to prevent its adoption, and makes the discussion of everything connected with it promiscuous and uncertain. The discussion which followed the reading of Mr. Patchell's paper was no exception to the rule. Those who heard it felt that most of the speakers knew very little about the subject—and that little they knew at second hand. The result was, of course, that the discussion, which was adjourned to the next quarterly meeting of the Institution, added little or nothing in the way of information to a sufficiently obscure subject. Perhaps Mr. Michael Longridge was the most interesting speaker. He contended that in order that superheating, as superheating, might be of use, the temperature of the steam must be raised to at least 300 deg. above that normal to the pressure. If there was not such an elevation of temperature, then liquefaction would take place in the cylinder. But to raise the steam to 600 deg. or 650 deg. there must be a temperature in the superheater of at least 1000 deg., and this fact disposed, in his opinion, of all schemes for superheating with the escaping products of combustion from a good boiler, because they would not be hot enough. Generally, Mr. Longridge seemed to say that the performance of a really good engine and boiler could not be improved by the addition of a superheater.

We have here a very good example of that indefinite treatment to which the subject so readily lends itself. Mr. Longridge did not handle his matter either from the point of pure theory, or with regard solely to practice, but he mixed practice and theory, using each as it suited him best to support his views. If we deal with the questions raised in their purely theoretical aspect, we cannot do better than go to Rankine for information. He handled the subject at considerable length, dealing with steam gas expanding adiabatically and isothermally. He applied his theory to two practical cases, and showed that in one the saving would be 15 per cent. as regards the engine alone, but 27 per cent. if the superheating was effected by waste heat from the furnace. Mr. Longridge ignored Rankine, however, and cited various experiments made by Hirn, Schröter, and others, to prove that when superheated steam was expanded, condensation always took place in the cylinder. We have here, no doubt, a curious fact, and it is to be hoped that when the discussion is renewed, Mr. Longridge or some one else will undertake the task of explaining precisely why the condensation does take place. Very great uncertainty seems to exist as to the specific heat of steam as a gas. Rankine states that if steam out of contact with water be raised about 40 deg. above the temperature normal to the pressure, it assumes the condition of a gas. Now, if we knew with any accuracy how much heat is required to raise one pound of the steam one degree in temperature, we could easily ascertain the temperature needed to prevent liquefaction under varying circumstances. If, for example, we assume, for the sake of argument, that it is the same as that of air, ·23, then a pound of dry steam would require to raise its temperature 300 deg., 69 thermal units, and it could part with that amount of heat before condensation or liquefaction could take place. Rankine gives a table which supplies all the data he regarded as reasonably available, but in the lack of further experiment it is out of the question to dogmatise on the subject. No one, in a word, really knows how much heat is required to raise the temperature of a ton, say, of superheated steam 1 deg. It would repay experiment to ascertain whether, for example, the total heat required to convert a pound of water at 32 deg. into steam gas at 500 deg. is equivalent, as stated by Rankine, to 1,014,488 foot-pounds. To convert a pound of water from 32 deg. into saturated steam of 500 deg. requires 944,928 foot-pounds of energy. But, in point of fact, all this speculation is in a sense waste of time. It has been abundantly proved that superheating can effect an economy of as much as 20 per cent. with all but the very best steam engines, and as the very best steam engines are not 10 per cent. of the thousands in use, it is quite clear that there is room and to spare for superheating.

It is useless to argue, as Mr. Longridge did, that within the limits of practicable superheating we must have water in the cylinder; whether we have or not is outside the question, it is a matter of academical interest. The broad fact with which steam users will concern themselves is, that a superheater will save coal, and, which is sometimes nearly as important, water. All this is known. What is not known is, how long a superheater can be got to last, and what is the best way of ensuring that the engine will not be destroyed very quickly by effects of the dry and hot steam. On these most important points no one had a word to say worth saying during the discussion. Most of the speakers confined themselves, indeed, to arguing either that the McPhail superheater was not a superheater at all, or that superheating was not of much use. Mr. Raworth held that good results were got simply because some 40 or 50 per cent. of heating surface had been added to an inefficient boiler. We have heard this argument urged a dozen times, and we have seen more than one instance in which it was applied in practice and totally failed. A large Lancashire boiler was not held to be economical, so a Galloway tube was put in at the back of each furnace. There was an improvement, due, no doubt, to better circulation. To make matters still better, a number of additional tubes were then put into each flue, with practically no benefit. On the other hand, we have known a boiler to be reduced as much as one-third in length, and the increase in fuel consumption was quite inappreciable. Nothing is more difficult than to prove that such a statement as that made by Mr. Raworth will apply to any particular case, because so much depends on the nature of the additions made to the boiler heating surface.

Considering how unsettled the theory of the steam engine still is, and how obscure is the part played by water in the cylinder, it is very rash to assert that superheating can be of but doubtful value, or that considerable temperatures are essential to its successful application. Professor Kennedy stated in the course of the discussion that at the Edinburgh electric light station he had saved 11 per cent. in steam, with only 30 deg. of superheat at the engine, and 22 per cent. with 65 deg., and this with engines which certainly cannot be called uneconomical, seeing that they were non-condensing Willans engines. Without superheating they required 31·3 lb. of steam per electrical horse-power, and with superheating only 24·2 lb. How was it possible, in the face of Mr. Longridge's argument, that a rise in temperature of only 65 deg. could produce such a result? Is it too much to hope that Professor Kennedy will say something on this point by way of elucidation at the next meeting of the Institution?

WEST OF SCOTLAND INDUSTRIAL OUTLOOK.

COMMERCIAL and industrial prospects in the West of Scotland have brightened considerably since the close of the engineering dispute, and the outlook is exceedingly good. Orders for new ships, which were held back during the strike, are now being placed freely, while many orders not announced were quietly booked during the course of the dispute, conditional on its termination. Some very large orders for iron and steel material have been placed within the last few weeks, and some still larger contracts are in course of being negotiated. Makers are now asking £5 7s. 6d., less 5 per cent., for ship plates, and the steel works are running at high pressure, so much so that workers are reluctant to give the amount of overtime the masters desire, even though the extra pay is enticing. A further considerable advance in iron and steel prices will probably result from the placing of the new contracts for vessels for our own Navy, while if the expected additions about to be made to the navies of Japan and China come forward, the stiffening of iron and steel prices will be still greater. Meantime it looks as if our own Admiralty will be able to place their new ships this year before the Japanese tenders are invited—a circumstance which is, perhaps, desirable. The ships to be given out to private firms by our own Navy include, it is said, one battleship, three first-class cruisers, five third-class cruisers, and sixty torpedo boat destroyers. The nature of the Japanese programme is as yet unknown exactly, but it seems probable that at least four battleships and four first-class cruisers will be included. The Clyde in all likelihood will secure a big share of the orders from our own Government, and it is regarded as very probable that at least a proportion of the orders to be given out by Japan will also find their way to the Clyde. Even more notable than the demand for ships and shipbuilding material is the demand for railway material and locomotives. All the Glasgow locomotive building shops are as busy as it is possible for them to be. During January alone no fewer than 300 locomotives were ordered for various parts of the world, while the demand of the home railways is also great. The works of the Caledonian and North British Railway Companies at present are exceedingly busy, while railway wagon makers have the greatest difficulty in coping with the orders showered upon them.

DUNDEE AND ABERDEEN HARBOUR EXTENSIONS.

THE Works Committee of the Harbour Trust of Dundee have formulated a scheme for the extensions of the wharfage and shed accommodation at the docks. Within recent years large extensions have been made at the docks, and about a year ago what are known as the eastern wharves, on which are three sheds covering in all some 29,000 square feet of area, were constructed at a cost of about £28,000. The proposal now before the Trustees is to extend this wharfage some 550ft. westwards, and to erect new sheds similar in dimensions to those already constructed. Each shed will have 9600 square feet of floorage, and will then provide accommodation for the storage of a considerable quantity of jute, which is a very urgent want at the present time. When the last extension was completed, it was felt that provision had been made in excess of what would be required for a considerable period, but the concentrated delivery of jute this season has been such that many of the Calcutta liners have had to remain in the river for several days before berths could be found for them at the jetties or in the docks, and even then discharging operations were delayed because of the crowded condition of the sheds, and often the unsheltered quays. With the new sheds completed by next season, however, it is believed the difficulty which has been experienced this year will not recur. At Aberdeen, at the present time, harbour extensions of considerable moment to the trade of the port are arranged for, or are under contemplation. At this port a scheme of improvements, involving an outlay of £35,950, received the sanction of the Working Committee of the Harbour Board on the 29th inst. It is proposed that Regent Bridge should be widened by the construction of a new quay wall, so as to provide 700 lineal feet of berthing accommodation. The work will be proceeded with without delay.

LITERATURE.

Cyanide Processes. By E. B. WILSON, E.M. New York: John Wiley and Sons. London: Chapman and Hall. 1896. 8vo., 116 pp.

THE cyanide process continues its successful progress, and consequently attracts attention, capital, the legal profession, the paper writer, the book writer, and others. The literature on the subject is increasing rapidly, and it is desirable that more and more light should be thrown on this simple but interesting process. The author of the present volume is quite of that opinion, and having investigated "Patent-office literature, together with such extracts as appeared from time to time in technical journals and society periodicals," has set to work to clear up matters that have puzzled and are still puzzling some of the highest authorities of the day; and this is how he does it.

He opens with some remarks on crushing, worthy of the early part of the sixteenth century, which are followed by some threadbare statements about amalgamation; the subject proper is then broached, and Hagen is said to have known that gold was soluble in cyanide of potassium solution in 1806. The well known platitudes on the oxygen question are introduced, the losses incident to the process are imperfectly set forth, and there is an incomplete list of the re-agents used, or suggested for use, to expedite the action of cyanide. NaO_2 is given as one of the latter, and we are told that in treating ores "not thoroughly oxidised from acid salts, losses must surely occur." Commonplace remarks about the practice of amalgamating and then cyaniding, or of amalgamating and cyaniding simultaneously, and about the effects of agitation, &c., are repeated at irregular intervals throughout the work. The chemical chapter contains the usual array of equations, many of which are rendered harmless by lack of explanation. One equation runs thus:—$6\,Au\,K\,Cy_2 + 6\,K\,H\,O + 3\,H_2\,O + 2\,Al = 6\,Au + 6\,K\,Cy + 6\,K\,H\,O + Al_2\,O_3$, which does not equate, the most important factor being left out, but that does not matter, as it is patented, so of course must be all right. Lime or sodium oxide, $Na_2\,O$, is stated to be used for neutralising sulphates in the ore, and the following important statement is emphasised, "That the more safeguards used to prevent loss will prove economical and beneficial." The author thinks "novices should study the subject of sodium before mixing with water." Whether this is a question of etiquette or sanitation is a mystery that is never solved, for the statement terminates a chapter, and is never again referred to. One chapter, VI., deals with zinc as a precipitant, is somewhat confused, but receives this lucid finishing touch, "After passing through the zinc boxes the solution should not contain 50 per cent. per ton of gold or hardly a trace, since this gold will no doubt be lost by precipitation from the weak solutions." Chapter VII. contains a hazy account of the treatment of bullion. In Chapter VIII. the author generalises about the recovery by the cyanide process, and writes about "such non-metal substances as antimony, bismuth, arsenic," and gives some bare numerical data.

Chapter IX. deals with laboratory work, and general information and ore sampling, and is as well left alone. In Chapter X. we are introduced to electricity as an agent in the cyanide process. The author says, "A good thing laying dormant is of no use to mankind." This is probably his reason for giving his views on electrolysis, which are very impressive. Here is an example: "That gold is positive there can be no doubt, and that cyanide of potassium is negative as an electrolyte there can be no doubt; but we are told that the solving action takes place at the anode. Hence the gold positive dissolves to the cyanide solution negative, with the result that the gold cyanide solution is positive. The gold is able to keep its electro-positive condition if not its chemical condition."

We encounter "electropositive and electronegative metals," making "little galvanic batteries" in the gold cyanide solution, and oxygen decomposing the potassium of the potassium cyanide, and many more such eccentricities in this and the next two chapters. Chapters XIII. and XIV. treat of the anode and cathode respectively, and serve specially for repeating much that has been said before, both in this book and elsewhere, and a few remarks about a few processes which are continued in Chapter XV. In one process a "vat, in the centre of which is a stirrer of metal—iron—and which is composed at the bottom of special amalgamated copper plates, is filled with crushed ore or tailings." The author to fill up this chapter reiterates a few statements he has made before, makes a few fresh ones, gives a list of people and publications to whom he is indebted, including both the *Mining Journal, Railway and Commercial Gazette*, London, and the *Mining Journal*, London, then with a page of "useful information" and two pages of single-column index, brings the book to a close. The useful information includes the following:—"Imperial gallon weighs 10 lb.; United States gallon, 8·33 lb.; Avoirdupois ton = 2000 lb., or 32,000 oz." The author points out that some eminent authority "long ago reached" the conclusion that "there is nothing new under the sun," and it is possibly for this reason that there is not much new in this book beyond the numerous quaintnesses, to some of which we have drawn attention. One thing is certain, that the book would not have been of much use had it been written carefully; but crowded as it is with such astounding evidences either of utter carelessness or of remarkable innocence of English grammar, chemistry, and electricity, it cannot be recommended as either a trustworthy or useful book, in spite of the author having "told all he knows of the subject at the present time."

A Text Book of Marine Engineering. By A. E. TOMPKINS, R.N. Griffin and Co., Portsmouth. 1896. 8s. 6d. net.

IN a text book of only 237 pages, printed in large type, and with numerous engravings, it would be unreasonable to expect an elaborate treatise on so stupendous a subject as that of marine engineering in all its branches. Mr. Tompkins has, however, compressed a large amount of interesting and instructive matter into his book. All historic study of past types of engines, boilers, and their accessories, has been judiciously omitted, and only such subjects dwelt upon as "will be of use to naval officers and others who take an interest in the progress and working of marine machinery." The book is one which will commend itself particularly to such naval officers as are not immediately associated with the engineering branch, and to lay outsiders, as affording them brief but comprehensive information on most recent types of marine machinery, explained in a simple and popular way; and young engineers will find in it valuable hints as to the construction and working of engines and boilers. As an illustration of this point we may allude to the many academic treatises which have recently been written upon the subject of water-tube boilers. Scarcely any of them allude, except perhaps casually, to the difficulties encountered in the working of these boilers.

Mr. Tompkins' work is divided into sixteen chapters, after which is a well-assorted list of questions, so that the student of marine engineering may test his knowledge of the subject after perusal. The first two chapters deal mainly with definitions and units, and show the relation between steam temperatures and pressures. The four following chapters go into the question of the boiler itself, its fitting and cleaning, care and maintenance, and combustion. An interesting table is appended to these chapters, giving the actual amount of horse-power indicated per ton weight of boiler, including water, in various classes of boilers.

As regards the vexed question of forced or induced draught, it is stated that "induced draught appears to have one great advantage, not as a better means of obtaining high rates of combustion, but as a convenience; the stokeholds are always open, and are cool and clean and comfortable, being much better ventilated by this means . . . . where saving of weight is concerned the closed stokehold system gives the best results. The size of fan is only one half that necessary to give the same draught as with induced draught." It is probable that many of the writers upon the advantages associated with forced draught have never themselves personally experienced the sensation of being screwed down under these circumstances for a four hours' trial. If they had they would appreciate the significance of the remarks made by Mr. Tompkins as to a cool, clean, stokehold, and this is a question altogether apart from the superiority of the induced draught in its effects in furnace and tubes.

Chapters VII. to XII. deal with the engine generally, its principal parts individually, the expansion of steam, the use of indicators and auxiliary machinery.

Diagrams are given showing plans of the arrangement of boilers, triple-expansion engines, and steam pipes, generally followed in the Navy; as also the bulkheads between the various compartments and surrounding them. The details of condensers, air pumps, and circulating pumps, are fully explained. The accessories and fittings of cylinders, such as liners, glands, and the various forms of pistons, form a separate chapter. The shafting and connecting-rods, being part of the rapid running gear, receive considerable attention. Gudgeon bearings and crossheads of piston connecting-rods, and the position of the latter at various points of the sweep of the rods, are explained in diagrams, the terrible strain thrown upon these parts when a set of rapid running engines is suddenly reversed or stopped being indicated very clearly by the position of the swinging parts. The elaborate question of auxiliary machinery is not so fully gone into as the more prominent features connected with propelling engines and their accessories. It is remarked, however, that the importance of economical auxiliary machinery will be understood by the fact that about ten tons of fuel is employed per diem in keeping it going on an ordinary battleship. Feed pumps, differential valves for reversing small engines, and steering engines, are illustrated and described. The chapter on "Evaporators" and "Feed Heaters" is not only incomplete but is inaccurate, both as to the originator of the evaporator for use on board ship, as to the use of live steam feed heaters and evaporators introduced by Messrs. Kirkaldy and Co. and the economical advantages which follow the use of live steam for this purpose; and he is wrong as to the order of introduction of these now universally used auxiliaries and requisites for modern marine boilers; but as the subject is introduced towards the end of the work, it is probable that the author means to deal with it more exhaustively in another edition. The chapter on "Care and Management of Machinery" will interest sea-going engineers.

Chapters XV. and XVI. deal with propulsion, ventilation, and water-tight door arrangements, and in the last chapter the immense importance of carrying out, with absolute integrity, the instructions given on the "Watch and Station Bill," are emphasized.

Rope Driving; A Treatise on the Transmission of Power by means of Fibrous Ropes. By JOHN P. FLATHER, Ph.B., M.M.E., Professor of Mechanical Engineering, Purdue University. New York: John Wiley and Son. London: Chapman and Hall. 1895.

SEEING that this little book was written by a professor, our first step was to search for formulæ for the proper tension of ropes. Professors in this country when writing about belts always insist on supplying formulæ for the proper tension of a belt. But as those who use belts never by any chance have any apparatus wherewith to measure the pull on the leather, while the pull varies with the weather, the age of the belt, &c., the formulæ in question are of no practical value whatever. Professor Flather has been unable to resist the temptation. He goes at some length into the question of tension; but he fails, as usual, to give us even a hint as to how it can be measured. We forgive all this, however, because it is a mere superfluity, and the remainder of the book is eminently practical, and on the whole excellent. The book is divided into twelve chapters. The first is historical; the second deals with the multiple rope system; careful instructions are given for splicing ropes, a curious operation which we do not think can be taught by books. The author prefers what are known in the States as "London" cotton ropes; the third with the continuous or wound rope system, but little used in this country, and the author describes in some detail the plant of the Western Electric Company, New York, where 400-horse power is transmitted to machinery on six floors by raw hide ropes extending from bottom to top of the building, and passing on each floor round a pulley to be driven. The shaft of this pulley gives power for that particular floor. In chapter four we have the history of Hirn's system of long-distance transmission, and much useful modern information. Chapter five deals with ropes of all kinds; chapter six with their manufacture. In chapter seven the wear of ropes is considered. In chapter eight the author deals with the horse-power transmitted. In chapter nine we have the mathematics of the catenary. chapters ten and eleven deal with losses, while chapter twelve is on the construction of rope pulleys. There are no fewer than twenty-two tables. There are ninety-two illustrations, for the most part excellent, though a few are atrocious.

It is not easy to overrate this book, because it is almost the only one of its kind, and it supplies information that cannot be found anywhere else. The author is by no means enamoured of theory. On the contrary, he describes and illustrates numerous examples of rope driving. The chapter on rope pulleys is really an excellent little treatise on a subject about which not much precise information exists. It seems that in the United States very rough-and-ready methods have been tried, and curiously enough, not a syllable is said about turning such wheels, except the general statement that manufacturers almost always turn the rims to template. Now the turning in a wheel, some 30ft. in diameter, of a couple of dozen grooves all precisely alike, is by no means a simple matter, and very special appliances are necessary for doing the work. The whole question of section of groove is fully dealt with, however, and examples of the very best wheels by American and English engineers are given. Much curious information is scattered up and down in the book.

The author's style is lucid, and his matter well arranged, and quite practical. We can very cordially recommend the book to all mill owners and mill engineers; indeed, to every one who is interested in the transmission of power.

SHORT NOTICES.

The Gas Engineers' Annual and Directory of Gas Undertakings, 1896. Edited by Charles W. Hastings. Seventeenth annual publication. London, Birmingham, and Manchester: J. G. Hammond and Co., Ld.—The editor of this annual keeps it well up-to-date as a directory, and by a judicious selection of articles on new discoveries, processes, machinery, and methods, makes it a requisite annual to all interested in gas manufacture and sale.

The "Every Hour Diary," 1896. *A full week visible at once. Indexed to every Month. A Record of Engagements, Appointments, Special Business, and Events for any Hour of any Day during the Year.* Dublin: Eason and Son, Ld.—This is a quarto diary with a week on an opening, a column being arranged for each of the seven days, the names and dates of the days being along the top of the two pages, and the hours of the day in the first vertical column. Thus appointments and incidents for each hour of the day for a week can be entered and seen at a glance. The total quantity of room for each day is a space of 9in. by 2¼in., which is enough for most men. It is arranged removably in a cover, which has on one side a blotting pad and on the other a pocket.

Machine Drawing, for the use of Students in Science and Technical Schools and Colleges. Comprising forty plates of machine details, with descriptive letterpress and numerous perspective illustrations. By Thomas Jones, M.I. Mech. E., and T. Gilbert Jones, B.Sc., Whitworth Scholar. Second edition. Published by the authors at 27, Barton-street, Moss Side, Manchester. Manchester and London: John Heywood. 1895. Price, in limp cloth, 3s. net; in boards, 4s. net.—This book, quarto size, contains a most judiciously selected series of examples from commencement to finish. The plane geometry has for examples its application to drawings of parts of machines; and the intersections of surfaces of solids, and the principles of projection, are taught by reference to common objects of the machine drawing-office. Throughout the book the examples are such as perform the double duty of subjects for well-made drawings and for teaching the eye by illustrations of good practice. There is nothing in the book the student will have to unlearn in the works later in life. The instructions which accompany the drawings contain also many useful practical suggestions, and the book is one of, if not the best of its kind. To the part devoted to spur and other gearing, it may be suggested that some examples on internal gearing should be given. Most books are incomplete in this respect.

The Universal Electrical Directory (J. A. Berly's). Containing a Complete Record of all the Industries Directly or Indirectly Connected with Electricity and Magnetism, and the Names and Addresses of Manufacturers in Great Britain, India, the Colonies, America, the Continent, &c. Price 6s. London: H. Alabaster, Gatehouse, and Co. 1896.—This directory of an industry which has been in existence but about sixteen years as now known, now fills over a thousand pages. This is the fifteenth year of publication, and a comparison of its contents with those of the first edition of 1882 affords a good idea of the greatness of the business and trades now based upon the applications of electricity and magnetism. It is a continental and colonial as well as British and American directory. For simplicity and facility of reference, it is divided into four groups, namely, British, Continental, American, and Colonial, which are again sub-divided into alphabetical and classified sections. The advantage of these divisions is somewhat destroyed by the admixture of advertisements with the first pages, which contain the tables of contents and indexes. The tables of contents might be amplified, and the title, "Index to Classified Trades," should be simply "Index," as it refers to all branches, including the professional part. In addition to the new names incorporated in the present issue, much financial information is given, the telegraphic addresses and local telephone numbers are given. The total of pages added to the work is fifty-four, as compared with that of 1895, making in all about 920 pages entirely of directory matter. The names of the parts are stamped on the edges of the leaves, and notches cut out of the edges so that each part can instantly be turned up.

BOOKS RECEIVED.

Howell's Steam Vessels and Marine Engines. By G. Foster Howell. New York: Published by the *American Shipbuilder*.

Transactions of the American Society of Mechanical Engineers. Vol. xvi. New York City: Published by the Society. 1895.

Journal of the Institute of Electrical Engineers. No. 119 of vol. xxiv. Edited by F. H. Webb. London: E. and F. N. Spon.

Notes on the Factory and Workshop Acts, 1878, 1891, 1895. By D. S. Davies, M.D., D.P.H., M.O.H., Bristol, and T. H. Yabbicom, A.M.I.C.E. London: The Sanitary Publishing Co., Ld. Price 4d., post free.

PARLIAMENTARY NOTES.

Postal pneumatic tubes.—If we remember rightly, in the early sixties there was a completely prepared scheme for the construction of a pneumatic railway for the carriage of mails from Euston Station to the General Post-office. It came to nothing at the time, but Mr. Henniker Heaton seems to think that it is time something was done. In reply to a question from him, Mr. Hanbury said that the Postmaster-General was aware that the United States Post-office had made certain experimental arrangements for the conveyance of mails with the companies running electric and cable cars over the street railways in several American cities, and it was, of course, also within his cognisance that telegrams were forwarded from the district post-offices in London to the Central Telegraph Office, St. Martin's-le-Grand, in pneumatic tubes. If any system of street railways should be established hereafter in London, or if any system of pneumatic tubes should be successfully inaugurated for commercial purposes, the question of utilising such lines and tubes for the conveyance of mails would receive the Postmaster-General's best consideration.

New Bills.—Leave was given to bring in the following, amongst other, Bills of private members. They have all been read the first time:—Mr. J. A. Pease: Bill to grant certificates to persons in charge of steam engines.—Mr. Tomlinson: Bill to amend the law relating to the rating of hereditaments containing machinery.—Mr. Boscawen: Bill to amend the law with respect to the use of locomotives on highways.—Mr. Atherley-Jones: Bill to amend the law relating to mining easements.—Mr. Ascroft: Bill to amend and extend the law affecting the introduction of steam and moisture in factories, sheds, and workshops, and for regulating the labour of young children and young persons working in same.—Mr. Rentoul: Bill to amend the existing laws in Ireland relating to county surveyors and their assistants, and to provide for superannuation and travelling expenses, and other purposes.—Sir C. Dilke: Bill to amend the Coal Mines Regulation Act of 1887.

Messrs. Yarrow and the Admiralty.—The old trouble about the use made by the Admiralty of the drawings of torpedo boat destroyers made by Messrs. Yarrow was revived on Tuesday. Mr. Holland asked the First Lord of the Admiralty whether Messrs. Yarrow's machinery designs for the torpedo boat destroyer Havock were forwarded by the Admiralty, under the late Government, to competing firms, without the previous knowledge or consent of Messrs. Yarrow, and, if so, whether the Admiralty intended to continue this system of distributing one firm's designs among other firms without the consent of the firms whose designs they distributed; whether, although Earl Spencer communicated with Mr. Yarrow in August, 1894, to the effect that their success in first constructing vessels of the high speed of the Havock and Hornet would be remembered in the future, yet in the spring of 1895, when tenders were invited for improved vessels, of thirty knots speed, the Admiralty refused Messrs. Yarrow's tender, although the original tender submitted by them was lower than the original tender sent in by another firm, who were successful in obtaining three boats after reducing their price; whether, in respect to these tenders, the Admiralty was party to the modification of the tenders after they were received, and, if so, whether the Admiralty intended to continue this system; and whether vessels of the same contract speed as the Hornet were subsequently ordered in the north, in some cases at prices between £3000 to £5000 per vessel more than that paid to Messrs. Yarrow for the Havock and Hornet, from builders who were supplied by the Admiralty with Messrs. Yarrow's designs. Mr. Goschen said this question dealt with facts long past and should have been addressed to their predecessors in office in the last Parliament, who had personal knowledge of them; but he was quite prepared to reply. In accordance with a long established practice, certain working drawings of machinery designed by the first makers of British torpedo boat destroyers, including Messrs. Yarrow, were communicated to firms who had entered into contracts with the Admiralty for later vessels. Those of Messrs. Yarrow were practically duplicates of machinery supplied to the Admiralty seven years before, as admitted by Mr. Yarrow to the Admiralty. Independently of this, however, and before that step was taken, Messrs. Yarrow and another London firm were distinctly told of the proposed action of the Admiralty in the following terms:—Extract from Admiralty letter of August 16th, 1893.—"I have further to state that, while recognising the good work done by your firm in the construction of torpedo vessels, it is considered desirable to encourage other firms in undertaking this class of work. It must therefore be understood that the Admiralty consider that they are entitled to make use of information in their possession respecting the torpedo boat destroyer type as may appear necessary in the public interest." No remonstrance followed at the time. Mr. Yarrow long afterwards stated that he had misunderstood this paragraph. As to the second question, the case, as stated, is absolutely misleading. Three firms were invited to tender, of whom two were London firms. The London firms, including Messrs. Yarrow, had sent in tenders over 16 per cent. and 18 per cent. higher than the North-country firm, which had tendered lowest. Their prices were clearly too high, as was shown by the result, for when the other London firm was offered three boats at £4000 per boat less than its tender it accepted the proposal without demur. Their original tender was slightly above that of Messrs. Yarrow. But a fact which the question suppresses is that an offer of the same reduction was made by the Admiralty to Messrs. Yarrow and declined. They were then offered three destroyers at exactly the same price as that accepted by the other London firm, and they declined again. In reply to the last paragraph, it is the fact that higher prices than those given for the Havock and Hornet were paid to other firms as well as to Messrs. Yarrow for boats put out to contract at a considerably later date, but in all cases the displacement and horse-power were greater than those of the Havock and Hornet, and the accepted designs were in many instances entirely dissimilar to those of Messrs. Yarrow, and in no instance did the principal dimensions correspond with those of the Havock and Hornet. Mr. W. Allan desired to know whether it was not a fact that Mr. Yarrow was sent for by the late Government, and asked to go to France to try and find out the designs of French fast torpedo boat destroyers, and whether Mr. Yarrow did not succeed and submit the designs to her Majesty's Government. Mr. Goschen said that he was not at the Admiralty at the time, but there was nothing inconsistent in the statement he had made. The late Government frankly appreciated the services rendered by Mr. Yarrow, and if his tenders were too high that was not the fault of the Government. Mr. Allan asked whether it was not a fact that £38,000 had been paid by the Government for a form of torpedo boat which Mr. Yarrow offered to build for £34,500. Mr. Goschen said the two forms of boats referred to were not identical. The boat tendered for by the firm in the North of England was greater in displacement and in horse-power than that of the other. Mr. Yarrow has since written to say that he was never instructed by the Government, as Mr. Allan's question suggested, to discover the designs of French destroyers, and that he did not submit such designs to the Government.

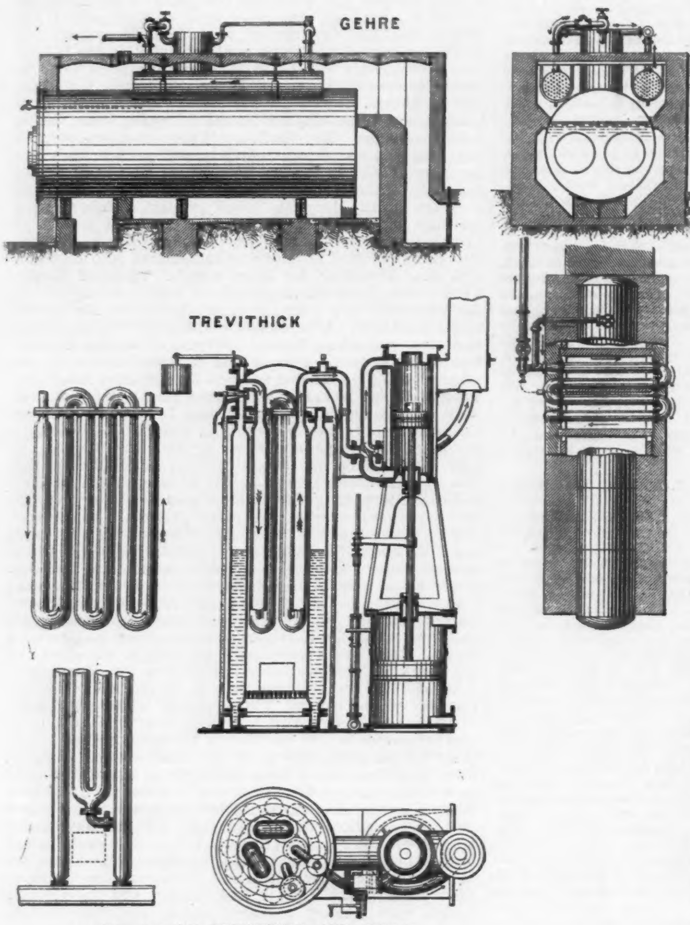
HUNGARIAN NATIONAL EXHIBITION, BUDAPEST, 1896.—Information has been received by the Department of Science and Art, through the Foreign-office, from the Austro-Hungarian Ambassador at the Court of St. James's, announcing that a National Exhibition, under the patronage of his Imperial and Royal Apostolic Majesty, will be held at Budapest this year, which will be coincident with the 1000th anniversary of Hungary. The Exhibition will be opened on May 2nd next, and will be of considerable interest to foreign countries.

MR. WILLIAM JOHN BIRD CLERKE, C.I.E., M.I.C.E., died on Thursday, February 13th. Mr. Clerke, who at the time of his death was an inspecting engineer under the Local Government Board, was educated at Trinity College, Dublin, where he graduated with distinction. After some years' work at his profession in Ireland he joined the Public Works Department under the Government of Bombay, and was employed for many years as an executive engineer in the Irrigation Department. In the great famine of 1876-77 the engineers had to find employment for large masses of unskilled and inexperienced workmen, and it was due in a great measure to Mr. Clerke's powers of organisation that under these conditions many large irrigation works of permanent utility were planned and completed in the Poona district when he was serving. When the Bombay Municipality decided to settle the question of the water supply of the city by the construction of the huge reservoir known as the Tansa Lake, Mr. Clerke was appointed to carry out the work with which his name will be permanently associated. The lake was formally inaugurated by the Viceroy of India in April, 1892, Mr. Clerke being created C.I.E. in recognition of his services. Mr. Clerke then closed his career in the East, leaving behind him a singularly high official reputation. He esteemed himself fortunate in securing employment under the Local Government Board instead of having, like the majority of retired Anglo-Indians, to rest in idleness. But he was attacked by a malignant disease in the throat, for which he underwent an operation on Tuesday, February 11th. Although it appeared immediately successful, pneumonia supervened, and he died on Thursday morning. He had almost completed his fifty-eighth year. He was never married.

NOTES ON STEAM SUPERHEATING.*

By MR. WILLIAM H. PATCHELL, of London.

Nature of steam superheating.—Superheated steam is steam of any pressure at a temperature higher than the temperature of its evaporation from water at that pressure. Saturated steam may be superheated by imparting additional heat to it at a constant pressure, during which process its volume increases. By permitting saturated steam of a given pressure to expand without doing work, superheated steam at a lower pressure may be formed. Steam cannot be superheated in the presence of the water from which it was evaporated, owing to the fact that the water takes up the heat and evaporates into further saturated steam. The corollary follows that water cannot exist in the presence of superheated steam: either the surplus heat in the steam will evaporate the water; or, if there be too little surplus heat to evaporate all the water, the steam will immediately become saturated by evaporating as much of the water as it can.



Figs. 1 and 2—TREVITHICK AND GEHRE

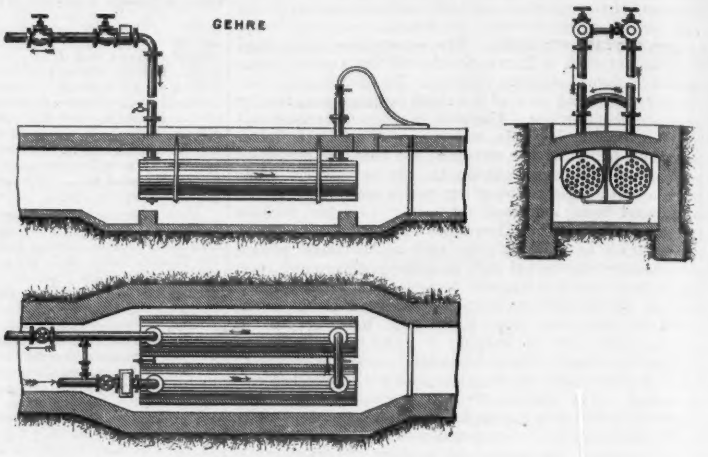


Fig. 3

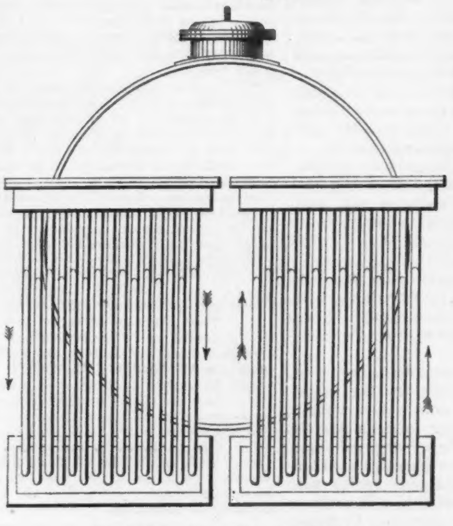


Fig. 6—McPHAIL AND SIMPSON

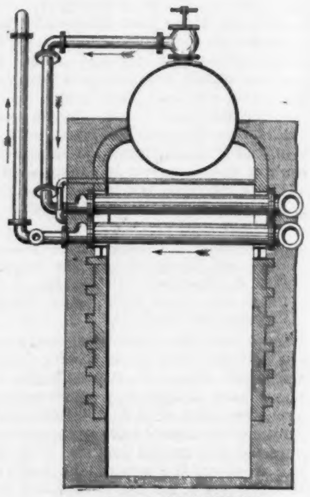


Fig. 10—SCHWOERER

Messrs. Fairbairn and Tate, Hirn, and Siemens, all found that saturated steam was not a true gas, and that its expansion on the application of further heat was at first much greater than that of a perfect gas. When a temperature of about 20 deg. Fah. above that of the saturated steam was reached, the volume increased at about the same rate as that of a perfect gas. No data appeared to be yet available as to the expansion of steam with high degrees of superheat; but there is little doubt that it would be that of a perfect gas. A marked feature in the use of superheated steam is the rapid fall in the superheat from radiation, &c. The reason of this more rapid fall in temperature as compared with saturated steam seems to be that the latter owes its heat-retaining properties to the water spray carried in it. It is only after this water spray has been evaporated that the steam becomes a true gas.

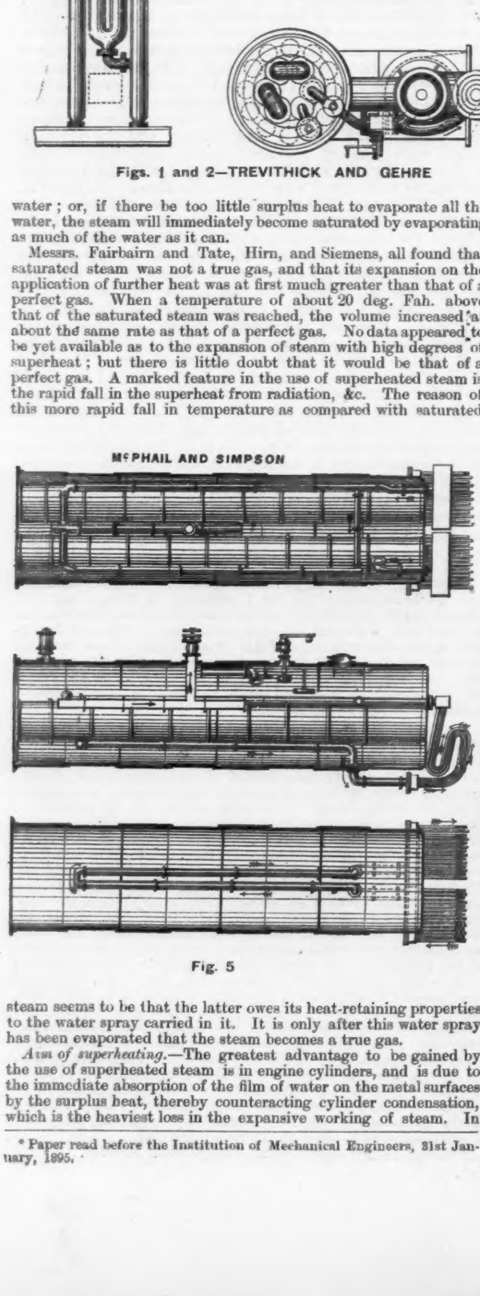


Fig. 5

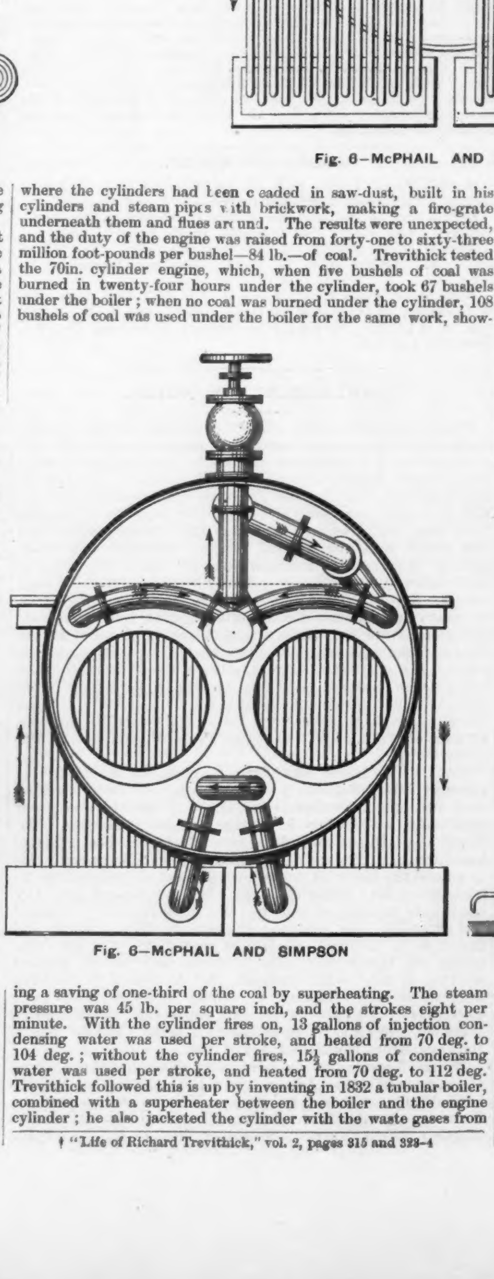


Fig. 6—McPHAIL AND SIMPSON

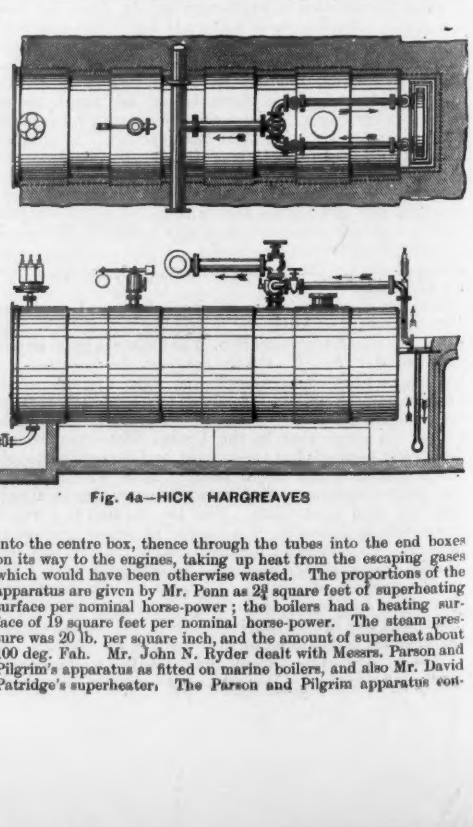


Fig. 4a—HICK HARGREAVES

Aim of superheating.—The greatest advantage to be gained by the use of superheated steam is in engine cylinders, and is due to the immediate absorption of the film of water on the metal surfaces by the surplus heat, thereby counteracting cylinder condensation, which is the heaviest loss in the expansive working of steam. In this connection superheated steam would appear to have an advantage over steam jackets, inasmuch as the heat is applied exactly where it is wanted, and during the period that it is wanted—that is, up to the point of cut-off; whereas a steam jacket wastes a considerable part of its heat and time in warming up the exhaust.

Early attempts at superheating.—That economy attends the use of superheated steam in engine cylinders has been known at least since 1828, when Richard Trevithick reported on the engines at Binner Downs mine in Cornwall.† The engineer of the mine, Captain Gregor, wishing to rival the record of a neighbouring mine where the cylinders had been cleaded in saw-dust, built in his cylinders and steam pipes with brickwork, making a fire-grate underneath them and flues around. The results were unexpected, and the duty of the engine was raised from forty-one to sixty-three million foot-pounds per bushel—84 lb.—of coal. Trevithick tested the 70in. cylinder engine, which, when five bushels of coal was burned in twenty-four hours under the cylinder, took 67 bushels under the boiler; when no coal was burned under the cylinder, 108 bushels of coal was used under the boiler for the same work, showing a saving of one-third of the coal by superheating. The steam pressure was 45 lb. per square inch, and the strokes eight per minute. With the cylinder fires on, 13 gallons of injection condensing water was used per stroke, and heated from 70 deg. to 104 deg.; without the cylinder fires, 15½ gallons of condensing water was used per stroke, and heated from 70 deg. to 112 deg. Trevithick followed this is up by inventing in 1832 a tubular boiler, combined with a superheater between the boiler and the engine cylinder; he also jacketed the cylinder with the waste gases from the furnace. In Fig. 1 is shown the arrangement, copied from his patent No. 6308 of 1832. The external series of vertical pipes, connected top and bottom to a hollow ring, constitute the boiler; the superheating pipes inside it are formed like inverted syphons, so as to avoid jointing at the lower end next the fire. Trevithick had been combatting cylinder condensation for thirty years before this date, having in 1802, in conjunction with Vivian, constructed a non-condensing engine, the cylinder of which was placed inside the boiler—a plan followed for many years with much success in agricultural portable engines by Messrs. Hornsby, of Grantham.

Owing doubtless to the difficulty in controlling the temperature imparted to the steam, superheating made but little headway till 1850, when it came to the front again. Many plans were then proposed for superheaters and steam driers in various forms, both attached to boiler flues and separately fired. Asbestos packings and brass bushes with plumbago plugs were then introduced to meet the demand for steam-tight glands under superheated steam.

More recent efforts.—Some results then obtained were reported to this Institution by Mr. John Penn in 1859—"Proceedings," page 195—followed by Mr. John N. Ryder in 1860—page 22. Mr. Penn described the apparatus employed by him in the Valetta steamer of the Peninsular and Oriental Company, with engines of 260 nominal horse-power, where the saving in fuel due to superheating was 20 per cent. The superheater consisted of two horizontal faggots, each of forty-four 2in. tubes, placed in the smoke-box. The tubes were fixed into three wrought iron boxes, welded up at the corners and closed with a flanged joint. The steam from the boiler passed into the centre box, thence through the tubes into the end boxes on its way to the engines, taking up heat from the escaping gases which would have been otherwise wasted. The proportions of the apparatus are given by Mr. Penn as 2¾ square feet of superheating surface per nominal horse-power; the boilers had a heating surface of 19 square feet per nominal horse-power. The steam pressure was 20 lb. per square inch, and the amount of superheat about 100 deg. Fah. Mr. John N. Ryder dealt with Messrs. Parson and Pilgrim's apparatus as fitted on marine boilers, and also Mr. David Patridge's superheater. The Parson and Pilgrim apparatus consisted of two horseshoe pipes fixed over the fire grate in the internal flue of the boiler. Tests on the steamers Osprey and Swift showed a saving over saturated steam of 30 to 40 per cent. in fuel; and on H.M. steam tug Bustler a mean of thirty-seven trials with a pressure of 8¼lb. and a temperature of 380 deg. in the cylinders, which is 144 deg. of superheat, gave 25 per cent. economy. Mr. Patridge's apparatus was a cylinder filled with tubes, placed vertically in the uptake. The gases passed through the tubes, and the steam around them; the working temperature was from 360 deg. to 390 deg. H.M. steamship Dee was fitted and tested for several months by the Admiralty, when an economy of fuel of from 20 to 25 per cent. was obtained. An aggregate of about 5000-horse power was stated to be then working with this apparatus. Following closely on Mr. Ryder's paper was one read by the Hon. John Wethered, of the United States, at the Institution of Civil Engineers—"Proceedings," 1860, vol. xix., page 462—wherein he animadverted on the futility of the common kinds of superheater, and strongly advised mixed or combined steam, which he claimed to have introduced from America four years previously.

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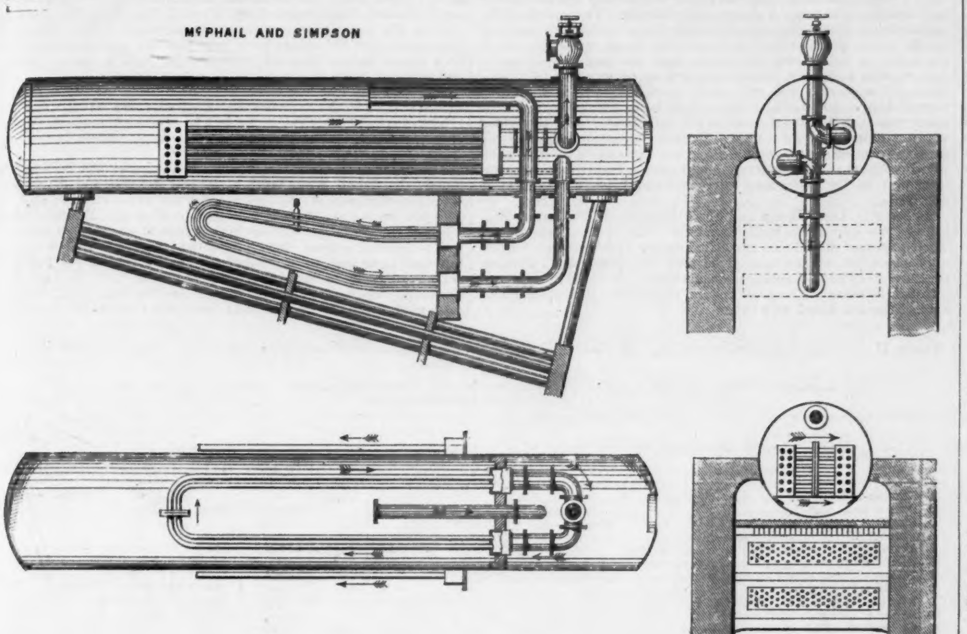
* Paper read before the Institution of Mechanical Engineers, 31st January, 1895.

† "Life of Richard Trevithick," vol. 2, pages 315 and 323-4



Figs. 7 and 8

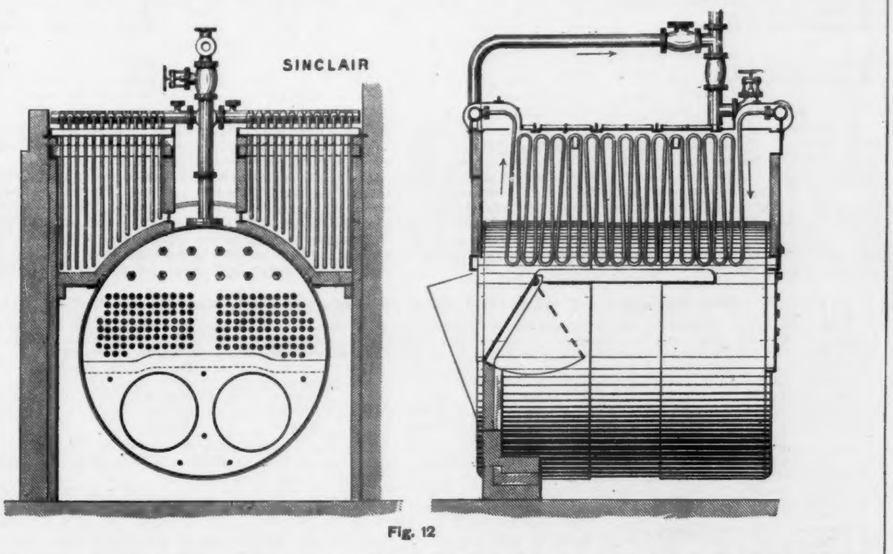


Fig. 12

Reasons for former abandonment.—If superheating was so common and of such manifest importance and efficiency in the saving of fuel some forty years ago, the question arises, why was it given up? and what factors that led to its abandonment have been eliminated in modern practice? Trouble was formerly experienced at the valve faces and in the cylinders from the decomposition and destruction, at the high temperatures of superheated steam, of the tallow and the low-class lubricants then in vogue. This trouble was two-fold: the cutting and excessive wear in the absence of lubrication, and the pitting caused by the fatty acids in the lubricant. On this score, however, no trouble need now be anticipated, at any degree of superheat likely to be attained, where good hydrocarbon oils are used. Gas engines run in regular working with a cylinder temperature in the neighbourhood of 2000 deg. Fah., lubricated with good oil; and with ordinary care and attention instances of cutting are not frequent. The common use of metallic packings for glands, and of piston valves in place of flat valves, has removed another serious obstacle. In this connection it will be well to note that pistons and valves which show little leakage when used with saturated steam may show considerable leakage with dry steam, probably owing to the film of water on the metal improving the fit when saturated steam is used.

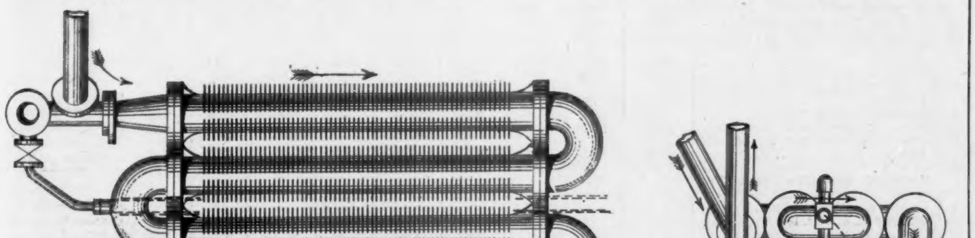


Fig. 11—SCHWOERER

Much of the trouble that has been attributed to the effects of superheat, in respect of cut cylinders and valve faces, has in the author's opinion been due in reality to the effect of alternate superheat and water in the steam, owing to want of proper control of the superheaters. A superheater may give a high degree of superheat when the fires are in good order, and at another time may even act as a condenser. The effect of this alternation demands much closer attention than it has at present received. A somewhat parallel case is the behaviour of a good hydrocarbon cylinder oil, which in one engine with normal dry steam leaves no deposit; whereas in a sister engine, at the same steam pressure, with wet steam a heavy deposit is formed from the same oil. An instance of a cut cylinder which had to be re-bored has lately come under the author's notice, where it appears from the evidence that the trouble is not to be attributed either to the degree of superheat in itself, or to the lubricant, or to neglect on the part of the engineer in charge, but to the alternate effects of superheated and wet steam in the cylinder.

The majority of the old troubles were met with in the engines; but the superheaters themselves do not appear to have been always above reproach. When endeavouring to trace failures to faults in pipes or joints, the author has sometimes found superheaters which were fixed with a bye-pass for the steam, but none for the gases. The boilers were then worked occasionally with the steam shut off from the superheater; and it is not surprising that the latter deteriorated rapidly, its position being eminently unsuitable for a combination of boxes, pipes, and expanded tube joints.

Re-introduction of superheating apparatus.—Concurrently with the increased efficiencies gained in late years in both boilers and engines, competition has also increased; and with it has arisen the continual cry for cheaper power, cheaper transport, cheaper means of production. The result is that engineers cannot afford to dismiss without careful examination the claims of any plan the adoption of which may diminish their consumption of fuel. It is this fact which has again brought superheating to the front, and has made it the subject of close inquiry in many quarters. Several kinds of super heater are now in more or less extensive use; but only one of them is a radical departure from those of forty years ago. Any change in the others is rather in manufacture than in design; and their parentage can be traced by their strong family likeness.

Gehre's superheater.—This is in extensive use on the Continent and has been introduced into this country by Messrs. B. Donkin and Co., of Bermondsey. It is shown in Figs. 2 and 3, and may be either fitted in the boiler flue or separately fired. Some of these superheaters have been fixed in England, but unfortunately they have not been tested. Mr. Bryan Donkin kindly gave the author a copy of a test made in Germany, of eight hours' duration, on a water-tube boiler with and without the superheater, Table I. The heating surface of the boiler was 861 square feet, and of the superheater 646 square feet. The superheater was placed directly behind the boiler in a special flue.

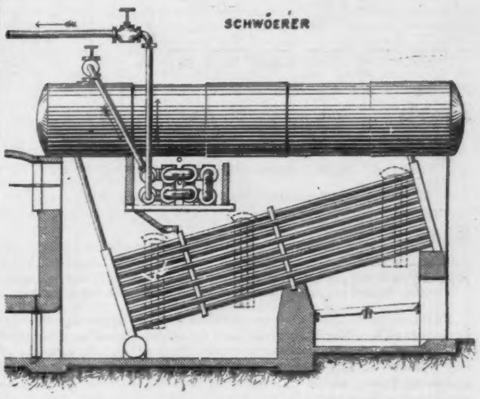


Fig. 9

TABLE I.—*Boiler Test with and without Gehre's Superheater.*

	With.	Without
Total coal used during trial, lb.	1,[illegible]	1,940
Total water used during trial, lb.	15,400	15,100
Temperature of feed-water, deg. Fah.	205	201
Superheat in steam, deg. Fah.	40	—
Temperature of furnace gases before superheater, deg. Fah.	600	600
Temperature of furnace gases after superheater, deg. Fah.	510	—
Water evaporated per lb. of coal, lb.	9·99	7·82
Water evaporated per sq. ft. of heating surface per hour, lb.	2·23	2·20
Pressure of steam per sq. in. above atmosphere, lb.	110-114	110-114
More steam used, per cent.	—	5
Less coal used, per cent.	34	—
Less work on engine, per cent.	—	7

Hick, Hargreaves and Co.'s superheater.—By the courtesy of the makers, the author has been favoured with the following particulars and tests, Table II., of their superheating apparatus in a mill at Bolton. As shown in Fig. 4, the apparatus consists of a nest of U tubes, bent to a large radius at the bottom, which are placed at the back of a Lancashire boiler where the hottest gases from the flues impinge upon them. The tubes are suspended from a tube-plate, forming the bottom of a box, in which they are fixed by being expanded in the usual manner. The box is divided down the middle by a vertical diaphragm, so that the saturated steam entering at one side passes down and up through the tubes, and leaves superheated at the other side. A by-pass valve is arranged to regulate the flow of steam through the superheater, because only a portion of the steam from the boiler is intended to be superheated. Main valves are also provided, so that the superheater can be disconnected for examination, or even taken out entirely, without interrupting the working of the boiler. The Lancashire boiler to which the superheater is applied is 8½ft. diameter and 30ft. long, with two flues of 3¼ft. diameter, having nine circulating tubes in each. The grate surface is 39 square feet; the heating surface in the boiler is 1195 square feet, and in the superheater 120 square feet. The area of passage through the superheating pipes is 22 square inches. The boiler pressure is 100 lb. per square inch above atmosphere. In the tests a portion only of the steam was superheated. The steam pipes to and from the superheater are 3½in. diameter, and are provided with valves, which were kept full open. The main stop-valve on the boiler is 8in. diameter, and was kept only $\frac{5}{16}$in. open. The steam was taken to the superheater from underneath this valve, and the return pipe from the superheater was conducted direct to the main range of steam pipe supplying the engine. The temperature of the gases

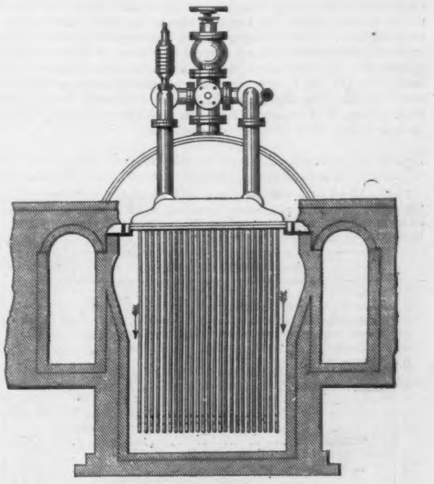


Fig. 4—HARGREAVES

was not taken. The engine is a horizontal tandem compound, fitted with Corliss valve gear; cylinders, $18\frac{1}{16}$in. and $36\frac{1}{16}$in. diameter, by 4ft. stroke. Each of the tests was of 7½ hours' duration. The much easier working of the boiler for the same indicated horsepower at the engine is to be noted. During the tests of March 20th and 21st and March 26th and 27th the load was practically identical. In the former tests with superheating the rate of coal consumption was 18·8 lb. per square foot of grate per hour, whereas in the latter tests, without superheating, the combustion went up to 23·4 lb. of coal per square foot of grate per hour. Where there is a low and uncertain chimney draught, this slower combustion alone would tend to much steadier and more economical steaming, and would more than counterbalance any obstruction in the flues caused by the superheating pipes, which appear to be more imaginary than real.

Table II.—*Boiler Tests with and without Hick, Hargreaves, and Co.'s Superheater.*

Dates of tests.	Number of tests with or without super-heater.	Mean load.	Water evaporated per hour.	Coal burnt per hour.	Water evaporated per lb. of coal.	Water evaporated per I.H.P. per hour.	Coal burnt per I.H.P. per hour.	Degrees of super-heat.
1895.		I.H.P	lb.	lb.	lb.	lb.	lb.	Fah.
February 19—20	2 without	308·55	5379·3	837·6	6·42	17·7	2·75	—
March 1—2 ..	2 with	290·5	4706·3	667·2	7·06	16·2	2·29	42°
„ 5-6-7-8..	4 with	298·06	4778·5	676·5	7·06	16·0	2·28	42°
„ 20-21 ..	2 with	311·2	5141·1	734·7	7·00	15·5	2·35	55°
„ 26-27 ..	2 without	311·8	5492·1	914·0	6·00	17·6	2·92	—
Means	without	307·67	5435·7	875·8	6·21	17·6	2·84	—
	with	299·45	4848·6	688·7	7·09	15·9	2·30	45·2°

Economy in water per I.H.P. per hour 9·6 per cent. with superheating.
Economy in coal per I.H.P. per hour 19 per cent. with superheating.

McPhail and Simpson's superheater.—This apparatus is the invention of Mr. Hugh McPhail, and is manufactured in Wakefield by McPhail and Simpson's Dry Steam Patents Co. It consists of two parts: the superheater proper, and the steam generator of radiating tubes, which distinguishes it from all other plans. As applied to a Lancashire boiler, Figs. 5 and 6, there are two nests of vertical steel tubes, expanded at top and bottom into cast steel boxes, or "headers," as they are called in water-tube boilers; these nests are placed preferably at the back end of the internal flues of the Lancashire boiler, in the down-take where the furnace gases impinge on them and pass between them. One of the top boxes is connected to the usual anti-priming pipe in the boiler; and the corresponding bottom box is connected to a block, which passes into the bottom of the boiler, and from which a copper pipe runs along the bottom of the boiler under the internal flues to the front end, and thence back again to the rear, where it passes out of the boiler and into the other bottom box. The second top box is connected to another copper pipe, which runs along the boiler over the internal flues, just below the water-line, and ends at the main steam stop valve. The course of the steam is from the anti-priming pipe to the first top box, then down the superheating tubes to the first bottom box, whence it enters the boiler, and passing through the lower copper pipe gives up part of its superheat to the surrounding water before leaving the boiler and entering the second bottom box. It is then further superheated in passing up through the second nest of tubes; and thence passing through the second top box into the upper copper pipe in the boiler, it again parts with some of its superheat before finally leaving the boiler at the steam stop-valve. The complete apparatus thus consists of two external superheaters and two internal radiators; and the final degree of superheat depends upon the proportion of the superheating tubes to the radiating pipes; the function of these radiating pipes is most important, as they give off to the water in the boiler the superheat which might be dangerous in the engines in times of heavy firing; and when the fires are green after cleaning and the flue gases low in temperature, they prevent any possibility of the superheater becoming a condenser. They thus tend to keep regular the amount of superheat in the steam as it leaves the boiler. It will be evident, therefore, that this superheater may be arranged either for improving the evaporative efficiency of a boiler and at the same time giving dry steam at the engine, or for the steam to leave the boiler highly superheated. In its complete form this superheater has been tested and fully reported upon by several engineers in this country, among whom may be mentioned Messrs. Crosland and Michael Longridge. In Tables III. to V. are given the results of some recent tests, one made by M. Armengaud at the works of Messrs. Isaac Holden and Son, Reims, and others at Kinleith and Thornliebank, for which the author is indebted to the manufacturers.

Table III.—*Boiler Tests without and with McPhail and Simpson's Superheater at Messrs. Isaac Holden and Son's Works, Reims.*

Lancashire boiler 28ft. long and 8½ft. diameter, with two internal flues 3ft. 3¾in. diameter; heating surface, 1012 square feet; grate area, 39 square feet; supplying steam to a Corliss engine. Quality of fuel, Dourges.

	Without or with superheater.	Without	With.
1	Date, 1894	June 20	June 28
2	Duration of trial, hours	7·83	8
3	Average boiler pressure per sq. in. above atm., lb.	73·6	91·5
4	Temperature corresponding with pressure, Fah. ..	318·7°	331·6°
5	Temperature of steam leaving boiler, Fah.	—	388·1°
6	Degrees of superheat, Fah.	—	56·5°
7	Average temperature of feed-water, Fah..	117½°	119°
8	Water evaporated, total during test, lb.	49,899	47,096
9	„ per hour, lb.	6,373	5,887
10	„ „ per sq. ft. of grate, lb.	163·4	151·0
11	„ „ per sq. ft. of heating surface, lb.	6·29	5·81
12	Coal burnt, total during test, lb.	7364·7	5435·3
13	„ per hour, lb...	941	679·4
14	„ „ per sq. ft. of grate, lb.	24·18	17·42
15	Ash and clinker, total, lb.	937	613
16	„ percentage of coal, per cent. ..	12·75	11·3
17	Combustible burnt, total, lb.	6427·7	4822·3
18	Water evaporated per lb. of coal, lb.	6·78	8·66
19	„ „ combustible, lb.	7·76	9·76
20	Average indicated horse-power, I.H.P.	328·3	328·5
21	Coal per I.H.P. per hour, lb.	2·86	2·10
22	Water per I.H.P. per hour, lb.	19·41	18·19
23	Gain in coal per I.H.P., per cent.	—	36·2
24	„ water per I.H.P., per cent.	—	6·8
25	„ „ evaporated per lb. of coal, per cent.	—	27·7
	Equivalent evaporation from and at 212 deg. Fah.		
	Superheat neglected		
26	Water per lb. of coal, lb.	7·69	9·81
27	„ „ gain per cent.	—	27·5
28	Water per lb. of combustible, lb.	8·80	11·05
29	„ „ gain per cent.	—	25·5
	Superheat included.		
30	Water per lb. of coal, lb.	7·69	10·07
31	„ „ gain per cent.	—	30·9
32	Water per lb. of combustible, lb.	8·80	11·35
33	„ „ „ gain per cent.	—	28·97

The Reims tests, Table III., were made before and after the apparatus was fixed on a Lancashire boiler 8½ft. diameter and 28ft. long, with furnace tubes 3ft. 3¾in. diameter. The heating surface is 2287½ square feet, and the grate area 39 square feet. The steam was used exclusively for a simple Corliss condensing engine, with cylinder 28in. diameter and 4½ft. stroke, running at sixty revolutions per minute, driving the machinery in a wool-combing mill. The work was arranged so that it should be as nearly as possible equal on the occassion of each test. Owing to an oversight during the test made before the superheater was fixed, the feed was left on while the boiler fires were being cleaned, the usual custom being to raise the water level before cleaning and then stop the pump. The result was a fall in the steam pressure from 78 lb. to 42½ lb. per square inch; and the boiler was so fully loaded that it took two hours to recover the normal pressure. The speed of the engine fell to fifty-eight revolutions per minute, although the trips on the Corliss gear ceased to act and full steam was being taken for nearly an hour; fifty-nine revolutions per minute were made for a further half hour, before the usual speed was re-established. During the second test the same procedure was intentionally repeated, in order that both tests might be exactly compared; the result was that the steam pressure fell only 3½ lb., and the speed was not affected at all. This difference is most striking, and is a forcible proof of the great increase in the capacity of a boiler when fitted with the superheating apparatus. The superheat was measured at the boiler stop valve, and was almost constant at 56 deg. Fah.

At Messrs. Henry Bruce and Son's Kinleith Mills, Currie, Midlothian, five Lancashire boilers are fitted with McPhail's apparatus. Their principal dimensions are 28ft. long by 7½ft. diameter; heating surface 920 square feet, grate area 36 square feet; working pressure about 90 lb. absolute per square inch. In Table IV. is shown a test of the complete range of boilers, six without the superheaters against the five fitted with them.

Table IV.—*Boiler Tests without and with McPhail and Simpson's Superheaters at Messrs. Henry Bruce and Son's Kinleith Mills, Currie, Midlothian.*

Lancashire boilers, each 28ft. long and 7½ft. diameter; heating surface 920 square feet, grate area 36 square feet.
Quality of fuel, local Scotch coal.

	Without or with superheaters.	Without.				With.				Gain due to super-heaters.
1	Number of test	1	2	3	Mean.	4	5	6	Mean.	per cent
2	Date of test 1895	July 2	July 3	July 4		Nov. 28	Dec. 4	Dec. 5		
3	Duration of test .. .. hours	9	9·16	9		8·75	9	9		
4	Number of boilers under test	6	6	6		5	5	5		
5	Average boiler pressure per sq. in. above atm. .. lb.	73·6	78	77·4	76·3	82	84·3	84·5	83·6	
6	Temperature corresponding with pressure .. Fah.	319°	322·5°	321·9°		325°	327·9°	327·5°		
7	Temperature of steam leaving boilers .. .. Fah.					413°	421°	420°		
8	Degrees of superheat .. .. Fah.					88°	93·1°	98·5°	93·2°	
9	Average temperature of feed-water .. .. Fah.	116°	124°	118°		112°	106°	106°		
10	Water evaporated, total during test .. .. .. lb.	393,095	345,581	371,640		392,410	420,867	413,375		
11	Water evaporated per hour per boiler .. .. .. lb.	7,280	6,399	6,882	6853	8,969	9,351	9,186	9168·6	33·8
12	Water evaporated per hour per sq. ft. of grate .. lb.	202	178	191		249	250	255		
13	Water evaporated per hour per sq. ft. of heating surface .. .. lb.	7·92	6·96	7·44	7·44	11·70	12·18	11·94	11·91	
14	Coal burnt, total during test .. .. lb.	57,792	53,256	56,817		47,452	49,423	47,544		
15	Coal burnt per hour per boiler.. .. .. lb.	1,067	969	1,052		1,084	1,098	1,056		
16	Coal burnt per hour per sq. ft. of grate.. .. .. lb.	29·7	26·9	29·2		30·1	30·5	29·3		
17	Ash and clinker, total during test .. .. .. lb.	7,071	6,741	7,479		5,096	5,520	5,024		
18	Ash and clinker, percentage of coal .. ..per cent	12·23	12·65	13·16		10·73	11·16	11·81		
19	Combustible burnt, total .. .. lb.	50,721	46,515	49,338		42,356	43,903	42,520		
20	Water evaporated per lb. of coal .. .. lb.	6·802	6·489	6·541	6·611	8·269	8·515	8·694	8·493	28·4
21	Water evaporated per lb. of combustible .. .. lb.	7·750	7·428	7·532	7·570	9·264	9·586	9·721	9·524	25·8
	Equivalent evaporation from and at 212 deg. Fah.									
	Superheat neglected.									
22	Water per lb. of coal .. .. lb.	7·713	7·306	7·404	7·474	9·418	9·758	9·968	9·713	29·9
23	Water per lb. of combustible .. .. lb.	8·788	8·365	8·526	8·550	10·552	10·985	11·140	10·892	27·2
	Superheat included.									
24	Water per lb. of coal .. .. lb.					9·799	10·158	10·406	10·121	35·4
25	Water per lb. of combustible .. .. lb.				8·559	10·978	11·436	11·636	11·350	32·6

At the works of the Thornliebank Co., Glasgow, a Lancashire boiler is fitted with McPhail's apparatus. Its dimensions are 28ft. long and 8ft. diameter; heating surface 955 square feet, grate area 39 square feet. One of their other boilers was tested against that fitted with the superheater, as shown in Table V. The superheat of the steam leaving the stop valve of the boiler fitted with the superheater averaged 56·2 deg. Fah. Since these tests a second boiler has been fitted with the same apparatus, producing steam at 80 lb. per square inch above atmosphere and at 558 deg. Fah., being a superheat of 234 deg. Fah.

Table V.—*Boiler Tests without and with McPhail and Simpson's Superheater at the Thornliebank Co.'s Works, Glasgow.*

Lancashire boilers, Nos. 6 and 7, each 28ft. long and 8ft. diameter; heating surface 955 square feet, grate area 39 square feet. Quality of fuel, Greenfield Virgin coal. No. 7 boiler had superheater attached. No. 7 boiler with superheater did 12·97 per cent. more work, or in other words, the saving effected was 19·08 per cent. Lowry being the regular fireman and acquainted with the boilers, obtained the best results.

	Number of test.. .. .. Date of test, 1895 .. .. Duration of test .. .. Fireman	1 Aug. 28 8 hours Lowry		2 Aug. 29 8 hours Parker		3 Sept. 5 8 hours Hannah		4 Sept. 6 8 hours Lowry		5 Sept. 10 8·66 hours Parker		Average gain due to super-heater.
	No. 6 boiler without and No. 7 boiler with superheater..	Without.	With.	Without.	With.	Without.	With.	Without.	With.	Without.	With.	Per cent.
1	Average boiler pressure per sq. inch above atm., lb	72	72	72·5	72·5	57	57	58	58	63	63	
2	Temperature corresponding with pressure, Fah.	317·8°	317·8°	318°	318°	304·8°	304·8°	305·7°	305·7°	310°	310°	
3	Temperature of steam leaving boiler, Fah..	309·3°	373°	304°	372°	303·8°	363·9°	300·1°	366·5°	300°	372°	
4	Degrees of superheat, Fah.		55·2°		54°		59·1°		60·8°		62°	
5	Average temperature of feed-water, Fah..	161°	156°	161·5°	155°	145·6°	151·0°	148·5°	153°	146°	151°	
6	Water evaporated, total during test, lb.	58,910	69,586	68,978	76,181	55,890	62,040	55,277	65,600	70,684	75,461	
7	Water evaporated, gain due to superheater, per cent.		18·1		10·4		11·0		18·6		6·75	12·97
8	Water evaporated per hour, lb.	7,363	8,698	8,622	9,522	6,986·2	7754·7	6909·6	8200	8,162	8713	
9	Water evaporated per hour per sq. ft. of grate, lb.	188·8	223·0	221·1	244·2	179·1	198·8	177·2	210·3	209·3	223·4	
10	Water evaporated per hour per sq. ft. of heating surface, lb..	7·71	9·10	9·02	9·97	7·31	8·12	7·23	8·58	8·57	9·12	
11	Coal burnt, total during test, lb. ..	9,632	9,632	10,976	11,200	9,086	9171	9408	9408	10,752	10,304	
12	Coal burnt per hour, lb..	1,204	1,204	1,372	1,400	1,135·7	1146·4	1176	1176	1,241	1,189	
13	Coal burnt per hour per sq. ft. of grate, lb...	30·4	30·4	34·3	35·0	28·4	28·6	29·4	29·4	31·0	29·7	
14	Ash and clinker, total, lb.	1,397	1,596	1,364	1,572	1,252	1486	1428	1521	1276	1292	
15	Ash and clinker, percentage of coal, per cent...	14·5	16·5	12·4	14·0	13·7	16·2	15·1	16·1	11·8	12·5	
16	Combustible burnt, total, lb.	8,235	8,036	9,612	9,628	7,834	7685	7980	7887	9476	9012	
17	Water evaporated per lb. of coal, lb...	6·11	7·22	6·28	6·80	6·15	6·76	5·87	6·97	6·57	7·32	
18	Water evaporated per lb. of combustible, lb.	7·15	8·65	7·17	7·91	7·13	8·07	6·92	8·31	7·45	8·37	
	Equivalent evaporation from and at 212 deg. Fah.											
	Superheat neglected.											
19	Water per lb. of coal, lb.	6·63	7·88	6·81	7·42	6·69	7·38	6·42	7·59	7·22	8·00	
20	Water per lb. of combustible, lb. ..	7·76	9·44	7·77	8·64	7·82	8·81	7·57	9·05	8·18	9·15	
21	Gain due to superheater (on combustible) per cent.		21·64		11·2		12·6		19·5		11·8	15·35
	Superheat included.											
22	Water per lb. of coal, lb.	6·63	8·12	6·81	7·70	6·69	7·59	6·42	7·84	7·22	8·24	
23	Water per lb. of combustible, lb. ..	7·76	9·72	7·77	9·00	7·82	9·06	7·57	9·34	8·18	9·42	
24	Gain due to superheater (on com bustible), per cent.		25·25		15·83		15·85		23·88		15·16	19·08

This type of superheater was adopted by the author in 1893 at the Maiden-lane station of the Charing Cross and Strand Electricity Supply Corporation, but had to be considerably modified to suit the Babcock and Wilcox water-tube boiler, as it was found possible to put only one set of superheating tubes in the limited space between the top of the water tubes and the underside of the drum, and only one set of radiating pipes in the drum: so that the arrangement represents only one-half of the complete apparatus as applied to a Lancashire or double-flued boiler. The arrangement is shown in Figs. 7 and 8. The saturated steam is taken from the anti-priming pipe to the upper box of the superheater, whence it passes down through the superheating tubes to the lower box, thence up into the radiating pipes in the drum, and through these to the steam stop valve. The principal dimensions of the Babcock and Wilcox boiler are:—9 × 9 = 81 tubes, 18ft. long and 4in. diameter; total heating surface, about 1827 square feet; drum, 23½ft. long and 4ft. diameter; width of fire grate, 5ft. 6in.; total grate surface, 34·4 square feet. The principal dimensions of the superheater are:—Seventy-five superheating tubes of 1in. diameter, heating surface 355 square feet; twelve radiating pipes of 2in. diameter, heating surface 174 square feet; area through superheating tubes 58·9 square inches, through radiating pipes 37·7 square inches, and through steam stop valve 28·27 square inches.

Complete tests of one boiler were made by Professor Kennedy, before and after the superheating apparatus was fixed; and the principal results are given in Table VI. The dynamos are Edison-Hopkinson continuous current shunt wound, driven by Willans engines.

The great increase in the capacity of the boiler will be noted in line 8; the steaming was much easier and steadier, and at the same time the efficiency of the boiler improved from 68·4 per cent. to 74·9 per cent.—line 29—and this with cold feed. Practically the whole of the superheat was lost in the range of steam pipes between the boiler and engine. The slight difference in water used per kilowatt hour may be accounted for by the engine not being in such good order in the second test as in the first. It had been thoroughly overhauled immediately before the June trial, and had been in daily use from that date until the October trial, so that both valve and piston rings would be somewhat slacker in October than in June. The same cause would affect the coal consumption, which nevertheless shows a saving of 13·5 per cent.

The increased capacity and ease in working of the boiler have been as marked in its subsequent use with the superheating apparatus; in regular work it is evaporating about 50 per cent. more than heretofore. At first the author had some misgivings as to incrustation forming in the superheating tubes from the priming water; but from examining them closely on several occasions after a run of 4000 hours and more, and finding them perfectly clean, he is satisfied on this point. The top box, by its increase in area over the steam pipe, gives a period of comparative rest in the flow of the steam, and acts as an efficient separator for the water or scum carried over. A steam trap fitted to the box discharges any such accumulation regularly, thus preventing its being carried into the superheating tubes. The bottom box is also fitted with a trap to intercept any leakage from the steam stop valve when the boiler is shut in.

The first apparatus proved so satisfactory that a second was applied to the companion boiler in 1894, when the effect of the superheated steam in the pipes began to be marked by a decrease in the discharge from the drains and in the leakage from joints.

TABLE VI.—*Boiler Tests without and with McPhail and Simpson's Superheater.*

		Without.	With.
1	Date of trial, 1893	June 20	Oct. 17
2	Duration of trial, hours and minutes	8—15	8—31
3	Indicated horse-power of engines working at full load, I.H.P.	135	135 + 80
4	Full output of dynamos, ampères × volts	750a × 105v	750a × 105v 450a × 105v
5	Coal burnt, total, lb.	3,229	4,528
6	Coal burnt per hour, lb.	389	532
7	Water pumped into boiler, total, lb.	28,000	43,655
8	Water pumped into boiler per hour, lb.	3,457	5,125
9	Mean electrical horse-power, E.H.P.	82·15	129·2
10	Total kilowatt hours (units)	686·4	824·2
11	Mean kilowatts	61·3	97·0
12	Boiler pressure above atm. per sq. in., lb.	131·3	140·3
13	Mean temperature of steam on leaving boiler, Fah.	355°	377·1°
14	Mean temperature of saturation at boiler pressure, Fah.	355°	361·0°
15	Mean temperature of steam in engine-room steam pipes, Fah.	—	365·1°
16	Mean temperature of saturation at probable pressure in engine-room steam pipes, Fah.	—	358·3°
17	Mean temperature of feed-water, Fah.	80·4°	79·76°
18	Calorific value of 1 lb. of coal, Th. U.	14,840	14,790
19	Equivalent evaporation per lb. of coal, lb.	15·36	15·31
20	Carbon value of coal per lb., lb.	1·023	1·020
21	Actual water evaporated per lb. of coal, lb.	8·89	9·65
22	Evaporation per lb. of coal from and at 212 deg., lb.	10·50	11·47
23	Evaporation per lb. of carbon value, lb.	10·30	11·22
24	Coal burnt per hour per sq. ft. of grate, lb.	11·3	15·5
25	Coal burnt per hour per E.H.P., lb.	4·74	4·12
26	Water per hour per E.H.P., lb.	42·1	39·7
27	Coal per kilowatt hour, lb.	6·35	5·5
28	Water per kilowatt hour, lb.	56·4	52·8
29	Efficiency of boiler, 100 × line 22 ÷ line 19, per cent.	68·4	74·9
30	Temperature of gases leaving boiler, Fah.	309°	376°
31	Mean chimney draught, inch of water, inch	0·3	0·4

There are altogether seven boilers, of which five or six are in general use on a common steam main. The figures in Table VII. show this effect clearly.

TABLE VII.—*Steam Tests without and with McPhail and Simpson's Superheaters.*

Without and with superheaters.	Without.		With.		
Boiler pressure, absolute, lb. per sq. in.	166	168	157	162	162
Corresponding temperature of saturated steam, Fah.	366·5	367·0	362·0	364·5	364·5
Temperature in main steam pipe in engine-room, Fah.	359	361	371	375	373
Fall or rise in temperature of steam, deg. Fah.	−7·5	−6·0	+9·0	+10·5	+8·5

TABLE IX.—*Boiler Tests without and with Schwoerer's Superheaters.*

Tests made by	Mr. Walther Meunier.								Professor Unwin.			
No. of test	1	2	3	4	5	6	7	8	9	10	11	12
Without or with superheaters	Without	With	Without	With	Without	With	Without	With	Without	With	With	With
Number of boilers in use	3	2	4	3	4	3	1	1	4	3	3	3
Duration of trial, hours and minutes	11—10	11—0	10—24	10—19	11—30	11—30	11—30	11—30	6—0	5—0	6—0	5—0
Mean indicated horse-power	278	276	554	564	310	309	116	119	475	491	501·4	502·3
Steam per I.H.P. per hour, lb.	19·8	17·1	21·87	17·44	19·00	15·70	21·6	19·2	19·75	15·63	17·06	15·61
Coal per I.H.P. per hour, lb.	3·16	2·37	3·78	3·01	2·98	2·38	3·45	2·64	3·15	2·59	2·56	2·51
Boiler pressure above atm. per square inch, lb.	—	—	86·7	86·7	68	65	—	—	95·72	99·05	93·74	94·00
Deg. of superheat at valve chest	—	115°	—	102	—	118°	—	—	—	118·3	119·2	126·9
Economy in coal, per cent.	—	25	—	20	—	20·7	—	23·5	—	17·6	18·5	20·1
Economy in steam, per cent.	—	14	—	20	—	17·4	—	11·0	—	20·9	13·6	20·9

Induced draught.—The duty of the boilers having been increased to the above extent, and the priming difficulty being quite overcome, the only limit to the evaporation was the chimney draught. As the two boilers were fitted with an independent flue and chimney, they lent themselves readily to an experiment in this direction. Having considered several schemes of forced and induced draught as an auxiliary, the author finally decided on putting a fan in the flue at the back of the boilers. As there was no space available for any form of economiser between the boilers and the fan, no attempt could be made to diminish the loss from heat in the waste gases. The gain sought for was in the direction of increasing the capacity of the existing boilers, so as to render steaming independent of the natural effects of foggy or heavy weather, and by working the boilers at a higher rate to diminish the proportion of radiation losses, which are practically constant at all loads.

The fan selected is a 72in. single inlet, made by Messrs. G. E. Belliss and Co., and driven direct by one of their tandem compound self-lubricating engines, having cylinders 3½in. and 6in. diameter and 4½in. stroke, working at 150 lb. boiler pressure, and running at 300 revolutions per minute. The engine and fan were put in somewhat large for the estimated work, in order to secure slow speed and quiet running, with the result that within a few feet of the fan it is impossible to tell by the sound whether it is running or not; this is a marked improvement on many fan engines. A draught in the flue at the fan inlet equal to a 2in. water gauge has been easily maintained. The usual method of working is to work the boilers on natural draught at times of light load, and then, as the load increases, to start the fan, close the by-pass in the flue, and work steadily at 1in. water gauge. With this draught the superheater tubes are continually bathed in incandescent gases, but not the slightest trouble has been experienced with them. In order to test the thorough reliability of the tubes, and in view of the fact that trouble was most likely to arise, if at all, when getting up steam, one of the boilers was shut in, and the steam let down day after day for some weeks, and then raised again with the induced draught, and there was an entire absence of any signs of irregularity or trouble.

When the boiler is steaming freely, an iron bar inserted through the brickwork to a point near the ends of the tubes soon becomes red hot, and the temperature, as taken by a platinum coil pyrometer at this point, is about 900 deg. Fah. At this temperature it appears to be of little importance whether the cooling agent is water or steam, so long as the circulation is kept up. This circumstance is most interesting, in view of Mr. Durston's Devonport experiments, reported in his presidential address to the Institute of Marine Engineers,[†] as to the permissible limit of temperature in a tube or tube-plate, which he places at about 750 deg. Fah., and in view also of the grave doubts that are frequently expressed as to the safety of steel tubes exposed to furnace temperatures without a perfect circulation of water on the other side of the metal. What temperature the tubes actually reach the author is unable to state, but the steam coming out of them is over 600 deg. Fah. The tube-plates would be lower in temperature than the outer ends of the tubes, because the gases are drawn downwards and away from the plates by the draught. No trace of leakage at any one of the tube ends has yet appeared.

A further test of the boiler with the induced draught was made on January 2nd, 1896. It was not possible to shut off part of the steam ring main, and to use the steam on certain steam dynamos only, measuring the electrical output from them, as had been done in the two former tests; an evaporative test only was, therefore, arranged for. The stop valve temperature was measured about 5ft. from the stop valve at the boiler, on a branch pipe about 10ft. long, connecting the boiler with the main ring. A mercury thermometer in a mercury cup let into the steam pipe was used in this position. Being anxious to get the temperature of the steam between the superheater and the radiating pipes in the drum, the author had tried mercury thermometers, which failed. The difficulties due to the high pressure and temperature were successfully overcome, however, by Mr. F. W. Burstall, to whose ingenuity and kindness in co-operation the author is indebted in this matter. With a temperature of 1058 deg. around the superheating tubes, steam entering at 362 deg. left them at 650 deg., and after passing through the radiating pipes in the drum, left the boiler at 403 deg. Fah. The principal results are given in Table VIII., the boiler being fired with Welsh steam coal. It will be noted that the application of the superheater, together with a stronger draught, has increased the capacity of the boiler by 140 per cent., or raised the evaporation from 3457 lb. per hour—Table VI.—to 8293 lb. without increasing the space occupied, which is a most important gain, and a saving both in capital and in rent. In comparing the temperature here given of the gases leaving the boiler with those given in Table VI., it should be noted that in Table VIII. the temperatures were taken between the back tubes and the wall in which is situated the damper communicating with the flue. In Table VI. the temperatures were taken in the flue, where the gases are cooled by the influx of cold air through the damper slots, and by any leakage through the other boiler, which was shut off at the time.

TABLE VIII.—*Test of Babcock and Wilcox Boiler fitted with McPhail and Simpson's Superheater.*

Date of trial, 1896	January 2nd
Duration of trial, hours	8
Coal burnt, total, lb.	8050
" per hour, lb.	1006·25
Ash and clinker, dry, lb.	476
Water evaporated, total, lb.	66,350
" per hour, lb.	8293·75
Boiler pressure above atm. per square inch, lb.	148·3
Temperature corresponding with pressure, deg. Fah.	365
Mean temperature of steam at stop valve, deg. Fah.	396·6
Degrees of superheat, deg. Fah.	31·6
Mean temperature of feed-water, deg. Fah.	48
Actual water evaporated per lb. of coal, lb.	8·24
" " " combustible, lb.	8·76
Water evaporated per lb. of coal from and at 212 deg. Fah., lb.	10·16
Water evaporated per lb. of combustible from and at 212 deg. Fah., lb.	10·80
Coal burnt per sq. ft. of grate per hour, lb.	20·3
Water evaporated per sq. ft. of heating surface per hour, lb.	4·37
Temperature of gases leaving boiler, deg. Fah.	655
Mean chimney draught, inches of water, inch	1·11

Schwoerer's superheater.—The superheater illustrated in Figs. 9 to 11 is the invention of Mr. Emile Schwoerer, of Colmar, Alsace, who was for some time private secretary to the late Mr. G. A. Hirn. It was Mr. Hirn who first took up superheating seriously; and it is due to his energy that so much has been done with it in practical working in Alsace. Mr. Schwoerer's improvements were in the direction of reducing the space occupied by the apparatus; and he attained this end by employing a coil of pipes with gills on them both inside and outside, thus getting large surfaces in a small bulk. Regulation of the superheat by deflecting the hot gases away from the tubes, rather than by varying the proportion of the total steam passing through the tubes, is due to Mr. Schwoerer, though this regulation does not appear to have been generally carried out. By the courtesy of Professor W. Cawthorne Unwin, the author is enabled to give the tests in Table IX. of Schwoerer superheaters in Alsace, some of which were carried out by himself and others by Mr. Walther Meunier, engineer-in-chief of the Alsatian Association of Steam Users. It will be noted that in tests 1, 3, 5, 9, one more boiler was required to do the work when saturated steam was being used at the engine. The boilers were of the elephant kind, with Green's economisers.

An application of the Schwoerer superheater has been made by Messrs. James Simpson and Co. to a Babcock and Wilcox water-tube boiler at the Grand Junction Waterworks, Kew. The arrangement is shown in Figs. 9 to 11. The boiler is of the same size as those fitted by the author with McPhail's apparatus at Maiden-lane. Full details of the trials unfortunately cannot be obtained, but the saving effected is satisfactory. Tests were conducted by Mr. Osbert Chadwick before and after the superheater was fixed, with the following results, Table X.:—

TABLE X.—*Boiler Tests without and with Schwoerer's Superheater.*

Date	Jan. 21, 1893	Dec. 20, 1893	Feb. 22, 1894	Mar. 13, 1894
Degrees of superheat, deg. Fah.	0	57·7	100·5	57·0
Steam per pump H.P. per hr., lb.	20·98	19·71	18·75	19·48
Saving effected, per cent.	—	6·05	10·63	6·75

A test was also conducted by Mr. Goodman, the superintending engineer at the pumping station, under ordinary working conditions from December 8th, 1894, to January 5th, 1895, the engine and boiler being kept continually at work. The fuel used was 86·98 per cent. anthracite peas and 13·02 per cent. breeze, the draught being assisted by a Meldrum blower. The results then obtained were:—

Duration of trial	723½ hours
Feed-water per hour	3223 lb.
Fuel per hour	471 lb.
Steam per pump horse-power per hour	17·74 lb.
Fuel " " "	2·58 lb.
Mean superheat	121 deg. Fah.

These results showed a saving of about 15 per cent. on what had been obtained before the Schwoerer superheater was fixed. This type of superheater is also made by Messrs. Fraser and Chalmers, Erith, who have one in constant use at their works.

Sinclair's superheater.—Another form of superheater is shown in Fig. 12, which is due to Mr. George Sinclair, of Leith. There is here a departure from the usual method of securing the tubes, which in this apparatus are flanged and bolted to the cross inlet and outlet pipes, instead of being expanded into them. In such positions an expanded joint is generally considered desirable, but here the joints are removed from the action of the hot gases, and a bolted joint gives much greater facilities for removing a tube in order to examine or clean it. In Fig. 12 the apparatus is shown in conjunction with a marine dry-back boiler, as fitted by Professor Kennedy at the Edinburgh electric lighting station. The arrangement is very compact, and should prove highly economical. The hot gases from the smoke-box at the front are led to the back over the top of the boiler, passing among the superheating tubes, thence down the sides of the boiler to the centre flue underneath it. The apparatus was described in Mr. Burstall's paper read at the last meeting—October, 1895—and in the discussion Professor Kennedy stated that further tests were then in hand; the author would be very glad if the present should be considered a convenient opportunity for publishing the results of them.

It is much to be regretted that so little has been done as yet with superheated steam at the engine. In nearly every instance the superheat appears to be gone, if not at the steam chest, at any rate immediately on admission to the cylinder. But even under these circumstances the advantage of superheating is manifest from many of the tests given above; and it must be recognised that, although the steam may be cooled down again to the temperature corresponding with the pressure, it is still dry steam, and is a better working gas than the saturated solution of water-dust supplied by an ordinary boiler. The desirable amount of superheat has been generally considered to be the equivalent of the heat lost by initial condensation; but this does not obtain in practice. The amount of heat lost in initial condensation is generally from 20 to 25 per cent. of the total heat of the steam above boiling point. Tests with superheated steam show a saving of 20 per cent., with only 5 per cent. extra heat in the steam. This point has been brought out clearly by Mr. W. H. Booth, in his paper on cylinder condensation, read to the Manchester Association of Engineers a few months ago, wherein it was shown that the amount of superheat is but little in excess of that necessary to supply the heat required for making good the latent heat which disappears as work during expansion.

When preparing to respond to the request that he would contribute a paper giving his own experience with superheating, the author found that, although a great deal had been done, but little information on this subject was to be met with in the Institution "Proceedings." He has, therefore, endeavoured to the best of his ability, during a particularly busy winter, to fill up the blank by collecting and recording all the data that he is himself possessed of. It is not imagined that the superheaters here described make up a complete list; and it is hoped that any which have not been included in the paper will be dealt with to better advantage by speakers in the discussion. The theory and advantages of superheating at the engine have not been touched upon, not only for want of space, but also in the hope that some member of the Institution who has given the subject much attention may be tempted to contribute a comprehensive paper thereon. In conclusion, the author desires to thank the several gentlemen and firms who have kindly given him information and plans.

CLEVELAND INSTITUTION OF ENGINEERS.

BRITISH TYPES OF LAND BOILERS.

AT the meeting of the Cleveland Institution of Engineers at Middlesbrough on Monday evening, Mr. J. E. Stead, President, in the chair, Mr. Edward G. Hiller, of the National Boiler and General Insurance Company, read a paper, of which the following is an abstract, on "British Types of Land Boilers." Mr. Hiller commenced by giving a brief sketch of the history of boilers from the time of Savery, about the latter end of the seventeenth century. He remarked that among engineers experience must always be the ultimate court of appeal, and on a large scale there is no doubt that experiment is practically what determines the success or failure of any appliance. Some appliances, however, such as engines and boilers, are in themselves costly and difficult to move or change, and hence, so far as individuals are concerned, the question of experimenting as to the relative advantages of any different kinds is one that can only be entertained by very few. To ascertain what is the particular apparatus which is best suited for any particular object is never a very simple matter, and now that engineering appliances are being used, improved, and developed into various differing forms in different parts of the world, although the amount of experimental information absolutely is increased, there is great difficulty in ascertaining the results of these experiments, and it is not always easy to determine what is really the best form of machine for the particular object and conditions which have to be dealt with. In the early part of this century England was almost alone in developing steam engineering, but now steam is largely used as a prime source of motive power by all civilised nations, and many most important improvements have in recent years emanated from foreign countries. At present, in this country, the new boilers which are being put down are comprised under a comparatively few heads. Mr. Hiller then gave details as to the advantages and disadvantages of the different types of those in use not only in Great Britain but also on the Continent.

In sketching the history of the steam boiler, the author said that Savery's engine was improved by Desagulier in 1718, who used a spherical copper boiler provided with a safety valve, the steam acting somewhat as in the pulsometer to pump water to a height. Newcomen, in the early years of the 18th century, was the next inventor who appears to have made any considerable improvement in the steam engine and boiler. His so-called fire-engine, or atmospheric engine, appears to have been introduced about 1710, and it was improved by Beighton in 1718, and Smeaton in 1772. The working pressure of the engine was generally at atmospheric pressure, or, at most, 1 lb. or 2 lb. above it. In the best boilers, Newcomen used lead for the dome portion of it, and copper for the lower parts exposed to the fire; afterwards iron plates were used. In Smeaton's boiler, designed by him for the engine of the Carron Iron Company in 1773, the boiler was of cast iron, 10ft. diameter and 16½ft. high; it weighed 15½ tons. The furnace gases proceeded from the grate round the bottom flue, and then round the upper flue to the chimney, and the boiler is said to have answered well. In Smeaton's portable engine the boiler was of the vertical type, provided with an internal furnace or flue. The internal flue was of cast iron, and the outer shell of wrought iron plates. This boiler in its general form bears indirect resemblance to many boilers which are at present in use. In 1773 a stone boiler was constructed in Cornwall, which it was designed to heat by means of the waste gases from some copper smelting furnaces. This stone vessel was about 20ft. long, 9ft. wide, and 8½ft. deep. Through it passed three copper tubes, each 22in. diameter, extending the full length of the boiler, and the heat was supplied to the boiler by the gases passing through these tubes. It is stated that the boiler failed in work, possibly owing to the loss of heat through the stonework. Another boiler, somewhat similar in form, was then constructed of iron, 22ft. long, 8½ft. wide, and 10¾ft. deep, provided with four internal tubes 22in. diameter. This is said to be the first record of a horizontal internally-fired boiler. About the latter part of the century, James Watt, in connection with his improved steam engine, greatly modified the form of the boiler. Almost all previous forms were of the vertical type. Watt, however, with an idea of obtaining increased heating surface, introduced the wagon boiler, which was fired under the bottom, and the furnace gases circulated round the side flues to the chimney. He afterwards modified it by introducing a central flue to obtain increased heating surface, and curving the sides and the bottom, the working pressure being increased to 7 lb. to 10 lb. per square inch, cross stays and longitudinal stays being used to strengthen the naturally weak form of the boiler. In the earlier forms of Watt's boilers the safety valve load was about 2½ lb. per square inch.

Although Watt's improvements of the steam boiler were considerable, they were less important than were the radical changes which he introduced into the steam engine itself, and it is necessary to look in other directions to find the great changes that have been made. It is not easy to determine who was the first to use the cylindrical horizontal boiler, probably it was Trevethick in this country and Evans in Pennsylvania, both about 1804. These boilers the author described, and he mentioned that one put down by Trevethick in 1801 at Tredegar Puddling Mill was in use till 1856. Trevethick introduced what is now known as the "Cornish" boiler into Cornwall. In 1811 he laid down some cylindrical hemispherical-ended externally-fired boilers at the Wheel Prosper Mine, and probably these were the earliest of that type. They were of wrought iron, and used steam at 100 lb. per square inch. In the same year he put down Cornish boilers at Dalcoath, which were in use till 1869. All the evidence is in favour of the assumption that both the cylindrical externally-fired and the Cornish internally-fired boilers began to be used about the same time. In this country the internally-fired boiler has since developed, until now it has almost become altogether predominant; while, on the other hand, in certain foreign countries the development has been in the main on the side of the externally-fired boiler.

[†] *Engineering*, October 4th, 1895, page 437.

The next most important improvement in stationary boilers was the introduction about 1844 of the "Lancashire" or two-flued internally-fired boilers. This step has been generally associated with the names of Fairbairn and Hetherington, of Manchester. The principle of this boiler is practically the same as that of the Cornish boiler, and the adoption of the two flues in the first instance was recommended by Fairbairn with the object of alternate firing, and thus producing good combustion of the fuel. This boiler has since that time been looked upon in this country as the best type for the production of industrial power, and has received the greatest attention as regards its improvement in construction.

Mr. Hiller then referred to the improvements introduced by the late Daniel Adamson, such as the use of steel plates, the drilling of the rivet holes, and the adoption of flanged seams for the flue tubes.

No census of the United Kingdom has ever been taken or exists as regards steam boilers, and therefore no accurate knowledge of the total number of boilers in use in this country is obtainable. Estimates varying from 150,000 to 200,000 have been made. He thought that, apart from boilers belonging to the railway companies, the total number of land boilers is about 150,000. Of each 100 in use, excluding the railway companies from consideration, the types are approximately as under:—

	Per cent.
Lancashire	38·0
Cornish	23·7
Small vertical, such as crane and similar boilers	16·6
Locomotive type, portable and similar boilers	11·0
Plain cylindrical externally-fired boilers	6·8
Water-tube boilers	1·8
Rastrick and similar vertical ironworks boilers	1·1
Other types	1·0

These figures are based upon the operations of one of the leading insurance companies. Among Lancashire boilers are also included Galloway, "Breeches-flued," and other modifications of the two furnace internally-fired boilers.

In dealing with the question of the safety of the various types, the author showed tables which indicated that the vertical fire-box was the least safe, having a rate of explosion of 48 per annum per 100,000 used. This is followed by the plain cylindrical externally-fired boilers with 37·2; then come the boilers of the locomotive or portable type with 32·5; next the water-tube with 26·6; then the Rastrick with 11·8; and the Lancashire, the safest, has only 5·75. The fact that the plain cylindrical externally-fired boilers stand second on the list as the least safe type of the larger boilers, and the Lancashire at the bottom as the safest, has an important bearing on the condition of affairs at the present time, and confirms the general judgment of steam users, who are gradually replacing cylindrical externally-fired boilers and similar types by good modern boilers of the Lancashire construction.

As regards economy, the author said the Lancashire boiler was generally 30ft. long by 8ft. diameter, and with a fire-grate 6ft. long. This gives a ratio of heating surface of 25·4 square feet to 1 square foot of grate surface. If this boiler were worked by itself at what is an ordinary rate of combustion in Lancashire, viz., about 20 lb. of coal per square foot of grate surface per hour, the proportion of heating surface would be deficient for the best economical results. Such boilers, therefore, when fully worked, are usually used in connection with a fuel economiser, which supplies the necessary heating surface in an advantageous manner. This boiler and economiser compare well with any other type in respect to economy. The steam surface per square foot of grate surface also is greater than in the cases of the portable, locomotive, vertical cross tube, and water-tube boilers, which would lead to the supposition that drier steam would be more likely to be produced in the case of the Lancashire. The steam space per cubic foot per square foot of fire-grate is 7·4, and the total water contained in the economiser and boiler at working level is 1238 lb. per square foot of grate surface, the boiler alone having 1084 lb.

The Cornish boiler is similar to the Lancashire, but the heating surface per square foot of grate surface is a little greater. The water contained per square foot of grate surface is 1359 lb. The proportion of heating surface is sufficient to give good economical results, and the best economy has frequently been obtained in Cornish boilers without any economiser being added to them. The explosion rate is comparatively high. Many of the explosions have arisen owing to weakness of construction of the flue tubes. It is the very old boilers that have been kept in use that have exploded. There is no reason to suppose that Cornish boilers, constructed according to the best modern Lancashire practice, would give rise to any more explosions than Lancashire boilers do.

The cylindrical externally-fired boiler has a low ratio of heating surface to grate surface, and generally speaking the ordinary sizes of boilers of this class in use may be taken to be comparatively wasteful. In other respects, however, the type of boiler which is the simplest form of steam boiler appears to be suitable for steam users' requirements, and until recent years it has been very generally used, especially in collieries and ironworks. It is a much less safe type of boiler than the Lancashire, though this arises partly from the conditions under which it is worked. The nature of the work in most ironworks and collieries is by no means so favourable to the boiler as is that in ordinary mills. Most of the boilers of this type also are of considerable age, and their construction never did receive the same attention as has been devoted to that of the Lancashire boiler. Cylindrical externally-fired boilers are liable to the following among other risks, which would not usually cause explosion in a Lancashire boiler:—Deficiency of water, deposit, ring seam rips. The last named are very liable to cause serious explosion in cylindrical boilers, whilst in Lancashire boilers they usually happen without causing any serious disaster. The same may be said with respect to deposit and deficiency of water.

The portable locomotive boiler has a fair proportion of heating surface, but the steam space and the weight of water per square foot of grate surface are low. The boiler is difficult to clean and examine, and easily damaged.

The vertical boiler with fire-box and cross tubes has one advantage—convenience—and every other disadvantage, and the high explosion rate arises largely owing to the condition under which the boiler is worked.

Water-tube boilers do not constitute any large proportion of the steam producing plant either of this country or the Continent, and it does not seem so suitable for ordinary commercial operations as the Lancashire boiler.

In France the externally-fired boiler known as the elephant is the predominant type, and the author could not see any reason why it should be safer than in England. In Germany there would appear to be a greater proportion of boilers of the externally-fired types, and also of the water-tube variety. Much greater attention is being given to water-tube boilers on the Continent than in this country.

Mr. Hiller gave the following table showing the proportions of the different types of boilers in use in different countries on the Continent:—

Country	United Kingdom.	France.	Germany.	Switzerland.	Austria.
Years referred to	1895.	1893-4.	1893-4.	1893-4.	1893-4.
Lancashire and similar types	38·0	4·7	35·7	19·6	29·7
Cornish ditto	23·7	8·2	15·3	40·8	
Cylindrical externally-fired	6·8	57·3	14·8	15·5	41·0
Externally-fired multi-tubular and similar	—	13·4	5·2	3·5	7·5
Locomotive	11·0	5·1	17·3	5·7	10·5
Small vertical	16·6	3·6	5·0	13·5	6·1
Water-tube	1·8	5·7	4·6	1·4	3·8
Other types	2·1	2·0	2·1	—	1·4

In the case of France the figures relate to about 12,000 boilers; in Austria, to 12,000; in Switzerland, to 3000; in Germany, to between 10,000 and 11,000; and in the United Kingdom, to 16,000.

Mr. Hiller said he was unable to give figures relating to types of boilers in the United States, but that most generally used was the cylindrical multitubular externally-fired boiler, consisting of a cylindrical shell, 10ft. to 12ft. long, 4ft. to 6ft. diameter, with flat ends, and with a number of smoke tubes in the lower half of it from end to end, the boiler being fired under the bottom, and the gases returning to the front end through the smoke tubes. The boiler is cheap, easy and simple to construct, and gives fair economy, having a large proportion of heating surface to grate surface.

In concluding, Mr. Hiller remarked that while it would appear that the Lancashire boiler is the best suited for the ordinary industrial steam producing operations of this country, he does not think that the time which has elapsed since the use of steam power in manufactories became general has been sufficient to enable us to arrive at any final judgment in the matter, nor does he think that any such specific judgment would be justified, taking into account the great differences which at present exist in the practice of the different countries.

The President, in inviting discussion, said they might congratulate themselves on having heard such an excellent paper, written by one who had a large experience with boilers, and had the best opportunities of judging their efficiency and safety. He—the President—then read a letter from Mr. Jeremiah Head, who was unable to be present, but who desired to make a communication relative to the efficiency and durability of plain cylindrical boilers. He had read a paper on that subject at the Merthyr Tydvil meeting of the Iron and Steel Institute in September, 1870, and two years later he read another before the same institute, which had special reference to the safety of these boilers. The disastrous explosion at the Redcar Ironworks in June last had naturally revived the interest which a quarter of a century ago was felt by all engineers in the North of England on the same subject. His experience was then that a given evaporation could be obtained from plain cylindrical boilers for a very much less first cost than from any other ordinary type, but that somewhat more coal was consumed. The great disadvantage was that they were liable to seam rips if suspended rigidly from saddles, as was usual at that time. From experiments which he made, he reasoned that not only is the long boiler continually changing its form, temporarily, according to the varying degree of heat applied below, but it permanently, though slowly, changes its shape by reason of the contraction of the plates which are exposed to heat, and then cooled in contact with water each time the boiler is laid off for cleaning. At most works employing these boilers the men in charge used to be in the habit of adjusting the saddle nuts to suit their own ideas. Generally they tightened them up so as to bear as equally as possible when the boiler was at work, and allowed it to take its chance when off work, whether full or not. The most dangerous time was when the boiler having been freshly filled with water, and bearing on the end saddles only, was connected with the others in the range by opening the stop valve. He had proposed a remedy, which was to suspend these boilers in such a way that whatever form they assume every suspension bolt and every saddle should always take its share of the load. To prevent changes in form under changes of temperatures, more or less locally applied, is simply impossible. The only thing is to make such arrangements that those changes of form shall not produce severe and dangerous stresses. He introduced volute springs between the saddles and the nuts upon the suspension bolts. The steam and feed connections should be made with circuitous bends in them, so as to yield sufficiently without fracture when the boiler alters its form. Some plain cylindrical boilers at the Newport Rolling Mills were altered in the way indicated, and though previous to the alteration seam rips had been frequent, afterwards there was not a single case up to the time the works were sold some eighteen years subsequently. This simple expedient certainly added very much to the safety of the plain cylindrical boiler, and if more extensively adopted, might have prevented some of the troubles which have occurred in the North of England in this class of boiler.

Mr. Charles Wood, of the Tees Ironworks, Middlesbrough, said as one of the oldest engineers in the district he had had experience of plain cylindrical boilers externally fired—which Mr. Hiller condemns—and other classes of boilers. He quite agreed with what the author said about the late Mr. Daniel Adamson, and the great improvements he had inaugurated in boilermaking. Mr. D. Adamson was born and bred in that district, and it was due to him to say that he put the whole business of boiler construction on a more scientific footing. His experiments in iron and steel plates, and on drilling as opposed to punching holes, had proved of enormous benefit to all persons who had boilers. From the way in which Mr. Hiller praised the Lancashire boilers, it might almost be thought that he held a brief for them. There was no doubt that he considered them the best, but he unstintedly condemned the externally-fired cylindrical boilers without in any way recognising any of their advantages. He—the speaker—had had considerable experience with boilers on the Continent, and especially with the Elephant boilers in France. They were excellent boilers, and were considered an exceedingly safe type. They were externally fired. In Germany, as in France, the externally-fired boiler was largely adopted; such boilers were the standard type, and were liked better than any other boiler. Having confidence in the type, he had designed one many years ago for blast furnaces, and found it work very well. He had been working with the plain cylindrical boiler, and the frequency of seam rip frightened him, and led to his introducing a modified form of the French boiler. They had been in use twenty-five or twenty-six years, and had given every satisfaction, and all he had to renew was a few plates. Blast furnace boilers, compared with Lancashire boilers, really did two or three times the amount of work. They were kept in operation constantly day and night, for six or seven weeks, whereas the Lancashire boiler was only worked generally eight or nine hours a day. He thought that when a comparison was made, the work that the boilers did, as well as the number, should be taken into consideration; and, further, he held that the externally-fired boilers, if properly attended to, were just as good as the internally fired.

Mr. William Hawdon, of the Newport Ironworks, remarked that he took it that Mr. Hiller advocated the use of the Lancashire boiler because of the safety which was to some extent ensured by the internal tubes tying the ends of the boilers. Another reason why the externally-fired boilers were not so safe as the internally fired, was because of the difference in the expansion of the various parts of the boiler. The bottom part did not expand more than the top. With regard to there being more explosions with Cornish than with Lancashire boilers, that could no doubt be partly explained by the fact that the latter had been more recently introduced, and were better made. Many of the Cornish boilers were very old, and thus were more liable to give way. He did not see why the Cornish boiler, constructed of material at present used, should be any less safe than the Lancashire. They had, since 1870, a large number of Cornish boilers at the Newport Ironworks, and it was not till last year that they had any important repairs to undertake in them.

Mr. Charles J. Bagley, Moor Iron and Steel Works, Stockton, said he had just recently had to decide upon the best boiler to put down under peculiar conditions. It was not likely to get much attention, would have to work continuously night and day, and the men had to work over it, while it had to be heated by the waste gases from the steel furnaces. The question of safety was paramount, and they adopted the Cornish. It had the largest feed of water, and if seam rips occurred they would not be of great consequence, as the boiler would be well stayed by the tubes. It had worked so far very satisfactorily, so satisfactorily that they were going to put another down. After what he had heard that night it was probable that they would try the Lancashire boiler also. The plain cylindrical boiler was certainly not sufficiently safe.

After a few remarks from Mr. W. P. Ingham, Middlesbrough, Mr. Alex. S. Keith, of the Skinningrove Ironworks, stated that he quite agreed with Mr. Hiller, that if any one had to put down new boilers they would not now adopt the long externally-fired cylindrical boiler. Seam rips were partly due to inefficient setting of the brickwork. One disadvantage of the Cornish boiler was that it was bad to clean.

Mr. Frank H. Marshall, Middlesbrough, held that age had a good deal to do with the bursting of boilers, and that was not touched upon in the paper. The superiority of the Lancashire boiler was due in a great measure, in his opinion, to the greater care employed in the construction, it being a more modern type than the others, and infinitely more trustworthy work was now put into boilers than used to be the case; besides, it was better looked after and nursed.

Mr. R. J. Worth, Stockton, held that the relative safety of boilers was greatly affected by the usage each type got, and that to a much greater extent than Mr. Hiller admitted. His statistics gave a poor place as to safety to the locomotive boiler, but it should be borne in mind that probably the greatest part of them belonged to the ordinary portable engine, and it never appeared to enter into the head of the user that the boiler can ever wear out. He gave some instances to illustrate this. As to the plain boiler, he agreed that it was a poor type, and when of extraordinary length was very treacherous, but when of ordinary proportions and well set, was not nearly so bad as painted. It had largely got its bad name through the continued use of worn-out boilers, and by the number of small ones that were, so to speak, home made, set so that they could not be examined, wretchedly supplied with fittings, and worked by men indifferent to danger or ignorant of it. He referred to the Babcock and Wilcox boiler, which was largely used in America, where its principal rival was the plain cylindrical multitubular, which had most faults that a boiler could have, and not many advantages. The Babcock, though much pushed here, had made little headway, as it had to compete with the Lancashire, which had every good property which could fairly be combined in one boiler, and only two disadvantages—great space occupied, and necessity for a large and costly chimney. Where great power was required, and space could be found, the Lancashire boiler was the best; but where space was a great object almost equal results could be got from the Babcock or from the locomotive type if good water could be procured.

After a few remarks by Mr. Henry Crowe, Mr. Hiller briefly replied. He said he held no brief for the Lancashire boiler. It was immaterial to him what boiler was adopted.

A vote of thanks was accorded to Mr. Hiller, and the President announced that the next meeting would be held at Stockton, when Mr. A. S. Keith would read a paper on the "Utilisation of Blast Furnace Gases."

LAUNCHES AND TRIAL TRIPS.

The turret deck steamer Selina was launched from the yard of Messrs William Doxford and Sons, Sunderland, on the 15th inst., having been built to the order of Messrs. George Horsley and Son, Hartlepool. She will receive the highest class in both the Bureau Veritas and British Corporation registries. Her deadweight capacity is somewhat over 5600 tons. She has exceptionally large measurement capacity, and is built on the single-deck principle.

On the 14th inst. Messrs. C. S. Swan and Hunter launched a fine steel screw steamer, 380ft. long by 48ft. 6in. extreme by 30ft. 4in. moulded depth, built on the spar deck grade to Lloyd's highest class; long bridge-house amidships, topgallant forecastle, cellular double bottom throughout. The vessel will be fitted with all the most modern appliances for the rapid loading and discharging of cargo, including iron crane posts, and a large number of steam winches. The fore and after cargo holds will also be insulated for carrying frozen dead meat. As the vessel left the ways she was named the Leitrim by Mrs. R. M. Hudson, jun., Sunderland.

Messrs. Lobnitz and Co., Renfrew, launched on Tuesday, the 18th inst., a twin-screw ocean telegraph steamer for the Japanese Government. The vessel is fitted with all the latest appliances for laying and repairing telegraph cables. She has twin-screw triple-expansion engines made by the builders. The vessel has been built to the order of his Excellency T. Kato, Imperial Japanese Minister, through Mr. A. R. Brown, Japanese Consul, Glasgow, to Lloyd's survey and Board of Trade passenger requirements, and under the superintendence of Mr. George McFarlane, engineer, Glasgow, and Captain Periam. On leaving the ways she was named Okinawa Maru, by Mrs. James Dixon, Bothwell.

On Tuesday, February 18th, 1896, there was launched from the Cleveland dockyard of Sir Raylton Dixon and Co., Middlesbrough, a fine steel screw steamer which has been built to the order of the Hansa Steamship Company of Bremen, under the supervision of Mr. D. Wulff, their superintendent engineer. Her principal dimensions are:—Length, 323ft.; beam, extreme, 42ft. 6in.; depth, moulded, 25ft.; with a deadweight capacity of about 3600 tons. She is of the spar deck type, and has been built under special survey for Lloyd's highest class. The poop, bridge, and forecastle decks are of teak. The captain, officers, and engineers are accommodated in houses on bridge deck, and the crew in topgallant forecastle. Quadruple-expansion engines, built to German law requirements, will be supplied by Messrs. Wigham, Richardson, and Co., Newcastle-on-Tyne, having cylinders 19½in., 28in., 42in., 61in. by 42in. stroke, with two large boilers working at 215 lb. pressure. On leaving the ways the vessel was named Minneburg.

On the 15th inst. Messrs. Irvine and Co., West Hartlepool, launched a fine steel screw steamer of about 4100 tons deadweight carrying capacity, built to the order of Messrs. Trechmann Brothers, West Hartlepool. The vessel will take Lloyd's highest class, and has been built under special survey. Her dimensions are 314ft. by 44ft. by 23ft. 3in. The deck erections consist of poop, bridge, and topgallant forecastle. The saloon and cabins for captain and officers are fitted up in poop. The engineers are berthed under bridge deck at sides of engine-room, and the crew in topgallant forecastle. The hull is built on the web frame principle with double bottom for water ballast fore and aft. Large hatchways are fitted, four steam winches by the builder, steam steering gear amidships, screw gear aft, two large donkey boilers, and direct steam windlass. The boats are placed on beams overhead, and all modern appliances will be fitted for general trading. Engines of the triple expansion type are being supplied by Messrs. Blair and Co., Stockton-on-Tees. The hull and machinery have been built under the supervision of Messrs. John Trechmann and J. Maddison. Miss Queenie Trechmann named the vessel Lorles.

THE Torquay Town Council have decided to apply for leave to borrow £22,300 for lighting the borough with electricity.

METHODS OF INSULATING UNDERGROUND SYSTEMS OF STEAM PIPING.*

By R. C. Carpenter.

This paper states in a concise way the results of the writer's experience with several methods of protecting systems of steam piping which are laid underground, but does not pretend to be a compendium of all the methods which have been used for this purpose. There are, in a general way, two methods of insulating pipes when used to convey steam long distances underground; these may be specified as the tunnel system and the trench system. In the tunnel system a conduit lined with brick or masonry of sufficient size for the pipes and for a person to enter for examination or repairs is constructed. In this the pipes are carried on suitable hangers and then wrapped with some insulating substances or covering. A sufficient number of expansion joints or equivalents are used to prevent injury to the line by expansion due to heating and cooling. While this system possesses many advantages over the trench system and is usually to be preferred, its cost is so great as to be in many cases prohibitive, and some method of trench construction is necessary.

The first system of underground steam piping which the writer saw constructed was put in about 1879. This system was about half a mile in length, and was intended to convey high-pressure steam for operating a steam pump which was located at about that distance from the boiler. The system was constructed in a very crude manner, very little attention being paid either to the effects of expansion or to protecting the pipe from surface water from the soil. In constructing the line a deep trench was dug, the steam pipe was screwed together, and joints of wooden pump log was placed over the steam pipe for insulation. The trench was then back filled. The line was used for the purpose intended for three or four years, but it was not at any time considered a success. The surface water at times covered the pipe, so that large masses of steam appeared at the manhole; several breaks were also caused by expansion and contraction. After three or four years of use expansion joints were put into the pipe and a tile drain was laid by its side to remove the surface water. It was then used successfully for some years afterwards, in fact, as long as it was needed. The next system was constructed in 1880 under the general directions of the writer. This system had a total length, including branches, of about one mile, and consisted of two independent lines of trenches, each containing main steam and return pipe. This system was used to convey the steam for heating purposes from a central boiler plant to a number of buildings belonging to the same public institution. The method of construction was very similar to that used at that time for conveying steam from central boiler plants through the streets of a city for heating purposes. For these special lines very careful surveys were made, and the line was laid with a continual descent from the buildings to be heated to the boiler house. After the trench was constructed a drain of 6in. tile, such as is used for farm drainage, was constructed, so as to be about 6in. lower than the steam pipe lines. The steam pipe lines were insulated from heat loss by a wooden tube with a shell 4in. in thickness. The diameter of the tube was 2in. greater than that of the pipe, and the pipe was held in a central position by iron collars. The tube joints were made by driving a tenon on one end of the pipe into a mortise on the other end of the adjacent pipe. The wooden tubes which were used for this purpose were made by special machinery out of large pine logs. The tubes were 8ft. in length. The logs from which they were made were first placed in a large lathe and the external circumference shaved off by a knife the full length of the pipe. This operation required a great deal of power, and sometimes the logs broke during the process of turning, in which case they were thrown with great force against the sides of the building. After the logs were turned to the proper size they were then bored, the auger for this purpose being a tube which cut away enough wood only to make clearance sufficient for its own motion. The core, which was cut out from the interior log, could be bored in a similar way with a smaller auger, and thus form smaller pipes without loss of timber. After the pipes had been turned and bored they were then placed in a lathe and strongly wound with a hoop iron arranged in a spiral form. This added very much to the bursting strength. They were then rolled in hot tar and covered with a coating of sawdust. Before the pipes were finished the ends were bored out for a short distance to form the mortise joint, and a short tube, which was allowed to project about 6in., was placed in one end to form the tenon. These pipes made in this way would withstand considerable water pressure, and many successful systems of waterworks have such pipes in use.

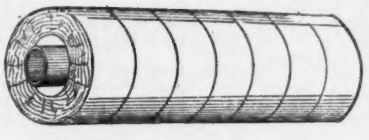


Fig. 1.—Pipe with Wooden Tube Insulation

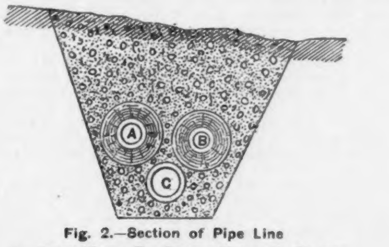


Fig. 2.—Section of Pipe Line

A.—Steam Main. B.—Return Main. C.—Drain.

In the system described, double-expansion joints were placed at distances of 240ft., and manholes were left at these points for inspection and for the repair of the joints. The expansion joint used was somewhat heavier than that ordinarily sold, and was provided with an inside lug, so that under no condition could the parts of the joint pull entirely apart. The wooden logs which were used for insulating purposes were very badly charred in five years from the date of laying, and contained a great many season checks, so that water could freely run from the soil on to the pipes. This reduced the efficiency of the line in a great measure. This line was anchored in each manhole midway between the two expansion joints, and, although steam was turned off every night at ten o'clock and on again every morning at six, no leaks whatever were ever traceable to this cause. This line is still in use, and for the first ten years after its construction did not require any repairs or any expenditure whatever, except such as related to the annual inspection and re-packing of the expansion joints.

The system next described was constructed in 1885, and in this both main steam and return pipe were used, the return pipe being laid in the centre of the main steam, so that the pipes were concentric. The outer pipe was wrapped with asbestos, and over the entire system a tube of sewer pipe was laid. The lengths of sewer pipe were split longitudinally, the upper half being put in place after the steam pipes were in position, the joints being protected by concrete. This system has proved very successful in use, and is still in service. The expense of running the return pipe in the centre of the main steam is considerable, and while it tends to prevent all heat losses from the return, is very difficult to construct. With this system the water would be received into the boiler at the temperature of the steam, and the work of the boiler would be simply to evaporate water into steam of the same temperature. The heat used in the building would be essentially that which is given out in the condensation of steam without change in temperature, the entire losses being those due to radiation from the steam main. Except for the difficulties of construction the system is perfect.

A system of underground steam piping was constructed by the writer in 1878, in which both main and return pipes were laid in a wooden box covered with concrete. The pipes were supported on suitable hangers, and provided with proper expansion joints, and were loosely wrapped in coverings of sheet asbestos and hair felt. A drain was laid underneath the trench to carry away the soil water. The general method of construction is shown in Fig. 3, and was as follows:—After excavating the trench a layer of concrete 4in. in thickness was then spread over the bottom, and was made about 6in. wider than the box to contain the pipes. The box, which was made of pine plank, was slipped in place without top and in sections. The pipe hangers were then put in place and the steam and return pipes laid. These pipes were then tested for leaks, then wrapped with the covering, as described. The top of the box was then put in place, and the whole box surrounded on top and sides with a layer of concrete 4in. in thickness. This system has proved successful, and has superior insulating powers to any of those previously described. In the pipe systems protected with the wood pipe, sufficient heat escapes in practice to thaw any snow which falls on top of the ground. Our experience with the construction described through several severe winters has shown that the ground is not thawed nor is the snow melted; this would indicate that the heat loss is quite small, as the snow is melted with a very slight escape of heat. The cost of the latter construction is much less than that of the wood pipe system of insulation.

The writer believes that an improvement in the system described could be made by supporting the pipes by hangers resting on the concrete; this would add much to its permanency. Wood used in underground construction of this character rots very soon, and if it is used in such a manner as to form an essential part of the support of the pipe line, its decay may affect the alignment of the whole system, and in that way interfere with the economic operation. Wood is, however, a very excellent insulating substance, and would no doubt be useful for such purposes for a long time after its power of supporting the pipe had been lessened by decay or by carbonisation.

The buildings of Cornell University were heated with steam which passes through a system of underground piping in 1888. In the system first used the boilers were situated in a building near the highest part of the campus, and but little of the return water could flow back by gravity. Consequently no attempt was made to return the water of condensation, except from the group of buildings immediately surrounding the boilers. In most of the buildings the return water was passed through a large cooling coil placed in a ventilating shaft, and as much heat as possible was extracted in warming the air used in ventilation. In this system the expansion of the pipe lines was taken up by variators constructed by the Holley Manufacturing Company. In the variator one end of the pipe was supported by a movable diaphragm, and the expansion and contraction of the pipe was compensated for by the motion of this diaphragm. These were placed at intervals of about 50ft. along the line. They were very simple in construction, and as they have no stuffing-boxes they are supposed to require no attention. As a matter of fact, however, they did not prove to be durable for the particular service to which this line was subjected. The alternate heating and cooling seemed to render the diaphragms brittle, and they gave out frequently.

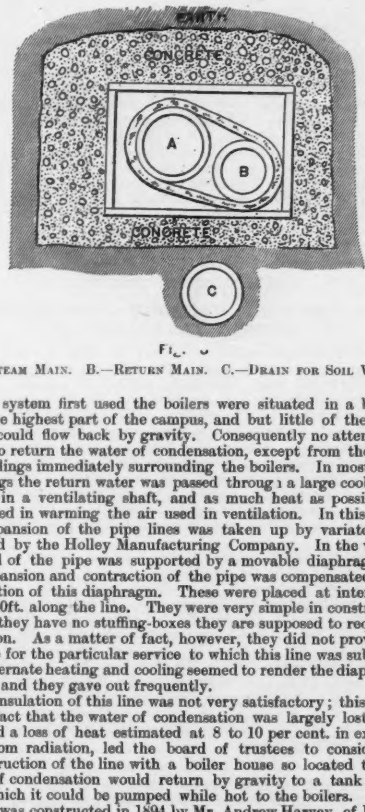


Fig. 3

A.—Steam Main. B.—Return Main. C.—Drain for Soil Water.

The insulation of this line was not very satisfactory; this, added to the fact that the water of condensation was largely lost, which involved a loss of heat estimated at 8 to 10 per cent. in excess of that from radiation, led the board of trustees to consider the reconstruction of the line with a boiler house so located that the water of condensation would return by gravity to a tank or well from which it could be pumped while hot to the boilers. Such a system was constructed in 1894 by Mr. Andrew Harvey, of Detroit. In the reconstructed system the method of insulation adopted was, first, a sewer pipe laid concentric with the steam pipe, and inside a wooden tube similar to that first described. Heavy expansion joints placed at distances of about 200ft. were used to take up the expansion. This system has now been in use two winters, and has proved to be of good mechanical construction. The heat insulating properties are not, however, superior to those of the old system which it replaced. The wooden pipes laid in 1886, and taken out in 1893, having been in use seven years, were in every case badly charred. Weather checks extended from the centre to the outside, and soil water could easily reach the main pipes. In both systems of pipe construction at Cornell University the question of soil drainage has been neglected, with the result that a good deal of trouble and great loss of heat is frequently occasioned by water flowing on to the hot steam pipes.

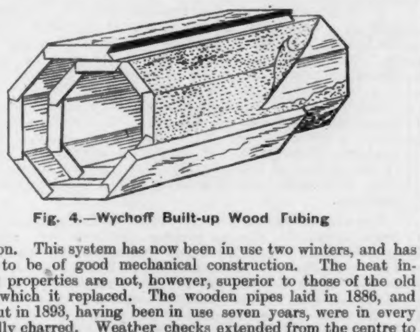


Fig. 4.—Wychoff Built-up Wood Tubing

The writer measured at one time the loss of heat in a pipe line at South Plainfield, N.J., which I believe was constructed by one of the honourable members of our Society for the purpose of conveying steam for power purposes from a boiler plant to several engines situated at considerable distance from the boiler. In this case the insulation was obtained by using the Wyckoff wood covering. This covering consisted of two thicknesses of inch board with tarred paper between, so laid as to break joints and form an octagonal pipe as shown in the sketch. This pipe, in the opinion of the writer, is much superior to the solid wood pipe, since it is less likely to check and crack. In this case, however, the pipe was not buried under ground, but the whole was enclosed in a large plank box partly filled with saw-dust, and placed on top of the ground. No expansion joints were used, nor were collars employed to keep the pipe in the centre of the wood casing. The ground in that locality was very swampy and wet, and it would have been impossible to keep it dry, so the location of the pipe was the best possible under the circumstances. The results of the test showed that the loss of heat was comparatively small, and in this respect the covering was satisfactory. The writer has been informed that the line has since been reconstructed. The result of this test is shown clearly in Fig. 5.

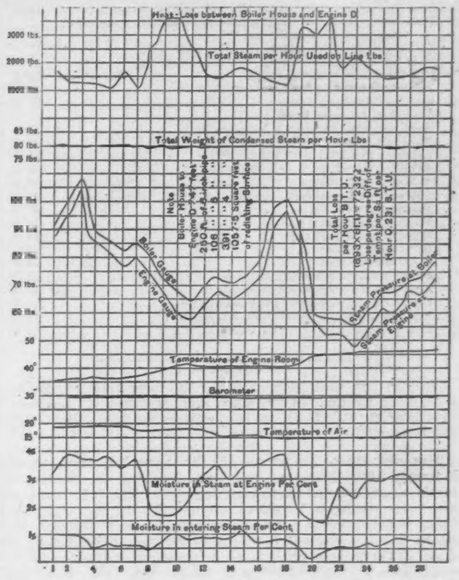


Fig. 5.—Diagram showing Results of Tests to Determine Heat Losses in Underground Pipe at South Plainfield, N.J.

Various other systems of insulation have no doubt been used with greater or less success. The writer is of the opinion, however, that whatever system is adopted the important points to be considered are in every case as follows: First, protection of the pipe from surface water—it should be remembered that evaporation of water from the outside of the pipe is accompanied by the condensation of an equal amount of steam; second, provision for taking up the expansion and keeping the pipe line in proper alignment; and third, insulation of the pipe from heat losses. It is the writer's opinion that no matter what system of construction is adopted, means should always be provided for thoroughly draining the soil.

The simple slip joint, when made sufficiently heavy, and when thoroughly anchored, seems to provide for expansion and contraction very well. It needs, however, occasional inspection and re-packing. A swinging joint has been used in some systems with success. On account of the bends in the pipe it produces some additional friction and slight loss of head. It also changes the lateral alignment to a greater or less extent, and cannot be erected in as narrow a space as the straight line with expansion joints.

The loss of heat depends entirely upon the insulation which is provided for the pipe. With the best quality of insulation the loss can be reduced to about 15 per cent. of that from a bare pipe in still air. Tests of various insulating substances as taken from a table in a recent work by the author on "Heating and Ventilating Buildings" give the results which may be expected in a very convenient form. It should be noted, however, in every case that the loss from a naked pipe is dependent principally upon the temperature of the steam, and is independent of the velocity of the steam in the pipe. Under ordinary conditions the condensation loss from a naked pipe in still air is about one-third of a pound of steam or about 320 heat units. This amount is increased by motion of the air, the results being substantially as shown in Fig. 6. It seems most convenient to refer all steam coverings to the bore of the pipe as a standard, and this method was adopted in the table quoted. It will be noticed that with some coverings having fairly good conducting power the loss of heat increases with

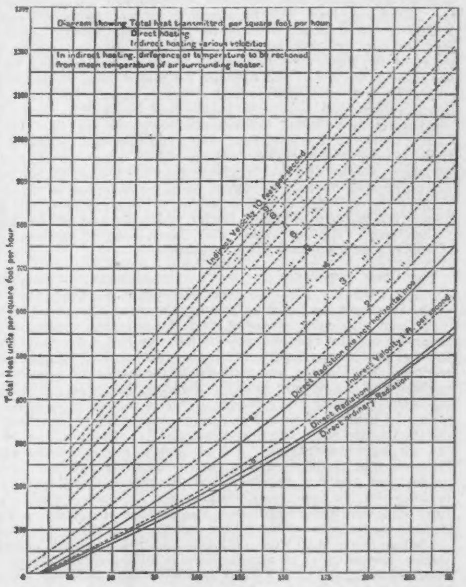


Fig. 6.—Loss of Heat from Pipes in Air under various Conditions

increase of thickness. This is due to the fact that an increase of thickness is accompanied by an increase in surface; if the heat passes readily through the covering the amount it gives off will depend largely on the nature of the surface, and as this is increased the conducting power also increases.

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* American Society of Heating and Ventilating Engineers—Annual meeting in New York.

The following gives results of tests of various pipe-coverings made at Sibley College, Cornell University †:—

Kind of covering.	Relative amount of heat transmitted.
Naked pipe	100·
Two layers asbestos paper, 1in. hair felt, and canvas cover	15·2
Two layers asbestos paper, 1in. hair felt, canvas cover, wrapped with manilla paper	15·
Two layers asbestos paper, 1in. hair felt	17·
Hair felt sectional covering, asbestos lined	18·6
One thickness asbestos board	59·4
Four thicknesses asbestos paper	50·3
Two layers asbestos paper	77·7
Wool felt, asbestos lined	23·1
Wool felt with air spaces, asbestos lined	19·7
Wool felt, plaster Paris lined	25·9
Asbestos moulded with plaster Paris	31·8
Asbestos felted, pure long fibre	20·1
Asbestos and sponge	18·8
Asbestos and wool felt	20·8
Magnesia, moulded	22·4
Magnesia, sectional	18·8
Mineral wool, sectional	19·3
Rock wool, fibrous	20·3
Rock wool, felted	20·9
Fossil meal, moulded, ¾in. thick	29·7
Pipe painted with black asphaltum	113·5
Pipe painted with light drab lead paint	126·7
Pipe protected by wood tube, 3ft. earth	32·0
Pipe protected by Wyckoff tube, 3ft. earth	18·0

Mr. Joseph Garland, F.G.S., has been elected President of the Institution of Mining and Metallurgy, London, in succession to Mr. J. H. Collins, who retires from that office in March next.

The Physical Society.—At the annual general meeting, February 14th, 1896, the ballot was held for the election of a president and council for the ensuing year. The following gentlemen were elected:—President, Captain W. de W. Abney, R.E., C.B., D.C.L., F.R.S.; vice-presidents, Shelford Bidwell, M.A., LL.B., F.R.S., Major-General E. R. Festing, R.E., F.R.S., Professor J. Perry, D.Sc., F.R.S., G. Johnstone Stoney, M.A., F.R.S.; secretaries, T. H. Blakesley, M.A., M. Inst. C.E., 3, Eliot-hill, Lewisham, S.E., and H. M. Elder, M.A., 50, City-road, E.C.; treasurer, Dr. E. Atkinson, Portesbery Hill, Camberley, Surrey; demonstrator, C. Vernon Boys, F.R.S.; other members of council, Walter Baily, M.A., C. V. Burton, D.Sc., L. Fletcher, M.A., F.R.S., R. T. Glazebrook, M.A., F.R.S., Professor A. Gray, M.A., G. Griffith, M.A., Professor G. M. Minchin, M.A., F.R.S., Professor W. Ramsay, Ph.D., F.R.S., Professor S. P. Thompson, D.Sc., F.R.S., and Professor S. Young, D.Sc., F.R.S.

Leeds Association of Engineers.—At the monthly meeting of this Association on January 30th Mr. R. Haste Carr read a paper on "A Ship Canal for Leeds." After explaining the general advantages of direct sea communications for inland towns, which had a special application in the case of Leeds owing to its prominent position amongst the cities of England and the competition of Manchester, he showed that in the river Aire we had an existing water-way available for the purpose of a ship canal. As compared with the Manchester and Caledonian Canals, the fall of about 30ft. was small. The defects of the Humber estuary were its great width, its comparative shallowness, and the changeableness of its channels. These could be remedied by training walls, the direction of which would be determined by the prevailing direction of the current and geological conditions, forming the basis for the subsequent construction of massive retaining walls rising above high-water level. Hundreds of acres of land would thus be reclaimed. The tidal portion of the river should be rendered free from inequalities, and made to extend as far inland as possible, the non-tidal portion shortened by straight cuts, the water supply conserved by locks, and the banks protected where necessary. The condition of the river in Hunslet during the summer months was a disgrace to civilisation. This was largely due to irregularities in width and depth, combined with scarcity of water, which would be remedied in the reformed river. A discussion followed, in which Messrs. Towler, Drake, Balkwill, Benton, Alf. Atkinson, and Robert Lupton took part, the general opinion being that, however good the scheme from an engineering point of view, it could hardly be made a financial success.

Water-tube Boilers.—On Saturday there was made at the works of Messrs. Yarrow, at Poplar, the hydrostatic test of three water-tube boilers which have been constructed for the Dutch Government. These boilers are to form part of a dual system of water-tube boilers combined with ordinary return-tube boilers. This form of design affords an excellent example of the saving in weight effected by the use of water-tube boilers. Three cruisers are at present being built in Holland—one at a Government establishment at Amsterdam, and the other two by private contractors at Flushing and Rotterdam respectively. Each vessel will have engines developing 9250 indicated horse-power. Steam sufficient for 2250-horse-power will be supplied by two large cylindrical boilers of the ordinary return-tube type. This will be sufficient for ordinary cruising purposes, but when higher speeds are required the water-tube boilers will be brought into use. There are eight of the latter, and they are estimated to give collectively steam for a total of 7000 indicated horse-power. The two cylindrical return-tube boilers in each vessel weigh 120 tons. The eight water-tube boilers in each ship weigh 88 tons, or 11 tons each. It will be thus seen that with water-tube boilers over three times as much steam can be obtained with an expenditure of only 88 tons in weight, as would be given off by 120 tons of the ordinary marine type of boiler. In regard to space occupied in the ship, each of the cylindrical boilers is 13ft. in diameter and 10ft. 6in. long. The water-tube boilers are 9ft. 3in. wide, and 9ft. 3in. high, by 9ft. long. The operations were carried out to the complete satisfaction of the Dutch naval authorities.

The Civil and Mechanical Engineers' Society.—On Saturday last, February 15th, the members of this Society visited the power station of the London Tramway Company's Brixton Hill and Streatham new cable tramway, and the pumping station of the Lambeth Waterworks Company on Brixton Hill. At the first of these places members were taken over the works by the resident engineer, Mr. Downie, and were shown the pair of 600-horse power engines, and the driving gear for working the cables. This gear consisted of, among other things, a 30ft. diameter grooved pulley driven by hempen ropes. The various arrangements for taking up the slack of the cable due to expansion and contraction—caused by the varying temperatures of the air, and to the stretching which takes place in the case of new cables—together with the various guides and gripping apparatus for the cars, and the method of braking both the motor cars and passenger cars, were seen by and fully explained to the members. The method of splicing, and the general construction of the cables, and the life of them, was clearly set before those that were present. At the Lambeth pumping station various types of engines were exhibited to the party, and carefully explained to it by the resident engineer of the station. The pumps and pumping engines varied considerably in type, some being of the Worthington and others of various forms of the beam type of pumping engine. The visit was also interesting from the number of types of boilers, fire-bars, and other details in connection therewith that were seen. A cordial vote of thanks was accorded to those who had invited the Society, and to their representatives.

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

Annual meeting of the American Society of Civil Engineers.—The reports presented at the annual meeting, held in New York in January, show that the membership is now made up as follows:—Eight honorary members, three corresponding members, 1240 members, 237 associate members, 74 associates, 278 juniors, 47 fellows, and 33 subscribers, making a total of 1920. The establishment of new and more commodious quarters has long been under consideration, and a site has now been purchased on West Fifty-seventh-street, on which it is proposed to erect a suitable building. No definite arrangements for plans have yet been made, but preliminary plans, prepared by Mr. J. M. Wilson, provide for a reception room of about 1200 square feet area on the ground floor in front, and for a meeting room or theatre capable of seating about 400 persons, on the same floor in the rear. This arrangement provides full facilities for meetings and entertainments in separate rooms, while the floor can be let out for other purposes than the uses of the Society, without interfering with any other portion of the house. The second floor, having an area of about 4000 square feet, is arranged for the business purposes of the Society. The third floor provides a reading room of 1600 square feet in front, which will also be used as the library for reference books, and a book stack in the rear capable of holding 150,000 volumes. Apartments for the janitor are provided in the basement. While it is believed that this will furnish all the accommodation which the Society will require for many years, it is proposed to construct the walls in such a manner that additional storeys may be added if required. The building will be of fire-proof construction throughout. When not required for other purposes, the reception room on the ground floor can be used as a reading and conversation room for the Society. The total cost is estimated at £18,000, or £34,000 including the site. The total expenditures of the Society during 1895 were £7770, and the total receipts £11,400. The Norman medal was awarded to Mr. William H. Hall for his paper on "The Santa Ana Irrigation Canal," and the Rowland prize was awarded to Mr. William R. Hill for his paper on "The Waterworks of Syracuse." Parties of members visited the Brooklyn Bridge, the power house of the United Electric Light and Power Company, the great four-track drawbridge over the Harlem River, and the Crocker-Wheeler Electric Works. In the evening there was a reception and supper at Delmonica's.

A large suspension bridge.—Since the completion of the great Brooklyn Bridge, connecting New York and Brooklyn, there have been numerous projects for other bridges farther up the river to relieve the present congested traffic of the present bridge, and to afford better facilities than those of the numerous steam ferries. One of these projects is now on a practical working basis, land and charters have been secured, provisional plans prepared, and the work has now been placed under the charge of a commission appointed jointly by the mayors of the two cities. The actual span over the East River has not yet been determined upon, but it will probably be between 1600ft. and 1700ft., no pier in the river being permissible. The clear headway will be 135ft. at high tide; the bridge will be about 118ft. wide, and will have two footwalks, two carriage-ways, four tracks for electric tramway cars—to accommodate the enormous traffic of the morning and evening—and two tracks for the trains of the Brooklyn Elevated Railroad. The live load will not exceed 10,000 lb. per running foot, but will be taken as 12,000 lb. to allow for future contingencies. About four months will be spent in preparing plans and specifications, upon which tenders will be asked, and no contracts can be let before July. It will be a stiffened suspension bridge, and there will be extensive approaches in both cities, with ample terminal facilities. With the experience of the present bridge in regard to the rapid increase of traffic and the difficulty of increasing the carrying capacity of a completed structure, it is hoped that the crowding and inconvenience of this present bridge will be avoided. This bridge has two roadways, two tracks for cable railway trains, and a broad promenade.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

A decided improvement has taken place in the general trade of the port during the past week. The coal shipments have amounted to nearly 80,000 tons. The docks are full of tonnage, and it is with some difficulty that shippers can obtain prompt berths. There is every probability that we shall continue in this strain for several weeks to come, as coal stems are well filled and chartering operations brisk. Among other tonnage, several large steamers of 5000 tons burthen and upwards are due here shortly. The river wharves have also been kept well employed with large consignments of iron ore and pitwood—a marked increase has taken place in the importations of the last two commodities. The ship repairing trade has not been quite so buoyant as compared with previous weeks.

Prices ruling on 'Change to-day were as follows:—Coal: Best steam, 8s. 3d. to 8s. 6d.; seconds, 8s.; best house coal, 10s. 3d. to 10s. 6d.; dock screenings, 5s.; colliery, small, 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 47s. 1d.; hematite warrants, 47s. 8d., f.o.b. Cumberland; Middlesbrough, No. 3, 38s. 3d., prompt; Middlesbrough hematite, 46s. 1½d. Iron ore: Rubio, 12s.; Tafna, 11s. 3d. Steel rails: Heavy sections, £4 15s.; light ditto, £5 5s. Tin-plate bars, £4; Siemens tin-plate bars, best, £4 5s.; all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel coke, 9s. 1½d. to 9s. 3d.; Siemens (coke finish), 9s. 4½d. to 9s. 6d.; ternes, per double box, 28 by 20 C, 21s. to 22s. Pitwood, 15s. 6d. to 15s. 9d. Freights, home steady, outward weaker.

Trade and Business Announcements.—Messrs. W. Shaw and Co., Wellington Cast Steel Foundry, Middlesbrough-on-Tees, have appointed Messrs. George Schultz and Co., of 90, Cannon-street, London, E.C., as their representatives for the London and surrounding districts.—Mr. J. P. Hall has resigned the position of managing director of Messrs. John Penn and Sons, Limited, Greenwich.

Yorkshire College Engineering Society.—At the meeting held on Monday, the 17th inst., Mr. A. F. Barker, Principal of the Textile Department, Bradford Technical College, gave a lecture on "Weaving Mechanisms." The lecturer, after a short description of the process of weaving, described the principal movements in a loom and the various devices used by different makers to obtain the same results, pointing out how some had advantages in one direction and some in another. The lecture was fully illustrated by lantern slides. Mr. J. Hartley Wicksteed, M.I.Mech.E., presided. A cordial vote of thanks was accorded to Mr. Barker, on the motion of the secretary, Mr. Gardner, seconded by Mr. Slade, and the meeting terminated with a like compliment to the chairman.

Hull and District Institution of Engineers and Naval Architects.—On Monday evening, the 10th inst., a paper was read by Mr. H. J. Rudgard on "The Removal of the Marsh-lane Tunnel, Leeds," the president, Mr. F. H. Pearson, in the chair. A short history of the line was given at the outset, the author then proceeding with a detailed description of the work of removal of the old tunnel, and erection of the present bridges and tunnel. He described the difficulties encountered and the method of dealing with the traffic, which is here very great—as many as 1273 trains passing over the line in one week, and on the August Bank-holiday, 1894, 261 trains passed over it in twenty-four hours—during the progress of the work. The paper was illustrated by large-size diagrams and also by lantern slides. At the close of the discussion which followed, a hearty vote of thanks was accorded Mr. Rudgard.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

The Midland Iron and Steel Wages Board has held its 20th annual meeting in Birmingham this week; Sir Benjamin Hingley, of Messrs. Noah Hingley and Sons,—chairman—presided. It was reported that there were now between sixty and seventy firms connected with the Board and only about twelve outside. This was considered very satisfactory. The rate of ironworkers' wages continued at 7s. 3d. per ton for puddling, and millmen's remuneration in proportion. It is a very gratifying fact that although in the last five years there has been a fall in the net average realised selling price by which wages were regulated of no less than £2 15s. per ton, the men continue loyal to the decisions of the Board, and no complaint under this head was made. High-water mark was touched in 1890, when the ascertained average for all classes of iron reached £8 4s. 11d. per ton; and low-water level was recorded in August of 1895, with £5 10s. Statements were put forward by the operative members of the Board, that at some of the works the managers had attempted to dissuade the men from adhering to the combination, by suggesting that "if the men's representatives had been loyal to those who sent them to the meetings," an advance in wages would have been secured. The employers strongly condemned such action, and expressed their entire willingness, if it could be proved, to dismiss managers guilty of such conduct in the future. The question of the recent report of the British Iron Trade Association on continental competition came up for discussion, and the chairman observed that the chief point established was the regularity and exactness with which the work was performed on the Continent. The deputation did not meet with a single case of drunkenness. Their investigations showed that the wages paid in Germany were very much on a par with those paid in this country, taking them all round. What they had to learn was, lest the German ironmasters, by the regularity of their work, the immense production of their mills and forges, and their excellent machinery, particularly that employed in sheet rolling, should beat our own ironmasters in the matter of charges. It was the waste which they wanted to avoid in Great Britain.

Prices in the iron and steel market this week are without much change. Quotations are moderately preserved at £5 10s. for common bars, £6 to £6 5s. for ordinary merchant sorts, £6 10s. for superior merchant brands and £7 for marked iron, and £7 12s. 6d. for Lord Ward's brand. Hoops and thin strip are changing hands at £6 5s. to £6 7s. 6d., though the Association quotation is upheld nominally at £6 10s. per ton.

Mail advices received this week from Australia bring good accounts of the iron market there. From Sydney, Melbourne, Perth, and elsewhere all the reports are better, iron bars, plates, sheets, and barbed wire being in active demand at firm prices, and further expansion being expected. This intelligence is received with particular gratification by the galvanised sheet iron firms. Prices in the sheet iron trade locally stand at £6 17s. 6d. to £7 for sheets of 24 W.G., and £7 15s. to £8 for sheets of 26 and 27 W.G. For iron of 20 W.G. suitable for galvanising purposes the figure is £6 15s. Galvanised corrugated iron is £10 5s. to £10 10s. f.o.b. for 24 W.G. in bundles. Stamping sheets are still quoted £9 10s., and best thin sheets £10 to £11.

Steel is in excellent demand, both imported and native sorts, and the works are fully engaged. Imported Bessemer blooms and billets are £4 7s. 6d. to £4 10s.; angles and plates, £5 10s. to £5 15s. and £5 17s. 6d.; sheets, £7 5s. to £7 10s.; and manufactured bars, £5 15s. to £6 per ton. Basic steel, locally-made girders, and angles are £5 5s. to £5 10s.; and boiler plates, £6 5s. Pig iron prices are unaltered on recent rates, and demand is somewhat slow.

The official statement of the Board of Trade Department as to the current state of employment in Birmingham and district indicates that seven branches in the engineering trade report work as good, with no members on short time and few idle. The pattern makers return employment as "satisfactory," with none in receipt of out-of-work pay; and the smiths and strikers as "good."

The Birmingham students of the Institution of Civil Engineers have just entertained Sir Benjamin Baker, President of the Institution, as the leading guest at their tenth annual dinner, and in replying to the toast of the parent Institution, Sir Benjamin said that the Council had recently been legislating, and with success, for the purpose of removing difficulties in the charter which practically disfranchised the county members. The Mayor of Birmingham, who was one of the subsequent speakers, said that the scheme undertaken by the city to get a new water supply from Wales was a work of much magnitude, although there was no great engineering difficulty connected with it. It was an engineering scheme which he believed the citizens would never regret. Before the proceedings closed it was announced that the strength of the local Association was 100 members and 10 students, which compared very favourably with the other great engineering centres, but really there were within reach of the meetings in Birmingham 230 members of all classes and 60 students.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—A general feeling of confidence prevails as to the prospects of the future throughout the engineering and iron trades of this immediate district. The ensuing year is to be one of good trade, with steadily increasing activity and improving prices; at any rate, such is the opinion which finds frequent expression on 'Change, and certainly the indications on which opinions as to the future are usually based tend in the above direction. The books of both makers and manufacturers of iron have not been so full of orders for several years past, and a satisfactory feature is that there has been less of the speculative element and more of buying for actual requirements, in the large business that has been put through recently. The position, all through, of engineering and other iron-using branches of industry is also decidedly better than it has been for the last three or four years, and there is a large weight of new work stirring or in prospect, which promises more or less general activity for some time to come.

A quieter tone was reported generally on Tuesday's Manchester Iron Exchange, and although there was a fair average attendance, there was a decidedly lessened weight of enquiry as compared with recent markets. In pig iron not more than a moderate business has been put through, with perhaps not quite so much firmness in prices as regards iron offering in second hands. Markets, however, were very firm at their full rates, the tendency in some cases being towards a further hardening rather than otherwise, with a disinclination here and there to quote at all for further business. Lancashire makers were quoting an advance of 6d. per ton upon last week's rates, 46s. 6d., less 2½, being now the minimum for No. 3 foundry qualities, delivered equal to Manchester. District brands continue very strong, makers being in some cases so heavily sold that they have practically little or nothing to offer for anything like early delivery, and they do not care to book far forward; in Lincolnshire, although there are still sellers at 42s. for forge and 44s. for foundry, net cash, delivered Manchester, orders have been booked during the week at 6d. above these prices, which are the maximum rates that fully sold makers have been asking for the last fortnight, but which buyers have held back from giving. Derbyshire iron also continues to harden, and good foundry qualities are now quoted 47s. to 47s. 6d. net cash, delivered Manchester. Outside brands offering here might perhaps be bought through merchants at something under last week's quotations, especially in Scotch, 47s. 6d. being about an average figure for Eglinton, delivered Lancashire ports, and 49s. 6d. to 49s. 9d. net cash, delivered dock quays, Manchester, with holders in some cases rather anxious to push sales. For good-named foundry brands of Middlesbrough, however, makers were asking a slight advance upon last week, 47s. 1d. to 47s. 4d. net cash, delivered Manchester, being about the minimum quotations, with ordinary G.M.B's. scarcely obtainable under 46s. 10d.

The upward move of 2s. 6d. per ton upon bars, reported last week, does not appear to have in any way checked business, makers reporting orders coming forward freely at the advanced prices, and £5 12s. 6d. to £5 15s. are the minimum quotations for Lancashire and North Staffordshire bars; sheets remain at £7 10s. to £7 12s. 6d.; and hoops at £6 2s. 6d. for random to £6 7s. 6d. for special cut lengths, delivered Manchester district, and 2s. 6d. less for shipment.

Nut and bolt manufacturers report a good demand for all descriptions of goods from engineers and boiler makers, and for general requirements. There has been no actual advance in prices, but these are now firm at full list rates.

In the steel trade there is a continued gradual hardening up in prices, and hematites, in which I reported last week some large sales, have been further advanced, 57s. 6d. up to 58s. 6d., less 2½, being now the average quotations for good foundry qualities, delivered Manchester district; ordinary billets remain at about £4 7s. 6d. to £4 10s., net cash. In manufactured steel bars are decidedly stronger, advances of 2s. 6d. per ton upon recent rates being quoted, whilst steel boiler plates, although they scarcely improve to the extent that was anticipated, are stiffening up to £6 7s. 6d. per ton as the minimum, for delivery in the Manchester district—although there are still some sellers at as low as £6 5s. per ton.

A brisk demand for all descriptions of manufactured goods continues the general report in the metal market, and a further upward move in prices has taken place, although this is at present confined to brass and copper wire, brazed brass tubes, and rolled common brass, which have been advanced ¼d. per pound, list rates for delivery Manchester district being now 5¾d. for brass wire, 7d. for copper wire, 7d. for brazed brass tubes, and 5½d. for rolled common brass; ordinary brass and copper tubes remain unaltered in price.

I continue to hear satisfactory reports from nearly all branches of the engineering trades throughout the district. Here and there establishments are still only moderately off for work, but this is mostly due to some special causes. The leading firms are practically, without exception, well supplied with orders, and generally report a considerable quantity of new work coming forward, many of the establishments being already full of orders for the remainder of the year. All the large engineering establishments in the Bolton district engaged on heavy stationary engine building are very busy, and much the same may be said with regard to the same branch of trade throughout other Lancashire districts. Machine tool makers are mostly well supplied with orders, and I understand there is an exceptional amount of tendering just now going on for further new work which is offering, whilst boilermakers and locomotive builders are all better employed than they have been for a considerable time past.

The annual reports of two of the largest coal and iron companies in Lancashire have been made public during the past week—that of the Wigan Coal and Iron Company, with a share capital of nearly two millions, and that of Andrew Knowles and Son, Limited, with a share and debenture capital of over one million. Some particulars from these two reports will be interesting as showing the condition of trade in this district, and the results set forth, so far as the coal industry is concerned, are anything but satisfactory. The output of the Wigan Coal and Iron Company's pits has been slightly less than in 1894, the collieries having again worked very short time, owing to the dull demand for fuel and the low prices which have ruled, these having continued to fall, and, the report adds, are still declining. The operations of the company in connection with their own works have been much more satisfactory than at their collieries. It is reported that during the latter part of the year there had been a better demand for both iron and steel, and prices had been higher, with the result that the works had been all fully occupied during the last three or four months. The accounts presented with the report do not enable any comparison to be made as to whether there has been a loss on one section and a profit on the other, or whether profits have been made on both the getting of coal and the manufacture of iron. The total result is a profit of £48,365, to which is added £12,663 brought forward from last year, and out of this a dividend of £2 10s. per cent. per annum, free of income tax, is being paid, leaving £15,786 to be carried forward to next year.

Messrs. Andrew Knowles and Sons, who, owing to the depreciation which has taken place in the value of colliery property, have just decided to reduce the capital by reducing the shares, on which £35 had been paid, to £22 10s. per share, and the uncalled capital of the company, of £366,000 to £187,500, state that the profit on the year's working had amounted to £16,727, to which is added £14,061, brought forward from last account, and it is proposed, after paying a dividend of 21s. per share, free of income tax, to carry forward a balance of £4538. It is added that the coal trade during the year had been bad, and prices have continued to drop, to which follows the significant intimation that notwithstanding this, there has been no change in colliers' wages, and as a similar phrase is made use of in the report of the Wigan Coal and Iron Company, it is perhaps suggestive that some action in connection with a reduction of colliers' wages is in contemplation.

The condition of the coal trade, as reported on the Manchester Coal Exchange, fully bears out the unsatisfactory results set forth in the above reports. The position not only remains without improvement, but the general statement of representatives of collieries is that, if anything, it gets worse. For all descriptions of fuel there is a continued slow demand, with even collieries that are favourably situated finding it difficult to keep on five days, whilst many of the pits are not running more than four days per week, and prices, if anything, show a rather downward tendency, notwithstanding the excessively low point to which they have already receded. The better qualities of round coal suitable for house fire purposes remain in but indifferent request for the time of the year, and with supplies plentiful, it is becoming more and more difficult to maintain list rates, sales being in some instances pushed at lower figures. It is exceptional where best Wigan Arley fetches 10s. 6d. per ton, 10s. being about the general average figure; with Pemberton 4ft. and seconds Arley ranging from 8s. up to 9s.; and common house coal from 7s. to 7s. 6d. per ton at the pit mouth. Steam and forge coals, notwithstanding the improvement in the iron trade, are in no really better demand, with prices extremely low, 6s. being an average figure for ordinary descriptions at the pit mouth. Engine fuel moves off fairly well, but prices are not more than steady at late rates, common sorts being obtainable at 3s. to 3s. 6d.; and best qualities averaging 4s. 6d. up to 5s. at the pit mouth.

For shipment business continues quiet, with prices ruling as low as ever, very common sorts of steam coal being obtainable, delivered Mersey ports, at 6s. 9d. to 7s.; with better qualities averaging 7s. 6d. to 7s. 9d. per ton.

Barrow.—The hematite market is steady, and there is a good consumptive demand. Speculators are also ready buyers, and they now hold large stocks representing 303,553 tons, a decrease on the week of 152 tons, but an increase of 14,378 tons since the beginning of the year. Some makers are also holding large stocks. Three additional furnaces have been lighted during the week, There being now thirty-nine furnaces in blast, as compared with twenty-three in the corresponding week of last year. Prices are firmer at 48s. 10d. net cash sellers, 48s. 9d. buyers. Makers quote nominally 49s. to 50s. 6d. per ton for parcels of Mixed Bessemer numbers net f.o.b. Orders are generally well held by makers, and makers have reason to believe they will be very busy throughout the year.

Iron ore is in better demand at 10s. per ton for ordinary qualities of native ore, but Spanish consignments are coming freely into the district, and this tends to check business with native sorts.

Steel makers report a much busier trade, and orders are freely offered for heavy rails and plates especially. Rails are firm at £4 15s. per ton, and plates are at £5 2s. 6d. Hoops and billets find a good market, and there are still plenty of inquiries for heavy steel castings.

Shipbuilders and engineers are busy. The Naval Construction and Armaments Company has tendered for two of the third-class cruisers required by the Admiralty, and some good commercial orders are also in the market.

Coal and coke are in steady demand, and prices are stiffer. Deliveries have lately increased, and a still further increase, it is expected, will be required. Shipping, as well as manufactures, are consuming more fuel.

Shipping is more actively employed. The exports of pig from from West Coast ports during last week represented 8883 tons of pig iron and 10,054 tons of steel, as compared with 7590 tons of pig iron and 8200 tons of steel, representing 1293 tons increase in pig iron and 1854 tons of steel. The shipments this year so far have totalled up to 39,610 tons of pig iron and 53,415 tons of steel, as compared with 34,318 tons of pig iron and 39,695 tons of steel in the corresponding period of last year, representing an increase of 5292 tons of pig iron and 13,720 tons of steel.

The directors of the Furness Railway Company have recommended a dividend of 1 per cent. per annum on the half-year's working up to December 31st last, as compared with 2 per cent. in the corresponding half of last year. The company, it is reported by the directors, have ordered six new engines of more capacity and power than any of those now owned by the company. It is also intended, in consequence of Board of Trade requirements, to order new passenger coaches to the value of £45,000. The directors of the company have given Sir James Ramsden a retiring allowance of £666 per annum, in consideration of his fifty years' services as manager, and subsequently as managing director.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE same depressed state of affairs exists in the South Yorkshire coalfield. Reports from the various localities testify to a very moderate trade. It is feared that before long there will be several wages disputes in this district. Generally speaking, the pits are still only making four days a week, and even with these limited working periods, stocks are accumulating at a few of the collieries. The mild weather is still checking the demand for house coal, and this is to such an extent that it is feared less time will have to be worked at this class of colliery. The metropolis is taking a poor tonnage as compared with former years, both of Silkstone and Barnsley house coal. The demand from other markets is very unsatisfactory, and not at all up to the average at this season of the year. Not much change has taken place in the quotations since last week, and in a few instances values cannot be kept at current prices. Best qualities of Silkstone coal are obtainable at from 8s. to 9s.; with secondary qualities at 6s. 9d. to 7s. per ton; Barnsley "softs" easy at 7s. to 8s. per ton; while Flockton coal can be procured at similar rates. Thin seam fuel is to be had in abundance at 6s. per ton. Steam coal is in the same quiet request, although one or two local collieries are forwarding large supplies to Hull. Grimsby is doing but a small business, and a similar remark applies to other ports. Values rule very low. The quotations range from 6s. 6d. to 7s. per ton. The various railway companies are taking an average supply on contract account. A good deal was written at the time about the low rates at which the North-Eastern placed their orders at the end of 1895. Coalowners—the orders were divided over nearly a score of firms—who obtained these contracts at 7s. per ton of 20 cwt. ought to consider themselves fortunate, as this quality of fuel can now be obtained in the open market at lower rates than those quoted at the close of last year. Gas coal is in decreased request, owing to the open weather now prevailing. This part of the output is in plentiful supply, and can be purchased at 6s. to 6s. 9d. per ton, and in many instances lower than that. Manufacturing fuel is in poor request. Values are as follows:—Screened slack, 3s. 6d. to 4s. 6d. per ton; ordinary pit slack, 2s. 6d. to 2s. 9d.; with an abundance of smudge at 1s. per ton. The coke business remains in about the same condition, with prices unaltered, and the request similar to last week.

The heavy industries of the city and neighbourhood are in an extremely satisfactory condition. In armour-plates there is work in hand for seven first-class battleships, four first-class cruisers, and other craft for our own Admiralty, who have just invited tenders for ten third-class cruisers of the Pelorus type. Gun forgings are also being freely ordered, with steel armour-piercing projectiles and common shell. Railway material is in large demand, and marine work is likewise being more freely placed. The railway companies having held all orders as long as they possible could, are now compelled to crowd their work upon the wagon builders and manufacturers of specialities for rolling stock. In consequence of this influx of orders, values of finished material have stiffened a little, although they have not actually advanced so far. The improvements in traffic returns will have a still further stimulating effect on the railway material trade, and will, no doubt, influence companies to place additional extensive orders for rolling stock, &c. Quotations remain very much the same as a week ago:—Bessemer billets, £5 12s. 6d. to £6; hematite irons, 54s. to 57s.; bar iron, £5 10s.; Lincolnshire forge iron, 39s. to 40s.; with Lincolnshire foundry, 40s. to 41s.

The lighter trades are not so well employed as they were before Christmas. Very encouraging reports are given of the file business. A good demand has set in, and prices are rather easier than a week or two ago. The men have plenty of work in hand in all the departments. The adoption of machinery, both in this and the cutlery trades, has been rather a serious factor to be contended with, but now happily all difficulties have been overcome, and the men have become accustomed to the new departure. Machinery is being universally adopted in all departments. Another fresh feature has been the employment of the sand-blasting process, instead of female labour as before, for scouring files. This innovation will undoubtedly spread, and that very quickly. Makers of joiners' tools are well employed on orders, which is undoubtedly owing to the fine open weather we are now experiencing.

The saw business is in a satisfactory condition, more especially in band and large circular saws. The demand for cutlery in the table and pocket qualities is exceedingly good, although there has been no material increase in the request from America. The largest business is at present being transacted in the commoner qualities of cutlery. The silver and plating trades are in a good condition, and orders are being placed to a gratifying degree. The men are well employed, full time being general in the leading houses. The fashion at the present time is for light artistic goods in sterling silver, and a good demand is being experienced for the medium qualities of plated wares. The smaller manufacturers report an excellent business doing in butter knives, jam spoons, and similar goods. Generally, the whole trade is in a good condition.

A disastrous fire at the works of Messrs. Joseph Rodgers and Sons, the well-known cutlery firm, will entail a loss of several thousand pounds. It will not interfere, however, very seriously with the usual conduct of the business.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

As a rule the works engaged in the iron and allied industries of this district are well employed; indeed, they have not been as busy since the autumn of 1890, and that a continuance of the improvement is to be experienced no one is now inclined to doubt. Confidence is steadily returning, and that the views of capitalists are sanguine is indicated by the number of idle works that are being restarted, and by the enlargement of others that are in operation. There have been more changes of this kind since the beginning of the year than have been known for many years, and it is satisfactory to see that the market values of the shares of the various iron and steel manufacturing and engineering companies are improving steadily, the general public having now apparently an idea that something is to be made out of speculative operations in them, and there is plenty of room for improvement, as a considerable proportion of the stock has been at a discount for a long time.

Buyers in all parts of the world seem to be moving, and orders are being received for iron and steel from markets which have been nearly closed to us for some years. The steady rise in prices that has been going on since the middle of January, and that over the quietest period of the year when generally prices are declining rather than rising, has led to the view that the consumer will not derive any advantage by waiting, but, on the contrary, is likely to have to pay more; therefore there is a disposition to buy without delay, for a very active spring season is promised, and the opening of the navigation will be earlier than usual, owing to the mildness of the winter. The Baltic trade will, it is expected, be re-opened early next month if the weather keeps as favourable as we have had it this month. The prospects, therefore, are decidedly good.

A tolerably active business has been done this week in the pig iron trade, and deliveries are heavy on local account, owing to the animation in the finished iron, steel, and founding branches, while the exports are above a February average. For three months past the consumption of Cleveland pig iron has fallen short of the production by 64,927 tons; but this month the excess of output is not likely to be much, and next month an excess of consumption may be looked for. The output has been increased this month by the blowing in of some furnaces; but these will not contribute to any increase in the output of Cleveland pig iron—to which alone the public stocks relate—for they are producing hematite pig iron. The Consett Iron Company have blown in a furnace this month, as have also Messrs. William Whitwell and Co., at the Thornaby Ironworks, Thornaby-on-Tees, this last being put out last July for relining; and in connection with this operation of blowing out an accident occurred, which caused the deaths of five of the men. Messrs. Whitwell now have all their furnaces at work; but they propose putting out one, which needs relining. Other furnaces in the district are expected shortly to be stopped for relining; but makers are not very ready to cease operations at any furnace when the market is improving, and as long as iron can be made at a profit by the furnace. The present prices of pig iron are fair, and most firms should be able to derive some profit, even where they have to buy all their materials in the open market.

The price of No. 3 Cleveland, G.M.B., pig iron this week has been firm at 38s. per ton, for prompt f.o.b. delivery, and less has not been reported. For delivery next month 38s. 3d. is taken, but for April and beyond 38s. 6d. is the minimum. No. 1, which is more freely bought by the continental firms, who are the chief consumers of the quality, is realising 39s.; No. 4 foundry, 37s.; and grey forge, 36s. 6d. for early delivery, with 3d. more for March-April. For M. Nos. of East Coast hematite pig iron 47s. is the lowest that will be accepted for early f.o.b. delivery, though in the early part of the week there was some business at 46s. 9d. That is out of the question now; for March-April delivery 47s. 6d. is obtainable. The rate for average Rubio ore is 12s. 9d., delivered at wharves on Tees, as rates of freight are increasing, Bilbao Middlesbrough being 5s.; Bilbao Tyne, 4s. 9d. Other rates are also rising. Pig iron shipments from the Cleveland district this month are very satisfactory; up to Wednesday night they reached 42,933 tons, as compared with 35,791 tons last month, and 25,491 tons in February, 1895 to 19th. The stocks in Connal's public warrant stores on Wednesday night amounted to 183,267 tons, or 2474 tons increase this month.

It was intimated a short time ago in these columns that there was a probability of two of the idle finished ironworks in the North of England being re-opened. The negotiations have now reached such a stage that it has been definitely decided to recommence operations at the Bowerfield and Richmond Ironworks, at Stockton-on-Tees. Messrs. Jno. Stevenson and Cowper, of Middlesbrough and Newcastle, who are the owners of the Richmond Ironworks, and who are also interested in the Bowerfields Ironworks, have had the matter in hand, and have formed a syndicate which will take over the two concerns, and recommence operations without delay. The Bowesfield Works, which have been idle since the autumn of 1890, were one of the leading iron plate manufacturing concerns in the district, and since there stoppage were acquired from the liquidator by a number of local gentlemen who have joined the present syndicate. The Richmond Works occupy the adjoining site, and both are situate on the north banks of the Tees, above Stockton, and near to the railway bridge over the river, and the Tees Bridge blast furnaces, the two works occupying 26 acres of freehold land admirably situated. It is the intention of the syndicate to alter the mills into sheet mills for the purpose of making black sheets, and to retain the large plate mill at Bowesfield Works as well as the bar mill at the Richmond Works for rolling miscellaneous sections of iron and steel. The company do not at present propose to produce galvanised sheets, but this may ultimately form part of their business, as also will the manufacture of heavy steel plates. The erection of steel furnaces for producing their own crude material is contemplated. The syndicate comprises some of the leading ironmakers of the district, and also Mr. Alfred Baldwin, M.P. for West Worcestershire, who is already largely engaged in the sheet trade, having works both in Staffordshire and South Wales. Messrs. Howson and Harrison, consulting engineers, Middlesbrough, are to act as engineers for the alteration of the works, which will be proceeded with as rapidly as possible. Hitherto the manufacture of such sheets as the syndicate propose to produce has been carried on on a very small scale in the North of England, Staffordshire and South Wales having a monopoly of the business, but at the Bowesfield Works it is intended to make them on an extensive scale. The demand for them has of late been extraordinarily brisk. The works in question are well situated for cultivating an export trade, as they can ship direct to the principal markets abroad, and besides, they are well situated for procuring raw material. A company comprising the gentlemen referred to is about to be formed, but there will be no application to the general public for capital.

Finished iron and steel works are generally well employed, and prices are very firm. Heavy steel rails are stiff at £4 15s. per ton net at works. Steel ship plates are quoted £5 2s. 6d.; steel boiler plates, £6 2s. 6d.; steel girder plates, £5 7s. 6d.; steel ship angles, £5; iron ship plates, £5; iron ship angles, £4 15s.; and common iron bars, £5 per ton, all less 2½ and f.o.t.

Orders for shipbuilders are more numerous, and generally the shipyards are well employed. Palmer's Shipbuilding and Iron Company has secured an order to build an 8500-ton steamer for the P. and O. line. A Stockton firm have undertaken to build a 5500-ton steamer for £29,900, or about £5 10s. per ton. Referring to the new naval programme of the Government, Mr. Robert Knight, the secretary of the Boilermakers' and Iron Shipbuilders' Society, in his monthly report says:—"This means work for our shipbuilders, but for engineers the prospect is even more enticing, for the bulk of the engines and machinery of the vessels to be built in the Government Dockyards, as well as those built in private yards, will be placed in their hands. The new programme opens out great possibilities for all branches of the iron and steel industries, and will give trade just that impetus which at present is required to ensure a return to general prosperity." The engineers at the iron and steel and engineering works in this district have this week sent in claims for an advance of wages amounting to 2s. per week on time and 10 per cent. on piece work from March 15th next. An application of this kind was not unexpected after the settlement on the Clyde and at Belfast, but it was not thought that the advance required would be so large, and it is not likely that any such amount will be granted.

The coal trade is quiet, and prices tend downward. The Pelton Collieries will supply the Stockholm Gas Company with 63,000 tons of coal at 9s. 11½d. per ton, delivered, which means about 6s. 1½d. f.o.b. Another contract for Gothenburg has been placed in the district, and will yield about 6s. 2d. f.o.b. There is great competition in the Northumberland steam coal trade, and best coal for prompt delivery is sold at 7s. 9d. f.o.b., while 8s. 6d. f.o.b. has been taken for delivery over the shipping season. Coke continues in fair request, both for local and West Coast consumption, and an increasing quantity is being shipped. The price is very firm.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE pig iron market has only been moderately active in the speculative branch. There is less demand than might be expected from outsiders, but the current of business in the ordinary departments of the trade appears to be gathering in force. Reports from other districts, and particularly from the United States, are such as to create a favourable impression as to the future condition of the iron and steel trades. A specially gratifying fact is that merchants report a better inquiry from abroad. The foreign demand has for long been the weak point in the Scotch trade, and an improvement in this respect would naturally be hailed with much satisfaction. Prices of pig iron warrants were inclined to ease off a little as the week advanced, but this is ascribed entirely to the state of the speculative account. Business was done in Scotch warrants from 47s. 4d. to 47s. 2d. cash, and 47s. 6d. to 47s. 4d. one month. The selling prices of Cleveland iron varied from 38s. 6½d. to 38s. 4½d. cash, and 38s. 7d. to 38s. 6d. one month. Cumberland warrants were from 48s. 8½d. to 48s. 10d. for cash.

The output of hematite pig iron in Scotland has been increased to the extent of about 900 tons per week, while that of ordinary iron has fallen off 300 tons. There are now 41 furnaces producing ordinary, 35 hematite, and 3 basic iron, total 79, compared with 78 last week, and 73 in the corresponding week of last year.

Prices of the special brands of Scotch makers' pig iron have been advancing, and in most cases they are 6d. to 1s. per ton better than of late. G.M.B., f.o.b. at Glasgow, No. 1, is quoted 48s. 6d. per ton; No. 3, 47s.; Monkland and Carnbroe, Nos. 1, 48s. 6d.; Nos. 3, 47s.; Clyde, No. 1, 50s. 6d.; No. 3, 47s. 6d.; Gartsherrie, Calder, and Summerlee, No. 1, 51s.; No. 3, 48s. 6d.; Coltness, No. 1, 53s. 6d.; No. 3, 49s. 6d.; Glengarnock, at Ardrossan, No. 1, 51s.; No. 3, 47s.; Eglinton, No. 1, 48s. 6d.; No. 3, 46s. 6d.; Dalmellington, at Ayr, No. 1, 48s.; No. 3, 46s.; Shotts, at Leith, No. 1, 53s.; No. 3, 49s.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 49s.

The shipments of pig iron from Scottish ports in the past week have amounted to 4183 tons, against 2475 tons in the corresponding week of last year. There was despatched to the United States 100 tons, India 170, Australia 405, South America 110, France 100, Italy 592, Germany 10, Holland 160, China and Japan 50, other countries, 130, the coastwise shipments being 2356 tons, compared with 2475 in the corresponding week of last year.

The makers of finished iron in the West of Scotland have issued circulars intimating an advance of 2s. 6d. per ton on all kinds of bar iron, strips and hoops being at the same time raised 5s. per ton. These advances are rendered necessary by the higher prices that have to be paid for pig iron, and it is believed that they will now be generally conceded, more especially as the prospects of the trade generally appear to be getting more satisfactory.

Reports concerning the steel trade are favourable. There is now plenty of work available for the makers, and orders are constantly being placed for a variety of material, among which mild steel for shipbuilding purposes forms a large proportion.

Contracts are being arranged for a considerable quantity of iron and steel goods for municipal undertakings, and others are intimated, which will in due course be placed. Among the latter are a number of schemes that will require considerable quantities of cast iron pipes. Shipbuilding orders continue to be received in steady numbers by the Clyde builders, and the amount of new shipping being placed in the water is large. The prospects of this important branch are very good. Marine engineers are well employed, and the general engineering branches are sharing in the revival.

A movement has been set afoot by various branches of operatives engaged in the shipbuilding trade for an advance of wages. There is every prospect that the negotiations to this end will be conducted in such a way as to avoid a rupture between employers and workmen.

The coal trade shows little or no improvement. The shipments from Scottish ports in the past week reached a total of 106,455 tons, compared with 116,246 in the preceding week, and 94,407 in the corresponding week of last year. Shipping business has been good in the Clyde district, and shows some improvement in Fifeshire, but the clearances at Firth of Forth ports are considerably lighter than of late. The household coal trade for home consumption is poor, but the inquiry for manufacturing purposes is expanding. On the whole, however, the trade is in a very unsatisfactory state. The colliers are obtaining only partial employment, being idle in a number of districts several days a week, and their wages are being gradually reduced. There is no change in coal prices.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE inquest on the Tylerstown explosion was resumed this week, before Mr. Rhys, the coroner. Mr. Woodfall, B.A., of Lincoln's Inn, was in attendance for the Home-office; Mr. Abel Thomas, Q.C., for the Ferndale Company; and "Mabon," M.P., and Mr. William Evans, agent of the Cambrian Association of Miners, appeared for the workmen. The usual procedure followed: first the address of the coroner, then the evidence of identification of the dead, the statement of the surveyor, and the examination of the manager. So far it has been elicited that shot firing by appointed firemen took place, and that an ample supply of water for the workings was handy; and, in addition, the dust was regularly cleared away from the main headings. One special point has been elicited, that correct lights were in use for a short distance from the bottom of No. 7 Pit. Gas was reported on Sunday in No. 8, the day before the explosion, but was believed to have been cleared. There is no doubt but that a thoroughly keen investigation will follow; though in this, as in many a previous case, the secret of the explosion is in all probability with the dead.

The coal shipments from Cardiff last week nearly totalled 300,000 tons, and yet the prevailing tone on 'Change is that there is a lack of animation in the trade. Shipments are large on account of the heavy contracts entered into. As regards general trade there is a degree of slackness, though prices are fairly maintained. Since Saturday last shipments have been heavy to Port Said, Savona, Hong Kong, and Teneriffe. Coaling H.M. fleet at Alexandretta has also been a marked feature, and some interesting facts have been brought to light respecting the rapidity with which coaling the Ramillies, Trafalgar, Hood, and Cambrian has been accomplished. The best average was given by the Trafalgar, equal to 141·6 tons per hour. When the result was made known, the commander—the Hon. Stanley Colville—and crew were jubilant, and the band was directed to play in honour of the event and of the Cardiff coaling steamers and men.

Coal business at Newport, Mon., has been fairly maintained, while Swansea showed last week an excess of 10,000 tons shipment over that of the corresponding week in 1895. The total included substantial shipments of anthracite to San Francisco. This week the coal trade at Swansea is not quite so animated.

Coal prices remain now about the same. Cardiff prices midweek were as follows:—Best steam, 10s. 3d. to 10s. 6d.; seconds, 9s. 6d. to 10s.; drys, 9s. 3d. to 9s 9d. Small steam, which is improving slightly, best, 5s.; seconds, 4s. 3d. to 4s. 6d.; dry, 3s. 6d. to 4s. Monmouthshire, best, 8s. 6d.; seconds, 8s., shipped at Cardiff. Swansea figures are:—Best steam, 9s. 6d. to 10s.; seconds, 8s. 9d. to 9s. 6d. Anthracite, 8s. 9d. to 12s., according to quality.

The house coal trade of late has been a little more brisk, varying as usual with the weather, which has become much colder, easterly winds prevailing. At Cardiff the demand has increased very perceptibly. Prices are, for best, 10s. 6d. to 11s.; No. 3 Llantwit, an excellent house coal, 11s.; No. 3 Rhondda, 9s. 7½d. to 9s. 9d.; brush, 7s. 9d. to 8s.; small, 6s. to 6s. 3d.; No. 2 Rhondda, 7s. 6d. to 7s. 9d.; through, 6s. 3d.; small, 4s. to 4s. 6d. No alteration at Cardiff in coke or patent fuel prices. Swansea prices for house coal this week have been much about the same. No. 3 Rhondda, 10s. to 10s. 6d.; through, 8s. 3d. to 8s. 9d.; small, 6s. 3d. to 6s. 6d. No. 2 Rhondda, 8s. 9d. to 9s. 6d.; through, 7s. to 9s.; small, 5s. to 5s. 6d.

I am still unable to record a settlement at Plymouth Collieries. The only work "permitted" is a little in the house coal. Negotiations are stated to be going on, but at the same time it must not be forgotten that mischief is going on also in the pits below. Every one knows how quickly an untenanted house depreciates, but that is nothing to the rapidity which a collapse takes place in an unworked colliery; roads "pucker," roofs fall, and if a re-start were made next week it would take some time to get into the old rut. Last week some families were obliged to go into the Union. This week the Local Board has found relief work for a few; at the most only 40 or 50 have had work.

After my despatch last week 1800 tons of steel sleepers were despatched to Bombay. Steel sheets for Canada are in hand at Dowlais, and prospects of steel rails for home use, the Colonies, and foreign countries are fairly certain. Rolling heavy rails will begin shortly at Ebbw Vale. Good indications of an improved steel trade are given in all directions from Swansea to Blaenavon. Large consignments of iron ore from Salta Capello and Bilbao have been coming in for the principal ironmasters, as well as for La Société Commerciale. But it is at Dowlais that the most prominent indications of better times are shown. This has been in the restarting of No. 19 furnace in the Upper Works, and instructions, I hear, are out for rebuilding No. 11 furnace, Lower Works.

The strike of the mechanics at Dowlais is to all appearance ending itself as usual, either the men return unconditionally, or will have to seek work elsewhere. The strike occurred just as times were mending, and the step is now regarded as a most unfortunate one, for many a place has been filled up. The times are inopportune for impulsive actions of that kind, with the keen rivalry shown by northern ironmasters. This week there have been large consignments of pig iron from the Grovesend Steel Company, Harrington, and also from Middlesbrough. Latest iron and steel quotations on Swansea Exchange are as follows:—

In pig iron there has been a slight depression, and prices left off a shade lower than they were last week. Glasgow warrants are at 47s. 2½d., cash buyers. Middlesbrough No. 3, 38s. 4d.; hematite warrants, 48s. 9d. for mixed numbers. Welsh bars, £5 5s. to £5 15s.; angles at usual extras. Sheet iron, £6 12s. 6d. to £6 15s. Steel sheets, £6 12s. 6d. to £17 6s. Bessemer steel bars for tin-plates, £3 17s. 6d. Siemens, best, £3 18s. Steel rails, heavy, £4 10s. to £4 15s.; light, £4 17s. 6d. to £5 5s. Tin-plates, Bessemer cokes, 9s. 1½d. to 9s. 3d.; Siemens, 9s. 3d. to 9s. 6d.; ternes, per double box, 28 by 20 C, 17s. 6d., 18s. 6d. to 22s. 6d.; best charcoal, 12s. 6d. to 13s. 6d., according to finish of brand. Wasters, 6d. to 1s. less. Block tin is easier.

Good news and the tin-plate trade appear to have parted company. The American trade was described on 'Change this week as very apathetic. The whole of the exports of tin-plates last week from Swansea was only 26,169 boxes, and the receipt from works was limited to 30,654 boxes. Stocks are now at 163,890 boxes. There is little change in the Swansea district. At Briton Ferry a little improvement has set in. Last week the Earlswood men resumed work, and at Gwalia, Villiers, and Baglan Bay, three mills were at work all the week. A fair amount of business is going on at the Briton Ferry Works in pig iron, and of steel bar and ingots at the steel works. Albion Works show an average make.

This week will decide the question of "Ayes" and "Noes" in the matter of the Llanelly new dock. The ratepayers have been appealed to whether 6d. per pound shall be given by the rates as a collateral security towards the cost of the dock.

Pitwood contines depressed at Cardiff, and sales are effected at a trifle over 15s.

The Taff Shipbuilding, Engineering, and Dry Dock Company has been registered at Cardiff, with a capital of £20,000 in £10 shares.

At the annual meeting of the Albion shareholders this week a dividend of 10 per cent. was announced. This is the well-known Cilfynydd colliery.

The Swansea triple scheme, to which I have referred on several occasions, is, so far as the purchase of tramways, one of the hopeful but unsuccessful aims of the Swansea Corporation. It was decided a little while ago to call in the opinion of one of the most able of independent experts, Mr. W. H. Preece, C.E., the eminent electrician, who supported the triple scheme in a most thorough manner, but at the eleventh hour a hitch occurred with the Tramway Company, and instructions have been given to withdraw the Bill. The electric lighting and the dust destructor scheme remain, and now the public must await events. Some still believe that there will be a successful termination.

I cannot vouch for the truth, but it is rumoured at Cardiff that Government has rather overbought itself in the matter of coal, and now that foreign questions are taking a more peaceful guise, is wishful to cancel some portion of the last contracts. I give this for what it is worth as a "gossip on 'Change," probably based on expectations.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE iron trade in this country is progressing satisfactorily. A good deal of work is coming to hand in most quarters, and the general tone of the market may be termed hopeful and firm, nearly all branches experiencing a better demand than at this time last year.

An active business is reported to have been done on the Silesian iron market during the week now past. Pig iron is briskly called for and quotations tend upwards. Two additional blast furnaces will be blown in shortly, one at the Laura works and another at the Königshütte. In the manufactured iron department new business is coming forward satisfactorily on home as well as on foreign account; bars are sold at M. 145 p.t.; sheets, M. 160 p.t.; while basis price for heavy plates is M. 145 p.t., free Breslau stores.

In Austria-Hungary the iron trade this week shows a little more life, and the slightly raised quotations of last week have been willingly paid in most instances. There is talk of a further advance in prices for bars, perhaps for girders also. The business done in these articles is developing much more favourably than during the first months of last year. Official quotations per ton, free Vienna, are:—For grey forge pig, 48 to 51 fl.; common forge, 45·50 fl.; Bessemer 45 to 51 fl.; ingots, 76 to 80 fl.; Styrian bars, 107·50 to 112·50 fl.; girders, 107 to 110 fl.; heavy plates, 142·50 to 165 fl.; galvanised sheets, 205 to 260 fl.; tin sheets, 27 fl. per box.

The French iron market has of late somewhat increased in firmness, although in some departments an uncertain feeling still prevails. But there have been some fairly large orders coming in just lately, chiefly for railway material. The worst feature of the iron market is that prices are so abominably low, with but little prospect of improvement in the immediate future. In the Departement Nord, for instance, the position of the ironworks is, as far as prices are concerned, decidedly more depressed than a year ago. Paris quotations are, for bars, 140f. p.t.; girders, 150f. p.t.

On the Belgian iron market the lively business of previous weeks has been well maintained all through this. Pig iron shows much firmness; producers are reported to have sold their output till end of second quarter, at 41f. to 42f. p.t., and consequently show little inclination to commit themselves very far forward at the present quotations. Athus quotes 43f. to 44f. p.t. for common forge pig. There will probably be one or two more blast furnaces blown in during the next quarter. Almost all sorts of malleable iron are in good request, and there has been a slight improvement in prices, those for bars and girders having been raised 5f. p.t. for export. Belgian export in manufactured steel was, for the first eleven months of 1895, 30,000 t. higher than in the year before. Exports in iron ore were 300,786 t., against 227,263 t.; imports being 1,731,930 t., against 1,776,021 t.

The industrial condition in the iron-producing districts of Rheinland-Westphalia continues satisfactory; prices are showing considerable firmness, and there have been symptoms of further improvement noticeable upon the week. Spring business is likely to be brisk, and the forges and foundries are looking forward to a busy time. In the iron ore trade output and consumption have been satisfactory. Prices met with an advance, Nassau red iron ore being sold at M. 9·30 p.t.; spathose iron ore fetches M. 8 to 9·10 p.t.; roasted ditto, M. 11 to 12 p.t.; Luxemburg minette, 40 p.c. contents, is quoted M. 3·20 p.t., net at mines; minor qualities realising only M. 2·10 to 2·60 p.t. Activity prevails in the pig iron trade, all sorts meeting with healthy request. Compared to the prices ruling at the beginning of the present quarter, quotations are, on an average, M. 2 p.t. higher. Spiegeleisen, 10 to 12 p.c. grade, is quoted M. 54 to 55 p.t.; forge pig, No. 1, M. 49 to 52 p.t.; No. 3, M. 42 p.t. Hematite, M. 65 p.t. Foundry pig, No. 1, M. 65 p.t.; No. 3, M. 56 p.t. Basic, M. 52 p.t.; Luxemburg forge pig, M. 46·50 p.t., free Luxemburg.

No change can be reported with regard to the malleable iron industry, the mills being regularly occupied, but complain of unremunerative prices. The bar mills are particularly well employed, foreign inquiries coming in rather more freely of late, and there is a fair activity secured for a considerable time. Girders, too, meet with a very healthy request, and hoops are also in good call generally. Heavy plates are selling briskly at slightly advanced prices. The employment in the sheet trade is stated to be satisfactory, prices being on an average M. 2 p.t. higher than formerly. In tubes, on the other hand, a slow business is transacted.

The following are the present list quotations, per ton, at works:—Good merchant bars, M. 100; angles, M. 118; girders, M. 84; hoops, M. 120 to 123; billets in basic and Bessemer, M. 81 to 83; heavy plates for boiler-making purposes, M. 160; tank do., M. 135 to 140; steel plates, M. 125 to 130; tank do., M. 115; sheets, M. 140 to 150; iron wire rods, common quality, M. 118 to 120; drawn wire in iron or steel, M. 118 to 135; rivet iron, M. 130; rivets, M. 150; wire nails, M. 127 to 130; complete sets of wheels and axles, M. 270 to 280; axles, M. 200; steel tires, M. 195 to 200; steel rails, M. 108 to 110; steel sleepers, M. 106; fish-plates, M. 112 to 120; light section rails, M. 95.

The following shows how prices for iron and steel have been moving upwards in 1895. From January 1st to 31st of December forge pig rose, in Rheinland-Westphalia, from M. 46 to 49 p.t.; Nassau, good forge quailty, from M. 43 to 48 p.t.; spiegeleisen from M. 52 on M. 54 and 56 p.t. Bessemer remained on M. 54 p.t. Basic rose from M. 37 on M. 40 to 42 p.t. Bars, from M. 100 on M. 108; boiler plates, from M. 124 on 125; drawn wire, from M. 105 on 118; steel rails, from M. 108 on M. 110; hoops, from M. 190 to 195 p.t.; axles, from M. 170 on M. 180; wheels remained on M. 170; springs rose from M. 180 on M. 220: all per ton. Tin sheets form an exception; while on the 1st of January, 1894, M. 16·8 per box—50 kgr.—was paid, the price realised on 1st of January, 1895, was M. 75·6, and on the 31st of December, 1895, M. 146 only was given.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, February 11tn.

THE financial and commercial sharps are everywhere predicting an early expansion of demand in manufacturing and jobbing circles, in consequence of the success of the Government loan. It is evident that already there is a better feeling, but as yet nothing has occurred to warrant the belief that there will be a rush of orders. Prices are low but not weak. Steel rails command 28 dols. at mill. Large orders were placed during the week. Street railway requirements will be heavier than last year. A large amount of mileage has been determined upon, and the work of construction begins early in spring. The iron trade is stronger than last week. Large orders for pig have been placed, in which Southern iron was favoured. Coke iron and charcoal are active in the Chicago region. There is a general increase of work in Western shops, preparatory to the spring demand from agricultural sources growing out of better wheat prices. Plate and structural iron orders are under consideration. Much office building in cities has been determined upon. Merchant bars have weakened under sharp competition. Pittsburgh mills are taking some business from the territory east of the Allegheny Mountains. The general merchandise markets show more activity. The banks have begun to be more liberal in the discounting of paper, and this will open the way to a larger volume of business.

KING'S COLLEGE, LONDON, ENGINEERING SOCIETY.—At a meeting held on the 14th ult., Mr. Wilson, M.I.E.E., delivered a lecture on "The Time Rate of Growth of Magnetisation of Iron, and its Importance to the Electrical Engineer." After briefly referring to the discoveries of Oerstedt, Arago, and Davy, relating to electro-magnets, and to Faraday's celebrated experiments on induced currents, the author proceeded to explain that although in small electro-magnets, and electro-magnets with laminated cores, the reversal of magnetisation practically occurred simultaneously with the reversal of the exciting current, yet in large electro magnets with solid cores this was not the case, but the reversal of magnetisation took place at an appreciable time after the reversal of the exciting current, the outer layers having their magnetisation reversed first, whilst those layers less remote from the centre lagged behind the outer layers. The author then showed experiments illustrating the above, the magnets and other apparatus being the same as used by Dr. Hopkinson and himself when delivering a paper before the Royal Society, Royal Institution, and Institution of Electrical Engineers. He next showed these effects by means of curves, which had been recorded by means of photography on a plate moving at an appropriate speed before the spot of light. The second part of the paper was devoted to the importance of this time-rate of change of magnetisation to the electrical engineer, and the author pointed out that supposing these induced currents could not be prevented, then direct current dynamos and the alternate current transformer would be rendered useless, and we should be thrown back on the alternate current machine, without iron in the armature, and have to use rectifiers for direct or intermittent currents. An experiment was then shown that by passing an alternating current round a solenoid containing a solid ring of soft iron, the ring speedily became heated, partly owing to magnetic hysteresis, but almost wholly due to induced currents. In conclusion, the author expressed his thanks to Dr. Hopkinson for allowing the use of his magnets, and also to Messrs. Cobb, Evans, Shawcross, and Welbourn for arranging and carrying out the experiments.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

6th February, 1896.

2693. Sunrays, G. Bodwell and F. M. Weston, London.
2694. Convertible Dress Waistcoat, C. Townley, London.
2695. Wheel Skates, G. Slater and A. H. Plante, London.
2696. Oil Lamps and Cans, E. and S. Brown, Birmingham.
2697. Optical Toy, E. A. N. Pochin, Chelmsford.
2698. Cycles, W. H. Goodman, Peterborough.
2699. Meat Mincing Machines, J. Higham, Manchester.
2700. Sliding Seats of Boats, W. Dickens, Leicester.
2701. Gut Ropes and Cords, F. Garner, Manchester.
2702. Bracket for Window Blind Rods, F. R. Baker, Birmingham.
2703. Receptacle for Tobacco Ash, F. R. Baker, Birmingham.
2704. Securing Grate Bars, J. Stevenson, Bradford.
2705. Blue Colouring-matters, W. H. Claus and A. Rée, Manchester.
2706. Billiard Tables, T. Whitty, Longport.
2707. Incandescent Electric Lamps, A. J. Howard, Taunton.
2708. Severing Metal Bars, F. Shirtliff, Glasgow.
2709. Treating Barley, J. and W. Dunn, Glasgow.
2710. Locking Apparatus for Gas Taps, T. A. Skelton, Southampton.
2711. Painting Photographs and Prints, M. Williams, Wigan.
2712. Door Fastener for Traps, F. Davies, F. W. Leggatt, and H. Vincent, Birmingham.
2713. Feed Pump for Steam Generators, T. Elcoate, Stockton-on-Tees.
2714. Chisel for Cutting Stone, &c., J. Dransfield, Barnsley.
2715. Supporting the Leaves of Partitions, J. B. Peace, Manchester.
2716. Watches, H. Heilmann, Manchester.
2717. Electric Switch, F. H. Royce and E. A. Claremont, Manchester.
2718. Boiler Furnaces, J. E. Cryer, Manchester.
2719. Cruet Stands, H. Moreton, Birmingham.
2720. Crank, T. S. James, London.
2721. Bottle Stand and Drip Catcher, B. R. Banks, London.
2722. Pulp Strainers, J. White, Glasgow.
2723. Cylinders of Wooden Staves, J. B. Delcroix, Brussels.
2724. Tube, E. Hénault, Brussels.
2725. Composition of a Paste for Matches, L. Caucheteur, Brussels.
2726. Chimneys, A. Ransom, Farnham.
2727. Buttonholes, L. C. Marshall, London.
2728. Buttons, J. Bate, Birmingham.
2729. Windows, G. W. Potts, London.
2730. Fireplaces, G. W. Potts, London.
2731. Swings, J. Bickerstaff, London.
2732. Rotary Engine, A. U. Chauveau and L. Guichard, London.
2733. Camera Adjustment, O. Linley and F. O. Scott, London.
2734. Money Pockets, W. Junge, London.
2735. Clockwork Domestic Apparatus, C. M. Walker, London.
2736. Bicycle Supports, G. Goddard, London.
2737. Cycle Bells, H. Lucas, London.
2738. Stop and Bib Cocks and the like, E. H. Page, London.
2739. Pendulum Automatic Scorer, E. J. Nowell, London.
2740. Hose Connection for Water Cocks, J. T. Jay, London.
2741. Medicine for Curing Indigestion, C. Campbell, Glasgow.
2742. Reduction of Refractory Ores, H. R. Angel, London.
2743. Making Tobacco, J. Busfield, London.
2744. Locks of Window Sashes, H. G. Lasenby, London.
2745. Blowing Organs, B. M. Drake and J. M. Gorham, London.
2746. Paving Blocks, E. Buchholtz, London.
2747. Golfing Tee, W. Forshaw, London.
2748. Sea Shell Reflector, J. J. Toon and W. Read, Leamington.
2749. Ball Cocks, J. Jones, London.
2750. Lamp Globes or Glasses, C. M. Wohlmuth, London.
2751. Mechanism of Embroidery Machines, H. Hill, London.
2752. Excentrics, W. N. Reazor, London.
2753. Gas Engines, F. Bamford and W. Wadsworth, London.
2754. Tins for Storing Tobacco, G. H. Williamson, London.
2755. Treating India-rubber Compounds, J. Barclay, London.
2756. Circular Knitting Machines, C. A. Allison.—(*The Providence Knitting Machine Company, United States.*)
2757. Umbrellas, F. Goldschmidt, London.
2758. Weaving Textile Fabrics, W. P. Thomson.—*Seydel and Co., Germany.*)
2759. Improved Saddles for Bicycles, A. Dodds, London.
2760. Scissors, R. Chalmers and A. R. Munro, Liverpool.
2761. Advertising Appliances, J. L. Morley and E. G. Simpson, Manchester.
2762. Movable Screens or Partitions, E. Phillips, London.
2763. Cigar Cases, &c., G. E. Molyneau, London.
2764. Heel-lift Cutting Apparatus, W. P. Bosworth, London.
2765. Stands for Displaying Dresses, T. Foster, London.
2766. Cigar-making Machines, A. H. Lake.—(*La Société Anonyme La double Cigarière, Belgium.*)
2767. Telephonic Systems, A. R. Bennett and G. J. Somerville, London.
2768. Machine for Painting Sash Bars, J. R. Hamilton, Hereford.
2769. Breech-loading Small-arms, H. W. Holland and T. Woodward, London.
2770. Sharpening Lead Pencils, A. Meydenbauer, London.
2771. Polyazo Dyes, T. R. Shillito.—(*J. R. Greigy and Co., Switzerland.*)
2772. Polyphase Dynamos, Siemens Bros. and Co., Ltd.—(*Siemens and Halske, Germany.*)
2773. Portable Electric Lamps, C. N. Gauzentes, London.
2774. Propelling Boats, G. F. Harvey, London.
2775. Heating Gas Engine Tubes, R. Hornsby and Sons, Ltd.—(*The firm of Burton Fils, France.*)
2776. Metal Lathing for Fireproof Ceilings, G. A. Harvey and J. F. East, London.
2777. Apparatus for Pressing Fabrics, W. Ambler, Bradford.
2778. Supporting Knickerbockers, &c., L. Jacobs, London.
2779. Slaughtering Cattle, N. Hart and H. Towndrow, London.
2780. Feathers, C. Souchon, London.
2781. Iron and Steel, F. B. Last and J. R. Wright, London.

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2782. Ash-pans, E. G. Pulford, Liverpool.
2783. Relief Devices for Cooking Utensils, E. G. Pulford, Liverpool.
2784. Saw Bench for Cutting Wood, J. Benton, London.
2785. Patent Cork Guard, J. E. Ballard, London.
2786. Supporting Lavatory Basins, M. J. Adams, London.
2787. Socket Hinge for Mail-carts, Y. Normington, Liverpool.
2788. Steam Generators, &c., W. W. Beaumont, London.
2789. Cotton Fabrics, R. Tasker and T. Thorpe, Manchester.
2790. Net Parcel Carrier for Cycles, A. R. Austen, Hereford.
2791. Golf Clubs, J. W. Price, London.
2792. Hardening Metals, R. Wallwork, Manchester.
2793. Steam Generators, J. Thom, Liverpool.
2794. Water Gauges, W. E. Heys.—(*Schaffer and Budenberg, Germany.*)
2795. Metallic Pistons, G. Saxon, J. Saxon, and A. Saxon, Manchester.
2796. Mustard Pot Covers, R. J. Smith, Birmingham.
2797. Holding Bread while Cutting, R. J. Smith, Birmingham.
2798. Toys, E. H. Goold, London.
2799. Holding Pens, D. P. Brown and W. F. Steele, Halifax.
2800. Shoulder Measure, J. Alexander, Newcastle-on-Tyne.
2801. Safety Pins, W. Holland, jun., Birmingham.
2802. Bedroom Comfort, D. E. Blackley, Wrexham.
2803. Locking Railway Points, S. T. Dutton, Worcester.
2804. Roller Frames for Signal Rods, S. T. Dutton, Worcester.
2805. Springs of Vehicles, W. H. Sewell and R. W. Aitken, Glasgow.
2806. Fire-arms, J. Hewetson.—(*J. Wright, Egypt.*)
2807. Steam Engines, W. H. Griffiths, Liverpool.
2808. Cycle Handles, T. F. Holloway, Glasgow.
2809. Wooden Drawer Knobs, H. Wright and G. Turner, Birmingham.
2810. Down-draught Brick Kiln, S. Abram, Manchester.
2811. Receptacles for Storing Fruit, J. T. Moore, Cheshire.
2812. Jointed Rule and Callipers, R. J. Broderick, Dublin.
2813. Continuous Firing Kilns, J. Higson, London.
2814. Door Fastenings, J. Ashbury and J. Vincent, Birmingham.
2815. Manufacture of Margarine, &c., J. Rose, London.
2816. Guards for Loom Shuttles, J. Scaife, London.
2817. Rack for Printers' Furniture, T. Reeves, London.
2818. Regulator for Delivering String, J. A. Riley, London.
2819. Kettles, F. G. Stokes, London.
2820. Magic Lanterns, S. H. Cousins, London.
2821. Photographic Dark Slides, R. E. Eggleton, London.
2822. Improved Guards for Shins, T. C. Richards, London.
2823. Brakes for Railway Engines, T. W. W. Roberts, London.
2824. Collapsible or Folding Boxes, C. McCallum, London.
2825. Securing Window Screens, H. M. D. Keith, London.
2826. Needles for Sewing Machines, E. Studd, London.
2827. Carriage Wheels, R. Donaldson and F. Buckland, Surrey.
2828. Hot Water Apparatus, W. Dilworth and E. Carr, London.
2829. Mud Guards for Cycles, G. A. Wilson, London.
2830. Pneumatic Tires, H. Jelley and C. Hubbard, London.
2831. Machines for Fabrics, H. Jelley and C. Hubbard, London.
2832. Fasteners for Gaiters, F. Schutze, London.
2833. Photographic Plate Holder, W. J. Windrum, London.
2834. Targets for Pistol Shooting, R. J. Home, London.
2835. Churns, E. T. Hughes.—(*N. Packard, United States.*)
2836. Floor Coverings, A. S. Oetzmann and S. J. Narracott, London.
2837. Aromatising Articles of Food, R. R. Cox, London.
2838. Pencil Holders, W. P. Thompson.—(*The American Lead Pencil Company, United States.*)
2839. Velocipedes, W. P. Thompson.—(*W. E. Prall, United States.*)
2840. Scouring Materials, T. Halliwell and J. Stones, Manchester.
2841. Increasing Machine Power, J. and J. Price, Birmingham.
2842. Holding Scaffold Poles, G. J. Kunkler, Liverpool.
2843. Lime Kilns, H. Simmonds and J. Delaney, Manchester
2844. Method of Dyeing, A. H. Brownlow and J. Stansfield, London.
2845. Railway Signalling Apparatus, W. J. Bonser, London.
2846. Attaching Shanks to Buttons, E. Teltschik, London.
2847. Spring Mattresses for Beds, &c., F. Krieg, London.
2848. Cycle Wheels, H. Godsal, London.
2849. Covers for Pneumatic Tires, H. Godsal, London.
2850. Trawl-warp Fairleaders for Steam Vessels, C. F. Amos, London.
2851. Valve Boxes for Feed Pumps, J. Martin, London.
2852. Brick Kilns, E. Thomas, London.
2853. Ventilating Manhole Covers, F. J. Holloway, London.
2854. A New Puzzle or Game, W. N. Homeyard, London.
2855. Padlock, F. A. V. Vallés and S. H. S. Steer, London.
2856. Cycle Locks, F. J. J. Gibbons, London.
2857. Linotype Machines, The Linotype Company, Ltd., C. L. Ireland, and F. J. Wich, London.
2858. Metallic Alloys, J. P. Fullerton and A. B. King-Church, London.
2859. Filtering and Purifying Liquids, J. G. Lorrain, London.
2860. Steam Traps, G. G. Picking and W. Hopkins, London.
2861. Letter-boxes, W. S. Barwick, London.
2862. Non-fillable Bottles, A. M. Riley and J. D. Crary, London.
2863. Castors, T. W. Martin, London.
2864. Puzzles, C. M. Fitz, London.
2865. Non-fillable Bottles, W. Magoffin, London.
2866. Puzzles, E. G. Solomon, London.
2867. An Improved Stirrup, H. Frères, London.
2868. Steam Generators, J. M. Stratton, London.
2869. Driving Mechanism, C. Kettel, London.

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2870. Watch Protector, C. Smallman, London.
2871. Rubber Brake for Cycles, &c., E. Holroyd, Bradford.
2872. Ladders, L. Seager, Milton.
2873. Conductor Culverts, H. L. Doulton and C. E. Morris, London.
2874. Oil Motor Pumps, T. B. Marchant, London.
2875. Incandescent Lamps, H. H. Hall and W. D. Cheyne, Manchester.
2876. Marine Propulsion, A. J. Jacobs, Bristol.
2877. Wheel Tires, H. Tee, Liverpool.
2878. Sound-signalling Apparatus, W. B. Barker, Liverpool.
2879. Velocipede Bearings, J. C. Walker and E. B. Day, London.
2880. Lamp-bearer for Lighting Machines, H. Appenzeller, Cologne.
2881. Rowlocks, E. de Riar London.
2882. Ink Wells, G. D. Spielman, London.
2883. Carpet Stretcher, F. M. Zander, London.
2884. Railway Vehicle Couplings, A. Atkinson, London.
2885. Kitchen Cabinet, W. Swenson, London.
2886. Stoppering Bottles and Hollows, R. Edgcumbe, London.
2887. Cooking Appliance, W. R. Morecraft, London.
2888. Gutters and Spouting for Roofs, R. H. Ash, Southampton.
2889. Pipe Joints, F. C. Lynde, Manchester.
2890. Speed Mechanism for Cycles, J. Clough and J. Bush, Bradford.
2891. Speed Mechanism for Vehicles, J. Clough and J. Bush, Bradford.
2892. Pneumatic Tire Valves, W. I. Chadwick, Manchester.
2893. Hinging of Window Sashes, G. C. Brown, jun., Glasgow.
2894. Electric Alarm Clock, A. H. Webb, Glasgow.
2895. Igniting Apparatus for Motors, W. J. Crossley and J. Atkinson, Manchester.
2896. Soap, J. Stockhausen, Manchester.
2897. Joint for Pipes and Tubes, W. Coppock, Manchester.
2898. Lock for Vehicle Door, J. B. McConville, Birmingham.
2899. Safety Bicycles and Velocipedes, R. W. Smith, Birmingham.
2900. Sleeve Cuff Links, W. J. Myatt, Birmingham.
2901. Furnace for Treating Refuse, S. Willoughby, London.
2902. Curing and Drying Casks, &c., J. Gillies, Glasgow.
2903. Purses, G. W. Paterson, Glasgow.
2904. Fire-lighters, T. M. Percy, Glasgow.
2905. Adjustable Shirt Cuff, D. W. T. Holloway, London.
2906. Woven Pile Fabrics, J. Clough and J. Park, London.
2907. Fastener for Attaching Buttons, T. M. Keene, Mold.
2908. Meat Safe for Butchers, &c., P. Hammond, London.
2909. Secondary Batteries, L. Falero and H. Lumley, London.
2910. Gas Burner, E. Ernst, London.
2911. Fasteners, A. B. Silverston, London.
2912. Ties for Barrels, E. Hale, Liverpool.
2913. Winding or Spooling Silk, H. Goodwin, Manchester.
2914. Driving Gear for Velocipedes, J. and J. Price, Birmingham.
2915. Gas Igniting, &c., Apparatus, A. Czarnikow, London.
2916. Tires for Vehicles, J. S. Taylor and C. Davies, Liverpool.
2917. Thill Supports, J. Q. Lemmon, London.
2918. Ball-bearings, A. J. Boult.—(*G. G. Brandenburg, United States.*)
2919. Journal Boxes, G. F. Godley, London.
2920. Sun-dials, A. J. Boult.—(*L. Braun, Germany.*)
2921. Photographic Plate Holders, E. G. Cone and D. R. Close, London.
2922. Mixing Mortar, R. Pilgrim and J. Pemberton, London.
2923. Dynamos, W. C. Johnson, L. J. Steele, and J. W. Ewart, London.
2924. New Gunpowder, O. Imray.—(*F. C. Glaser, Germany.*)
2925. Surface Condenser, E. B. Caird and J. T. Rayner, London.
2926. Motor Wagon, O. W. Ketchum, London.
2927. Ball-bearings, J. G. Dixon, London.
2928. Check on Billiard Markers, J. G. Dixon, London.
2929. Applying Acetylene Gas, J. R. Wigham, Dublin.
2930. Conveying Air or Gases, S. H. Wright, Monmouth.
2931. Obtaining Metals from Ores, J. S. Wallace and J. Castell-Evans, London.
2932. Boot Trees, H. T. G. Phillips and St. J. Adcock, jun., Dublin.
2933. Packing-cases, F. Barnett, London.
2934. Composing Machines, C. Meray-Horveth, London.
2935. Rudders, J. A. Coghill, London.
2936. Portable and other Forges, W. and E. Allday, London.
2937. Tubular Lantern, J. Hinks and Son and H. D. Hinks, London.
2938. System for Propulsion of Vehicles, A. G. New, London.
2939. Printing Machinery, W. Muller, London.
2940. Window Fasteners, W. H. Hatch and R. F. E. and J. A. H. Ferrier, London.
2941. Cooking Apparatus, W. H. Hatch and R. F. E. and J. A. H. Ferrier, London.
2942. Winches, J. B. Furneaux, London.
2943. Burring Apparatus, J. Holden, London.

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2944. Electro-magnetic Instruments, H. W. Sullivan, London.
2945. Calming Seas, A. J. van Beek, London.
2946. Sulpho-acid, Levinstein, Ld., and A. Levinstein, Manchester.
2947. Fluid Pressure Brakes, J. G. A. Kitchen, Manchester.
2948. Holder for Railway Tickets, W. H. W. Mason, London.
2949. Toasting Appliances, A. J. Aspinall, Liverpool.
2950. Embrocation or Liniment for Horses, E. J. Barker, Glasgow.
2951. Steam Vessel, J. Mackenzie, Newcastle-on-Tyne.
2952. Rod for Window and other Screens, T. White, London.
2953. Skates, W. Adkins, Birmingham.
2954. Safety Pin, J. Boyd, Dublin.
2955. Lamp Wick Mechanism, W. T. Webber, Birmingham.
2956. Manures, D. Cross, Glasgow.
2957. Platinum Vessels, H. A. Kent, London.
2958. Beam Flange Protector, C. Fish, Darwen.
2959. Preventing Vessels Capsizing, W. H. Bradford, Chester.
2960. Fastening Cords to Sashes, J. Lumsden, Aberdeen.
2961. Band Sawing and other Machines, A. Smith, London.
2962. Bottles, J. Ledbrook and C. L. Edkins, Birmingham.
2963. Clip Stud for Cyclists' Gaiters, G. A. Tydeman, Waltham Cross.
2964. Wiring for Electric Installations, R. C. Quin, Brighton.
2965. Photographic Camera, &c., T. P. Bethell, Liverpool.
2966. Pipe Wrench, Spanner, and the like, D. N. Bertram, Glasgow.
2967. Musician's Friend, T. Hill, W. T. Keay, and G. Tallis, jun., Birmingham.
2968. Locking Points, S. T. Dutton and W. Buck, Worcester.
2969. Fuel Economisers, J. Pimbley and W. A. Rothwell, Manchester.
2970. Superheating Apparatus, J. Pimbley and W. A. Rothwell, Manchester.
2971. Dyeing Yarns, T. Hoyle and Sons, Ld., and J. A. O'Loughlin, Manchester.
2972. Pipes for Smoking Tobacco, H. D. Bailey, Manchester.
2973. Target Frame for Rifle Ranges, M. Mullineux, Manchester.
2974. Watches, T. Sumner, St. Helens.
2975. Scale Reader or Indicator, L. P. Asbury, York.
2976. Washing Board, S. Austin, Manchester.
2977. Lock Nut and Friction Washer, E. Lagier, Dublin.
2978. Ladies' Imperceptible Skirt Band, H. S. Scott, York.
2979. Intercepting Trap Grating, W. H. Reading, Birmingham.
2980. Station Finder and Angle Indicator, W. Pilkington, East Runton.
2981. Basket, W. Halliday, Edinburgh.
2982. Paper Bags or Envelopes, H. Abraham, London.
2983. Substitution for Gut, H. Thompson and L. Dawes, London.
2984. Facilo Ornamental Hair Pin, E. Rudolph, London.
2985. Leaf Turner, C. Müller, London.
2986. Compensating Arm for Banjoes, H. A. Beardmore, London.
2987. Curtain Suspenders, H. L. Benham, London.
2988. Heating Asphalte, H. D. Blake and A. Stapley, London.
2989. Skate Wheels, G. M. Gibbs and B. Hallett, London.
2990. Seams in Waterproof Apparel, S. Ornstein, London.
2991. Gymnastic Apparatus, F. P. Boisset, London.
2992. Attaching Hats to the Head, W. Hawthorn, London.
2993. Adhesive and Agglutinating Substance, A. Zendroni, London.
2994. Chimney or Ventilator Tops, M. H. Foster, London.
2995. Chimney or Ventilator Top, M. H. Foster, London.
2996. Controlling Fluid-pressure Engines, H. Swanton, London.
2997. Production of Iron, E. J. M. Servais and P. Gredt, London.
2998. Elevators for Cleaning Material, J. Denis, London.
2999. Sulphonic Acids, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Bruning, Germany.*)
3000. Colouring Matter, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Bruning, Germany.*)
3001. Carriage for Quick-firing Gun, D. M. B. H. Cochrane, London.
3002. Construction of Wheelbarrows, M. W. Fenton, London.
3003. Automatic Apparatus, D. Cameron and F. J. Commin, London.
3004. Preventing Bursting of Water Pipes, W. H. Le Roy, London.
3005. Device for Keeping Plants Supplied with Water, G. T. Martin, London.
3006. Shipping Boxes for Animals, G. Bell, London.
3007. Thermometers, S. Goldman.—(*R. Grosse, Germany.*)
3008. Toy for Educational Purposes, J. Clewlow, London.
3009. Apparatus for Closing Vessels, E. Stern, London.
3010. Wheels, L. L. Izart, London.
3011. Ink-bottles, R. T. Vise, London.
3012. Lance Holders, H. J. Haddan.—(*W. Strohn, Germany.*)
3013. Odometers, B. Westhüsing, London.
3014. Joints or Unions for Pipes, &c., W. Shoosmith, London.
3015. Draught Apparatus of Carriages, A. J. Boult.—(*J. Langer, Germany.*)
3016. Pinchers for Lasting Boots, &c., F. Cutlan London.
3017. Hand Tackers for Boots, F. Cutlan, London.
3018. Vessels Containing Effervescent Liquids, J. Friedländer, London.
3019. Ticket Punchers, A. R. Fairer and G. Salter, London.
3020. Chimney Cowls, C. H. Upright, London.
3021. Obtaining Luminous Effects in Pictures, J. B. O. Suidter, London.
3022. Electrodes of Secondary Batteries, H. H. Lake.—(*H. J. Tudor, Belgium.*)
3023. Measuring the Power of Gases, H. H. Lake.—(*Sprengstoff Actien Gesellschaft-Carbonit, Germany.*)
3024. Bale Ties, H. Williams, London.
3025. Bottles, W. T. Williams, London.
3026. Producing the Appearance of Mounted Photographs on Plain Cards, J. Bacon, London.
3027. Pressure Gauges, F. Beeby, London.
3028. Polyazo Dyestuffs, S. Pitt.—(*L. Cassella and Co., Germany.*)
3029. Nail and Washer, C. Husk.—(*J. Mitchell, New Zealand.*)
3030. Railway Locomotives, F. O. Prince, London.
3031. Toilet Paper, F. F. Aichlburg, London.
3032. Self-acting Electrical Signalling Apparatus, H. O. Krapf, London.
3033. Appliances for Spraying Oil, &c., The Pneumatic Painting Machine (1895) Corporation, Ld., and H. C. Cleaver, London.
3034. Operating Switches of Railways, H. Bartz, London.
3035. Reduction of Nitro-benzol, J. Y. Johnson.—(*Chemische Fabrik Griesheim, Germany.*)

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3036. Sinkers for Knitting Machinery, F. J. Cartledge and H. B. Dawson, London.
3037. Self-cleaning Smoking Pipe, W. S. Vaughan, Liverpool.
3038. Spring Apron Hook, C. Payne, Croydon.
3039. Type-writing Machine Keyboards, M. Bartholomew, London.
3040. Spring Grips for Securing Ball Ends to Tubes, G. Chisholm, jun., Stirling.
3041. Hair Curler, C. Burch, London.
3042. Steam Generators, E. Makin, jun., Manchester.
3043. Wool-holders, T. G. Russell, London.
3044. Station Indicator, W. H. Milligan, Belfast.
3045. Steam Boilers, J. Blake, Middlesbrough.
3046. Safety Pocket Clip, E. E. Evans, Gloucestershire.
3047. Construction of Settling Tanks, J. B. Petrie, Rochdale.
3048. Lensed Glasses for Lamps, &c., J. Hulls, Birmingham.
3049. Trap for Drains, &c., E. Codling, Manchester.
3050. Making Black Puddings, E. Turner and J. Bell, Liverpool.
3051. Trap for Catching Rats, &c., S. C. Dyer, London.
3052. Ink-wells, R. Bell and L. Hall, South Shields.
3053. Metallic Packing for Piston-rods, &c., W. Harbinger, South Shields.
3054. Shaping, &c., Metals, J. Robertson, Lancashire.
3055. Hand Cameras, A. C. Jackson, London.
3056. Glowery Holes, H. H. Pitt and Sowerby's Ellison Glass Works, Ld., Barnsley.
3057. Skirt Suspenders, C. W. E. Towers, London.
3058. Scouring, &c., Yarn, W. Hepworth-Collins, Bolton.
3059. Mechanical Device for Battleships' Ramming Purposes, R. J. Plunkett, Bristol.
3060. Ships' Berths, &c., T. Young, Birmingham.
3061. Securing the Lids on Jars, &c., H. P. and G. A. Phillips, Birmingham.
3062. Oil Evaporisers, D. G. Taylor, London.
3063. Condensers, J. Spittall, Glasgow.
3064. Spring Tooth Cultivators, T. Hunter, sen., A. Hunter, and T. Hunter, jun., Glasgow.
3065. Traps for Shooting Purposes, G. H. Laxton, London.
3066. Sand-blast Apparatus, D. Young.—(*J. E. Parker, United States.*)
3067. Running Gear for Vehicles, O. Wilson, London.
3068. Improved Tobacco Pipe Cleaner, A. Lehmann, London.
3069. Securing Tires to Rims of Wheels, J. Adair, London.
3070. Securing Tires to Rims of Wheels, J. Adair, London.
3071. Motor Collecting Brushes, G. E. Dorman, Stafford.
3072. Cooling and Circulating Air, W. Garden, London.

3073. Twisting and Winding Machines, E. and R. Dawes, London.
3074. Bottle and Stopper Therefor, H. O. Choles, London.
3075. Billiard Cues, H. O. Choles and J. Sawyer, London.
3076. Valve for Domestic and like Boilers, J. Cattrall, London.
3077. Lubricator for Wheels, T. C. Blanchflower, London.
3078. Boots, Shoes, Slippers, and Gaiters, R. T. Brand, London.
3079. Buckles, C. J. Westwood and J. G. Baxter, London.
3080. Stoppering Bottles, J. Y. Johnson.—(*C. H. Davis, United States.*)
3081. Promoting Perspiration, &c., G. J. Epstein, London
3082. Induction Motor Armatures, A. L. Cushman, London.
3083. Electrical Ceiling Rose, &c., R. W. Braham, London
3084. Polo and Golf Balls, A. E. C. Pobgee, London.
3085. Plumb Bobs and Lines, J. F. Hyett, Norwich.
3086. Extraction of Gold, Silver, &c., J. B. Torres, London.
3087. Wheel Builder, J. H. Player, London.
3088. Appliance for Use in Cookery, E. E. Spencer, London.
3089. Plate Polish, W. Mylrea, London.
3090. Reduction of Organic Compounds, C. Kellner, London.
3091. Filling Paste of Batteries, R. Linde, London.
3092. Controllers, J. Devonshire.—(*W. B. Potter, United States.*)
3093. Controllers, J. Devonshire.—(*W. H. Knight and J. W. Darley, jun., United States.*)
3094. Regulating Phase Relation, J. Devonshire.—(*E. J. Berg, United States.*)
3095. Brake for Cycles, &c., W. F. Fremersdorff, London.
3096. Regulating the Tension of Electric Currents, J. Imray.—(*La Société Anonyme pour la transmission de la force par l'Electricité, France.*)
3097. Pneumatic Tire Inflator, A. Gladding, London.
3098. Collection of Carbonic Acid Gas, A. J. Boult.—(*The Pabst Brewing Company, United States.*)
3099. Footballs, J. Cooper, London.
3100. Lamp Burners, J. Gregory, London.
3101. Devices for Heating Apparatus, P. Frase, London.
3102. Blast Rocking Furnace Grates, J. L. White, Leeds.
3103. Food, A. J. Boult.—(*W. Meadows, United States.*)
3104. Apparatus for Recreative Purposes, J. W. Cawdery, London.
3105. Veil Fasteners, G. C. Ferguson, London.
3106. Umbrella Holder for Carriages, S. A. Parkes, London.
3107. Steps, W. J. Barkway, London.
3108. Window Stand for Goods, &c., J. Mitchell, London.
3109. Preventing Boiler Explosions, W. J. Dear, London.
3110. Sash Fasteners, C. Maitland and W. G. Thomas, London.
3111. Couplings for Vehicles, H. H. Lake.—(*C. A. Gould, United States.*)
3112. Refrigerating Apparatus, F. N. Mackay, London.
3113. Sewing Machines, H. H. Lake.—(*E. L. Sprague, United States.*)
3114. Pumps, J. West, London.
3115. Smoke-condensing Apparatus, S. S. Pridham and G. Heinkel, London.
3116. Cocks, C. J. Thornhill, London.
3117. Guard for Dressing Hair, H. de V. Pery, London.
3118. Bill Files, W. O. Gottwals, London.
3119. Wood Wheels for Vehicles, A. Reichwald.—(*A. Resow, Germany.*)
3120. Slate-pencil Sharpener, J. A. Worsnop and J. Midgley, Halifax.
3121. Ankle Guards for Football, J. J. Eckert, Kent.
3122. Tip Carts, B. Norrington, London.
3123. Water-tube Boilers, J. C. Hudson, London.
3124. Cycle, &c., Wheels, H. V. Swan and W. Swan, London.
3125. Buffers for Vehicles, H. F. von Rösslerstamm, London.
3126. Space Bars of Linotype Machines, The Linotype Company.—(*The National Typographic Company, United States.*)
3127. Journal Bearings, O. Boyce and J. W. Ward, London.
3128. Hinge, W. G. Smith, London.
3129. Drying Malt, W. P. Thompson.—(*L. A. Henze, United States.*)
3130. Granulated or Powdered Food Extracts, W. P. Thompson. —(*The New Process Food Company, United States.*)
3131. Impregnating Fibrous Substances, W. P. Thompson.—(*F. Hasselmann and A. Sonnemann, Germany.*)
3132. Ore Crushers, J. Roger, London.
3133. Electric Clocks, J. Wiesner and A. Witzel, Liverpool.
3134. Obtaining Chlorine from Chlorides, P. J. Beveridge, Liverpool.
3135. Embossing Hollow Metal Bodies, C. Huber, London.
3136. Japanned and other Paint Boxes, W. Burton, London.
3137. Screw-stoppered Bottle Neck, J. H. Williams, London.
3138. Self-setting Carriage Jack, G. W. Jessop, Godalming.
3139. Dress Skirt Holders, &c., F. W. Steinhoff, London.
3140. Check Protectors, Daters, and Cancellers, G. C. Marks. —(*The Beebe Check Protection Company, United States.*)
3141. Apparatus for Desiccating, J. M. Boustead, London.

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3142. Acetylene Gas Generator, F. S. Thorn and C. Hoddle, London.
3143. Ladies' Hat Fasteners, &c., F. S. D. Scott, London.
3144. Vacuum Tubes, L. S. M. Pyke, London.
3145. Printers' Galleys, S. W. North and L. Kershaw, Leeds.
3146. Dipping Fire-lighters, E. Pollard and J. Metcalfe, Bradford.
3147. Grooving Fire-lighters, E. Pollard and J. Metcalfe, Bradford.
3148. Washing Machine, W. H. Murton, W. S. Varley, and E. O'Hara, Keighley.
3149. Mud-guard for Cycles, H. Kiddier, J. White, and W. Walker, jun., Nottingham.
3150. Shuttles of Looms for Weaving, H. Hanson, Bradford.
3151. Arc Lamp, A. T. and F. T. Schmidt, Birmingham.
3152. Rotary Engines, G. P. Grace, London.
3153. Ventilators, T. A. Dove and T. Jamieson, Glasgow.
3154. Type Blocks, H. D. Whiteley, Manchester.
3155. Latrine Closets, J. J. Green and W. Oates, Halifax.
3156. Operating Shuttle Boxes, G. Keighley and F. Rosskothen, Halifax.
3157. Combined Hoe and Rake for Weeding, A. C. Hall, Glasgow.
3158. Tires for Cycles, R. Pritt, Lancaster.
3159. Cycle Gear Cases, W. H. Higgitt and W. Crowson, Birmingham.
3160. Chain Wheel Mechanism for Cycles, E. Evans, Birmingham.
3161. The Flexible Shoe Lifter, T. R. Morse, Bristol.
3162. Muzzles, J. Fletcher, London.
3163. Revolution Counter, V. L. M. Renard, Manchester.
3164. Library Shelving, W. H. and F. A. Winslow, Glasgow.
3165. Valves for Pneumatic Tires, J. T. Nelson, Leeds.
3166. Water Ports, T. R. Lee and G. A. Morgan, Sunderland.
3167. Roundabouts, T. Walker, G. F. Alder, and J. Studt, Tewkesbury.
3168. Steam Generators, W. Fairweather.—(*The Babcock and Wilcox Company, United States.*)
3169. Steam Generators, W. Fairweather.—(*The Babcock and Wilcox Company, United States.*)
3170. Metallic and Rubber Tires, J. M. Leigh, Manchester.
3171. Vices, W. E. Heys.—(*J. Milburn, United States.*)
3172. Bedsteads, Folding Chairs, &c., J. T. Petford, Manchester.
3173. A New Holder for Curtains, T. Whittingham, Manchester.
3174. Reversing Gear, W. F. Smith and J. G. Beardall, Derby.
3175. Pure Rain Water Shoe, F. Bingham, Bristol.
3176. Iron Plate Bevelling Tool, T. W. Sidgwick, Middlesbrough.
3177. Yarn Winding Machinery, J. D. Whyte and Whyte's Patents, Bradford.
3178. Preparing Cutch for Sale, J. R. Carruthers, Glasgow.
3179. Lamps, &c., J. Heggie and M. Buckley, Manchester.
3180. Looms for Weaving, J. Greenwood and A. Binns, Keighley.
3181. Manufacture of Saponaceous Compounds, G. B. Hay, Glasgow.
3182. A Lamp Wick Holder, W. Griffiths, Northwich.
3183. Pads Suitable for Trusses, &c., E. Dodd, London.
3184. Cycles, G. Willetts and J. Smith, Birmingham.
3185. Valve for Pneumatic Tires, H. M. Boxer, London.
3186. Pipe Joints, A. Jones, London.
3187. Self-righting Lamp, C. Mather, Lancashire.
3188. Cycle Bosses, T. Middlemore and C. Rossiter, London.
3189. Spinning Frames, A. D. Oates, L. Binns, and E. Earnshaw, London.
3190. Collar, J. E. H. Smit, W. F. and A. H. Jubb, London.
3191. Physical Panoramas, C. Hagenbeck, Birmingham.
3192. Extracts of Tea, G. H. R. Dabbs, London.
3193. Insect Destroyers, E. T. Burrowes, London.
3194. Riveting Machine, C. A. Skeie, London.
3195. Puzzle, J. Griffiths, London.
3196. Concentrating Sulphuric Acid, W. M. Mackey, London.
3197. Grip or Holder for Kettles, R. Pearce-Brown, London.
3198. Drinking Fountains, W. E. and H. Clarke, London.
3199. Securing Stoppers in Bottles, G. T. Richardson, Hampton Wick.
3200. Binding Books and Pamphlets, W. Shedlock, London.
3201. Extracting Manganese from Ore, J. B. Torres, London.
3202. Extracting Gold from Ore, E. L. Oppermann, London.
3203. Bottles for Aerated Waters, A. E. Hopkins, Chesterfield.
3204. Producing Flash Light, T. Maloni, Ayr.
3205. Typewriting Machine, T. Oliver, London.
3206. Cushioning Device for Doors, A. Spencer, London.
3207. Support for Bicycle Saddle, L. E. Stanhope, London.
3208. Life Buoys and Bicycle Boats, W. H. Larkins, London.
3209. Extracting Gold from Ores, C. T. J. Oppermann, London.
3210. Clips for Bicycle Saddles, H. A. Lamplugh, London.
3211. Condensing Guides, E. T. Hughes.—(*R. H. Cook, United States.*)
3212. Fire-extinguishing Apparatus, E. T. Hughes.—(*W. B. Guild, United States.*)
3213. Flashing Filaments, J. H. Douglas-Willan and F. E. W. Bowen, London.
3214. Adjustable Bust for Clothing, W. and H. Strathman, London.
3215. Bolt, F. Mann, London.
3216. Conveyance and Drawing-off of Beer, V. Lapp, London.
3217. Gas Engines, C. D. Abel.—(*The Gasmotoren Fabrik Deutz, Germany.*)
3218. Evaporating or Drying, W. A. E. Crombie, London.
3219. Acetylene Gas, E. B. Pym and J. Gore, London.
3220. Concaves for Threshing Machines, G. F. Russell, London.
3221. Lubricating the Spindles of Machines, J. O. O'Brien.—(*E. Kessler, France.*)
3222. Pneumatic Tires, J. R. McKif, Liverpool.
3223. Coffins, M. Karnicki, Liverpool.
3224. Conduits and Insulators, &c., W. H. Scott, London.
3225. Maps for Kindergarten Sewing, J. Likeman, London.
3226. Small-arms, G. McKoen and G. and W. S. Lewis, London.
3227. Cleaning Tramway Rails, F. W. Golby.—(*A. Morel, Belgium.*)
3228. Linings for Dresses, R. J. Löwen, London.
3229. Wound Protector for Horses, A. Cole, London.
3230. Production of Polysulphides of Potassium, F. L. Bartelt. London.

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3231. Alarm Gauges for Steam Generators, J. Hopwood, Longport.
3232. Constructing Fire-proof Floors, J. T. Hanson, London.
3233. Boiler Tubes for Water-tube Boilers, J. A. Thompson, London.
3234. Compound Lens and Camera, G. Bamberg, London.
3235. Electric Cranes, E. G. Fiegehen, Bedford.
3236. Paraffin Lamps, H. Baxter, Belfast.
3237. Slop Blocks for Sink Pipes, F. Hodgess, Manchester.
3238. Manufacture of Hearth-rugs, &c., G. W. Ramsden, Manchester.
3239. Dress Suspender, A. H. Gibson, Manchester.
3240. Garments, L. L. Goolman, Manchester.
3241. Creating Moist Air, R. J. Wood and H. Simcock, Birch, near Heywood.
3242. Cycles, W. E. Fellowes, Bradford.
3243. Tee Markers for Golf Links, C. E. Pronger, Bradford.
3244. Lavatories, W. Cassels, Kirkintilloch.
3245. Lifting Plastic Hollow Pottery Ware, The Cleland Pottery Company, Ld., and R. A. Mathieson, Glasgow.
3246. Lighting Devices for Lamps, R. Neuss, Manchester.
3247. Trueing Rubber Rollers of Knife-cleaning Machines, H. Liebert, Manchester.
3248. Safety Tray, J. Wooliscroft, Staffordshire.
3249. Theatrical Stage Curtains, E. Lytton, Manchester.
3250. Distribution Slide Valves, R. B. Armstrong and G. H. Robinson, Newcastle-on-Tyne.
3251. Fenders, C. Lindsay and D. Fulton, Glasgow.
3252. Show Cases, J. H. Weston and W. Smith, Birmingham.
3253. Steel Telescope Stretcher, W. Hallam, Chesterfield.
3254. Cut Chaff and Grain Cleaners, &c., J. Dibbs, Harrowgate.
3255. Draw-plate Ovens, J. Price, Liverpool.
3256. Electric Cables, G. H. Nisbett, Liverpool.
3257. Bicycles, E. S. Symes, Nottingham.
3258. Letter Thief Foiler, J. Ridge, Sussex.
3259. Propelling Bicycles, F. W. Webb and A. M. Thompson, Crewe.
3260. Alimentary Substances, T. Hyatt, London.
3261. Hydraulic Valves, J. S. Nettlefold, London.
3262. Glowing Nets for Gas Light, H. Burkert, Berlin.
3263. Fenders, H. E. and E. O. Newey, Dudley.
3264. Fenders, H. E. and E. O. Newey, Dudley.
3265. Railway Carriage Heating Apparatus, T. Durnan, Sheffield,
3266. Means for Shaping Pearl Scales, C. Hanson, Sheffield.
3267. Water-closets, D. Hurst, Manchester.
3268. Money Pocket, H. Marshall, London.
3269. Appliance for Use in Ink Bottles, G. Thomson, Fife.
3270. Brush for Bottles Holding Gum, G. Thomson, Fife.
3271. Tobacco Pipes, G. Thomson, Fife.
3272. Pressure-testing Apparatus, E. M. Munro and H. Brecknell, Bristol.
3273. Steam Boilers, S. Alley, Glasgow.
3274. Looms, W. Rodger, Glasgow.
3275. Furnace and Boiler, C. E. Alger, Newport, Mon.
3276. Tricycle, F. W. Jac'son, Stalybridge.

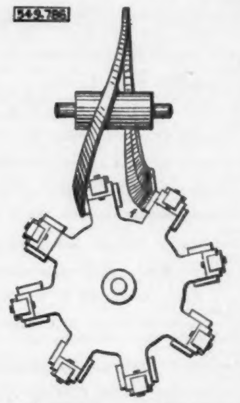
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

549,786. Gearing, *A. H. Haney, Dayton, Ohio.—Filed July 27th*, 1895.

Claim.—(1) The combination with a driving shaft, of a worm or screw the thread of which is angular in cross section, and assumes a straight line midway between its leading and retiring ends as at *g*, a worm wheel mounted at a right angle to said worm or screw, and a series of radial arms projecting from the periphery of said wheel, and a series of anti-friction rollers mounted in said arms, substantially as herein shown and described. (2) The combination with a worm wheel provided with a series of radial bearing arms, a series of rollers mounted in said arms, and detachable caps enclosing the ends of said arms and forming bearings for the outer ends of said rollers, of a worm or screw the thread of which is angular in cross section, to provide a bearing surface *f* adapted to be in parallel relation with said rollers during the period of contact, substantially as shown and described.

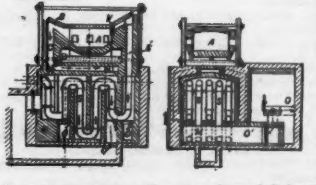
549,786



549,996. Regenerative or Recuperative Furnace, *A. Dauber, Bochum, Germany.—Filed October 12th*, 1894.

Claim.—(1) In combination with a furnace A having a narrowed passage B and a channel C for the exit of the hot gases, a channel E and a zigzag channel G, a door D at the end of channel C and a door L at the end of zigzag channel G; the gas pipes S and air flues M placed in said zigzag channel G and ending in uptakes S' and N respectively, both of these communicating at the upper end with a common mixing chamber V, from which the mixed gas and air are discharged into the furnace A. (2) In combination with a furnace A having a narrow passage B and a channel C for the exit of the hot gases, the zigzag channel G, in which are placed air and gas heating pipes M and S respectively; the combined regulating valves P' P² in a gas main O at the side of the furnace, said valves communicating with channels O' O² respectively, the first one of which is connected to the gas pipes in the zigzag channel G, the other one O² leading direct to the uptakes S² between the uptakes S' and N at the other side of the furnace; the whole as illustrated and for the purpose set forth.

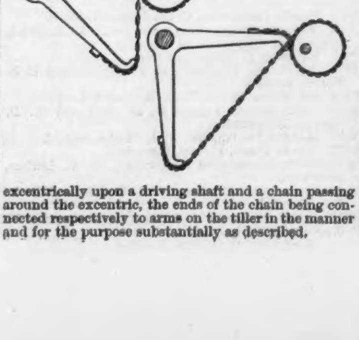
549,996



550,001. Steering Gear for Ships, *W. H. Harfield, London, England.—Filed July 13th* 1895.

Claim.—Steering gear for ships or boats consisting of a tiller fixed to the rudder head, a chain wheel set excentrically upon a driving shaft and a chain passing around the excentric, the ends of the chain being connected respectively to arms on the tiller in the manner and for the purpose substantially as described.

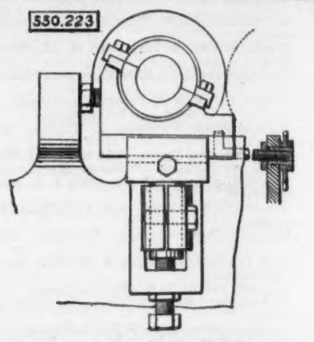
550,001



550,223. Bearing for Rolls of Roller-mills, *W. Griscom, Philadelphia, Pa.—Filed October 24th* 1894.

Claim.—(1) The combination of the bearing box for the roll journal, a vertically adjustable carrier for said box, and an adjusting screw stem for effecting the horizontal sliding of the box in the carrier, said adjusting screw stem being carried by the fixed frame, but offering no resistance to vertical movement of the box and its carrier, substantially as specified. (2) The combination of the bearing box having on the under side a rounded rib, a carrier located beneath the bearing and having a recess in which said rib can both turn and slide, the walls of said recess extending above the centre of and engaging the rib, and means for effecting the sliding adjustment of the box in said carrier, substantially as specified. (3) The combination of the fixed frame, the bearing box having a rounded rib on the under side, a split carrier having a recess in which said rib can both turn and slide, a split lug in which the stem of the carrier can both turn and vertically slide, clamping devices for the split lug and carrier, means for effecting the vertical adjustment of the carrier and the sliding adjustment of the bearing box therein, and a set screw having a bearing on the fixed frame and serving to lock the bearing box in position after adjustment, substantially as specified.

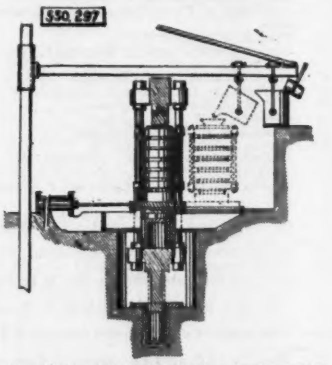
550,223



550,297. Manufacture of Band Saw Plates, *W. H. Singer, Allegheny, Pa.—Filed January 19th*, 1894.

Claim.—The improvement in the art of making band saw plates, consisting in casting steel with an ingot mould having a sheet metal lining, compressing the steel to form a solid and homogeneous ingot, removing the sheet metal shell and other foreign matter from the compressed ingot, and heating and reducing the blank so produced to a band of desired width and thickness, substantially as set forth.

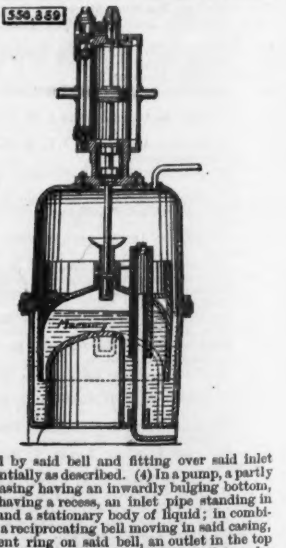
550,297



550,359. Exhaust Pump, *G. Westinghouse, jun., Pittsburg, Pa.—Filed November 26th*, 1892.

Claim.—(1) The combination with a casing, of a reciprocatory bell therein provided at its top with a valved outlet and a body of liquid in said casing which entirely fills said bell when the latter is in its lowest position, and an inlet pipe the open end of which is above said body of liquid, substantially as described. (2) In a pump, a stationary body of liquid and a reciprocating bell having an outlet in combination with a sealing valve in said outlet, a displacement ring around said bell and an overflow valve, for permitting the return of overflowing mercury to the main body, substantially as described. (3) In a pump, a partly exhausted casing having an inwardly bulging bottom, said bulge having a recess, an inlet pipe standing in said recess and a stationary body of liquid; in combination with a reciprocating bell having a valved opening in its top and moving in said casing, and a sealing tube carried by said bell and fitting over said inlet pipe, substantially as described. (4) In a pump, a partly exhausted casing having an inwardly bulging bottom, said bulge having a recess, an inlet pipe standing in said recess and a stationary body of liquid; in combination with a reciprocating bell moving in said casing, a displacement ring on said bell, an outlet in the top of said bell, and a sealing valve in said outlet, and a sealing tube carried by said bell and fitting over said inlet pipe, substantially as described. (5) In a pump, a partly exhausted casing having an inwardly bulging bottom, said bulge having a central recess and a side recess, an inlet pipe standing in said side recess and a stationary body of liquid; in combination with a reciprocating bell moving in said casing, a displacement ring on said bell, an outlet in the top on said bell, and a sealing valve in said outlet, and a sealing tube carried by said bell and fitting over said inlet pipe, substantially as described.

550,359



NAVAL ARCHITECTURE.—A FEW PRINCIPLES POPULARLY EXPLAINED.

No. III.—STABILITY.

IN our last paper it was stated that the quality of stability in a floating body may be due to its form, to the position of its centre of gravity, or to both combined. Let us now see in what way the moment of stability due to a vessel's form, apart from any other consideration, may be determined. We have first to assume that the centre of gravity of the vessel coincides in position with the centre of buoyancy when in the upright condition. Turning now to Fig. 13, it will be seen that when the vessel is inclined through an angle $L A L_1$ so that $L_1 L_1$ becomes her new load water-line, and B_1 the altered position of her centre of buoyancy, we have then two forces acting upon her, constituting what is styled a "couple." The weight of the vessel D acts downward along the line B D in a direction perpendicular to the surface of the water, while the buoyant support D, afforded by the water in which she floats, acts upwards through the new position B_1 of the centre of buoyancy along the line $B_1 M$, which is also perpendicular to the surface of the water. Hence B D and $B_1 M$ are parallel lines, and the moment tending to restore the vessel to the upright condition is the weight of displacement D multiplied by B N, the perpendicular distance between the parallel lines along which the opposing forces act. But B N is equal to B M multiplied by the sine of the angle of the vessel's inclination; for the angle $B M B_1$ is the same as the angle $L A L_1$. Wherefore the moment of stability in this case is $D \times B M \sin L A L_1$. This is termed the "surface stability" of the vessel at that inclination; being the stability due to the vessel's form alone, without regard to the distance which separates her centre of gravity from her centre of buoyancy.

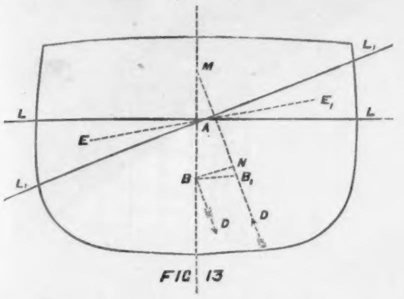


FIG 13

Let us now see what modifications have to be made in the above expression for the moment of a vessel's surface stability, at any angle of inclination from the upright, in order to allow for the actual position of her centre of gravity, when the latter is not coincident with the centre of buoyancy. First consider the case wherein the centre of gravity is below the centre of buoyancy. Referring to Fig. 14, we have such a condition depicted. In that figure, G, the centre of gravity of the vessel, is below B. From the point G, draw G Z perpendicular to the line $M B_1$ produced. The "couple" tending to restore the vessel to the upright condition is now $D \times G Z$

$$\text{or } D \times G M \sin L A L_1$$
$$\text{or } D \sin L A L_1 (B G + B M).$$

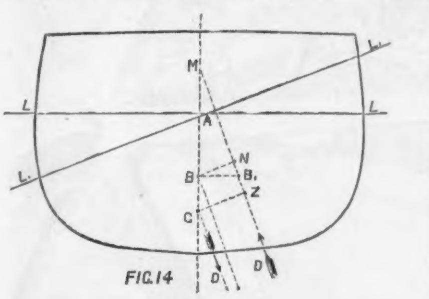


FIG. 14

The total moment of stability is therefore in excess of the stability due to the vessel's form alone (supposing G and B coincident) by the amount $D \times B G \sin L A L_1$.

Next, consider the case wherein the centre of gravity of the vessel is above the centre of buoyancy, but below the metacentre—see Fig. 15. The moment of stability in this case is again $D \times G M \sin L A L_1$, but G M is now equal to B M — B G, so that the expression

$$D \times G M \sin L A L_1$$
$$= D \sin L A L_1 (B M - B G),$$

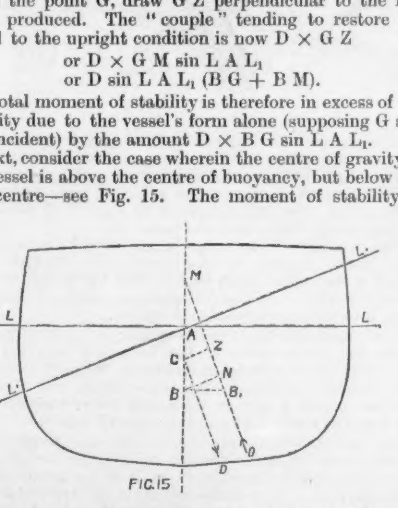


FIG. 15

and consequently the actual stability is less than that due to the vessel's form alone (supposing G and B coincident) by the amount of $D \times B G \sin L A L_1$. This diminution in value grows as G approaches M, and when G and M are coincident, $D \sin L A L_1 (B M - B G)$ becomes zero, and there being then no righting couple left, the vessel is without stability at that position of M and angle of inclination. It is easy to conceive that when G is above M the mechanical couple in operation is no longer a righting but an upsetting one, for when B G is greater than B M, the expression B M − B G has a negative value. To make the matter quite clear, however, let us turn to Fig. 16, where we see plainly that the mechanical couple $D \times G Z$ is an upsetting one.

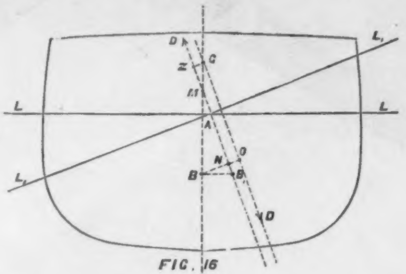


FIG. 16

For $D \times G Z = D \sin L A L_1 (B M - B G)$, B G is evidently greater than its part B M, and consequently the moment is a negative one, and $D \times G Z$ is an upsetting couple.

From the foregoing we may deduce certain broad principles which determine the conditions of a vessel's stability. Referring to Fig. 13, it will be noticed that the value of B N at any angle of inclination is determined by the extent of the horizontal movement of B_1 from B, which takes place in consequence of that inclination. The greater the value of $B B_1$ the greater will be the value of B N, and consequently the greater will be surface stability of the vessel at that inclination from the upright. Let E be the centre of gravity of displacement of the wedge-shaped portion of the vessel which emerges from the water, and E_1 the centre of gravity of displacement of the wedge-shaped portion of the vessel which is immersed, in order for $L_1 L$ to be the new water-line. Join $E E_1$. Then, by a simple law of statics, if V be the weight of displacement of either of these equal wedge-shaped figures, and D the weight of displacement of the whole vessel,

$$V \times E E_1 = D \times B B_1.$$

From which it is seen that the greater the distance $E E_1$ between the centres of gravity of displacement of the wedges $L A L_1$ and $L_1 A L$, the greater will be the movement of B to B_1, in a direction parallel to $E E_1$. Now the distance E to E_1 increases with the breadth of the vessel, and consequently the distance from B to B_1 must do the same. Hence, it follows that if the displacement of the vessel remains constant, the surface stability—or that portion of her entire stability due to her form alone—increases as the breadth of the vessel increases. In point of fact, the surface stability at small angles of inclination actually increases in the ratio of the cubes of the breadths of the vessel at the water-line. For:—the area of the triangle $L A L_1$ ($L A L_1$ being a small angle) is approximately

$$A L \times \frac{A L}{2} \sin L A L_1$$

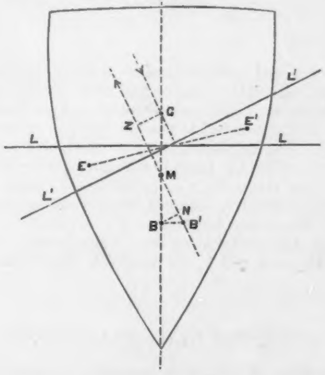
and $$E A \text{ or } A E_1 = \frac{2}{3} A L.$$

(E and E_1 being the centres of gravity of the triangles $L A L_1$ and $L_1 A L$.) Hence the moment due to the transference of $L A L_1$ to $L_1 A L$ is $\frac{A L^2}{2} \times \frac{4}{3} A L \times \sin L A L_1 = \frac{2}{3} A L^3 \sin L A L_1$, which shows that other things being the same, the surface stability of a vessel at small inclinations increases as the cube of her breadth at the water-line.

In the several cases shown by Figs. 14, 15, and 16, it is evident that the moment of stability is increased as B N increases, and therefore with the breadth of vessel at L L.

In Fig. 17 we see the case of a vessel which is narrow at the water-line in proportion to her depth, and therefore wanting in surface stability. The distance from E to E_1 being necessarily small, that from B to B_1 is correspondingly diminished, which, as is seen in the figure, has the effect of lowering the position of M. In this case the tendency of the centre of gravity of hull and cargo is obviously to be above the metacentre M, and consequently the couple is an upsetting one and the vessel is unstable. By fitting a large block of lead in the bottom of the vessel, as shown in Fig. 18, the centre of gravity is sufficiently lowered to produce a righting couple, and we have then a representation of what exists in the case of many recent racing yachts.

FIG. 17



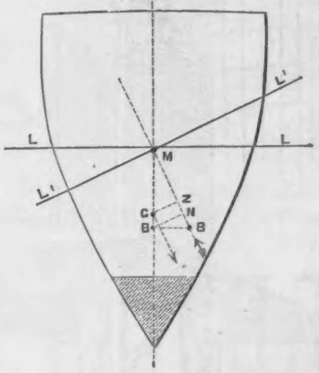
We have thus established a few general principles in regard to the stability of a vessel. These are:—

I. That, other things being the same, broadening a vessel at or about her load water plane tends to increase her stability; and conversely, narrowing her tends to reduce her stability.

II. That, other things being the same, increasing the depth of a vessel below her load water plane tends to diminish her stability; while conversely, reducing her depth tends to increase her stability.

III. Lowering the centre of gravity of the weights in the hull and cargo of a vessel tends to increase her stability, while raising the centre of gravity tends to diminish her stability.

FIG. 18



We will now seek to extend these principles by further investigations. It has already been shown that the surface stability of a vessel, or the stability due to her form alone, increases with the cubes of the breadths of the ordinates of her load water-line. Now, in vessels of ordinary form, the breadth of the inclined load water plane is greater than that of the upright one for every angle of inclination up to that at which the angle of the deck is submerged, and sometimes for even a still greater inclination. Hence it follows that the moment of surface stability increases with the angle of heel up to a certain inclination, beyond which it diminishes with the increased immersion of the deck, and finally becomes zero. This may be shown in another way.

We have already pointed out that the moment of surface stability at the angle $L A L_1$, Fig. 13, is

$$D \times B N$$
$$= D \times B B_1 \cos B_1 B N$$
$$= D \times B B_1 \cos \frac{L A L_1}{2}$$

(for $B B_1$ is parallel to $E E_1$ and B N to $L_1 L_1$).

It has also been shown that

$$D \times B B_1 = V \times E E_1,$$

in which V is the weight of displacement of either of the wedge-shaped bodies $L A L_1$ or $L_1 A L$.

$$\text{Hence } D \times B N = V \times E E_1 \cos \frac{L A L_1}{2},$$

which increases as V increases until the angle $L A L_1$ becomes very large. In other words, the moment of surface stability increases as the volumes of the wedges of immersion or emersion increase, up to a certain angle. That certain angle is the earlier reached in proportion as the edge of the deck is the sooner immersed, when the vessel is inclined. From this we have a further principle determined, viz.:—

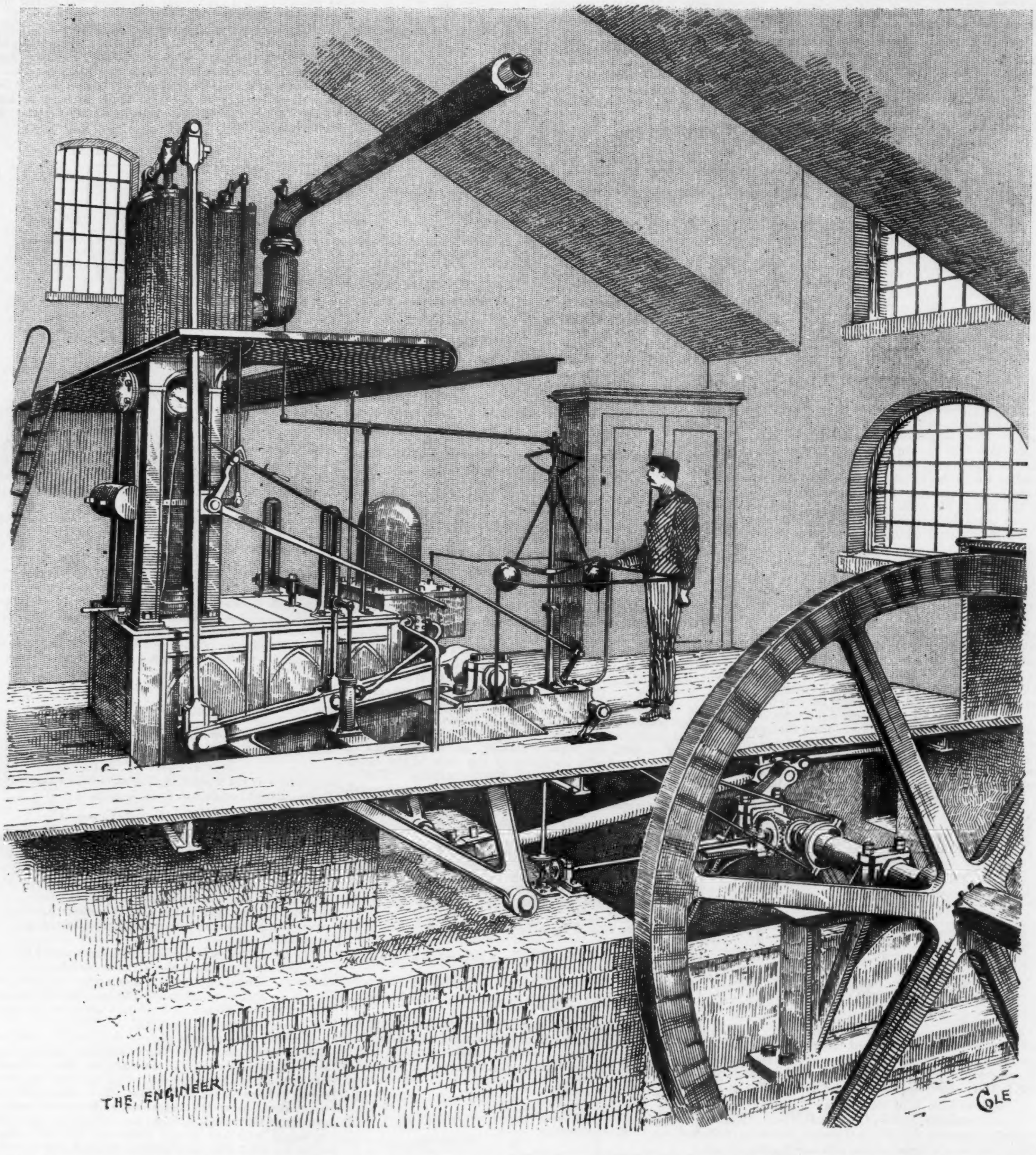
IV. Other things being the same, increasing the height of a vessel's upper deck above the water-line adds to the angle of inclination at which her surface stability continues to increase. Explained in technical language we have it thus: increase of freeboard tends to increase the range of stability, and *vice versâ*.

We have thus several ways of designing a vessel sufficiently stable to be safe from capsizing up to a certain angle of inclination from the upright. We may add to her breadth at the water-line, diminish the ratio of her depth to her breadth at that line, add to the height of her upper deck above the water-line, or lower the centre of gravity of the weight put into her. Either or all of these measures will add to the resistance she will offer to capsizing; but the naval architect is not free to employ them all to an unlimited degree, because of other considerations which have to be attended to. The chief of these are the conditions which lead to rolling or the contrary when she is among waves.

Now the phenomenon of rolling is one dependent upon physical conditions which require for their investigation more mathematics than are suitable for articles of an elementary character such as these. Suffice it to say, that the rolling of a ship is set up by waves of the sea, and that sea waves are due to the force of the wind, which gives to the sea surface an undulatory form, in which wave follows wave in continuous succession. The summit of a wave is known as the "crest," and the lowest point in its surface is termed the "trough;" the time occupied by two consecutive crests or troughs in traversing a certain distance is known as the period of the wave and the time occupied by a vessel in a complete roll, until she returns to the position at which she started, is termed the period of rolling of the vessel. Every vessel has a period of rolling peculiar to herself, based upon her form, the positions of the weights in her and other considerations which will be dealt with presently. The period of any series of waves is determined by their length from crest to crest; if the natural period of rolling of a vessel coincides with, or is a simple multiple of the period of the waves which pass her, then it is evident that each successive wave which reaches her when in the upright position adds to the rolling impetus she already possesses.

Hence it is desirable that the natural period of a vessel's free rolling should not synchronise with that of the waves

A CURIOUS OLD WATT ENGINE, SOHO FOUNDRY



she is likely to encounter. It is found by experience that slowly rolling vessels are those which tend to synchronise least with the waves ordinarily met with.

But slowly rolling vessels have another advantage over those which roll quickly. Quick rolling implies great stability, and therefore strong effort to return to the upright position—which strong effort carries the vessel beyond that position to a considerable inclination the opposite way, after the manner of a pendulum. So that lowering the centre of gravity beyond a certain safe point serves to so increase the stability as to make a vessel an uneasy roller. The best ships of war as steady gun platforms are those which have no more stability than is required for purposes of safety. It is said of such ships that "their G M is no more than is needed," but G must, of course, be always below M.

Sailing vessels with a large positive G M are safe from capsizing, but may roll so badly as to break off their masts, and so become unmanageable.

It is, therefore, a most important question for the naval architect to solve, to so proportion his vessel that she shall have sufficient stability when properly laden to be safe against capsizing, without having so much stability as to roll dangerously. It is also an important matter for the shipowner and stevedore to so stow the cargo in a vessel that the centre of gravity of hull and cargo may be low enough for her to be stable, and not so low as to make the vessel a dangerous roller.

When all that can be done in the matter of stowage has been effected without curing a vessel of her rolling tendencies, the only resource left is to fit her with bilge keels, which, as their name would suggest, are simply keel-like pieces secured to the lower part of the bilge on each side. The resistance offered by these projections is found to increase the period of rolling, and diminish the amplitude of the roll; the latter result being probably due to the want of agreement thereby set up between the period of the vessel and that of the waves.

Setting fore-and-aft canvas contributes further to diminishing the rolling of a vessel when the wind is abeam.

A CURIOUS OLD STEAM ENGINE.

In our issue of November 1st, 1895, coupled with some concluding remarks upon our inability to convey an adequate idea of the historical interest attached to the Soho Foundry, we expressed a hope that at a future date we might have something to say upon one of the steam engines of the old firm which was of a very special design.

We have spoken and written with a feeling of no little admiration upon the subject of the machine tools made and used so effectively in Watt's day, and we now have the pleasure to place before our readers a free-hand sketch of a type of engine which very few of the present generation can have seen. It seems to have been designed by the late James Watt during the lifetime of his father, and is probably 75 years old, and having regard to the celebrated tools which, through the courtesy of Mr. H. Darlington, the manager for the firm, we have from time to time been enabled to describe, we gladly couple with them the satisfactory performances of this engine, from which some of the principal tools derive their motion, and which appears to be as capable of discharging its duty in the future as in the past.

The peculiarity of its design caused it to be known as the "bell-crank" engine. In all probability the dual work with which it was called upon to deal was the necessity which brought forth its general arrangement, adapted, as will be seen, both for pumping and tool driving.

With regard to the former capacity, our general view will show the lower arms of the bell-crank levers coupled by a cross-bar, from the centre of which the main connecting-rod transmits motion to the main crank, and thence by another rod to a second bell-crank lever, which works a lift pump in a well shown in the annexed diagram.

The duty of this pump was to lift water from a cooling pond situated in some gardens outside the works into an upper culvert and reservoirs in the yard for condensing and other purposes. For works driving it appears to have been used for several important tools; its main shaft being below the ground level, was in position for driving the famous vertical boring bar, illustrated in our issue of September 27th, 1895, which, it will be seen, receives its motion from below the saddle plate. Large lathes also and machine tools in the screwing shops were driven by this engine, among the latter being a heavily geared tapping machine. Messrs. James Watt and Co were no believers in thread cutting otherwise than by tapping, as is universally done in dealing with small sizes; but here were to be seen ponderous tools for the production of nuts to fit threads of 5in. diameter, the taps being as long as 2ft. 6in.

We are informed that the vacuum of this engine was so good that it could boast of enough and to spare, and that a 6in. pipe was connected with the condenser of a 24-horse power beam engine in an adjacent building for the purpose of reducing the inefficiency of the latter. In all other respects, we understand, its character has universally been that it was ready for work night and day for weeks together. This ever ready quality was a necessity because the engine drove the boring bar which could boast of such capacities as those mentioned in our description of this particular tool. Its working pressure was that usually adopted in those far-off days, viz., 10 lb. The main shaft, which is square, is below the ground level, and is carried upon pedestals supported upon brick piers, and the rocking shaft upon which the bell-crank levers are keyed has its bearings just above the ground level.

The air pump is worked from the horizontal arms of the side levers, and the excentric rod is thrown out of gear by means of the disengaging apparatus, so much used in those days, which acts in opposition to the gravity of the rod.

Diameter of cylinder = 18in.; stroke = 26in.
Do. air pump = 15in.; do. = 11in.
Do. well pump = 10½in.; do. = 19in.
Do. fly-wheel = 11ft. 6in.

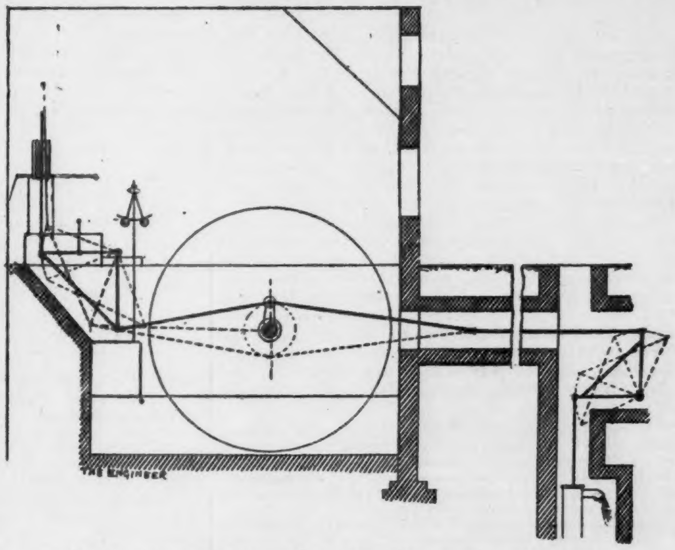


DIAGRAM SHOWING CONNECTIONS BETWEEN ENGINE AND PUMPS

The well pump is about 43ft. from the main shaft, and its lift is about 15ft., the stroke of 19in. being due to unequal leverage of its bell-crank arms. The slide valve is worked from the top of the steam chest by side rods connected with levers on a rocking shaft off the main frame, and the engine is controlled by the old type of fly-ball governor—one of Watt's minor, yet most essential inventions.

In concluding our several notices of these far-famed works, almost coincident with the hundredth anniversary of the memorable inauguration of 1796, we do so with feelings of regret that the works have not been more successful, and it only remains for us to chronicle the fact that in making a large radial suction pipe, 24in. diameter, for the Warsaw Waterworks, the famous firm of James Watt and Co., of Soho Foundry, Smethwick, poured their last ladle of metal at 4.50 p.m. on Wednesday, September 18th, 1895.

We add with pleasure that Messrs. W. and T. Avery, who are now the proprietors, having purchased the establishment upon a valuation, as a going concern — but not until the contents of the mint had been scattered—have decided to carry on the works under the style and title of James Watt and Co., without removing some of the machine tools which we have been able to speak so highly.

Messrs. Avery have decided to abstain from dismantling this substantial and well-tested collection of machinery. They have plenty of room for new tools, and some of the old will be useful for almost any heavy work.

We have freely expressed our opinion upon the value of these works and their capabilities in the course of writing the five notices which have appeared since September last, and the world has seen that which has been turned out by the Soho Foundry in mechanical engineering. We are personally well acquainted with the quality of the work delivered as late as last year, and think there can be no doubt that what has been done in the past can just as well be repeated in the future; and since the means of access both by rail and water are still important factors in the world of competition—and here we find both—there is no reason why much of that business which has unfortunately been lost should not return. The last set of pumping engines constructed at Soho, and delivered in Warsaw at the latter end of 1895, were in every respect equal to anything of the kind ever produced at Soho or elsewhere. The finish was admirable, and not exceeded by any of the engines ever turned out for Mr. Hawksley. We must not omit to mention the fact that all the important parts, and those requiring the greatest amount of skill in the engines referred to, were produced by men of experience who are still in the employ of the late firm's successors.

LIGHT RAILWAYS IN SOUTH WALES.

A VIGOROUS agitation in favour of a somewhat comprehensive scheme of light railway construction is proceeding in the western counties of South Wales, and as the need there is undoubtedly great, while the difficulties arise out of the circumstances of every sequestered and hilly country, whether it be Cardiganshire, Somersetshire, or the Scottish Highlands, the case of West Wales may be regarded as typical, and will profitably repay a brief examination in the light of Mr. Ritchie's Bill. A glance at a railway map reveals a remarkable contrast in the appearance of the eastern and western extremities of South Wales. Up to Swansea the lines form a complete reticulation, or one might more aptly say a gridiron, connecting the north and south valleys with the Great Western Railway and the ports. North Pembrokeshire and Cardiganshire, on the other hand, present extensive blank spaces, and there is perhaps no other part of the kingdom in which a recluse, if he so desired, could find himself so far removed from a railway station. In the latter county there is only one line connecting the north with the south, and that skirts the eastern boundary, the railway giving Cardiganshire access to the Great Western running within the Pembrokeshire border. The short line, which bears the ambitious title of the Manchester and Milford, is in a chronic state of loggerheads with the Great Western; the time-tables never seem to synchronise, and as Mr. Morgan Richardson, a Cardiganshire authority, has pointed out, "it is far simpler to travel from Cardigan to London than from Cardigan to Aberystwith, and the journey by road from one place to the other in the same county is actually shorter in point of time than the journey by rail." From where the Great Western makes its southerly dip to New Milford, and between Milford Haven and St. Bride's Bay, there is a large peninsula entirely cut off from railway communication. North of the Great Western to St. David's there is another large district in exactly the same position. The coast of Cardigan Bay, from Aberystwith to Cardigan town, is studded with more or less primitive and always picturesque fishing villages, which are even now sought out by adventurous holiday-makers; but Llanon, Aberaeron, New Quay, Aberporth, are all miles away from the nearest railway.

The benefits the light railways are expected to confer on West Wales are those which are supposed to follow improved means of communication in any agricultural district near the coast. The argument in Cardiganshire is pretty much the same as that the Duke of Sutherland and Lord Warwick addressed to Mr. Ritchie on behalf of the Highlands and of Essex respectively, only possibly a little stronger. The seas around the western point of Wales are teeming with fish, and there is a considerable local fishing industry; but except for a few steam carriers—one or two from the Bristol Channel, occasionally one or two all the way from Hull or Grimsby—there is absolutely no means of conveying the catch to the populous towns in Glamorganshire. It is not, as a whole, a good agricultural country, and the farmers for the most part have to fight a hard battle with Nature, though here and there are to be found valleys of rare fertility. But the struggles of the farming population, it is said, are increased by, if they are not mainly due to their isolated position, cut off from the lines of traffic, and debarred alike of the opportunity of sending their produce to a profitable market, or supplying themselves from outside with the essentials of a higher cultivation of the soil.

Great stress is laid, and justly laid, it would seem, on the important effect a system of light railways, connecting the coast with the Great Western main line, would have in creating a summer tourist traffic, and developing the seaside retreats on the south of Cardigan Bay into prosperous watering places. "Visitors flock to these places every summer," one Cardiganshire resident observes, "despite the difficulties of access; and there is unquestionably a great future for one and all of them as soon as there is railway communication with the outside world." The railway communications proposed to serve these admittedly desirable ends consist of some half-dozen lines all necessarily running to the Great Western Railway or its adjuncts. The chief points of attack are:—(1) St. David's, where the most ancient of Welsh cathedrals stands remote on the grand cliffs, against which the Atlantic dashes its waves in vain; (2) from New Quay to Llandyssul, a route which Sir James Szlumper is understood to have surveyed; (3) from Aberporth to a junction with the line last named; (4) from Broadhaven, in St. Bride's Bay—a delightful spot, with splendid sands—to Haverfordwest. The more sanguine promoters are talking of a coast line between Aberystwith and Cardigan; but such an undertaking stands obviously outside the scope of a Light Railway Act, and is certainly not contemplated in the measure of the President of the Board of Trade.

Now, if for a railway chart there were substituted a map showing the physical configuration of this part of West Wales, it would be seen that it presents an invariably broken surface, by no means mountainous like North Carmarthen or Brecon, and still less undulating, in the ordinary acceptation of the word. It is a region of abrupt hills, sharp declivities, and sudden valleys; one of the worst of countries to construct an ordinary railway across in a direct course, and presenting not much less difficulty in the case of a light line, however narrow the guage. The avowed object of the supporters of light railways is to make "short cuts." They are veritable Romans in their insistence on a straight road, because, as they urge, it will in the end be the most economical. It is not too much to say that in a rugged county like Cardigan anything approaching a straight line is impracticable, except at such an enormous cost as would remove the railways from the category comprised in the description Mr. Ritchie gave of the Government scheme. The traffic would be light, doubtless; but unless there were a good deal of tunnelling, the gradients would be terrible, and would necessitate the construction of roads as heavy, with the employment of locomotive force as great, as on any portion of the Great Western between Carmarthen Junction and Haverfordwest. This, however, it may be said, is one of the instances in which a point-to-point course could be abandoned in favour of Mr. Ritchie's suggestion that the main roads should be utilised for the light railways. The proposal is possibly applicable, even unobjectionable, in some parts of England, say the East Coast plain; but in Cardiganshire and North Pembrokeshire, apart from the ancient highway running east and west, there is hardly a main road to be found. West Wales is, in this respect, very much like Devonshire: it is a region of lanes rather than roads, directly the arterial highway is departed from; lanes, with high banks and over-arching hedges, wherein the country carts or tumbrils have difficulty in passing one another. These byeways, moreover, of course, follow the contour of the country. Mr. Vaughan Davies, M.P., told Mr. Ritchie, of the "huge mountains and deep valleys" of Wales, and made them an argument in favour of light railways. Huge mountains are an odd exaggeration of the condition of the district Mr. Vaughan Davies represents at Westminster; but such as the "mountains" are, clearly they increase the difficulty and the cost of constructing even the lightest of steam tramway lines.

On this point Mr. Morgan Richardson, who has already been quoted, would appear to speak for Cardiganshire with more accuracy than Mr. Vaughan Davies. As to using the highways, he says:—"Our roads are far too narrow, and the gradients would make such a scheme impossible. For example, who would undertake to drive an engine and five or six coaches up Brongest or Llandyfriog Hills, or who would care, however heavily insured, to sit in the carriages when making the descent?" There remains yet another problem which the West Wales Light Railway project raises, and in some degree illustrates. It is the general desire to make direct communication with the Great Western Railway, in order to avoid breaking bulk at the junctions, because a second handling of goods or produce involves an extra item of expense, to say nothing of the risk of damage. This means that the new railways would have to be built to the breadth of the Great Western gauge, and *cœteris paribus*, that seems to be the most sensible plan.

But when all these things are taken into consideration, it is evident that a series of railways which answered the requirements of West Wales in necessary solidity, hauling power to overcome the stiff gradients, and of a gauge permitting the transfer of traffic in bulk to the trunk line, would have little except the name to identify it with the light railways foreshadowed by Mr. Ritchie. In short, the very circumstances which create the demand for light railways in an isolated country—the circumstances which have deterred the trunk companies from penetrating into the remote districts beyond the hills—prove obstacles to the construction of economical lines according to the Government design, and would apparently entail an expenditure little short of that involved in building an ordinary railway.

A CANAL PROPOSAL.

A GREAT deal has been heard lately about "amphibious" boats, and the particulars have recently been sent to us of what the projectors state to be "an improved method of utilising canals for traffic" by the employment of boats of this character. The inventors and patentees of this scheme are Mr. W. B. Cooke and Mr. F. Willoughby, solicitor, of Daventry. The promoters claim for their idea "that by the means proposed merchandise can be conveyed as expeditiously as by railway, and that canal undertakings will be restored, not only to their former prosperity, but will become of largely increased utility and value; that it will materially improve the status and social condition of the canal employés; that it will restore to the works and manufactories established on the canal banks the advantages of canal transit which they formerly enjoyed; that it will supply a great want to depressed agriculture in the isolated parts of the country through which canals pass; and that a large quantity of water now required for canals will be available for domestic, trade, and sanitary purposes.

If any scheme can accomplish all this it should be well worthy of consideration, and, admitting that the views of the promoters are sanguine, they are at the same time laudable. The scheme is based on the assumption "that the most economical and most convenient means of inland water transport over long distances is the old-time present-day 25 to 30 tons narrow boat hauled by one horse and manned by two boat people, with casual assistance at flights of locks, which vessels, loaded or empty, cannot cover more than one and a-half to two miles an hour under favourable circumstances on well-maintained routes." The average speed on a level canal is subsequently given as 1·41 miles an hour, and if steam power is used, as 2·54 miles an hour; the cost of transport over a typical distance of ninety miles for the conveyance of coal being put at 14 per cent. more than the present day railway charge, and the reader is informed that the slow pace and "this heavy charge is steadily and surely forcing inland water transport out of existence." To remedy this the promoters propose to draw off the water from all the existing long-distance canals, and lay down on the bed thereof a railway with inclines in the place of locks. These railways are to be connected with the existing short-distance distributing canals in the neighbourhood of busy centres. The canal boats are to be conveyed along the railways on 45-ton bogie steel trucks capable of carrying loaded or empty canal craft, or any minerals or goods on the railway. The canal boats are to be floated on to these trucks, when "they will be ready to journey any distance at any speed up to the present-day goods train;" and the canal boat will "be speeded up from two miles an hour to fifteen or twenty miles an hour."

The cost of transforming the canals and providing rolling stock is put at £4000 a mile, the estimated cost of existing canals is taken at £10,000 a mile, making the total cost £14,000 a mile, for which "a fully equipped railway canal system for goods and mineral traffic, with the overwhelming advantage of quick transport," will be obtained.

For this idea the promoters have taken out a patent. Except for the wholesale way in which it is proposed to apply the principle, it is difficult to realise in what the novelty of the invention consists which has led the promoters to take out a patent. The conversion of canals into railways has already frequently been effected, although perhaps there is a novelty in running the trains up and down the steep gradients required to get over the site of the locks. The plan of placing floating barges on to trucks, and so conveying these trucks to and from an inland coal mine, has been in successful operation on the Aire and Calder Canal for some time; but it is possible, considering the views expressed as to the way in which canals can be conducted under modern conditions, the promoters are ignorant of the way in which this and other improved waterways are now managed.

Blackwall Tunnel.—A paper on this important and nearly completed undertaking will be read by its engineer, Mr. Alex. R. Binnie, M.I.C.E., on the 6th March, at 9 p.m., at the Royal Institution.

RATES OF SPEED AND RATES OF FREIGHT.

In a paper under the above title, read before the Institution of Engineers and Shipbuilders in Scotland on Tuesday last, Mr. John Inglis, the well-known Glasgow shipbuilder, discussed the question of the commercial efficiency of steamships in an original and most interesting manner. Illustrated as this paper was with a series of elaborate diagrams, it is impossible in this notice of it to do that justice to the author's arguments which are demanded, both by their merits and by the importance of the subject. Mr. Inglis appears to be among those who are of opinion that the competition between some of our principal ocean steamship lines in seeking to attract passengers by means of vessels possessing enormous engine power and great speed, must result in a financial loss to the shareholders at the present rates of freight for passengers and cargo, unless the companies are aided by Government subsidies in consideration of the national service rendered by the existence of such vessels in our mercantile marine. Whether as present mail carriers or as prospective cruisers in time of war, it is quite clear that the Campania, Teutonic, and other such vessels are a source of national strength; and, consequently, those who order them to be built should at least be assured that they will not be losers, pecuniarily, by their enterprise. But up to the present time the only reward which these companies receive from the State consists in a somewhat meagre postal subsidy for the carriage of H.M. mails. Hence, in discussing the commercial efficiency of steamships, one is compelled to adopt strictly business principles, putting the cost of running on one side, and simply the receipt from passenger fares and cargo freights on the other side of the account. It was the purpose of Mr. Inglis to show under what conditions of speed, cargo freight, passenger fares, and despatch it was possible for an ocean steamship company to pay the modest dividend of 5 per cent. to its shareholders.

Mr. Inglis asked his audience to permit him some assumptions consisting of a state of things which are perhaps desirable, but such, as he admitted, we are not accustomed to. Said he:—

> "I shall ask you to conceive a ship of about 10,000 tons gross, differing from all other ships in possessing the remarkable property of a variable displacement on a given draught: that is to say, she alters her form and becomes finer and finer as the power of her engines and the desired rate of speed is increased; or otherwise, let there be an infinite number of such steamships differing from each other in form by very minute gradations.
>
> "Then we are to suppose that the shipowner can choose any rate of speed he likes without thereby affecting the volume of his business, his hand not being forced in any way by competitors; also, that he can always fill his ship with cargo to its utmost capacity, and that the number of passengers is the same on the average whatever time the ship takes over her voyage."

Having started with this assumption, Mr. Inglis said:—

> "Let us first take the case of a voyage out and home between two ports exactly 3000 miles apart, performed at average speeds varying from 15 knots to 21 knots. Our steamer is assumed to have a displacement of 18,000 tons when adapted to the 15-knot rate, and for every knot added to the mean speed at sea 600 tons is taken off the displacement."

By means of a diagram it was made clear that an increase of speed from 10 to 20 knots effects a saving of 6¼ days on the voyage, but to go from 20 to 30 knots only results in a saving of 2 days 2 hours, and from 30 to 40 knots of no more than 25 hours.

It is not difficult to guess what particular voyage it was that Mr. Inglis had in his mind when pointing out these elementary yet very pertinent facts. Nor was it purposeless that he called attention to the very small return in shortened duration of voyage which resulted from the enormous outlay involved in obtaining the higher increments of speed. Taking values of indicated horse-power for which he considered he had sufficient warrant, and making allowances for weights of machinery, coals, stores, &c., from data in his possession, Mr. Inglis finds that the surplus displacement available for deadweight cargo, which in the 15-knot steamer is 7373 tons, has dwindled down to 18 tons—or practically zero—in the ship of 21 knots. Hence he concludes 21 knots as the limit of speed on a 3000 miles run for this imaginary vessel.

From this Mr. Inglis turns to the question of the duration of the vessel's stay in port, and the consequent number of voyages she can make in a year. Starting upon the basis of 750 tons a-day, which he finds is the average rate at which cargo can be discharged or loaded, taking into account inevitable causes of delay, it would appear that the very fast vessel with a very small cargo would be able to start off again almost at once. But there must be a minimum time in port, even when there is little or no cargo, so that Mr. Inglis is advised that seven days is the minimum for such a ship, according to the custom of some ports. This period of seven days in port corresponds exactly with the time occupied in loading and discharging the cargo of the imaginary vessel when she has a speed of 19¼ knots.

> "The ship, therefore, which is adapted to that speed, according to our hypothesis, will carry just as much cargo as can be discharged and loaded in seven days, and all the faster ships of that family will have a certain amount of lost time, unless the delay in port be necessary for other reasons. The extreme importance of this will become apparent later on."

Mr. Inglis next considers the various items of which the total expenditure is made up, viz.:—The port charges, office expenses, wages of officers and crew, provisions for the ship's company and passengers, insurance, maintenance and repairs, shore gang and docking, coal and engine-room stores, and depreciation. He assumed that:—

> "Forty days in the year, besides the intervals between voyages, are reserved for overhauling and repairing, leaving 325 working days per annum. The average number of passengers is supposed not to be affected by the speed. This is not likely to be the case until after wars and fightings have ceased among rival steamship lines, but it is convenient for the purposes of this paper to make the assumption."

From information supplied by different Atlantic steamship lines it was estimated that a reasonable average per voyage on that route is 185 first class, 110 second, and 400 third each way, and these figures Mr. Inglis adopts in his calculations; for, as he naïvely remarks, "Although the ships and route are quite imaginary, it is better to get as near to practical conditions as possible."

Maintenance and repairs he charges at 2½ per cent. on the hull cost and 7½ per cent. on the machinery; depreciation he takes at 7½ per cent. on first cost. This last item, he remarks, may appear excessive when compared with the allowance which income tax surveyors are disposed to make,

> "but it must be remembered that in many trades, especially where passengers are carried in large numbers, the fashions change rapidly, and a vessel which has not appreciably deteriorated as a structure may be found out of date and greatly reduced in value after a not very extended period of usefulness."

The curves of expenditure due to the items just enumerated are, it seems, discontinuous at the point indicating when the time in port is a fixed minimum, and begins to be longer than is absolutely necessary for the handling of the cargo. The expenses mount up less rapidly, but it happens that the receipts have a downward tendency from this point, unless this be corrected by a raising of the rates.

A curve of receipts is drawn from the following data:—The price of a first-class passage is taken at £6 per 1000 miles, a second-class at £3, and a third-class at £1 10s. Deadweight freights are taken at 3s. per ton per 1000 miles.

And here we come to the most interesting results from the graphical mode of analysis which Mr. Inglis has adopted. The margin of profit widens slightly but continuously as the speed rises until a speed of 19¼ knots is reached, when the time in port is fixed at a minimum of seven days; above that speed profit rapidly decreases, becomes zero at 19·675 knots—less than half a knot above the speed of maximum profit—and is transformed into a loss of £34,589 annually, equal to 9⅓ per cent. on the cost of the vessel when the speed is 21 knots.

He now seeks to remedy matters by shortening the time in port, and thereby increasing the number of voyages accomplished in a year. Reducing the stay in port to four days, the best paying speed is raised from 19¼ knots to 20 knots, and the vessel adapted to that speed makes a profit of £13,898, instead of a loss of £7555. The speed at which profit vanishes is 20·425 knots instead of 19·675 knots, and the loss on the 21-knot steamer is reduced from £34,589 to £18,893.

From these striking figures Mr. Inglis concludes that:—

> "The paramount importance of despatch is thus shown in a very striking manner. Evidently it is by no means advantageous to encumber the working of costly passenger steamers by the carrying of heavy cargoes, which cannot be discharged from and loaded into such vessels with the rapidity which is quite possible in the case of vessels expressly built for cargo carrying.
>
> "It might even be shown that it would be more profitable to run the 15-knot steamer with half cargoes, so long as she could obtain her average complement of passengers on more frequent sailings, rather than keep her in port for the additional time necessary to handle the full cargo, but in that case she would be unnecessarily full in form for the purpose."

He next turns to the most finely formed ship of the series and modifies the power and weight of machinery as required for the various speeds ranging from 15 to 21 knots. Having analysed this case, he compares it with the other, and summarises the results in tabular form. Instead, however, of showing the variable profits arising from fixed rates, he rather shows the variation in the first-class fare that would have to be paid in order to ensure a 5 per cent. dividend, it being understood that a first-class passenger pays as much as two second-class, four third-class, or 40 tons of dead weight cargo.

Table I.—*Ports* 3000 *miles Apart. Displacement varying with the Speed.*

No. of round voyages per annum.	Speed.	D.W. cargo.	Days at sea, single voyage	Days in port at each end.	Cost of each round voyage.	First-class fare to pay 5 per cent. dividend.			D.W. cargo carried per annum
	Knots.	Tons.			£	£	s.	d.	Tons.
6	15·3	7100	8·16	18·88	17,650	19	6	0	85,200
8	17·425	4950	7·17	13·16	15,840	19	2	0	79,200
10	18·55	3600	6·74	9·57	14,650	18	18	10	72,000
12	19·237	2680	6·50	7·13	13,800	18	14	7	64,320
14	19·70	2000	6·35	5·32	13,200	18	9	7	56,000
15	19·875	1760	6·23	4·66	12,930	18	6	7	52,800
16	20·325	1050	6·15	4·00	13,000	19	5	3	33,600
16·31	21·	18	5·95	4·00	13,414	21	8	1	587
12·26	20·	1600	6·25	7·00	14,268	20	12	8	39,232
12·54	21·	18	5·95	7·00	15,030	24	5	8	451

Table II.—*Ports* 3000 *miles Apart. Constant Displacement,* 14,400 *tons.*

No. of voyages per annum.	Speed.	D.W. cargo.	Days at sea, single voyage	Days in port at each end.	Cost of each round voyage.	First-class fare to pay 5 per cent. dividend.			D.W. cargo carried per annum.
	Knots.	Tons.			£	£	s.	d.	Tons.
8	15·4	4600	8·13	12·23	14,130	17	6	1	73,600
10	17·325	3400	7·22	9·04	13,540	17	12	6	68,000
12	18·45	2550	6·78	6·78	13,120	17	16	10	61,200
14	19·19	1900	6·52	5·05	12,730	17	18	6	53,200
15	19·46	1650	6·42	4·38	12,560	17	18	7	49,500
16	20·325	800	6·15	4·00	12,900	19	8	11	25,600

Comparing these tables, it will be noticed that in the first the fares yielding 5 per cent. profit decrease as the speed increases up to a certain point, whereas in Table II. the fares increase from the lower limit of speed. The finer type of ship carries passengers more economically than the fuller up to a speed of 19·85 knots, when the paying passenger rate becomes £18 7s. 3d. for both. Above that speed the rates can be reduced a little in the fuller vessel, as the extra cargo she carries will make up for the decreased receipts from passengers.

Commenting upon these figures, Mr. Inglis says:—

> "If these remarks should reach any shareholders in steam shipping property of a type resembling that under consideration, they will probably recognise what may be called the precariousness of the results, and how much the gains depend on a sagacious choice of form and proportions, the narrow limits within which the managing owner's judgment must be exercised, and the slightness of the change which suffices to convert substantial profit into serious loss."

Leaving the 3000 miles voyage, he next turns his attention to one of 6000 miles between the terminal ports. In order to simplify the question, he assumes there are no stops on the way, and that the vessel therefore carries coal for the whole voyage. This compels him to reduce the limit of speed from 21 to 19 knots, as at the higher speeds the necessary coal supply could not be carried by his supposed vessel. It is also assumed that the fixed weight for mails, passengers, baggage, stores, and fresh water is increased from 500 to 700 tons, owing to the greater length of the run. Seven days are supposed to be a short enough stay at each end after a voyage of such length.

The vessel making eight round voyages of 12,000 miles has the same annual mileage as that making sixteen voyages of 6000 miles, but her speed is 19 knots as against 20·325. But her delay in port of fourteen days for each round voyage amounts to only 112 days in the year, whereas the eight days per round voyage of the vessel on the shorter run gives her a total of 128 days' delay in port. This, as Mr. Inglis points out, largely accounts for the fact that the cost of the 12,000 miles' voyage is only about 46 per cent. greater than that of 6000 miles.

He presents us with Table III., showing how these and other considerations affect the passenger rates. Of course it will be remembered that the rates shown are for a voyage twice as long as in Tables I. and II.

Table III.—*Ports* 6000 *miles Apart. Displacement varying with Speed.*

No. of round voyages per annum.	Speed.	D.W. cargo.	Days at sea, single voyage	Days in port at each end.	Cost of each round voyage.	First-class fare to pay 5 per cent. dividend.			D.W. cargo carried per annum.
	Knots.	Tons.			£	£	s.	d.	Tons.
6	15·875	4290	15·74	11·44	20,340	25	7	7	51,480
7	16·9	3200	14·80	8·53	19,120	25	5	5	44,800
8	19·0	165	13·16	7·00	19,019	30	12	2	2,640

Remarking upon this table, Mr. Inglis says:—

> "Under the chosen conditions, a first-class passenger can be carried over a 6000-mile voyage at the speed of about 17 knots for almost exactly a penny a mile, but if he must travel at 19 knots he ought to pay a shilling for ten miles, whereas the passenger on the 3000-mile voyage would have to pay about fourteenpence for the same service in the same ship."

Of course Mr. Inglis is well aware of the modifications in his figures which would be due to delays *en route* for mails, coaling, &c., the effect of alterations in size of vessel, and many other possible variations in the conditions under which a vessel may be worked. Indeed, he distinctly admits as much, but he was deterred from following up these considerations in consequence of the formidable addition they would lead to in the length of his paper. Sufficient was, however, presented by him to show that whoever it may be that is benefited by the race for the Atlantic record, it can scarcely be the owners of the vessels that take part in it. It is quite clear that, as compared with lines of steamers engaged upon long ocean voyages, those on the Atlantic ferry are at a great financial disadvantage by reason of the necessarily long time they spend in port. If they make a voyage in six days, they are most of them idle during eight other days; and although they are not consuming coals during those eight days, yet they are always consuming something, and are certainly not earning a penny.

Mr. Inglis is to be congratulated upon the clear form in which he has presented these important facts for the consideration of the country. He has a happy faculty of penetrating at once to the root of a subject, and he never bores his audience by a waste of words. It would be a misfortune if such investigations as these should tend to discourage maritime enterprise in this country; but we are sure that the object of Mr. Inglis in the preparation of this interesting paper was rather to foster such enterprise, by pointing out under what conditions alone it may profitably be conducted.

London's Amateur Engineering Contractors.—According to a report which came under the consideration of the London County Council on Tuesday, the enterprise of that body in carrying out public works without a contractor is being conducted with unabated vigour, and with results increasingly expensive to the ratepayers. The latest achievement of this kind has reference to the repair of the roadway on the Victoria Embankment. Commenting on it, the *Standard* says:—Two committees were concerned in settling the estimate for this piece of work—that is to say, one prepared the estimate and the other approved it, while the Council adopted it. Thus the combined wisdom of the Highways Committee and the Works Committee was brought to bear on the subject, supplemented by the decision of the Council itself. The estimated expenditure being fixed at a little under four thousand pounds, the Works Department took the matter in hand, and, having completed what had to be done, has just sent in its "little bill," which proves to be seventeen hundred and seventy pounds more than the estimate. This excess of above 40 per cent. has rather startled the Highways Committee, who have accordingly inquired into the cause. Here we have a Highways Committee unable, apparently, to ascertain the length and breadth of the road they have to repair. When the account has to be paid, there are the "extras," and we find them in this case just as a contractor might send them in, if he had the chance. Additions are made for "extra work" and "extra expedition," all leading up to the sequel of an "extra" cost. But even contractors generally fall short of adding 40 per cent. to the reckoning. The Highways Committee feel that the Council should "know the reasons" why the cost has been so much in excess of the estimate; but, in fact, the "reasons" seem almost the worst part of the affair, as opening up a prospect of unconscionable "extras" in time to come, in addition to such as are already on record. It was bad enough to have the Works Committee playing pranks. But in this case we have two committees pulling the same way, to the plundering of the ratepayer. One blunders and the other approves, rendering it impossible at the outset to tell what the cost will be at the end.

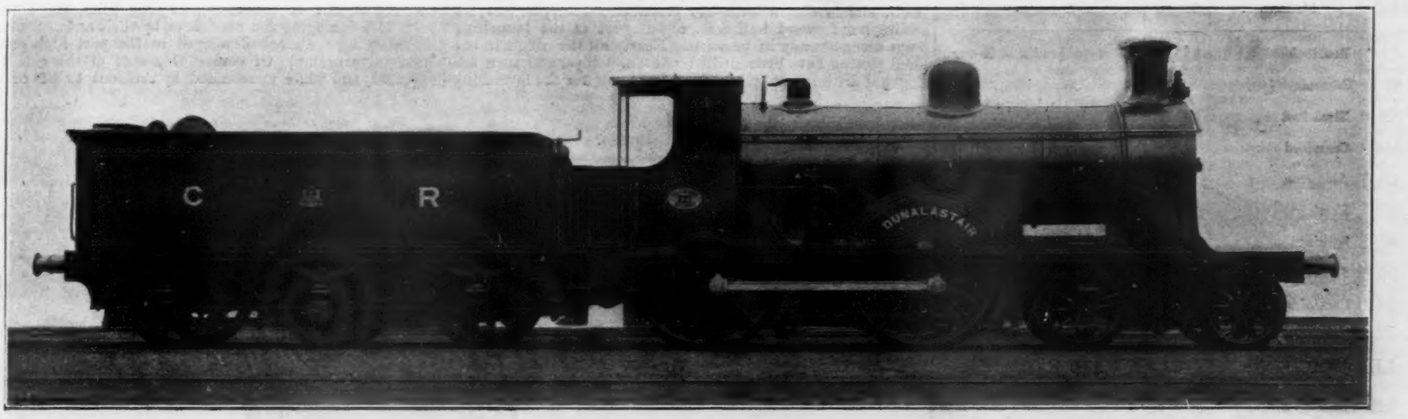
THE NEW CALEDONIAN EXPRESS-ENGINE DUNALASTAIR.

By CHARLES ROUS-MARTEN.

AN absurd paragraph has gone the round of several of the London daily papers to the effect that in preparation for a renewal next summer of last season's "Race to Aberdeen," the Caledonian Railway Company had built a new engine weighing 134 tons!

In comparison with such huge dimensions as would be involved in so gigantic a weight as this, the real figures will probably appear disappointingly moderate. For it is a fact that a new and remarkably fine engine has just been turned out by the St. Rollox Works of the Caledonian Company as a precursor of a batch of fifteen, not, however, with a special view of "racing" or other exceptional work, but simply to carry on the ordinary express traffic of the line, which has become so much faster and heavier during the past year as to demand increased power on the part of the locomotives by which it is worked.

Another fresh departure has, in fact, been taken by Mr. J. F. McIntosh, the very able new locomotive superintendent of the Caledonian Railway, similar to that with which his penultimate successor, Mr. Dugald Drummond, was identified about twelve years ago. Up to that time the Caledonian express traffic had been worked by the engines designed by Mr. Benjamin Connor during the previous twenty years. These comprised two main classes, the 8ft. 2in. singles, of which one was in the International Exhibition of 1862, and the 7ft. 2in. coupled class, the former having cylinders 17¼in. by 24in., and the latter 17½in. by 24in. In point of speed the engines of both of these classes were all that could be desired, and with the comparatively small loads then in vogue they attacked with fair success—aided, no doubt, by a good deal of piloting—the heavy banks of Beattock and Dunblane. Most of the once-famous 8ft. 2in. singles are now extinct, a fact greatly regretted by many enthusiastic admirers, who would gladly have seen them rebuilt with larger boilers and cylinders for use on the more level express work of the railway. The fiat, however, has gone forth, and they are doomed; but at least it may not be deemed intrusive to express a hope that one of these fine old engines will be preserved as an interesting relic of the past, as has been done in the case of the Great Western Lord of the Isles and North Star, and of the London and North-Western Cornwall, and has not been done, unfortunately, in the case of many a most interesting locomotive of the past which assuredly was worth far more as an historical relic than its mere intrinsic value as scrap iron. I hope it is not too late to save one of the old "eight-footers" from the scrap heap.



CALEDONIAN EXPRESS LOCOMOTIVE

The 7ft. 2in. coupled engines, on the other hand, are being rebuilt with excellent results, and are doing very good work.

When Mr. Drummond took charge at St. Rollox, he rebuilt, as express passenger engines, a number of the old 6ft. 2in. coupled express-goods engines, and for a long time the Carlisle-Edinburgh expresses were run by these rebuilt engines. That instances of efficient work are recorded to their credit is unquestionably true, but on the whole they were unsuited to fast express work, from which they have for some years been almost wholly excluded. For fast goods or heavy stopping passenger trains they are well suited, and this class of duty they still perform in a very satisfactory manner.

But for his best express work Mr. Drummond soon put in hand an entirely new class, the 6ft. 6in. coupled bogie engines, which were a reproduction with minor modifications of the admirable type that he had previously made the standard one for the North British line, which have from the first been famed for uniformly excellent work, and which have remained virtually unchanged as the standard Caledonian type, through the reign of Mr. Drummond's successor, Mr. John Lambie, until the present time. Ten of these fine engines were first built, Nos. 66-75; then eighteen more, Nos. 60-65, 76-79, 86-91, 113 and 124, and finally six by Mr. Lambie, Nos. 13-18. In these last six a small variation was made in placing the Ramsbottom safety-valves over the fire-box instead of in the dome on the middle of the boiler as previously, while the dome was of the ordinary plain pattern as seen on most British railways. Of the other engines in that class, No. 124, the Eglinton, which was in one of the Edinburgh Exhibitions, alone differed at first from the rest in being fitted with the Bryce-Douglas valve gear, and in having 19in. cylinders. It being found, however, that this gear did not work satisfactorily on locomotives which had to run at high speeds, it was removed and replaced with the Stephenson link motion, the cylinders also being reduced to 18in. diameter, so as to be uniform with those of all the other engines of the same class. The other exhibition engine of that type—which was shown at the last Edinburgh Exhibition—No. 79, the Carbrook, had originally 200 lb. steam pressure, but this, too, was altered into uniformity with the 150 lb. pressure carried by the rest of the class.

Of the much bepraised 7ft. single, No. 123, which came out about the same time as No. 124, but which still remains the sole representative of her class, it needs only to be said that while most efficient in running light trains at high speeds—as in the Edinburgh racing trains of August, 1888, and of the 5.25 p.m. up train from Aberdeen, which she has worked regularly and very satisfactorily for a long time past—she has not sufficient boiler power for the heavy fast expresses now compulsorily run on the Caledonian line, but she is about to receive a thorough overhaul and probably a new and larger boiler, with a view of enabling her to grapple with more important duty next season if required.

Of the splendid work performed by the 6ft. 6in. coupled bogie engines, placed on the road by Mr. Drummond and Mr. Lambie, it has already been my lot to say much in the columns of THE ENGINEER, especially in connection with last summer's "Race to the North." But superb as were their performances during that memorable period, feats of equal merit were almost daily achieved with the ordinary expresses. In illustration of this I may mention the following:—No. 87 took the West Coast corridor dining train—equal to twenty-two coaches—from Symington to Carlisle, just under 67 miles, in 72 min. 57 sec. The 17 miles to Beattock summit, 13 being uphill—the last two at 1 in 100—1½ level and only 2¼ downhill, occupied but 22 min. 13 sec., and the speed did not fall below 35 miles on the last 2 miles of 1 in 100 up. The 50 miles from Beattock Summit to Carlisle were done in 50¾ min. No. 14 took the corridor train—equal to seventeen coaches—from Symington to Carlisle in 71½ min.; No. 79 took seventeen coaches from Beattock Summit to Strawfrank, 23½ miles—start to stop—in 23 min. 11 sec.; No. 75 took seventeen coaches from Forfar to Perth, 32½ miles, in 32 min. 59 sec.; No. 67 made the same run with thirteen coaches in 32 min. 41 sec., and with ten coaches, in 32 min. 24 sec.; all being from start to stop. Such work as this speaks for itself.

Nevertheless, keeping in view the persistent and rapid increase alike in weight and in speed of the work demanded of the Caledonian express engines, and in order to avoid extensive piloting, Mr. McIntosh determined, when about to add fifteen more to the thirty-four of the first-class already possessed by the company, to adopt a new design which should give largely increased power, combined with improved handiness and efficiency in many very important respects. He accordingly set himself last year to design a locomotive which should fulfil these requirements, and the magnificent engine No. 721, Dunalastair, is the outcome.

The foregoing description of the steady growth of the Caledonian express work, and of the manner in which it is performed by the engines hitherto in use, will have enabled the reader to realise the demands in the way of power and speed which the new engines had to be designed to supply. They had to be equal to even finer work than that recorded above.

On inspecting the accompanying illustration of Dunalastair, and bearing in mind that her driving wheels are 6ft. 6in. diameter, the first thing that strikes an observer is the great height of the engine and the vast size of her boiler. The middle line of the boiler stands nearly 8ft. above the rails, and the diameter is so large that it bulges out well beyond the driving wheel splashers. Indeed, it is mainly in order to enable the boiler to clear the wheels that it has been placed so high, thus compelling the chimney to be made unusually short. This arrangement gives the engine a peculiarly sturdy and imposing appearance. Indeed, when standing on the rail level the proportions of the engine appear absolutely gigantic, and this aspect is even more striking when the locomotive is viewed from the front, as approaching with a train. The boiler contains no fewer than 265 tubes, and has a heating surface of 1403 square feet. The steam pressure is 160 lb. to the square inch. The cylinders—placed inside—are 18¼in. diameter, not "18½in.," as has been rumoured. The length of piston stroke is 26in. The dome is placed on the middle of the boiler, and the Ramsbottom safety valves are over the fire-box, as in Mr. Lambie's latest engines. The weight on the coupled wheels—available for adhesion—is 31½ tons. The total weight of engine and tender is 87 tons. The total length of engine and tender is 53ft. 4in. The engine is fitted with numerous improvements, notable among which is Mr. McIntosh's patent protector for the water-gauge glasses. This protection is in the form of a hemi-cylinder of thick toughened glass, which easily slips into the holders of the gauge glass, and is retained by a sliding ring and india-rubber washers. This protector has been stringently tested, and has undergone an explosive pressure of 3000 lb. to the square inch without breaking. It will be a valuable safeguard to the driver and fireman against the usual consequences of a somewhat common and very dangerous mishap—the bursting of the water-gauge glass. The engine has also the Drummond air-blast sanders, the carriage steam heating apparatus, and the Westinghouse brake. The tender carries seven tons of coal, and 3750 gallons of water.

Another point which will impress anyone on seeing the engine for the first time is the remarkably artistic neatness and compactness of her external design. Special care has been taken to keep all the injector pipes, brake-rods, &c., entirely out of sight, while at the same time they are readily and easily accessible. This is a vast improvement to the outside appearance of the engine, as the lines of her boiler and frame are unbroken, save by the Westinghouse pump cylinders. The side view is particularly pleasing in its extreme neatness and uniformity, as well as on account of the artistic form of the locomotive. The dark blue colour, picked out with narrow white and broader black lines, long associated with Caledonian engines, is maintained, and the company's arms are painted on the driving splasher, which, in the case of the first of the series, also bears the name Dunalastair, after the estate of one of the Caledonian directors, while the number plate is on the trailing splasher. The other fourteen of the class will be numbered 722 to 735, but will not have names. Nos. 721, 722, 723, and 724 are already out, and the others will follow at the rate of one weekly.

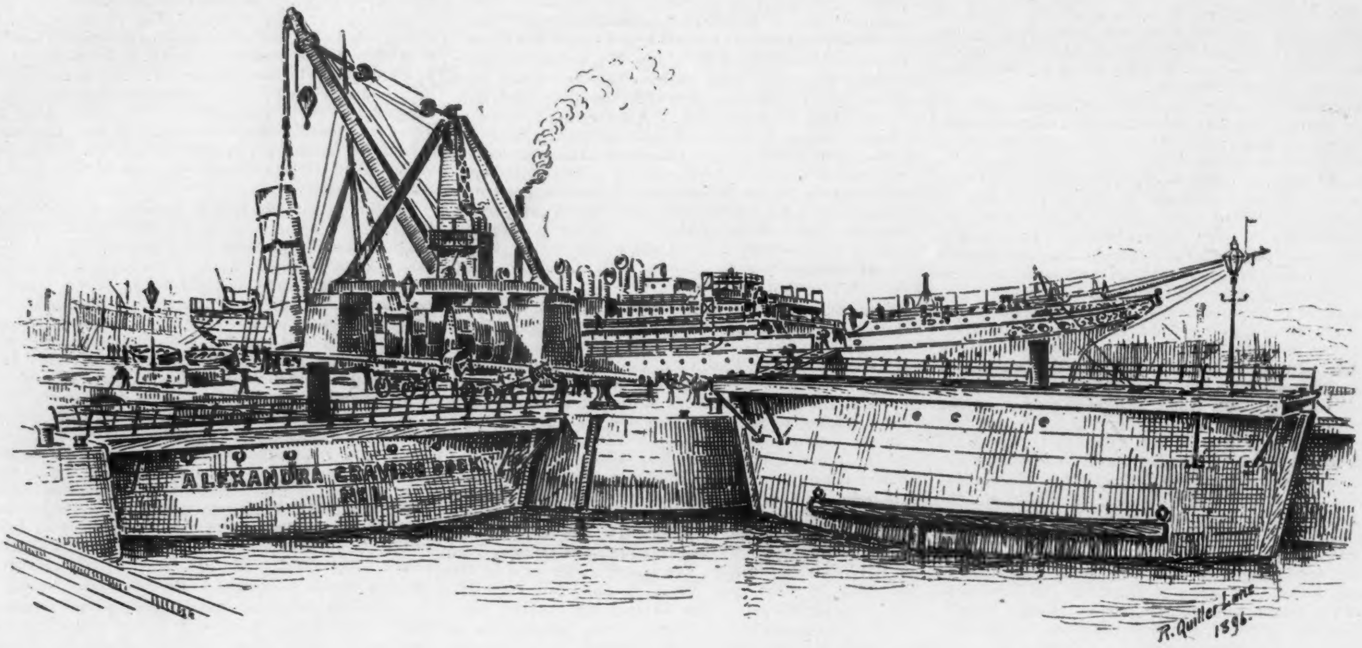
At present the Dunalastair is not employed regularly on the "best" trains, being only in her trial stage; but so far she has more than answered all the expectations of her designer, although she has never yet been put to anything like her full power. A few days ago she took the day mail from Carlisle, and through the courtesy of Mr. McIntosh I had the pleasure of personally observing her working. The run chosen for observation was that from Beattock to Carstairs, which included the ascent of the Beattock bank and the descent from the summit. It was not feasible to press the engine to the utmost, as, the train being in good time, this would have involved so much too early an arrival as almost to render it certain that we should be "blocked." Even as it was this happened, as will be seen from the sequel.

The train consisted of thirteen heavy coaches, equal to a gross weight of about 200 tons, exclusive of engine and tender. The weather was fine, with light head wind and a dry rail.

Starting from Beattock, the line first rises two miles at 1 in 88, then two at 1 in 84, and finally six at 1 in 75 to the summit. This steep bank was ascended under easy steam, the regulator being only one-third open, and the reversing lever in the fourth notch. The steam pressure all the time was maintained just under blowing-off point. The lowest speed up the 1 in 75 was 25·7 m. h., but the engine was simply "playing with" the train, and working a long way within her powers. The summit—10 miles—was reached in 21 min. 41 sec., and then, after a very steady descent of the two miles of 1 in 100, a short spurt was made down the length of easier falling gradient toward Lamington. The last three miles before this point were done at 73·8, 76·3, and 79·0 miles an hour respectively, and a still higher velocity would have been reached but for an aggravating check near Lamington, the train being a little before its due time, so that a preceding goods had not had time to get out of our way into a siding. After coming nearly to a standstill and losing fully three minutes, we proceeded; but there did not remain time enough to reach a higher speed before arrival at Carstairs, as three miles of ascent at 1 in 200 intervened. Up these, however, the Dunalastair took the train easily at 65 m. h. As it was, the run from Beattock was done in nearly six minutes under time, and could easily have been made in a very much shorter period, as will assuredly be done when the engine is in regular working order.

Mr. McIntosh was with me on the footplate, and took a keen interest in the working of his splendid engine. The running throughout was remarkable for its steadiness. I may add that among other advantages she possesses an exceptionally spacious and commodious cab, and is so cleanly to work that not one of the four persons on the footplate showed the slightest symptom of the griminess

THE MAIL STEAMER SCOT IN THE ALEXANDRA DOCK



which ordinarily is an inevitable concomitant of footplate travelling. Fuller details of construction and dimensions will be given in a later article.

The log of the run is as follows ;—

Miles.	Stations.	Times.	Remarks.
—	Beattock (dep.) ...	4.15.51	Slowest ¼ mile = 35 secs.
10	Summit (pass) ..	37.32	
12¾	Elvanfoot ,, ...	41.5	
15	Crawford ,, ...	43.29	
17½	Abington ,, ...	45.44	¼ miles = {12·2, 11·8, 11·4} secs.
23	Lamington ,, ..	50.2	Bad signal check, nearly stopped dead.
26½	Symington ,, ..	54.40	
28¼	Thankerton ,, ...	56.16	
33¼	Carstairs (arr.) ...	5. 1 .12	Gradual stop.

LENGTHENING THE CAPE MAIL STEAMER SCOT.

The Scot is already known as a long steamer, and has been compared to a huge yacht. But long as she is, she is now undergoing the process of having some 50ft. added to her. The operation is being carried out by Messrs. Harland and Wolff, of Belfast. Up to the present the work done consists in the removal of her foremast, funnels, three double-ended boilers, and the donkey boiler, and she has gone into the Alexandra Graving Dock, where the work of cutting her in two and lengthening her is to be performed. The two sketches show her at the 100-ton crane, and as she now is in the dock.

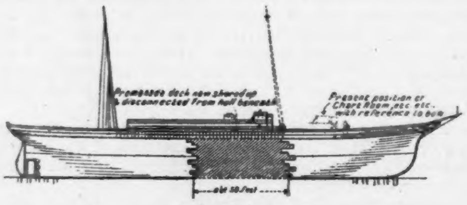

Promenade deck now shored up & disconnected from hull beneath
Present position of Chart Room, etc. etc. with reference to bow
abt 50 feet

DIAGRAM Fig. 1

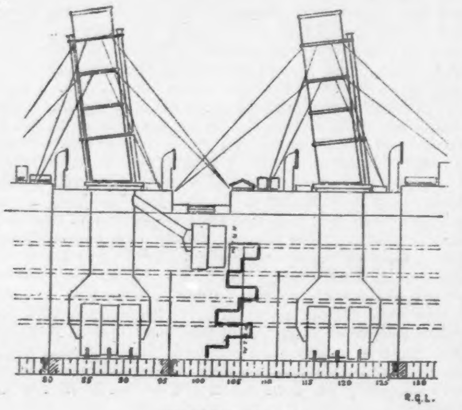
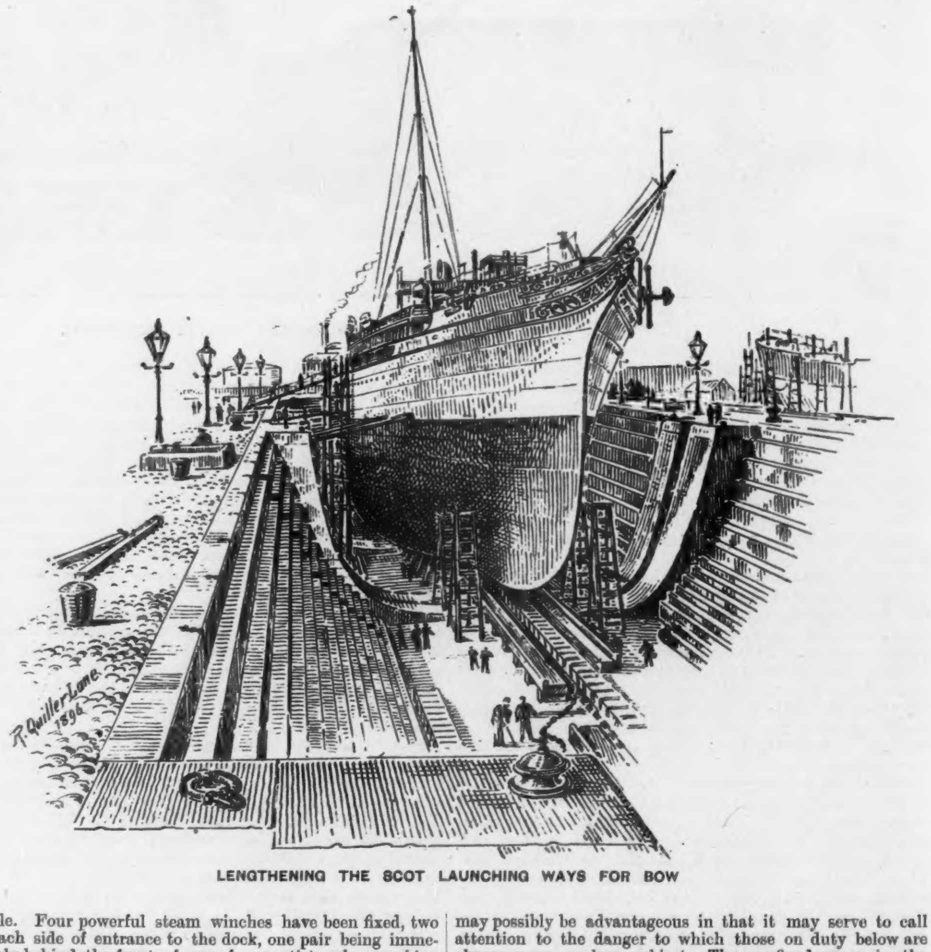


DIAGRAM Fig. 2

In the first the workers are just slinging ashore her second funnel, the first having already been disposed of and removed out of the way. Her foremast, with crow's nest, may be seen lying on the quay, together with the three great boilers, while men with horses and vans are engaged in removing the last of the coal from her bunkers.

In the second and smaller sketch, which almost explains itself, she is shown with the preparations in progress for sliding her forward half 50ft. ahead, part of the launching ways being already in position. Nearly all the rivets in her shell plating have been drilled out amidships, and men are engaged drilling out others near her bows, for the launching cradle. Four powerful steam winches have been fixed, two on each side of entrance to the dock, one pair being immediately behind the front of one of our artists when making this sketch, the other pair on the opposite side. Large quantities of massive chain cable are lying about, and, in fact, every indication of an operation of more than usual magnitude. Hydraulic jacks will be used to start the huge fabric, but at the best it will be a very slow and delicate undertaking, requiring the utmost skill and forethought.



LENGTHENING THE SCOT LAUNCHING WAYS FOR BOW

If our readers will refer to the large plate of this vessel, which we published on July 3rd, 1891, they will see exactly where the separation is being made by comparing it with the small diagrams, Figs. 1 and 2, where a thick black line shows the form the joint takes, following the vertical and horizontal seams in the plating. The proportions are not far from being correct.

ENGINE-ROOMS OF DESTROYERS.

The torpedo boat destroyers Havock and Surly came to serious grief during the recent mobilisation of the vessels of this class. The Havock knocked out both ends of one of her intermediate-pressure cylinders, owing to the fracture while running of one of the connecting-rod bolts, the deranged parts also damaging the condenser by their antics; while in the Surly a large crack developed in the port high-pressure slide valve casing. Of course this sort of thing is to be expected, and while unattended by accident to life or limb, may possibly be advantageous in that it may serve to call attention to the danger to which those on duty below are always more or less subject. The confined space in the engine and boiler rooms, the cramped machinery of enormous power running at a very high speed, render this condition unavoidable. At the same time, we think the Admiralty would do well to consider still further the artificers and stokers who are engaged in this harassing service. It requires adamant nerves and physique to stand it for long, altogether apart from the question of ever present danger of breakdown. We are glad to see these vessels in commission. Nothing could be better than the training they will afford. They constitute a distinct branch of the service in themselves, and if manned by men accustomed to them, will play havoc with our enemies' torpedo flotillas, if the times should ever demand it of them. We are nearly as rich in this respect as all the navies in the world put together, which is, of course, just as it should be. We probably shall soon be richer.

RAILWAY MATTERS.

The Congo State Railway has reached Kimpesse, where the caravans for Stanley Pool recruit fresh carriers. The *Times* says this first section of the line covers 160 kiloms.

According to the New York *Electrical Engineer*, the Cleveland, Akron, and Columbus Railroad Company has taken off its road four passenger trains on account of the electric line competition between Cleveland and Akron.

The Simplon Tunnel Convention was signed on the 22nd inst. by the Minister of Public Works, the Minister of Finance, and the Minister of the Treasury on behalf of Italy, and by the representatives of Switzerland.

The State Railroad Commissioners of New York have refused the application of the Kings, Queens, and Suffolk Railroad Company for a certificate to permit the construction of its proposed so-called bicycle railroad between Brooklyn and Far Rockaway. There are two railroads already in existence between the termini; if the rates by these lines are too high the State has power to reduce them.

Messrs. Easterbrook, Allcard, and Co., Sheffield, have obtained, through a merchant house, an order to provide a complete plant for a locomotive workshop for an Asiatic Railway Company. The machinery to be laid down comprises double-wheel lathes, capable of turning the two large driving wheels of a locomotive on their own axle at once, double axle-box boring machines, drilling machines of various sizes, heavy slotters, punching machines, shearing machines, screwing and tapping machines, wood-working machinery, &c., with the necessary driving gear.

The recommendation made by the Board of Trade inspector who reported on the broken rails at St. Neots is that much heavier rails should be used, namely, at least 90 lb. per yard. This is the recommendation long urged by Mr. Sandberg, and many lines are now adopting it to meet with the demands of the very heavy engines now running. At the same time it must not be forgotten that the St. Neots rails had been in use over thirteen and probably eighteen years, and other causes of fracture than mere weight come into play, as shown by the breaking into so many pieces.

Another curious freak of the electric current caused great annoyance to passengers on the Metropolitan Elevated Railroad in Chicago on the night of January 22nd. The current is delivered to the cars through a third rail. A sleety rain caused a coating of wet ice to form over the rail and the ties, by which the current was grounded and the whole car system came to a standstill until the ice could be cleared from the line, which took several hours. As drops of rain fell upon the electrified ice sparks were given out, and at times the whole line glowed as if it were ablaze. *Engineering News* thinks the trouble lasted from 8 to 11 p.m. It makes an argument against the three-rail and in favour of the overhead trolley system.

The British South Africa Company has authorised the necessary steps to be taken, in conjunction with the Directors of the Beira Railway Company, for the immediate extension of the Beira Railway from its present terminus at Chimoio to Umtali, the first township situated within the borders of the British South Africa Company's territory. By this construction the entire stretch of the low-lying country within the Portuguese sphere is traversed by the railway, and machinery and merchandise will be conveyed from the coast direct to the company's territories on the high plateau. Salisbury, the capital of Rhodesia, will now be brought within 150 miles of the railway terminus. The reduction in freight charges will be very great, and the cost per ton from Chimoio to Umtali, which now averages from £25 to £50, according to the season of the year, will be reduced to less than £5 per ton. The line will be completed by the end of the present year. It was resolved that the preference should be given, if possible, to tenders from English firms for the rails and sleepers. The future extension of the line from Umtali to Salisbury will immediately follow.

The Report by the Board of Trade upon all the railway, canal, tramway, gas, electric lighting, and Water Bills and Provisional Orders deposited for the present session has been issued. It states that the total number of Bills deposited relating to railways, canals, tramways, and the supply of gas, electricity, and water is 157, as compared with 129 for last session. The total amount of money proposed to be raised under these Bills is £41,009,183, as compared with £23,236,850, being an increase of £17,772,333. As regards the 89 Bills promoted by existing and new railway companies, the length of new lines proposed is 810 miles, as compared with 771 miles, and the amount of capital proposed to be raised is £30,113,833, as compared with £19,492,096, or an increase of £10,621,737 over last year. The total number of Bills relating to tramway undertakings is 22, under which power is sought to construct nearly 103 miles of tramways, and to raise sums of money, amounting in the aggregate to £2,353,200, which is an increase over last year of £2,116,146. By the 53 Bills relating to gas, electric lighting, and water undertakings, power is sought to raise £8,542,150, or more than £5,038,450, as compared with 1895.

At a meeting of the Society of French Civil Engineers in Paris, M. Henri Varennes, a leading engineer of the Orleans Railway, stated that this company, in order not to be distanced by the Northern and P. L. M. companies in point of fast running, has decided that on June 1st next, the beginning of the summer service, the morning and evening expresses to Bordeaux would cover the distance of 376 miles in seven hours. The Orleans Railway Company, which has hitherto had no train running at a greater speed than 40 miles an hour, is about to shorten by 50 minutes the journey between Paris and Bordeaux, and by a full hour that between Paris and Toulouse. At the present time the day express between Paris and Bordeaux is 8¾ hours, and, as the distance is 359 miles, the speed is not quite 40 miles an hour, whereas the day express from Paris to Calais travels 185 miles in 3¾ hours, or 49 miles an hour, and the express trains—day and night—from Paris to Marseilles, 536 miles in 13 hours, or 41 miles an hour. With the journey from Paris to Bordeaux reduced to 8 hours, the speed will be 45 miles an hour, so that the Nord Company will be first, the Orleans second, and the Paris-Lyon Méditerranée third in regard to the speed of their fastest trains.

According to a Board of Trade report on the accident that occurred at 2.55 p.m. on December 28th, 1895, at Maidenhead Station, on the Great Western Railway, when an eight-wheeled third-class bogie carriage, which was the second vehicle from the rear, left the rails and travelled a distance of 1319 yards with all the wheels off, till the train was brought to a stand by the application of the continuous brake by the rear guard of the train, Mr. Dean, the locomotive superintendent, on examination of the wheels which got off the road found "that one wheel had shifted on the axle, and on gauging the portion of the wheel-seat thus left exposed, it was found to have been turned slightly below the proper gauge, so that although an entry is made in our book that the wheel was pulled on the axle with a force of 62 tons, it is likely that it was pulled on at a lower pressure. The wheels were put on the axle in August, 1894. As a rule great care is taken in the manufacture of our carriages, wheels, and axles, and I am unable to account for the man at the wheel-press allowing the wheel in question to pass. He would have no pecuniary interest in doing so, and I can only suppose that he read the pressure gauge incorrectly. The wheels hitherto in use by the Great Western Railway have cast iron bosses, and the fit between the wheels and axles is such as to require a pressure of 60 tons to force the wheels on to their seats." But Mr. Dean intends in future to adopt wrought iron or steel bosses for the wheels, and to force them on to their seats by a pressure of 80 tons, thereby largely increasing the grip of the wheels on the axles.

NOTES AND MEMORANDA.

At a recent meeting of the Edinburgh Royal Society, Dr. Buchan read a paper on the recent great atmospheric pressure. So far, the highest reading had been that recorded at Ochtertyre, in Perthshire, where 31·107in. was registered on the 9th. This place, curiously enough, had the "record" for low readings, a pressure of 27·333in. having been recorded there in January, 1884.

An interesting article on electrical radiation appears in the last issue of the *Electrical Review*, referring to the writings of Varley, Crookes, Hertz, Lenard, Thomson, Kelvin, and others. The same issue gives photographs taken by the Moore etheric light and an article on Röentgen rays. The photographs taken with the light obtained from a make and brake in an exhausted tube by Mr. Moore are very interesting and remarkable.

Experiments on the influences of vibration on the resistance of wires have recently been described by Sig. Murani. To avoid the heating due to friction, the vibrations in a series of metallic wires were induced by an electro-magnetic tuning fork, wires of hardened iron, platinum, hard steel, hard copper, German silver, and manganin being tested, and in no case was any variation in the electric resistance detected by the most delicate methods. Quoting an Italian paper, the *Electrical Engineer* says it is consequently concluded that the resistance of metallic wires is not altered by vibrations, all results to the contrary obtained by other observers notwithstanding.

Seeing the invisible directly, and not by the aid of a photograph, has now become possible. Mr. A. A. C. Swinton writes that, with the assistance of Mr. J. C. M. Stanton, he has succeeded by means of the Röntgen rays in actually seeing the coins inside a leather purse, the metal instruments inside a closed wood and leather case, a coin through a piece of wood half an inch in thickness, and also through a sheet of aluminium. The shadows of the enclosed objects were made directly visible to the eye by means of a fluorescent screen. The precise arrangement was similar to that recently described by Professor Solvioni, of Perugia, whose results have been received in this country with a certain amount of scepticism.

At the request of the Council of the Royal Society of Edinburgh, Mr. Frederick Ives, of Philadelphia, recently gave an address on the stereo-photochromoscope. The essential features of Mr. Ives' method are as follows:—By means of a specially constructed stereoscopic camera, three pairs of negatives are taken at once. Each pair, by a suitable intervention of colour filters, secures those parts of the object from which one of the Young-Helmholtz three primary colours is reflected. When the six positives are subjected to the synthetic action of the photochromoscope, a coloured, solid-looking, optical illusion is the result. Not the least interesting feature of the process, as was remarked at the meeting, is, *Nature* says, the light which it throws on the Young-Helmholtz theory of colour vision.

At the Meteorological Society's meeting on the 19th inst., Mr. R. H. Scott, F.R.S., read a paper on the recent unusually high barometer readings in the British Isles, in which he stated that the daily weather chart for 6 p.m. on January 8th was the first in these islands that ever showed 31in. The station was Stornoway, and by the next morning all over the Northern portions of Great Britain and Ireland the barometers were above 31in. The highest reading of all was 31·119in., photographically recorded at Glasgow at 9 a.m. on the 9th. The barometric pressure then gave way, and the region of highest readings moved southwards along our west coast, and finally left the south of Ireland on the 15th. Weather throughout the period was mild, an unusual thing, with a very high barometer. At the end of the month a second anti-cyclone spread over the country, when the barometer rose to 30·96in. at Cork. Reference was made to previous excessively high barometer readings in England and in Siberia, and it was stated that a reading of 31·62in. at Barnaoul in Siberia in 1877 was probably the highest ever observed.

In Mr. Swinton's experiments in seeing the invisible, the purse or other object was held against the diaphragm, with the Crookes tube beyond it, so that the rays from the latter cast a shadow of the coins through the leather and black paper upon the inner impregnated screen. The platino-cyanide fluoresced brightly under the stimulus of the rays of those portions of the blotting paper where no shadow was cast; and, consequently, the form of the metallic object was made clearly visible. Besides being exceedingly interesting, and possibly capable of sufficient improvement to render it of service in medicine and surgery, the appliance will be very useful for the purpose of ascertaining, without the tedious process of exposing and developing a plate, whether any given Crookes tube is suitable, as regards exhaustion and form, for photographic purposes. It can be seen at once whether the tube is working to the best advantage, and is giving clearly-defined shadows. The apparatus consisted of a tube of opaque pasteboard, with a simple aperture at one end, to which the eye was applied. The other was provided with an opaque diaphragm of double black paper, upon which, on the other side, was laid a piece of blotting paper, impregnated with platino-cyanide of barium in a crystalline state.

Writing on original work, and the numerous copyists who nowadays immediately absorb, repeat, and rush into print with their parasitic work, Dr. W. Ramsay, in a letter to *Nature*, says: "A habit has been growing of recent yearsamong certain scientific men which many of those with whom I have discussed the subject join with me in regretting. It is this: After the announcement of an interesting discovery, a number of persons at once proceed to make further experiments, and to publish their results. To me it appears fair and courteous, before publication, to request the permission of the original discoverer, who probably has not merely thought of making identical experiments, but who has in many instances made them already, and has deferred publication until some grounds exist for definite conclusions. Should such trespassing on newly-sown ground come to be the rule, instead of, as I fervently hope, the exception, the result will be this: Scientific men will provide their private laboratories with a good lock; they will communicate their ideas to none until they are worked out; and the pleasant and friendly intercourse, which is now universal, must be abandoned. Such a state of matters would be greatly to be regretted; and it is obvious that the progress of scientific discovery would be not immaterially hindered if every scientific man were obliged to protect himself against what, after all, comes near to a breach of the eighth commandment."

In a lecture on light at the Royal Institution on Saturday last Lord Rayleigh said there was a paradox, even from the physical point of view, in saying that coloured lights were contained in white light. But light might be thought of as coming on to us like sound, and an analogy might be drawn from the line cut in the wax of a phonograph. This contained all the different sounds that reached the instrument, and in the same way, if we could see the curve of light, it would contain all the colours, though we should not be able to recognise any particular colour by inspection. The lecturer then illustrated the action of various absorbing agents on the colours of the spectrum, and said that on this basis the colours of ordinary objects must be explained. Colour was a shadow, resulting from the removal of light, and therefore a substance which absorbed all the colours of the spectrum but one was of the colour which it did not absorb. If we had an ideal blue glass, cutting away the red, yellow, and green, and put with this a red glass, we should not mix the colours and get purple, but, since the colours acted by subtraction, should obtain nothing but blackness. A piece of white paper reflected light containing all colours in equal degree. If it were painted, the colour was not generated in the act of reflection, but was produced by absorption; the layer of paint might be regarded as stopping certain colours out of the white light reflected by the white paper underneath.

MISCELLANEA.

The Inflexible's refit has been taken in hand at Portsmouth, and she will be provided with a secondary battery of quick-firers.

No. 1 torpedo boat, the Lightning, we read, is for sale. She was built nineteen years ago by Messrs. Thornycroft and Co., and was the first torpedo boat order by her Majesty's Government. She has been running till quite recently.

Harbour works at the port of Algiers are to be contracted for, at a cost of 800,000f. They consist, says *La Marine Française*, of the completion of the lengthening of the northern pier, enlarging it also for a length of 200 metres from its commencement.

The French sea-going torpedo-boat Aquilon has made her full-speed trials at Cherbourg. According to the *Army and Navy Gazette*, the mean speed attained was 26·7 knots, exceeding by 1 knot the contract speed. M. Normand has thus won a premium of 20,000f.

Representatives of the Scotch oil trade met in Glasgow on Monday, and discussed the proposed revised list of regulations by the Thames Conservancy Board as to the inspection of oil-laden vessels previous to their entering the London Docks. The feeling of the meeting was against the proposed rules, but it was agreed that a committee of Scotch companies should confer with the Thames Conservancy Board on the matter.

The Campania Anonima la Electricidad, of Caracas, intends developing power from two falls in the El Guaire river, the power to be electrically distributed to Caracas, and used there. The company's representative has recently visited the Niagara Falls with a Westinghouse Electric Company's man and inspected the power plant there. Quoting an American source, the *Electrical Review* says that the combined heights of the two falls is 345ft., and they will develope 3000-horse power.

The Middlesbrough steamer Bull, belonging to Messrs. James Watson and Co., while leaving the dock at Grangemouth on Saturday, through some misunderstanding of the signals to the engine-room, collided with the gates of the dock, demolishing them and rendering them completely useless. There can be no traffic to or from the dock until new gates are provided. Here, again, is a great loss which would probably have been avoided if reversible propellers controlled from the deck had been in use.

Messrs. Bemrose and Sons have sent us some samples of their brown sensitised paper for making engineering and architectural tracings or reprints. These reprints may either be white lined on the dark brown or brown black base, or may be brown black lines on white base. The samples sent us are very satisfactory, and can be made from drawings or engravings, a tracing original not being necessary. The necessary exposure is, we are informed, much less than for the white line blue ground paper. Sensitised line is also made by the firm.

Experiments are being carried out by the German Admiralty with petroleum fuel on board the Carola, the Siegfried, and several torpedo boats. The ironclads Odin and Œgir and Ersatz Prussen, now in course of construction, are to be fitted for this description of fuel. In our own Navy, the Gladiator will be the first ship fitted with apparatus for burning liquid fuel. It will be carried in tanks, but, oddly enough, the Gladiator will have larger coal capacity than the Eclipse class, which seems to show that the Admiralty does not yet take oil fuel quite seriously.

Another application of the Niagara water-power is its application to the new process of Blumenberg for the manufacture of chlorate of potash by the action of the direct electric current upon tanks of potassium chloride. The electric current is at a remarkably low voltage. Important by-products are also obtained. Operations will begin next July. The Alkali Union, which controls the world's output of chlorate of potash, has reduced the price from seventeen to ten cents a pound, in anticipation of this undertaking; but the new manufacturers will probably undersell them in all the markets of the world.

On the 20th inst. a very shocking cage accident occurred at the Higher Hall Pit, Leigh, eight men being dashed to pieces by the failure of the side safety hooks, when the cage was accidentally hauled up to the pit gear and disengaged. At several other pits the Westleigh Colliery Company, to whom this pit belongs, have Ormerod's safety link in use, but not at this one. If this link had been in use, previous experience leads to the belief that the overwinding of the cage would not have been attended with any fatal results. The cage containing the eight men had a clear fall of over 1200ft.

An extraordinary turn of affairs has arisen in connection with the suggestion to spend £70,000 on the proposed Blea Tarn reservoir. A provisional order has been granted, but the Local Government Board are withholding borrowing powers. At the meeting of the Lancaster Town Council Mr. Alderman Smith stated that the whole difficulty was on account of the Local Government Board's affection for Thirlmere, but they had shown them that that source was financially impossible as against their own. He had never before known a Department stand in the way of what Parliament had sanctioned.

Mr. Frank Caws, of Sunderland, has received a batch of six models of German warships, including the Imperial cruiser yacht Hohenzollern, from the German Admiralty, with instructions to ascertain their merits of form and the relation of resistance to speed. Mr. Caws will test each model with his special apparatus in an experimental tank 40ft. in length. According to the *Naval and Military Record*, each model will be towed by a falling weight, and the rate of its acceleration will be compared with two other unbalanced weights, as used in Attwood's machine, to determine the rate of acceleration of a certain mass under a certain proportion of force. By setting the Attwood weight as a standard, a means of comparison is given with the action of any towing weight upon a model of any given displacement.

At the conversazione held at the Finsbury Technical College on the 20th inst., the Electric Welding Company, of 21, Hindon-street, S.W., showed one of their automatic electric welders in operation. The working of this machine was watched with great interest. They also exhibited a very fine selection of samples welded by the Thomson process. Among the most interesting specimens were some carriage tire sections that can only be welded electrically, printers' chases in all sizes and varieties, iron and steel tubes butt welded, samples of welded iron rod bent double at the weld without cracking, a good assortment of chains, from key chains to massive iron chains, and a collection of welds made on finished gun parts. The process was demonstated by the engineer of the company, Mr. Reginald J. Wallis-Jones.

The Government ownership of certain Atlantic coast canals is advocated in a joint resolution presented to the United States Senate by Senator Quay. He would authorise the Secretary of War to appoint a commission of engineers to ascertain at what cost the Government could obtain absolute control over the property, rights, and franchises of the Delaware and Raritan, the Chesapeake and Delaware, and the Albemarle and Chesapeake canals, and all other canals connecting the great bays and waterways of the Atlantic coast states. The arguments advanced for this action are that the control of these canals by private corporations results in an unnecessarily heavy tax upon persons using them for transportation purposes, and that the Government should control such important waterways. As *Engineering News* says, the same arguments would apply equally well to the Government ownership of railways, telegraph lines, mines, and, in fact, the bulk of large industrial enterprises.

SCHMIDT'S COMPOUND HORIZONTAL ENGINE FOR SUPERHEATED STEAM

MR. SCHMIDT, DURLACH, ENGINEER

(*For description see page 221*)

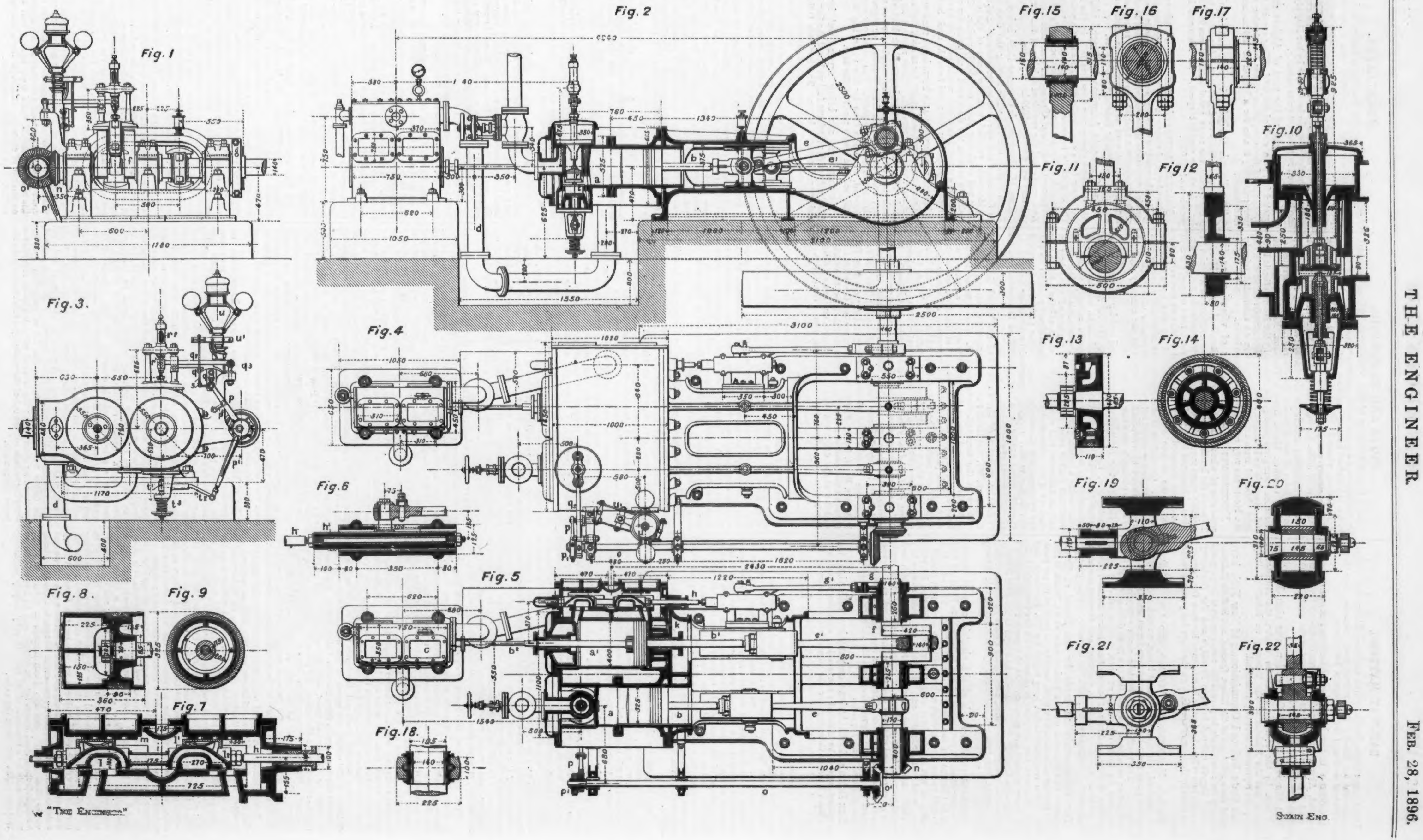


Fig. 1
Fig. 2
Fig. 3.
Fig. 4
Fig. 5
Fig. 6
Fig. 7
Fig. 8.
Fig. 9
Fig. 10
Fig. 11
Fig. 12
Fig. 13
Fig. 14
Fig. 15
Fig. 16
Fig. 17
Fig. 18.
Fig. 19
Fig. 20
Fig. 21
Fig. 22
2500
3100
2430
1620
1220
1780
1550

"THE ENGINEER"

SWAIN ENG.

CARNEGIE DOUBLE-FORGED, FACE-HARDENED ARMOUR, TESTED AT ST. PETERSBURG

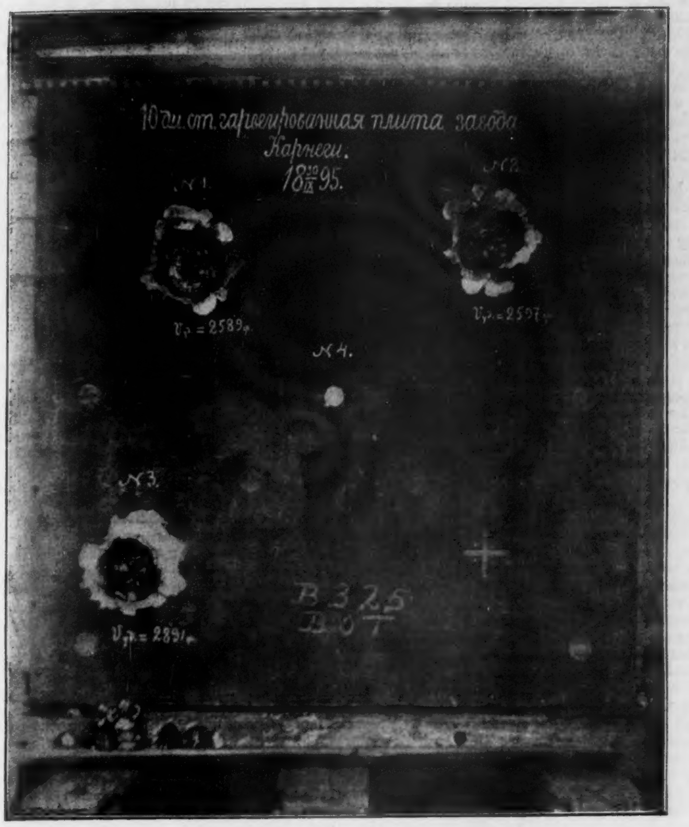


Fig. 1

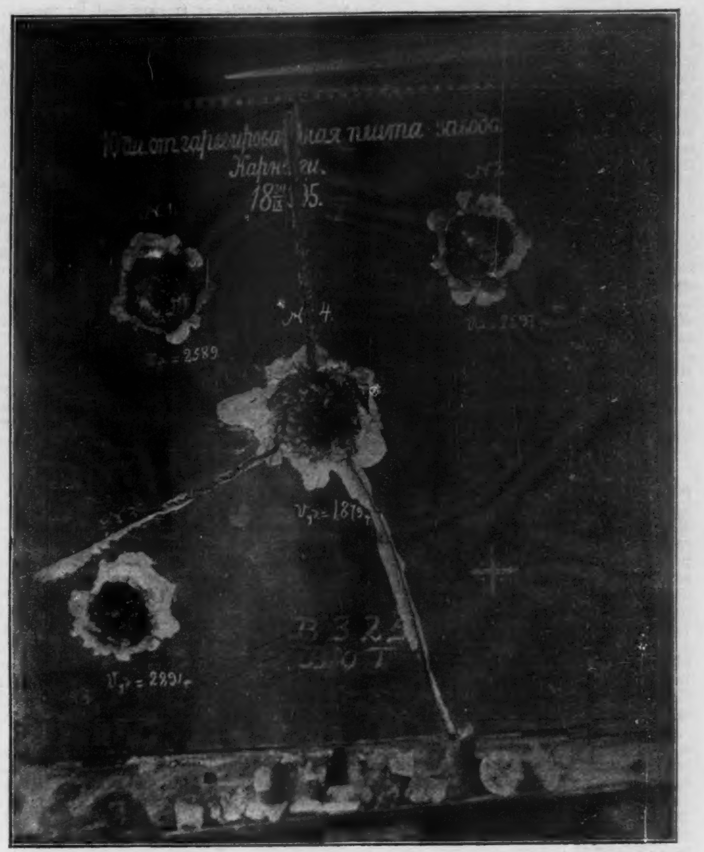


Fig. 2

CARNEGIE'S DOUBLE-FORGED PLATES.

THE two photographs reproduced above show the results of a trial of a Carnegie double-forged nickel steel Harveyed plate, tested at Ochta, near St. Petersburg, towards the end of last year. The plate measured 8ft. by 8ft. by 10in. Fig. 1 shows the plate after completely defeating the attack of three 6in. projectiles. Fig. 2 shows the effect produced by a 9in. shot. The details of the trial are shown in the following table :—

Round	Projectile.		Striking velocity.	Striking energy.	Calculated penetration through iron.	Estimated actual penetration.
	Diameter.	Weight.				
	inches.	lb.	f.s.	ft.-tons.	inches.	inches.
1	6	88	2589	4090	19·2	7·9
2	6	88	2597	4116	19·3	8·5
3	6	87·35	2891	5063	22·5	10·2
4	9	402·7	1879	9856	20·6	11·75

The projectiles were all of Poutiloff make. The three first struck at 1½ degrees to the normal to the plate face and the last at 3 degrees. It may be observed that the first three rounds produced no cracks, and were, in fact, wholly defeated. Their calculated perforations were greatly in excess of what would have been expected that any 10in. plate could resist until recently. Dividing the calculated perforations, which are worked by Tresidder's formula, by the plate's thickness, the figures obtained are: 1·92, 1·93, 2·25, and 2·06, implying that the plate resisted blows capable of perforating from 1·9 to 2·1 times its thickness of wrought iron. It is difficult to give its exact figure of merit in perforation, seeing that it was not completely perforated; also the last round got deeper in than that preceding it, although its calculated perforation was less, showing that the defeat was due, as of course we know, to the fracture of the shot, and that the larger shot held more stoutly together, and so delivered more of its energy in the work of perforation than the smaller ones. One interesting feature is the extremely high velocities employed. This is the first armour plate attack which we have seen made with velocities exceeding 2500 foot-seconds. The third round, it will be seen, struck with a velocity of 2891 foot-seconds. This being so, it is instructive to note that the projectiles did not deliver an overpowering amount of their energy before they broke. Judging from one previous plate trial, it might have been thought likely that the 6in. shot striking with this very high velocity would have done more justice to its theoretical power of penetration than the 9in. striking at a thousand foot-seconds lower velocity. This we find was not the case. The projectiles, however, did get deeper than is usual for shot that are completely defeated. Was this due to their high velocity or to their high quality? Such questions cannot be answered until we all purchase each other's projectiles, and so compare their respective powers, or test them by some standard shot. The plate, it is needless to remark, is a first-rate one judged by any standard, but resistance to perforation is certainly more striking than its resistance to fracture. It will be seen that the smashing blow obtained by dividing the striking energy of the third blow by the probable weight of the plate, which we calculate as 11·72 tons, amounts to 432 foot-tons per ton of plate. This the plate resisted. That of the last blow is 841 foot-tons per ton of plate nearly. Under this the plate broke, the shot being, however, as we have seen, fractured and kept from perforating. As an example, both of a double-forged plate and of armour attacked by shot with very high striking velocity, this experiment is most interesting, and Messrs. Carnegie are to be congratulated on the result.

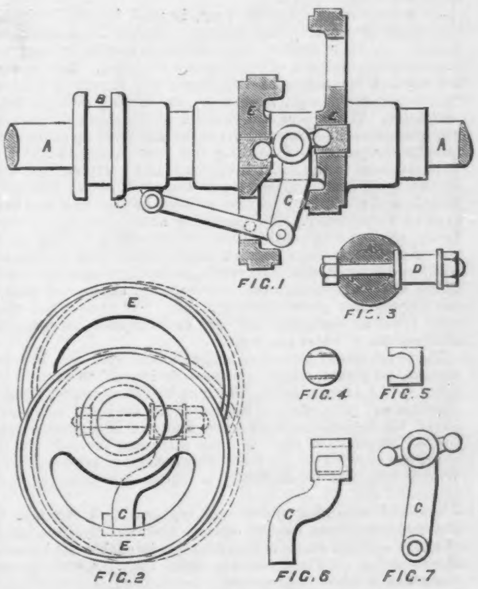
THE FEDERATED INSTITUTION OF MINING ENGINEERS.

SHEFFIELD MEETING.

THE members of this Institution had the opportunity, if they so desired, of becoming acquainted with various of the local industries of Sheffield, by taking part in the excursions arranged for them, and also in private visits kindly permitted by those in authority where excursions had not been arranged; consequently many members lingered in that centre until the end of the week, and were thus enabled to have ocular demonstration of matters referred to in some of the papers read at the meeting, and which we for this reason left unnoticed until after these inspections. These papers were: "Lead and Lap of Winding and other Engines," by Mr. Hargrave Walters, and "Coal-washing Plant at the Wirral Colliery, Neston, Cheshire," by Mr. James Platt. Another important paper read at the meeting was on "Photography in the Technology of Explosives," by Mr. Alfred Siersch, and will be noticed with other articles recently published by the North of England Institute of Mining and Mechanical Engineers. It was also announced that prizes had been awarded to the authors of the following papers that had appeared in the "Transactions" of the Federated Institution for the year 1894-95, vols. viii. and ix.: "The Magnetic Survey of Great Britain," by Prof. A. W. Rücker; "Investigations on the Composition, Occurrence, and Properties of Black Damp," by Messrs. John Haldane and W. N. Atkinson; "Canals," by Mr. Lionel B. Wells; and "Electric Transmission of Power," by Mr. Alexander Siemens.

Lead and lap of winding and other engines.—Mr. Walters has devised the following arrangement to give lead and lap in the admission, letting-out, and cutting-off steam. To accomplish this object, the excentrics are rendered capable of being moved on the shaft forward and backward, at will, at any time while the engine is in motion. This the writer has done in the manner shown in the accompanying engravings, a method equally applicable to almost every class of steam engine, but more especially to winding and hauling engines, working under variable conditions. The following is a description of the invention:—The engine shaft A, or a secondary shaft B, sliding on the shaft A, moves the lever C, carried on a stud D, fixed on and driven by the shaft A. The lever C operates on the excentrics E, moving them round the shaft A inversely, thus giving the necessary lead to the valves, as shown by the dotted lines, Fig. 2. The sleeve B is moved by a forked lever and a light shaft, placed conveniently to the engineman, and worked either by a treadle or a hand lever, or a wheel, driving a quick-threaded screw. This arrangement is suitable for engines fitted with single excentric, or single and coupled link motion. A few cases were described, in which the use of variable expansion gear is an absolute necessity for the proper working of an engine, under varying conditions and speeds. This invention evoked some criticism, hostile and otherwise; but anyway it was demonstrated at Birley Collieries, East Pit, that it could be easily adapted to an engine and that it could be very easily worked by hand lever. As to its efficiency, however, sufficient evidence was not adduced to pronounce definitely one way or another.

Coal-washing plant at the Wirral Colliery, Neston, Cheshire.—The Elliott washer is adopted, and is capable of dealing with 100 tons of coal per day of ten hours, the coal consisting of all that passes a screen with 1in. and 1¼in. parallel bars, but a vibromotor screen is provided to perform any desired separation. The washer consists of a steel trough 60ft. long, 1½ft. wide at the bottom, with the sides opening out to 2½ft. wide at the top; it is fixed at an incline of 1 in 12, and scrapers are attached at intervals of 6ft. to an endless chain, passing round sprocket wheels fixed at each end of the trough, and caused to move slowly along the bottom of the trough from the lower to the higher end and against the stream of water. The scrapers are 4in. deep and fit the trough accurately at the sides and bottom. Water is supplied at the upper end of the trough by a centrifugal pump, 3ft. in diameter. It gives an ample supply, which is regulated by a valve, any surplus overflowing back to the pump. At the end of the trough a fine mesh screen serves to separate the water from the coal. The quantity of water in circulation is about 150 gallons per minute. The coal is charged into the trough midway down from a hopper by an automatic feed which can be regulated; the dirt sinks with comparative rapidity, and is drawn to the upper end of the trough by scrapers and discharged there, while the coal is washed down to the lower end by the current of water, and is delivered into the boot of an elevator which raises it to a storage box. It is stated that there is very little waste of water and that the work done by this washer is good; and certainly an inspection of a plant for dealing with 400 tons a day at the works of the Hardy Patent



WALTERS' EXCENTRIC SHIFTING GEAR

Pick Company leads one to agree with the author in acknowledging that the plant is of an extremely simple construction, and if properly attended should not give much trouble on the score of repairs, and in this direction if not in others also, should undoubtedly compare very favourably indeed with other coal-washing plants of more complex character. With regard to washers of similar character, an opportunity was given the members of seeing the Murton washer at the Nunnery Collieries. This washer consists of an endless articulated steel trough belt, about 60ft. long, 3ft. wide, and 8in. deep, set an incline of about 1 in 18, and furnished with stops about 2in. high, at intervals of 3ft. inside the trough. Supporting drums and rollers are provided, and the belt travels at a speed of 8ft. to 10ft. per minute towards the coal and water supply, which are near the upper end. Three different trough belts were dealing with good sized nuts, medium nuts, and smudge respectively, and were disposing of large quantities of material in a short space of time; but as there was no opportunity of testing the quality of the work done, and as no working plant of the Elliott type was seen in operation, no absolute decision could well be arrived at as to their relative merits, although there were points suggestive of superiority in the latter. There was no need for hesitancy as to the relative merits of the other washer visited; this was a simple trough washer, where both trough and dams are stationary, and coal, dirt, and water scramble down together until the dams are packed to the top with dirty coal; the stream is then diverted into another trough, the dams temporarily removed, and the dirty coal shovelled out by hand. This was evidently far behind both the Murton and the Elliott in all points.

At the dinner the depression in the coal trade was referred to, but some hope of helpful legislation was kindled, as the chairman was an M.P. The chairman, Mr. Emerson Bainbridge, pointed out that, concerned as he was in the production of about 5,000,000 tons of coal per annum, he regarded his position there as appropriate, and pointed out that the present state of the coal trade might be described as represented by the figures of three collieries losing money to one colliery that was making it. He suggested four remedies—the first, a Bill for arbitration in labour disputes and fixing railway rates; the second, the adjustment of the latter to meet the requirements of the producer; the third, the rational regulation of wages; the fourth, a federation of mines, somewhat in the manner proposed some years ago by Sir George Elliott.

The excursions.—The Nunnery Collieries were visited by a large party of members, who were much attracted by the banking arrangements, the dressing and washing, the engines and the brick-making plant. The following is an account of the general equipment of these collieries:—The Silkstone winding-engine has cylinders each 30in. in diameter, and 5ft. stroke, working a rope drum 18ft. in diameter. The Parkgate winding-engine has two cylinders, each 24in. in diameter and 4ft. stroke, working a drum 16ft. in diameter. The winding-engine at the new pit has two horizontal cylinders, 32in. in diameter by 6ft. stroke; the Cornish valves are fitted with Thornewill and Wareham automatic cut-off; the drum is of cone-shape. These engines were designed to raise 1800 tons per day of nine hours from a depth of 900ft. The shaft guides at the old pits consist of steel rails, which are twice the cost of ropes in the first instance, the advantage of their use being that the cages can be brought closer together. Rope guides are used at the new pit. The haulage in the Silkstone coal seam is performed by a head rope 11,000ft. in length, which works an inbye incline, bringing 42 tubs, containing 21 tons of coal, up a gradient of 1 in 7 at the steepest part to a point one mile distant from the shaft, whence they are brought by a main-and-tail rope engine to the pit bottom. Both of the hauling-engines are worked without spur gear, and the single-rope engine is condensing and is fitted with clutch gear. Both engines have two cylinders, each 24in. in diameter, and are erected on the surface, the ropes running down the shaft in pipes.

An endless rope, 19,000ft. long, is used in the Parkgate coal seam for working the haulage. In the East Parkgate district, another endless rope, 9600ft. in length, is used for the combined purpose of hauling and pumping. Two pumps are worked by means of this rope; the pumps are three-throw plunger pumps, geared to 5ft. driving pulleys, fixed vertically. The pumps are capable of pumping 50 gallons per minute each. Two endless ropes are used upon the surface for the purpose of hauling the New Silkstone and the Parkgate coal to the main heapstead, and carrying dirt, &c., to the spoil heap. These ropes are each about 2700ft. in length, and are driven by two pulleys having five and four grooves respectively. The pumping at the colliery is very heavy, power being provided for raising 6000 gallons of water per minute. A large Cornish beam-engine, with a cylinder 86in. in diameter, and 10ft. stroke, is kept constantly at work. Three duplicate horizontal, direct-acting, compound pumping engines are placed underground. They are fitted with rams 15in. in diameter, and are each capable of pumping 1000 gallons of water per minute.

There are nine Lancashire boilers fitted with the Proctor mechanical stoker, which enables inferior coal to be used for firing. The Arnold boiler, 30ft. long by 8ft. diameter, has a longitudinal tube running from near the back end to a point about 4ft. behind the bridge, the flues are in welded barrel-shaped sections, so that thinner plate can be used, and no rivets are exposed to the fire. Ventilation is produced by a Walker fan 20ft. in diameter, a Guibal fan being kept in reserve.

The old screening plant was replaced last summer by improved balanced jigging screens and coal cleaning bands of the Wood and Burnett system, so as to enable the increase of output from the new pit to be dealt with. A considerable reduction in labour charges will result from the adoption of mechanical tipplers, and the switchback arrangement on the bank, which were all working very well. The tipplers make a complete revolution, and are self-adjusting. The plant consists of three sets of jigging screens, which separate the large coal into sizes, and three large travelling belts on which the dirt is picked out by boys. The coal is mechanically divided into twelve different sorts, and the plant is capable of dealing with 250 tons of coal per hour. The coal-washing plant of the Murton type, already referred to, is capable of dealing with over 800 tons of coal per day. The rough slack is carried direct from the main screens to the new washery, where it is divided into three classes of nuts and coking smudge, and washed by means of five trough belts. The washed smudge for coking is carried partly in wagons and by water a distance of half a mile, and dropped into large hoppers close to the coke ovens.

The electric plant consists of an Immisch dynamo and motor, the current being transmitted through a cable to the motor fixed at a distance of 10,000ft. from the dynamo. The dynamo is driven by the fan engine, the speed being obtained by means of a counter-shaft with pulleys, driving two leather-link belts. The power required to drive the dynamo at full load is 22-horse power. Power from the underground motor is transmitted by means of a leather-link belt on to a countershaft, which has spur gearing of 5½ to 1 on to the pump shaft. The three-throw ram-pump delivers 50 gallons of water per minute, through 6000ft. of pipes, against a head of 385ft. An Ingersoll air compressor is in operation for working underground hauling engines. The brickworks are capable of turning out 20,000 bricks per day. Fawcett's semi-plastic machines have been adopted to use some of the pit shale, and thereby save the high charges for spoil-heap land. A Sercombes—14 chambers—continuous burning kiln, which is an improvement upon the Hoffman's type, has been built.

Woodthorpe pit.—A Capell fan has recently been erected at this pit, it is driven direct by a Willans and Robinson engine, running at 280 revolutions per minnte. Four Lancashire boilers of Arnold type are working at a pressure of 100 lb. per square inch. A Robinson coal-washing machine has been in successful operation at this colliery for a number of years.

The party proceeded to the Birley Collieries, where luncheon was generously provided by the Sheffield Coal Company. At these collieries the workings of the west and south pits are separated by an upthrow fault to the south, which runs in a continuous straight line eastward. There is a shaft at Birley Moor used for drawing men, and another shaft at Moorhole, used for the same purpose and for pumping water. The shafts are situated near to the outcrop of the Silkstone coal seam to the west. The collieries are connected with the Manchester, Sheffield, and Lincolnshire Railway by a single branch line three miles in length, from Woodhouse Junction Station to Birley Vale Colliery, passing by the east pit. The equipment is as follows:—

West pit.—The west pit and downcast shaft, 12ft. in diameter, is 426ft. deep to the Silkstone coal seam. The winding engine has two cylinders, each 26in. in diameter and 4ft. stroke, and is fitted with a parallel drum 14ft. in diameter and an ordinary foot brake. Single deck cages are used, and two tubs are drawn together. The whole of the coal is banked and run over a gangway to the screens, where it is tipped on to a series of plain bar screens of unusual breadth, affording ample facilities for the detention of tubs containing dirty coal. The coal then goes upon several picking bands, 60ft. long and 4ft. wide, where it is sorted, and the dirt picked out. On leaving the end of the bands, the coal passes over a short bar screen, so as to remove any small coal made in sorting, and thence into the wagons. The slack coal from the screens falls into hoppers, and is conveyed by creepers in troughs to a hopper, from which it is elevated to a revolving screen, and finally to a shaking screen. The nut-coal is discharged into a hopper; the fine smudge falls from the revolving screen into washing spouts—supplied with water by means of two No. 8 pulsometer pumps—and thence into a number of large draining hoppers, from which supplies are drawn for coke ovens. Underground, all the coal is drawn from the dip working to the pit bottom, up planes from 7000ft. to 9000ft. long, with an average gradient of 1 in 12. One plane is worked by a steam hauling engine, with two cylinders each 16in. in diameter and 2¾ft. stroke; the drum 2½ft. in diameter and 2ft. wide—loose upon the engine shaft—is driven direct by ordinary clutch gear. Two other planes, delivering upon one bank head, are worked by a steam hauling engine, having two cylinders, each 21in. in diameter and 3½ft. stroke. The engine has two drums—loose upon the shaft—each 3ft. in diameter and 2ft. wide, driven direct by clutch gear; a separate drum and rope is used for each plane. The trains consist of 30 to 35 tubs, and travel necessarily at a high speed. The ropes are of best plough steel, and ¾in. in diameter. Water is forced to the surface by two double-acting ram pumps, 9in. in diameter and 3ft. stroke, driven by a steam engine with two cylinders 16in. in diameter and 3ft. stroke, and geared wheels as 3 to 1. The pit bottom and plane tops are lighted by incandescent lamps by means of a dynamo and engine placed in the pit. Above ground, arc lights are used during the winter season. There are twelve hand-fired boilers of various kinds, and eight boilers heated by waste gases from the coke ovens, working at a pressure of 45 lb. per square inch. The mine is ventilated by a Waddle fan 40ft. in diameter, driven by a vertical engine, with a cylinder 30in. in diameter and 3ft. stroke; the air is drawn up two shafts, respectively 9ft. and 10ft. in diameter. A second shaft is used for lowering and raising workmen during coal-drawing hours.

South pit.—The drift from the surface is about 1800ft. long to the Silkstone coal seam, with a gradient of 1 in 5. The coal is delivered on the same pit bank and screened with the best pit coal. A steam engine with cylinder 18in. in diameter and 3ft. stroke, fixed under the landing-stage on the surface, with geared drum, hauls the coal by means of an endless rope up the drift; and beyond, up an incline for a distance of 6000ft. At present coal is drawn to this point by means of a plane rope and drum, situated at the bottom of the drift, driven by an endless rope from the surface placed in the Birley Moor pit. Within a few weeks, however, an endless rope will be worked from the terminus of the present endless rope for a further distance of 6000ft., 3600ft. of which length is dipping, and the remainder lies over an upthrow fault of 90ft., beyond which the seam assumes its usual southward dip of 1 in 12. The rope is placed over the tubs, lashed by ⅜in. chains each about 12ft. long. The loaded tubs move in pairs, the empty tubs in sets of four. At present the south pit workings are ventilated by means of a Waddle fan 15ft. in diameter.

East pit.—The east or downcast shaft is 16ft. in diameter and 768ft. deep to the Silkstone coal seam. The winding engine has two cylinders, each 30in. in diameter and 5ft. stroke, fitted with a parallel drum 15ft. in diameter, and a foot brake. Four tubs are drawn at once in double-decked cages with two tubs on each deck. The coal is banked at a considerable elevation above the surface and screened under the same roof. The screens are similar to those used at the other pit; the picking bands, slack creepers, &c., are of similar type to those previously described. The pit bank and screen erections are built of iron columns and girders—the main girders, each about 80ft. long, formed a portion of the ill-fated Tay Bridge.

A new shaft has recently been sunk, and the mine is now ventilated by a Waddle fan 45ft. in diameter. Previous to this the pit was ventilated to the west pit by a Walker fan 8ft. in diameter, placed underground, and driven by an endless rope from the main haulage gear. The winding engine has two cylinders, 24in. in diameter and 6ft. stroke, and was used for sinking the new pit. The drum will be parallel, 15ft. in diameter, and the shaft fitted up with cages for drawing men during working hours. The wooden headgear, about 30ft. high, stands upon brickwork forming part of the raised pit top. There are upwards of 24,000ft. of empty and loaded sidings for trucks, the whole lying at an inclination of 1 in 60, and after the empty trucks are put into the sidings on the upper side of the pit, they can be lowered by the application of brakes throughout the rest of the system. The coal is all drawn from dip workings by power applied from the surface by means of a main endless rope driven by a steam engine to the power shaft at the pit bottom, from whence two endless ropes are taken to the north and south planes—each about 3000ft. long. Several other lesser endless ropes are driven from the same power shaft. A pump, having two rams each 7in. in diameter and 3ft. stroke, driven from the main rope, forces water to the surface. There are eight Lancashire boilers, each 30ft. long and 7ft. in diameter. The pit bottom and the pit bank, sidings, &c., are lighted by electric lamps; the former impressed the visitors very favourably. About 2500 safety lamps are in daily use, all of which are of the Protector type, fitted with two gauzes, and bonneted. There are 156 beehive coke ovens at Birley Vale, 84 of which are connected to a large flue, and the waste gases are used for producing steam under eight boilers. The briquette plant is capable of producing about 30 to 40 tons of compressed coal fuel per day, and is only worked when required.

The equipment of the surface of the East Pit at a cost of less than £9000 gave rise to much comment, but there was striking evidence of the remarkable economic ingenuity of Mr. Hargrave Walter was encountered at all points; and this accounted for the small outlay.

Messrs. Markham and Co. threw open their Broad Oaks Ironworks, and provided luncheon for members. They make and had in progress winding engines, hydraulic presses, air compressors, rock boring machinery, hauling machinery, pit cages, steel head gear, coal sorting machinery, &c. They employ electricity extensively as a power for driving machinery, as well as for lighting, &c.

Various well-known works in the town were open for inspection:—Messrs. William Hutton and Sons, Messrs. Joseph Rodgers and Sons, and Messrs. Walker and Hall's electro works, in addition to the Firth College and the affiliated Sheffield Technical School, where mining, engineering, and metallurgy form the chief subjects of instruction. The mining school is one of the largest and most influential in the provinces.

Engineering Department.—The engineering section is under the direction of the principal, Prof. W. Ripper. In connection with this department there is a laboratory equipped with a vertical tubular steel boiler, working at a pressure of 100 lb. per square inch, and a compound steam engine, capable of indicating 50 horse-power, fitted with surface and jet condensers, brakes, indicator gear, gauges, measuring tanks, &c., and designed to work under a variety of conditions, for illustrating steam engine economy. There is also a gas engine, a 50 tons testing machine, a hydraulic pump and accumulator, and dynamometers, indicators, pyrometers, draught gauges, oil tester, &c. A machine and fitting shop, wood-working department, and smiths' shop, contain all necessary shop and bench tools and appliances. The large physical laboratory, fitted up with all necessary appliances for practical electrical work, and the large drawing-offices, are also in connection with this department.

Metallurgical Department.—This, the distinctive feature of the Sheffield Technical School, is under the direction of Professor J. O. Arnold. The work of this department is principally carried on in a building equipped with a 25-cwt. open-hearth steel furnace, with three systems of gas-producing—viz., ordinary, oil, and water gas—hydraulic cranes, forced draught appliances, and falling weight test. A crucible steel house with two melting holes, and a pot house with pot making tools, are situated in a separate small building. There is a flame and ore annealing furnace for the production of malleable iron castings, and a complete ironfoundry, equipped with belted cupola, drying stove, and all the appliances necessary for the production of green and dry sand castings in iron and steel, and also an assay laboratory, and an iron and steel laboratory fitted up with all the necessary apparatus for rapidly carrying out tests. The steel furnace was designed with the object of combining in a compact form the ideal requirements for satisfying the fullest measure of efficiency. Special apertures are provided at various portions of the furnace in order to test the temperature, to aspire the gases for analysis to ascertain the progress of combustion and decarbonisation, and to test the light of combustion and effect of oxidation spectroscopically. The aim in designing the gaseous fuel generating plant was to provide means for generating the various characters of useful combustible gases from solid and liquid hydrocarbons, so that the student may be able to study the respective advantages and disadvantages of each, chemically and otherwise. The plant also serves to demonstrate the chemical and physical actions involved in the cycles of production, and permits the following combustible gases to be generated:—(*a*) Water gas; (*b*) oil enriched water gas; (*c*) oil gas; (*d*) carbon monoxide, or ordinary producer gas; and (*e*) any mixture of these gases.

In this department, too, valuable and interesting work is being done in connection with the microscopic study of metals; and we had the gratification of having a private view of Professor Arnold's carefully and laboriously prepared microscopic sections, and of noting the extraordinary manner in which minute as well as larger quantities of foreign substances arrange themselves in masses of iron, steel, copper, and gold, setting up planes of discontinuity in various directions, and altogether disorganising the arrangement of particles that exists in the absence of the foreign substance or substances. We are glad to note, too, that a truly technical training is given in this institution—no working to make money by cramming students to pass certain examinations, nor to acquire credit for working up to some arbitrary standard set up by folks neither connected with nor caring for the institution and its objects. The object is to teach matters required in certain professions, and these certainly appear to be taught practically and thoroughly. The visit to the Firth College and Technical School left a good impression on many of the members of the Federated Institution, who hoped that the authorities would attain what they desired—incorporation with the Victoria University.

A matter of by no means small interest incidental to the inspection of the Elliott washing plant in course of construction by the Hardy Patent Pick Company was the walk through its works. These cover an area of about five acres, and consist of foundries, forges, finishing, fitting, wood-working, &c., departments, stores, and offices, and give employment to 400 hands. No one could possibly imagine the amount of thought and good work that is put into the picks, shovels, forks, hammers, &c., and the fashioning of any of the articles from a piece of bar steel, whether by mechanical stamping or by hand—for to suit the idiosyncrasies of the labouring world both means have to be employed—is a fascinating spectacle; then the expeditiousness of the casting of the malleable iron sockets—the moulds are prepared in a machine in rapid succession, the dried cores put in, the moulds lifted from the machine and placed side by side on the floor until there are sufficient to take a pot of metal, which is then poured, and in a few minutes the moulds are broken up, the castings taken out and put to anneal. These operations go on continuously, so that in the space of a few minutes all stages can be witnessed. If the casting is rapid, the annealing is not, for that takes a fortnight. The need of this precaution, however, is obvious, and indeed, unannealed sockets would not be able to even stand the strain of being wedged on to the helve, which is itself a neat operation, like many more connected with this industry. There, too, was to be seen what may be considered the complement to Elliott's washer, namely, a giant Vibromotor screen, 18ft. in length by 4½ft. wide, containing, even in its unfinished state, some 30 cwt. of material, and destined to deal with seven or eight hundred tons of coal a day, and to separate it into four sorts.

A striking contrast to the Hardy Patent Pick Company's works is the works of Messrs. William Jessop and Sons, founded in 1793, with an area of thirty-three acres, five miles of railway, and two locomotives always at work, and where tool and other kinds—almost incredibly numerous—of steel are prepared and fashioned ready for the manufacturer or for some special purpose—tools, dies, pins, springs, saws, rivet work, &c. Here are nine steam hammers, and thirty tilt hammers, driven by steam and water, and of which many may be seen thumping rapidly away on a little bar of heartless steel that will not yield; unlike the pliant pieces of bar that we had previously seen, almost instantaneously transformed into picks, &c., under comparatively innocent looking weapons. In fact, the amount of thumping that a bit of tool steel gets is quite astonishing. But this is not the only cause for astonishment in this works, for the bewildering refinements of steel-making furnish another source, and lead one to admire the judgment of those in charge of the cementation or other furnaces where any one of the vast number of varieties of steel may at any time be required to be produced and is produced. There are twenty-one crucibte steel furnaces, each twelve holes; twenty 20 to 25-ton converting furnaces; a 5, 10, and 15-ton Siemens-Martin furnace, and fifteen trains of rolls. Another department of this works, where gearing of all kinds and sizes, cylinder covers, pistons, repairs, stern frames, rudders, steering quadrants, &c., for single and double screw steamships, are made, is, however, simply stupendous. A slight idea may be gathered from the fact that some of the moulds are built up of masonry, and that there are 15 and 30-ton road travelling cranes, and eight overhead steam travelling crane from 15 to 60 tons capacity. At the time of our visit the latter was carrying a 21-ton ladle charged with 15½ tons of steel, which was being poured into moulds—arranged along the floor to form tires for railway wheels, a steering quadrant, &c. The annual consumption of coal is 45,000 tons, of coke 20,000 tons, and there are twenty-seven engines and thirty-four boilers. It is impossible to do justice to such enterprises in the few remarks of a general notice; but sufficient has been said to indicate the interest and the magnitude of some of the industries in the neighbourhood of Sheffield, which, realising the important centre it now is, is rearing for itself a magnificent pile, architecturally ornamental, to be used as a town hall and for municipal offices; at the same time vast sums of money are being expended on widening and improving the streets of this remarkably hilly town, which has left so many pleasant reminiscences on its visitors of last week.

LANCASHIRE, DERBYSHIRE, AND EAST COAST RAILWAY.

Rapid progress is being made in the construction of this railway, on which there are numerous works of interest, some of which we illustrate by the views on page 118.

One of these, the Chesterfield Viaduct, carries the railway over the new Manchester, Sheffield, and Lincolnshire Railway at Chesterfield, and also over the Midland Railway, and is of the following description:—One span over the Derby-road of 58ft., a single span over the Midland Railway Company's property, consisting of steel girders 115ft. clear span, with cross girders, rail bearers, and buckle-plate flooring. Three spans over the Manchester, Sheffield, and Lincolnshire Railway Company's property, comprising two spans of 44ft., and one of 51ft. These are also of steel, with a girder under each rail, and buckle-plate flooring. The viaduct is completed with five brick arches, varying in span from 30ft. to 38ft. 4in., its total length being 232 yards, and its greatest height from the foundations to rail level is 63ft.

The Bolsover viaduct, of which the engraving on page 118 shows a portion only, the central part, which consists of eight semicircular arches, each of 35ft. span. The greatest height, which is above the proposed Glapwell extension of the Manchester, Sheffield, and Lincolnshire Railway, is 80ft. from foundations to rail level. The foundations, which are of Portland cement concrete go, down, on an average, 20ft., and are founded on hard blue bind. The construction is of brick with brindle brick facings throughout, all angles, both in piers and arches, being bull-nosed.

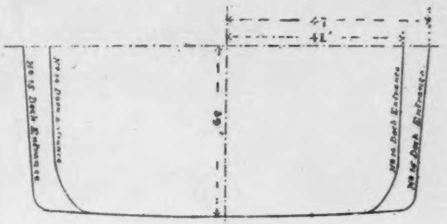
The third illustration on page 118, is of the Markland Grips viaduct. This carries the Beighton branch over a picturesque valley, on the property of the Duke of Portland, near Welbeck Abbey. It consists of six semicircular arches of 28ft. span, and is constructed of stone, with the exception of the arches, which are of brindle brick with ashlar quoins.

These are striking pieces of bridge engineering, and the Markland Grips viaduct shows how a railway may be carried through ornamental property without in any way spoiling the scenery. Mr. Cooper is to be congratulated on these designs, and Messrs. Pearson and Son on their realisation.

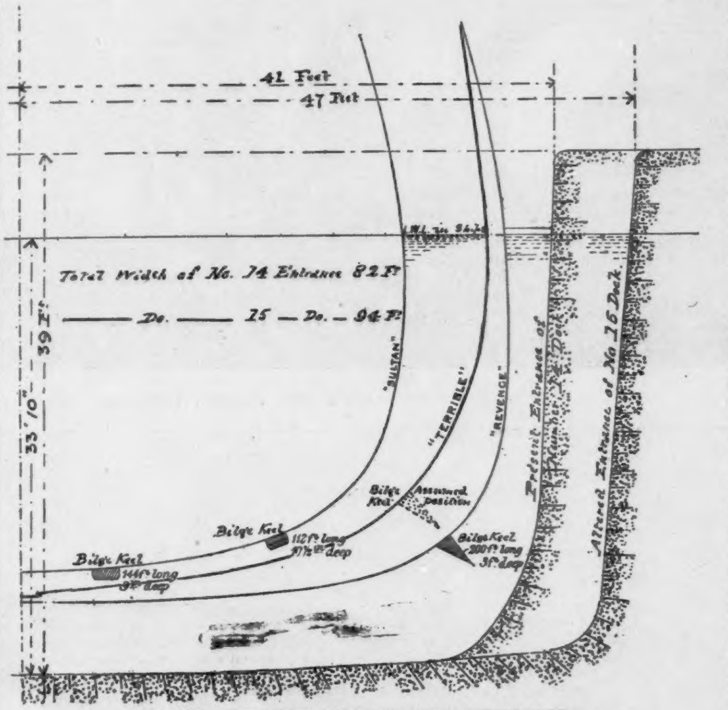
Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—Fleet engineers: Joseph Monk, to the Galatea; David J. Gyles, to the Galatea, to be detailed for duty in the Iris; and Ivie A. Couper, to the Galatea, to be detailed for duty in the Calliope, all to date February 1; George J. Fraser, to the Collingwood, undated. Chief engineer: William C. Burnett, to the Pembroke, additional, for the Pelorus, to date February 24th. Staff engineer: Thomas H. Hyde, to the Victory, additional for the Imperieuse, to date February 21st. Naval instructor: Maurice A. Ainslie, to the Collingwood, undated. Engineer: John E. Vibert, to the Collingwood, additional, for appointment when recommissioned, to date February 24th. Assistant engineers: Gilbert H. Page, to the Blake, to date February 24th; and Walter S. Hill, Ivor E. S. Roberts, and George W. Woolbridge, to the Collingwood, undated.

MODERN WARSHIPS AND DOCK ENTRANCES.

We remarked, in our recent paper upon the construction of the New Docks, numbers 14 and 15, at Portsmouth, that the addition of deep bilge-keels to battleships and cruisers of heavy displacement and wide beam, raised an important question as to the size of many of our dock entrances. Feeling that the subject is one of special and considerable interest, we have prepared engravings showing the widest existing and proposed entrances; also showing midship half sections of the Sultan, as representative of the earlier classes of battleship fitted with bilge-keels, and of the Revenge and Terrible, as representative of the most recent types. Each of these half sections is shown as it would appear if the ship was entering one of the new docks at spring tide high water level, viz., 33ft. 10in. above the sills. Practically, the water in the large fitting basin is a little lower at most times—sometimes, indeed, as much as 2ft. lower—owing to the calls made upon it, when ships are taken into the docks around. So that the full head of water would not generally be found at the entrance sills. In the engraving the actual position and size of the bilge-keels of the Sultan and Revenge are given, in proportion to the scale employed. Those of the Terrible are only assumed, but there is little doubt that they will occupy, approximately, the position indicated.



We mentioned that the original entrance of No. 14 dock, as prepared some years ago, would be untouched for the present at least, but that the entrance to No. 15 was being enlarged from 82ft., its original width, to 94ft., from "stop" to "stop," on either side. Fig. 2 shows both entrances, the old and the new. It will be observed that the contour of the sides is very much altered in the entrance to No. 15. The curve near the bottom is cut away so much that the entrance becomes nearly box form. This modification has been effected to give more room for deep bilge-keels. Fig. 1 shows half sections of the two dock entrances, as well as half sections of the ships going through. It is apparent that very great care must be exercised in entering such a dock as No. 14 will be, with a battleship of the Royal Sovereign class. And with vessels of the Majestic class, where the form of bilge is slightly more square in section, the difficulty is, of course, emphasised. As can be readily seen, even with the maximum head of water over the sills—a desideratum rarely obtained —there is only a free space of 3ft. between the edges of the keels and the spring of the arch at the side. In point of fact, if one of these large ships was injured, and had a list to starboard or port, she could not get in at all; yet the width of this dock entrance, of 82ft., is representative of the largest dimensions found at Portsmouth in docks long enough for the Royal Sovereign class. It is true that the draught of ships can be modified and the narrow space above the dock entrance sills avoided by emptying out ballast tanks, &c. But docks should be of such dimensions that a disabled ship may be accommodated at once under exceptional circumstances, so that it is plain that even the largest of the existing docks at Portsmouth is only just sufficiently wide at the entrance and deep enough over the sills to accommodate a Revenge or a Magnificent.



SECTIONS OF DOCK ENTRANCE AND BATTLESHIPS

Hence, apart from a consideration of the requirements of prospective vessels of still more colossal dimensions than those now afloat, there is the fullest evidence that the authorities of the Admiralty have done wisely in increasing the width of the entrance of one of the new docks to 94ft.—which is 6ft. 6in. wider than that of the monstrous dry dock just completed at Southampton—and in so arranging that the other dock can be ultimately widenened at the entrance with facility if required. An idea has been mooted that it is only in No. 15 dock when completed, and not in No. 14 as well, that the Powerful or the Terrible can be docked. This is quite a misconception. Either of these two docks will be available for receiving the two great cruisers, or, provided the docks were empty and occasion required it, both the ships might be docked at one and the same time, as the original entrance width of 82ft. is ample to float them through. This fact is rendered apparent by a reference to Fig. 1. The beam of the Terrible is only 71ft., her draught is only 27ft., and the coefficient of fineness of her midship section below the water-line is considerably more sharp than that of the Revenge.

But the tendency of the present day appears to be in large battleships and cruisers towards increased beam, whilst draughts remain constant, or are, indeed, in some cases diminished. The new first-class cruisers of the Andromeda type, for instance, are to have a beam of 67ft. 11in., an increase of nearly 3ft. over the beam of the Blake, of which they are the anti-type, whilst the draught is actually reduced from 25ft. 9in. to 25ft. 4in. It is quite possible, therefore, that the anticipated necessity for a dock whose entrance is 94ft. wide may rapidly be fulfilled, and we understand that all contemplated new docks have been designed with this end in view. That is to say, with the idea that both displacement and beam will probably increase.

The addition of numbers 14 and 15 graving docks to the establishment at Portsmouth will be very important, and will render the resources for docking very complete. There are already at the station the accompanying large dry docks, besides several smaller ones:—

	Extreme length. Ft.	in.	Width at entrance. Ft.	in.	Depth over sill, H.W. Ft.	in.
No. 3 {7, 10} double	658	1	80 83	5 6	27 27	6 8
No. 12 single	456	0	80	0	33	4
No. 13 single	456	0	82	0	33	10
Deep lock D	460	3	82	0	41	6
North lock B do E	466	0	82	0	42 33	6 10
South lock C do F	466	0	82 80	0 0	41 33	6 4

Any of these will accommodate, with a little adjustment, ships of the Royal Sovereign or Majestic type, but as the locks could not permanently be considered as available for docking, if vessels were being rapidly entered and removed, say in the hurried emergencies which might arise during a war—the accommodation for such large vessels would be practically restricted to three or four docks. With the two new ones now building all likely requirements are pretty sure to be met.

Chatham is also well off as regards big docks, there being, including locks, eight positions into which the heaviest battleships can be received; but it has no accommodation at all, whether by utilising a double dock or otherwise, for receiving ships of the Powerful class.

Devonport is sadly behind hand in this respect. It has no docks at all of sufficient dimensions to receive either a Revenge or a Magnificent, and it is with the utmost satisfaction that we hear of the intention of her Majesty's Government to proceed forthwith to remedy the evil, by the formation of considerable dockyard extensions at Keyham, £1,920,000 having been sanctioned for this purpose. It is of quite as much importance to have Devonport well found in dock accommodation as Portsmouth. It would probably be the first shelter which disabled vessels would reach in running up Channel.

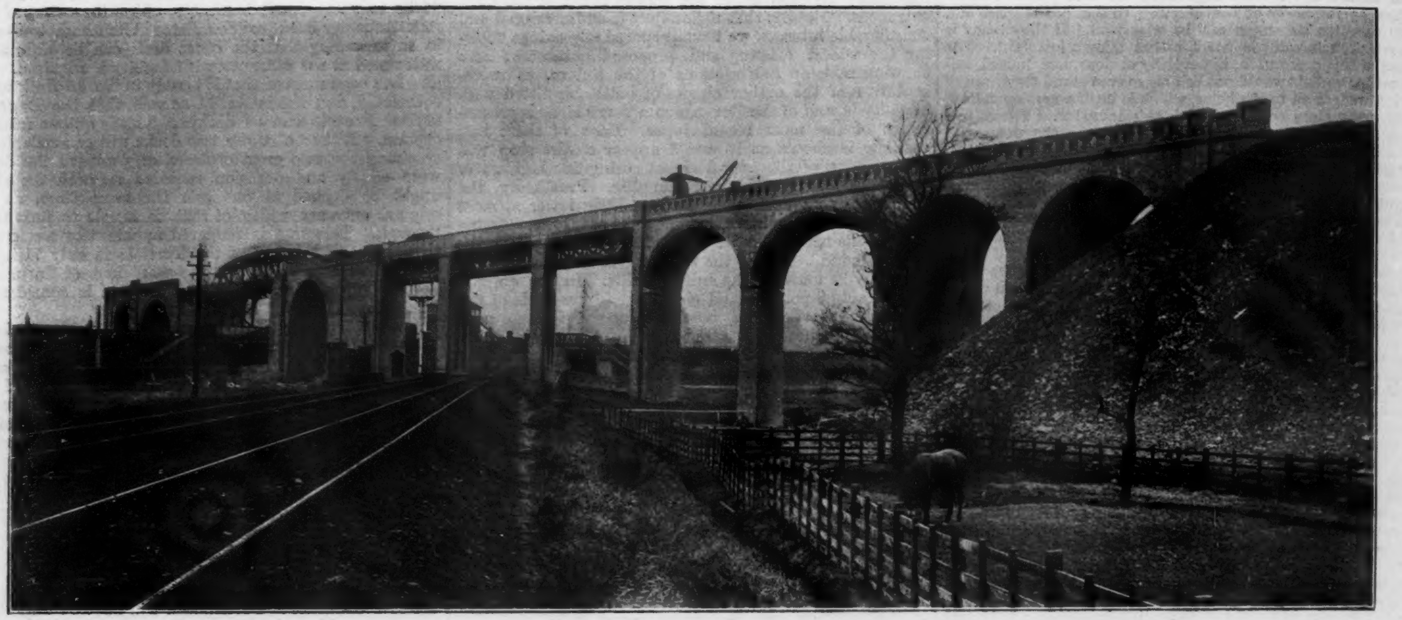
It is somewhat singular that Hong Kong, Sydney, Halifax, and Malta, should at this moment be ahead of Portsmouth, Devonport, and Chatham in docking accommodation for our new gigantic cruisers, but such is actually the case.

The Institution of Civil Engineers—Newcastle-upon-Tyne Association of Students.—The fourth meeting of the present session was held in the Durham College of Science, Newcastle, on the 19th inst., Mr. R. S. Rounthwaite, A.M.I.C.E., Sunderland, in the chair, when Mr. John Rae Baterden, A.M.I.C.E., one of the vice-presidents of the Association, read a paper on "Road and Street Making in Towns." The paper described in detail the first cost, wear and tear of macadam, granite paving, asphalte, and wood paving, with special reference to the use and wear of the Australian hard woods, jarrah and karri, for this purpose. The cost of maintenance of the various classes of pavement were also given, and some notes on scavenging. A discussion followed.

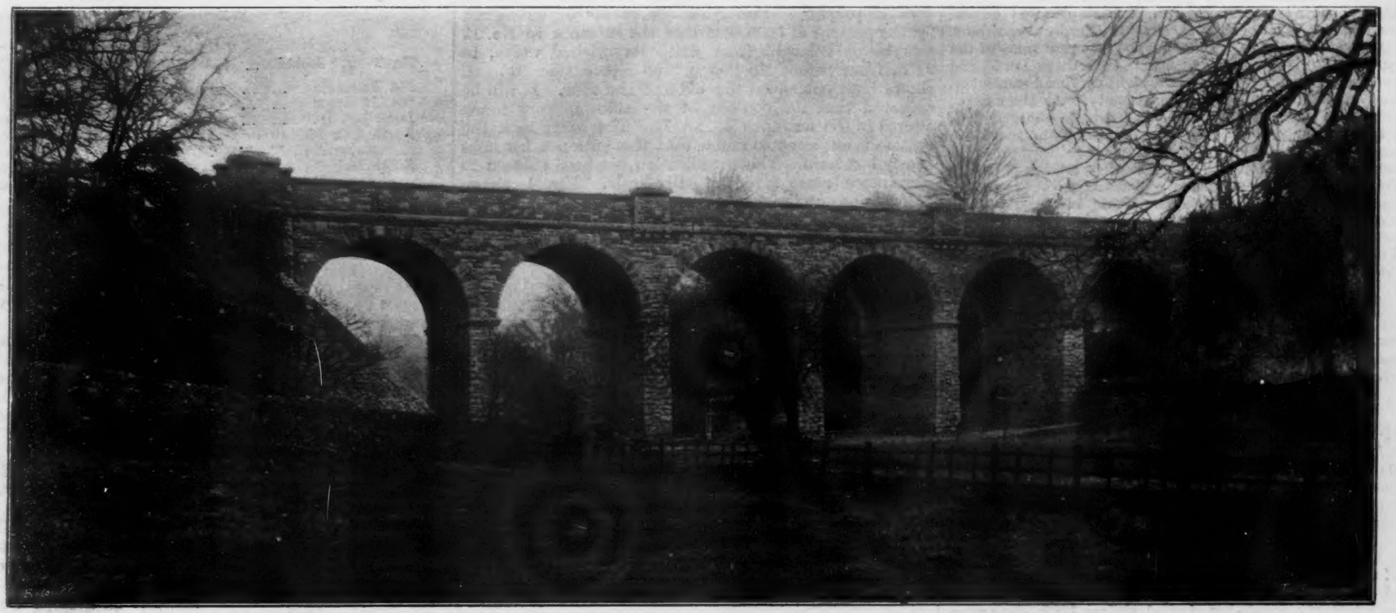
VIADUCTS, LANCASHIRE, DERBYSHIRE, AND EAST COAST RAILWAY

MR. R. ELLIOTT COOPER, M. INST. C.E., ENGINEER; MESSRS. S. PEARSON AND SON, CONTRACTORS

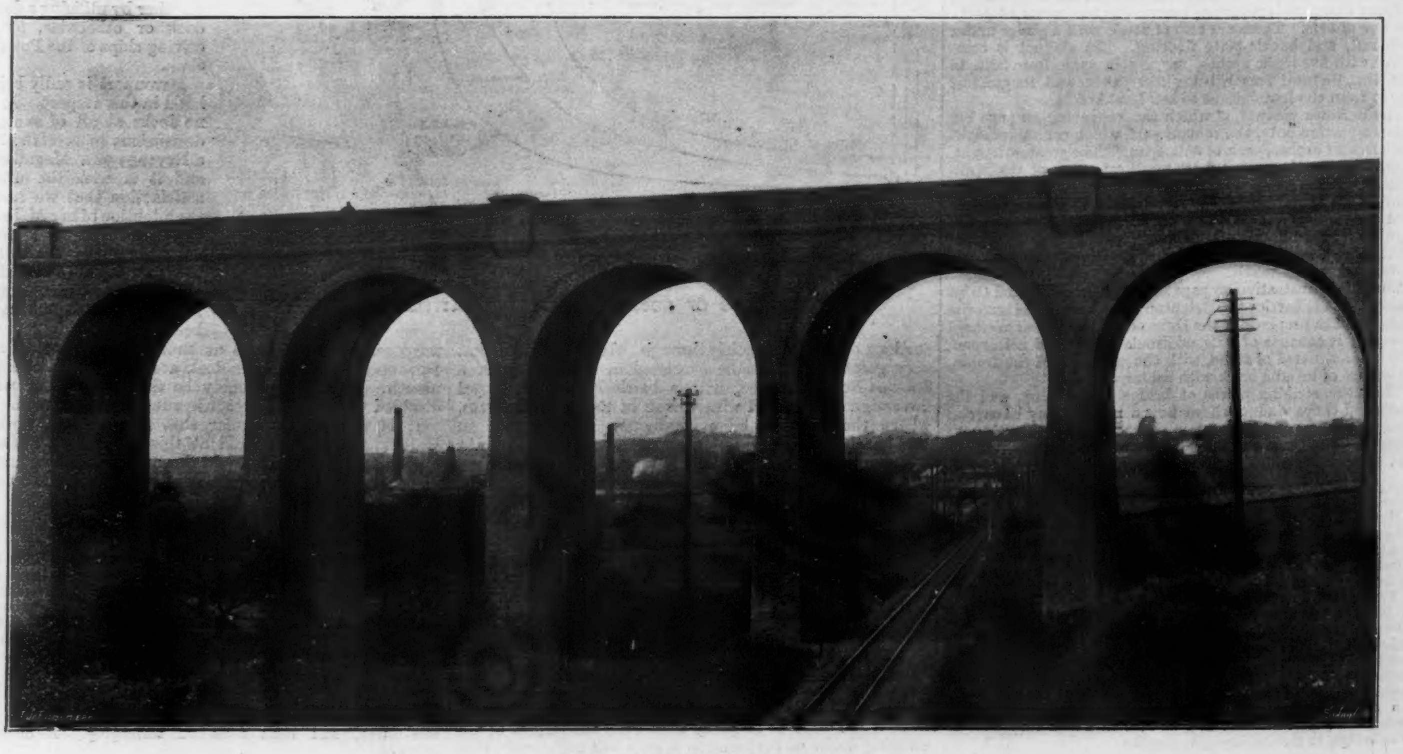
(For description see page 213)



CHESTERFIELD VIADUCT, IN COURSE OF COMPLETION



MARKLAND'S GRIP VIADUCT, NEAR WELBECK



PART OF BOLSOVER VIADUCT

FOREIGN AGENTS FOR SALE OF THE ENGINEER.

AUSTRIA.—Gerold and Co., *Vienna.*
CHINA.—Kelly and Walsh, Ld., *Shanghai and Hong Kong.*
FRANCE.—Boyveau and Chevillet, *Rue de la Banque, Paris.*
GERMANY.—Asher and Co., *5, Unter den Linden, Berlin.*
A. Twietmeyer, *Leipsic.*
INDIA.—A. J. Combridge and Co., *Esplanade-road, and Railway Bookstalls, Bombay.*
ITALY.—Loescher and Co., *307, Corso, Rome.*
Bocca Freres, *Turin.*
JAPAN.—Kelly and Walsh, Ld., *Yokohama.*
RUSSIA.—C. Ricker, *14, Nevsky Prospect, St. Petersburg.*
S. AFRICA.—Gordon and Gotch, *Long-street, Capetown.*
R. A. Thompson and Co., *33, Loop-street, Capetown.*
J. C. Juta and Co., *Capetown, Port Elizabeth, and Johannesburg.*
AUSTRALIA.—Gordon and Gotch, *Queen-street, Melbourne; George-street, Sydney; Queen-street, Brisbane.*
R. A. Thompson and Co., *180, Pitt-street, Sydney; 362, Little Collins-street, Melbourne; 7, King William-street, Adelaide; Edward-street, Brisbane.*
Turner and Henderson, *Hunt-street, Sydney.*
NEW ZEALAND.—Upton and Co., *Auckland.*
Craig, J. W., *Napier.*
CANADA.—Montreal News Co., *386 and 388, St. James-street, Montreal.*
Toronto News Co., *42, Yonge-street, Toronto.*
UNITED STATES OF AMERICA.—International News Co., *83 and 85, Duane-street, New York.*
Subscription News Co., *Chicago.*
STRAITS SETTLEMENTS.—Kelly and Walsh, Ld., *Singapore.*
CEYLON.—Wijayartna and Co., *Colombo.*

PUBLISHER'S NOTICE.

⁂ *With this week's number is issued as a Supplement a Four-page Working Drawing of a Narrow-gauge Locomotive, Cape Government Railways. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it. Price 6d.*

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TO CORRESPONDENTS.

Registered Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

⁂ ***In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and bearing a penny postage stamp, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.***

⁂ ***All letters intended for insertion in The Engineer, or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.***

G. B. (Huntingdon-road).—*The engine is being engraved, and we hope to publish the engraving next week.*

W. W.—*See our advertising pages. You can obtain what you want from the Metallic Tubing Company, 96, Holborn.*

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S. J. G.—*The induced draught wind cowl shown in your sketch is in all but a few unimportant details very old and well known. Such cowls are used by the hundred on board ship and on ventilating pipes and chimneys. It was, as well as we remember, first illustrated in the* Mechanics' Magazine *about the year 1863.*

Toggle.—*We are not surprised that you find the pins bend. When the toggles are nearly at right angles to the rope the stress on the pins is nearly infinite. Consult any treatise on mechanics for diagrams of the stress. Toggles usually have rounded ends resting in suitable sockets. You can reduce the stress as much as you please by increasing the angle between the rope and the toggle bars.*

J. H. T.—*The only special treatise on light railways which is likely to answer your purpose is one written many years ago by Mr. Fairlie, "The Battle of the Gauges." It is possible that you may be able to obtain a copy through Messrs. Spon. The "Proceedings" of the Institution of Civil Engineers contain many articles and papers on the subject. The same may be said of the back volumes of* The Engineer. *See also "Light Railways as a Practical Means of Exploration," by E. R. Solway. London: Spon.*

Sceptic (Cheltenham).—*If a train fitted with the Westinghouse automatic brake parted in two, the brake would instantly be applied with full force to both portions of the train. The latter half might very easily be pulled up in its own length. The first half, being pulled on by the engine, would run a little further, but not much, because the brake resistance is enormous as compared with the pull of the engine.*

G. C. O. W. (Newport).—*Air condensers are very much used, and are efficient. One form is made by the Farringdon Works, Limited, Shoe-lane. You will find illustrations of one at the Bellville Works of the Paris Compressed Air Company, in our issue for May 3rd, 1889, page 366. A stack of tubes, through which the steam passes, has a shower of water poured over it by a pump. The rapid evaporation which takes place in the open air carries off the heat. They are also to be seen at the Margarine Works, Southall.*

PLATTING MACHINES.

(*To the Editor of The Engineer.*)

Sir,—I should feel greatly obliged if any reader could give me the addresses of makers of platting machines to plat ¼in. cords into flat gaskets.

B.

Bilbao, February 22nd.

SUBSCRIPTIONS.

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of The Engineer.

MEETINGS NEXT WEEK.

The Institution of Civil Engineers.—Tuesday, March 3rd, at 8 p.m. Paper to be read with a view to discussion: "On Littoral Drift in Relation to River Outfalls and to Harbour Entrances," by Mr. William Henry Wheeler, M. Inst. C.E.

Society of Engineers.—Monday, March 2nd, at 7.30 p.m., at the Royal United Service Institution, Whitehall. Paper: "The Mechanics of Horse Haulage," by Mr. T. H. Brigg, of which the following is a synopsis:—Fundamental principles of economy relative to the application of physical force for haulage or transport purposes—Experiments illustrating the common practice of costermongers with their carts and loads—Illustrations of the principles upon which work is made easy or difficult by the aid of common levers, some upon fixed, and others upon trailing fulcrums—A distribution of work done over as many muscles as possible to secure the power of endurance, instead of concentrating the work done upon a few, thus limiting that power, either in man or beast—Pulling and thrusting experiments showing the difference of work done—How the mechanical conditions of horse haulage are affected by various conditions—A new system of yoking horses, which shall act automatically at all times in favour of the horse, reserve his physical forces, and prolong his useful life.

The Institution of Junior Engineers.—Friday, March 6th, at 8 p.m. Paper: "Coal Handling for Steam Generation," by Mr. Charles H. Fletcher, Member.

Royal Institution.—Friday, March 6th, at 9 p.m. Paper: "The Blackwall Tunnel," by Mr. A. R. Binnie, M. Inst. C.E., Chief Engineer, L.C.C.

Society of Arts.—Monday, March 2nd, at 8 p.m. Cantor lecture: "The Chemistry of Certain Metals and their Compounds used in Building, and the Changes Produced in them by Air, Moisture, and Noxious Gases, &c.," by Professor J. M. Thomson, F.R.S.E. Tuesday, March 3rd, at 8 p.m. Foreign and Colonial Section. Paper: "The Commercial Prospects of English East Africa and British Central Africa," by G. Scott Elliot. Sir James Crichton Browne will preside. Wednesday, March 4th, at 8 p.m. Paper: "Röntgen's Photography of the Invisible," by A. A. Campbell Swinton. Professor James Dewar, M.A., LL.D., F.R.S., will preside.

DEATHS.

On February 20th, at Albert House, Sutton, John Henry Davis, (late) M. Inst. C.E., M.I.M.E., M.I.S. Inst., F.R.G.S., &c., and Commander of the Order of the Medjedjie in the Turkish Empire.

THE ENGINEER.

FEBRUARY 28, 1896.

SLIDE VALVES FOR LOCOMOTIVES.

A discussion which has proceeded in our correspondence columns during the last few weeks is an instructive example of the recrudescence of certain topics. These are always open to discussion, because they never get settled. It is obvious to every mechanical engineer that slide valves are pressed hard on the faces on which they rub; and that to overcome the friction between the rubbing surfaces requires some expenditure of power. Thus the pressure on the back of a locomotive slide valve may amount to as much as seven or eight tons, and to rub a valve so loaded back and forward through a distance of 4in. or 5in. at a high speed cannot be done without some expenditure of energy. It is known, too, that valve spindles break and bend and valve buckles burst. Such things point to a great resistance; but when we come to investigate things a little it is soon seen that the power expended may be so small that to some it represents no pecuniary saving; that locomotives perform their duties very well without the aid of expedients for relieving the pressure on the slide-valves, and that the wear and tear are not excessive. There is, in short, small stimulus for invention, or even for investigation. Again, the difficulties which lie in the way of determining the power required to move slide-valves in locomotive engines are very grave. Mr. Aspinall has done more than any other engineer in Great Britain to obtain information, and the results he has obtained have been so anomalous, so various, and so hard to utilise for the deduction of a law, that it cannot be said that we have made any decided advance to a knowledge of general facts. It is for such reasons as these that the subject is always ripe for discussion, and because so few harmonious facts are available, that the discussion may be endless.

It is not in this country alone that locomotive superintendents talk about slide valve friction; both in France, Germany, Belgium, and the United States, the subject has been handled from time to time. Within the last few weeks it has been brought up again at a meeting of the New York Railway Club. M. Pomeroy opened the discussion, and stated that the first locomotive fitted with balanced slide valves was built by John Gray about 1838 for the Liverpool and Manchester Railway. We confess that we possess no information whatever about this engine; perhaps Mr. Stretton, or other lovers of antiquarian lore, can supply some information. It is said that Gray designed a locomotive with piston valves, but this is not, we think, what M. Pomeroy meant. Most of our readers are, no doubt, familiar with the semicircular piston valves used by Mr. Beattie on the South-Western Railway, and Gooch's balanced slide valves on the Great Western Railway. Indeed, we are tolerably safe, we think, in stating that on nearly all the principal railways in Great Britain balancing has been tried at some time or other. After a long period of slide valve pure and simple, the piston valve is coming into use; Mr. Johnson is trying it on the Midland, Mr. Worsdell on the North-Eastern. There is no reason why its use should not be quite satisfactory; but a piston valve is not a balanced slide valve, nor has it much to do with the subject in hand. The gentlemen who spoke at the Railway Club seemed to be one and all in favour of balancing or relieving some part of the pressure on the back of the valve. It has not been found desirable to take off more than about half the pressure. If more relief is given, the valve is liable to rise from its seat and blow through. This fact deserves more notice than it gets. It is a common experience that the whole of the pressure must not be taken off, and this emphasises our ignorance of the conditions ruling in a valve chest. It is quite easy to calculate on paper what the pressure holding the valve up to the port face is, but it is really very difficult to get at its true amount. Nominally, the loading area will be that of the steam port or ports covered plus the area of the exhaust bridge in the slide valve. Steam finds its way between the two rubbing surfaces and tends to keep them apart; but while there appears to be no room for doubt on this point, there is room for doubt as to the pressure of the steam between the two surfaces. Probably it is always somewhat less than that in the valve chest. Attempts have been made to measure it, but they came to nothing. Again, oil, or water, or both, find their way between the surfaces, and it is almost impossible to squeeze them out—a very fortunate circumstance, we may add. One result is that the frictional resistance is a desperately variable quantity. It fluctuates continually, and the most that can be done is, perhaps, to fix maximum and minimum limits above and below which it cannot go. Most of us have seen a clattering nut on a reversing screw silenced by admitting a little oil to the valve chest, and it is well known that without lubrication the valves are very apt to cut. The New York railway engineers dealt with the whole subject from an extremely practical point of view. They did not concern themselves with questions of waste of power, but with questions of waste of valve. One speaker said that he got from 30,000 to 40,000 miles out of his engines without drawing the valves, which were balanced. But he made a further statement, which we fail to understand, to the effect that with the balanced valve he got a higher average pressure than he did with the plain valve. From this we gather that the port area was larger in the engines with balanced valves than in those without it.

After all has been said that can be said, we find that the true crux is pecuniary. There are half a dozen different ways in which a valve can be balanced; will it pay to balance? The ordinary English engine, with inside cylinders and vertical valves, cannot use any balancing device, because there is no room. In the United States all cylinders are outside, and the engineer can do as he pleases. Is it worth while to abandon the British type to reduce slide valve friction? On this point data are needed. Every locomotive superintendent does his best to keep his engines out of the repair shops. The true test of excellence of design has come to be mainly one of repair. We do not suppose that the consumption of fuel per mile is affected appreciably, but the total expenses incurred by the locomotive may be augmented a good deal, or they may not. On this point the experiences of Mr. Johnson and Mr. Worsdell are sure to be valuable. Mr. Forney, who appears to have summed up the discussion at the New York Railway Club, said:—"It seems as though the balanced valve was one of the greatest improvements made in locomotives. It is one of those curious cases in which all the advantages are advantages, and there seem to be no drawbacks to them. In the first place, it increases the amount of effective work which a locomotive can do, because it lessens the amount of power consumed in moving the valve. In the next place, it lessens the amount of the wear of the valve on its seat. Next, it lessens the amount of wear in the valve gear; and, lastly, it lessens the amount of wear in the muscles of the engineer, which is a matter of some importance, perhaps. So that, altogether, in view of the fact that the size of the valves is gradually being increased, and the pressure of steam is gradually being increased, it seems that it would be almost impossible to run locomotives at the present time without balanced valves." We do not go so far as Mr. Forney, but there seems to be a mechanical fitness about the balanced valve, and a wanton waste about the ordinary valve, which commend the former to the engineer, irrespective of all other considerations. The advantages may be more in appearance than in reality. But as a matter of conscience, so to speak, the balanced valve ought to find favour in the eyes of locomotive superintendents.

TRACTION ON HIGHWAYS.

The laying of rails on highways is a favourite scheme with the advocates of light railways. It is not easy to see what are the advantages to be secured. They appear to be limited to the possible value of the land which is saved, and a certain amount of fencing. On the other hand, the disadvantages of the plan are very considerable; so considerable, indeed, that we hold that light railways, even when they run alongside a highway, should be fenced off from it and kept to themselves. Let us assume, however, that rails are to be laid along a highway leading to some considerable country or agricultural town. The sleepers, of course, cannot be placed on the existing macadam. There must be a special track worked at the side of the roadway. Now, highways differ from railways in two respects. In the first place, they have inclines and curves which would be intolerable on a railway; and, secondly, their surface is uneven; that is to say, there are ups and downs in all but the very best roads. We may take, say, half a mile of road, rising or falling, or nominally level, as the case may be; a gigantic straight-edge laid along its surface would show that it was extremely uneven—the unevenness being partly the result of wear and tear, partly the result of more or less injudicious repair. Now, a railway track must have an even profile, and the result would be that the track at the side of the highway would be sometimes a little above it, sometimes a little below it, and this would, beyond doubt, cause trouble to ordinary vehicles. Most of our roads have been run pretty straight from point to point up hill and down dale; and there are few places in the country where it is possible to find a length of ten miles on which there will not be found very sharp curves and very steep inclines. Now, steep inclines cannot be worked by toy locomotives, and, on the whole, it seems to be a fact that if the light railway is to be successful it must have a route of its own, and that a certain amount of embankment and cutting must be regarded as necessary. We do not know what the proposed weight of train would be, but we may take it for granted that a paying load of 25 tons per train would have to be carried. With smaller loads it is difficult to see how any good could be done to a district, or any money be earned. But a load of 25 tons means at least 25 tons of dead weight, and we have thus a train of 50 tons, to be hauled at, say, 15 miles an hour. On a light railway the rolling stock will have wheels of small diameter, and for various reasons besides, the resistance must be very high as compared with that of a normal railway. All experience is to this effect. Taking the resistance at 15 miles an hour at 15 lb. a ton, which is below the mark, we have a resistance for the level of $50 \times 15 = 750$ lb. The smallest possible weight of the locomotive will be 12 tons. Taking its resistance at 20 lb. per ton, we have 240 lb. The total tractive effort needed on a level will be 990 lb., say, 1000 lb. We shall have to surmout inclines of at least 1 in 40, possibly more. The total weight of our train is 62 tons, 138,880 lb.; dividing this by 40, we get 3472 lb. as the effort required to overcome the resistance of gravity. As the incline will be climbed at a slow speed, we may take the frictional resistance as less than 1000 lb. We shall be near enough if we say that our engine must be able to exert a gross tractive effort equal to 4000 lb. at the rails. The total load available for adhesion must be at least six times this, or, 24,000 lb. Thus it will be seen that 12 tons is not far from the smallest weight required. Such an engine will not be a toy, and its magnitude and the conditions of English life all render it inexpedient that the highway should be utilised by the railway. It may be pointed out that no semblance of punctuality would be possible on a road on which ordinary traffic was carried on. The locomotive would have to give way to flocks of sheep, droves of cattle, and so on, particularly on market days, when punctuality would be most needed. The argument that in Belgium the rails are laid at the side of the highway goes for nothing. If a train is late the Belgian peasant does not write to the papers to complain. There is no Board of Trade to interfere. All the conditions of life are totally different. If we are to have light railways, then let us keep them off the highways to a track of their own. The attempt to work steam traffic through an average English country district on highways will end in failure. The highway will spoil the railway, and the railway will spoil the highway.

There is, however, a way in which the existing highways may be greatly increased in utility. Let us have steam haulage properly carried out. Nothing is needed but a modification in the law. A speed of eight miles an hour can be readily attained, and a locomotive weighing six or seven tons, or even less, would do excellent service at that speed. It would be much more useful to the agriculturist than any light railway. The engine or engines working a district would leave, say, every morning at the farms needing them one, two, or more wagons, and would call again in the evening or afternoon for these, and haul them loaded to the town. It would be almost waste of time and space to explain in detail the method to be adopted in working a district. It is enough to say that the engines and wagons would be the property of a company possessing sufficient capital, and the work of haulage would be done just as systematically as by rail. If the conditions justified it, then an omnibus could be run drawn by a light locomotive at seven or eight miles an hour, or even more, and this would take the place of the carrier's cart, now used in many districts as the sole means of locomotion by those who do not keep horses. The omnibus would start at regular hours, and would keep at least as good time as the trains on a light railway. In all this we suggest nothing that has not been done. We have, indeed, very recently illustrated engines for high-speed common road traction. Such engines have been built by Messrs. Ransomes and Sims, of Ipswich; Messrs. Burrell and Sons, of Thetford; and Messrs. McLaren, of Leeds, and several others, but never for service in this country, because of an Act of Parliament which was an anachronism from the outset.

But the high-speed common road locomotive of the future will not be like any of these; it will, on the contrary, resemble very closely the railway locomotive. There will be a pair of inside cylinders between side frames under the boiler, the fore carriage will answer to a bogie; the driving wheels will have rims without the absurd diagonal cross-pieces—india-rubber tired or the Boulton wood block wheels appear to be about the best—the driving wheels may be driven either by gearing or by a chain. In any case the engine will be carried on long laminated springs. We suggest nothing here that has not been done. Such an engine was built by the late Mr. Smith, of Coven, in Staffordshire, about the year 1860, and was perfectly successful. Messrs. Marshall, Sons, and Co., exhibited an engine of the type at the Smithfield Club Show about ten years ago. Such a design presents nothing offensive to horses, for the whole of the machinery may be enclosed, and it runs very silently. For various reasons on which we need not enter, weight can be saved in many directions, and a locomotive can be produced which will be close to the ground, quite unobtrusive, and handsome in appearance. Nor will there be much trouble experienced in designing wagons to suit. If once the railway companies felt that a serious effort was being made to feed their lines by steam on common roads, they would not be slow to work into the hands of the owners of the road locomotives. It would be easy to construct platform railway wagons, each of which would take two common road wagon bodies. These would avoid the trouble of breaking bulk, for at the railway station yard a crane could lift the bodies off one frame and transfer them to another.

Of course all this is impossible without a change in the law. It may be taken, however, as proved that there would be no difficulty in working short wagon trains on highways at an average speed of eight miles an hour, and omnibuses at ten miles an hour. The goods could be collected from the farmer's own yard, and he would not have to do any horse haulage whatever. The first cost of the necessary plant would be very much less than that of a light railway. Indeed, the rolling stock for common road traction would probably cost rather less than that for a light railway, and the whole expense of the permanent way and land, &c., could be saved. The cost of traction would be greater on the common road than on the railway in the sense that more fuel would be used, and wear and tear would be greater; but, on the other hand, the interest on capital invested would be much less because the capital would be much smaller, and there would be no repairs and renewals of permanent way. Five thousand pounds invested in a common road steam traction undertaking would be far more likely to pay 4 per cent. per annum than would £5000 invested in light railway shares. There are, no doubt, districts where a light railway would be of much more service than any traction engine scheme could possibly be; but these are not purely agricultural districts, and it is to these last that what we have to say is mainly intended to apply. But we must not shut our eyes to the fact that there are many manufacturing or partially manufacturing districts in which steam traction could find full and remunerative employment if only it were given a chance. Happily the drift of public opinion is in favour of a repeal of the vexatious clauses of the Locomotives Acts, and it is not improbable that before we have any extended system of light railways, traction engines will have rendered such a system unnecessary.

WAGES IN THE CLYDE SHIPBUILDING TRADE.

The Clyde Shipbuilding Employers' Association have recently had under consideration applications for an advance of wages from practically all the trades attached to shipbuilding. These comprise blacksmiths, patternmakers, shipwrights, joiners, drillers, and painters, the demand being for an advance of 10 per cent. on existing rates. At a meeting on the 25th inst. the several applications were disposed of. To the shipwrights, blacksmiths, and joiners it was decided to offer an advance of 5 per cent. The claims of the painters and drillers have been settled on that basis, and it is believed the members of the other trades will also accept, as neither the engineers nor "black squad" got better terms. No offer has as yet been made to the patternmakers, whose application, of course, had to be made to the Engineering Employers' Federation, but it is believed that a compromise of 5 per cent. —practically the equivalent of the advance to the engineers—will ultimately be arranged. The advances affect both the Clyde and Belfast. The Federation of Employers now embraces the leading shipbuilding districts in the kingdom. The Boilermakers and Iron and Steel Shipbuilders' Society proposes to introduce on the Clyde, with the consent of its members, whose vote on the matter will be given on the 28th inst.—to-day—the scheme of wages agreement now in successful operation in the north-east coast of England. The Clyde employers have been consulted on the subject, and are willing to come to a similar arrangement. The first and principal clause in the agreement is to the effect that six months shall elapse between all wage alterations, with a month's notice on either side, and that no single alteration shall be more than 5 per cent. A second clause has reference to sectional or individual disputes. These are, in the first instance, to be referred to the society's officials and the employer or his representative, pretty much as at present, but failing a settlement they are to be adjusted by a standing committee or Board of Conciliation, consisting of three employers and three workmen, within fourteen days. Pending settlement of disputes of this kind—or indeed of all disputes, whether concerned with price or otherwise—work must proceed without interruption. In the interim wages can be drawn to the amount the employers have been accustomed to pay; or the disputed job can be done at day rates, if so agreed upon between the firm's officials and the district delegate. A third clause provides for a revision of rates at any time, in view of the addition of labour-saving appliances or of improved facilities of any kind in any yard. The whole scheme is to be tried for a period of five years, and to be afterwards terminable by six months' notice on either side. The agreement, which is signed on behalf of the society by Mr. Knight, the general secretary, is commended to the acceptance of the Clyde workmen in some very sensible and persuasive remarks by the same tactful official.

TRADE IMPROVEMENT.

The remarks of Lord Stalbridge last week at the half-yearly meeting of the London and North-Western Railway Company that no doubt trade had improved, and that we might look forward to prosperous conditions, have not been the only declarations recently made by men well capable of forming an opinion that commercial prospects are brightening. A week or so before Lord Stalbridge spoke, Mr. Marks, one of the leading ironmasters of Warrington, and an accepted authority on iron trade matters throughout Lancashire, publicly expressed the conviction that we are undoubtedly on the eve of better times. There are, he declares, influences at work at home and abroad which are steadily, but not the less surely, working out new conditions of prosperity, in which all the trades of the country will share to a much greater extent than they have done for a long time past. Speaking recently at Sheffield, Mr. A. J. Mundella, M.P., said that there was abundant evidence that trade has lately entered upon better conditions generally, and he expressed the opinion that this year would show a steady advance upon 1895. The ex-President of the Board of Trade supported his argument by the statement that last year showed an improvement of £10,000,000 in the British and Irish exports over 1894, and that altogether the trade of 1895 progressed by £20,000,000 over the previous year. Similar testimony to the trade revival has been borne by Mr. E. Slater, the President of the Leeds Chamber of Commerce. This capable critic testifies that there is a substantial revival in many branches of trade. Prices of raw materials and of some manufactures have advanced; labour disputes are disappearing; and there is now a fair prospect of the beginning of a settled trade revival. The Vice-President of the Manchester Chamber of Commerce has just expressed the conviction that with last year finishing so well, English manufacturers may rest fairly assured that 1896 will prove all the more favourable to commerce. In illustration of his contentions this gentleman states that the aggregate of the country's foreign trade last year amounted to the enormous total of £702,000,000, as compared with £682,000,000 in the previous year. The recent utterances testifying to an improvement in trade to which we have here briefly directed attention are distinctly reassuring, and are emphatically supported by the reports which are being received from many of the engineering and steel-making centres of the country in the ordinary way of business at the present time. The outlook, therefore, for trade appears to be brightening in many directions. The circumstance is one for abundant gratification.

THE MANCHESTER SHIP CANAL.

The Manchester Ship Canal half-yearly accounts show that for the latter half of 1895 the toll-paying sea-going traffic amounted to 606,659 tons, compared with 425,052 tons in the preceding year, an increase of 181,607 tons, or 42 per cent. Including barge traffic, the total for 1895 reached 758,775 tons, and shows an increase of a little over 200,000 tons. The *Manchester City News*, a paper which has never failed to criticise the Ship Canal methods and management, more or less severely, has an article headed, "What the Ship Canal has done for Manchester." It commences by stating that the ratepayers will have to submit to a Ship Canal rate of 1s. 6d. in the pound, but goes on to say that the prospect of trade at Manchester and in the neighbourhood is very different from what it was twelve or fourteen years ago. It contrasts the abundance of employment for workpeople, and the absence of empty houses at the present time, with the different condition of affairs in 1882, when Sharp, Stewart & Co.'s large engineering and locomotive works were removed to Glasgow to get nearer the sea, and similar movements were being made and in contemplation. As a matter of finance, the *Manchester City News* says that persons using the canal for transport purposes have gained a reduction of 5s. per ton in rates, and that the railways have reduced their charges on all goods by an average of 2s. per ton. The estimate of traffic thus benefited is 6,000,000 tons per annum, and the average reduction 2s. 6d. per ton, a very moderate computation. This makes the saving to the community £800,000 a year. In conclusion, it says:—"The canal has achieved every forecast of its founder, 'Daniel Adamson,' except in the matter of paying interest to its shareholders, and for this we must wait a time longer in patience and unwavering confidence." There is a revival of confidence in the district, and this with the prestige attaching to the accomplishment of a great undertaking, in spite of vehemenent opposition and great difficulties, is reflected in the feelings and conduct of the inhabitants.

THE P. AND O. COMPANY AND TWIN-SCREW STEAMERS.

The Peninsular and Oriental Company, following the lead of the other great shipping lines—the American, the Cunard, the Union, &c.—has decided to go in for the "intermediate" type of modern steamship, mainly for cargo carrying, with moderate speed and great capacity. It has placed orders for two twin-screw steamers, each of about 8500 tons carrying capacity—one with its old-time builders, Messrs. Caird and Co., of Greenock, and the other with Palmer's Company, of Jarrow-on-Tyne. The vessels will have engines of 4000 indicated horse-power, to drive them at about 12 knots loaded at sea. The adoption of twin screws is quite a new departure for the old-established P. and O. Company, but two screws seem to be a recognised essential in the big ocean carriers of modern times. The order for these vessels is likely to be followed by others from the same quarter, and the fact emphasises the tendency, now very marked, for the bulk of the ocean-carrying trade to drift into the strong hands of the great shipping lines. The P. and O. Company, it may be added, have also on order at Messrs. Caird and Company's and Messrs. Harland and Wolff's, Belfast, other two steamers, more of the ordinary fast mail and passenger type. These vessels are each of 8000 tons register and 11,000 effective horse-power. When these four vessels now under way are completed, the entire fleet will consist of fifty-seven steamers of approaching 280,000 gross tons and 282,000 effective horse-power, the largest and undoubtedly the most valuable commercial fleet under one flag anywhere in the world. During the last ten years the company has made additions to the fleet amounting to 164,142 tons, at an outlay of nearly four millions sterling, and it sold during the same period 60,000 tons. Originally costing £2,104,487, this tonnage only realised £171,380, a significant fact of which due note has been taken by the company in fixing the allowances for depreciation in its present fleet.

PROPOSED RAILWAY AND HARBOUR WORKS, HEYSHAM.

Application is to be made during the present session of Parliament by the Midland Railway Company for power to construct a harbour at Heysham, a fishing village on Morecambe Bay, known only hitherto to visitors at Morecambe as one of the most picturesque resorts on the Lancashire coast. The proposed harbour has long engaged the attention of the company, and power to construct a railway to Heysham from the main line is already acquired. The staking out of the line was accomplished during the past week. It will be 4½ miles long, terminating at the site of the proposed pier and harbour. A triangular junction will be formed on the main line, eastward of Morecambe station, and the traffic brought to the new harbour will have a direct through connection with Yorkshire and the Midlands. The proposal will, it is expected, have an important effect on the shipping of the Lancashire coast. The harbour will be formed in Heysham Lake, where vessels of the largest draught can enter at all states of the tide. The present harbour at Morecambe will be dispensed with, and the Belfast shipping service will be transferred from Morecambe to Heysham. The scheme will enable the company to develope much more extensively its western traffic, particularly with Ireland, and it may prove a considerable rival to the London and North-Western at Fleetwood and Holyhead. The development of Heysham as a pleasure resort will be an important consideration, for it possesses natural advantages of a very promising character. One direct advantage to Morecambe will be the abolition of the railway crossings that now intersect and disfigure the promenade. It is a singular circumstance that the scheme the Midland Company has now on foot for Heysham was entertained by a small group of Lancaster capitalists forty years ago, but it never came to anything for want of enterprise.

A HARLAND SCHOLARSHIP IN NAVAL ARCHITECTURE.

A STIMULUS to the study, if not to the practice, of naval architecture and marine engineering on the Mersey will result from the generous and appropriate action of the White Star Company through its managing director, Mr. T. H. Ismay, in giving to the University College, Liverpool, the sum of £2000 for the purpose of founding a naval architecture and marine engineering scholarship. The gift is the outcome of the company's desire to commemorate the work and worth of the late eminent shipbuilder and naval architect, Sir Edward J. Harland, of Belfast, whose skill and ability are so splendidly exemplified in the famous White Star fleet of ocean liners. Edward Harland acquired his experience and mastery in his profession by persistent study and resolute perseverance, and no more appropriate memorial could have been devised than the creation of additional facilities for the acquisition by future students of a thorough knowledge of the science of shipbuilding and engineering. The action of Mr. Ismay's company in founding this "Harland Scholarship" will doubtless be regarded as an example worthy of emulation, and though the Glasgow University has its Chair of Naval Architecture, founded to commemorate the name of John Elder—in connection with which some three years ago the committee of Lloyd's Register founded a scholarship worth £150 annually—and Newcastle also has its educational agencies connected with naval architecture in Durham College, there is still room for the exercise of such well-directed munificence as has been evinced by the White Star Company with regard to Liverpool.

THE SCHMIDT SUPERHEATED STEAM BOILER.

THE compound form of the Schmidt motor, constructed by the Gritzner Engine Works at Durlach, consists of a combination of a single-acting high-pressure with a double-acting low-pressure cylinder; the two being placed side by side and coupled on the same shaft at 90 deg. Mr. Schmidt, on account of the high degree of superheating, which, he says, renders the steam, so to speak, insensible, arranges his engines so that no great range of expansion is possible, and the differences in cylinder capacity are less than those of an ordinary two-cylinder compound engine. In the example shown on page 214, the difference in the diameter of the cylinders is only about 3in.—high-pressure 325 mm., low-pressure 400 mm.—with a stroke of 500 mm. The ordinary crossheads and slipper guides are used, instead of the trunk piston of the simple high-pressure form of engine. The distribution of the steam in the high-pressure cylinder is effected by double beat valves of the Sulzer type, the bottom one serving the exhaust being moved by a lever coupled directly to the tail of the excentric, while the upper one for steam admission is opened by a tappet moving on a concave guide, whose path can be varied by a system of levers under the control of the centrifugal regulator. The closing of the valves is in both cases effected by coiled springs. The high-pressure exhaust steam passes by a U pipe below the cylinder to the low-pressure valve chest, where it is distributed by a double piston balance tubular slide valve, moved by a single excentric on the main shaft in the ordinary way. The valves on the high-pressure side receive their motion by mitre gearing connected with the opposite end of the shaft. The air pump is horizontal and driven by the tail rod of the low-pressure piston.

The twin high-pressure non-condensing forms of this engine, made by the same firm, are generally similar to those described in our impressien of the 31st ult. (see page 105), but a lever and ratchet gear has been added for barring the fly-wheel by hand. These engines are made in nine different sizes, with cylinders from 200 mm. to 425 mm. diameter, and 300 mm. to 600 mm. length of stroke. The smaller size, 200mm. by 300mm. developes 22-horse power when cutting off at one-seventh, and 36-horse power with one-third admission; the corresponding values for the largest 425 mm. by 600 mm. size being 136-horse power and 226-horse power respectively; the maximum boiler pressure in all cases being 150 lb. The largest size boiler has 115 square metres of heating surface, of which 24 metres are in the boiler proper, and the remaining 91 metres in the superheater coils.

NARROW GAUGE LOCOMOTIVE, CAPE GOVERNMENT RAILWAYS.

WE publish this week sections of the narrow gauge goods engines constructed by Messrs. Neilson and Co., Hyde Park Locomotive Works, Glasgow, an external elevation of which will be found in our issue for November 26th, 1895. The three Glasgow firms of locomotive builders are now constructing between them 28 goods engines for the Cape Government Railways, similar to those illustrated, but with the boiler centres raised and their diameters increased, also with the capacity of the tender tanks considerably enlarged. Of these 28 engines, Messrs. Neilson and Co. are building 12, Messrs. Dübs and Co. 8, and Messrs. Sharp, Stewart and Co., Limited, 8, all exactly alike.

THE NEW JAPANESE BATTLESHIP FUGI.

IN the illustrated descriptive article on the Thames Ironworks and Shipbuilding Company, which appeared in our issue of December 13th last, we briefly described as under construction at that company's works, a new battleship to be named the Fugi, which was being built to the order of the Imperial Government of Japan. As we have watched with interest the gradual construction of this vessel, from the laying of the keel-plate to the present time, and have lately had an opportunity of more particularly noting the progress which has been made in her, we have pleasure in being able to record in our pages, for the benefit of those of our readers who are interested in warship construction, the present state of advancement towards completion of this fine battleship.

The principal dimensions of this new vessel were given in the article referred to above, but to enable present readers to judge of her size, we may repeat that her length between perpendiculars is 374ft., her breadth 73ft., and her displacement at her load draught of 26ft. 6in. will be 12,450 tons.

The term originally agreed upon for the construction of the ship was three years and six months, but as war unhappily broke out between the Japanese and Chinese Governments not long after the building contract was signed, this term was by a subsequent agreement reduced to three years.

The keel of the ship was laid on September 1st, 1894, but there being at that time no pressing necessity for rapid construction, the contract time for completion being ample, about 66 tons of material, on an average, per week were worked into her. Later on, however, after the war had commenced, this rate of building was sensibly increased, and has been continued — considerably over 100 tons in some weeks having been added to the weight on the blocks—until at the present time, barely eighteen months from the keel being laid, 6334 tons of material have been worked into the hull, the steel work in which is now complete.

It must be borne in mind that although the laying of the keel is assumed to be the starting time in the building of a ship, in both royal and private shipyards, it is a matter of common knowledge that in the former, some 300 tons or 400 tons of material are frequently prepared beforehand ready to be put in place on the blocks on the keel being laid, therefore any comparison between private shipyard and royal dockyard work would be unfair.

The steel-plated upper, main, and belt decks of the Fugi are laid, and the wood decks nearly completed, except over the engine and boiler rooms, the funnel casings, bridges, &c., being also in place. The stanchions for handrails, boat and anchor davits, &c., are made and fixed in place; and all ladder-ways and ladders nearly complete. Below decks the shell and store-rooms are well forward, and the magazines nearly finished. The cabin bulkheads and linings, which, to safeguard them against fire, are all of sheet steel, are rapidly approaching completion. All fittings to go into the ship after being launched, such as masts with their military tops, launch derricks, boat chocks, &c. &c., are nearly ready. The steam launches, and all the boats with which the Fugi will be outfitted, are being made by her builders, and are well in hand.

Being built in the open, and not hampered for headroom, above her upper deck the ship's armour belt plates—excepting two, which will be in place in a day or two—are fitted in place and secured to the ship's sides; the redoubt armour plates are going on rapidly, and the armour for the screen bulkheads athwartship are nearly all on. The internal fittings of the casemates are well in hand, but the casemates themselves are not so far advanced, but will be in place during the next two months. The capstans with their engines, the anchor gears and their fittings, the rudder and steering gear are all ready for putting on board, and will shortly be in place.

The propelling machinery of the Fugi, which we have previously recorded as being constructed by Messrs. Humphreys, Tennant, and Co., of Deptford, is all completed, and ready to be put into the ship. As she will be launched with her armour complete, the material and fittings which will have been worked into her at the date of launching, which is to take place on the last day of next month, will bring up her launching weight to 7400 tons.

HORSELESS CARRIAGE NOTES.

WE are indebted to Mr. Hiram S. Maxim for the following useful notes on the materials for and the methods of making joints as used in petroleum vessels, pipes and motors:—"Now that so many are working on petroleum motors with a view of making them applicable to road carriages, a few hints in regard to the proper manner of making petroleum joints which will not leak cannot fail to be appreciated. Many have supposed it to be quite impossible to make a petroleum joint that would not leak, especially with the light varieties, such as naphtha and gasoline, when subjected to both heat and pressure. However, as a matter of fact, it is no more difficult to make a petroleum-proof joint than a water-proof joint. In making up steam or water joints we naturally employ something which is insoluble in water. If an ordinary steam or gas-fitter is asked to make a petroleum-tight connection, he is almost sure to employ red lead and oil, and for a gasket or washer he is equally sure to use india-rubber, both oil and india-rubber being quite soluble in petroleum. In my experience I find that a joint which is screwed together dry is less apt to leak petroleum than a joint made up of the orthodox red lead and oil. To make a good petroleum joint with common iron pipes, a very good system is to heat both the male and female threads sufficiently to dissipate every trace of oil; then make the joint up with thick shellac varnish, which may be combined with ordinary dry vermilion or even Venetian red. A joint of this kind I have found to stand well. A very good joint can also be made with ordinary yellow bar soap rubbed into the threads of the pipe, the grease first being removed. Treacle, honey, glue, mucilage, or glycerine are quite petroleum proof. For a stuffing-box, ordinary wicking saturated with common yellow bar soap may be safely employed. Canvas saturated with shellac varnish makes a good washer, but soft metallic washers are better. A very good flexible diaphragm for a regulator may be made of closely-woven cotton fabric varnished on both sides with a compound of gelatine and glycerine. About equal parts by weight make a very tough and elastic compound. Wooden vessels, bags, &c., may also be made petroleum-tight by saturating or varnishing with this compound. As a rule, all substances which are soluble in water are quite insoluble in petroleum. For stuffing-boxes for standing both water and petroleum, castor oil may be employed, as this peculiar oil seems quite insoluble in either water or petroleum."

THE arrangements for the Horse and Horseless Carriage Exhibition at the Crystal Palace are rapidly being made by the manager, Mr. Henry Gillman, and those assisting him. The exhibition is to be of a comprehensive and international character of all things appertaining to the road, to travel, and to road locomotion, is to be opened in May next. It has been represented to the directors that if, concurrently with the exhibition and demonstration of the most modern applications of science to mechanical locomotion upon common roads, an exhibition of all kinds of animal-drawn road vehicles and carriages of both historical and current interest be held, great commercial, educational, and recreative advantages would thereby accrue, and they have therefore decided to carry out this desire to the greatest extent the space at their disposal—and this is great—will admit. The exhibition will be divided into twelve sections, subdivided into classes to include examples of primitive modes of travel of all kinds; ancient and mediæval conveyances, both wheeled and wheelless; ancient and mediæval caparisonments; exhibits of historical and current interest concerning the carrying of mails; modern coaches; modern pleasure and travelling carriages; all means and modes of road transport of goods and merchandise; military transport; light and heavy mechanically propelled road vehicles employing steam; electricity; oils, spirit and petroleum. A section will be devoted to muscularly propelled conveyances such as cycles, cycle cabs, cycles with variable hill climbing and high speed gears, cycle military transports, cycle machine gun carriages, and fire engines, and parcels delivery carts, and another class will be devoted to all accessories to travel and sport. The grounds will provide excellent room for the display of all these modern means of sport, pleasure, and business transport.

TENDERS.

FOR SEWERAGE AND SEWAGE DISPOSAL, BERKHAMSTEAD.

THE following are the tenders received for carrying out the work. James Lemon, M. Inst. C.E., engineer, Lemon and Blizard, 9, Victoria-street, Westminster:—

Name and address.	*Contract A.	Contract B.
	£	£
Messrs. Thos. Free and Son, Maidenhead	79 70	6000
Mr. C. G. Raynor, Liverpool	7650	5650
Mr. Geo. Taylor, Blackburn	7560	4217
Mr. Thos. Adams, Wood Green	6800	4800
Mr. John Jackson, Plaistow	6700	4400
Mr. Geo. Bell, Tottenham	6253	4356
Messrs. Siddons and Freeman, Cundle	5900	3900
Messrs. B. Cooke and Co., Battersea	5743	3732
Mr. W. Cunliffe, Kingston-on-Thames	5561	3895
Mr. J. Bentley, Preston	5358	3375

* Engineer's Estimate, £6000.

THE CITY OF NEW YORK is to have an Electrical Exhibition commencing on May 4th next, and continuing until June 1st. The exhibition is to be held under the auspices of the National Electric Light Association in connection with its nineteenth convention, and promises to be the largest and most interesting display of electrical apparatus of all kinds ever made in that country. The exhibition will be held in the great Industrial Building, which occupies the entire block on Lexington-avenue between Forty-third and Forty-fourth streets. Many novel and unique features in electrical displays will be introduced in connection with the exhibition. There will be given a series of popular and practical lectures on electrical subjects by eminent scientists, also afternoon and evening concerts by famous military bands, and special spectacular effects, all of which will be open to the general public.

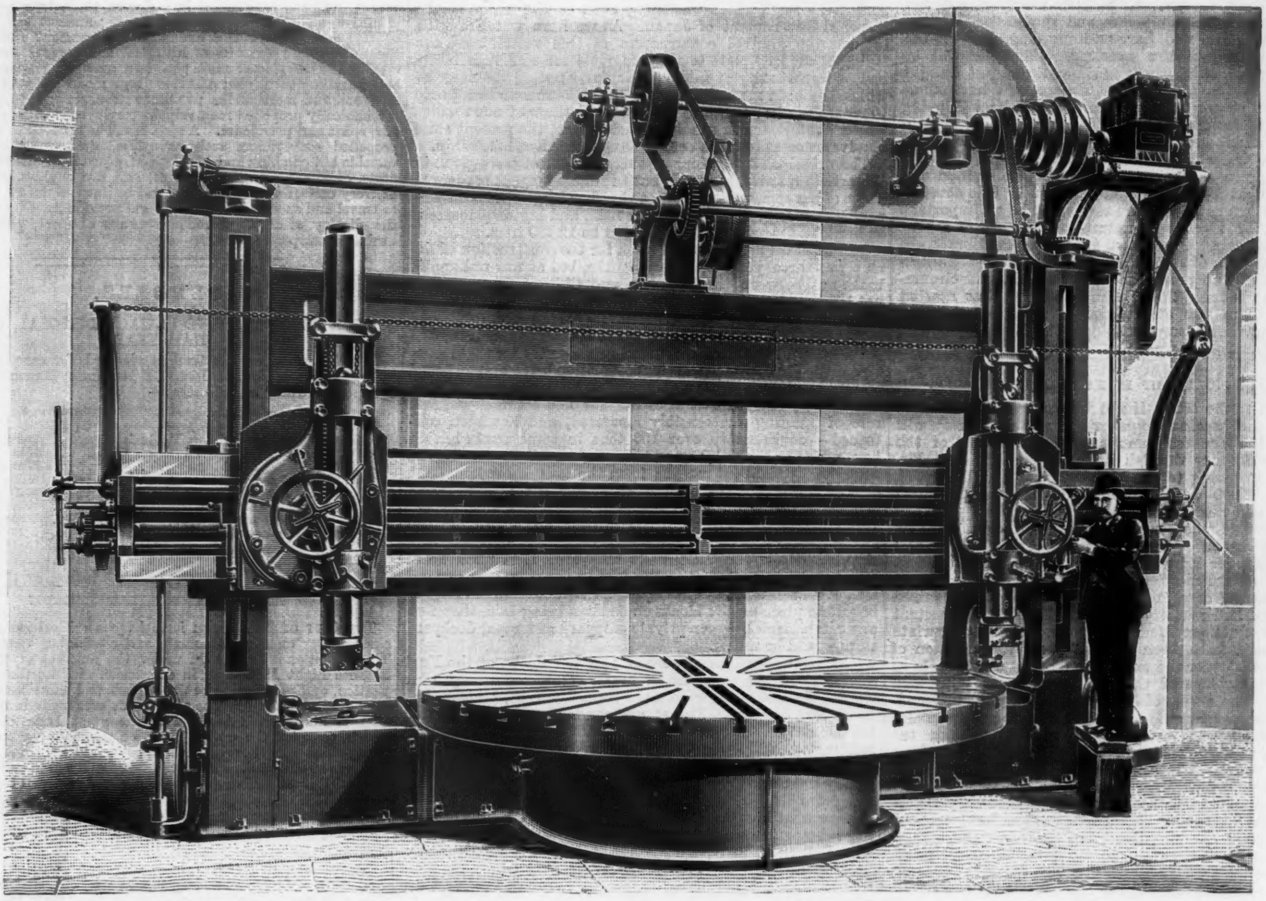
TRADE AND BUSINESS ANNOUNCEMENTS.—Messrs. Henry Tats and Sons, of Liverpool and London, have converted their business into a limited liability company, under the style of Henry Tate and Sons, Limited.—Mr. W. H. Severn announces that he has lately concluded a partnership with Mr. H. F. Gooch, a nephew of the late Sir Daniel, and son of W. F. Gooch of the Vulcan Foundry, near Warrington. He has changed his office address to 9, Bridge-street, Westminster.—Messrs. Easton, Anderson, and Goolden, Limited, of the Erith Ironworks, Kent, and 3, Whitehall-place, announce that a syndicate has been formed under the most powerful South African and Australian auspices to take over the selling rights in the "Niagara" crusher and concentrator which has been attracting so much attention in mining circles. Messrs. Easton, Anderson, and Goolden, Limited, retain, of course, their exclusive right to manufacture these machines throughout the world, but all inquiries with regard to them should be sent to the Niagara Pulveriser, Limited, 3, Whitehall-place, S.W. — We understand Messrs. Drake and Gorham have received the contract for the electric lighting of Bidborough Court by means of an isolated plant consisting of an oil engine, dynamo, and fifty-three D.P. cells.—Mr. Sam Deards, of Victoria Works, Harlow, Essex, has appointed Messrs. Christie Brothers, of 188, St. Vincent-street, Glasgow, sole agents for Scotland and North of England for his patent system of glazing.

THE GLUT OF ELECTRICAL ENGINEERS.—Despite the rapidity with which electrical applications have progressed in America, we hear from influential quarters that there is little doubt that in that country, as in England, the number of so far qualified electrical engineers turned out by the different colleges far exceeds the number of posts available. It is, of course, a fact that nearly all the professions, both here and abroad, are very much over-crowded, but, as the *Electrical Review* says, there "are few, if any, for which provision has been made for training such a large number of men as for electrical engineering. There is little doubt that the industry, if not still in its infancy, as so often stated by the general public, has vast possibilities before it, and the next century will probably see developments beside which the progress of the last thirty years will seem inconsiderable; but it has to be remembered that all electrical applications are, in a very advanced degree, labour-saving devices, and when we reflect on the vast amount of work which can be carried out by machinery operated and controlled by half-a-dozen men, it would seem likely that numbers now crowding into the profession have only disappointment in store for them." A profession which it is thought can be learned by payment of fees and purchase of books is sure to be crowded for a time. The royal road which educational leaders promise is bound to prove in this, as in other matters, delusive, until it has by disagreeable experience been found that the royal road *viâ* college and books is only a very small part of the whole road.

IRON AND STEEL INSTITUTE.—The autumn meeting of the Iron and Steel Institute will be held at Bilbao at the beginning of September. The programme will include visits to the leading iron and steel works, and to the important mines from which so large a proportion of the iron ore used in Great Britain is obtained. Assurances of a hospitable reception have been received from the President of the Provincial Deputation, Don José Maria de Arteche, and from the Alcalde of Bilbao, Don Emiliano de Olano, as well as from the leading iron masters, mine owners, and engineers of the district. In view of the limited hotel accommodation at Bilbao, arrangements are being made to secure one of the Orient Company's steamers to convey the members to Bilbao and back, and to serve as a floating hotel. The steamers are fitted with electric light, baths, smoking rooms, and the cuisine is first class. An experienced surgeon is carried, also musicians, stewardesses, and an ample staff of stewards. The routine of meals will be maintained in port, and communication with the shore will be provided without extra charge. The cruise will last a fortnight, and calls will be made at some of the Spanish and French watering-places. The passage money will be about 20 guineas, including board on the steamer while in port. As the size of the steamer to be detailed for this service will depend on the number of members likely to avail themselves of the invitation to visit Spain, the secretary will be obliged if members will state their intentions promptly, so that the arrangements with the Orient Steam Navigation Company may be matured. The annual general meeting of the Institute will be held at the Institution of Civil Engineers, on May 7th and 8th next.

HEAVY TURNING AND BORING MILL

MESSRS. SMITH AND COVENTRY, SALFORD, ENGINEERS



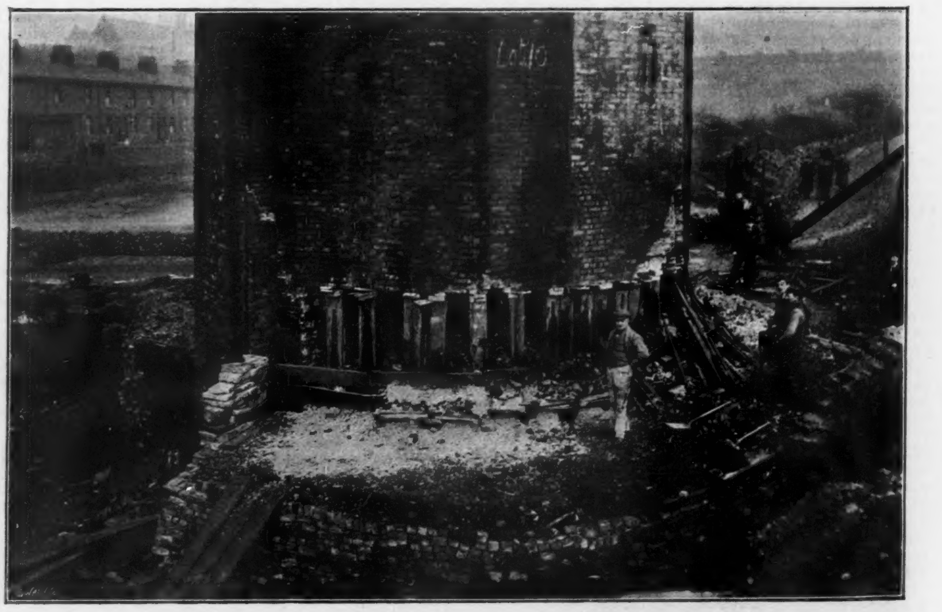
EIGHTEEN-FOOT HEAVY TURNING AND BORING MILL.

THE 18ft. heavy turning and boring mill which we illustrate on this page is the largest of a series of useful machines of a new type brought out by Messrs. Smith and Coventry, of Gresley Ironworks, Salford, Manchester. These machines, which possess several distinct advantages, are made in sizes to admit work ranging from 1ft. 6in. to 18ft. in diameter, and are taking the place of the larger face-plate and chucking lathes. It is claimed for these machines that they are capable of doing from one and a-half to six times the amount of work in a given time which can be done by ordinary face-lathes, considerable time being saved in chucking the work. The table, which is driven by spur gearing, is attached to a massive vertical spindle which is carried in the bed and receives all lateral thrust. It is further supported near the periphery by a broad annular bearing which is self-oiling. The larger mills of the series have an arrangement for raising the table off its outer bearing when it is required to run at an accelerated speed. The speed cone and gearing are correctly graduated to give the table the proper cutting speed for all diameters, the position for the belt being indicated under the driving cone. The machine has a heavy cross slide, which is raised and lowered by power on the uprights. It carries two heads, which are quite independent of each other, and can be controlled from either side of the machine. The uprights are rigidly set, being bolted and gibbed to the bed of the machine, and stayed together at the top by a cross-stay of deep section. The heads are made right and left-hand, so that the tool bars may be brought close together. They have self-acting and hand traverse by screw in either direction along the cross slide, the larger machines having a quick hand traverse by rack and pinion. The tool bars are octagonal in section, and each bar is carried on its saddle in a swivel slide controlled by worm and wheel. The traverses of the tool bars are independent and automatic in all directions, and the bars are counterbalanced, so that they travel up or down with equal facility. There are separate and independent feeds for each head and tool bar. By this means variations of feed may be given to the heads, either in the same or in opposite directions on the cross slide. The tool bars may also be fed independently of each other, either up or down or at an angle.

The 18ft. machine which we illustrate was built for Messrs. Siemens Brothers and Co., and was put up at their works at Woolwich, where it is giving every satisfaction. It is driven by electricity, as will be seen on reference to our engraving, where the motor is shown at the top, on the left proper of the machine. The motor is a Siemens two-pole H.D. $\frac{9}{15}$, giving about 6-brake horse power at 175 revolutions. It is coupled direct to the countershaft, and fitted with a reversing switch, to avoid the necessity for open and crossed belts with the accompanying loose pulleys and striking gear, the whole forming a very compact and handy arrangement. The switches are so arranged as to be easily operated by the attendant. By the arrangement of running the face-plate on a circular race, great solidity is obtained and very heavy cuts can be taken. No matter how much the work is out of balance, no counterbalancing is required, thus saving much time. A number of similar pieces of work can moreover be easily and quickly disposed around the horizontal face-plate, and all simultaneously turned. In fact, the advantages of this machine over lathes with a horizontal spindle and a vertical face-plate are very pronounced for many kinds of work, especially of the heavier and not easily fixed forms.

THE DEMOLITION OF A MILL CHIMNEY AT MANCHESTER.

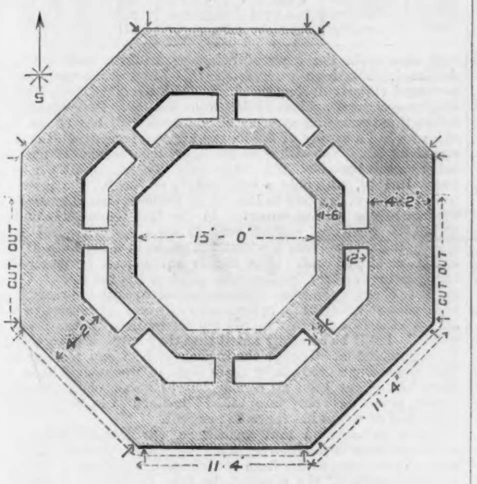
THE attention of the public has recently been painfully drawn to the risks connected with the presence of tall chimneys, especially in the manufacturing districts of Lancashire, where in the town of Burnley the lamentable accident on January 4th occurred, when by the falling of one of these columnar structures three lives were lost, particulars of which were given in our issue of the 7th inst., and it may be interesting to our readers if we give a description of the razing of one of these tall stacks, of more than ordinary size and weight, which took place on Thursday, the 13th inst., in the city of Manchester, the huge structure being dropped without loss of either life or property. The chimney in question was connected with the Broughton Paper Mills, situated on the easterly side of the Bury New-road, within the city of Manchester. These paper works have not been in use for some time, and are now about to be demolished, in order to admit of the development of the land for new streets, houses, &c. The chimney itself was very conspicuous, for although it was built in a hollow, its great height and massive proportions could be observed at a considerable distance.



BROUGHTON PAPER MILLS CHIMNEY UNDERPINNED

On the northerly side, and about 80 to 100 yards away, are several rows of cottages, and on the east is the empty dam, with its deposit of mud, whilst on the west side is the existing mill, in fair condition, of three stories in height and seventeen windows in length, and on the south is a piece of vacant land, at a considerable elevation above the base of the chimney and works. The structure, which was twenty-eight years old, was octagonal in shape, each of the eight sides or "cants" being 11ft. 4in. wide, or over 90ft. in circumference, and 270ft. in height, with a taper of $\frac{5}{8}$in. to the yard, built entirely of brick, and with no attempt at architectural embellishment. About 100,000 bricks were used in the foundations which were nearly 25ft. deep, whilst in the superstructure over 1,000,000 bricks were employed, those at the angles being special. There was an inside brick lining of 1ft. 6in. thick, faced with $4\frac{1}{2}$in. fire-brick, and a cavity of 2ft., but the inner and outer walls were tied together by eight midfeathers, 14in. thick—see plan—and the outside shell or case was 4ft. 2in. thick at the bottom and 14in. at the top, the diameter of the flue at the base being about 13ft., and the estimated weight of the column was 4000 tons. There was a lean or cant of over 2ft. in a northerly direction, and although we have not heard it alleged that the structure was unsafe, the reason for its demolition being the one assigned above, still there were perpendicular cracks up each corner, thus making the preparation for the "dropping" of the stack a most hazardous undertaking.

The owners of the premises, having disposed of the buildings as materials only, the purchasers of the chimney, Messrs. Mason and Hulbert, of Manchester, engaged Mr. Joseph Smith, of Rochdale, the well-known "Lancashire Steeple Jack," to raze it to the ground. After a careful examination of the structure, Mr. Smith decided that it should fall in a southerly direction, and on to the vacant land above referred to, and made his arrangements accordingly. He caused to be cut away a portion of the base on the five sides, viz., east, south-east, south, south-west, and west, as shown by dotted line on plan, and about 5ft. 6in. in height, and as the cutting away of the brickwork proceeded, timber lintels or carriers were inserted and supported on props, wedges being used to pack up the bricks, and this was a most difficult operation, considering the thickness of the walls and cavity to be provided for—7ft. 8in.—and all on the same bearing. The timbers used were of common spruce, 9in. by 5in., the number of props being 130, placed 7in. apart, and perforated for the reception of resin and other inflammable substances to insure quick combustion.



PLAN OF BASE

Cracks (Vertical) at Corners where Marked thus ∨

Several days were occupied in cutting away the brickwork and inserting these supports, and during the execution of the work the chimney assumed a directly perpendicular position, the cant or lean of 2ft. disappearing altogether, though a series of cracks on the northerly side were apparent, some of which were of considerable dimensions, extending for several feet, and in many places the bricks had moved in bulk. Whilst the work of underpinning was in progress several reports of cracks were heard from time to time, especially the day before the fall, when, to use the expression of the "Steeple Jack," the structure talked a great deal, but as the timber supports took up the compressive strain, these noises gradually ceased. When this work was completed the spaces between the upright timbers and surrounding them were filled up with shavings, pieces of wood, coal pitch, tar, &c., and over this was poured a considerable quantity of creosote and paraffin oil; and at five minutes past three in the afternoon of the 13th inst., in the presence of many thousand spectators, a light was applied to the inflammable material, and immediately large bodies of flame shot up, and smoke poured out of the top of the chimney and from innumerable cracks at various positions in the columnar structure.

The fire continued with great fury, and during its continuance, Mr. Smith was busily employed in feeding the flames with paraffin oil, at various places where he desired the timber to be more quickly destroyed; and subsequently he ascended a short ladder which he had reared against the chimney on the north side—the fire being on the south side—and after a brief minute examination of the structure he descended, and had moved only a few yards away, when the stack quietly leaned over to the south, but it had not gone far out of the perpendicular when the portion near the base dropped into itself, and the support being thus removed the remainder of the structure literally collapsed in telescopic form and fell in a southerly direction, the whole of the *débris* covering an area of about 25 yards long—less than half its own height—by 15 yards wide, and in the position indicated by Mr. Smith before the fire was lighted. The time occupied in the destruction of the timber supports, *i.e.*, from lighting the fire until the fall, was about seven minutes. Little noise was heard when the stack was falling, but a considerable shock was experienced as the heavy mass fell on the ground. Two tons of coal, one barrel of creosote, two barrels of paraffin oil, and about 350 cubic feet of timbers, in props and lintels, &c., were used in the destruction of this giant of chimneys.

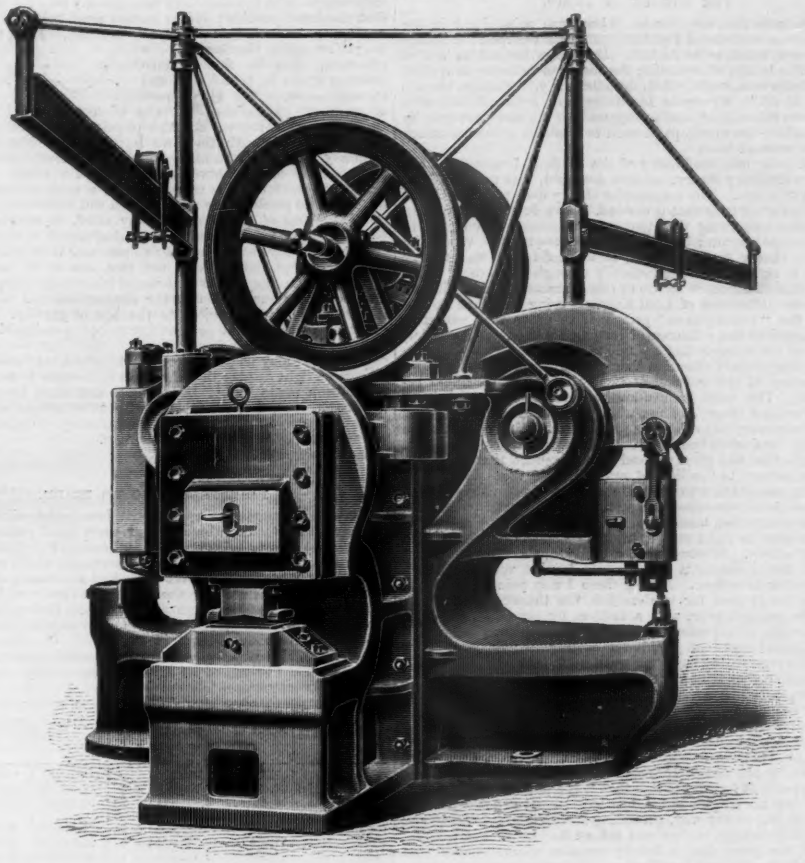
The work was most skilfully and satisfactorily performed, especially when we consider the magnitude of the undertaking, for this is, by a long way, the largest and heaviest chimney ever brought down by the process of underpinning to our knowledge; the largest previously recorded being only 600 tons in weight, as against 4000 tons in the present instance. Upon inspection of the *débris* after the collapse, it was very evident that the bricks and mortar used in the construction of the shaft had been of good quality, as large portions of the walling were still unbroken, and not more than probably 10 to 15 per cent. of the bricks had been materially damaged in the coming down of the stack; though we are not very favourably impressed by the design of the chimney, which we consider would have been greatly improved if the midfeathers between the inner and outer casings had been omitted, and the two walls left absolutely independent of each other.

PUNCHING AND SHEARING MACHINE.

THE accompanying illustration represents a cam and lever punching and shearing machine, with a stringer punch on the side, designed and constructed by Mr. John Cameron, of Salford, the well-known maker of pumps and shipbuilders' tools. This machine is capable of punching at one end 1¾in. hole through 1½in. iron plate. The punch ram is of mild steel, machined all over, and fitted with a disengaging motion. This machine is made with Mr. Cameron's original patent cam motion, which gives a quick lift to the punch, and a pause between each stroke. The punch gap is 39in. The shear at the other end cuts 1½in. iron plate, and has 33in. gap. The punch and shear levers are of cast iron, and are fitted with hardened steel plates, where the cams act on them, and wrought iron draw-backs to lift the punch and shear blade away from the plate. On the side of the machine is attached a stringer punch capable of making notches of any size up to 8in. by 6in. in the edges of iron plates 1in. thick, this punch being specially arranged to shear the piece out of the plate. The die is fixed into a strong die-holder, which is bolted to the stringer punch body; the cutter or punch is bolted to a cast iron slide, which is provided with a suitable stop motion for putting it in or out of gear, and is worked by a steel excentric shaft, the excentric end being fitted with a gun-metal nut. The machine is driven by an engine bolted to the side of the body. This engine is specially designed for quick running, and the wearing surfaces are large for durability and to prevent heating. There are two cranes made of wrought iron, supported from the main body of the machine. The total weight of the complete machine is 29¼ tons.

CAM AND LEVER PUNCHING AND SHEARING MACHINE

MR. JOHN CAMERON, SALFORD, ENGINEER



THE INSTITUTION OF CIVIL ENGINEERS.

THE ELECTRIC STREET RAILWAY SYSTEM OF MONTREAL, CANADA.

AT the ordinary meeting on Tuesday, the 18th February, Sir Benjamin Baker, K.C.M.G., the President, in the chair, the paper read was on "The Electric Street Railway System of Montreal, Canada," by Mr. G. C. Cuningham, M. Inst. C.E.

The author traced the rapid development in Canada and the United States of the application of electricity to street railways. In the United States in 1888 there were about twenty electrical roads in operation, having a total of 80 miles of track, and working ninety motor cars, while there were now 10,363 miles of track, on which were operated over 40,000 motor cars. While this had been the progress in the United States, Canada had not been slow to adopt a system that was manifestly so convenient for the public. Montreal, Toronto, Hamilton, Ottawa, Winnipeg, Brantford, Niagara Falls, and other places had their electric systems either complete or in process of construction. Almost all the lines were constructed on the overhead trolley-wire system.

In Montreal the electric street railways comprised 74 miles of single line, laid on 41½ miles of streets. A daily service of 140 motor cars, and about 50 trail cars was now running. The gradients were in many cases very severe. On the streets running at right angles to the St. Lawrence River, there was a continuous rise in most instances, and short sections had gradients of 1 in 10, and even 1 in 8. These gradients were a severe test for the motor cars, but they were overcome successfully, and caused little difficulty.

The ordinary rail adopted was 6$\frac{9}{16}$in. in height, and weighed 72 lb. per yard. The rails were laid on a foundation of concrete, or imbedded in it, according as block pavement or asphalte was used for the roads. The rails were constructed in complete electrical continuity, and where they passed the power-station they were directly connected by copper wiring to the generators. Bond wires were riveted into the web at each joint. To still further improve the return circuit, track return wires of the same size, 0·460in. in diameter, as the line feeders were riveted into the web at various points and carried back to the generators directly by overhead insulated copper wires. At first earth returns had been used, the rails being connected by copper wire to cast iron car wheels buried between 7ft. and 8ft. in the soil; but considerable electrolytic action was found to be set up between the earth and gas or water pipes. It was determined not to use the ground for this purpose, and to construct a complete metallic return.

The trolley wire used throughout the system was of bare copper, 0·365in. in diameter, carrying a safe current of about 440 ampères. It was suspended from poles between 110ft. and 120ft. apart at the curb line on either side of the street, at a height of between 18ft. and 20ft. over the centre of each track. In some instances the trolley wire was carried by a central line of posts placed between the double tracks. The current had been at first supplied to the trolley wires connected in one continuous system; but this was now divided into various independent sections, so that trouble on any one was felt there only, and did not affect the others. Each section was fed directly from the power station by feed wires, and had its own system of return wires. The feed wire and return wire mostly used was 0·460in. in diameter, but within a three-quarter mile radius of the power station heavier insulated cables were inserted, about 1in. in diameter, carrying a safe current of about 600 ampères. Ten such wires led from the power station, and ten others of same size acted as return wires, allowing for a total output from the power station of 6000 ampères. The difference of potential maintained at the generators was 550 volts.

The boiler-house and engine-room were placed fairly centrally in the system, and near to the Lachine Canal, whence water was obtained for condensing purposes, and to the coal wharves. There were fifteen Lancashire boilers, each 28ft. long by 7ft. in diameter, with double furnaces. They developed each 300-horse power, and carried a working pressure of 125 lb. per square inch. The gases from the furnaces, after passing through the boiler flues, returned under the boilers and along their sides to the main flue. They then passed, at a temperature of between 439 deg. Fah. and 480 Fah., into Green economisers placed on each side of the chimney, which heated the feed-water to about 260 deg. Fah. The temperature of the gases entering the chimney was between 225 deg. Fah. and 250 deg. Fah. The feed-water was obtained from the condensing water, and entered the economisers at an average temperature of 90 deg. Fah. The fuel used was bituminous coal from the Cape Breton mines, of an evaporative power of 6½ lb. of water per pound of coal.

The engine and dynamo room was 235ft. long by 89ft. wide. There were six horizontal cross compound condensing engines developing 600-horse power each, with a boiler pressure of 125 lb. per square inch. The cylinders were 24in. and 48in. in diameter, and steam jacketed with Corliss valves. The diameter of driving wheel was 22ft., its peripheral velocity at seventy revolutions per minute being nearly 4900ft. per minute. The total weight of each engine was 85 tons. The engines were placed in a row next to the boiler house, 26ft. from centre to centre, on foundations of cement concrete and brick in cement. Each of the first three engines drove four Edison generators, developing 200 kilowatts apiece. The driving wheels were double crowned, and carried two pairs of belts, driving 41in. pulleys, fixed on the armature shaft of the generator. The three remaining engines drove each a pair of multipolar generators by one 52in. belt on one pulley, 48in. in diameter. The two generators were mounted on the same bed-plate, with the pulley between them. The armature shaft and the pulley shaft were in alignment, and were connected by two friction clutches. By this means the generators could be driven together or separately. The generators were supported on a continuous length of foundation wall built in brick and cement, and sufficiently massive to be free from vibration.

The rolling stock equipment in the summer amounted to 163 motor cars; in winter it was 145 closed cars with double motors, and 14 snow sweepers with triple motors. There were besides, 53 open trail cars and 60 closed trail cars belonging to the former horse system.

The motors developed 25-horse power or 30-horse power each, and were all of the single reduction type, the ratio of the pinion to the gear wheel being generally about 4 to 1. The average speed of the cars was about 7½ miles per hour. Electric snow sweepers, 18ft. long, carried on two pairs of 33in. wheels, were used. To each axle was geared a 30-horse power motor, a third motor being placed in the car to drive the rotatory brooms.

The cost of working for July, 1895, was almost exactly 3¾d. per car mile, and that of the power was less than ½d. per car mile. For the year ending September, 1895, the cost was 5⅓d. per car mile, the average cost of power being slightly under ⅝d. per car mile.

In an appendix particulars were given as to the amount of coal consumed and electrical energy developed at the William-street power station, with details of the operation of the system during the past four years.

LETTERS TO THE EDITOR.

We do not hold ourselves responsible for the opinions of our correspondents.)

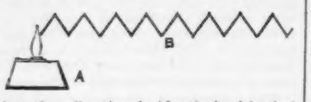
THE THEORY OF LIGHT.

Sir,—On more than one occasion it has been pointed out in the correspondence columns of The Engineer that the received theory of light leaves much to be desired. Dr. Lodge himself, in one of his admirable books, after stating the theory of radiancy as applied to light phenomena, is obliged in despair to say, "Perhaps there is no motion at all." My object in writing now is to call attention once more to this subject, and to suggest that the new photography—as it is called—may perhaps be used to establish a rational theory of light on a sound basis.

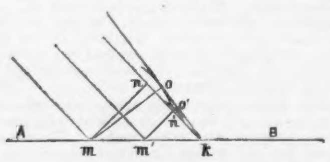
Without going into the history of the subject, I may point out that the undulatory theory, as first accepted, was very different from what it is now. The corpuscular theory died very hard, if at all; I am not at all clear that it is dead. I can detect in more than one utterance concerning the Röntgen phenomena a tendency to bring it forward again; but this is beside the mark. When the undulatory theory first came out, it was held that waves were projected in right lines longitudinally through the ether. It is now held that Röntgen waves are of this character, and an old and long-forgotten utterance of Lord Kelvin is being furbished up and used, on the "I-told-you-so" principle, to prove that authority always recognised the existence of longitudinal waves. As a fact, however, we can scarcely find a single modern treatise on light in which the longitudinal vibration theory is not ignored.

The history of the undulatory theory is one of continual re-adjustment. The most tremendous efforts have been made to reconcile fact and theory. Thus, when polarisation was discovered it became necessary to explain its phenomena. This could not be done at the time while the longitudinal hypothesis held the field. Accordingly, that was given up, and it was assumed that the waves were all transverse to the line of radiancy, and that polarisation was nothing more than a twisting of the plane of vibration. In the one case we have a stretched string vibrating horizontally right and left; when polarisation takes place the string vibrates up and down at right angles to right and left. The explanation was so far quite satisfactory. It constituted a beautiful theory, but when it came to be tested closely it was seen to involve very great difficulties in other directions. Among these I may point out that the transverse theory goes far to demolish the theory of reflection. The trouble was got over, after a fashion, by Sir G. B. Airy, but his explanation is attended with difficulties and perplexities so great that I feel that I am justified in stating that no physicist of any position regards the explanation as more than a clever shot, a guess at truth rather than any anything more solid or scientific. I shall return to this in a moment, but it is necessary in the first place to try and attach ideas to words.

What is meant by a light "wave," or a radiant "wave?" The ether is supposed to be a continuous something, not made up of particles, or molecules, or atoms. It is amorphous, principally remarkable for absence of characteristics. The nearest idea the mind is capable of forming of it is that it is a perfectly transparent jelly. It has no weight, but it has inertia. It is not capable of acting on matter in any way, pervading it with absolute freedom; but, curiously enough, matter can act on it. I shall not attempt to extend the great list of totally opposite characteristics that might be drawn up, and I will go on at once to consider what a longitudinal wave means. It implies that a portion of the ether, say one inch long, is compressed to half that length. That recoil takes place; the first inch opens out and the next inch contracts, and so on. No doubt something of this kind takes place when sound is transmitted, especially through air. And we can readily understand how it is that a wave starting a mile away from the ear may travel until it reaches the ear. Now the transverse wave is a totally different thing. In the first place, it is not quite correct to speak of the waves as though they were transverse only. If that were the case there could be no longitudinal propagation of light at all. We have to assume, then, that the transverse wave is like the annexed diagram. Here A is supposed to be a lamp and B one ray. By some authorities we are told that the vibration is identical with that which occurs in a rope if we hold one end and shake it up and down or from side to side, and the transverse vibration then takes the form shown herewith. There are no angles, only easy curves. We may consider what takes place in the surrounding jelly-like ether—which must have a density infinitely greater than that of tool steel or it could not vibrate fast enough—when any portion of it is set in motion, by considering what takes place in the air if we wriggle a rope in the way named above. It must be remembered that by hypothesis the ether is absolutely continuous. There is no space, so to speak, into which any portion of it can flow by squeezing out another portion. There can be no molecular crowding. Motion can only take place by change of density being set up. I ask your readers who may be interested in this question—such men as Mr. Tolver Preston for example—to endeavour to form an idea of a continuous substance which shall have a greater density in one place than it has in another, and that a variable density. I cannot manage it, but others may be more successful. But let this pass, and also let the fact pass that one of the greatest of French mathematicians said that there must be six different ethers in space to account for all the phenomena of light, and assume that transverse radiant waves do exist.



Now, a very little thought will suffice to show that very serious difficulties arise the moment we attempt to explain how transverse waves can be reflected. There is no trouble at all about the longitudinal or corpuscular theory. But how is the transverse wave, almost parallel to the reflecting surface, to be reflected at the angle of incidence? As I have said, the difficulty was held to be overwhelming for years. At last Airy advanced an explanation, which I shall now give. Your readers may judge for themselves whether it is sound or not. Suppose $m\ n$ the front of a light wave about to impinge on the reflecting surface A B, and meeting it first at m. Each portion is supposed, as it encounters the surface A B, to become the centre of a new set of spherical waves which will travel backwards with their former velocity, since the medium has not been changed. When n, therefore, has travelled as far as k, the front of the wave flowing from m must be in the circumference of a circle whose radius $m\ o$ is equal to $n\ k$. And in the same way, when n^1 has travelled to k, the waves from m^1 must be in the circumference of a circle whose radius $m\ o^1 = n^1\ k$. Now the surface which at each instant touches all these circles is the front of the reflected wave; and since $m\ o$ and $m^1\ o^1$ are proportional to $m\ k\ m^1\ k$, this surface is the tangent plane passing through k. Further, since $m\ o = n\ k$, and the angles at n and o are right angles, we shall have $< n\ m\ k + < o\ k\ m$, which signifies that the angle of incidence is equal to the angle of reflection. I have tried to use Airy's own words as nearly as possible.



It is difficult to keep in mind, while we are reading this demonstration, that radiant lines must, for other purposes of the mathematician, be supposed to have no breadth or thickness, and that, consequently, there is no broad advancing front of a wave to strike on a metal plate; and that, furthermore, the waves are supposed to be so inconceivably minute—if I may use the phrase—that the finest possible polished surface must bear about the same relation to the wave that the Alps do to a man. Thus, for example, in yellow light, the length of a vibration, that is, the distance between A and B, B and C, C and D, and so on, is the 44,000 part of an inch. It is easy to write of mathematical planes and impinging wave fronts, but the physical facts are quite other things, and it is with them we have to do. Nor is it easy to form any mental picture likely to be at all near the truth of the impingement of a transverse vibration on a solid. It is not a particle of matter that is reflected, it is a motion, and it is quite impossible to produce any model which will reproduce in any way the conditions of reflection. To my mind, in nothing does the theory of light break down more conclusively than in this.

I am not going to advocate the corpuscular theory, but I cannot resist the temptation to point out that one of its most powerful opponents was Arago, and that one of his strongest arguments was based on the assumption that the corpuscules had weight; that, in a word, they were subject to the law of gravity. But as the ether is supposed in the present day to be imponderable, the objection has no longer any force.

Further, it may be pointed out that up to a very recent date all writers on light assume that the ether is discrete in texture. The assumption made by Dr. Lodge first, and since by many other mathematicians, that the ether is without structure, greatly augments the probability that the existing theory of light is radically wrong in ways too numerous to mention. M. A.

Woodstock, February 20th.

FREE TRADE AND NO TRADE.

Sir,—It is a matter for regret that bimetallists should weaken their case by attacking those who advocate fiscal reform, and that they should seek to bolster up this miserable free trade fetish by going out of their way to circulate statements which will not bear a moment's investigation. We have had a lecturer, Mr. Everett, who is at present stumping the country in favour of bimetallism, gravely telling an Edinburgh audience that Protection will be no cure for the present depression, seeing it is as bad, if not worse, in protective countries. What are the facts? On referring to the "Statistical Abstracts," which only give us the returns for foreign countries down to end of 1893, we find the yearly average under wheat and corn crops as follows:—

	Acres under wheat.		Inc. or Dec. P. c.	Acres under corn crops.		Inc. or Dec. P. c.
	1880-82	1891-93.		1880-82.	1891-93.	
United States	37,587,643	37,700,248	+ ½	123,627,630	140,013,386	+ 13¼
Germany ..	4,490,430	4,861,815	+ 8½	33,936,415	36,932,318	+ 9
Austria-Hungary	8,810,791	10,981,638	+ 25	35,386,216	40,677,129	+ 15
France	17,074,598	16,313,954	− 4	37,395,761	36,035,612	− 3¼
Italy	11,699,662	11,187,343	− 4	19,662,309	20,286,283	+ 3½
United Kingdom	3,065,617	2,215,355	− 28	10,648,903	9,314,463	− 13

In 1895 we had only 1,456,228 acres under wheat, or a decline from the average of 1880-82 of 52 per cent. In 1893 France had 17,470,443 acres under wheat, which yielded 37½ million quarters, against in this country, in 1895, 4,700,000. These countries not only derive a considerable revenue from the duties on corn, which by their amount enables them to relieve their people of other taxation, but the prices of wheat in their markets are from 6s. to 8s. a quarter higher than in free trade England—and that, as the Consular Reports show, without bread being dearer in any country in Europe than in Britain.

Is it within the limits of possibility that the country where the agriculturist, in comparison with the heavy taxation he has here so unjustly to bear, can scarcely be said to be taxed at all, should be as badly off as this country, which stands with open ports to receive the surplus agricultural products of the world? If our monetary system is the cause, as bimetallists so confidently assert, why should Germany and Austria-Hungary not be suffering as we are? It is the same, with the single exception of France, as regards our exports of domestic produce, as shown by the following table in millions of pounds sterling:—

	1875.	1893.	Increase or decrease per cent.
	£	£	
Germany	125	155	Increase 30
Holland	45	92	,, 105
Belgium	44	54	,, 23
France	155	129	Decrease 17
Russia	60	61	Increase 1¼
Austria	55	67	,, 22
United States	104	173	,, 63
United Kingdom	228	218	Decrease 2
United Kingdom, excluding coal and machinery	204	186	,, 9

	1850.	1875.	1893.
	£	£	£
Coal exported	1,284,224 ..	9,658,088 ..	17,371,331
Machinery exported ..	1,042,066 ..	9,058,647 ..	14,205,215

I have given the exports of coal and machinery separate, as, both being imported by foreign countries mainly for the purpose of manufacturing goods they formerly bought from us, the rapid increase in the export concurrent with the falling off in that of other commodities, is not a subject for congratulation, but rather for alarm. And it is in ignorance, I shall hope, of such simple facts as these, Mr. Everett tells a meeting of Scotch agriculturists that depression in trade and agriculture is as bad, or worse, in protective countries than in Great Britain.

The object bimetallists seek to attain is a higher level of prices, which will undoubtedly be secured by the restoration of silver to its former position. How will this benefit agriculture? It goes without saying that nothing can do so that will fall short of such a rise in prices as will put it in the power of the cultivator to obtain a profit. This, they assert, will be secured to him by bimetallism. But will it? It will simply have the effect of depriving silver-using countries of the advantage they now have over gold-using, such as the United States and the Australias, which will still be able to undersell our producers; and as supply and demand fix prices, it is idle to look for any diminution in the former until this foreign unrestricted competition is checked. This can alone be effected by protection, to which, disguise it as we may, we shall sooner or later have to return. So long as the foreigner can lay down his produce in this country at a lower cost than our cultivators, so long will his sendings to us increase, our produce diminish, and a return of prices to a paying level be impossible.

Between bimetallism and protection there is this noteworthy and vitally important difference. While the former would enhance the cost of living of the working classes, it would give them no compensation in the way of increased employment, inasmuch as imports of manufactures and agricultural produce would still continue to displace their labour, with the result in course of time of a fall in wages, which the latter would raise to a proportionally greater extent than any increase they might at first have to pay for the commodities they consume. How does Mr. Everett propose to meet this difficulty?

While there is no hope at present of bimetallism being adopted, we have it in our power to administer a quietus to a far more serious evil, the putting down summarily of which could harm no honest man in the community and prove of enormous advantage to our industries. I refer to this ruinous and reckless gambling in "futures" of wheat, silver, cotton, wool, &c., begun in the Western States in 1876, and first introduced into this country in 1883. The following table will at a glance show your readers the disastrous effect of these "bear operations" on the prices, and consequently on the home production of wheat:—

Years.	Average yearly supplies of wheat and flour. Quadrennial periods.			Per head of population. lb.	Prices per Quarter	Natural prices per Quarter
	Imports. Quarters.	Home Production. Quarters.	Total Quarters.			
					s. d.	s. d.
1871-74	11,253,192	11,800,831	23,054,523	346	57 0	50 7
1875-78	13,686,966	10,842,287	24,529,253	356	48 7	49 2
1879-82	17,113,197	8,566,227	25,679,424	355	44 8	49 4
1883-86	17,504,607	9,402,287	26,906,894	358	35 3	48 11
1887-90	18,780,418	9,456,111	28,236,529	365	31 6	47 11
1891-94	22,008,346	7,459,712	29,468,058	369	28 4	47 5
1895	23,360,952	4,700,000	28,060,952	344	23 1	50 10

In this table the exports, being so trifling, have not been deducted. The high price from 1871-74 is accounted for by increased exports during the war, which averaged from 1871-74 357,929 quarters, against 57,910 from 1865-69. Past experience, before these gambling systems were introduced, has shown that when we had a supply of 350 lb. per head of population, the price was about 50s. Yet with only 344 lb. for 1895, instead of the price being on this basis 50s. 10d., it is only 23s. 1d., or 52 per cent. less. In 1894, with only a total supply of 365 lb., the price fell from 26s. 3d. in January to 17s. 8d. in October, and thereafter, in the face of our having imported in the first ten months of 1895 20,120,680 quarters, against only 17,833,470 during the same months in 1894, we have a rebound in prices in the middle of 1895 to 26s., or 45 per cent. Here clearly this cannot be ascribed to our monetary system, for the value of silver has not risen. Unless the laws of supply and demand have ceased to regulate prices, if not to enormous "fictitious" supplies, created by bear operations, to what are we to ascribe these extraordinary fluctuations in the prices of wheat? Let it be carefully noted that they only occur in commodities gambled in. Though the imports of beef and mutton have been increasing more rapidly than those of wheat and flour, and there has as yet been no diminution to speak of in the home supply, prices have only since 1875-78 declined 25 to 30 per cent., while that of wheat has fallen 63 per cent.

Is it to be tolerated that agriculture, our greatest industry, is to be sacrificed in the interest of a gang of unscrupulous gamblers, whose operations, so far from contributing anything to the productive wealth of the country, tend to its serious diminution? The United States, Germany, Austria, &c., have Bills in preparation to put these gambling systems down, while we, as usual, when our trade and agriculture are in peril, are content to sit with folded hands doing nothing. This loss of wealth in the past created from the soil is serious enough, but nothing to the frightful risk we should incur in time of war, our indifference in regard to which the statesmen of Europe view with amazement. Observe what would happen. The moment war was declared the big Chicago operators would seize the opportunity to telegraph to this country to purchase 5 to 10 million quarters of wheat, refuse to sell at any price, and starvation would stare us in the face. Such is the danger the nation seems content to incur, rather than admit the utter collapse of Cobdenism, with all its grotesque absurdities and ludicrous prophecies. A. Williamson,

Author of "British Industries and Foreign Competition."

15, Moray-place, Edinburgh, February 18th.

WATER-TUBE BOILERS.

Sir,—Great was my disappointment when I received your paper of the 21st inst., containing abstracts of Mr. Patchell's paper on the MacPhail and Simpson superheaters. The preliminary annoucement, that by the addition of this apparatus and forced draught, the duty of Babcock and Willcox boilers had been increased three times, had raised my curiosity to the highest pitch; when, lo and behold, the production of steam per unit of surface when at its maximum did not come up to that of any good Lancashire boiler.

The boiler had originally a heating surface of 1827 square feet, and evaporated 3457 lb. of water, or say about 1·9 lb. per square foot. The boiler surface was then increased by the addition of 355 square feet to 2182 square feet, and evaporated 5125 lb., or 2·35 lb. per foot per hour. This is nothing but play. Forced draught was then added, and the duty increased to 8293 lb., or about 3·6 lb. per square foot hour. Why this is less than the duty of a good Lancashire boiler with Galloway tubes without forced draught.

With forced draught a locomotive boiler will evaporate easily 8½ lb., and tubulous boilers of the Thornycroft, Clyde boiler, or the Normand type, will do something like 20 lb. per foot, so that Mr. Patchell's experiments amount to this—he takes a boiler evaporating 1·9 lb. per foot, and brings up the evaporation to 3·6 lb. This is no miracle, in regular practice here we evaporate 20 to 25 kilos. per square metre heating surface, say, 4·2 to 5·2 lb. per square foot with natural draught, and this is not the best.

In general, the tubulous boilers for land purposes give a very low evaporative duty per unit of heating surface. I have tried nearly every kind; the worst of all is the Belleville. I have put up three of these, but none of them run six months; at the end of the six months the tubes were all crooked and formed steam pockets. When the evaporation was kept below 5 kilos. per 1 metre surface they could be worked continuously, but when forced to 10 kilos., the result was ruin, and a boiler which will not do this duty has no *raison d'être* commercially. I am afraid our Admiralty has some trouble in store with the Bellevilles.

There is only one practical fact for the general run of tubulous boilers, and that is, they are all bad. The catch word "inexplosible" sells them. The above applies to the types Babcock and Belleville. It is possible to build very good tubulous boilers. There are several very good forms, cheap to build, and giving very high duty, but these are not the types which are pushed and advertised.

I take the liberty of writing you these few lines, so that in case you give another leader on the wondrous Patchell experiments that you may call attention to the fact that with all the tinkering the result is very poor. Not long ago there were several tubulous boilers of the Babcock and Belleville types at work in the manufacturing districts of the Alsace, but if I am rightly informed these have now all disappeared. C. Brown.

91, Guter Strasse, Basel, February 24th.

[Mr. Brown's experience is certainly not that of English and American electric light engineers, with whom water-tube boilers are in high favour.—Ed. E.]

PRIOR PUBLICATION OR NOT.

Sir,—With reference to the facts stated by "J. H.," in your issue of February 21st, the case is possibly hardly put fully enough. Supposing, however, that the model was of such a nature that it took the invention out of the experimental stage and established its utility, the leading decisions which seem to govern the case stated by "J. H." are:—Humpherson *v.* Syer, C.A. (1887), 4 R.P.C., 415, when Fry, L. J., in his judgment, stated: "Is it the fair conclusion from the evidence that some English people, under no obligation of secrecy arising from confidence or good faith towards the patentee, knew of the invention at the date when the plaintiff took out his patent? That appears to me the question." It was held the plaintiff's patent was invalid. Possibly

Saxby *v.* Gloucester Wagon Company, H.L. (1883), goes farther than Humpherson *v.* Syer, when it was held "that drawings made not with a view of taking out a patent, but with the view of working the invention, there was publication." *A fortiori*, how much more would a model be publication? Lord Blackburn, in Patterson *v.* Gas Light and Coke Company, 3 App. Case, 244, "The consideration for a patent is the communication to the public of a process that is new." In "Hindmarch on Patents," page 33, it is laid down that "If the public once becomes possessed of an invention by any means whatever, no subsequent patent for it can be granted, either to the true or first inventor himself or any other person; for the public cannot be deprived of the right to use the invention, and a patentee of the invention could not give any consideration to the public for the grant, the public already possessing everything that he could give." This is, in my opinion, a correct statement of the law.

Then, again, "J. H." states it was shown with a "view of selling the invention." Now it is plain the inventor was seeking consideration other than the grant of the patent. It is as if the inventor said, "You give me so much for my invention, and I surrender to you my rights." What are the inventor's rights? Clearly in this case the grant of letters patent. The cases that go to this view are:—Wood *v.* Zimmer, 1815; Germ Milling Company *v.* Robinsons, 1886; Losh *v.* Hague, 1838; Hancock *v.* Somerell, 1851; Oxley *v.* Holden, 1860.

I think there can be no doubt at all that the opinion of the first patent agent is correct in all respects, and the facts are but an addition to the list of melancholy examples of an inventor not taking proper advice of an experienced patent agent in due time.

W. M. Llewellin, C.E., F.S.P.A.

15, King-square, Bristol.

ADMIRALTY CONTRACTS.

Sir,—In some quarters we find there is a misapprehension concerning the questions lately asked in Parliament by Mr. Holland with reference to the relations between the Admiralty and its contractors, and in order that the public may be fully informed, we should be glad if you will kindly publish the enclosed copy of letters which have passed between the authorities and ourselves. These letters led to certain interviews which we had the honour to have with Earl Spencer, and we hoped that the matter to which they refer had been finally closed. The subsequent action of the Admiralty, however, in allowing tenders after they had been sent in to be modified to our disadvantage has led us to bring the subject forward again, the necessity for which we regret.

Although we believe we are entitled to compensation for the wrong which we contend has been done us by the Admiralty in distributing our working drawings, we are not claiming any such compensation, but are contending for a principle, and by drawing attention to the subject are endeavouring to secure what we believe to be proper treatment to contractors throughout the country, and to uphold the dignity of the engineering profession.

Yarrow and Co.

Poplar, London, February 24th.

Copy of letter addressed by the Admiralty to Messrs. Yarrow and Co., dated March 13th, 1894, in reply to Messrs. Yarrow's complaint of the distribution of their designs:—

"I am commanded by my Lords Commissioners of the Admiralty to acknowledge the receipt of your letter of the 7th ult., and in reply thereto have to state that there has been no such 'broadcast' distribution of your designs over the country as is suggested therein.

"Paragraph 5 of the letter of August 16th, 1893, clearly conveyed the intentions of the Admiralty in regard to making use of information in their possession regarding the torpedo-boat destroyer type, and its terms are considered quite clear and explicit. Your price, moreover, was presumably fixed in view of this condition among others.

"Their Lordships regret if there has been any misapprehension on your part in this matter; but are unable to admit that they had exceeded their rights in any action taken by them.

"They have already acknowledged in previous letters the satisfactory fulfilment by your firm of the numerous contracts undertaken, and are desirous in the public interest of availing themselves in future of your services in extensions and improvements of the torpedo flotilla. At the same time, the sources of supply for torpedo vessels must be extended under existing circumstances."

Copy of letter addressed to the Secretary of the Admiralty by Messrs. Yarrow and Co., dated July 21st, 1894:—

"We should feel obliged if you would kindly lay before the Board of Admiralty, at an early date, the following further communication in reference to our letter dated February 7th and the Admiralty answer of March 13th.

"We did not reply to the above Admiralty letter immediately, wishing to make minute inquiries on the subject of these communications. This has now been done.

"That our designs of the Havock and Hornet machinery have been distributed among firms building destroyers is beyond question, and this distribution has been even more extensive than we at first believed possible. Mr. Yarrow has seen at the works of some of the contractors complete sets of our designs, embracing every essential part of the machinery, which had been copied from our drawings, these having been forwarded by the Admiralty—without our knowledge or consent—to the various firms.

"We beg to draw attention to the fact that these designs are our own and not the property of the Admiralty, and they were simply submitted for approval in accordance with the conditions of the specification, and the use to which they have been put is a distinct breach of the terms upon which we tendered. We are sure their Lordships will be the first to admit the great injustice done us, and against which we strongly protest. We are prepared to face any amount of fair competition; but are not prepared to have the result of costly experiments, great study, and a lifetime of hard work placed at the disposal of other firms without our consent and to our prejudice.

"In the Admiralty letter above referred to it is stated that 'the intentions of the Admiralty are considered quite clear and explicit,' but the words used certainly would not lead to the belief that such an unusual course as the distribution of our working drawings was contemplated. Even if they did admit of that interpretation, we would point out that an unjust act is not made just by a statement that such an act is intended. In the Admiralty letter it states that our 'price, moreover, was presumably fixed in view of this condition,' from which we see the Admiralty recognise that compensation is due to us. We did not, however, include in our estimate for the three boats last ordered any such compensation, as we were not asked to do so.

"It appears, as we have already stated, that the drawings were distributed in the most complete form possible, thereby giving the result of our lengthened experience, careful study, and costly experiments, to others, causing the work of years to be turned actually to our own disadvantage.

"The Admiralty in France frequently make use of designs belonging to certain contractors for the guidance of others, but they always first make equitable arrangements with those whose designs they distribute. We presume it is the desire of the authorities that business relations between them and private firms should be governed by the same rules as control transactions between firms of the highest standing; and, with all respect, we would point out that no firm of the first rank would place designs of one contractor in the hands of others.

"We would further observe that such a performance as that of the Havock and Hornet at Portsmouth on the 14th inst. is only made possible by sufficient encouragement being given to those firms who have made such constructions their study; and if the action of the Admiralty in distributing designs in the manner described be continued, it will crush progress, and this country will soon be left far behind those European Powers where another course of action is adopted.

"We are convinced that neither their Lordships nor the country can wish the public interest served by an injustice; and the action of the Admiralty in this matter is condemned not only by the profession generally, but also by those firms with whom we have been in communication, and who have been supplied with our designs for their guidance. We therefore respectfully, but firmly, beg to differ from their Lordships when they say they 'have not exceeded their rights.'

"We feel sure that what has been done cannot have come fully to the knowledge of their Lordships. We deeply regret to have to make so grave a charge against a public department, and reserve ourselves the right to make public, in whatever manner we think fit, the correspondence which has passed."

HORSELESS CARRIAGES.

The following interesting, and in many ways amusing, article appears in the current number of *La Locomotion Automobile*:—

Decidement l'Angleterre bouge, et si le Parlement ne s'y oppose pas plus longtemps, par le maintien de règlements surannés et anti-progressistes, elle va emboîter après tout le monde le pas automobile. Certains indices permettent d'espérer qu'on va retirer enfin de la circulation ce piéton nanti d'un drapeau rouge qui, d'après les lois actuelles, doit précéder toute automotrice en marche. Cette grave question va, paraît-il, être sérieusement agitée par devant le Banc de la Reine: de puissantes influences sont mises en œuvre pour la trancher du côté qu'il faut. Encore quelques mois, une douzaine de rapports bien documentés, autant de discours et de consultations d'experts, à peine deux ou trois procès perdus ou gagnés par les transgresseurs modernes de ces règlements d'autrefois, et, s'il plaît à sa Gracieuse Majesté, qui n'en profitera guère, hélas! les automobiles pourront rouler en liberté. Voilà qui va bien; on ne saurait être plus expéditif.

D'autre part, on nous communique la note suivante au sujet du concours de voitures sans chevaux, dont le journal Engineer, de Londres, a pris courageusement l'initiative.

"Le journal Engineer vient de suivre en Angleterre l'exemple donné par le *Petit Journal*, en instituant un concours de voitures automobiles.

"Il ne s'agit pas d'une course unique à effectuer par les concurrents, mais d'un ensemble d'épreuves, laissées dans une certaine mesure à l'appréciation d'un jury composé de Sir Frederick Bramwell, docteur J. Hopkinson et M. J. Audley F. Aspinall.

"Les véhicules à présenter au concours devront rentrer dans l'une des catégories suivantes:

"A.—Prix de 350 guinées—la guinée vaut 26f. 47—pour la meilleure voiture automobile pouvant porter quatre personnes ou davantage, sans dépasser un poids de 2 tonnes—2030 kilos.—tout compris.

"B.—Prix de 250 guinées pour la meilleure voiture automobile pouvant porter une, deux ou trois personnes, sans dépasser un poids de 1 tonne—1015 kilos.—tout compris.

"C.—Prix de 150 guinées pour la meilleure voiture automobile pouvant porter 1 tonne—1015 kilos.—de marchandises ou paquets, sans dépasser le poids de 2 tonnes—2030 kilos.—tout compris.

"D.—Prix de 150 guinées pour la meilleure voiture automobile pouvant porter 5 cwt.—250 kilos.—au moins de marchandises ou paquets, sans dépasser le poids de 1 tonne—1015 kilos.—tout compris.

"Chacun de ces prix pourra être partagé par le jury entre plusieurs véhicules, à égalité reconnue de mérite.

"Tous les moyens de propulsion autres que la force musculaire pourront être employés, à la condition de faire partie intégrante de la voiture.

"Aucun liquide, huile ou autre, employé dans une machine pour la production d'un mélange explosif de vapeur, ou pour le chauffage, ne devra avoir une densité inférieure à 0800, ni un point d'éclair inferieur à 73 deg. Fah., à l'appareil d'Abel.

"Les essais consisteront en une course d'au moins 100 milles—160 kilos.—à l'aller et 100 milles au retour, ou un parcours total d'au moins 200 milles, suivant un itinéraire qui sera ultérieurement désigné. Après l'achèvement de cette course, les voitures seront tenues d'exécuter tels autres parcours ou subir tels autres essais que le jury estimera nécessaires.

"Comme le but du concours n'est pas de réaliser des vitesses considérables, il a été décidé que toute vitesse supérieure à 10 milles à l'heure ne serait pas comptée. Cette allure est bien suffisante pour les applications usuelles et une course de vitesse entre les concurrents provoquerait des oppositions. Les concurrents pourront marcher comme ils voudront, à la vitesse qu'ils jugeront convenable, sans arrêt ni jour ni nuit, ou bien avec tels arrêts qu'il leur plaira. Mais on ne leur tiendra comptre que de la vitesse de 10 milles à l'heure. Ainsi, deux voitures faisant le parcours de 200 milles, l'une en 20 heures, l'autre en 18, seront mises à égalité au point de vue de la vitesse.

"Tout constructeur, marchand ou inventeur d'une voiture, pourra la présenter au concours, mais il n'y aura pour chaque voiture qu'un titulaire.

"Le concours n'aura probablement pas lieu avant le mois d'Octobre, 1896, ce qui laisse aux intéressés environ un an pour les études, la construction et les essais préalables."

Ce qui frappe, avant tout, dans cette note, c'est son caractère restrictif: restrictions pour le poids des véhicles, restrictions pour le nombre des places, restrictions pour la densité du pétrole; le programme ne renferme guère que des restrictions. C'est une des mille et une formes de l'*english prudery*. Chez nous, un tel programme ne serait pas tolérable; chez nos voisins d'outre-Manche, habitués à être gênes dans leurs entournures locomotrices, il passera peut-être pour le plus large et le plus libéral des programmes.

Raisonnous un peu. Qu'importe, à quelques centaines de kilogrammes près, le poids des véhicules; qu'importe la densité de leur pétrole, pourvu qu'en somme ils marchent et nous mènent rapidement où nous voulons aller? Quelle que soit notre préférence personnelle pour les voitures légères, nous ne pouvons admettre qu'on vienne ainsi, d'un trait de plume, fixer des limites au génie inventif du constructeur, qui croit bien faire en augmentant leur poids pour augmenter leur puissance. S'il se trompe, on le voit plus tard à l'épreuve: son expérience malheureuse profite à lui-même et aux autres. Lui imposer par avance des obligations si rigoureuses, dans une question encore à l'étude, c'est tout simplement préjuger sans fondement sérieux les conditions que doit rempler le parfait moteur.

Si l' Engineer croit être fixé sur ce point, le concours qu'il organise doit lui sembler à peu près inutile; si, au contraire, ce qui est plus probable, il n'a que des principes incertains, il a tort d'agir comme s'ils étaient coulés en bronze.

Cette préocupation visible de vouloir établir parmi les véhicules existants des catégories distinctes et de ne vouloir admettre dans un même concours que des types comparables entre eux part évidemment d'un bon naturel. Pourtant, on conviendra bien que ce sentiment de l'équité que cinquante termes dans la progression, et cependant les transitions étaient si habilement ménagées que le roi lui-même ne pouvait dire, en la parcourant des yeux, où finissait la poire et où commencait . . . . la sienne.

A fragmenter les concours on risque fort d'égarer l'opinion, de l'énerver en ne lui fournissant que des résultats confus et disparates. Mieux vaut lui présenter en bloc tous les véhicules courant ensemble et laisser à son infaillible bon sens le soin de tirer les conclusions.

Pour le public, le mérite propre d'une voiture automobile, retour d'une course suffisamment longue, pour prouver son endurance, est indépendant de son poids et de son système mécanique, aussi bien que de la nature de son combustible ou de la densité de son pétrole; mais il admet poussé à l'extrême condurait à créer autant de catégories et par conséquent de concours qu'll y a de systèmes automobiles différents. Ce qui serait irréalisable, absurde et directement opposé au but poursuivi: la comparaison. Où s'arrèter dans cette voi, lorsque déjà la série des automobiles passe, par degrés insensibles, de Mobilette à l'Omnibus à 50 places, et lorsqu'on prévoit que le progrès, en multipliant les types, adoucira encore la nuance des transitions. Je ne puis m'empècher de songer à cette suite célèbre de caricatures dont la première était une poire et la dernière la tête de Louis-Philippe: il n'y avai d'intuition qu'il est directement proportionnel à la *vitesse moyenne* et au *nombre* de places occupées, et inversement proportionnel à son *prix d'achat* et à sa *dépense kilométrique*.

On peut exprimer cela au moyen de la formule algébrique:

$$M = \frac{v \times n}{p \times d}$$

dans laquelle M exprime le mérite du véhicule en fonction des 4 facteurs, *v*, *n*, *p*, *d* (vitesse, nombre, prix, dépense), qui sont les seuls éléments sérieux d'appréciation dont on puisse faire usage pour l'attribution des récompenses dans un concours où rien ne doit être laissé à l'arbitraire du jury.

La fraction $\frac{v \times n}{p \times d}$ augmentant en même temps que son numérateur augmente et *diminuant* à mesure que son dénominateur *augmente*, en vertu des éternals principes, il est aisé de voir que le constructeur qui désire mettre toutes les chances de son côté doit chercher à réaliser la plus grande vitesse avec le plus de places possible, baisser sur son catalogue les prix qu'il serait plutôt enclin à majorer, et réduire à son minimum la dépense kilométrique. Or l'acheteur ne demande pas autre chose. Si donc le vendeur y trouve aussi son compte, je ne vois pas quélle objection on pourrait faire à ma formule.

Son application à la détermination du mérite relatif des véhicules les plus variés courant dans une même épreuvre, est aussi rapide qu'élémentaire.

Soit, par exemple, deux types quelconques ayant respectivement, au point de vue du tourisme, des mérites représentés par M et M' et les éléments suivants relevés par les contrôleurs de la course.

$v = 20$ km.	$v' = 15$ km.
$n = 3$	$n' = 4$
$p = 3000$ fr.	$p' = 4000$ fr.
$d = 0$ fr. 15	$d' = 0$ fr. 10.

On a:

$$M = \frac{20 \times 3}{3000 \times 0{,}15} = \frac{6}{45}$$

et—

$$M = \frac{15 \times 4}{4000 \times 0{,}10} = \frac{6}{40}$$

La fraction $\frac{6}{45}$ étant plus petite que $\frac{6}{40}$, c'est M' qui a l'avantage sur M.

Supposons maintenant que le prix 3000 tombe à 2600, les autres facteurs restant les mêmes. Il vient:—

$$M = \frac{20 \times 3}{2600 \times 0{,}15} = \frac{6}{39}$$

La fraction $\frac{6}{39}$ étant plus grande que la fraction $\frac{6}{40}$, M a cette fois l'avantage sur M'.

Avec cette base d'appréciation il devient possible de lancer ensemble dans la lice l'Omnibus de famille et Mobilette.

Puisque je suis en mal de chiffres, je vais dédommager les Anglais de la petite critique que j'ai osée à leur endroit, en passant au crible algébrique certaine clause du programme de la course Paris-Marseille, qui n'a peut-être pas encore reçu—espérons-le—sa sanction officielle, dans un texte *ne varietur*.

Je lis dans le nº 2 de la *France Automobile*:

"M. Levassor, le vainqueur de l'année dernière, a fait, à ce sujet, d'intéressantes propositions que la presse a déjà indiquées et que nous résumons ici. On répartirait la somme totale affectée aux prix, en parties proportionnelles au nombre de voitures de chaque catégorie ayant pris part à l'épreuve; le nombre des prix de chaque catégorie serait égal au tiers des voitures faisant partie dé chacune de ces catégories; enfin, la valeur des prix serait établie dans chaque catégorie de telle façon que le premier serait double du second, celui-ci double du troisième et ainsi de suite."

D'autre part, il a été décidé que la montant des souscriptions serait réparti ainsi qu'il suit entre les trois catégories de véhicules concurrents auxquelles on s'est arrêté:

40 0/0 aux voitures de plus de 4 places.

50 0/0 aux voitures de 2 à 4 places.

10 0/0 aux véhicules légers—mobilettes à vapeur ou à pétrole, tandems, tricycles et quadricycles automobiles.

Si je comprends bien, une course qui réunirait, par exemple, 6 voitures de plus de 4 places, 24 voitures de 2 à 4 places et 45 mobilettes,—proportion indiquée approximativement par le nombre de véhicules de ces trois catégories figurant au dernier Salon du Cycle,—fournirait le tableau suivant:

I (en négligeant les centimes).
6 voitures de plus de 4 places.—2 prix.
(40,000 francs.)

1er prix: 26,666 francs.
2e prix: 13,333 francs.

II (en négligeant les centimes).
24 voitures de 2 à 4 places.—8th prix.
(50,000 francs.)

Soit x le 8 prix.
Il vient:

$$x + 2x + 4x + 8x + 16x + 32x + 64x + 128x = 50{,}000$$
$$255x = 50{,}000$$
$$x = 196.$$

1er prix: 25,088 francs.
8e prix: 196 francs.

III (en tenant compte des centimes).
45 mobilettes.—15 prix.
(10,000 francs).

Soit x le 15e prix.
Il vient:

$$x + 2x + 2^2x + 2^3x \ldots\ldots + 2^{14}x = 10{,}000$$

La formule connue donnant la somme des termes d'une progression géométrique

$$S = \frac{a\,(q^n - 1)}{q - 1}$$

permet d'écrire immédiatement:

$$\frac{x\,(2^{15} - 1)}{2 - 1} = 10{,}000$$

Pour abréger ce calcul un peu long, il faut avoir recours aux logarithmes.

Logarithme $2 = 0{\cdot}30103\ldots$
Logarithme $2^{15} = 15 \log. 2 = 4{\cdot}51545\ldots$
4·51545…… correspond au nombre 32768.
D'où:

$$x\,(32768 - 1) = 10{,}000$$
$$32767\,x = 10{,}000$$
$$x = 0{,}30$$

1er prix: 9,830 fr. 10
10e prix: 9 fr. 60.
15e prix: 0 fr. 30 centimes (en négligeant les millimes).

Constructeurs, je n'ajouterai rien à l'éloquence de ces chiffres: méfiex-vous des progressions.

Emmanuel Aime.

For the benefit of M. Aimé we may explain that the weights we have given are adapted to what, we believe, will be the limits to be fixed by Act of Parliament, and that the regulations under which alone the mineral oils of light specific gravity, such as petroleum spirit, benzoline, and benzine, can be sold and stored in this country are so exacting that the use of such light oils is practically prohibited for the purpose of locomotion. There is, of course, no hardship incurred by anyone as a consequence of our rule, because there is no difficulty in using the heavy and safe oils, either to drive internal combustion engines or as a fuel to make steam.

Siam Railways.—It is stated that the contract for the Glenkoy-Chiengmal Siam Railway extension is to be given to a London firm, and that the effect of this will be to greatly extend British influence in North Siam.

THE ENGINE, BOILER AND EMPLOYERS' LIABILITY INSURANCE COMPANY.

At the annual meeting of this company held on Wednesday week at the head offices of the company, No. 12, King-street, Manchester, the managing director, Mr. R. B. Longridge, in moving the adoption of the directors' report, stated that during the past year there had been no explosion of any boiler insured by the company, but breakdowns of engines had been of frequent occurrence, and a large amount had been paid for damage resulting therefrom, yet notwithstanding these casualties, the result of the year's work, as shown by the balance-sheet and statement of accounts, had proved satisfactory.

Referring to boiler explosions generally, he stated that but for one serious disaster, the number of explosions would not have exceeded the low average of recent years. In the case referred to, the failure of one boiler belonging to a range of fifteen boilers at blast furnaces in the Middlesbrough district caused the immediate explosion of eleven of its neighbours. The destruction of property was immense, and twelve persons lost their lives, while eight others were seriously injured. The boiler belonged to a type which was fast disappearing, the use of which he had many years ago deprecated, and the disappearance of which had been accelerated by this accident. The destruction caused by this unfortunate event, though very appalling, was not so serious as in some of the explosions of former years when boiler insurance and inspection had not become so widely appreciated and adopted, as now. Take, for instance, the explosion of one boiler at the Millfields Ironworks, South Staffordshire, in the year 1862, when twenty-eight persons were killed, and many others seriously injured. In that year the number of lives lost from boiler explosions was 102, a number, which, though large as compared with the experience of recent years, was not then exceptional. At that time there was only one boiler insurance company in existence, of which he—the chairman—was chief engineer and manager. The Millfields case, however, caused some consternation in the district, and the iron masters conscious that many of their boilers would not pass the scrutiny of the Manchester Company, formed a company of their own, which some years ago became extinct. No less than eighteen companies had been formed, twelve of which had succumbed after attempting to carry on business at rates below the cost of the efficient inspection which all right-minded boiler owners expect and demand. Notwithstanding these failures, the work of boiler insurance has progressed, and now extends to all parts of the United Kingdom, the number of boilers under inspection being estimated at 85,000 or thereabouts. The statistics collected during the last thirty-seven years show remarkable improvement as regards the safety of property and lives.

The annual average of explosions of land boilers for a period of ten years commencing with 1859, when the first boiler insurance company was formed, was forty-nine, and the average number of deaths seventy-eight, whereas for a similar period ending 30th June, 1895, the latest date to which the Board of Trade reports are complete. The average number of explosions, including collapse of flues, was 26·4, and of deaths 13·8. Taking into account the enormous increase in the number of boilers during the period mentioned, and the continuous rise in steam pressures, this comparison was all the more striking, and he—Mr. Longridge—claimed that the system of inspections which he had had the honour of inaugurating forty-one years ago, had contributed in no small degree to the bringing about of these beneficent results. It was resolved to declare a dividend of 7s. 6d. per share, to add £2500 to the Reserve Fund, and to carry forward the balance of £1517.

The re-election of Mr. Walmsley Stanley as director, and Messrs. Aldred, Astbury, Turner and Co., as auditors, closed the business of the meeting.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

There was a large attendance on 'Change to-day. Inquiries for steam coal were good at last week's prices. The briskness which has, happily, manifested itself in the coal shipments of late has been well maintained during the week. We may safely predict that this state of things will continue for some weeks to come, as a large amount of tonnage is stemmed to arrive in the port shortly. The importation of iron ore and pit props has not shown up so well as compared with previous weeks. The ship-repairing trade has been fairly busy. Rumours are again rife as to the speedy construction of an additional dry dock on the east side of the river.

Prices ruling on 'Change to-day were as follows:—Coal: best steam, 8s. 3d. to 8s. 6d.; seconds, 8s.; best house coal, 10s. 3d. to 10s. 6d.; dock screenings, 4s. 9d.; colliery small, 4s. 3d. to 4s. 6d.; smith's coal, 6s. 6d. Patent fuel, 10s. 3d. Pig iron: Scotch warrants, 47s. 4d.; hematite warrants, 48s. 11d., f.o.b. Cumberland; Middlesbrough No. 3, 38s. 5d., prompt Middlesbrough; hematite, 46s. 4d. Iron ore: rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel: rails, heavy sections, £4 15s.; light, £5 5s. Tin-plate bars, £4; Siemens tin-plate bars, best, £4 5s.; all delivered in the district cash less 2½ per cent. Tin-plates: Bessemer steel coke, 9s. 1½d.; Siemens coke finish, 9s. 4½d.; Ternes, per double box, 28 by 20 C., 21s. to 22s. Pitwood, 15s. 6d. London Exchange Telegram:—Copper, £46 2s. 6d.; Straits tin, £60 15s.; freights without change.

Tramways in the United States.—The total length of the street railway lines (tramways) in the United States equals 13,176 miles, an increase of 3514 miles over those in operation in 1891. Of this total, 13,176 miles, 409 miles are operated with steam dummies, 10,238 by electric power, 578 by cable, and 1950 by animal traction. The capitalisation of 12,797 miles reporting is shown to be £104,149,170 stock and £73,538,895 bonds, an average of £8138 per mile of stock and £5666 per mile of bonds, equal in the aggregate to £13,805 per mile of stock and bonds, as against £11,322 per mile for steam railways.

Foreign Navies.—The Czar has approved Estimates which have just been prepared by the Russian Minister of Marine for seven years in advance. These Estimates amount altogether to £66,080,000. The Minister proposes an expenditure of £9,200,000 for 1895-6, carried by annual increments of £80,000 each, to £9,630,000 in 1901-2. A large proportion of the outlay contemplated is to be devoted to the construction of new ships, which are to be pushed forward as rapidly as possible. The expenditure upon new constructions for 1895-6 is to be £2,880,000. The Russian squadron in the Pacific now comprises one ironclad—the Nicholas I.—four first-class cruisers, two second-class cruisers, two despatch torpedo boats, five gunboats, and two torpedo boats. In the Atlantic, Russia has now one first-class cruiser, and in the Mediterranean three first-class cruisers, one second-class cruiser, and three gunboats. Captain Tsoucknine, who has been for some time in command of the Russian first-class cruiser Pamial-Azowa, has been promoted Rear-Admiral. He has been replaced in the command of the Pamial-Azowa by Captain Virenisus. The French ship-of-war Pourvafy has been despatched to Madagascar for coast-guard duty. The Aquilon, having completed a series of trials at Cherbourg, is about to be attached to the French Northern Squadron, in which she will replace the Dauphin. The Swedish Budget for 1896 provides for the construction of two ironclads, four torpedo cruisers, and six torpedo boats. The Garibaldi ironclad, built to the order of the Argentine Government, has just made some satisfactory trials at Genoa. The French cruiser Bayard has left Torraine for Haiphong. The French cruiser Roland has arrived at Vera Cruz. The French cruiser Fulton has arrived at Port-au-Prince. The French cruiser Cosmao has arrived at Lattakieh. The Cosmao and the Lixois will shortly return to Toulon.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Little change is this week noticeable in the condition of business, but the market mostly rules healthy. Generally speaking, sheets are still selling at the former values, with £6 15s. as a basis for singles, £6 17s. 6d. to £7 for doubles, and £7 15s. to £8 for lattens, and the belief is that the proposed starting of new works will not much affect current market values. New proprietors will, however, themselves be naturally prepared to make some concessions in order to get business. Prices are pretty well upheld at £8 2s. 6d. for trunk sheets of 24 W.G. cold rolled and close annealed, and £8 17s. 6d. for the same sheets of 26 and 27 gauge. A large demand is reported for this class of iron, some consumers being hardly able to get sufficient supplies with the needed rapidity. Bucket sheets are quoted £7 5s. for doubles, and £8 to £8 5s. for sheets of 28 gauge made in this district. A large inquiry is expressed for thin sheets for gear-case making by the Birmingham cycle firms, who are just now extremely busy. Prominent among the materials offered for the purpose are Welsh black plates of steel about 26 W.G., which are quoted £9 10s. per ton. The material is pickled, cold rolled, and close annealed, the pickling process removing every bit of scale and rendering the sheets some of the best in the market.

Common bars are quoted at £5 12s. 6d., and although £5 10s. is occasionally heard of, it is said that this low quotation is usually for specially favourable specifications, and for large tonnages necessitating little or no change of machinery. Merchant bars keep at £6 5s. to £6 10s., and best bars at £7.

The demand for pig iron is steadily upheld, sellers declaring that principals are well booked forward to the end of the quarter, and that they do not care to make further immediate sales of much size. Forge pig iron is quoted at 55s., 42s. to 43s., and 36s. 6d. to 37s. 6d. for all mine, part mine, and common sorts respectively, while Northampton and Derbyshire metal is 42s. to 43s. respectively nominal, with 1s. concession to good buyers.

"A Bill to Amend the Chain Cables and Anchor Acts of 1864, 1871, and 1874." This is the title of a Bill which Sir Benjamin Hingley, M.P., has drawn up dealing with the prevention of the issue of false certificates as to the testing of shipping chains; and he and Sir Alfred Hickman, M.P., will do their best to get it passed into law. If it becomes law it will in a great measure protect the public from fraud, and will leave buyers and users of chains the option of taking private or public tests as they may desire. This is the outcome of the bogus certificate agitation to which I have made reference in previous letters. It is admitted that hoisting and crane chains are just as dangerous, if not properly tested, as shipping chains, but the promoters feared that if all kinds of chains were included, no legislation could be obtained, hence they have restricted themselves to shipping chains.

The employers in the Birmingham metal rolling trade are soliciting the operatives' alliance in the new trades combination movement, and two-thirds of them are prepared to grant a 10 per cent. bonus to the workpeople as soon as it is found practicable to advance selling prices, a further condition being that 5 per cent. of the amount shall remain as a fixed increase, unaffected by any subsequent rise or fall of prices. The projected alliance would embrace about 5000 operatives. The Case or Bedstead Tube Makers' Association have already entered into a similar alliance with their workmen, and a Wages Board is to be formed on which employers and men will have an equal representation.

At the annual meeting of the Patent Nut and Bolt Company on Tuesday, when a 10 per cent. dividend was declared, the chairman—Mr. Arthur Keen—announced that the reserve fund had now been brought up to £100,000, which, having regard to all possible eventualities, he considered a matter of great importance. The shareholders would no doubt expect him to say something with regard to the conditions and prospects of trade, but he did not think it would be wise for him to prophesy or speak too confidently concerning the future. He might say, however, that at the moment there was an improvement, but the future course of that movement it was impossible at present to foresee.

Gasometer builders, and makers of other gas-producing and storing plant, may be interested in the annual address of the President—Mr. W. N. Cooper—of the Midland Association of Gas Managers, at its nineteenth annual meeting. He urged that it was the duty of gas managers to supply good and pure gas, and to exercise the greatest economy consistent with efficiency. They should also aim at manufacturing it in such a way as to cause the least possible annoyance to their neighbours, remarking that gasworks need not be an intolerable nuisance. He was of opinion that the electric light would not greatly interfere with the advancement of the gas industry. The manufacture of coal gas continued to make steady progress, and they need not oppose electricity, but let it steadily go on. Electricity would be used in certain spheres without doubt.

The death is announced, at the age of sixty-eight, of Mr. Charles Vernon, member of the firm of Messrs. Jones, Vernon, and Holden, of the Sandwell Iron and Axle Works, Smethwick. The deceased gentleman, before his association with the firm, was one of the leading engineers in South Staffordshire, and was proprietor of the Vulcan Engineering Works, West Bromwich.

The Wolverhampton Corporation are desirous of obtaining powers from the Local Government Board to borrow between £15,000 and £16,000 towards the cost—estimated at £30,000—of providing an additional source of water supply to the borough, by sinking an additional artesian well and laying down additional works and two powerful engines upon the site. At an inquiry this week, before the Local Government Board Inspector, it was stated that the area of the water district was about sixty-four square miles, with a population of 160,000. Borrowing powers are also sought for the introduction of the waste water sanitary system into the borough in place of the present pan system.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—As indicated last week, there is a slackening off in the weight of business just now coming forward, but although the push of buying which has recently been so marked a feature would seem for the present to be over, a strong and healthy tone continues, and both makers and manufacturers are for the most part so heavily sold that they are in a position to wait, and are not at all disposed to entertain offers at anything under their full list rates; some of them, in fact, being quite indifferent about selling further at all, the prevalent belief being that prices will be still higher as the year advances. Only a moderate business was reported on the Manchester Iron Exchange on Tuesday, but there was a very firm tone as regards prices both for raw and manifold material. Local brands of pig iron remain at about late quotations. Some moderate orders have been booked for district brands, and in Lincolnshire iron from 3d. to 6d. over minimum list rates is being got—forge qualities, delivered in the principal Lancashire finished iron-making centres, having been sold on the basis of 36s. 10d. at the works, and about 43s. net cash, delivered Warrington, whilst for foundry brands nothing under 44s. 6d. net cash is now being taken, for delivery Manchester district, with Derbyshire foundry averaging 47s. to 47s. 6d. net cash, delivered here. In Middlesbrough iron, makers decline to book at anything under 47s. 4d. for special foundry brands, with G.M.B.'s obtainable at about 46s. 10d. net cash, delivered Manchester, and Eglinton averages 47s. 6d. to 47s. 9d. net prompt cash, delivered Lancashire ports.

In finished iron, although local makers are scarcely selling readily at their late advance upon bars, enough business is coming forward to replace orders that are being worked off, and local makers are not disposed to entertain offers at anything below £5 12s. 6d., delivered Manchester district. In sheets and hoops there is a fair business doing at late rates.

In the steel trade there is a continued strong hardening tendency. Good foundry hematites are firm at 57s. 6d. to 58s. 6d., less 2½; steel boiler plates are not quoted under £6 7s. 6d., and in manufactured steel the recent upward movement in raw material will in all probability be followed by an official advance upon bars, angles, &c., which, I understand, will in any case not be less than 2s. 6d. per ton, and which, when it comes into operation, will represent an advance of something like 7s. 6d. to 10s. per ton upon the minimum quotations which were ruling only a very short time back.

Inquiries in the metal market have fallen off considerably during the past week, consumers holding back from placing further orders except for the merest hand-to-mouth requirements, apparently in the belief that the present prices are too high. With, however, the continued steady hardening in raw material, any downward move in manufactured goods would certainly seem to be altogether improbable, and makers are very firm at their full list rates.

All branches of the engineering trade are maintaining a steady improvement, the reports I receive with regard to new work coming forward being highly satisfactory, and in most cases establishments, with very few exceptions, are well supplied with orders. These are coming from all quarters of the globe, and one leading machine tool maker mentioned as an illustration that one of the first letters he opened the other day was an order for machine tools for railway requirements at Uganda, one of the most recent of the opened-up portions of Africa.

Some time back I referred to the fact that to a considerable extent the shipment of pig iron into this district is being gradually transferred from the ports on the Mersey to the Manchester Ship Canal, and this business has of late been developed with remarkable activity, numerous cargoes coming by the Ship Canal from Scotland, Cumberland, and the Cleveland district. Since the beginning of last month nearly fifty cargoes of pig iron, steel bars, &c., have been discharged in the canal, nine cargoes arriving last week from Glasgow, Ardrossan, Bowling, Barrow, Harrington, Millom, Ulverston, and Whitehaven, and the neighbourhood of the Manchester Dock Quays is becoming an important store for pig iron, from which the requirements of the district can be supplied.

At a meeting of the Northern Society of Electrical Engineers, held on Monday in Manchester, Mr. H. Lindley, of Messrs. Browett and Lindley, Patricroft, read an interesting paper on the development of electric lighting engines. Whilst not attempting to discuss the advantages or objections to slow or high-speed engines, he observed that although *per se* slow speed had certainly obvious objections, for some reason or other slow-speed engines were to-day still much used for driving high-speed electric-lighting machinery. It was not difficult to find a reason in the fact that it was in the nature of a legacy from past ages. The up-to-date Lancashire mill engine entered the field of electric lighting almost completely prepared for the work; the only objection was that in the early days of electric lighting it was rather too big, and as there were not many large installations requiring to be driven, it soon became evident that the newly opened-out field of electric lighting was likely to require the services of a large number of small sized steam engines. This led to the birth of the modern moderate speed engines, and in these special features had, of course, to be introduced; firstly, the stroke wanted shortening, then the bearings wanted increasing before a correct proportion was obtained. Lubrication also became an important question, the large number of wick and screw adjustment oilers being replaced by a central oil box, with a pipe to each important bearing, and having a sight drop arrangement, whilst by a still more perfect method a crank-pin or main bearing could be made to run absolutely noiselessly even though the brasses were considerably worn. Another important detail that led to the success of the modern moderate speed engine was the use of white metal in the bearings, without which not only the engines referred to, but the fast running engines of to-day, including marine and locomotive engines, would be almost impossible. There were also various improvements in the fastenings about the engine, and his firm had abolished lock-nuts, except on main bearings, and used more secure devices in their place. The valves might be either of the flat or piston type, but he was expecting that good results could be secured by a valve having steam expanded rings for main pistons. With regard to the steam chest and cylinder cover joints, these should be made metal to metal, scraped and ground together, and any more jointing material than boiled oil should be dispensed with. On the question of governing, Mr. Lindley suggested that a shaft governor be used, altering the angular lead and throw of the excentric, so as to vary the cut-off and compression. In conclusion, the author observed that as the term "high speed" was a relative one, and if it was desirable to attain speeds in the engines corresponding to those in the dynamos, why was it that the highest speeds to-day did not exceed 500 revolutions? It was not because dynamos could not be made to run faster than this, as faster speeds were possible, but one reason appeared to be that the centrifugal strain imposed a limit on the speed, and it was, therefore, not likely any great increase of speed would be attained in engines of the class considered or where there was rubbing contact.

Mr. J. G. Stewart, of Glasgow, read before the members of the Manchester Association of Engineers, on Saturday, a paper on "Welded Steel Mains and Joints." Steel pipes for waterworks purposes to withstand working pressures of 500ft. head had, he said, been supplied from 12in. diameter of no greater thickness than No. 12 wire gauge, weighing for a 12in. pipe no more than 39 lb. per yard, as compared with the weight of a 12in. light cast iron pipe of 247 lb. per yard; 25in. pipes had been made $\frac{3}{16}$in. thick, with a weight of 132 lb., as against 784 lb. for the lightest cast iron pipe. Engineers were slowly giving more consideration to steel for steam pipes, and where they had been used he did not hear of any dissatisfaction with the results. The difficulty of keeping steam pipes free from condensed water and providing properly for expansion, suggested that more attention should be given to the designing of steam lines than heretofore. Sliding expansions were seldom required with steel pipes, as a steel pipe line with only a few bends was far too flexible, and an unduly great vibration was set up. Steel suitable for welding, and capable of withstanding free heating, could be produced at little more cost than the ordinary boiler plate, and could be welded so as to show at the weld an average strength equal to the rest of the tube. With reference to tests, engineers would do well to test only strips cut from the finished pipes, which ought to satisfy an ultimate tensile test of 21 to 26 tons and an elongation of 20 per cent. When less than ¼in. thick, the strength should be about a ton greater, whilst other tests should also be applied. A high hydraulic pressure might be applied to each pipe, and while this was done the pipe should be subjected to percussive stress by heavy hammering upon the welded part from end to end. Steel pipes formed out of the solid would appear, on the face of it, to offer the best possible pipe for withstanding pressures, but the difficulty of making large pipes without welding had scarcely been overcome, and the small weldless pipes were not of any better quality than welded ones. So far as his experience went, weldless tubes were less reliable and had no real advantage, as at present made, and the cost of even the small sizes was not low enough to enable them to be used for most of the ordinary purposes to which welded tubes were applied, whilst, as the quality of the latter had been greatly improved there would appear to be no inducement to pay the much larger price asked for weldless tubes.

With regard to the form of joint to be used for connecting steel pipes, Mr. Stewart observed that this depended upon whether the joint was to be permanent or temporary, and upon the pressure and nature of the stresses to which the joint was to be subjected. A light and simple form of joint for the most moderate pressures was made by bulging and turning over the end of the pipe to form the flange, and for the highest pressures a steel or iron flange welded on to the end of the pipe was used. A form of joint which, although used sometimes for temporary purposes, was more generally permanent, was the connecting together of pipes with screwed sockets, which had been made for sizes up to 30in., but the labour involved in putting together these large pipes by this kind of joint made it difficult to see how it could be advantageously used as a removable joint. Amongst permanent joints was the collar joint for water mains formed by a rolled and welded steel collar, enclosing a certain length of the ends of the two pipes to be joined, with a space between the collar and the pipe, which was filled with lead. The patent inserted lead joint, formed by bulging one end of the pipe so as to hold the other or spigot end of the neighbouring pipe, was an improvement upon the one previously described, as it had only one joint. It was very generally used for water pipes, as the joints could be formed very rapidly, whilst it provided for elasticity, and allowed for expansion and movement of the pipe, with scarcely any leakage. The only other form of permanent joint was by riveting the pipes together, either by making them conical or telescopic, but as it involved more labour and time in making the joint it was not generally so suitable as the other methods. Riveted-on steel flanges, with inside riveting flush so as to offer no resistance to water flow, had been used for mining mains. Generally speaking, for hydraulic pressure, the welded-on or screwed-on flanges were most suitable; for steam, these flanges, with the addition of those containing the flanges formed from the tube; for water, where the pipes have to be removed, the steel flanges and stamped rings, or cast steel flanges riveted on, were generally used; and for permanent purposes the lead joint, with the socket pressed from the solid pipe, was most suitable.

In the discussion which followed, Mr. Saxon said he thought there was a very large field for the use of these wrought iron or steel pipes in connection with gas mains. Mr. O. M. Row remarked that corrosion seemed to be one of the greatest objections to steel. Mr. Webb considered that steel was the right material for pipes, whether weldless or welded. Mr. Bates referred to the Belleville boilers as an instance of the use of screwed-on flanges, which he maintained were as good as the welded flanges, and Mr. Brown said be had seen screwed flanges used with very satisfactory results in America. The president, Mr. J. Nasmith, referred to the importance of testing the weld in pipes. With regard to the question of whether to use solid or welded pipes, there was no doubt that if properly made there was no diminution of tensile strength at the point where the weld was made, whilst the question of cost was in favour of welded pipes. Mr. Stewart, in reply, said there was no doubt steel would corrode more rapidly than iron, but the difference was not great. With respect to solid drawn tubes, they were all right for small sizes, but it would be a long while before they would become a commercial article for large sizes.

The coal trade is still without appreciable improvement. House coals have brisked up slightly with the more seasonable weather, but other descriptions continue a drug and are very low in price, with pits in many cases only working four days per week. Pit prices remain at about late quotations, but the lower sorts of fuel are weak and irregular owing to surplus lots being pushed for sale in the open market.

The demand for shipment is slow, with common steam coal, delivered Mersey ports, obtainable at 6s. 9d. to 7s. per ton.

Barrow.—A good business has been done during the week in hematite qualities of pig iron, and the market continues to show life and permanence. Supplies required by users are increasing on home as well as on foreign account, and there is a marked increase in the consumption of Bessemer iron by makers of steel, local and otherwise. Prices this week are steady at 48s. 6d. net cash, sellers of warrant iron, and 48s. 5d., buyers, while makers are quoting 49s. to 50s. net, f.o.b., for mixed Bessemer numbers. The increased make of iron has been required to meet delivery engagements.

Iron ore sells better than it did. There is a greater consumption, but of course the large importation of foreign ores swallows up much of this. Ordinary native qualities are quoted at 10s. per ton net at mines, and Spanish at 12s. 9d., delivered at West Coast ports.

Steel makers are very busily employed, and there is very marked activity at the rail mills and at the plate mills, orders for both these departments being well booked forward, and the demand is still very well maintained. The trade in tin bars has fallen off, but activity is noticeable in heavy steel castings, sleepers, hoops, and billets. Prospects in the steel trade are very good, and it is confidently expected from present indications that a very busy year will be experienced.

Shipbuilders and engineers are expecting new orders, but on commercial account there is at present a very poor prospect, as the orders finding favour with owners are at a price which allows no margin of profit to the builder and places him in an undesirable position, in view of the probability of an advance in wages being demanded by the men.

Mr. A. Blechynden, late engineering manager for the Naval Construction and Armaments Company, has been appointed manager of the engineering works of Messrs. John Penn and Co., London.

The coal and coke trades are busier and supplies are fuller, while prices are a trifle higher.

There are 38 furnaces in blast, as compared with 23 in the corresponding week of last year. Stocks have been decreased during the week by 165 tons.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE South Yorkshire coal trade remains in pretty much the same condition. Although the long-continued mild weather materially affected the demand for house fuel, and caused stocks to accumulate, a sudden frost has set in, which, while I write, promises to assist the holders of heavy quantities. Should the change last for another fortnight values might go up a point. Taking coal all round, the actual tonnage disposed of is not much below the average at this season of the year. It must be taken into account, however, that during the last few years there have been very large additions to the number of collieries, and these are continually being augmented. This, of course, makes competition excessively keen, and, combined with the small number of working days, tells against values. The pits are only employed three days a week, although in a few exceptional cases four days can be made. Strikes and threatened strikes are too many. In various cases these are at local collieries which do a large trade with Hull. Only a very moderate tonnage of Barnsley house and Silkstone coal is being forwarded to London, and very discouraging reports are coming in from agents in the metropolis. A similar remark applies to the eastern counties as well as other markets. Depression gets deeper among the thin seam colliery owners. Thick seam coal can be procured at such low rates that manufacturers of the thin qualities find it extremely difficult to find buyers. The competition of sea-borne coal is telling very hard at the present time. Quotations remain as reported a week ago. Best Silkstone. 8s. to 9s. 6d.; ordinary, 6s. 9d. per ton; Barnsley house, 7s. to 8s.; with Flockton at 6s. 9d. to 7s. 6d. per ton. Thin seam fuel can be purchased as low as 6s. per ton. The steam coal trade is fairly active. The leading collieries producing thick seam qualities are transacting a moderate business with Hull. Only a quiet trade exists with Grimsby, owing to the monopoly by Derbyshire coalowners of the business from that port. Goole is supplied by West Riding pits, although a small trade is done by local owners. Gas coal is not in such large request, and offers of producers show too clearly that stocks are existing at many pits. This quality of coal is procurable at 6s. to 7s. per ton, with slight concessions to large purchasers. Manufacturing fuel remains in very much the same condition, while the coke trade is stationary. Derbyshire is taking an average supply, with an increased request from North Lincolnshire, which is due to the blowing-in of another furnace. Values range from 8s. to 9s. per ton.

The Bolsover Colliery Company, Derbyshire, reached coal at Cresswell, within sight of the Dukery District at Welbeck, on the 24th inst. The seam was the top hard, which was found to be 5ft. 11in. thick, and of excellent quality. It was won at a depth of 445ft. The sinking operations have been conducted without the slightest accident. It is expected that this colliery will be one of the largest in the Midland coalfield, if not in the country, and will be equipped to raise some 3000 tons per day when in full operation.

The heavy industries continue to maintain the steady business reported a few weeks ago. The iron market is firm, with a very slight decrease in the number of sales. This is due to purchasers having secured supplies for some little time to come, and not feeling equal to buying further ahead. Quotations for hematites are as follows:—West Coast qualities, 56s. to 57s.; East Coast, 54s. to 55s. There is no change to mention in the values of Lincolnshire and Derbyshire irons. Scrap iron is in increased demand, with prices 2s. to 2s. 6d. per ton higher than a week ago. Manufacturers of English girders for building purposes are obtaining an advance of 5s. per ton on last month's quotations. Many Belgian girders are still being received. Bessemer steel is in excellent request for use in the local trades, prices ruling from £5 12s. 6d. to £6 per ton. Many of the leading firms are well booked forward at these rates.

The increased use of Siemens-Martin steel, noted some months ago, still continues—it is selling at £7 10s. per ton. Firms producing Swedish Bessemer are exceedingly busy, the difficulty being to obtain sufficient quantities of material from Sweden to cope with the demand. All the departments producing war material are very well employed. Business is done both night and day, and on Sunday repairs and renewals are looked after. Railway material has been further ordered in large quantities both from home and abroad. Encouraging reports are coming in from the engineering and moulding departments, while further requirements have been placed for both machinery and castings. Full time is being worked in all the departments.

The condition of the lighter industries is a long way behind that of the heavy trades. Another lull has to be reported, while orders from home and abroad have not come forward in such large quantities as anticipated. Manufacturers of cutlery and white metal have some very good orders on hand, mainly for abroad, while at other houses business is very limited. Trade with America exhibits no improvement, and orders at present coming in are for very small quantities. The improvement noted last quarter has now ceased, and it is the opinion of many houses, both English and American, that no change will take place till after the presidential election next November. This is usually the unwelcome feature of the year when that event takes place, and it will be more apparent than ever this year.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THAT trade is improving steadily all round cannot be doubted, as there is incontrovertible evidence of this in the activity of the various works, the smaller number of the unemployed, the blowing in of more blast furnaces, and the re-opening of finished ironworks which have long been closed on account of the depression. It is years since manufacturers spoke so cheerfully about their business, and, judging from the orders booked, full work is assured for several months to come, even if it should happen that no more were secured. In the engineering industries the advent of the revival was delayed long after it made its appearance in the iron trade, but the improvement has progressed quickly during the last few weeks, and now establishments which were very irregularly occupied when the year opened are really busy.

Some firms are so well supplied with orders that they have had to refuse contracts which they would have welcomed two or three months ago, as they saw no prospect of executing them within the required time. One of the leading Tees-side engineering firms has booked orders which will keep their establishment fully occupied till next November. So far, however, there has been but little improvement in prices, as competition has been so keen; but as the engineers are getting their order books well filled, they will shortly be able to stand out for higher prices. At present they have to take what barely covers cost of production.

With respect to the re-opening of idle ironworks, it was reported last week that the Bowesfield and Richmond Ironworks, at Stockton, were to re-commence operation, and now it is stated that the West Stockton Ironworks are to be re-started. They are in any case to be offered for sale by public auction, on March 28th; but the report is that Lieut.-Colonel Ropner is negotiating privately for the purchase of the concern, so that he may make the plates he requires for his shipyard. The concern, which had thirty-three puddling furnaces and made some 500 tons of puddled iron weekly, was closed in December, 1892, and has been under the care of the Court of Chancery. Their chief production consisted of iron plates; but it is not probable that when re-opened that will be so, because there is so small a demand for iron plates, and it may be expected that they will be devoted to the manufacture of steel plates, in which case the steel ingots would have to be bought from neighbouring works. There is, however, plenty of room in which to put Siemens furnaces, even if the old puddling furnaces are not pulled down. Mr. Ropner is one of the largest shipowners in the country, and also one of the leading shipbuilders, for last year he came third in the United Kingdom in regard to the amount of tonnage launched.

The pig iron makers are doing a fair business, and there is a large inquiry for iron for spring delivery. Iron for prompt delivery is rather more plentiful, but this is usually the case towards the end of a month, when some of the speculators are obliged to sell. Less Cleveland iron is going into Connal's public warrant stores than has been the case for some months. On Wednesday night Messrs. Connal had 184,190 tons, and the increase for the month has only been 3397 tons, whereas in February the increase was 9093 tons, and in December 15,352 tons. The estimate with respect to the total stocks of Cleveland pig iron in the district is that there will be an increase of about 20,000 tons this month, notwithstanding the good shipments and the active inland consumption. Last month the production exceeded the consumption by 26,000 tons, and in December by 34,388 tons, but the output this month has been increased.

The price of No. 3 Cleveland G.M.B. pig iron for prompt f.o.b. delivery is 38s., but for delivery over the spring months not less than 38s. 6d. will be accepted by the makers, and they can obtain that for most brands. The price of No. 1 Cleveland pig iron is 39s.; No. 4 foundry, 37s.; grey forge, 36s. 6d.; mottled, 36s.; and white, 35s. 6d. per ton, all for early delivery, with 6d. more for forward. For M. Nos. of Cleveland hematite pig iron, 47s. is quoted by the makers for early delivery, but 47s. 6d. is their price for spring delivery. Some merchants, however, early this week sold small lots for prompt delivery at 46s. 6d., but that would not be taken now. Rubio ore is dearer, some large sales having been made in Spain; indeed, one line alone was said to be for 700,000 tons.

The demand for finished iron and steel continues to show a very satisfactory improvement, and prices are exceedingly firm. The chief British steel rail makers have formed a combination to regulate prices, and their figure for heavy steel rails is £4 15s. net at works. Inquiries for rails are very numerous, especially from India, and British companies are also purchasing more freely. There is also an active demand for bridge work, rolling stock, &c., and the manufacturers thereof have every prospect of an active year. The North-Eastern Railway Company's Wagon Works at Shildon are to be considerably extended, and Messrs. Bellerby and Rhodes, of York and Leeds, will construct the necessary buildings. For steel ship plates the demand is excellent, and there is full employment at nearly all the works. The present price of steel ship plates is £5 2s. 6d.; steel boiler plates, £6 2s. 6d.; sheet girder plates, £5 7s. 6d.; steel ship angles, £5; iron ship plates, £5; iron ship angles, £4 15s.; iron sheets, singles, £7; iron sheets, doubles, £7 10s., all less 2½ per cent., f.o.t. Messrs. Furness, Withy, and Co., at Middleton Shipyard, West Hartlepool, are about to enlarge their yard, so that they may be able to construct the largest types of vessels now afloat.

The Executive Council of the Cleveland Miners' Association, at an interview with their employers at Middlesbrough on Monday, claimed for the deputies an advance of wages, on the ground that their wages fell short of those of the miners. As it was made clear that such was not the case, the claim was withdrawn. The mineowners decided to reduce the price of squibs to the miners.

A further step in reference to the transference of the Tees-side Iron and Engine Works, Middlesbrough, to Sir Christopher Furness is to be taken next Monday, when an extraordinary general meeting of the shareholders is to be held at the offices at Middlesbrough "for the purpose of receiving a report from the directors as to the sale of the undertaking to Sir C. Furness, in consideration of his undertaking all the debts and liabilities of the company, and agreeing either to issue to the company certain fully paid-up preference shares in any new company promoted by him to work any portion of the company's property or to make a cash payment to the company, and to pass a resolution approving an agreement already made by the directors for effectuating such sale."

The North Bitchburn Coal Company has at its Randolph Colliery, between Bishop Auckland and Crook, had sixty coke ovens constructed of the Coppie type. But before deciding upon the kind of oven to be adopted, quantities of the coal intended to be used, and which contains 32·5 to 34 per cent. of volatile matter, and therefore requires great heat to coke it, were tried at one of Messrs. Bolckow, Vaughan and Co.'s collieries, where the same class of ovens were in use, and the results proved very satisfactory, a coke of good quality, hard, and bright in appearance, and containing only 1·3 per cent. to 1·8 per cent. of moisture being produced. The old Beehive oven, which was formerly exclusively employed in coke making, is being steadily superseded by the newer forms of ovens, as they can utilise classes of coal which are not suitable for coke making by the old process. At some places the by-products are recovered, but at the Randolph Colliery this is not the case, but the waste gases are utilised for firing six Lancashire boilers for raising steam at the colliery. The Coppie ovens are 30ft. long by 6ft. 6in. to the spring of the arch, and 2ft. wide in the middle of the oven, but each oven has a taper of 2in., the oven being wider at the front than at the back to allow the coke to be more easily pushed out. The sixty ovens are divided into three blocks of twenty ovens each. The cold air is taken first to longitudinal arches running under the entire length of the three blocks. From the longitudinal arches, the air, after having travelled under the entire length of each block, rises upwards to meet a series of cross and longitudinal flues placed on the top of the longitudinal arches. Here again the air travels under the entire surface of the block. The object of the cold air travelling in this way under the ovens is two-fold: Firstly, the cold air cools the foundations; and secondly, it is heated before being used in the ovens, and thus adds to the heat in them. The ovens are worked in pairs, and when one is in full operation, the other is being recharged. The coal for coking is delivered into four bunkers capable of storing 250 tons of coal, but this capacity is being doubled. The water for cooling the coke is pumped direct from the pit into three large tanks placed 60ft. above the coke oven bank. These tanks are capable of storing 23,000 gallons, which is sufficient to coal a day's make of coke—125 to 135 tons. Each oven burns a charge of about 7 tons in 48 hours and gives a yield of 64 to 65 per cent.

The coal trade continues depressed, more especially the steam coal branch, but the coke trade is improving, the blowing in of additional furnaces in the North-east and North-west of England having increased the consumption, while at the same time the output has been lessened, and coke is now really scarce. Manufacturers have, therefore, put up their prices this week 3d., and in some cases 6d. per ton.

The graduates of the North-East Coast Institution of Engineers and Shipbuilders paid a visit to the shipbuilding yards of Messrs. C. S. Swan and Hunter, at Wallsend-on-Tyne. Mr. G. B. Hunter, chairman of the directors, welcomed the visitors, and at the conclusion of the inspection stated that it was possible that what they had seen that day might form the subject matter of a paper at one of the meetings of their Institution.

NOTES FROM SCOTLAND.

From our own Correspondent.)

THERE has been considerable activity in the Glasgow pig iron warrant market this week. At first the market was somewhat flat, but on good reports being circulated as to shipments and the general state of trade, an improvement set in, the prices rising about 3d. per ton all round. Scotch warrants sold in considerable quantity from 46s. 11½d. to 47s. 5d. cash, and 47s. 3½d. to 47s. 7d. one month. The prices of Cleveland warrants were from 38s. 2d. to 38s. 4d. cash, and 38s. 3½d. to 38s. 6d. one month, only a moderate business being done. For hematite warrants the demand was moderate, at from 48s. 6½d. to 48s. 8½d. cash, and 48s. 9½d. to 49s. one month. A good proportion of the business was for one month, and this is held to be a favourable omen regarding the future of the market. The improvement in the pig iron shipments is encouraging, but it would have more weight in producing a favourable effect if the increase were to occur in the foreign department of the business. It is noticeable that the past week's increase has arisen in the coastwise shipments. Brokers report that there is not much demand at the moment for pig iron warrants on the part of outsiders.

The stocks of pig iron have been slightly on the increase. About 800 tons were in the course of the past week added to the stock in Connal and Co.'s Glasgow stores, but the total stocks there are still 60,000 tons less than at this time last year, and they are much lighter in the aggregate than they have often been in former years. It is considered doubtful whether makers' private stocks of pig iron are in reality increasing, and if there is an increase it must be of small importance. The output of hematite pig iron in Scotland is, in proportion to that of ordinary iron, much larger than in previous years, this being, of course, a result of the great expansion in the steel trade. There are 35 furnaces producing hematite, against 26 this time last year, while the number making ordinary iron is 41, compared with 43 in 1895. In Scotland altogether there are 79 furnaces blowing, against 73 at this time last year.

The prices of Scotch makers' pig iron are steady. G.M.B., f.o.b. at Glasgow, No. 1, is quoted 48s.; No. 3, 46s. 6d.; Govan, Monkland, and Carnbroe, No. 3, 46s. 6d.; Clyde, No. 1, 50s. 6d.; No. 3, 46s. 6d.; Gartsherrie, Calder, and Summerlee, No. 1, 51s.; No. 3, 48s. 6d.; Coltness, No. 1, 53s. 6d.; No. 3, 49s.; Glengarnock, at Ardrossan, No. 1, 50s. 6d.; No. 3, 46s. 6d.; Eglinton, No. 1, 48s. 6d.; No. 3, 46s. 6d.; Dalmellington, at Ayr, No. 1, 48s.; No. 3, 46s.; Shotts, at Leith, No. 1, 53s.; No. 3, 49s.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 49s.

The shipments of pig iron from Scottish ports in the past week were 7332 tons, compared with 3234 in the same week of last year. Of the total there was despatched to Italy 315 tons; India, 161; United States, 130; Australia, 25; France, 55; Germany, 30; Holland, 210; Belgium, 40; China and Japan, 116; other countries, 627; the coastwise shipments being 5623 tons, compared with 2499 in the corresponding week of last year.

The finished iron trade is busier, the demand having, if anything, improved since the increase of prices that took place ten days ago. The chief demand is for the home department of the trade, but a fair inquiry is also reported for shipment, and this is expected to increase with the advance of the season. There is great activity in the steel trade, the works being generally employed to the extent of their capacity, and the prospect is that they will have a prolonged season of busy trade.

In the different departments of the engineering trade a great amount of work is available, and the position of matters is better and more hopeful than for a long time past. The foundry trades are also becoming busier.

The coal trade shows no improvement, for while the shipments are a little better than of late, the output is much greater than can be disposed of, so that the market is very heavy. The past week's coal shipments from the various ports aggregated 121,291 tons, compared with 106,455 in the preceding week, and 94,526 in the corresponding week of last year. At the Firth of Forth ports a considerable improvement has taken place, and the clearances at Glasgow were above the average. All over, the coal trade is in a most unsatisfactory state. It is impossible to obtain prices that are remunerative, rates at the ports, indeed, tending lower than formerly. The colliers' wages are being gradually reduced, and a great deal of dissatisfaction is felt in consequence among the men, whose leaders are beginning to urge that efforts should be made to restrict the output, and so steady, if not raise, the prices. There can be no doubt that the miners are now suffering from the evil effects of their own conduct in the last strike, which was the means of the masters losing their principal continental contracts. The coals that used to be carried away under these contracts are now being thrown on the open market, and this is the main cause of the present depression.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

LAST week was a brisk one all around in the steam coal trade, and particularly so at Cardiff, where the total coal exports amounted to 320,000 tons. This week again promises to afford a large total, though at the present time several important collieries are idle. A few large coal contracts have again been entered into, but one of these will only affect the last half of the year. A number of large tonnages continue to go to coaling stations, Port Said in particular, and this week an exceptional steamer of 5000 tons left for Rio de Janeiro.

Swansea coal shipments last week included 4750 tons of anthracite and coke for San Francisco. The exports have been small of tin plates, almost the lowest that has been recorded, not a solitary vessel having traded for America. This week promises to yield a contrast in that respect, four being expected in for New York, Baltimore, and New Orleans, and one each for Cadiz, Hamburg, Cette, Genoa, Lisbon, Nantes, and Bordeaux.

Newport iron coal exports have been a good average, and this week 350 tons railway wagon work left for Buenos Ayres.

With regard to prices, there has been little or no change, only mid-week on 'Change they were characterised by a firmer tone for prompt and early shipment. Latest prices are, best steam, 10s. 3d. to 10s. 6d. Seconds are favourably regarded at from 9s. 6d. to 10s.—always a good sign when prices run so closely to best. Drys are moderately enquired for at 9s. 3d. to 9s. 9d. This kind is rather inactive. Small coal is in slightly improved demand at prices varying according to the quality from 3s. 6d. to 4s. 6d. House coal has exhibited no spurt of late, prices remain at 10s. 6d. to 10s. 9d. for best; No. 3 Rhondda, 9s. 6d. to 9s. 9d.; brush, 7s. 9d. to 8s.; small, 6s. to 6s. 3s.; No. 2 Rhondda, 7s. 6d. to 7s. 9d.; through, 6s. 3d.; small, 4s. 3d. Swansea prices are as follows: best steam, 9s. 6d. to 10s. 3d.; seconds, 8s. 9d. to 9s. 3d.; bunkers, 7s. to 9s.: small, 4s. 3d. to 4s. 6d.; bituminous coal, No. 3 Rhondda, 10s. to 10s. 6d.; through, 8s. 3d. to 8s. 9d.; small, 6s. 3d. to 6s. 6d.; No. 2 Rhondda, 8s. 9s. to 9s. 6d.; through, 7s. to 7s. 9d.; small, 5s. to 5s. 6d.

Glasbrook Brothers, who from time to time have been identified with many coal winnings, again came under notice this week by successful sinking in the neighbourhood of Cadoxton-juxta, Neath. Coal was reached of good quality 135 yards below the surface. The stoppage of the Plymouth collieries continues. This is now running into the fourth week, and amongst the improvident destitution is beginning to prevail. Soup kitchens have been started for the children, and local effort is busy in that direction, and District Council work has been found for about 200 of the men.

A dispute exists at Porth, affecting 800 men.

The verdict of the jury on the Tylerstown explosion singularly fulfils the prediction I ventured to make last week, that in all probability in this, as in many other cases, the secret of the explosion was with the dead. After a very long and able inquiry, in which Coroner Rhys displayed his thorough acquaintance with colliery matters, and a specially adapted mind for such investigations, the jury returned on Tuesday the following verdict:—"We are of opinion that the cause of the explosion was the firing of a shot in gas, in Daniel Williams's stall in No. 8 pit, and that the air passing through the fall was charged with gas, and probably came in contact with the flame of gas in Daniel Williams's stall, and the explosion was accelerated by coal dust. We are also of opinion that no one living is responsible for the explosion."

At the meeting of the Cambrian Association held on Monday at Pontypridd, the Tylerstown disaster was the subject of a good deal of comment. The chairman, Mr. Jenkins, remarked that it was very unfortunate in these days of progress that dreadful explosions should take place so often, and he thought that the efforts of their Association should be directed towards minimising them as much as possible. The point of his concluding remarks seemed to be a reflection somewhat upon the Home Secretary, in connection with the appointment of sub-inspectors.

In the course of the meeting the subject of the Discharge Note System was discussed, and since the meeting was held rather an alarming condition of things has been brought about.

On Tuesday a meeting of the workmen's representatives on the sliding scale took place in Cardiff, Alderman Dr. Morgan in the chair. The chief subject of discussion was the Colliers' Discharge Notes question, and a joint conference with the coalowners' representatives was suggested; and the opinion of the leaders appeared to be, that if refused, an open conference of the colliery workmen of South Wales and Monmouthshire will be held at an early date. The opinion of the principal members is, that as the introduction of these notes is a violation of the sliding scale, it may be necessary, if persisted in, to direct a general stoppage. There is a grain of comfort in this, for if proved to be a "violation," the Sliding Scale Committee may be expected to prevent the introduction.

I referred a little time ago to the fact that two important collieries in the Aberdare district had stopped. These were the Aberdare Merthyr and the Nantmelyn Hirwain, employing nearly 700 men. A few weeks ago a liquidator was appointed, and the collieries kept open in the hope of a reconstruction of the company. On Friday last a notice, signed by the liquidators, was posted at the collieries to the effect that the services of all persons employed in and about the collieries would not be required after the 20th February, and the liquidators would not be liable for any wages after that date. Some take a gloomy view of the situation, but it is not known for certain that the reconstruction scheme has or not been abandoned.

A fine example of the patent turret system came into Cardiff this week represented by the Oak Branch, a steamer of 5500 tons, built last autumn by Messrs. Doxford and Son, of Sunderland. Some description of this, one of the latest specimens of naval architecture, may be of interest. Her length between perpendiculars is 340ft., extreme breadth 45ft. 6in., depth moulded, 26ft. 9in. She steams 10½ knots on a very light consumption, being fitted with Serve tubes and induced draught, working out at 1·3 lb. per indicated horse-power per hour. She is also fitted with triple compound surface condensing engines, 26in. × 42in. × 68in.; length of stroke 42in., which gives an indicated horse-power of between 1600 and 2000. Two boilers are used, 13ft. 3in. diameter by 11ft. 6in. in length, fitted in each with two furnaces. The boilers are connected with 275 Serve tubes. One of the special features, and one which minimises the labour of firemen, is one Leeds hydro-pneumatic ash ejector. The improved fittings include McDougall's patent steam traps, and Morrison's evaporator feed-heater, and circulator. The construction of the steamer was under the direct supervision of Mr. Arthur Ritson, M.I.N.A., and a sister steamer I hear is being turned out by the same builders, who will contribute some interesting models to the forthcoming Cardiff exhibition.

The slackness in the tin-plate trade continues to tell unfavourably upon the principal ironworks, as a much lessened make of tin bar is required. At one of the leading works this week the sidings were almost deserted. Fortunately there is a better steel rail trade doing, though in the Swansea district complaints are strong this week that in two instances America and Germany have secured orders by underselling the Welsh works to the extent of 7s. 6d. per ton. The pig iron market is unaltered as regards Glasgow warrants; Middlesbrough hematite is 3½d. weaker. Steel rails, heavy, £4 10s. to £4 15s.; light, £4 17s. 6d. to £5 5s. Welsh bars remain: Sheets, steel and iron, £6 12s. 6d. to £6 15s.; Bessemer bars, £3 17s. 6d.; Siemens, £3 18s. Tin-plates: Bessemer, 9s. 1½d. to 9s. 3d.; Siemens, 9s. 3d. to 9s. 4½d.; ternes, 17s. 6d. to 22s. 6d.; best charcoal, 12s. 6d. to 13s. 6d.; wasters, 6d. to 1s. less. Block tin, £60 15s. to £61 5s. Lead, English, £11 10s. to £11 12s. 6d.; Spanish, £11 8s. 9d. to £11 10s.

A notable shipment of 1400 tons of "iron" for the Cape has taken place from Cardiff.

There is no improvement in the tin-plate industry. On Tuesday a meeting of tin-plate manufacturers was held in Swansea, when it was stated that out of the 515 mills in existence, 266 promised to support the movement for founding new markets, 168 refused, 53 gave no response, and 28 are permanently idle. The committee was then dissolved, and an excellent start is, unfortunately, abandoned. The export last week was only 13,441 boxes; receipts from works, 19,881 boxes. Stocks are 170,330 boxes. A more cheerful condition is shown at Briton Ferry, and signs are not wanting of the cloud lifting in other quarters.

The allied industries are tolerably brisk. Coke is in active demand at improved prices, furnace ranging from 13s. 6d. to 14s. 9d.; foundry, from 15s. 6d. to 16s. 6d., and special is firm at 19s. 6d., Cardiff. For patent fuel the demand has quickened; best brands, 10s. 6d.; seconds, from 10s. to 10s. 3d., Cardiff. Swansea prices, 10s. to 10s. 3d. Pitwood is selling fairly well, but in the face of heavy stocks prices are weak, and 15s. 3d. is about the highest price obtained, while sales have been effected at 15s. Iron ore prices are maintained. Cardiff prices from 11s. to 12s., and the weather being fine large consignments have come to hand.

The principal subject of discussion at Newport, Monmouthshire, this week has been the Alexandra Dock Bill, and the amalgamation of the Alexandra Dock, the Newport and South Wales Docks and Railway Company, and the Pontypridd, Caerphilly, and Newport Monmouthshire Railway. Meetings in favour and support of the Bill have been held, and at the last Lord Tredegar presided, and spoke with his accustomed point and ability.

A rumour of a great English industry being transplanted to the Glamorgan shores is again to the front, and Barry named as the site; but no definite information is to hand.

Llangennech corrugated iron industry movement is progressing well.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE improvement in the iron and allied trades continues; almost all departments of the crude and malleable iron industry are in healthy activity, and makers and merchants regard the future with confidence.

Silesian iron masters give a good account of last week's trade in iron and steel; pig iron is gaining strength, and there is likewise a distinct improvement in the demand for manufactured iron, prices being firm all round. Railway materials, especially rails, are not so well paid for as could be desired, but in hardware a decidedly upward tendency in quotations has of late been noticeable. Bars and all sorts of plates are in very good call, and a further advance of M. 5 p.t. has been agreed upon for the first-named article. During the last two years quotations for bars and plates per ton, free Breslau, were as follows:—

	Bars. M.	Heavy plates. M.	Sheets. M.
1894—1st January	122·50	140	140
25th "	127·50	140	140
20th February	132·50	140	145
21st March	140	145	155
8th April	150	145	160
15th June	132·50	145	160
11th September	125	140	140
20th November	120	135	145
1895—16th April	125	135	145
12th August	130	135	150
26th September	135	135	150
1st November	140	140	155
1896—1st February	145	145	160

The position of the Austro-Hungarian iron trade is becoming more satisfactory. A fair improvement in demand was experienced last week for structural iron, and the steel and engineering department is also in a pretty active state, numerous orders for railway requirements having been given out. The Kaiser-Ferdinand-North Railway, for instance, placed orders for 550 coal cars, 85 covered load wagons, and 110 passenger cars with three of the largest local machine and wagon factories.

Business on the French iron market shows no perceptible improvement, but the works continue, as a rule, fairly well employed, and prices, though decidedly not very favourable, have still been pretty firm upon the week. French foreign trade in iron was for 1895 as under:—

	Import.		Export.	
	1895. Tons.	1894. Tons.	1895. Tons.	1894. Tons.
Pig iron	80,920	108,330	161,309	117,993
Malleable iron	37,145	28,320	27,630	24,221
Steel	7,974	7,674	18,760	15,513

There was further exported:—Scrap iron, 922 t., against 351 t. in 1894; old foundry pig, 105 t., against 71 t.; and old steel, 8318 t., against 6756 t. in 1894. Imports in iron ore were, for 1895, 1,651,422 t., against 1,638,458 t. in 1894, of which 1,213,271 t. came from Germany, against 1,162,545 t. in the year before; from Spain 357,393 t. were imported, against 396,475 t. in 1894; from Belgium, 41,901 t., against 45,559 t.; Algiers, 9409 t., against 16,259 t.; Italy, 120 t., against 3712 t.; other countries, 29,328 t., against 13,911 t. in the previous year. Exports in iron ore were, for 1895, 236,923 t., against 247,519 t. in 1894.

A firm tone is to be noticed throughout the Belgian iron trade. Changes in quotations cannot be reported, except that foundry pig, No. 3, shows a rising inclination, minimum quotation being now 48f. p.t., but towards the end of the present month 49f. p.t. will be realised most likely. The majority of the works have sold their output in forge pig till end of second quarter. Comparing the prices ruling on January 1st and on February 1st, it appears that bars rose 5f. p.t., for export 2·50f. p.t. Girders, f.o.b. Antwerp, rose from 115 on 117f. p.t.; the same, Belgian station, from 120 on 125f. p.t. Plates show no alteration, but steel rails for export rose from 107·50f. on 110f. p.t. On February 1st there were twenty-seven blast furnaces in blow out of forty-three existing, nine on forge pig, four on foundry pig, and fourteen on basic. Output in pig iron was, for January, 1896, as compared to the same month in 1895, as under:—

	1896. Tons.	1895. Tons.
Forge pig	27,125	37,820
Foundry pig	6820	8990
Basic	35,650	30,690
Totals	69,595	77,500

The Belgian coal market is in exactly the same condition as before, and there is now but little hope that a severe frost will set in and cause a rise, if only temporary, in the demand for house coal. Stocks are pretty large. In the Centre the summer prices have been quoted. Fortunately the demand for engine classes of fuel is increasing steadily, and April or July, the period when new contracts are placed, will most likely bring an advance in quotations. All things considered, there is a decidedly less favourable tone prevailing in the coal trade now than quite in the beginning of the year, or at this time last year. There could not be a worse time for strikes, and yet they are increasing in almost all parts.

In the coal district of Seraing all the colliers are reported to be on strike. With regard to Belgian business in coal and coke during the last two years, it is stated that import in coal was for 1895 1,532,454 t., against 1,377,009 t. in the year before, of which 772,659 t. came from Germany, against 714,450 t.; while from England 318,617 t. were imported, against 307,151 t. in 1894. Import in coke amounted to 382,656 t., against 326,188 t., 366,764 t. coming from Germany, against 316,427 t. last year. Export in coal was 4,646,983 t., against 4,539,525 t.; to France 3,618,585 t. were sent, against 3,559,539 t. in the year before, while to Germany 266,276 t. were exported, against 226,394 t. in 1894. Export in coke amounted to 869,409 t., against 879,278 t.; 146,854 t. being sent to Germany, against 154,379 t. in the year before.

In the different departments of the Rhenish-Westphalian iron industry a steady demand is experienced, prices showing considerable firmness, with a rising tendency here and there. Pig iron meets with ready sale, basic having been in particularly good call upon the week. A lively business has likewise been transacted on the malleable iron market. The bar trade shows considerable animation, and producers are realising fairly good prices. Hoops are also in tolerably good request, and girders are selling briskly, comparatively speaking. The plate and sheet makers are well supplied with fresh orders, and might be considered in a satisfactory condition but for the depression that continues in prices. This year the 37th meeting of the Society of German Engineers will take place in Stuttgart on the 8th, 9th, and 10th of June.

The following shows German trade in iron ore, raw and finished iron, as well as steel, during the year now past, as compared to 1894. Import in iron ore to Germany went down from 20,930,070 q.—100 kilos.—in 1894, on 20,171,359 q. in 1895; the same was the case with export, which amounted to 24,801,355 q. in 1895, against 25,587,292 q. in the previous year. Import in scrap iron has risen from 78,999 q. in 1894, on 113,392 q., export also increasing from 777,228 q. on 848,143 q. In pig iron, imports were for 1895, 1,882,166 q., against 2,039,478 q., which chiefly came from Great Britain. Export amounted to 1,352,894 q., against 1,546,470 q. in the previous year; Belgium, Austria, and France being the chief consumers. In angles export shows a decided improvement, being for 1895, 1,728,626 q., against 1,304,576 q. in 1894. Import amounted to 1243 q. only, which was 1203 q. less than in the year before. Foreign demand in German fish-plates, sleepers, &c., showed a slight improvement against previous years, being for 1895 456,188 q. Import in these articles was very limited, having decreased from 8774 q. in 1894 on 6711 q. in 1895. Export in steel rails shows a falling off against 1894, being in 1895 1,166,273 q., against 1,194,103 q. in previous year. Import also went down from 35,421 q. in 1894 on 18,305 q. for the year that is now past. Bars likewise show a decrease in export from 3,005,585 q. on 2,779,909 q.; import decreased by 1887 q. A rise from 419,917 q. on 618,075 q. may be noticed for ingots, blooms, and iron rails; export in these articles was small, amounting to 7566 q. only. In plates and sheets import as well as export has improved, the former rising from 44,753 q. on 93,767 q., while export increased from 932,884 q. on 1,285,205 q. The reverse was the case with tin sheets, import decreasing from 20,407 q. on 14,396 q., while export went down from 3167 q. on 2844 q.

Foreign consumption in iron wire was 2,053,311 q. for 1895, against 2,098,179 q. in the year before, the chief consumers being Great Britain and Belgium. Imports in iron wire, principally from England and Sweden, amounted to 55,826 q., against 48,876 q. in 1894. In manufactured articles there were sent to other countries 899,253 q., against 826,907 q. in 1894; while 114,413 q. were imported in 1895, against 91,725 q. in previous year. Export in hardware increased from 189,282 q. on 233,385 q.; import was only 19,782 q. for 1895. Import and export in locomotives and small engines of different descriptions was, for 1895, 20,025 q. and 79,879 q. respectively, the corresponding figures for 1894 being 25,384 q. and 56,860 q. In machines and appurtenances 1,286,609 q. were exported in 1895, while import amounted to 450,354 q. only.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, February 20th.

OF the sixty odd million dollars already paid into the United States Treasury, nearly ten millions were drawn out of the Treasury to do so. Another bond issue will become necessary in a few months, but happily the present administration will soon be out. The financial outlook is encouraging, though merchants and manufacturers complain of slow collections. Railroad earnings for January on 131 roads showed an increase of 11 per cent. over last January, and 64 roads for first week of February showed an increase of 12½ per cent. over same week last year. To the American business man these are regarded as significant points. There is an improving under-tone to all markets, and so far as experience and prudent counsels go, there must be an enlarging demand, an increase in manufacturing activity, and an increase in investment in all channels. There is, however, a conservative feeling everywhere. This is particularly manifest in the iron trade. The advancing tendency has prudently halted. Pig iron production is still dropping. A few furnaces blow out this week, and some steel mills have reduced production. Billets do not go as fast as makers expected. Bar mills are not picking up much business yet. Plate and structural steel is asked for by railway managers, shipbuilders, and building office buildings and "sky scrapers," which has become quite an industry.

That which concerns business men more than present low prices is the danger of a sudden advance in prices of most staple products. Wheat for export, for instance, was 65 cents in January, 62 cents in December. Flour per barrel, 14 cents higher than a year ago. The American markets are waiting for the clearing up of this loan business. The stringency it caused led to an increase in failures. The defeat of a silver measure in the House means nothing. The issue will be squarely presented to the people in the coming presidential campaign. The masses will vote for silver, a fact which the press dishonestly hides. Gold mining is rapidly increasing, and preparations have been made to open valuable producing gold fields as soon as the weather permits. Makers of mining machinery are busy.

IT having been found—says the *Naval and Military Record*—that difficulties arise in ships fitted with long internal feed pipes, the Admiralty have directed that in cases where vessels so fitted go into dockyard hands for repairs, these pipes are to be removed and short lengths left, delivering the water from 6in. to 12in. below the top of the heating surfaces, both main and auxiliary feed discharges being similarly treated.

LAUNCHES AND TRIAL TRIPS.

The Admiralty dredger, St. Ives, recently constructed by Messrs. Wm. Simons and Co., to the order of the British Admiralty for service at Portsmouth dockyard, has completed her dredging and steaming trials with very satisfactory results.

On February 19th Messrs. Wm. Simons and Co., Renfrew, launched complete the St. Austell, the second of the two very powerful barge loading dredgers recently constructed to the order of the British Admiralty. The vessel, which is to be employed at H.M. Dockyard, Devonport, is of the following dimensions: — Length, 195ft.; breadth, 35ft. 6in.; depth, 13ft. She St. Austell is propelled by two sets of compound surface condensing engines of 1000 indicated horse-power—either set of engines being available for dredging—and has all the latest improvements in dredging appliances. The gearing is specially adapted for rock dredging, and the bucket ladder works to a depth of 46ft. below water. Its place in the yard will be occupied by a hopper dredger for Wexford, recently ordered by the Wexford Harbour Commissioners.

On Monday morning, the 24th inst., the s.s. Kingtor, just completed by Messrs. Ropner and Son, of Stockton-on-Tees, to the order of Messrs. J. Holman and Sons, of London, left the river Tees for her official trial trip. The steamer's compasses were duly adjusted on her arrival in the Tees Bay. Afterwards a very satisfactory run was made, resulting in a speed of from 10½ to 11 knots, the engines working very satisfactorily, and without a hitch of any kind; the boilers at the same time maintaining an ample supply of steam with ordinary firing. Mr. R. H. Holman, and Captain A. C. Holman, of London, were present at the trip, the latter gentleman having superintended the vessel during construction, whilst Messrs. E. J. Caiger and Co., of London, have taken the overlook of the machinery department. Mr. R. Ropner, jun., who represented the shipbuilders, was also present at the trial. After a very satisfactory and pleasant run, the steamer proceeded on her way to Cardiff, where she will load for the Black Sea.

On Tuesday, the 18th inst., the s.s. Manzanillo, which has been built by Messrs. Craig, Taylor, and Co., Thornaby-on-Tees, to trade on the coast of Mexico, had her trial trip, which proved highly satisfactory. She is a full powered vessel, and realised a speed of over 11½ knots, being 1½ knots in excess of the guaranteed requirements. She is fitted with accommodation for a large number of both first and second-class passengers, and is also arranged to carry two quick-firing guns on her forecastle. The saloon is fitted up with plate glass in sized mirrors, which, with the electric light, produces a fine effect; she has also strong-room, bullion and mail-room. She is equipped with steam winches by Messrs. Roger and Co., who also have supplied the steam steering gear; patent steam windlass by Messrs. Emerson, Walker, and Thompson Bros. The electric light, which has been fitted throughout in a very complete manner, is by Holmes and Co., of Newcastle, and showed to very great advantage on the trial. The engines, which worked exceedingly well without a hitch, are from the shops of Messrs. Westgarth, English and Co., Middlesbrough.

On Thursday, February 20th, the steel screw spar-deck steamer Wolfsburg, built by Sir Raylton Dixon and Co., Cleveland Dockyard, Middlesbrough, for Messrs. the Hansa Steamship Company, Bremen, was taken out to sea for her official trial trip, under the command of Captain Pfeiffer. Her dimensions are:—Length, 323ft.; beam, 42ft. 6in.; depth moulded, 25ft. Great care has been taken in the construction of the vessel, so as to meet the company's requirements for their River Plate trade; the poop, bridge, and forecastle decks are of teak, and handsome accommodation is provided for captain, officers, and engineers in houses on bridge deck. Triple-expansion engines, built to German law requirements, have been fitted by Messrs. T. Richardson and Sons, Hartlepool, having cylinders 22½in., 36in., and 62in., by 42in. stroke, with two large single-ended boilers working at 205 lb. pressure. The hull and machinery have been constructed under the supervision of Mr. D. Wulff, superintendent engineer for the Hansa Company. During the trials everything worked most satisfactorily, and the vessel proceeded direct to Bremen.

The Baluchistan, a fine steel screw steamer, built by Messrs. William Gray and Co., to the order of Messrs. F. C. Strick and Co., of Swansea and London, left the port of West Hartlepool a few days ago for her trial trip. The vessel has been built to Lloyd's highest class, is 300ft. in length, 42ft. in breadth, and 19ft. 9in. deep. The deck erections consist of poop, raised quarter deck, and partial awning deck. A handsome saloon, state room, and accommodation for captain and officers have been fitted up in the poop, and comfortable quarters for the engineers amidships, and for the crew forward. The hull is built with web frames and cellular double bottom, and there is also a large ballast tank in the after peak. Four steam winches, large donkey boiler, steam steering gear amidships, hand screw steering gear aft, direct steam windlass, schooner rig, boats on beams overhead, and all modern appliances have been fitted. The engines are of the triple expansion type, supplied by the Central Marine Engine Works of William Gray and Co. The cylinders are 22in., 35in., and 59in. diameter, with a piston stroke of 39in. The boilers are made of steel, of large size, and give an ample supply of steam, the working pressure being 160 lb. per square inch. The vessel left the harbour about six o'clock in the morning, and after manœuvring in the bay for some time and having her compasses adjusted, was boarded about 10.30 a.m. by a party of inspecting engineers and others interested. The engines were then put full speed ahead and a continuous run of between two and three hours made, the performance of the vessel and her machinery being highly satisfactory. The owners were represented by Captain Rosser and Mr. Archibald Walker, the latter gentleman having superintended the construction of the vessel and her machinery; the shipbuilders by Captain Murrell; and the builders of the engines by Mr. Lindsay. On the conclusion of the trial the Baluchistan proceeded to London, where she takes in part of the cargo for her first voyage.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

⁂ When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

13th February, 1896

3277. Puzzle Lock, G. W. Herbert and W. K. Ingham, Birmingham.

3278. Bell-shaped Glass for Gas Lamps, E. Wolfcarius, Brussels.

3279. Axle-box with Oil Reservoir, F. A. Gruel, Brussels.

3280. Rover Frames, B. von Harenne and E. Schwilden, London.

3281. Slide Rules, R. Belshaw, London.

3282. Generating Steam in Boilers, A. W. Knotts, London.

3283. Drawing-off Liquids from Tanks, A. M. Lake, London.

3284. Seats, Chiefly for Velocipedes, M. Solomon, London.

3285. Tip Cart, H. J. Chesterfield, London.

3286. Keys for Fastening Rails, S. Ballard, Birmingham.

3287. Combination Spindle Stud, &c., G. H. Moore, London.

3288. Machinery for Making Paper, E. Davies and H. M. H. Goodfellow, London.

3289. Lock, J. Stoddart, London.

3290. Egg Cutter, H. Barrett, London.

3291. Boxing Gloves, S. Wither, J. H. Chandler, and F. W. Jacques, London.

3292. Shirts, G. W. E. Hoar, London.

3293. Stop Mechanism, The Linotype Co.—(*The National Typographic Company, United States.*)

3294. Key-board Mechanisms, The Linotype Co.—(*The National Typographic Company, United States.*)

3295. Pneumatic Tires, C. G. Page, London.

3296. Simplex Machine R. J. Eke, London.

3297. Machinery for Working Stone, F. Trier, London.

3298. Driving Mechanism for Cycles, W. J. S. Strange, London.

3299. Embossing of Paper, Envelopes, &c., R. Platz, London.

3300. Bowls for Incandescent Gas Burners, E. J. Shaw, London.

3301. Device for Cutting Off Coupons, T. F. Dalglish, London.

3302. New Table or Rest for Beds, P. L. Hibbert, London.

3303. Match-boxes, A. J. Boult.—(*Von Deylen and Sohn, ——.*)

3304. Hoes, J. R. Burton.—(*R. Mackinnon, New Zealand.*)

3305. Piano Guards and Rests, L. W. Norcross, London.

3306. Preserving Butter, A. J. Boult.—(*M. Buffard, France.*)

3307. Bedsteads, H. Reinhold, London.

3308. Making Barrels, &c., T. G. and A. Stevens, Greenhithe, Kent.

3309. Chocks for Ships' Boats, P. Ford and G. M. Hamlyn, London.

3310. Dust Collectors, F. Prinz, London.

3311. Painters' Brushes, W. P. Thompson.—(*The Vereinigte Pinselfabriken, Germany.*)

3312. Making Soft and other Soaps, W. Hanley, Manchester.

3313. Stopping and Starting Tramcars, J. J. Hooker, Manchester.

3314. Hunting Stocks, C. Clarke, Liverpool.

3315. Engraving Copper Rollers or Dies, H. Lyon, Manchester.

3316. Igniting Gas Lamps, J. M. Canellopoulos, London.

3317. Method of Producing an Alarm, R. W. J. Kraus, London.

3318. Rollers of Paper Machines, C. Lhomme, London.

3319. Means for Igniting Gas in Incandescent Gas Lamps, J. M. Canellopoulos and H. O. Kratz-Boussac, London.

3320. Napping Machines, E. Schweinefleisch, London.

3321. Manufacture of Firelighters, A. Morgenroth, London.

3322. Electric Batteries, J. Fuchs and L. Thiemann, London.

3323. Valves, G. A. Williams, London.

3324. Manufacture of Fuel Blocks, C. M. Schnauder, London.

3325. Typewriting Machines, N. L. Anderson, London.

3326. Cycles, M. J. A. de Belleville, London.

3327. Cutting Tools and Tool Holders, J. Garnier, London.

3328. Marking of Soap Tablets, G. D. Macdougald and The London and Dundee Syndicate, Ltd., London.

3329. Marking of Soap Tablets, G. D. Macdougald and The London and Dundee Syndicate, Ltd., London.

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3330. Nesting Boxes, H. Piquet, Port Talbot, Glamorganshire.

3331. Automatic Lubricators, W. Reynolds and L. G. Astley, Coventry.

3332. Openers for Meat and other Tins, W. J. Fox, Manchester.

3333. Preventing Shocks and Vibrations, J. C. Wilson, Nottingham.

3334. Candlesticks and Save-alls, G. Castleden, Framlingham, Suffolk.

3335. Fuel, T. H. Gittins, Liverpool.

3336. Atttaching Coal Tubs to Colliery Ropes, J. F. Phillips, Leigh.

3337. Double-barrelled Guns, L. Barratt, Birmingham.

3338. Manufacture of Acetylene Gas, J. H. Exley, London.

3339. Pianos, H. Hartley, Bradford.

3340. Braces, T. Helbing, Birmingham.

3341. Eyeleting Machines, S. Thompson and A. A. Megson, Manchester.

3342. Device for Typewriting Machines, E. C. Wienholt, London.

3343. Weighing Machines, C. C. Madan, Didsbury, near Manchester.

3344. Pipe Stopper, J. Ostler, Hull.

3345. Centrifugal Machines, J. Laidlaw and J. W. Macfarlane, Glasgow.

3346. Metal Box Covers or Lids, &c., J. T. Paul, Glasgow.

3347. Locks or Fastenings for Cycles, T. B. Armstrong, Birmingham.

3348. Reception of Letters and Parcels, H. Thomas, Redditch.

3349. Tool for Bending Tubes, S. Wilkes and J. Caswell, Birmingham.

3350. Coin-freed Apparatus for Electricity, K. Rudolf, London.

3351. Bricks and Tiles, G. Viggars, Newcastle-under-Lyme.

3352. Impressing Thin Metal, &c., H. S. Fearon, London.

3353. Pocket Books, Letter Cases, &c., H. S. Fearon, London.

3354. Umbrellas and Parasols, A. and W. Hill, Bristol.

3355. Shedding Mechanism, W. R. G. Farey and R. Langhorne, Manchester.

3356. Jute Tow, F. Livingston and H. C. Young, Manchester.

3357. Construction of Draught-boards, G. W. Hawker, Birmingham.

3358 Smoothing Irons, A. H. Maclean, Glasgow

3359. Electrical Furnaces, E. Bailey and J. Dunn, Glasgow.

3360 Tobacco Pipe and Whistle, F. H. Kilner, Sheffield.

3361. Electro-plating of Iron, J. Kirkwood, Edinburgh.

3362. Dollies for Washing Clothes, J. Crosbie, Glasgow.

3363. Driving Gear for Cycles, C. B. Lawson, Glasgow.

3364. Syphons for Emptying Cisterns, W. A. McCormick, London.

3365. Treatment of Hydrocarbons, H. B. McKenna, London.

3366. Trollies for Gravity Railways, W. J. Brewer, London.

3367. Vehicle Wheel, W. H. Peck, London.

3368. Braces, A. Kaye, London.

3369. Bottle Filling Machines, J. F. Clarkson, London.

3370. Frames for the Saddles of Cycles, &c., H. A. Lamplugh, London.

3371. Finding a Ship's Course on the Chart, A. Jefferson, London.

3372. Skates, W. Wyatt, Birmingham.

3373. Tiles for Lining Walls, G. H. T. Ferrington, Birmingham.

3374. Operating Fire-proof Doors, J. Booth, London.

3375. Clocks, &c., T. S. Paynter and G. C. Walker, London.

3376. Producing Mouldings on Articles, W. Osment, London.

3377. Bottling Carbonated Liquids, P. J. Britten, London.

3378. Cycle Supports, A. J. Boult.—(*H. Lieneweber, United States.*)

3379. Self-propelled Vehicles, H. J. Lawson, London.

3380. Boots, J. Wood, London.

3381. Engines, G. S. Baker, London.

3382. Vehicle Tires, E. Lofts and G. H. R. Dabbs, London.

3383. Stacking Hay and other Material, F. Gibas, London.

3384. Typewriting Machines, J. S. Foley and G. Salter, London.

3385. Fly-papers, T. Le Beau, London.

3386. Capping Cartridge Shells, The Normal Powder Syndicate, Ld.—(*L. G. Ohman, Sweden.*)

3387. Sorting Cartridge Shells, The Normal Powder Syndicate, Ld.—(*L. G. Ohman, Sweden.*)

3388. Brake Apparatus, B. Endler and H. Freyberger, London.

3389. Engine Cranks, C. F. Hunter and H. C. Shaw, London.

3390. Device for Holding Ladies' Dresses, A. A. Smith, London.

3391. Banks or Creels, W. P. Thompson.—(*E. Claviez, Germany.*)

3392. Nut Locks, W. P. Thompson.—(*R. Robertson, United States.*)

3393. Tethering Pin, T. Berg, Liverpool.

3394. Glow Lamps, G. Webb, jun., and L. J. Underwood, London.

3395. Pipes, J. F. W. Rose, London.

3396. Applying Pedo-motive or other Force, C. Gordon, London.

3397. Self-propelled Vehicles, C. T. J. Oppermann, London.

3398. Driving Gear for Machinery, J. P. Moss, London.

3399. Elevators, H. Mautner, London.

3400. Grates, H. McGovern, London.

3401. Treating Eggs, J. Swan, London.

3402. Stop Valves, D. B. Morison, London.

3403. Advertising or like Purposes, G. C. Fricker, London.

3404. Oscillating Baths or Tanks, C. Messaz, London.

3405. Wheels, J. B. Dunlop, jun., London.

3406. Indicating Levels of Liquids, J. E. Whiting, London.

3407. Packing Goods, J. Fischer and E. Heusinger, London.

3408. Motors, H. J. Lawson and E. J. Pennington, London.

3409. Recording Electric Meters, A. Wright, London.

3410. Wheels of Carts, Wagons, &c., W. H. Keep, London.

3411. Manufacture of Tea Chests, J. C. Roberts, London.

3412. Manufacture of Plastic Mixtures, L. F. A. Magdolf, London.

3413. Combination Garments, G. Slingsby, London.

3414. Trousers, G. Slingsby, London.

3415. A Flexible Tire for Wheels, T. Sutcliffe, London.

3416. Kerbs, Edging Blocks, &c., R. F. Tyhurst, London.

3417. Mucilage Bottles, C. S. Kellogg, London.

3418. Wrenches, J. C. Gregory, London.

3419. Puzzles, G. M. Houtz, London.

3420. Game Counters, L. C. Werner, London.

3421. Bottles, H. H. Summers, London.

3422. A New Gas Regulator, M. J. Amick, London.

3423. Appliances for Branding Corks, N. W. Mitchell, London.

3424. Candle Saving Device, W. C. Wilson, T. Ward, and A. Bean, London.

3425. Attaching Milk Cans to House Doors, H. W. Townsend, London.

3426. Boilers, W. E. Parkinson, London.

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3427. Perforating Metal Sheets, W. C. Barns, London.

3428. Ink Bottle Caps, J. G. and E. E. Betjemann, London.

3429. The Marjack, H. N. Davidge, London.

3430. Metallic Balance Covers for Jugs, J. Clarke, Cobridge.

3431. Friction Clutches, R. F. Hall, Birmingham.

3432. Screens, J. and F. S. Turner, Dudley.

3433. Tap, J. D. Ellis and D. T. Hames, Aberystwyth.

3434. Window, A. Holmes and H. J. Wallis, jun., Liverpool.

3435. Churns, J. H. Hopkins and Sons, and A. N. Hopkins, Wolverhampton.

3436. Pails, J. Ralph and J. A. Jordan, Wolverhampton.

3437. Attachment for Suspending Pictures, W. W. Hands, Birmingham.

3438. Firegrate, W. Peyton, Halifax.

3439. Lifebuoy, C. A. Williamson, Southampton.

3440. Step Ladders, J. Dunbar, Southampton.

3441. Telephones, J. H. Bennet, Liverpool.

3442. Making Firelighters, G. W. Adkins, Liverpool.

3443. Attachment for Securing Hooks, T. H. Taylor, Belfast.

3444. Roofing Buildings, E. W. Klinkmüller, Glasgow.

3445. Looms for Weaving, R. Richmond and S. Hacking, Halifax.

3446. Carding Engines, J. C. Horsfall, Halifax.

3447. Carpets and Rugs, A. B. Burrows and J. W. Brook, Halifax.

3448. Combination Shaving Vessel, H. E. Watson, Ipswich.

3449. Washing Machine, F. and C. H. Chapman, London.

3450. Applying Advertisements to Soap, R. J. Smith, Birmingham.

3451. Mitre Cramp, W. Ludlow, Birmingham.

3452. Mudguards for Cycles, C. Stamper, Manchester.

3453. Golf Clubs, C. Ashford and A. H. Wolseley, London.

3454. Fog Signalling, H. and W. J. Jackson and W. R. Lane, London.

3455. Syphon for Flushing Cisterns, A. Clifford, near Dartford.

3456. Paring the Curls of Hat Brims, J. Higginbotham, Manchester.

3457. Securing Flowers to Garments, T Douglas, Glasgow.

3458. Hair Pins, T. Douglas, Glasgow.

3459. Ink, E. J. Adams, Sheffield.

3460. Weighing Apparatus, G. H. Denison Leeds.

3461. Production of an Incandescent Substance, G Isaac, Brussels.

3462. Mangers, W. Singleton, Leeds.

3463. Receptacles for Removal of Refuse W. Skeate, London.

3464. Gas Generator, J. C. Hall, H. C. A. Dance, and A. R. Hall, Liverpool.

3465. Sheet Adjuster for Printing Machines, W. H. Clegg, London.

3466. Machinery for Casting Pipes, J. Ducket and Son, Ld., and J. W. Bullock, London.

3467. Ingot Moulds for Casting, &c., W. Burgan, Sheffield.

3468. Fixing a Dress Guard, E. and H. E. E. Hall, Leicester.

3469. Doors, F. S. D. Scott, London.

3470. Hair Pins, F. S. D. Scott, London.

3471. Hand Camera, E. C. Stanley and W. Darbin, London.

3472 Steam Trap, J. E. Slack, Manchester.

3473. Filter, W. Wise, London.

3474. Caps or Ferrules for Slate Pencils, G. Taylor, London.

3475. Bits, J. H. Tonge, London.

3476. Extinguishing the Flame in Lamps, J. Rumball, Birmingham.

3477. Cooking Utensils, E. Peckover, London.

3478. Switches for Controlling Lamps, W. J. Davy, London.

3479. Knives, W. Ellis, London.

3480. Learning Cycle Riding, J. Cottrell and W. Heatley, London.

3481. Dynamo-electric Machines, S. Z. de Ferranti, London.

3482. Tangs of Chisels, W. G. Lack and W. J. Shrive, London.

3483. Cases for Carrying Watches, A. J. Grayston, London.

3484. Blotting Pad, E. Nash, London.

3485. Corrugated Iron Roofs, J. Carter, London.

3486. Cycles, J. Browning, London.

3487. Saddles for Cycles, J. Browning, London.

3488. A New Night Light Box, H. C. Michahelles, London.

3489. Baby Comforters, A. R. Stocker, London.

3490. Valves for Brass Instruments, W. R. Griffith, London.

3491. Crank Driving Gear, W. W. Walker, London.

3492. Carding Engines, E. Edwards.—(*B. Jehn, Germany.*)

3493. Slide Valves, R. Eltz, London.

3494. Respirators, R. R. von Walcher-Uysdal, Dr. G. Gaertner, and G. Benda, London.

3495. Oil Cooking Stoves, T. Pfister, London.

3496. Coin-freed Apparatus, H. H. Lake.—(*Stollwerck Bros., Germany.*)

3497. Boots and Shoes, Z. T. French and W. C. Meyer, London.

3498. Shoes for Horses, E. Bush, London.

3499. Window Sash Fastener, H. E. Allder, London.

3500. Cryptographic Instrument, R. Harte, London.

3501. Cryptographic Instrument, R. Harte, London.

3502. Resistance of Air to Trains, E. A. Bath, London.

3503. Igniting Gas Engines, A. and F. Shuttleworth and P. Deed, London,

3504. Railway Signals, W. H. Deakin, London.

3505. Lamp Reflectors, B. J. Brearley, London.

3506. Quick-firing Guns, A. Radovanovic, London.

3507. Furniture Castors, J. Wilson, London

3508. Wood-block Cutting Machinery, T. B. Marchant, London.

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3509. Fluid Column Impeller, E. Arnold, Newcastle-on-Tyne.

3510. Tapping Casks, J. H. McCullough, Belfast.

3511. Golf Club, J. Armstrong, Rutherglen, near Glasgow.

3512. Joints for Metallic Fencing, I. Price, Wolverhampton.

3513. Dressing Cases, D. A. P. Anderson, Edinburgh.

3514. Leggings, A. F. Seed, Manchester.

3515. Transmitting Power, F. J. H. Lascelles, Newcastle-on-Tyne.

3516. Advertising Mediums, H. Gaillard, Manchester.

3517. Back-washing Machines, J. R. Hoyle and H. Colburn, Keighley.

3518. Tanning, R. D. Bailey, London.

3519. Bituminous Cement, W. Wardle, Burton-on-Trent.

3520. Automatic Weighing Machines, W. H. Baxter, London.

3521. Cutting, &c., Machinery, J. E. Thornton, Altrincham.

3522. Connecting Tubes of Bamboo, &c., E. Young, London.

3523. Actuating Slide Valves, A. Boyd, Gateshead.

3524. Syringes for Medical Purposes, W. E. Gray.—(*H. Wulfing-Luer, France.*)

3525. Gear for Propelling Cycles, H. Whyte, Co. Kerry.

3526. Making Cased Sash Frames, T. E. Tubbs, London.

3527. Rack Pulley, T. D. Harries, Aberystwith.

3528. Pneumatic Tires, W. H. Casley and A. F. Woodman, Exeter.

3529. Digestive Bread, H. Latchford, Wealdstone.

3530. Ticket-printing Machines, D. Carlaw, Glasgow.

3531. Economising the Consumption of Fuel, W. Chatrerley, Crabb's Cross, near Redditch.

3532. Mechanism for Composing Types, C. F. Hilder, Surrey.

3533. Fibrous Material, J. A. Maquaire, London.

3534. Light Chimney Scaling Ladders, W. R. H. Inglis, Frodingham, near Doncaster.

3535. Electric Signalling Apparatus, W. R. H. Inglis, Frodingham, near Doncaster.

3536. Padlock, A. Cashin, Birmingham.

3537. Securing Window Sashes, &c., R. Tolladay, Birmingham.

3538. Metal Sectional Heel Tips, W. Freeman, Leicester.

3539. Tin Bands with Hook-shaped Needles, H. Löwenthal, Berlin.

3540. Heating Apparatus, A. Deidesheimer, Berlin.

3541. Dolly for Washing Clothes, &c., T. Dawson, Southport.

3542. Automatic Weir, W. Osborn, Taunton.

3543. Pressure and Vacuum Gauges, H. Smithurst, Liverpool.

3544. Cutlery, R. H. Radford, Sheffield.

3545. Draught Preventers for Doors, &c., G. Vall, London.

3546. Fire-boxes for Boilers, E. Ingleton, London.

3547. Chains for Cycle Purposes, J. Mills, London.

3548. Trousers Mud Guard, F. Villani, London.

3549. Feeding Bottles, A. A. Davidson, Canada.

3550. Simultaneous Telephony, E. W. Smith and The New Phonopore Telephone Company, Ltd., London.

3551. Detachable Shirt Cuffs, J. A. C. Edgley, London.

3552. Producing Decorative Printing Surfaces, C. Young, London.

3553. Holder for Weft Forks, J. Drake, Accrington.

3554. Locking Bolts, J. Charlton, London.

3555. Manufacture of Camphors, J. C. Richardson, London.

3556. Telephone Paper Racks, J. F. Bullock, London.

3557. Gearing for Cycles, T. Terrell, London.

3558. Charging Cartridge Shells, The Normal Powder Syndicate, Ld.—(*L. G. Ohman, Sweden.*)

3559. Joining Rails, A. Butler, sen., and A. Butler, jun., London.

3560. Apparatus for Burning Liquid Fuel, A. Quentin, London.
3561. Preparation for Cure of Toothache, C. E. Hillman, Bristol.
3562. Musical Instruments, E. Edwards.—(*W. Mecklenbeck, Germany.*)
3563. Turning the Leaves of Books, G. Mumford, London.
3564. Steam Generators or Boilers, W. J. Jobling, London.
3565. Sugar Refining, M. Zahn, London.
3566. Igniting Devices for Gas, &c., H. Winkler, London.
3567. Belts for Holding Babies, M. C. Carpenter, Liverpool.
3568. Pad for Liquid Gum, A. W. Hosking, Manchester.
3569. Furnaces, E. Petzholtz, Liverpool.
3570. Necktie, F. W. Bowring, London.
3571. Single-bit and Curb Rein, E. Maxwell, London.
3572. Sterilising Apparatus, S. S. Bromhead.—(*Dierks and Möllmann, Germany.*)
3573. Indicating Callipers, A. J. Boult.—(*A. Siele, Germany.*)
3574. Puzzles, J. E. K. Bynoe, London.
3575. Cooling Agent, A. J. Boult.—(*M. W. Judell, Australia.*)
3576. Apparatus for Sinking Wells, F. Honigmann, London.
3577. Making Box Blanks, A. J. Boult.—(*J. Uhri, United States.*)
3578. Apparatus for Cleaning Sieves, P. Turner, London.
3579. Cotton Wool Mattresses, C. Christensen, London.
3580. Varnish for Books, H. H. Lake.—(*O. Leproux, France.*)
3581. Postage Stamp, A. E. Batson and H. J. Batson, London.
3582. Life-saving Apparatus, J. Ball, London.
3583. Incandescent Oil Burners, S. Henlein, London.
3584. Heating Stoves, P. Jensen.—(*E. Harzer, Germany.*)
3585. Controlling Air Supply, C. G. P. de Laval, London.
3586. Mechanically-driven Vehicles, E. J. Pennington and M. D. Rucker, London.
3587. Counting Apparatus, L. Biedermann and A. R. Fairer, London.
3588. Machines for Channelling Stone, A. W. and Z. W. Daw, London.
3589. Window-cleaner Protector, &c., C. Grath, London.
3590. Corn Planters, H. Hall, London.
3591. Rules and Stamp Holders, W. M. Simonson, London.
3592. Pipes, W. Hinchliffe, London.
3593. Cylinder Valves for Steam Engines, J. C. Getty, London.
3594. Hair Pins, R. Haddan.—(*L. Dumas, France.*)
3595. Ball Bearings, R. Haddan.—(*N. Rousselle, A. and J. Snutsel, Belgium.*)
3596. Gathering Apparatus, J. Barthe, London.
3597. Artificial Asphalt, A. Hanneman and G. Boisly, London.
3598. Brushes with Removable Bristles, H. Wentzky, London.
3599. Repairing Pneumatic Tires, J. Y. Johnson.—(*C. W. Youngman, United States.*)
3600. Masks, C. H. Gorringe.—(*H. M. Dunlap, United States.*)
3601. Hydraulic Door Checks, S. Hill and R. Hodges, London.

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3602. Hussifs or Needle Work Cases, B. I. Keyzor, London.
3603. Extractions of Manganese from Ores, J. B. Torres, London.
3604. Steam Traps, P. J. Wilson and W. E. Wright, Sheffield.
3605. Lubrication of Bearings, J. E. Livesey, London.
3606. Mechanism for Velocipedes, D. R. Roberts, Belfast.
3607. Cleaning Lamp Chimneys, J. Leach and H. Bancroft, Blackburn.
3608. Separating Photographic Plates, F. Bishop.—(*M. Lehmann, France.*)
3609. Hanging Wall Splashers, &c., R. B. Wheeler, London.
3610. Convertible Mail Carts, T. F. Simmons, London.
3611. Locking the Heads of Cycles, A. J. Riley, Birmingham.
3612. Sieves, S. Wilson and T. Leech, Leigh, Lancashire.
3613. Boiling Sugar and other Syrups, E. Shaw, Bristol.
3614. Machines for Filling Bottles, A. P. Blaxter, sen., London.
3615. Preventing Window Sashes being Opened, J. Sloane, Dublin.
3616. Apparatus for Softening Water, W. Leach, Bradford.
3617. Horse Scrapers, T. Sedgwick, Manchester.
3618. Foods, J. Dunn, Glasgow.
3619. Making Iron Doors, J. J. Salisbury. London.
3620. Rock Drilling Machines, J. W. Larmuth and R. B. Howarth, Manchester.
3621. Water Filters, J. Liddle.—(*The American Tripoli Company, United States.*)
3622. Bilge Ejectors, C. S. Madan, Salford.
3623. Openers, J. J. Bailey and J. Garnett, Manchester.
3624. Floor Cleaning Machines, J. E. and W. J. Gee and The Scrubbing Machine Syndicate, Stockton-on-Tees.
3625. Splash Preventer for Frying Pan, W. R. Shapley, Birmingham.
3626. Portable Tea, &c., Can, W. R. Shapley, Birmingham.
3627. Telephones, W. H. and G. E. Russell, F. M. Neale, and H. Connett, Wolverhampton.
3628. Dynamo Brush, F. E. Elmore, Leeds.
3629. Facile Revolving Displayer, G. D. Stewart, London.
3630. Loom Motions, T. Roberts and J. Townsend, Manchester.
3631. Alarms for Use with Valves, G. Mills, Manchester.
3632. Convertible Spray and Jet Nozzles, W. L. Boyle, Glasgow.
3633. Electric Alarms, F. G. Thomas and J. Thornton, Manchester.
3634. Bird and Poultry Protector, F. J. Sparrow, London.
3635. Pneumatic Ore Crushing Stamps, D. Embleton, Bradford.
3636. Shaping and Printing Butter, &c., J. Hellier, Weston-super-Mare.
3637. Wheels without Spindles or Axles, G. McAnney, Blackpool.
3638. Flexible Elastic Tubing, W. Brookes, Manchester.
3639. Tires for Bicycle Wheels, J. Knight, Huddersfield.
3640. Puzzles, J. Walker, Birmingham.
3641. Gas Burners, W. Welch, Portsmouth.
3642. Malleable Iron or Steel Cleat, D. Ragg, West Sunderland.
3643. Locking Cycles, R. J. Gillespie, Glasgow.
3644. Brakes, A. Cameron, Glasgow.
3645. Turning the Leaves of Books, H. Cassey, jun., Salisbury.
3646. Pneumatic Tires, H. du Cros, jun., and A. du Cros, London.
3647. Saw Setting Device, J. F. Strahlf, London.
3648. Bicycle Crank, G. A. Lindström, London.
3649. Stove Pipes, J. R. Tercy, London.
3650. Fence Stay, E. Litt, London.
3651. Marine Alarm Signalling Machine, H. J. Chapman, London.
3652. Bicycles, C. E. Bryant and A. L. Sargeant, London.
3653. Bicycle Supports, C. H. Holman, London.
3654. Splicing Hosiery, W. Buckler and D. Routledge and Co., Ld., London.
3655. Game, H. Adams, London.
3656. Blind Ladders, G. Parrott, London.
3657. Aerial Machine, J. Roots, London.
3658. Joints for Conduits of Mains, G. Shultz, London.
3659. Shaving Brush and Soap Reservoir, A. Hamilton, London.
3660. Carpet Sweeping Machines, T. Friant and A. B. Linn, London.
3661. Tobacco Pipe Cleaners, J. J. Snyder, London.
3662. Purifying Carbonic Acid Gas, A. D. Delsemme, London.
3663. Guard for Toasting Forks, D. F. A. Hervey, London.
3664. Threshing Machines, W. P. Thompson.—(*C. Sinner, Germany.*)
3665. Lamps, J. B. Brown, Liverpool.
3666. Pumps, C. G. Pinette, Liverpool.
3667. Bicycle Brake, F. E. Stafford, London.
3668. Hydro-extractors, T. Jenkins, London.
3669. Bolt, A. J. Lely, London.
3670. Pipes, F. A. Roebuck, London.
3671. Table Game, T. C. Smith, London.
3672. Corsets, W. H. King, London.
3673. Bottle Filling Machines, W. M. Fowler, London.
3674. Safety Device for Boilers, &c., L. Schutte, London.
3675. Elevators for Threshing Machines, H. Mautner, London.
3676. Drawing-off Liquids, G. J. Porter, London.
3677. Exercising Apparatus, A. H. Spencer, London.
3678. Pump, G. Lansell, London.
3679. Purifying and Heating Water, J. E. Prunty, London.
3680. Cementing of Armour-plates, D. Vickers, London.
3681. Mantles for Incandescent Gas Lighting, W. Mackean and the Incandescent Gas Light Company, Ld., London.
3682. Switches, Siemens Bros. and Co., Ld., and Z. H. Kingdon, London.
3683. Rolling Tubes, J. Imray.—(*M. Mannesmann, Germany.*)
3684. Variable Speed Gear, F. J. Warden-Stevens, London.
3685. Boot and Shoe Lace Fastener, W. J. Tooley, London.
3686. Governors, W. Sisson, London.
3687. Machine for Cutting Butter, G. S. Jakins, London.
3688. Portable Drilling Machines, E. B. Donkin, London.
3689. Water-tube Boilers, H. F. Phillips, London.
3690. System of Propulsion, A. C. Shuttleworth, London.
3691. Mortise Fastenings, S. Hill and R. Hodges, London.
3692. Machines for Open Metal Work, J. F. Golding, London.
3693. Waist Belts or Bands, A. and J. Hopkinson, London.
3694. Stone Bore, H. Schwartzenhauer, London.
3695. Fixing Button-hole Protectors, C. Sander, London.
3696. Engines, W. B. and C. S. Brough and A. Smith, London.
3697. Cyclometers, C. Dinichert, jun., London.
3698. Wheel Rims, G. J. Stevens, London.
3699. Clips, G. J. Stevens, London.
3700. Boat Detaching Gear, A. M. Clark.—(*T. J. Eldridge, China.*)
3701. Tires, Z. Foster, London.
3702. Adding and Printing Machines, G. W. Dudley, London.
3703. Shear Cutting of Cloth or Fabrics, F. Leslie, London.
3704. Means for Promoting Perspiration, G. J. Epstein, London.
3705. Dynamo-electric Machines, V. A. Fynn, London.
3706. Pharmaceutical Product, J. Y. Johnson.—(*Vereinigte Chininfabriken Zimmer and Co., Germany.*)
3707. Brace Connector, C. R. Harris and W. Freeman, London.
3708. Lathes, R. Haddan.—(*J. B. Clyne, United States.*)
3709. Lathes, R. Haddan.—(*J. B. Cline, United States.*)
3710. Making Imitation Straw Hats, J. L. Pollock, London.
3711. Rack for Storing Fruit, W. Walton and W. Ellis, London.
3712. Accumulators, F. Mouterde, C. Chavant, and J. George, London.
3713. Calendering Machines, E. Gessner, London.
3714. Laundering Apparatus, D. Reynolds, London.
3715. Treating Skins, J. W. Peirson and F. A. T. Moor, London.
3716. Door Mats, &c., J. Archer and J. Archer, jun., London.
3717. Seats or Saddles for Cycles, H. J. Wells, London.
3718. Motor Vehicles, H. J. Lawson, London.
3719. Ring Spinning and Doubling Frames, T. Bour, London.
3720. Producing Art Decorations, J. T. Lawrence, London.
3721. Air-tight Boxes, T. Gracey, London.
3722. Cleaning Tobacco Pipes, I. B. Sturgis and J. E. Young, London.
3723. Lawn Rakes, A. C. Peynton, London.
3724. Capsule Machines, S. A. Rickard, London.
3725. Colours, R. McKenzie, London.
3726. Brick Moulds, J. A. Noel, London.

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3727. Air Compressors, C. A. Allison.—(*The Berner-Mayer Company, United States.*)
3728. Whistle, Hawkes and Co. (J. H., B. R., A. E., and B. J. White), London.
3729. Making Lasts for Boots, F. A. Pugh, Northampton.
3730. Vegetable, &c., A. S. Walker and T. H. Hooper, London.
3731. Cycle Rest, P. Weston, H. Johnston, H. Vahey Birkenhead.
3732. Wickless Oil Lamps, F. Windham, London.
3733. Pneumatic Tired Wheels, S. H. Pillar, Dublin.
3734. Indicator, S. Williams, Cardiff.
3735. Shutter Fasteners, A. Jones, Bromwich.
3736. Electrical Accumulators, T. Parker, Wolverhampton.
3737. Parts of Cycles, B. Shorthouse, Birmingham.
3738. Vacuum Brakes, D. Tindal, Glasgow.
3739. Motors, W. J. Crossley and R. D. Hulley, Manchester.
3740. Water Taps, &c., T. G. Rhodes and R. Gaunt, Leeds.
3741. Heating and Forging Furnaces, W. W. Barnes, Cumberland.
3742. Core Bars, G. E. Vaughan and J. and S. Roberts, Birmingham.
3743. Attaching Handles to Brushes, J. Sullivan, Cardiff.
3744. Bakers' Ovens, J. G. Ayton, Glasgow.
3745. Levelling Instrument, F. R. M. Phelps and P. Daw, Birmingham.
3746. Forks for Cycles, S. G. Whitehouse, Birmingham.
3747. Flushing Apparatus, T. Holcroft and Sons and A. H. Mould, Wolverhampton.
3748. Construction of Heavy Bells, A. W. Spence, Dublin.
3749. Rack Pulley, T. D. Harries, Aberystwyth.
3750. Metallic Packing for Rods, E. Waddington, Barrow-in-Furness.
3751. Saws for Stone Cutting, J. H Howarth, Manchester.
3752. Force Pump, F. J. Cheesbrough.—(*J. Schanz and Co., Germany.*)
3753. Soles and Heels of Boots and Shoes, A. Barr, Glasgow.
3754. Paper Bindings, &c., T. S. Griesbach, Birmingham.
3755. Letter Boxes, O. F. von der Pfordten, Berlin.
3756. Detachable Pneumatic Tire, C. A. L. Burkitt, Birmingham.
3757. Manufacture of Chests of Drawers, A. Novitzki, London.
3758. Packing for Piston Rods, &c., T. Keene, Liverpool.
3759. Incandescent Gas Lighting, &c., D. McFie, Glasgow.
3760. Construction of Wheels of Cycles, T. Burrows, London.
3761. Eight-day Electric Alarm, G. H. Skee, Bishop Auckland.
3762. Scouring and Polishing Powder, T. C. Childs, London.
3763. Method of Cure for Consumption, C. Dorr, London.
3764. Producing Photographic Prints, J. Martyn, Suffolk.
3765. Holders or Containers for Vestas, F. Hymmen, London.
3766. Waist Attachment for Cyclists, J. R. Pearce, London.
3767. Agricultural Forks, J. Mills, Lye, near Stourbridge.
3768. Ropes, S. H. Hudston, London.

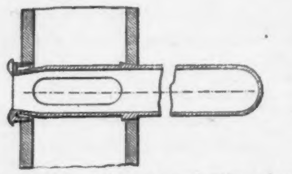
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

550,350. Metallic Joint for Boilers, *J. P. E. and A. G. L. Niclausse, Paris, France.—Filed August 27th*, 1895.

Claim.—(1) In combination with two or more perforated parallel boiler-plates, a tube adapted to be inserted in the perforations of said plates, the exterior of said tube being provided with conical bearing shoulders corresponding in number with said plates, one or more of said shoulders being flexible, and the taper of all the shoulders extending in the same direction, substantially as described. (2) In combination with two parallel perforated boiler-plates, a tube adapted to be inserted in the perforations of said plates, and having on its exterior at one end a flexible conical bearing shoulder, and provided at a distance therefrom slightly less than the distance between said plates with an external fixed conical shoulder, said shoulders adapted to be driven into the perforations of said plates, and the flexible shoulder adapted to enter its perforation before the solid shoulder, substantially as described.

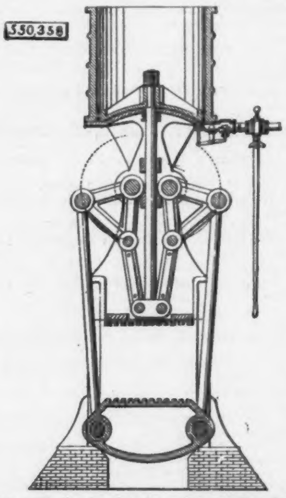
550,350



550,358. Cotton Compressor, *S. J. Webb, Shreveport, La.—Filed February 16th*, 1893.

Claim.—(1) The combination with the main frame and stationary platen, of the movable platen, the compound toggles, each consisting of the three sides in triangular form, pivotally mounted on the frame, the piston-rod and links connecting the toggles with the piston-rod, the links being normally in substantially a right line with the inner sides of the toggles and rods connecting the platen with the toggles at a point on a line between the pivotal point of the toggles and the point of connection with the links, substantially as described. (2) The combination with the main frame, a piston and piston-rod, and a stationary platen, of the movable platen, the triangular compound toggles pivoted to the frame at their upper inner angles, rods connected to the movable platen and to the toggles at their outer angles, and links pivoted at one end to the lower angle of the toggle and connected at their other end to an engine, substantially as described.

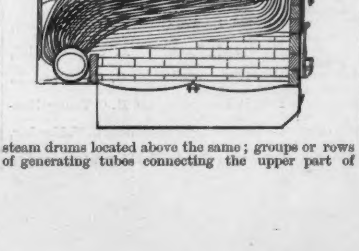
550,358



550,571. Steam Generator, *C. D. Mosher, New York, N.Y.—Filed August 24th*, 1894.

Claim.—(1) A steam generator comprising in its construction one or more water drums, one or more steam drums located above the same; groups or rows of generating tubes connecting the upper part of the water drum with the upper part of the steam drum, and a group or row of return or circulating tubes, said row extending lengthwise of drums and connecting the lower part of the steam drum with the water drum, and the tubes of the row being closely assembled to form a closed wall outside of said generating tubes. (2) In a steam generator, a steam drum having a hole at a suitable part, a hollow boss or neck fastened to the drum around the said hole and having an internal annular protuberance at a point removed from the drum, and a feedwater pipe passing through the said hole in the drum and fastened in said annular protuberance.

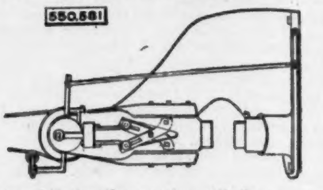
550, 571



550,581. Power Hammer, *W. H. Botting, Fitchburg, Mass.—Filed August 15th*, 1894.

Claim.—(1) In a power hammer, the combination with the reciprocatory hammer head, power shaft and spring arms interposed between the power shaft and hammer head, of the drive pulley journalled loosely on the power shaft, the clutch for connecting the pulley and shaft, the clutch shifter for throwing the clutch into engagement, the loose belt for the pulley and the belt tightener moved by the clutch shifter, whereby the clutch may be thrown into engagement and the belt tightened by a continued operation, substantially as described. (2) In a power hammer, the combination with the reciprocating hammer head having the ways formed in a single piece of metal secured thereon, said ways being inclined for a short distance at the top, then running vertically, and then having their lower ends inclined again, as shown, the power shaft, the crank on the power shaft, the pair of spring arms reciprocated by the crank and working in the ways, said arms forming the support for the hammer head, substantially as described. (3) In a power hammer, the combination with the reciprocating hammer head, power shaft and spring arms interposed between the power shaft and hammer head, of the drive pulley journalled loosely on the power shaft, the clutch for connecting the pulley and shaft, the disc having the cam or projection mounted on the shaft between the pulley and frame of the machine, whereby when said disc is turned the cam or projection will force the disc and pulley outward and throw the clutch into engagement, substantially as described.

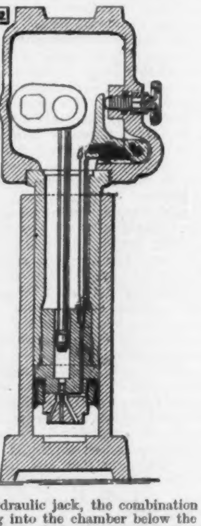
550,581



550,702. Hydraulic Jack, *J. Weeks, New York, N.Y.—Filed August 27th*, 1895.

Claim.—(1) In a hydraulic jack, the combination of a pump detachable from the ram, and which discharges into the chamber below the ram, a back flow passage made in the pump, separate and distinct from the bore thereof, a bonnet at the lower end of the pump having a water passage connected with the said back flow passage, a valve actuated by a bell crank and a screw plug actuated from the exterior of the jack, which operates said bell crank, for the purposes set forth. (2) In a hydraulic jack, the combination of a pump discharging into the chamber below the ram, a back flow passage made in the pump, separate and distinct from the bore thereof, a valve actuated from the exterior of the jack and a spring whose normal tendency is to unseat said valve, for the purposes set forth. (3) In a hydraulic jack, the combination of a pump discharging into the chamber below the ram, a back flow passage made in the pump, separate and distinct from the bore thereof, a valve which closes said back flow passage, a lever to close it, a spring to open it, and means operated from the exterior of the jack to actuate said lever, for the purposes fet forth.

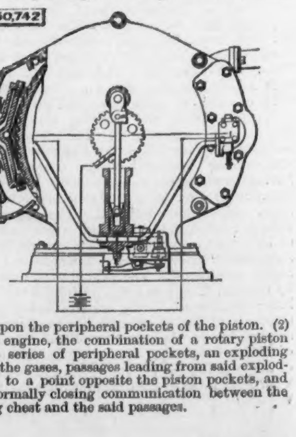
550,702



550,742. Rotary Gas Engine, *W. R. Campbell, Philadelphia, Pa.—Filed April 2nd*, 1895.

Claim.—(1) In a gas engine, the combination of a rotary piston having peripheral pockets, an exploding chest for the gases, and a valve normally closing said exploding chest, said valve being so arranged and disposed as to be opened by the force of the explosion to permit the exploded gases to escape from said chamber and act upon the peripheral pockets of the piston. (2) In a gas engine, the combination of a rotary piston having a series of peripheral pockets, an exploding chest for the gases, passages leading from said exploding chest to a point opposite the piston pockets, and a valve normally closing communication between the exploding chest and the said passages.

550,742



QUICK-FIRE NAVAL GUN SIGHTS.

THE latest developments in the construction of the breech mechanism and ammunition supply of naval ordnance appear to have brought advance in the direction of speed to finality, for it is found that with a competent crew the gun is always ready before the gunner if any alteration in aim is necessary between the shots, or if the motion of the vessel necessitates the seizure of a certain moment for the discharge of the projectile. With the 4·7in. Elswick pattern quick-fire guns, for example, eleven rounds a minute unaimed can be fired; but good practice at a moving target cannot be attained at a rate exceeding slightly more than half this speed. With guns of larger calibre the possible rapidity of fire is slightly reduced on account of the very considerably heavier charges and projectiles to be handled, but at the same time, the quickness of training and elevating is also lessened, though not in a marked degree till the 8in. gun is reached. In larger guns, as the ammunition has to be supplied separately, the rapidity of fire is greatly reduced, two rounds per minute being about the maximum to be expected from a 10in. gun, and possibly two rounds in three minutes from the new 12in. But in all these sizes, as the weight of the mountings renders it impossible to train and elevate expeditiously by manual power, machinery of some sort, either steam, hydraulic, or electric, has to be employed, and in the starting, stopping, and reversing of machinery there is always a certain percentage of time lost. The momentum produced in a large mass moving at a high speed renders it necessary to slow down before finally stopping, so that the last part of a movement must be always more or less a crawl. The consequence is then the same as that with the smaller guns, that the gun, except under very favourable conditions, is ready for firing before the aim is obtained.

There can be no doubt whatever that as soon as it is asked for, an 8in. or 10in. gun, capable of firing seven or eight rounds a minute unaimed, will be produced. It is not probable that such rapidity of fire in ordnance of larger calibre will ever be demanded. The life of a big gun is comparatively short, say from seventy to eighty full rounds; and though in warfare the half charge or even quarter charge would be used as frequently as possible, the maximum number of mixed rounds would not exceed, say, 150, before the precision of the gun would be destroyed, and re-lining, of the chamber end at any rate, necessitated. It may, then, be safely assumed that, except under excessive pressure, the very greatest care would be taken that every shot from a big gun found the target it was aimed at, and under the average conditions of naval warfare this would mean a great number of mis-aims, if we may employ the term to signify witholding fire because of doubtful aim, so that the actual maximum speed of firing big guns would not probably exceed two in six minutes under existing conditions. The probability, however, is that the maximum size for ship guns in the future will not exceed 10in., the great reduction in weight of the piece, which more nearly varies as the square than directly as the calibre, and the consequent decrease in the weight of the mounting, will then render it possible to attain a greater speed of fire, and with further improvements in the handling of ammunition and loading, we may expect in a short time to come to a similar position to that now held by the smaller guns, that is to say, the gun will be ready before the gunner. It is desirable that this should be so to a limited extent, by, say, about one round in ten, but not more.

The direction in which we must look then, if greater rapidity of fire is to be found, is towards the improvement of sighting arrangements. The problems which are presented for solution before any advance can be expected are exceedingly difficult of solution, for as the present form of sight has been brought to almost if not perfect mechanical perfection, it is necessary, if any important progress is to be made, to enter entirely new fields. In order to bring the question as clearly as possible before our readers, let us enumerate the essential characteristics of a first-class sight as now employed, and then point out the features which we consider must be sought for and obtained before a sight equal in perfection to the gun shall be found. A first-rate quick-fire sight then must, besides being accurate—(1) be entirely independent of any motion of the gun in recoil; it must be attached, that is to say, to the carriage or part of the mounting which is unaffected by firing; (2) it must be simple in construction, easily repaired, and readily replaced; (3) it must not be affected by severe blows on the shield or even mounting, but should keep in accord with the gun as long as the latter is serviceable; (4) its manipulation must be rapid and of the simplest character, small scale readings and verniers are not admissible; (5) it must be serviceable by day and night, and be so placed that the field of vision within its range is wide; finally, it must be unaffected by the weather, strong and accurate in construction, open to the readiest comprehension, and not liable to slip or change its position from the shock of firing. Furthermore, it must be placed in such a position that the gunner is in a convenient attitude, leaning against a support by preference, for its use, and at such a distance from him that both the fore and back sight may be kept in focus at the same time. All these conditions are very fairly met by the sights now used in our own and most foreign navies. One very grave objection, however, obtains; and one very important feature is absent. To correct the first, and to produce the second, must be the work of inventors in this field. The objection is that the sight is placed in a most hazardous position, and in one which necessitates considerably weakening the gun shield. This position is unfortunately necessitated by the existing conditions, and the design of the sights and mountings; for in order to avoid small scale division, and to ensure accuracy, the fore and backsight must be about 36in. apart; at the same time the rear sight must not be closer than 12in. to the eye of the operator, or both points cannot be got into focus at the same time. The result is that the front sight is altogether about 4ft. from the operator, who stands beside the gun, and consequently has to project through the shield, which, in order to save space, is as close to the actual mounting as possible. This means that it is entirely unprotected, except by the gun. Furthermore, as the field of view must not be restricted, a large hole is necessary in the front of the shield around the sight, and as the sight must clear the shield at all angles of depression or elevation this hole becomes a long slot extending in some mountings right along the inclined roof of the shields. In our Navy it is customary to duplicate the sights so that two similar apertures, one on the right and one on the left of the mounting, have to be cut. It is unnecessary to point out that these not only very considerably weaken the shield, but leave way for the small shot of the enemy's quick-fire guns to reach the gun crew. As it is impossible to overrate the importance of the sights to instruments of such precision as the modern quick-fire gun, it is a fact that is greatly to be regretted that it is still necessary to put them in so vulnerable a position, and it is sincerely to be hoped that a place of more safety may be found for them. We may mention here in passing that the fore sights of big guns in barbettes protected by shields, as in the two latest battleships, the Majestic and Magnificent, stand up as steel rods on the roof of the shield, a position where, it would seem, they could not for a moment live in a battle, as the explosion of even a small shell on the roof would mean in all probability the destruction of both. Of course they are readily replaceable from within the shield, but that is not sufficient. Some means of protecting them is needed.

The feature that we must look for in the new instrument is that it shall be not only a sight but a range finder, and a range finder of such a property that the same operation which would, or does, show the distance of the target brings the gun to the correct elevation to strike that target. A little consideration will show that if the first is obtained, the second is easily achievable. We cannot at this time enter into a discussion of the various range-finders which have from time to time been made or suggested. Only one, the Barr and Stroud, that has been actually made and used with success, comes within any possibility of the application we suggest. It depends for its action on the optical measurement of an exceedingly small angle.

Another instrument has been hinted at, and we believe some experiments have been made with it. If it can ever be brought to perfection, it is the very thing that will meet the case almost completely. Roughly it may be described as a telescope, the mere fact of focussing indicating at once the range. The development of the idea is in the province of opticians, who we hope will attack the problem; the application of it would belong to the artillerist, and with it he could do great things. It could be attached, let us suppose, by a joint close to the object glass, allowing of movement in elevation and depression near a small hole in the shield front. Its angle with the horizon would not affect or be affected by the gun, but the same hand-wheel which would be actuated, as at present, to elevate the gun would be connected with the focussing apparatus of the telescope, so that the very means of bringing the target in focus would at the same time bring the gun to the right elevation to strike it. There would be no setting of angles or judging of distances, no need of an officer to direct the elevation, no need to think of the elevation at all. The operation would be simple, direct, and perfect. Whether the design of such an instrument is possible we cannot say, it is a matter, as we have already said, for the optician. Possibly the same principle of a divided image which Professors Barr and Stroud have used so ably might still be employed; possibly a moving diaphragm might be used to find the true focus. There are many very great difficulties to surmount, and when they are surmounted there will still be the objection to the apparatus of the presence of glasses or prism. Still it would be a move in the right direction, and we hope to see some capable minds directed to the solution of the problem.

ENGINEERS IN THE UNITED STATES NAVY.

FOR many years complaints, more or less energetic, have been made by the engineers of the United States navy concerning their treatment. These complaints have been supported and extended by men who thought of their country first, and of the engineers subsequently. The engineers grumbled because they had very hard work to perform and got little in return, either in the way of pay or position; but the patriots held that the efficiency of the whole class should be augmented on national grounds, that large additions should be made to the number of engineers, and that increased pay and better position should be given, as a means of obtaining men and of making them when obtained contented. Mr. Melville, the Engineer-in-Chief of the United States Navy, has constantly directed the attention of Congress to the pressing need for reform; but nothing has been done. At the present moment the position of the naval engineer in the United States, his status, his rank, are almost identical with that of his English brother. The grievances which exist are practically similar. The same charges are brought at both sides of the Atlantic against the exclusiveness and arrogance of the executive, or military element, and the like difficulty is experienced in obtaining engineers. Hitherto the Government has relied largely on the Training Academy at Annapolis; but the supply of cadet engineers is quite inadequate. In 1861 the United States navy contained fifty-two sailing ships and thirty-six steam ships in commission. On board these were 667 naval officers and 174 naval engineers. The civil war rendered large additions necessary, and these were maintained for some time, so that in 1865 there were on the navy register 2463 naval officers and 2279 engineers. Subsequently large reductions were made, and the numbers stand at present at 710 officers and 172 engineers. If war broke out, it is feared that much difficulty would be experienced in obtaining engineers. To provide a supply, Mr. Squire has brought a Bill into the Senate, and one somewhat similar has been introduced at the same time into the House of Representatives by Mr. Wilson. Officially, these are regarded as one, and spoken of by the New York Press as the Wilson-Squire Bill. In another page we give the full text of this Bill. The Bill was introduced in the Senate by Senator Squire, of Washington, on the 10th of December, 1895, and the House Bill by Mr. Wilson, of New York, on the 10th of January, 1896. The latter Bill gives the engineer a far better position than he has hitherto occupied. The Bill places in the hands of the engineer-in-chief the inspection of steel for the ships of the new navy, thus seeking to avoid any repetition of the troubles which have occurred over steel inspection in the last few years. It permits the staff officer to rise to the rank of commodore. It allows staff officers to retire after thirty-five years' service. It gives substantial encouragement to enlisted men to work for commissions.

Long since it was felt that difficulties might arise, and preclude the Government from obtaining a sufficient number of trained engineers. To meet this difficulty an Act was passed in 1879 which runs as follows:—

> For the purpose of promoting a knowledge of steam engineering and iron shipbuilding among the young men of the United States, the President may, upon the application of an established scientific school or college within the United States, detail an officer from the engineer corps of the navy as professor in such school or college; provided that the number of officers so detailed shall not at any time exceed twenty-five, and such details shall be governed by rules to be prescribed from time to time by the President; and provided further, that such details may be withheld or withdrawn whenever, in the judgment of the President, the interests of the public service shall so require.

It seems that no action was taken in consequence. The technical schools and colleges did not ask for an engineer instructor. The Act became a dead letter. Recently, however, the State University of Washington applied to the Bureau of Steam Engineering for an engineer instructor, and the request was refused on the ground that there was not an engineer available for the duty. The facts are very instructive for our own Government. Here we find the United States Government offering special advantages to technical schools and colleges, up to the number of twenty-five, and not one availed itself of the privilege. Why? Simply because the naval service was so unattractive that none of the pupils would enter it. If service in the engineer corps of the United States Navy had been worth having then the colleges and schools would have been crowded with students anxious to prepare for it.

In the United States the Press has taken up the question with much energy and spirit. Popular opinion appears to be aroused, and the probabilities are that something will be done. Quite a flood of literature has been distributed discussing the question from various points of view. The following quotation from a pamphlet will serve to show one:—

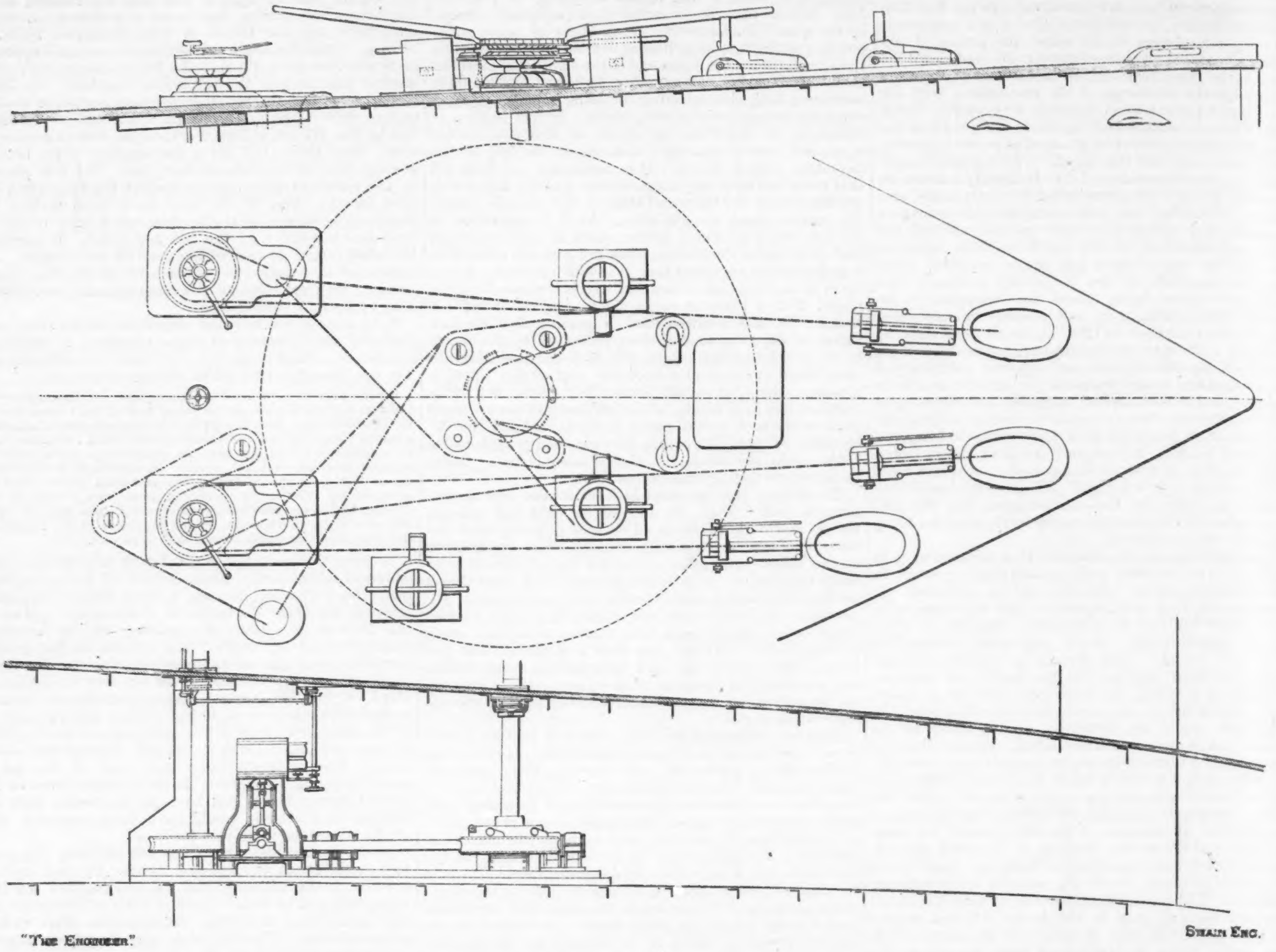
> A modern warship is absolutely destitute of sails, so that when its machinery is at rest, the vessel lies an inert hulk on the water, powerless for offence, and almost totally so for defence.
>
> The engineer *personnel* has thus absolutely superseded the seamen contingent so far as concerns the knowledge and practice of propelling the ship.
>
> The sailor *personnel* has disappeared with the sails, and their real function is simply to use the artillery of the vessel and to perform those routine duties which require no special training of either officers or men. These routine duties consist of maintaining police order, keeping the bright work and hull clean, and supervising the petty details of life on board ship. The navigation of a modern vessel, whose motive power is steam alone, is not a difficult matter, and has been learned in a few weeks by an ordinarily educated lad. The special function of the line *personnel* therefore on a modern battleship is the care, maintenance and operation of the artillery service, which includes the care of the torpedo. No special education is required for anything else in either officers or men. The modern vessel is a mass of complicated machines, whose efficiency therefore rests upon the ability and skill of the naval engineer.

It may, perhaps, be urged that this is going a little too far; but it will be admitted that it is difficult to talk of sailors when a ship never sails. The dominant idea still existing in the British Navy—indeed, in all navies—is that there must be sailors; that the sailor stands first, that the sailor is most important, and that the engineer and his crew are only adjuncts, so to speak, of little real importance. It is quite time that this theory was given up. It had a sound basis while ships were only fitted with auxiliary machinery. In such vessels, for example, as the old Blenheim or the more modern Duke of Wellington, the sailors were still all important, the engineers had very little to do; the engines were of small power and seldom used. The Blenheim, for instance, indicated about 500-horse power, the revolutions were 43 per minute, and the speed of the ship 5·8 knots. With the batteries of the ship the engineers had nothing to do. The part they played was, from first to last, subordinate. The crew was divided roughly into gunners, sail trimmers, and marines—that is, sea soldiers. A certain number of men were always enlisted with the condition that "they should stoke when required." In the modern ship the crew is virtually divided into gunners and stokers. The officers are artillerists or engineers. There is no longer a sailing master; his place is taken by the navigating officers. The gunners are mainly dependent on the engineer; the torpedoist is quite dependent on him. The most important man save the captain on board a modern man-of-war is the chief engineer. It seems mere waste of time to insist on the point; and yet the fact might as well not exist. The naval engineer still holds in our fleet a subordinate position. There are still attached to the office certain disabilities, and the service is still so unattractive that great difficulty is met with in obtaining the requisite number of men.

In dealing with this question in this country, and we may add in the United States, the advocates of progress and prudence have found the great obstacle in their

ANCHOR GEAR FOR H.M.S. VICTORIOUS

MESSRS. BAXTERS LIMITED, SANDIACRE, NOTTINGHAM, ENGINEERS.



"The Engineer" Swain Eng.

path to be the inertness of the opposition which they encountered. The authorities have never disputed the accuracy of the facts; they have never argued that the policy of those who want to see the engine-rooms of our warships well supplied with cheerful, competent men, was wrong; they have let the whole case against them go by default, and yet they have done nothing; they have simply taken no notice; they have disputed nothing; they have done nothing. Recent events have awakened the country to the necessity of strengthening our Navy. But the strength of our Navy lies at least as much in the engine-room as the barbette; in the stokeholds as in the principal battery. Mr. Goschen has an unrivalled opportunity now of doing what is right—let us hope that he will avail himself of it. That which is being done in the United States may perhaps help him on the right path. It is to the last degree unlikely that a single voice would be raised in the House of Commons if the First Lord of the Admiralty proposed to improve the position of the engineers of the Royal Navy, to increase their pay, add to their rank, and augment their numbers; none would say him nay, unless, indeed, it might be a small section of the executive, jealous of their privileges and antiquated in their prejudices.

In the United States a determined attempt is being made, and properly made, to give the engineers higher social standing by assimilating their titles to those of the executive. In this country something of the kind has been done as regards the medical branch of the army, for we have now such titles as surgeon-captain, surgeon-major, and so on. One writer says, referring to the Wilson-Squire Bill:—

> By giving the engineer all the prerogatives of his rank there would be real discipline maintained instead of the present unsatisfactory system, which is merely nominal discipline. The present naval organisation invites dissension, and there is a constant conflict between the officers of the line and the staff, the parallel of which is not seen in the army. By giving positive ranks and title there would be efficient action on the part of all, whereas no such action is possible now, except by the rare concurrence of persons of exceptional qualities on both sides, who tacitly agree to ignore absurd regulations, and to act on the basis of common sense and self-evident propriety. The patriotic and important provisions which are contained in these measures will be nugatory unless the engineer officers are given positive rank and all the prerogatives which such rank should confer. The title should in reason, custom and propriety accompany the rank when it is given by Congress, and the only people in the country who object to such action are the few line officers of the navy. The line of the army make no claim that the possession of titles by the staff is derogatory to the interests of the military establishment. To pretend that the titles of admiral, captain, commodore, lieutenant, &c., indicate, *sui generis*, the profession or duties of line officers, is false and misleading. There are officers of other corps whose duties require an exactly similar arrangement of rank and title; so that their position with others in the military and naval service may be absolutely established. The officers of the staff corps should have therefore the same title or name of rank, their official address, however, being that title with the addition of the name of their corps. Such an arrangement would show at once where each officer stands relatively to all other officers in the service. It is the only way in which they can be known officially as officers at all either in practical life or when on duty.

This means, of course, that the title only refers to rank and not to duties. The chief-engineer of a ship would rank as engineer-captain, or engineer-commander. It may be said that this would at once place the engineer on a level with the executive officers. Quite so: that is the intention, and it remains to be seen why he should not be on that level. Under all possible circumstances the captain of a ship is supreme; but we do not see why we should not have an engineer-lieutenant as well as a gunnery-lieutenant, or a navigating-lieutenant. Sooner or later the change must come, and the position and power of the engineer will be recognised. We hope that the action taken in the United States may receive in this country the notice that it deserves; and, in the discussion of the Naval Estimates, the attention of the Government may be drawn to the Wilson-Squire Bill, and at last an expression of opinion elicited in the House. Even that would be something gained.

ANCHOR GEAR FOR H.M.S. VICTORIOUS.

Not the least important of the auxiliary machinery on board a modern ironclad is that part for manipulating the anchors, an illustration of which we give this week. The arrangement as shown is that fitted on board H.M.S. Victorious, and is known as Baxter's vertical gear. Among the many advantages claimed for this arrangement, it may be pointed out that the brakes, otherwise a source of great trouble, are readily overhauled, removed, and cleaned. The principal working parts are portable, and so arranged that each separate part can be overhauled without dismounting the main parts, and the stresses are kept low down to the decks, reducing to a minimum the risk and danger of broken gearing, bent shafts, and disabled engines, so frequent in the old type of gear.

The two main cable holders for the bower cables are mounted upon cylindrical bearings securely bolted to the deck, through which the driving spindles pass, thereby confining the torsional stresses to the spindles, and the shearing stresses to cylindrical necks. For heaving in cable, either of the cable holders is connected frictionally to the spindles by setting up the hand wheel; and it may here be mentioned that at the steam trial carried out by the contractors at their works, the test load of 35 tons was lifted up by the frictional contact set up by one man by means of a 3ft. lever, thus proving that the anchors and cables of the extreme dimensions used in a first-class battleship are capable of being controlled, let go, and brought up by one man.

The main spindles are driven by a double cylinder engine, through worm gearing, which, in combination with the frictional connection above referred to and the pawling action of the worm, gives a security against the parting of cables should exceptional shocks occur.

The capstan is designed with a cable holder for working either of the sheet cables, and is also fitted with a cat chain wheel for catting and fishing purposes, and is arranged for working by steam through worm gearing, and by hand with capstan bars.

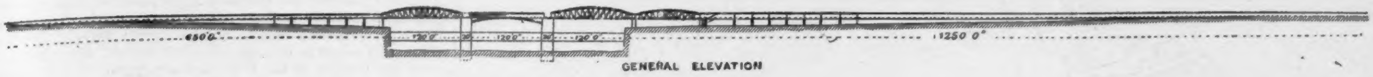
The gear was satisfactorily tested at the contractors' works in the presence of Admiralty officials by lifting a dead weight through 10ft. at the rate of 25ft. per minute. The weight in the case of the forward gear is 35 tons, and of the after gear 15 tons.

THE NEW PHOTOGRAPHY.

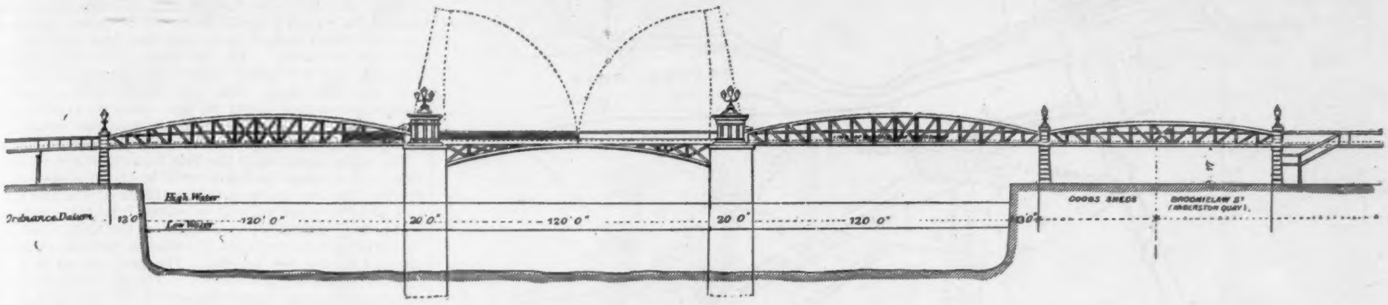
It is barely two months since the news of Professor Röntgen's striking experiments was received with scepticism. By many it was looked upon as a journalistic hoax, and it was ridiculed pretty freely in the photographic and other journals. Within a month of the details of the discovery being made known the experiments had been repeated by several independent investigators, and instead of the alleged discovery being looked upon as an impossibility, it had arrived at that second stage in the history of most new inventions when it is said to be something which everybody knew before. Professor Röntgen found that when passing the discharge from a large induction coil through a well exhausted Crookes' or similar vacuum tube, a particular class of rays or emanations was given off which differed in some respects from any before known to the scientific world. While invisible to eyesight, they had the power of penetrating through all substances to a greater or less extent; the fact of their penetration being proved by their effect on an ordinary sensitised plate such as is used in photography. Where the rays were prevented from acting with their full force on the sensitive plate by the interposition of some substance, a shadow of the substance was cast and left its image on the plate after development by the ordinary methods. Thus the professor's hand held in front of the plate gave an image showing the bony skeleton very plainly, with the flesh faintly outlined around it, while the image of a ring on one finger was more clearly defined than the bones. The rays passed freely through boards of pine over an inch in thickness and through a book of a thousand pages, while a plate of glass half an inch thick greatly reduced their power. Besides their invisibility, the rays had other properties which rendered them unlike the rays of ordinary light; they could not be reflected, nor could they be refracted, by prisms containing water or bisulphide of carbon, so that the use of a lens to concentrate them was rendered impossible.

So far Röntgen's experiments, although of a much more practical and striking character than any previously achieved, did not point so much to a new discovery as to the confirmation of the previous discoveries of Hertz and Lenard, and the labours of both these investigators are referred to in Professor Röntgen's paper. Some years ago Hertz showed that particular emanations from the vacuum tube would penetrate thin metal, and in 1893 Philip Lenard described before the Prussian Academy of Sciences an arrangement by which the rays were made to pass through a plate of aluminium of about the thickness of gold leaf, and also succeeded in photographing objects in this way. The prin-

PROPOSED NEW BRIDGE OVER THE CLYDE AT GLASGOW



GENERAL ELEVATION



ELEVATION OF PART ACROSS RIVER & QUAYS

cipal difference between the new and the old radiations appears to lie in the fact that the latter, which are known as cathodic rays, can be deflected by magnets, while the former, which for the present are spoken of as *x*-rays, cannot be so deflected. Cathodic rays also will only pass through very thin films of glass, aluminium, and other substances, while the *x*-rays, as before pointed out, will pass through much greater thicknesses.

No sooner had the necessary details of apparatus and methods become known than scores of experimenters were at work, and within a few days results were obtained quite as convincing as those of the original investigator. Mr. Gifford, Mr. Campbell Swinton, Prof. Oliver Lodge, Prof. Sylvanus P. Thompson, and Mr. Leslie Miller, in conjunction with the editor of the *Photographic News*, were amongst the first in the field, and numerous photographs of skeleton hands and feet, coins, keys, metal rings, and other objects were obtained under conditions which three months ago would have been declared impossible. In various hospitals the new discovery was put to use in revealing broken bones, bullets embedded in the flesh, calculus in the bladder, and other matters of surgical interest. In spite, however, of the number of experts who have been engaged in its investigation, it must be confessed that no additional light has been thrown on the nature of the rays.

So far as theory goes, nothing but conjecture has yet been made public. Röntgen himself only ventures to suggest that they may be due to longitudinal vibrations in the ether, which up to the present have never been demonstrated to exist, but which Clerk Maxwell and other physicists look upon as probable. Professor Lodge has also expressed his inclination to adopt this theory. Certain details which are necessary to obtain successful results have been pointed out by Prof. Thompson and others, great stress being laid upon the thorough exhaustion of the Crookes' tube and the use of a current of appropriate strength. A curious experiment detailed by Mr. G. M. Keevil shows that it is possible to dispense with the Crookes' tube, using in its place a 50-candle incandescent lamp with the filaments broken and the ends of the filaments half an inch apart. Mr. Keevil placed a dark slide containing a sensitive plate within 3in. of the lamp, and found that after twelve hours' exposure he had obtained photographic images of objects placed on the outside of the dark slide. It has been asserted that similar results have been obtained with an ordinary paraffin lamp, but this so far lacks confirmation.

The latest development of the discovery, as described in a communication from Mr. Leslie Miller, dated February 25th, and since confirmed by other workers, is of great interest, inasmuch as it goes to prove that the photographing of the images may be dispensed with, and that they can be made directly visible to the eye; that is to say, that with the aid of the Röntgen rays it is possible to see metallic substances when shut up in a wooden box. The process depends on the fact that the rays excite fluorescence in certain chemical substances, amongst others crystals of barium platino-cyanide. Mr. Miller arranged a plate of ground glass horizontally, covered it with the crystals, and on top of these placed sheets of brown and black paper. A coin enclosed in a match-box was placed above these, and illuminated with the rays from a Crookes' tube, when it was found on looking at the under side of the ground glass by means of a reflector that the rays penetrated the paper and wood, making the crystals glow with fluorescence, while in the middle was seen the shadow of the comparatively opaque coin. Whatever may be the final outcome of Röntgen's discovery, it is evidently one which will have important influences on both theoretical and practical science. Professor Schuster has expressed his belief that we are on the eve of a discovery which will link the hitherto isolated force of gravity with the higher forces of nature.

THE PROPOSED NEW BRIDGE OVER THE CLYDE AT GLASGOW.

THE rapid growth of the commerce of the "Second City of the Empire" is making itself felt in demands for increased facilities in cross-river communication, and the attention of the Special Committee on the subject has recently reported to the Glasgow Police Commissioners in reference to the district lying between Jamaica-street Bridge and Finnieston Ferry, a distance of 1800 yards, which is entirely without provision of any kind for vehicular cross-river traffic, notwithstanding the enormous increase of late years, both in dock accommodation and industrial works, in this locality.

In the space of 1521 yards above Jamaica-street Bridge no less than four bridges occur, viz., Victoria and Albert Bridges for heavy traffic, and South Portland-street and St. Andrew's Bridges for passenger traffic; whilst a little higher up both Rutherglen and Dalmarnock Bridges are situated, a state of matters pointing to the imperative necessity of additional facilities below Jamaica-street Bridge.

Attention is directed to a point about half-way between Finnieston-street and Jamaica-street, where the erection of a bridge with an opening span, would not inconvenience the river traffic, which is sufficiently small to cause the minimum of interruption to cross-river vehicular traffic by using the open span. At this point, which is just below, or to the west of Kingston Dock, the following traffic is found for twenty-four hours:—January 13th, 1896, vessels passing up, 12; vessels passing down, 20; total, 32.

The designs for the bridge show it to consist of three spans, each of 120ft., the centre one of which opens on the bascule principle, following the type adopted in the Tower Bridge, London. On the northern approach a span of 110ft. carries the structure over warehouses and sheds on the quay, and a series of smaller spans about 25ft. each gradually lower, each approach to form junctions with the streets at existing levels. The gradients on the north and south approaches are 1 in 169 and 1 in 63 respectively, and connection is formed with Stobcross-street and Paisley-road on the north and south sides of the river. Two piers will be founded in the Clyde, each having a width of 20ft. The bowstring type of girder has been adopted for the main spans, with a double system of lattice, the depths of the 120ft. and 110ft. spans being 15ft. and 10ft. respectively at the centres. The clear headway beneath the side spans at high water has been fixed at 25ft., a height sufficient to allow the "Cluthas," as the small river passenger steamers are locally known, and similar craft to pass beneath. The level of the bridge above that of the quays will be only 16ft. and 17ft. on the south and north sides respectively; and direct access to the bridge will be gained from the quays by staircases, enabling foot passengers to cross the river from quay to quay without traversing the approaches.

Some interesting statistics may be added to show how small inconvenience is caused either to land or water traffic by swing bridges. The swing bridge at Queen's Dock, Glasgow, during the year 1895, was opened on an average 24 times in 24 hours; whilst the daily average opening of the Kingston Dock Bridge, Glasgow, was 10 times per 24 hours. The rapid development of the trade of Glasgow cannot be better illustrated than by briefly pointing out that in the last fifty years the population has doubled itself, and that the revenue of the Clyde Trust has increased four-fold since 1854; and yet in all this period, and with all this growth, no alteration has been made for affording means of cross-river communication in this important district, over a mile in length, save the substitution, some twenty-five to thirty years ago, of steam ferry boats to convey passengers across, in place of the old hand-rowed craft; and this improvement was only carried out owing to an appalling accident which cost twenty-five lives, and raised public opinion.

When we add that the traffic on Jamaica-street Bridge is over 12,000 vehicles per twenty-four hours, a large proportion of which has its origin and destination on the north side, to the north and north-west of Jamaica-street, and on the south side to the south-west of Bridge-street, it will be noted how imperative is the need for the new structure whose erection is now occupying much attention in the flourishing commercial capital of Scotland.

LIGHT RAILWAYS.

ON the 20th ult. a lecture on "Light Railways" was given at the Imperial Institute by Mr. W. J. Brewer, who said the Light Railway question is one which is deservedly occupying much of the public attention, and the tone of the many letters and articles which have appeared during the last few months distinctly shows that the time has now come when something must be done to improve the means of transit between the various places in the districts under consideration. Government support is of vital importance, and it is hoped that the knowledge of the successful and ever increasing competition in commerce between this and foreign nations will induce Parliament to grant those facilities which will enable engineers and contractors to acquire concessions on a fair and reasonable basis without the present long, tedious, and expensive legal process. These light railways will doubtless do much good in districts not served by railways. The many arguments put forth by those having no sort of knowledge as to the meaning of light railways is merely waste of words, but unfortunately these people shout the loudest. What practical men require is a freer hand to turn concessions quickly and cheaply. Many years' experience on railways led him to think that nothing compared with a properly organised system of feeders for the main lines of railway conveying both passengers and goods. Electric lighting and electric transport might be jointly conducted. These lines will be a means by which a system of telegraphs and telephone lines can be established at a slight expense, and add to their income. Further, the station should be so constructed that the farmer or manufacturer may store his goods into cars ready for removal at these stations. The station-master should be in touch by telegraph or telephone with all his customers in his district.

The "autocar" will no doubt find its place for light goods and people who may like to take the country roads, but the "autocar" can never do the work of a light railway, because no road can ever equal the surface of a rail. If we could maintain in country districts roads equal to those in towns, then "autocars" would be vastly more serviceable than they ever can be on an ordinary road.

Some have urged that these feeder lines should be of the same gauge as the main lines with which they connect. This argument is simply absurd, and is quite unnecessary. The loads on the cars of the feeder lines can and will be so arranged as to be moved from one car to the other, *i.e.*, from the feeder car to the main line car, with the least possible amount of trouble or waste of time. Once the legal restrictions are removed, our practical men and mechanics will soon solve any minor difficulties of detail. Points, signals, and signalmen can well be dispensed with except at the terminal stations. Turn-outs at their central parts will allow trains to pass each other and keep up a continual service between their objective points. No greater mistake can be made than to overload a light line by first initial cost. When these lines have thoroughly paved the way for further extension, and the traffic is sufficiently large to provide extra working capital, then the carrying capacity and speed can be increased. Speed may be taken at ten to twelve miles per hour; but when approaching a station, town or village, this would be reduced to that of an ordinary tramway, and while passing over level crossings all trains should be provided with an audible and automatic signal; as a further safeguard, the train should work a signal when approaching all level crossings.

Haulage power should be reduced to a minimum, and there can be, and is now, no difficulty in this. It is quite impossible to state what gauge or weight of rail and size of car is required till a thorough survey has been made of the district in which it is proposed to supply a light line. These are matters requiring experience, skill, and tact. The greatest care should be taken not to encroach upon existing privileges, and I am convinced that a light line adhering to its principle of being a feeder line will find no opposition from existing main lines.

ELECTRIC LIGHTING ACT FOR CALCUTTA.

THIS Act, which has been hanging fire for the last three years, has at last become law. The Act is more or less a repetition of the English Act of 1882, with the addition of a few sections taken from some of the Indian Acts, viz., India Act V. of 1857, Act XLV. of 1860, Act I. of 1887, and Act II. (B.C.) of 1888.

Part I. of the Act treats of granting of licences, powers of local government, and conditions to be inserted in licences. Part II. relates to the powers of "undertakers," and Part III. offences against the Act.

We notice that the Act is so worded that no single company can obtain a monopoly for the supply of the current in Calcutta. This is as it should be, as it is very healthy rivalry that guards the consumer from exorbitant charges.

Section 24 (1) C. (7) provides for the protection of telegraph lines and their being interfered with by the electric light wires. Some time back complaints were made by the telegraph authorities in London against the electric light companies for the damage and trouble caused to the telegraph wires by induction from the electric wires, especially when heavy alternating currents were passing, and some of the instruments in the telegraph offices played erratic tricks that could not be accounted for at the time.

Section 26 (3) of the Act says:—"Whoever maliciously or fraudulently abstracts, causes to be wasted or diverted, consumes or uses any electricity, shall be guilty of theft within the meaning of the Indian Penal Code and punishable accordingly;" or, in other words, anyone using current other than that which passes through the meter placed on the premises by the "undertakers" is liable for theft.

So far as we can gather the Act protects the "undertakers," but as regards the consumer little or nothing is said; and we are afraid that if electric lighting comes into general use in Calcutta, the Act will have to be amended and certain new clauses added.

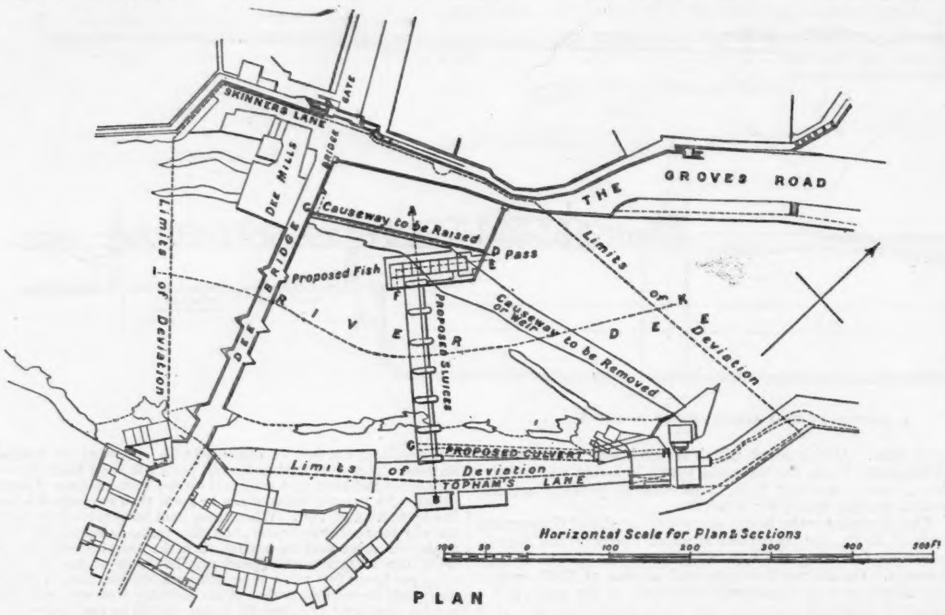
The Act is silent on a number of points which, *Indian Engineering* says, hereafter will have to be considered.

Now that the Act is practically law, we shall watch with interest the adoption of the electric current in Calcutta, but knowing the usual methods of working new projects in the metropolis, we do not feel very sanguine as to satisfactory results for some time to come. So far what little electrical work has been put up has been anything but successful. This is not the fault of the electric system, but of those who have had to do with the management, and whose ignorance as regards things electrical is patent.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.—We are requested to remind intending exhibitors at the Royal Show, to be held at Leicester from the 20th to the 26th of June next, that applications for space in the Implement Department at that meeting must be made by Wednesday, April 1st, 1896. Entries for the various departments of live stock, poultry, produce, &c., must be made by Friday, May 1st, 1896.

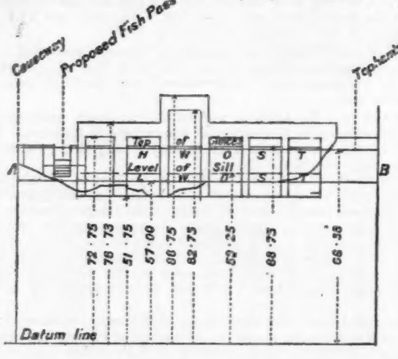
THE CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—At the ordinary meeting of this Society a lecture was delivered on Thursday evening, February 27th, by Mr. A. S. E. Ackermann, A.M.I.C.E., of the City and Guilds of London Technical Institute, at Kensington, on "Testing the Materials of Construction." The lecturer entered into the method of arriving at the various formulæ used in connection with his subject, the special methods required for testing different substances, and he explained one or two of the more recent special instruments used in connection with testing; he also described the diagramatic method of arriving at results, and showed various typical samples of test pieces, and drew special attention to the results obtained in producing rods by means of Dick's squirting process, and the good effect resulting, especially in connection with aluminium. On Saturday, February 29th, several members of the Society visited the extension works of the Surrey Commercial Dock Company, now in course of construction under the direction of Mr. J. Wolfe Barry, C.B. The extension works will, when completed, form a very important addition to the docks of London, as they will permit of vessels drawing 30ft. of water being docked, and docked in a position in the heart of London, and not at a distance so far away from it as to necessitate a railway journey, and an additional handling of goods in consequence thereof, before they are distributed. The visitors were conducted over the works by Mr. Bennet, the resident engineer. Mr. E. H. G. Brewster, past president of the Society, acted as its presentative in the absence of the president, Mr. S. à Court.

PROPOSED DEE SLUICES AND IMPROVEMENT WORKS

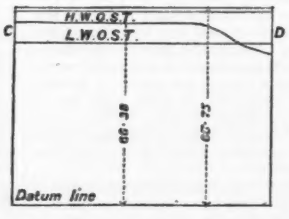


PLAN

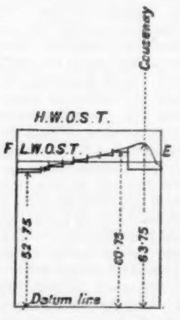
Section on centre line of proposed sluice



Section on line C.D.



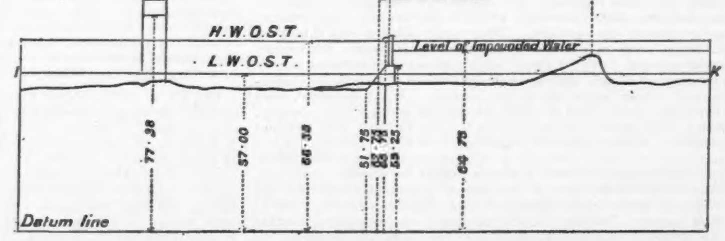
Section on line E.F.



THE DEE SLUICES BILL.

THE Corporation of Chester are promoting a Bill in Parliament to enable them to place sluices across the Dee at a short distance below the existing weir. The main object is to prevent the flood tide from flowing past the sluices and fouling the intake of the waterworks. The Company supplies the city with water pumped from the Dee, and in consideration of the benefit to be bestowed, the shareholders are called upon to pay one-half the cost of the Bill and works. It is further claimed that the sluices will diminish the flooding of land in the valley for twenty miles above the weir, and power is sought to tax such lands in proportion to the benefits that they will derive from the projected works. The boating interest above the weir is to be benefited by impounding an additional foot of water, and the navigation of the lower Dee is also to be improved, while the inhabitants of the entire watershed are to be brought under more stringent regulations as to sewage disposal, in order to purify the Dee for the use of the citizens of Chester. The numerous purposes for which the Bill is being promoted appear to be more than usually antagonistic, and we think it will tax the ingenuity of the authors to obtain the sanction of Parliament to the measure, unless it is materially altered.

Longitudinal section of River on line I.K.



The Dee is a considerable river rising in Merionethshire. It flows through Bala Lake, and receives the rainfall from 850 square miles, much of which is high land. Only a small portion of this area lies below Chester. Few rivers have been the subject of so many Parliamentary and other official inquiries as the Dee, and numerous undetermined controversies on engineering and kindred subjects are associated with it. This is mainly due to the fact that the trade of Chester has never been of sufficient importance to warrant the expenditure of the amount of money which it would be necessary to spend to keep the channel and port facilities abreast of the times, and therefore discontent instead of progress reigns among the mercantile community of the city. The glories of Chester as a port are, we believe, somewhat mythical, and to be attributed to the smallness of the vessels for which accommodation was required in the olden days.

If we limit our retrospect to seventy years, we find Telford writing in 1828:—"During the last two months I have examined and reported on four navigable rivers, viz., the Dee at Aberdeen, the Tay at Dundee, the Forth between Leith and opposite coast of Fife, and the river Clyde below Glasgow. In every river there are local peculiarities, but the last mentioned, viz., the Clyde, and the river Dee at Chester, bear the same resemblance in regard to their navigable length, the dimensions and shape of their estuaries, and the means which have been employed to acquire and maintain a proper depth of water in their upper portions. The Clyde has not yet been rendered so perfect as the Dee, but similar means are still employed to render it so, and there has now been obtained from 11ft. to 12ft. at good spring tides, but with a navigation which is evidently inferior to that of the Dee, there is now produced a revenue of £18,000 a year." This describes the situation accurately, and with a trade producing a goodly revenue skilfully employed on works for improving the estuary, the navigation of the Dee would no doubt be equal to or even better than the Clyde, seeing that the tidal range at the bar is 25ft. on spring tides, more than double the range on the Clyde, while the drainage area is about equal.

We are, however, wandering somewhat from our subject. The better to understand the main feature of the Bill, we publish a plan showing the existing weir and also the projected sluices and their adjuncts, together with sections explaining more in detail the present condition of the river and the alterations which the Bill seeks to effect. At Chester the Dee has been obstructed "time out of mind" by a weir or causeway, as it is often locally termed, and the expression is perpetuated on the Parliamentary plan. The construction of the one now existing is attributed to Hugh Lupus, the Norman Earl who acquired land and authority in that part of England at the Conquest, or to some of the grandees who wielded power in the district before his time. It consists of a rubble mound, and effectually ponds up the river to 10ft. above its bed, and thus provides a reservoir from which the mills on either side draw water for power, the Waterworks Company water for drinking and other purposes, and the citizens take advantage of the fine pool extending seven or eight miles above the weir for boating. In fact, people from Manchester, Liverpool, and the populous districts adjoining flock to Chester at holiday times for the express purpose of boating, and use the Dee as a playground as Londoners use the Thames.

The weir is a mound, as seen by the section I K; it is paved with rough blocks of rubble stone, and lies at an oblique angle to the river banks. It is upwards of 500ft. long. The river narrows immediately above to about 200ft., but is nearly double that width below. Indeed, it appears as if the right bank of the mill race once formed the river bank, and that on the line of the proposed sluices A B prolonged, the width was formerly as much as 350ft. On this line it is intended to erect six sluices 26ft. span in the clear, which will allow a passage of 168ft. lineal; the sills do not reach the bottom of the river, but are carried on a stone wall or dam 4ft. above the bottom, and only 4ft. 6in. below the crest of the existing weir. It would therefore appear that a fixed weir 500ft. long is to be replaced by a weir 168ft. long, the crest of which is 4ft. 6in. lower; it is very evident that this area will not afford a free discharge for a river 200ft. wide and 10ft. deep. The weir would give a more ready discharge to a flood rising 2ft. 6in. above its crest than could be obtained at the same level through the sluices. With floods at 2ft. and under the sluices would be more efficient.

The main objection to the Bill, from an engineer's point of view, is that more tidal water will be excluded than hitherto. Spring tides top the weir to the extent of 3ft. and upwards, and pour a great volume of water into the reach above. Upwards of 200 tides per annum top the weir, and 5,000,000 to 10,000,000 cubic yards of water is ponded up to be discharged as the tide recedes. The proposal to stop this at Chester by raising the sluices to 4ft. above the weir level is one fraught with great danger to the navigation below. There are several thriving ports on the Dee, Saltney, Connalis Quay, and Flint. The average tonnage using them approximates 200,000 tons register per annum, and those persons who are interested in shipping and wharves cannot look upon the proposal to stop all tides at Chester with indifference. The aim should be to get rid of the obstruction due to the weir at neap tides and increase the tidal flow. Independently of the actual diminution of the quantity of tide flowing up and down, the fact that the water below the sluices will become quiescent throughout the tide will allow silt to be deposited, and although we know of many rivers more heavily charged than the Dee, still its waters are very muddy, and a deterioration of the channel will ensue. The proposal to stop the tide is a retrograde movement, and opposed to the report of the Tidal Harbours Commissioners, made so long ago as 1846. They complained that already too much tide had been kept out of the estuary owing to the land reclamation scheme of the River Dee Company, who, under their powers, had enclosed 8000 acres and excluded the tidal waters, while failing to provide a channel of 15ft. deep up to Chester on an ordinary spring tide, as provided by the statute.

No doubt the boating interest will be benefited; the additional foot of water will give them greater freedom of movement, and as one span of the sluices is to be made to lift as high as the underside of the bridge below, boats of larger size than hitherto will be able to pass, and on all high tides boats drawing 4ft. to 6ft. will have the power of entering the fresh water portion of the Dee. The sluices have been designed by Mr. F. G. M. Stoney on the same principle as the Beleek and Richmond sluices. The estimated cost is given as £21,890.

SOCIETY OF ENGINEERS.

THE MECHANICS OF HORSE HAULAGE.

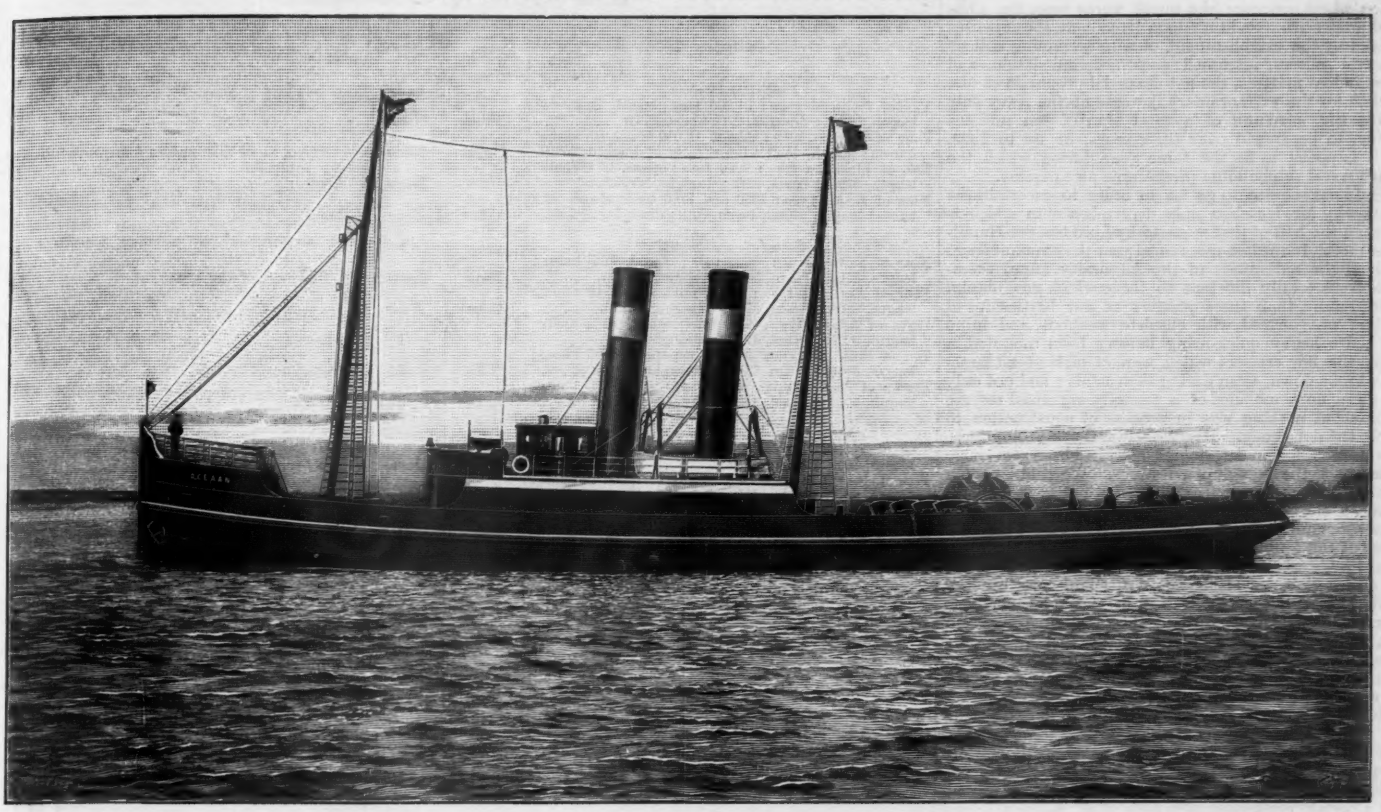
AT a meeting of the Society of Engineers, held at the Royal United Service Institution, Whitehall, on Monday evening, March 2nd, Mr. S. Herbert Cox, president, in the chair, a paper was read by Mr. T. H. Brigg on "The Mechanics of Horse Haulage."

The author pointed out that it was well known, first, that it is easier for a horse to draw a two-wheeled cart up a hill if the load be put forward, and, secondly, that on the level or going down hill the load should be placed at the back. The principle involved in the first case is that a horse can pull and exercise his force better when the weight is applied so as to hold him more firmly to the ground; whilst in the second case, when a horse does not require to exert much force to keep the load in motion, he should be relieved of all the burden possible, and even himself be partially carried, in order to save his legs both from physical exertion and percussion, thus enabling him to travel farther and easier. This moving of the load to and fro has been practised with two-wheelers of every description ever since the time when Roman charioteers stood backward or forward in their chariots as they travelled up or down hill. Exactly the same principles, only to a greater extent, apply to horses drawing four-wheeled wagons, &c., with their heavier loads, though perhaps the application of the principle is not so obvious to the ordinary observer as in the case of two-wheeled vehicles. The author explained that his system of attaching draught animals to vehicles is one which automatically confers those mechanical conditions which enable them to do the most work at the least cost. In a perfectly simple manner the shafts of both two and four-wheeled vehicles are made to constitute the necessary mechanical levers, which are so actuated by the horse's own pull, and by an automatic upward lift, that at one time the horse makes himself equal to a much bigger and heavier horse, therefore can pull a bigger load, whilst at other times he is equal to a strong but lighter horse, thus able to move along with ease and comfort. The acting and co-acting forces are effective in causing the wheels, at certain convenient times, to ease the horse by carrying a part of his weight; whereas, at other times, when climbing hills and starting loads, the horse is enabled, automatically, to transfer such a proportion of the load to his own body as the condition of the road and load may require. In this way his feet not only obtain a better grip upon the ground, but his body gains a two-fold mechanical advantage over his load. With the new system there is no possibility of the horse having to carry a load down hill or on level ground as with the old system. The horse will maintain a good and sprightly action over a greater period of time, because the attachment avoids needless hammering of his legs and feet, thus causing him less pain, less exhaustion, and giving the animal greater speed and power of endurance. By the Brigg attachment the author showed that the horse's useful life is, in many cases, more than doubled, for he is not hampered, on good road, by having to carry any portion of the load or vehicle, but the reverse; thus his energy, his legs, and his feet are effectually and profitably preserved, and the author claims that it practically gives a new life to old horses. In the morning the Prince of Wales and the Duke of York attended with Lord Suffield and and a few other gentlemen to witness the action of the Brigg haulage attachment, as attached to Lord Lansdowne's handsome and to several vans, and were much interested in it and took pains to ascertain the nature of the mechanism and its operation, with which they were favourably impressed.

THE vapour from gasoline used in cleaning carpets in a Pullman car at Pittsburg, Pa., was exploded by fire in the heater, on February 15th, smashing the windows and interior fittings, and injuring three of the car cleaners. A gasoline explosion occurred on a pleasure launch at Eureka, Cal., on February 7th. The boat was destroyed, but the passengers escaped.

THE DUTCH TUGBOAT OCEAN

MESSRS. SMIT AND ZOON, KINDERDYK, HOLLAND, BUILDERS



THE DUTCH TUGBOAT OCEAN.

WE this week illustrate a very powerful screw tugboat named Ocean, which has recently been built for the towage company, L. Smit and Co., by L. Smit and Zoon, shipbuilders, at the Kinderdyk, Holland, and engined by the Royal Engineering and Shipbuilding Company, the Scheldt, at Flushing. The principal dimensions are:—Length between perpendiculars, 151ft. 8in.; breadth, 28ft. 3in.; depth, 15ft. 2in. The vessel can be trimmed by four water ballast tanks of a capacity of 65 tons. She is rigged as a fore-and-aft schooner with pole masts, and is fitted with a bridge house and monkey forecastle. The space under the forecastle is used for stores and the steam anchor winch.

Four water-tight bulkheads divide the hull into five compartments, viz., ballast tanks, chain locker, and stores; hold for ropes, and fitted with twelve berths for runners; coal bunkers extending forward and into the sides of the engine and boiler-room, with a total capacity of 300 tons; cabins for the engineers and mate; a door from the engineers' cabin opens into the engine-room. Abaft these cabins are the lodgings for the crew—on the starboard for the firemen, on the port for the sailors. The vessel's stern is fitted up for water ballast tanks and store.

The coal bunkers are filled through a large hatch just forward of the bridge house, and through a number of deck scuttles besides. Under the bridge house there is a fine saloon with a neat cabin and a companion, with w.c., cupboards, lockers, and a stair leading up to the wheel house. This part of the vessel is intended for the captain. The steering cabin and wheel house stand on the bridge deck. The foremast is placed abaft the forecastle, the mainmast between the bridge house and engine-room hatch. Behind each mast strong towing bitts, made of steel plate, are riveted to the bottom framing. The stockless anchors, as well as the steam steering gear, anchor winch, &c., are of the best British manufacture. A cabin for one of the managers or other passenger, as well as the galley and crew's w.c., are in the bridge house.

The engines are of the vertical triple-expansion type, having cylinders of 18in., 28in., and 46in. diameter, by 30in. stroke, with a working pressure of 160 lb. per square inch. The cylinders are supported at the back by three columns cast on the condenser and carrying the guide plates. At the front there are six columns of polished steel. The cylinder covers, high-pressure valve chest cover, and the pistons are of cast steel. The intermediate-pressure and low-pressure pistons are fitted with Buckley's patent springs and rings, and the high-pressure piston with Ramsbottom rings. Flat equilibrium slide valves are fitted to the high and intermediate, and an ordinary double-ported valve to the low-pressure cylinder. This type of equilibrium valve is invariably fitted by this firm to all cylinders, unless otherwise specified, and consists of a double face valve with through ports, exhaust as well as steam, working between the cylinder port face and a loose face with false ports of exactly the same area. This face is held at the proper distance from the cylinder face by two ribs cast on and resting on the cylinder face. The four faces are scraped to a steam-tight fit, and remain so for apparently any length of time without any further adjustment whatever. The covering plate is held up to the cylinder face by a light spring, to prevent it falling back when the steam is shut off. Although these valves are more expensive to make than piston valves, the builders believe that the reduced chance of breaking the cylinders from water suddenly finding its way there, combined with the absence of repairs and the minimum amount of wear to the valve motion, fully repay the extra cost in a very short time. The throttle valve is of the same description, and can be made so steam-tight that the slide valve chest cover can be removed and replaced without any inconvenience, although there may be considerable pressure in the steam pipe, while under full steam the valve can be handled with very little effort, and thereby instantaneously opened and closed. All the valves are worked by a double excentric link motion, with adjustable brasses throughout. The steam reversing gear is a brass-lined cylinder, with piston-rod and Buckley's piston spring and ring of gun-metal, and works directly on the weigh-shaft by a single stroke, no brake cylinder being used. The weigh-shaft is placed in front of the engines, and each lever is independently adjustable to enable the power to be equally divided on the three cranks.

The crossheads are of peculiar construction; the idea being to obtain something safer and more convenient than the ordinary two vertical bolts type. The head is forged solid with the piston-rod and slipper guide, and is slotted out to receive the brasses, which are held up and adjusted by a wedge block drawn forward by a strong square-threaded bolt. The crosshead pin is quite distinct from the connecting-rod, simply lying on the ends of the forked part and held there by two substantial bolts passing bodily through the pin and projections forged on the connecting-rod for the purpose. The whole makes a very light, compact, and safe crosshead and looks well.

The shafting is of steel throughout, and the crank shaft has a total length of bearing of 51in. The crank pins are 10in. diameter and 10in. long. All the journal work is in cast steel bearings, fitted with white metal. The thrust block is in the engine-room, and built in one with the bed-plate, the lower part of the block forming a bath for oil and water in which the thrust collars run. There are five horseshoe collars, each capable of being lifted out and examined without disturbing the others. They are of cast steel, fitted with white metal.

The condenser, at the back of which are bolted the air, feed, and bilge pumps, contains 487 tubes, ¾in. external diameter by 19 B.W.G. thick, and has a total cooling surface of 1247 square feet. The pumps are worked from the low-pressure engine crosshead by single forged steel levers; the air pump is single-acting, 16in. in diameter and 15in. stroke, fitted with Kinghorn's patent multiplex valves. There are two feed pumps and two bilge pumps of 2¾in. diameter, all having a stroke of 15in. The feed and bilge pumps are each cast in one piece with its valve box of gun-metal, the discharge valves being fitted with brass springs. The working of these valves is so noiseless that it is only by noting that the hot well does not overflow, that the engineer can see whether the pumps are working or not. A 7½in. direct-acting centrifugal pump supplies the necessary circulating water. The propeller is four-bladed, of cast steel. Its diameter is 10ft., and the pitch 11ft., with a blade area of 40 square feet.

Following up the latest custom of the Admiralty, there is no overboard discharge of the air pump; this pump discharges into a large tank placed as high as convenient, and has an overflow in the engine-room bilge well in view of the engineer. A small pipe connects the bottom of this tank with the hot well, so that the feed pump keeps the tank drained, the tank merely acting as a reservoir to accommodate the water which accumulates in the condenser during the heating up of the engine, or from standing for some time, and which is thrown up by the air pump on starting. As a minimum size for such a tank, the builders take the amount of feed-water used by the engine working full power for fifteen minutes. The auxiliary feed consists of a powerful duplex feed and deck pump by Tangyes, a Morrison's evaporator of 12-ton capacity, and a Rankine's feed-water filter are fitted.

There are two boilers of Martin-Siemens mild steel, 13ft. diameter by 9ft. 9⅜in. long, with three furnaces of Purves' patent 3ft. in diameter. The tubes are of steel, 3¼in. external diameter by No. 9 B.W.G. thick by 6ft. 4½in. long between the tube plates. The total heating surface of the two boilers is 3208 square feet, and grate area 96 square feet. All holes are drilled in place and the riveting done by a huge 150-ton hydraulic riveter having a 12ft. gap.

The stokeholds, which are unusually cool, are ventilated by Mr. W. H. Martin's patent arrangement, the designer of the engines, whereby no cowls are required. On the trial 1100-horse power was easily obtained, the engines making 128 revolutions per minutes, and the vessel running full 12·6 knots, the machinery working during the whole time to the perfect satisfaction of all present, the supply of steam proving ample and the vibration practically nil. Although this vessel has only been a few months in service, she has already earned a very good reputation in Liverpool, Hamburg, and other important shipping centres.

THE DUNALASTAIR.

IN our last impression Mr. Rous-Marten dealt at some length with the performance of the new Caledonian engine Dunalastair. Through the courtesy of Mr. McIntosh, we are now able to give an engraving of the engine and the following particulars of its construction:—

Four Wheels Coupled Express Passenger Bogie Engine No. 721, Dunalastair.

Cylinders—	
Diameter	1ft. 6¼in.
Stroke of piston	2ft. 2in.
Distance between cylinders (centre)	2ft. 3in.
Wheels—	
Diameter on tread (bogie)	3ft. 6in.
" " (driving)	6ft. 6in.
" " (trailing)	6ft. 6in.
Frames—	
From centre of bogie to front buffer beam	5ft. 4¼in.
" " " centre of driving wheels	9ft. 11in.
" " driving to centre of trailing wheels	9ft.
" " trailing wheels to end of frames	3ft. 10½in.
Distance of frames apart	4ft. 1½in.
Thickness of frames	1in.
Boiler—	
Height of centre of boiler from rails	7ft. 9in.
Length of barrel	10ft. 3½in.
Diameter of barrel (mean)	4ft. 8⅛in.
Thickness of barrel plates	9/16in.
Fire-box shell—	
Length, outside	6ft. 5in.
Breadth, outside at bottom	4ft. ½in.
Depth below centre of boiler (at front)	5ft. 6in.
" " " (at back)	5ft.
Thickness of throat plate	¾in.
" sides and top	⅝in.
" back	⅝in.
Tubes (brass)—	
Number	265
Length between tube plates	10ft. 7in.
Diameter (outside)	1¾in.
Height of chimney above rails	12ft. 11¼in.
Heating surface—	
Tubes	1284·45 sq. ft.
Fire-box	118·78 sq. ft.
Total	1403·23
Firegrate area	20·63 sq. ft.
Working pressure	160 lb. per sq. in.

Weight of engine in working order—	Tons.	Cwt.	Qr.
Bogie wheels	15	14	3
Driving-wheels	16	0	0
Trailing wheels	15	5	0
Total	46	19	3

Tender for Four Wheels Coupled Express Passenger Bogie Engine No. 721.

Capacity	3570 gallons
Wheel base—	
Centre of leading wheels to centre of middle wheels	6ft. 6in.
" middle " " trailing "	6ft. 6in.
Diameter of wheels on tread	4ft.

Weight of tender—	Tons.	Cwt.	Qr.
Empty	19	4	3
Full	39	1	2
Distribution when in working order—			
Leading wheels	12	13	0
Middle wheels	13	4	0
Trailing wheels	13	4	2
Total	39	1	2
Total weight of engine and tender in working order	86	1	1

THE NAVAL PROGRAMME OF 1896.

ONE of the most remarkable features of the new Naval Programme is its extreme moderation. Divested of that portion which concerns the naval works vote, the additional proposed expenditure upon armament, the expenses involved by the establishment of a new training college for naval officers, increased dock accommodation, and other kindred matters, the net financial proposals of Mr. Goschen for the extraordinary increase of the Navy only involve the spending of a total sum of ten millions sterling, to be spread over three years, or up to 1899, which happens to be the same year during which the French naval shipbuilding programme also expires.

We do not require to go far in order to ascertain the reason why Mr. Goschen only demands a sum which is less than the half of that required by Lord George Hamilton in 1889. In the last-mentioned year the circumstances in which the authorities of the Admiralty found themselves were totally different to those which now obtain. In 1889 more than three-quarters of our battleships of the line were armed with obsolete weapons, and in no case had a heavy quick-firing battery been mounted in them; the few cruisers which were of high speed hopelessly broke down, even during their trials; and not only was there no semblance of a properly organised reserve of ships, but nothing was in process of construction to supply the deficiency. Hence there was everything to be done in 1889, for no determined effort had been previously made to set the Navy upon its legs. We said that the now existing circumstances differed widely. That is so. Thanks to the vigour of the Administration in power seven years ago, and to the loyal support which its policy obtained at the hands of Lord Spencer, we have a Navy afloat to-day which is the admiration, if not the envy, of the entire globe. This is not written in any boastful spirit, but with the recollection in view of that broad principle, already laid down in these columns, that our fleet is "the Armour of Peace" of the British Empire. Hence the duty which lay before Mr. Goschen was not the re-creation of a Navy, but suitable provision for the keeping up of an existing fleet.

Here we arrive at a very important feature of the subject under consideration. In order to obtain a useful view of the strength of our existing naval position, quite independently of the relative character of that strength in respect to the navies of other nations, but assuming that a certain proportion of vessels of all classes is bound to be kept in commission to meet the requirements of a vast maritime empire such as our own—also assuming that the vessels now in commission answer those requirements—we must also face the condition of the reserves. The Navy afloat is the first question; that of the reserves, and ships building and completing, naturally follows. Feeling the immense importance of this question of reserves, we have prepared tabular statements giving, not abstract numbers of first and second-class battleships and cruisers, which convey no actual meaning—for no two authorities are agreed as to classification—but nominal lists of armoured and unarmoured types containing the eighty-one battleships, coast-defence ships and armoured cruisers, and the 142 unarmoured cruisers of which our fighting fleet is composed, specifying those of each type which are now in commission, those which are in reserve, and those which are building, renovating and completing, as well as the new ships proposed to be laid down in the naval programme of Mr. Goschen. It will be seen in a moment that this is a much more explicit statement than that prepared by the Admiralty. What we want to know is not whether we have 20 armoured vessels, or 53 unarmoured vessels "in reserve," but of what do the figures 20 and 53 consist?

A glance at the "reserve" column, enumerating either armoured or unarmoured ships, shows the gravity of this point. We find, for instance, from the reserve column of armoured vessels, that the Ajax and Agamemnon, Glatton, Hercules, Nelson, and Temeraire, are about the most effective battleships which could be sent out now from our dockyards to replace a disabled Majestic or Revenge. The idea is preposterous. As a matter of fact, there is not an armoured vessel of effective modern type in reserve at this moment in any one of our dockyards. All are at sea. The seven splendid battleships of the Majestic class now building and completing will, together with the Renown, form, therefore, a most welcome and necessary addition to the reserve cadres of our fleet. Under the new programme five improved Renowns are to be laid down, whose dimensions are to be as follows:—Length, 390ft.; beam, 74ft.; draught, 24ft. 9in.; displacement, 12,900 tons; the speed being made superior to that of the Renown by the employment of water-tube boilers. These dimensions approximate very closely to those of the Majestic class, except in the draught, which is 2ft. 9in. less—an enormous difference. It was only last week that we drew attention in our columns to the present tendency towards reduced draughts. The decision to lay down these battleships has not come a day too early. Even when completed, our total of first-class vessels of this character in reserve will only compute to thirteen. Their speed, coal endurance, and handiness should be exceptionally good. It must be remembered that they will pass through the Suez Canal with ease.

When we turn to our existing reserve of unarmoured cruisers, the prospect is equally discouraging *for the moment*. Only one of the really effective second-class cruisers of recent type is in reserve—the Fox. The five of the Rainbow type shown, and eight of the Apollo type, are not nearly so satisfactory, either as gun platforms or sea boats, as their larger companions in the class, hence they could not replace any of these last, which should be disabled. When the Powerful and Terrible, the four cruisers of the Diadem or Andromeda type, the nine cruisers of the Talbot type, and the four of the Arrogant type, are passed into the reserve, this last will of itself comprise a most formidable fleet. We do not think that the dimensions of the Diadem type have been published before. They are as follows: Length, 455ft.; beam, 67·9ft.; draught, 25·3ft. They are called improved Blenheims. Adopting, therefore, the coefficient of the prototype, we arrive at a displacement of 11,000 tons at least as the probable tonnage. Next to the Powerful type, they will, consequently, be the largest British cruisers afloat. We observe that special efforts are being made to push forward the completion of all these cruisers, particularly those of the Talbot type. It is certainly a most momentous consideration, in view of the existing condition of our reserves.

Existing Unarmoured Fleet and New Programme.

Description.	In commission.	In reserve.	Building and completing.	New programme.
First-class Cruisers.				To be laid down
Two of Powerful type: 14,200 tons; speed, 22 knots; length, 500ft.; draught, 27ft.; beam, 71ft.	None	None	2	
Four of Diadem type: About 11,000 tons; speed not known; length, 455ft.; beam, 67·9ft.; draught, 25·3ft.	None	None	4	4 of this type, or "Improved Blenheim"
Two of Blenheim type: 9000 tons; speed, 21·6 knots; length, 375ft.; beam, 65ft; draught, 25·75ft.	2	None	None	
Nine of Edgar type: 7350 and 7700 tons; speed, 20·5 knots; length, 360ft.; beam, 60ft.; draught, 23·75ft...	9	None	None	
Second-class Cruisers.				
Nine of Talbot type: 5600 tons; speed, 19·5 knots; length, 350ft.; beam, 53ft.; draught, 20·75ft.	None	None	9	3 of this type
Four of Arrogant type: 5750 tons; speed, 19 knots; length, 320ft.; beam, 57ft.; draught, 22ft.	None	None	4	2 of this type
Eight of Astræa type: 4360 tons; speed, 19·75 knots: length, 320ft.; beam, 49·5ft.; draught, 19ft.	7	1	None	
Ten of Rainbow type: 3600 tons; speed, 19·7 knots; length, 300ft.; beam, 43·7ft.; draught, 17·5ft.	5	5	None	
Eleven of Apollo type: 3400 tons; speed, 20 knots; length, 300ft.; beam, 43ft.; draught, 16·5ft.	3	8	None	
Third-class Cruisers.				
Two of Pelorus type: 2135 tons; speed, 20 knots; length, 300ft.; beam, 36·5ft.	None	None	2	4 of this type
Five Medea type: 2950 and 2800 tons; speed 19 knots; length, 265ft.; beam, 41ft.; draught 16·5ft....	4	1	None	
Nine of Pallas type: 2575 tons; speed, 19 knots; length, 265ft.; beam, 91ft.; draught, 15·5ft.	8	1	None	
Two of Bellona type: 1830 tons; speed, 17·8 knots; length, 280ft.; beam, 35ft.; draught, 13·25ft.	2	None	None	
Four Barossa type: 1580 tons; speed, 16·5 knots; length, 270ft.; beam, 35ft.; draught, 19ft.	4	None	None	
Older Cruisers of various types.				
Sixty-one of displacements from 1130 to 4300 tons... ...	24	37	None	
	68	53	21	13 ships of new programme

Existing Armoured Fleet and New Programme.

Description.	In commission.	In reserve.	Renovating or building and complete.	New programme.
Battleships.				
Nine Majestic class: 14,900 tons; speed, 17·5 knots; length, 390ft.; beam, 75ft.; draught, 27·5ft.	Magnificent Majestic	—	Cæsar Hannibal Illustrious Jupiter Mars Prince George Victorious	
Eight Royal Sovereign class: 14,150 tons; speed, 17·5 knots; length, 380ft.; beam, 75ft.; draught, 27·5ft.	Empress of India Hood Ramillies Repulse Resolution Revenge Royal Oak Royal Sovereign	None	None	
One, 12,350 tons; speed, 18 knots length, 380ft.; beam, 72ft.; draught, 26·75ft.	—	—	Renown	Five improved Renowns: 12,900 tons; speed, 18½ knots; length, 390ft.; beam 74ft.; draught, 24·75ft
Two Nile class: 11,940 tons; speed, 16·7 knots	Nile Trafalgar	None	None	
One, 10,470 tons; speed, 17·2 knots	Sans Pareil	None	None	
Two Centurion class: 10,500 tons; speed, 18·5 knots; length, 360ft.; beam, 70ft.; draught, 25·5ft.	Centurion Barfleur	None	None	
Six Admiral class: 10,600 tons; speed, 16·9 knots	Anson Benbow Camperdown Collingwood Howe Rodney	None	None	*Remarks.*
Two Edinburgh class: 9420 tons; speed, 14·2 knots	Colossus Edinburgh	None	None	Inferior as to gun platforms
Two Hero class: 6200 tons; speed, 15·2 knots	Conqueror Hero	None	None	
One, 11,800 tons; speed, 12·8 knots	Inflexible	None	None	The bad steering qualities of these ships detract seriously from their value
Two Ajax class: 8660 tons; speed, 12 knots	None	Ajax Agamemnon	None	
Coast Defence Ships.				
Fourteen low freeboard class: 10,820 to 3560 tons; speed, 14·5 to 9·3 knots.	Devastation Dreadnought Rupert Thunderer Hecate Orion	Belleisle Cyclops Glatton Gorgon Hotspur Hydra Neptune Prince Albert	None	Only the Devastation, Thunderer, and Dreadnought are sea-going ships amongst these
Renovated Battleships.				
Twenty-two, from 10,780 to 5390 tons; speed, 15·5 to 12·4 knots.	Alexandra Black Prince Minotaur Northampton Penelope	Achilles Agincourt Audacious Bellerophon Hercules Invincible Iron Duke Nelson Swiftsure Temeraire	Monarch Northumberland Shannon Sultan Superb Triumph Warrior	Amongst these, the Alexandra, Temeraire, Hercules, Sultan, Monarch, and Superb are powerful ships, which can steam 14 and 15 knots. The remainder are slow. None of them, therefore, should be classed as "cruisers," which seems to be the case in official list
Armoured Cruisers.				
Nine, viz.: seven of Aurora class; 5600 tons; speed, 18·1 knots; and two of Imperieuse class; 8400 tons; speed, 16·7 knots.	Impérieuse Warspite Aurora Australia Galatea Immortalité Narcissus Orlando Undaunted	None	None	

Only thirteen cruisers are proposed to be laid down according to the new programme. This limiting of the numbers is perhaps judicious, when we consider how powerful most of the units are. Four of the Diadem type, three of the Talbot type, two of the Arrogant type, and four of the Pelorus type. Added to the twenty-one already building or completing, the thirty-four cruisers, ranging in type from the Terrible to the Pelorus, will be a fitting complement to the thirteen battleships already under consideration.

The entire number of vessels in the new programme is forty-six, including twenty-eight torpedo boat destroyers of increased size and superior power and speed. The scheme is, therefore, certainly not an excessive one; in point of fact, if there is any fault that we have to find with it, it is on the score of its being too moderate. The forty-six new vessels will form an excellent and adequate reserve under ordinary peace conditions, but they would only be a drop in the ocean towards our requirements for the exigencies of war.

The decision, under the new programme, to build three new docks at Gibraltar is one the wisdom of which we most heartily endorse. But the question of docking accommodation for vessels of our fleet is one which will have to be faced all over the world. At Mauritius and Simons Town the matter is already in hand, as the scheme provides for preliminary surveys, which will, of course, be followed by the construction of docks. But Bermuda has only a floating dock, which is too short for a Revenge or Magnificent. Jamaica has none whatever, nor are there any in Ceylon. Last, but not least, if another battle of the Nile were to take place, we should have no docks conveniently near into which our disabled vessels could be received, as we have none eastward of the island of Malta.

LAUNCH OF THE JAPANESE BATTLESHIP YASHIMA.

ON Friday last, February 28th, the first-class battleship Yashima was launched from the Elswick shipyard of Messrs. Sir W. G. Armstrong and Co., of Newcastle-on-Tyne. The day was fine, and a distinguished company of visitors assembled to witness the launch, which was most successfully performed. A description of the vessel, the first of her type to be placed on the list of the Japanese Navy, will be of interest to our readers. She is being built to the order of the Japanese Imperial Government, and was commenced on December 6th, 1894, so that little over a year has been occupied in completing her for the launch, and it is expected that she will be completed for sea, with all armament on board, in about the same time. The dimensions and particulars of the vessel are as follows:—

Length between perpendiculars	372ft.
Breadth, extreme	73ft. 6in.
Draught, mean	26ft. 3in.
Displacement, in tons	12,300
Indicated horse-power, forced draught	14,000
Indicated horse-power, natural draught	10,000
Speed, forced draught, estimated	18¾ knots
Speed, natural draught, estimated	17¼ knots
Coals carried at designed draught	700 tons
Coals carried with bunkers full	1200 tons

She is provided with a steel armour belt 8ft. in width, carried from 3ft. above to 5ft. below the designed load waterline. This belt extends over a length of about 230ft., and has a maximum thickness of 18in., tapered to 14in. at the extreme ends. The thwartship armour bulkheads which terminate the belt are 14in. thick.

Immediately above this belt there is a light belt of armour 4in. thick, terminated by screen bulkheads extending from the sides of the vessel to the barbette armour. Behind this 4in. armour coal bunkers are arranged, so as to afford additional protection against gun-fire. A protective deck 2½in. thick is worked horizontally over the main belt and bulkhead armour, and under water decks of the same thickness give protection to the ends of the ship outside the limits of the armour. At the fore-and-aft ends of the belt, rising directly from the protective deck, are the two barbettes, formed of steel armour, 14in. thick on the upper portions, reduced to 9in. below.

The main armament of the Yashima will consist of four 12in. 49-ton guns mounted in pairs in the barbettes previously referred to, and having also the protection afforded by 6in. armoured gun-houses. The foremost pair train from direct ahead to 30 deg. abaft the beam, and the aftermost pair through a similar arc.

The auxiliary armament will consist of ten 6in. 100-pounder quick-firing guns. Four of these guns will be mounted on the main deck in armoured casemates 6in. thick, and six on the upper deck in sponsons and protected by heavy shields. In addition there will be twenty-four 3-pounder guns, four mounted in the fighting tops, eight on the shelter decks, four on the bulwarks and on the main deck. There will be five fixed torpedo tubes, one above water forward, and four submerged, two forward and two aft. All the armament is being constructed at Elswick. The Yashima will be propelled by twin-screw triple-expansion machinery, constructed by Messrs. Humphrys, Tennant, and Co., of Deptford. Steam will be generated in ten single-ended cylindrical boilers, with a working steam pressure of 155 lb. There will be a great number of auxiliary engines throughout the ship, amongst which will be included the steering engines, air compressing engines, evaporating engines, capstan engines, distilling engines, hydraulic engines, and steam pumping engines for working the big guns. After the launch the company adjourned to the mould loft, and the usual toasts were drunk. Lord Armstrong presided, and was supported by the ladies and gentlemen who took part in the earlier proceedings.

Lord Armstrong was cheered on rising to propose "Success to the Yashima." His lordship said:—I beg leave to propose the toast of success to the noble ship which has been launched to-day, coupled with the health of the lady who has officiated so effectually on the occasion. It is very rarely that we have in this country the distinction of a Japanese lady acting in this capacity, but I trust it will not be the last occasion if the performance is to be at Elswick. This ship is one of the largest vessels ever launched on the Tyne. I need not trouble you with details of her construction and dimensions, which will most probably be published, but I may state some general facts concerning her. Her displacement will be 12,300 tons; she will be completely armoured, both on sides and deck, with steel plates hardened by the Harvey process, and varying in thickness from 18in. to 2½in., according to the defensive requirement of the different parts of the vessel. She will be propelled by engines of 14,000-horse power, which, when working under forced draught, ought to give, and I have no doubt will give, a speed of 18¾ knots, and when steaming under natural draught may be expected to give 17¼ knots. Her armament will comprise four great guns, weighing 48 tons, mounted in pairs in two strongly armoured barbettes. These guns, weighing only 48 tons, using cordite, will have a greater penetrative power than the 68-ton guns of a few years ago; also ten quick-firing 100-pounder guns, and twenty-four quick-firing 45-pounders, besides numerous smaller guns, making in all an armament of very unusual power. She will also have a very complete torpedo equipment. Whatever may be the destiny of this splendid vessel, we may be sure that she will be handled with the ability, the skill, and courage recently displayed in the Japanese Navy, and that she will prove worthy of the highly civilised and progressive nation to which she belongs.

His Excellency the Japanese Minister—Mr. Kato—who was cordially received on rising to respond to the toast, said:—My lords, ladies, and gentlemen,—On behalf of my wife I wish to thank our chairman most sincerely for the very gracious way in which he has proposed this toast, and to you for the very kind way in which you have received the same. My wife requests me to say that she is very glad to have been able to come down and perform the function of launching the new ship—a ceremony I need hardly say which is most important to the navy of my country, and I venture to add also of importance to the Elswick Works. It has been a most successful and satisfactory launch, and I hope and trust that the Yashima may be finished and got ready for sea very shortly in an equally satisfactory and admirable manner. It is true that Japan has had several ironclads and other warships of various types and descriptions, some of the most important of which were built in these works in years past, and have so recently given such a good account of themselves as to greatly enhance, if possible, the credit and reputation of their builders. But of the so-called battleship Japan has had none so far; and this new ship, with her sister ship, which will be launched elsewhere in the course of a few weeks, will be the first battleships to be placed on the list of the Navy of Japan, the first I hope of a series of ships of a similar kind and description which will adorn in the future the Navy of his Imperial Majesty the Emperor of Japan. When these two ships are taken into Japanese waters, some time next year, quite an epoch will be made in the history of the Japanese Navy; and I fervently hope and wish that the new ship Yashima will have a very long, useful, prosperous, and successful, and, if possible, a peaceful career, and will behave herself always in such a way as to be a credit to her builders. He concluded by asking the assembly to join him in drinking "Success and prosperity to the firm of Sir W. G. Armstrong and Co."

Sir Andrew Noble responded to the toast, and said there was perhaps no country in the world except England to which a proper representation in the navies of the world was more necessary than Japan, and he felt sure that the vessels, the first of which they had seen launched that day, would be, as Lord Armstrong had said, if ever the occasion arose, most efficiently handled. His Excellency had said that he hoped these vessels would be peacefully employed, but they well knew that to secure peace they must be prepared for war when it might be necessary. From long experience with inspectors, he had come to the conclusion that the most efficient assistants that the manufacturers could have were efficient inspectors. He had, therefore, great pleasure in proposing the health of Captain Yendo, Captain Takayama, Captain Kitagoga, and Mr. Iwata.

Captain Yendo responded to the toast, and on behalf of the Japanese inspectors thanked the officials of the firm for every facility and privilege, and above all, the great kindness they had shown them, which had facilitated the work of the inspectors a great deal. It was a great pleasure to him to be able to say that. He proceeded to explain that the meaning of Yashima, the name of the vessel, was Japan, it being the ancient and poetic name of his country, the literal meaning of which was "the eight islands."

Sir Andrew Noble proposed the toast of "The Designer of the Yashima, Mr. Philip Watts."

Mr. Watts responded, and said it was a very great honour to launch the first battleship built for the Japanese Navy. In completing the construction of the Yashima they had done everything to make her the best warship possible, and they were satisfied that when she was completed she would not have a superior in her class, either for defence or offence.

The whole of the armour plates on this vessel, some of which weigh 40 tons each, were manufactured by Messrs. Charles Cammell and Company, Limited, of Cyclops Steel and Iron Works, Sheffield.

H.M.S. DORIS.

THE latest addition to her Majesty's Navy was made on Tuesday last, shortly after noon, by the launch of the new twin-screw second-class cruiser Doris from the shipyard of the Naval Construction and Armaments Company, at Barrow-in-Furness, she being the second of the two vessels of that class at present building by the company for her Majesty's Government, and one of the nine designed by Sir W. H. White, Director of Naval Construction, under the late naval programme, three of which are building in Royal Dockyards, and six by private contract, all of which, when finished, will be the largest type of second-class cruisers yet constructed for the British Navy.

The hull of the Doris (with the exception of her stem—which is ram shaped—stern, and rudder posts, which are of phosphor bronze) is constructed entirely of steel, and is of the following dimensions:—Length between perpendiculars, 350ft.; beam, 54ft.; and displacement, when fully equipped, 5600 tons, at which her water draught will be 24ft. 6in. She is double-bottomed amidships the whole length of the machinery space, and has water-tight flats to magazine and shell rooms, which are carried well forward and aft, the bottom being well subdivided into water-tight compartments. She is also well supplied with longitudinal and transverse water-tight bulkheads, which, while giving additional strength to the hull, minimise the risks by localising the effects due to any damage to it under water. To increase the steadiness of gun platform, and counteract any tendency to excessive rolling, the vessel is fitted with bilge keels; and being intended for foreign service and long cruises, she is completely sheathed with teak, and coppered up to well above the deepest load line.

The Doris has no side armour, but the protection of her vital parts is effected by a strongly built protective deck, which runs through her whole length; the engines being additionally protected by an inclined breastwork of Harveyed armour plated up to and above the tops of the steam cylinders. The ship has bunker accommodation for 1000 tons of coal, the reserve bunkers being on the protective deck on either side over the engines and boilers. A conning tower armoured with Harveyed steel is located forward, and has within it the usual means for directing operations in action, and navigating the vessel, the connecting gear for effecting which is carried down to the protective deck through an armoured tube. A director tower is also provided at the after end of the vessel, conning bridges being fitted on the tops of these towers for navigating purposes, and for operating the three search lights with which the ship is fitted. Above the protective deck the ship will be ventilated by the ordinary means of cowls and down-cast shafts, while below it electrically-driven fans will be used for the same purpose.

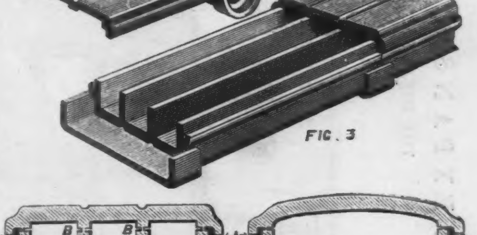
The Doris will be propelled by two complete sets of inverted direct-acting screw engines, fitted in separate water-tight compartments or engine rooms. The engines, which are being made by the shipbuilders, will be of the three-cylinder triple-expansion type, the cylinders being 33in., 49in., and 74in. diameter, for high, intermediate, and low pressures respectively, all having a piston stroke of 39in., piston valves being fitted to the high-pressure, and double ported slide valves to the intermediate and low-pressure cylinders, the valves being actuated by double excentrics and ordinary link motions. The crank shafts are interchangeable, and have large bearing surfaces. Each set of the main engines has its own surface condenser — built of naval brass — the total cooling surface being 10,600 square feet. Auxiliary condensers are provided for condensing the steam from all the auxiliary engines in the ship. The main engines when running at 140 revolutions a minute, and with steam at 150 lb. pressure per square inch, are designed to developē 9600 indicated horse-power, the steam for which will be supplied by eight single-ended cylindrical three-furnaced boilers, which will be worked with closed stokeholds and forced draught when they and the engines are developing their full power.

The armament of the Doris will consist of five 6in., six 4·7in., nine 12-pounder, and seven 3-pounder quick-firing guns, together with four ·45in. Maxims. The military tops to her two masts—which are of steel—will also be armed with machine guns, and there will be two submerged torpedo tubes forward, and one tube above water aft. The accommodation for the officers and crew, of which there will be a total complement of 450, is amply provided for, the latest and most improved fittings for their quarters being furnished.

The ceremony of naming the Doris was gracefully performed by the Hon. Fanny Hood, daughter of Admiral Lord Hood of Avalon. On the dog-shores being knocked away the vessel gathered momentum down the ways, and within a minute was safely afloat in the water of Walney Channel, from where she was towed to the Devonshire Dock, where she will be fitted with her machinery.

DOULTON'S STONEWARE CONDUITS.

MESSRS. DOULTON and Co. are making a number of special and very convenient forms of troughs and casings for underground electric mains; two out of many forms we illustrate by the annexed engravings. The special feature of these casings is that they provide for access to the cables at any point, and for making house-connections at a minimum cost, and without the insertion of service boxes. They are made in various sections, Figs. 1 and 2, in lengths of 2ft., and are manufactured by a newly devised and protected method which enables each length to be made in one piece, which is, when necessary, readily divided longitudinally into an upper and lower portion. During manufacture, a partial division of the substance is made, as seen at A A and B in the sections, leaving sufficient material to preserve continuity and sufficient strength. A portion of the material is also cored out to reduce the area at this part and to make room for jointing material after separation. By means of a chisel the upper portion may be at any time detached. The two portions need not be separated until after the casing has been laid and access is required to the cables. Where a house service connection has to be made, the upper portion is removed from one of the lengths, and a special cover, as seen at Fig. 4, is substituted, provided with a socket to receive the branch cables. The division between the upper and lower portions is of a rebated cross-section, and facility is therefore afforded for making the longitudinal joint water-tight. The casings are supplied with the required number of ducts, and the cover can be made to include one or more of them as required.



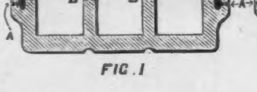


FIG. 1

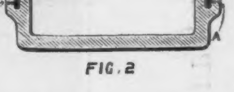


FIG. 2

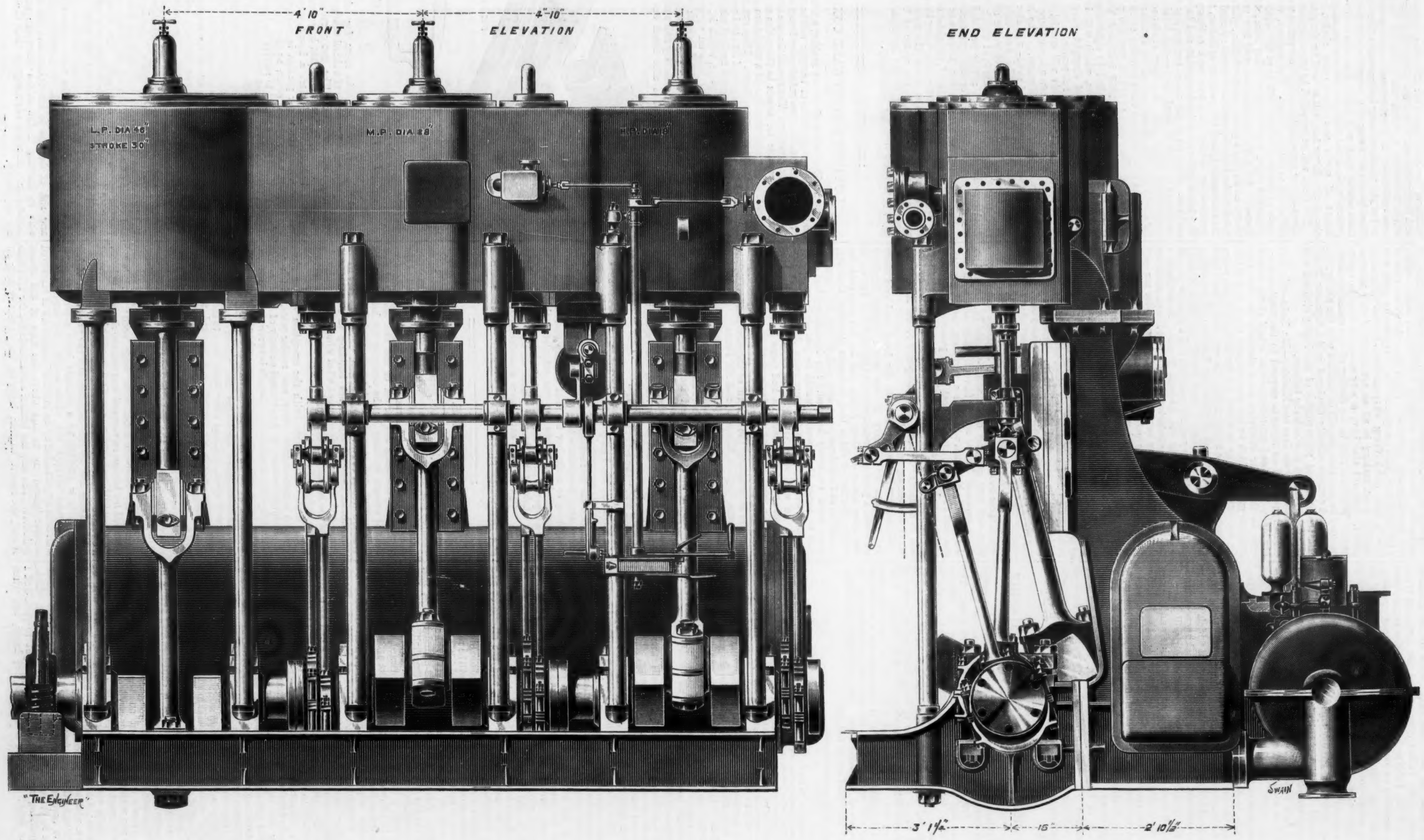
In laying the casings, the ends of the lengths are brought together on a stoneware chair, and the joint is rendered water-tight with Portland cement. The casings can be very rapidly and cheaply laid.

About eight miles of three-way conduit, with ducts 2¼in. square, have recently been laid by the Portsmouth Corporation. In this scheme the distributing cables are drawn into one of the outside ducts—that nearest the houses—and the covers provide access to this duct only. The other two ducts are occupied respectively by the feeders and arc-light mains. When the casing Fig. 3 is adopted, the upper portion of each length, if desired, may be removed before the ground is filled in, and the cables laid in the their respective ducts. The covers can then be replaced. This method entirely obviates any risk of damage to the cables, and will often be preferable to drawing in the cables after the casing has been covered in. Another advantage is that these cable casings are very cheap.

TRIPLE-EXPANSION ENGINES OF THE TUGBOAT OCEAN

THE ROYAL ENGINEERING AND SHIPBUILDING COMPANY, FLUSHING, ENGINEERS

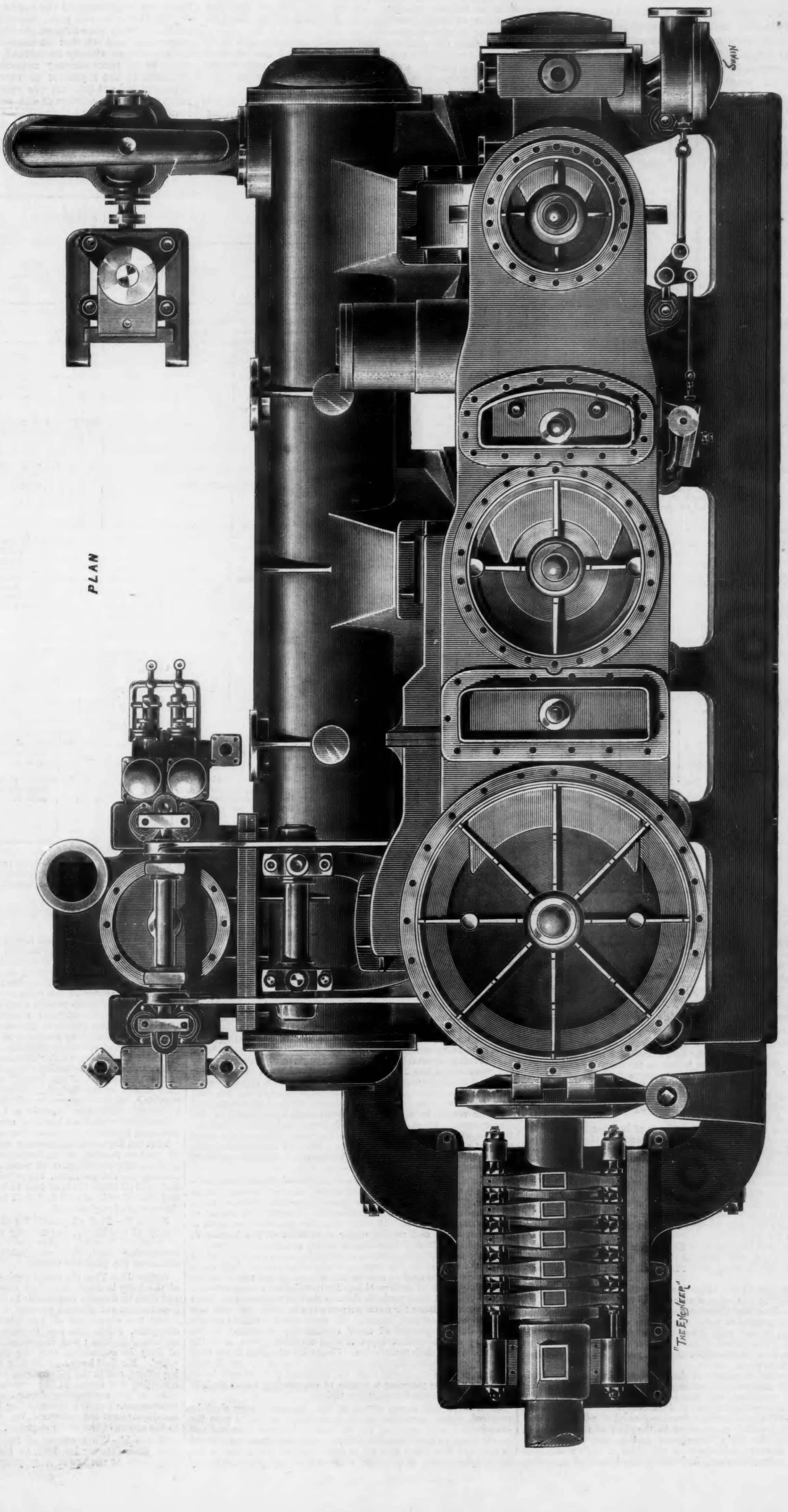
(*For description see page 235*)


4' 10"
4' 10"
FRONT ELEVATION
END ELEVATION
L.P. DIA 46"
STROKE 30"
M.P. DIA 28"
H.P. DIA 18"
3' 1½"
15"
2' 10½"
SWAIN
"THE ENGINEER"

TRIPLE-EXPANSION ENGINES OF THE TUGBOAT OCEAN

THE ROYAL ENGINEERING AND SHIPBUILDING COMPANY, FLUSHING, ENGINEERS

(For description see page 235)


PLAN
SWAIN
"THE ENGINEER"

BELLEVILLE BOILERS IN THE ROYAL NAVY.

It will be remembered that H.M.S. Sharpshooter has been fitted with Belleville boilers for experimental purposes. After certain dock trials had been successfully carried out, the vessel was commissioned and sent to sea with Lieut. Dodgson in command, with orders to cruise and test the boilers under all possible conditions. Lieut. Dodgson's report has been issued as a Parliamentary paper, and runs as follows. It will be seen that the performance of the boilers has been in all respects satisfactory :—

I have the honour to report that, in compliance with Admiralty letter—S. 14,436—of the 9th October, 1895, I carried out in her Majesty's ship under my command the trials mentioned in paragraph 2 of that letter on three occasions, viz.: — (*a*) At Portland on the 2nd December whilst at torpedo practice. (*b*) Off the Nab on the 10th December at target practice. (*c*) At Spithead on the 11th December at torpedo practice.

In all cases the ship was manœuvred as she might be in battle, the vessel cleared for action, and the men at their stations for general quarters. Full power for four boilers was used, giving a speed of 13½ knots, 190 revolutions, and 1450 indicated horse-power.

The following manœuvres were practised: Stopping frequently from full speed and starting again, without warning, after intervals of five minutes to 1½ hours, getting away at full speed from banked fires.

All that was found necessary in the stokeholds was to close the draught plates of the furnaces, and open wide the tube box-doors, and in the engine-rooms to make a moderate use of the blow-off valves to the condensers when suddenly stopping. There was no priming at the engines. Fires were banked on the 9th December at 7 p.m., steam maintained all night at 150 lb. to 200 lb. till 8 a.m. on the 10th, when the ship was got under way and started immediately at full speed, and manœuvred, as already mentioned, for six hours. On this trial, as a precautionary measure, a petty officer was stationed at the separator to ensure that its blowing-out apparatus did not fail, but the apparatus acted most satisfactorily, and the services of the petty officer were not once required. During the above trials the stokers employed were the men forming the first training class, who had been in the ship about a fortnight.—I have, &c.

(Signed) A. Dodgson,
Lieutenant-Commander.

H.M.S. Sharpshooter Special Sea Trials.

Number of trial.	Date.	Distance run.	Duration of trial.	Nature of trial.	Indicated horse-power.	Speed by log.	Number of boilers in use (total number eight).	Grate surface in use.	Total heating surface in use.	Coal.			Engines eased during trials.					Feeding of boilers; was it regular and constant?	Did boilers prime?	Was there any flaming at the funnels?	Repairs.		
										Total during trial.	Per square foot of grate per hour.	Per indicated horse-power per hour.	From.		To.		Cause.				Main engines.	Auxiliary engines.	Boilers.
													Date.	Time.	Time.	Date.							
	1895.	Miles.	Hours					Sq. ft.	Sq. ft.	Tons.	Lb.	Lb.											
1	June 20th to 22nd	693	48½	Sea	1,553	14·3	6	202	5,770	63	14·4	1·87	June 21st June 21st June 22nd June 22nd June 22nd	9.20 p.m. 11.15 p.m. 2.40 a.m. 3.50 a.m. 5.45 p.m.	10.0 p.m. 1.50 p.m. 3.0 a.m. 8.25 a.m. Discontinued trial at end of 693 miles.	June 21st ,, 22nd ,, 22nd ,, 22nd	Thick fog. ,, ,, ,, ,,	Yes	No	No	Nil	Nil	Nil .. .. ..
2	June 25th to 28th	1,000	60	Sea	1,549	14·4	6	202	5,770	91·4	14·6	1·91	Engines not eased		—	—	—	Yes	No	No	Nil	Nil	Four coned sleeves fitted to feed nipples.
3	July 3rd to 6th..	1,000	66½	Sea	1,569	15·0	6	202	5,770	96·5	16·0	2·07	Engines not eased		—	—	—	Yes	No	No	S. I. P. piston rings broken.	Nil	Two coned sleeves fitted to feed nipples.
4	July 11th to 14th	1,000	68	Sea	1,554	14·7	6	202	5,770	91·8	14·9	1·94	July 11th July 12th	11.30 p.m. 11.45 p.m. Banked fires all day, till 1.50 a.m. of the 13th.	12 (night) Stopped.	July 11th	H'vy squalls	Yes	No	No	Crack in web of S. H. P. cylinder.	Nil	Nil .. .. ..
—	July 19th .. .. July 23rd	Trial abandoned on account of bad weather.																					
5	July 28th to 31st	1,000	66¾	Sea	1,804	14·9	6	202	5,770	103·4	17·2	1·92	Engines not eased		—	—	—	Yes	No	No	Crack in brazing of P.I.P. receiver pipe	Nil	Nil .. .. ..
6	Aug. 7th to 11th	1,000	69½	Sea	1,820	14·4	6	202	5,770	104·2	16·6	1·84	Aug. 9th Aug. 9th	8.15 a.m. 9.30 a.m.	9.30 a.m. Banked fires and distilling till 2 p.m. of the 10th.	Aug. 9th	Squalls and thick fog.	Yes. Crack discovered in plunger of one feed pump, but feed maintained by starting another pump.	No	No	After propeller shaft bearings worn; condenser leaked.	Feed pump plunger cracked.	Nil .. .. ..
7	Sep. 18th to 21st	1,000	65	Sea	2,016	15·3	6	202	5,770	105·1	17·9	1·8	Engines not eased		—	—	—	Yes. Feeding of one boiler was by hand for part of the time, as a small piece of wire got under the valve of the automatic feed.	No	No	Nil	An obstruction removed from the valve box of one feed pump.	Piece of wire removed from one automatic feed valve. Spindle of one blow-off valve broken.
8	Sep. 28th to Oct. 1st	1,000	62½	Sea	2,037	15·7	6	202	5,770	103·2	18·0	1·79	Engines not eased		—	—	—	Yes	No	No	Stud of reversing gear broken.	Nil	Nil .. .. ..
9	Oct. 8th to 13th	1,000	62	Sea	2,194	16·1	6	202	5,770	105·4	18·8	1·73	Oct. 8th Continued trial	8.50 11.0	— Drew fires in five boilers, banked fire in one boiler. 11.5	— Oct. 10th	Gale of wind causing engines to race excessively.	Yes	No	No	Bracket of reversing gear broken.	Furnace air engine damaged by a spanner.	One bolt for securing element to feed nipple. Brick work of furnace.
	December 2nd, 1895. Torpedo practice ,, 10th, ,, Target ,, ,, 11th, ,, Torpedo ,,				1,450	About 13·5	4																

ABSTRACT OF MANŒUVRING TRIALS (*details attached*).

Ship manœuvred as in action, machinery suddenly stopped (frequently from full speed), starting again without warning after intervals of from five minutes to 1½ hours, getting away at full speed from banked fires. Fires were banked on the 9th December at 7 p.m., and steam maintained all night at 150 lb. to 200 lb., till 8 a.m. on the 10th, when the ship was got under way, and started immediately at full speed and manœuvred for six hours. There was no priming at the engines during these trials.

ENGINEERS IN THE UNITED STATES NAVY.

We give here the full text of the Wilson-Squire Bill, to which we have referred at length on another page. Mr. Wilson, of New York, introduced the Bill in the House of Representatives on January 10th, 1896. It was read twice, referred to the Committee on Naval Affairs, and ordered to be printed:—

A Bill to organise and increase the efficiency of the personnel of the Navy; to increase the usefulness and numbers of the Corps of Naval Engineers; to induce the scientific institutions to provide a naval engineering reserve for time of war; to establish a naval engineering experimental station, and to encourage the study of the mechanic arts and sciences, and particularly that of naval engineering in the technological colleges of the country.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that the active list of the Engineer Corps of the Navy shall consist of eighteen captains, twenty-five commanders, sixty lieutenant-commanders, seventy lieutenants, sixty-five lieutenants of the junior grade, and sixty-five ensigns, and a number of engineer cadets, as provided by subsequent sections.

That these offices shall be filled by the commissioning of the officers of the Engineer Corps of the Navy borne on the active list at the time this Bill shall become a law, in the order of seniority, beginning at the top.

That there shall be a chief of the bureau of engineering of the Navy Department, who shall be director-general of naval engineering, and while holding said office shall have the rank of rear-admiral.

That there shall be two inspectors-general of naval engineering, who while holding said office shall have the rank of commodore.

Section 2.—That the director-general of naval engineering and two inspectors-general of naval engineering shall be appointed by the President, by and with the advice and consent of the Senate, from the list of the officers of the Engineer Corps of the Navy not below the grade of lieutenant-commander, and shall hold office for the term of four years.

Section 3.—That the duties of the director-general of naval engineering shall comprise everything relating to the engineering material and personnel, and that he shall be a member of every naval board concerning the policy of the Navy.

Section 4.—That the senior inspector-general of naval engineering shall be detailed as assistant to the chief of the bureau of engineering of the Navy Department, and in case of the death, resignation, absence, or sickness of the chief of the bureau, such officer shall, unless otherwise directed by the President according to the provisions of section one hundred and seventy-nine of the Revised Statutes, perform the duties of such chief of bureau until his successor is appointed or such absence or sickness shall cease.

That the duties of the senior inspector-general of naval engineering shall, under the direction of the chief of bureau of engineering, consist of designing and preparing the plans and specifications of all new machinery. He shall also have direct charge of all experimental research in connection with matters relating to the marine, electrical, and mechanical engineering sciences under the cognisance of the bureau of engineering. At least once every two years he shall visit those technological schools which shall have established a course of engineering satisfactory to the Secretary of the Navy, and where an officer of the Engineer Corps of the Navy is detailed; he shall make such reports as will show their usefulness and efficiency to the naval service. He shall be a member of the speed trial boards, which shall recommend whether vessels built by private firms shall be accepted by the Government. He shall prepare such forms and books of instruction as will aid the officers of the Engineer Corps in the more efficient performance of their duties. He shall also perform such duties as may be assigned him by the director-general of naval engineering.

Section 5.—That the junior inspector-general of naval engineering shall be detailed as assistant to the chief of bureau of engineering. That the duties of the junior inspector-general of naval engineering shall be, under the direction of the chief of bureau of engineering, as follows:—He shall have the general supervision of all construction and repairs under cognisance of the bureau of engineering. He shall have charge of the selection of the various auxiliary mechanical appliances required for naval purposes, which are not designed by the bureau of engineering, and shall make experiments from time to time as will secure for the naval service the highest types of such machines for installation aboard our war-ships. He shall make periodic visits to the several industrial plants where such machines for naval purposes can be built, and shall also visit modern merchant vessels. He shall submit detailed reports to the director-general of naval engineering in regard to the efficiency of the various types of such machinery, and as to the best manner of their installation. Under his direction there shall be prepared monographs upon subjects relating to the naval engineering profession, which shall be furnished free of cost to all students who are pursuing a course of engineering which shall fit them for appointment as engineer cadets.

Section 6.—That every officer of the Engineer Corps shall be required, before promotion to the next higher grade, to pass the examination now provided for by section fourteen hundred and ninety-three of the Revised Statutes. All except those who served in the Civil War shall also be required, before promotion to the next higher grade, to pass the examination now provided for by section fourteen hundred and ninety-six of the Revised Statutes, as amended by the following section.

Section 7.—That section fourteen hundred and ninety-six, Revised Statutes, be, and is hereby, amended by the addition of the following proviso:—"Provided, That the aforesaid board shall be composed of officers of the same corps as that of the officer to be examined, and that no records than those which may be on file in the Navy Department from commanders-in-chief, commanding officers, and senior officers of the same corps as that of the officer being examined shall be accepted as evidence in determining his mental and professional qualifications."

Section 8.—That the title "Bureau of Steam Engineering of the Navy Department" is hereby changed to "Bureau of Engineering of the Department of the Navy," and it shall have charge of all that relates to the designing, building, installation, fitting out, repairing, and management of all main and auxiliary steam, hydraulic, pneumatic, electric and other machinery and their appurtenances used on board of naval vessels, not including gun carriages, torpedoes, torpedo tubes and fittings.

That the bureau of engineering shall hereafter have control of all matters relating to the inspection and tests of steel material used in the construction of vessels of war, and of all matters relating to the purchase, inspection, character, and quality of coal, and all other kinds of fuel to be used for all naval purposes; and that all tests of such fuel shall be made under the direction of the bureau of engineering.

Section 9.—That all boards for the examination, inspection or survey of machinery, engineering material, tools and supplies, or contract therefor, under the cognisance of the bureau of engineering, shall, when practicable, be composed exclusively of officers of the Engineer Corps.

Section 10.—That the senior engineer officer attached to a vessel of the Navy in commission shall command the engineers' division, and shall be directly responsible to the commanding officer for the preservation and efficient working of all machinery and appliances under the cognisance of the bureau of engineering; for the discipline, instruction and training of the enlisted men of the engineers' division; and, in general, for the execution of all details of duty in connection with the engineering department of the vessel. He shall have no authority independent of the commanding officer, and in the performance of his duty shall be regarded as executing the orders of the commanding officer. The officer on duty in the engineering department shall be regarded as the representative of the commanding officer so far as the duties of the department are concerned, but he shall at all times be subject to the orders of the senior engineer.

Section 11.—That officers of the Engineer Corps of the Navy shall, after January 1st, 1897, be placed on the retired list when they arrive at the age of sixty years, and officers so retired shal receive seventy-five per centum of the sea pay to which they are entitled at the date of such retirement as established by existing law.

Any officer of the Navy who has served, or shall have served, faithfully thirty years may, upon his own application, and in the discretion of the President, be retired from active service and placed upon the retired list, with three-quarters of the sea pay of his grade, and any officer below the rank of commodore who has served, or shall have served, honourably thirty-five years may, upon his own application, and in the discretion of the President, be retired from active service and placed upon the retired list of the Navy, with the rank and retired pay of the next higher grade.

Section 12.—That each Senator of the United States and each Delegate of the House of Representatives shall nominate candidates for appointment as engineer cadets at the United States Naval Academy in the same manner and under the same regulations as now govern the nomination and appointment of naval cadets by members and delegates of the House of Representatives.

That the President shall appoint one engineer cadet from the district of Columbia and three at large, as he now appoints naval cadets.

Until the number of officers of the Engineer Corps provided for in this Act is reached each Senator shall be entitled to have two cadets pursuing the prescribed course at one and the same time, but after that number has been reached but one cadet at one and the same time.

After the passage of this Act, at the date designated, the senior Senator from each State shall nominate a candidate for appointment as engineer at the United States Naval Academy. At the same time in the following year the junior Senator from each State shall nominate a candidate for appointment as engineer cadet at the United States Naval Academy, and any vacancy in the preceding year's appointments shall be filled by the Senator who made the original nomination, or by his successor. The third year the senior Senators shall make their second nominations, and the fourth year the junior Senators shall make their second nominations, and thereafter whenever a vacancy occurs until the number of officers in the Engineer Corps has reached the limit fixed in this Act, when each Senator will be entitled to but one cadet pursuing the course at any one time.

The Presidential appointments, one from the district of Columbia, and three at large, four in all, and the nominations by the delegates shall be made one each year, in each case until the positions are filled, and thereafter whenever a vacancy occurs. The Secretary of the Navy shall designate the order in which the delegates from the Territories shall nominate their candidates. A vacancy in the above Presidential and delegate appointments occurring during these first four years shall be filled at the date of yearly appointments next following, in addition to the original appointments of that year.

From the passage of this Act until the class first appointed under its provisions shall enter its fourth year, appointments shall be made to the engineer division of the first class of naval cadets at the United States Naval Academy according to the laws in force governing such appointments previous to the passage of this Act, except that volunteers only shall be so appointed.

Section 13.—That graduates of technological schools of the United States whose course of instruction in mechanical engineering may be considered satisfactory by the Director-General of Naval Engineering, and approved by the Secretary of the Navy, may be eligible for appointment as engineer cadets in the Engineer Corps of the Navy.

That the appointment of engineer cadets in the Engineer Corps of the Navy shall be made from the engineer cadets of the United States Naval Academy at the end of the four years' course, and from the graduates of the before-mentioned technological schools.

That on the 13th day of June after the passage of this Act, and yearly on the same date, and until the number of commissioned officers allowed by this Act has been reached, the number of engineer cadets appointed in the Engineer Corps of the Navy shall be thirty, plus the number of vacancies occurring in the Engineer Corps during the year preceding ending May 31st. After the number of commissioned officers herein provided for has been reached, the number of appointments made on the 30th of June of each year shall be double the number of vacancies occurring in the lowest grade of commissioned officers in the Engineer Corps of the Navy during the year then ending.

Until the total number of officers in the Corps provided for by this Act is reached, the number of graduates of technological schools appointed engineer cadets, as above provided, is to be equal to forty, less the number appointed from the United States Naval Academy, and after this limit is reached to be equal to the excess of the existing vacancies over the number of engineer cadets of the engineer cadets of the United States Naval Academy available each year.

All applications for appointments from civil life must be made to the Secretary of the Navy on or before the first day of June of each year. Such candidates must not be less than nineteen nor more than twenty-four years of age, and before appointment must undergo a physical examination before a board of medical officers of the Navy, and must possess the physical qualifications required of naval cadets.

Section 14.—That the engineer cadets appointed in the Engineer Corps of the Navy shall be assigned to cruising ships for one year, and at the end of that year shall be ordered for one year to the various working navy-yards, or to such scientific post graduate schools as may be established by the Secretary of the Navy, for such practical instruction as may be recommended by the director-general of naval engineering and approved by the Secretary of the Navy. At the conclusion of this two years' service they shall undergo a physical examination before a board of medical officers of the Navy, and a professional examination at the United States Naval Academy as now prescribed by regulation, and from those who pass, and in the order of merit as shown by that examination, shall be commissioned as engineer officers to fill vacancies in the lowest grade of commissioned officers of the Engineer Corps of the Navy: Provided, that at least one-half of such vacancies shall be filled by graduates of the United States Naval Academy: And provided further, that after the number of commissioned officers allowed by this Act has been reached, the number of officers so commissioned in the lowest grade of the Engineer Corps shall be equal to the number of vacancies occurring in the Engineer Corps of the Navy. Those engineer cadets who have successfully passed the examination, but who do not receive commissions, shall be honourably discharged from the naval service and shall receive one year's pay, as now provided by law. If the number of vacancies in any year is greater than the number of engineer cadets who have successfully passed the required examination, the surplus vacancies shall be filled from the successful engineer cadets of the following years, as they become available.

Any enlisted man who has served three years in the Navy in the Engineer's Department, and who is not over twenty-five years of age, shall have an opportunity to compete with the engineer cadets for commission in the Engineer Corps of the Navy. He shall be commisioned as assistant-engineer, if his order of merit at such examination shall entitle him to such commission.

The pay of engineer cadets shall be the same as that now provided by law for naval cadets, except that they shall receive the rate of pay known as "sea-pay" during the time they are under instruction at the navy-yards and scientific post-graduate schools as above provided for.

That upon application to, and approved by, the Secretary of the Navy, an officer of the Engineer Corps shall be detailed to each technological school or college mentioned above, as professor of naval engineering, and that the number of officers now authorised by law for such purposes is hereby increased to permit such detail.

Section 15.—That in order to promote the study of marine engineering as contemplated in the previous sections, the bureau of engineering is hereby empowered to loan, under conditions imposed by the Secretary of the Navy, to such scientific institutions as may establish the course of study herein provided for, and shall give the Navy a corps of trained men as a naval engineering reserve, such models, plans and machinery as can be spared without detriment to the naval service.

Section 16.—That sections 1484 and 1485 of the Revised Statutes of the United States be amended so as to read as follows:—

"*Section* 1484.—Officers of the staff corps of the Navy graduated at the Naval Academy shall take precedence in their several corps and in their several grades, and shall take rank with officers of the line of the Navy, according to the dates borne by the diplomas or certificates awarded to them at the completion of the course of study at the Naval Academy before performing service afloat in other than practice ships, and according to their relative proficiency at such dates, as shown by the ratio which the merit mark obtained by each graduate bears to the maximum obtainable mark, and officers who have been lawfully advanced or lost numbers on the Navy Register shall be considered to have gained or lost rank accordingly."

Section 17.—That officers of the Corps of Naval Engineers shall not be entitled by virtue of their rank to command in the line or in other staff corps, except when assigned to such command or duty by competent authority.

Section 18.—That every commissioned officer of the Engineer Corps of the Navy who shall have a regular or supervisory watch in the engine-room shall be a ward-room officer.

Section 19.—That the sum of seven hundred and fifty dollars is hereby appropriated to engrave a plate for printing the new commissions, which shall be furnished the officers of the Engineer Corps affected by this Act.

Section 20.—That by reason of the scarcity of naval engineers all the naval cadets of the engineer division who have completed the course of study at the Naval Academy, and who are now performing duty at sea or elsewhere, shall be ordered to Annapolis at the earliest practicable day for the final examinations preliminary to promotion, and upon passing the several examinations satisfactorily, as required by the Academic Board, shall be commissioned by the President as ensigns of the corps.

Section 21.—That for the purpose of providing a suitable place where engineering experiments may be carried on to the best advantage, the naval station at New London, Connecticut, shall be placed in the charge of the chief of the bureau of engineering in the Department of the Navy, who shall, under the Secretary of the Navy, conduct such experiments and make such researches as may be necessary or expedient for the best interest of the naval service. That there shall also be established at this station, which shall be called the United States naval experiment station, a post-graduate course for engineer officers of the Navy and Revenue-Marine Service, under such rules as may be approved by the Secretary of the Navy.

That the sum of five thousand dollars, or so much thereof as may be necessary, is hereby appropriated, in addition to the regular appropriation now made for the naval station at New London, Connecticut, to carry into effect the provisions of this section.

Section 22.—That the pay of the officers of the Engineer Corps of the Navy shall be the same as that for the line, grade for grade: Provided that the pay of a commodore on shore duty shall be four thousand five hundred dollars; on leave or waiting orders, three thousand six hundred dollars; that the pay of a captain on shore duty shall be four thousand dollars; on leave or waiting orders, hree thousand three hundred dollars; that the pay of a commander shall be, at sea, four thousand dollars; on shore duty, three thousand five hundred dollars; on leave or waiting orders, three thousand dollars; and that the pay of no officer who served in the civil war shall be reduced by this Act.

Section 23.—That all laws or parts thereof now in force inconsistent with the provisions of this Act are hereby repealed.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

COAST DEFENCE SHIPS.

SIR,—Referring to Mr. McGlasson's letter on the above subject, I presume to think that a scheme for coast defence which I suggested in 1858 would answer better. My plan was to construct a railway on the beach, above high-water mark, to be traversed by batteries of heavy guns, firing *en barbette*, and drawn by locomotives, which could keep abreast of any invading fleet which escaped our own men-of-war, and deal with the hostile force wherever it attempted to land. The railway in cross section by training the cliff slopes, and utilising the material from same as a glacis on the sea face of beach, was practically formed into the "covered way" of a fortress. A wet ditch at foot of slope of cliffs was expected to dispose of such shells as did not bury themselves in the slope, and fenced the line on the landward side. The profile of the railway in cross section admitted, of course, of its being defended like a fort by infantry firing from the banquette at foot of parapet of glacis. Barracks to house the batteries and gunners were to be provided, so that the latter could always be ready for service and in telegraphic connection with War Department. Of course our fleet is our first line of defence. What I suggested was to be a second, and I aimed at placing an obstacle in the way of the invader if he did attempt to land, so as to give time for the forces inland to come up and complete the resistance. Soldiers put up in boats or small vessels could be better dealt with then than when once on shore, and entrenched probably. Of course it would not be necessary to construct the railway all round the coast, but only at such portions as would naturally be selected for attack—on probably the south or east coasts. Mr. Stanhope claimed to have made the attack on London by the estuary of the Thames impossible. But suppose a force of 100,000 men thrown on shore reaching Maldon, and marching rapidly forward circling London, and cutting the railways which now feed it—is not that a possible deadly peril? London depends on country supplies for its daily bread, and such a catastrophe as I assume—with the multitude of mouths to be fed in the great city—would perhaps reduce it to extremity before succour from inland could arrive. Whether we are now so organised militarily as to make such a disaster as this impossible, is more than I can say. If not, the sooner we put ourselves on a proper footing of defence the better. My own views run in favour of a compulsory military training of the whole male population on the Swiss model, or at least of such a percentage as would unquestionably provide efficiently for home defence. In view of the hostility against us on the Continent, this may yet have to be adopted. The railway suggested would give facilities for torpedo launching, and for carriage of lifeboats to vicinity of wrecks, and for prevention of smuggling. J. H. R. ROSE.

3, Derby-road, Hightown, Wrexham,
Denbighshire, February 28th.

PRIOR PUBLICATION OR NOT.

SIR,—I beg to thank you for the mention of my inquiry, also both your and Mr. Llewellin's remarks upon the subject.

I did not state definitely the circumstances of the case I am personally interested in, as I wanted the question to be of general interest to your readers as well as myself. No doubt this question of prior publication is a matter of importance to many, as it not only concerns patentees but also those who work and purchase patents.

The model in question was a full-sized working model, and was shown only in the inventor's workshop, and under the assumption that steps were being taken by the inventor to obtain a patent, but unfortunately there was some delay in making the application. The question, I think, resolves itself into this—Is the mere inspection by a British or British subjects of a new article or machine which is in the possession of the inventor, who is about to apply for a patent, sufficient to invalidate the patent subsequently granted for the same?

I have always been under the impression prior publication means that another person beside the inventor had in his possession, previous to the application for a patent, either a machine, model, drawing, or written description sufficient to enable a skilled workman to carry out the invention.

No doubt, Mr. Llewellin is perfectly correct in pointing out that, when an invention is known to others besides the inventor, that there is no object for granting a patent. But does the inspection of a machine prove that the inspector has grasped the invention?

There are people who might examine a machine for a week, and then not be able to describe it; or an expert might not have sufficient time or take sufficient trouble to understand the invention, and therefore could not prove that he had done so, unless he recorded it in some way. In the case in which I am especially interested, neither description, drawing, or any other record was in the hands of anyone but the inventor previous to his application for a patent. J. H.

Peterborough, March 4th.

BOILER INSPECTION IN NEW ZEALAND.

SIR,—A brief account of the history and work of this department may interest your readers a little. The Inspection of Machinery Act came into force in all New Zealand on January 1st, 1875, requiring the inspection of all boilers every year and all machinery however driven. Certificates are issued for boilers stating when inspected, pressure allowed, and date of expiration of certificate. The department started with a chief inspector and four inspectors; I was appointed for Canterbury, and am still in charge of the district; there are now seven inspectors and chief inspectors. The first annual report shows there were 971 boilers inspected in all New Zealand, the last annual report shows 2750. The fees charged are small, and are intended only to pay expenses of the department, which, on account of the scattered districts, are rather heavier than they would be per boiler in a country more thickly populated.

Besides the inspection of boilers and machinery, we also examine engine drivers for certificates to drive traction engines, engineers for certificates of competency, first, second, and third-class, and survey steamers, 212 being the number for last year, and twenty-seven engineers of all classes examined.

The report shows there was no accident of any kind in connection with boilers, and only fourteen accidents from machinery, two of which proved fatal. During the twenty-one years the Act has been in force there have been only three explosions of boilers, and in each case they were small boilers causing no extensive damages, such as we read of in your paper occasionally. As our work embraces machinery as well as boilers, and the survey of steamers and examination of engineers, our inspectors are all engineers.

During the past year there were 159 new boilers added to our number, 81 of which were made in the Colony under our supervision.

In conclusion, I may say owners generally are always pleased to see us come round, and are ready to comply with our requests, never object to getting boilers ready for inspection, and are grateful for any advice we may give them. GEORGE CROLL,

Christchurch, New Zealand,
January 21st.

A CANAL PROPOSAL.

SIR,—I beg to thank you for publishing in last week's ENGINEER an account of my invention of an improved method of utilising canals for traffic, and I feel much gratified by your favourable opinion of the objects which the invention is designed to accomplish. There is, however, a slight inaccuracy in your article which, perhaps, you will allow me to correct. You give my estimate of the average speed on level canal as 1·41 miles per hour, whereas it should be as stated—page 6—1·86 miles per hour. The figures 1·41 refer to the average speed on a through journey, allowing for delay in passing locks, stoppages, &c.

I am acquainted with the mode in which the Aire and Calder canalised rivers, and other improved waterways, are worked at the present time, which was fully considered by the eminent counsel who settled my specifications, and who were perfectly satisfied that the invention was of such a nature that it would be protected by letters patent. Your doubt on that part of the subject therefore appears to be unfounded.

Daventry, March 3rd. WILLIAM B. COOK.

JAMES WATT AND CO., SOHO WORKS.

SIR,—Referring to the last paragraph in your concluding article on the machinery at Soho, you say:—"We must not omit to mention the fact that all the important parts, and those requiring the greatest amount of skill in the engines referred to—that is, late engine contracts—were produced by men of experience, who are still in the employ of the late firm's successors."

Perhaps you will allow me to correct this. A large and expensive office and staff, with the proprietor at the head, existed in London, where all the designs for the modern engines you praise were made and issued to the works at Soho. This office is closed, and all the staff of designers scattered. Further, all the draughtsmen at Soho who designed local work and carried out the required works—details of the London office designs—have left, and are employed elsewhere. All the foremen are gone, except one; also the skilled artisans, except perhaps two or three, who have been kept to carry out small local repair jobs; which seems to be all that is left of the famous business of Boulton and Watt.

London, March 3rd. ONE OF THE STAFF.

COAL PREMIUMS.

SIR,—Having read with great interest and pleasure the able articles by Mr. Charles Rous-Marten upon the actual running of modern locomotives upon the leading railways, I am anxious to ask his opinion with reference to the effect of coal premiums being given to engine-drivers and firemen.

Of course it is a well-known fact that engine-drivers and firemen are not in favour of the present coal premium systems. I am of opinion that it does not pay the railway companies, and I know for a fact that the premium often causes trains to be late. In many instances the companies have gone, and are going to great expense to build new and larger engines, when the fact is the present engines could do the duty perfectly if the drivers could have extra coal with which to do the work. The coal premium system also causes a considerable amount of double-engine running on many lines. CLEMENT E. STRETTON.

Saxe-Coburg House, Leicester, March 4th.

THE HARDENING OF ARMOUR-PLATES.

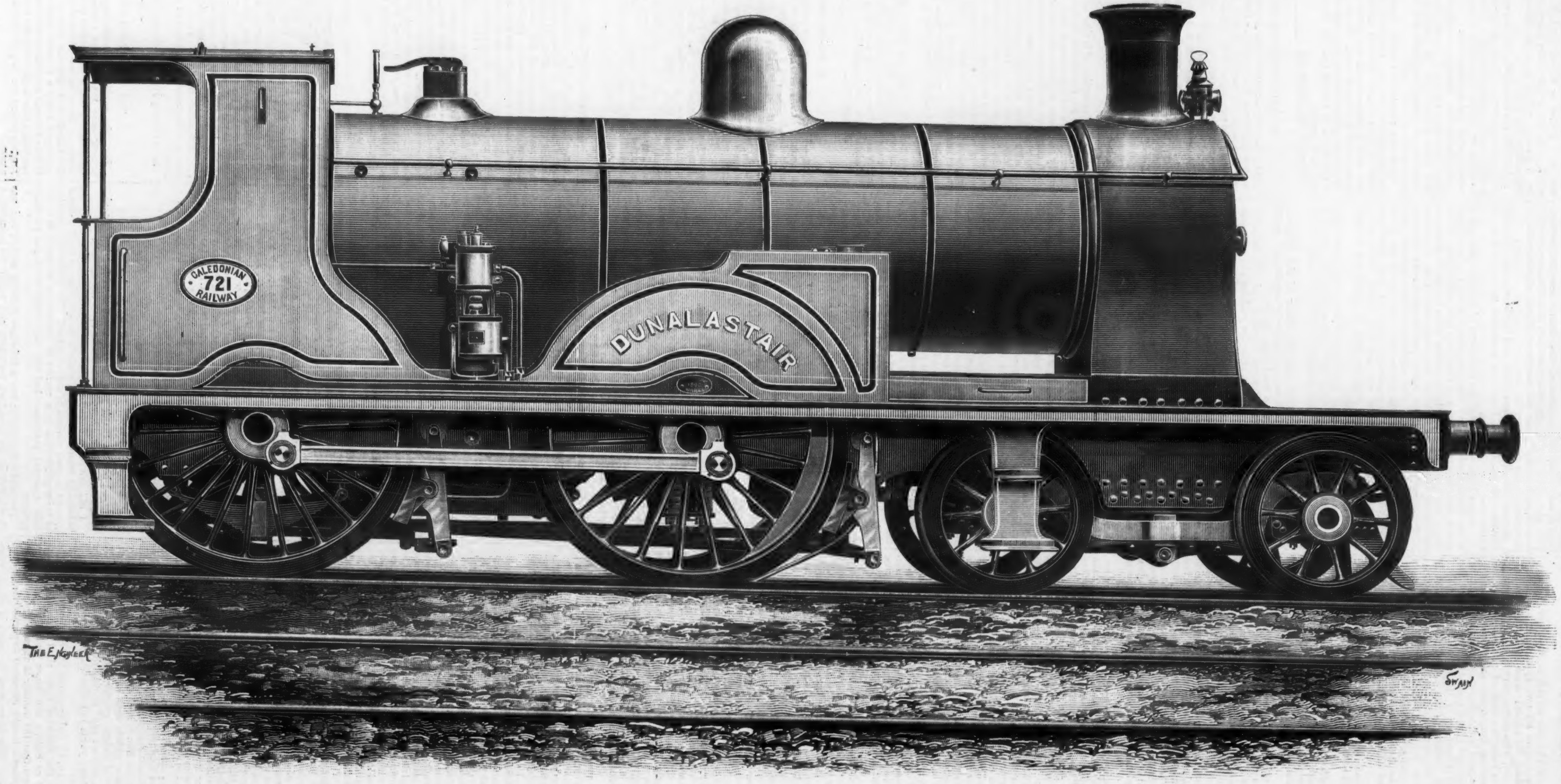
SIR,—On reading through your article on modern methods of armour-plate manufacture appearing in a recent issue of THE ENGINEER, I find a description of the latest procedure adopted by Krupp at Essen for hardening the armour-plates manufactured by this famous firm, and one said to give excellent results, the agent employed being a gaseous hydrocarbon applied under pressure. It may interest English metallurgists to know that this hardening method, as far as this country is concerned, is covered by my 1893 English patent for improvements in the manufacture of armour-plates. B. H. THWAITE.

29, Great George-street, Westminster, March 4th.

EXPRESS LOCOMOTIVE, CALEDONIAN RAILWAY

MR. J. F. McINTOSH, ENGINEER

(For description see page 235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TO CORRESPONDENTS.

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**** All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

**** We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

J. W. (Jersey).—*Your son is too young to begin his apprenticeship. He should attend some good technical school for a couple of years.*

J. H. T.—*Since the publication of your inquiry our attention has been called to a book on light railways by J. C. Mackay, A.M.I.C.E., about to be published by Crosby Lockwood and Co. 15s.*

E. M.—*There is no published formula for the crushing resistance of the precise section you mention. You must be guided by the resistance of analogous sections. Consult for some of these books in the Patent-office Library, open every evening.*

J. C. AND B. (Bolton).—*We cannot give you any information about solidified petroleum, because there is none. Many attempts have been made to produce it as a fuel, but generally the nature of the process has been kept secret, and the attempts have ended in failure. The general idea seems to be to convert the heavy oil into a species of soap with lime.*

W. A. C.—*You will find the answer to your question in almost any treatise on mechanics. The speeds of the pulleys will vary in the inverse ratio of their diameters; that is, the smaller the pulley the more rapidly it will revolve. Dividing 1200 by 250 we have 4·8. The diameter of a pulley running 250 revolutions per minute must be 4·8 times as great as that of the pulley to run at 1200 revolutions.*

E. H. J.—*There is nothing novel in the principle of your governor. Like all other marine governors it would fail because it does not anticipate. In a triple-expansion engine there is always steam enough to cause racing if the load is taken off. What is required is a governor which will shut off steam just before the stern lifts, and will turn it on again just before the stern drops. A man at the throttle valve can do this, but no governor has yet been produced that will.*

A. S. (Milan). *We believe that if you fit your nuts in the marble as shown in your sketch, and run them in with melted sulphur instead of cement, you will have no reason to complain. Have you tried this plan? The cement probably fails because there is too little of it. There is a very fusible brass made by alloying zinc with a small proportion of copper. It would be worth while to try this instead of lead. The colour would be nearly that of the brass letters, but whiter.*

IRONWORK.—*For triple-expansion engines allow 1½ square feet of cooling surface per indicated horse-power. Temperature of cooling water under 60 deg. Add half a square foot for every 10 deg. Fah. rise in temperature. For compound engines add about 50 per cent. of surface. For non-compound engines double the surface. The capacity of the air pump, single acting, may be one-twentieth that of the low-pressure cylinder. For single-cylinder engines make it one-twelfth. These are maximum figures. Practice varies a good deal, and excellent results are got with very small air pumps. You cannot use too much circulating water, and ought not to use less than thirty-five times the amount of the fuel. (2) "Laxton's Price-book" is published by Kelly and Co., London.*

ECONOMIC PRODUCTION OF LIME.

(*To the Editor of The Engineer.*)

SIR,—Will you kindly allow us to ask for information on (1) the best construction of kiln, (2) cost for coal per ton of lime, as we propose to start a kiln?

J. F. S.

Belfast, February 29th

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, March 10th, at 8 p.m. Paper to be further discussed: "On Littoral Drift in Relation to River Outfalls and to Harbour Entrances," by Mr. William Henry Wheeler, M. Inst. C.E. Papers to be read: "The Lixiviation of Silver Ores," by Mr. J. H. Clemes, Assoc. M. Inst. C.E. "Mining and Treatment of Copper Ore at Tharsis, Spain," by Mr. C. F. Courtney, M. Inst. C.E. "Tin Smelting at Pulo Brani, Singapore," by Messrs. John McKillop and T. Flower-Ellis. Friday, March 13th, at 8 p.m. Students' meeting. Paper: "Tests of Centrifugal Pumps," by Mr. J. C. Cornock, Stud. Inst. C.E. Dr. Alexr. B. W. Kennedy, F.R.S., Member of Council, will preside.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, March 12th, at 8 p.m. Paper: "High Voltage Lamps and their Influence on Central Station Practice," by G. L. Addenbrooke, Member.

INSTITUTE OF MARINE ENGINEERS.—Monday, March 9th, at 7.30 p.m., at Stratford. Discussion on paper: "Liquid Fuel," by Mr. Wilson. Friday, March 13th, at 7 p.m. Annual meeting of members.

LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—Saturday, March 7th, at 8 p.m. Paper: "On the Manufacture of Crank and Propeller Shafts, and some Causes of their Breakage," by the President, Mr. Wm. Royal.

ROYAL INSTITUTION OF GREAT BRITAIN.—Tuesday, March 10th, at 3 p.m. Lecture: "The External Covering of Plants and Animals: Its Structure and Functions," by Professor Charles Stewart, M.R.C.S., F.L.S. Thursday, March 12th, at 3 p.m. Lecture: "Masters of Modern Thoughts—II. Rousseau," by the Rev. William Barry, D.D. Friday, March 13th, at 9 p.m. Discourse: "The Theory of the Ludicrous," by William Samuel Lilly, Esq., M.A., Hon. Fellow of Peterhouse, Cambridge. Saturday, March 14th, at 3 p.m. Lecture: "Light," by the Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., M.R.I., Professor of Natural Philosophy, R.I.

SOCIETY OF ARTS.—Tuesday, March 10th, at 8 p.m. Applied Art Section. Paper: "English Book Illustration, 1860-70," by Joseph Pennell. Lewis Foreman Day will preside. Wednesday, March 11th, at 8 p.m. Paper: "Peasant Life and Industries in Ireland," by Professor A. C. Haddon. The Duke of Abercorn, K.G., will preside.

THE ENGINEER.

MARCH 6, 1896.

MR. GOSCHEN AND THE NAVAL ENGINEERS.

MR. GOSCHEN'S programme is magnificent, but it is not war, because the best possible guarantee of peace is Great Britain's power. The figures which he has given are impressive. What other nation exists that could regard as a moderate addition to its naval strength the rapid construction of five battleships, four first-class cruisers, three second-class cruisers, six third-class cruisers, and twenty-eight torpedo boat destroyers? A splendid navy in itself. Where is the nation wealthy enough to spend ten millions sterling without the addition of a single penny to the taxation of the country? The facts cannot, we think, fail to convince possible foes that we can be terribly in earnest on occasion, and that discretion may be the better part of valour, where our rights are concerned. That Mr. Goschen's proposals are in the main satisfactory is certain. It is possible, nay, even likely, that something may be said, and said with advantage, in the way of criticism when we have descriptive particulars of the ships before us; but the time for criticism of this kind has not yet arrived, and there is nothing in Mr. Goschen's statements to shake our faith in the skill and talent of Sir William White and his colleagues at the Admiralty.

But however contenting to the nation the Admiralty Programme may be, it is in a most important particular so defective, that we trust pressure may be brought to bear on Mr. Goschen in order that it may be amended. The engineers, without whom the finest navy in the world is useless, are passed over with scant ceremony. All the claims so long urged for better treatment are ignored, and four or five lines of Mr. Goschen's statement are deemed enough to set forth the intentions of the Government. "The list of engineer officers will be raised from 200 to 300." "A new scale of pay has been fixed for engineer officers by an Order in Council of July 4th, 1895, with a view to placing the higher ranks more on an equality with the senior officers of the other civil branches of the Navy, and in order to provide adequate remuneration for their increasingly arduous and responsible duties."

It is not quite clear what Mr. Goschen means by "200 engineer officers." There are on the Navy-list about 764 engineer officers of all grades. The number required for existing ships alone is about 1100. The question was exhaustively discussed in our pages just twelve months ago. It is possible that the First Lord of the Admiralty means that 200 or 300 engineers will be added to the 764. But this number is not sufficient, and we have no idea whence the additional men are to be obtained. We are told, indeed, that the Admiralty school at Keyham is doing good work, but it can scarcely be seriously contended that Keyham can supply in a reasonable time 300 trained engineers. They cannot be drawn from the mercantile marine, because we have been assured by one First Lord after another that a very special education indeed is needed to fit an engineer for duty on board a warship. It must not be forgotten that Keyham Naval Engineers' College will not be completed until November 30th, 1896. Turning from Mr. Goschen's printed statement placed in the hands of members on Monday to his speech, we find little that is encouraging. All that he has to say about engineers is very easily reproduced. After a statement concerning the warrant officers and their pay, promotion, and position, which are all three to be improved, the First Lord went on, "I am able to say also that the training of engineer students in the college at Keyham is progressing in a most satisfactory manner. Two members of the Board visited that college not long ago, and they were struck by the general appearance and aptitude of these young recruits to her Majessy's service. The profession of engineers in the Royal Marine is a fine profession, and the men who enter it now come from all classes of society. They have, when they enter the profession, a certain professional career. They have that advantage over civil engineers. Having once entered the service they are sure of being on full pay until they retire, there being no half-pay in their case, as there is in the case of the active list. The prospects of engineer students, who are to mess with gun-room and ward-room officers, are not generally known in the country, yet the number of applicants is such as to meet the necessary requirements of the service." If the Admiralty are content to cut down the number of engineers far below what it ought to be, the statement may be correct. But we maintain now, as we have frequently maintained before, that there is not a sufficient number of engineers available even for peace, and that we have absolutely no reserve worth the name for war. There are two reasons for this. The first is that successive Boards of Admiralty have made no adequate edeavour to obtain men; and the second is that the pay and position are not good enough to induce men to take up naval engineering as a profession.

Mr. Goschen states that he has no difficulty in getting all the stokers that he needs. We are very glad to hear this, yet we are by no means certain that he fully realises how many really are needed. The teaching of the naval manœuvres has convinced several competent authorities that if our ships were engaged in actual warfare, they would be found to be short handed in the stokeholds. There is no reserve of force. Mr. Goschen possibly relies on the stokers as aids to the engine-room staff. What such aid may be worth remains to be seen; and it is an unpleasantly suggestive fact that the engine-room artificers have been passed over in silence; all that is said about them is that their number is to be augmented by 342. This is as it should be; but again we ask, where are they to be got, and what are the new inducements offered to obtain them? The old idea still reigns at the Admiralty that the engineers and their crews are of secondary importance. The truth that they are of the first importance, that the whole efficiency of any modern navy depends absolutely on these men, is one that the Admiralty cannot take in. The danger incurred by engineers and firemen will be at least as great in action as that to any other men in the ship. In fast cruisers they make up about half the crew; and yet it is next to impossible to obtain anything like adequate recognition of their services, or a proper estimate of the value of the duties they are called upon to discharge. In another place we have explained the action now being taken for engineers in the United States, Why should not some similar action be taken in this country? Highly educated gentlemen such as the engineers of the Royal Navy are in the present day, want something more than a trifling addition to their pay to satisfy their aspirations. The services they render to their country are in no way less valuable or important than the work of the fighting or navigating hands. Why should not justice be done now? It is earnestly to be hoped that before the discussion of the Navy Estimates has been brought to a close some one of the all-too-few engineer members of Parliament will put sufficient pressure on the Government, and so obtain that substantial improvement in the position of naval engineers that they fully deserve.

LIGHT RAILWAYS.

THE Bill brought in by Mr. Ritchie, "To Facilitate the Construction of Light Railways in Great Britain," was read the second time on Monday night. It is a lengthy document, and we do not reproduce it in our pages because any one of our readers specially interested can obtain it from the Queen's printers for 2½d. With much of it we have, indeed, no concern. The essence of it lies in a few clauses out of the twenty-two of which the Bill consists. Instead of the promoters of a line having to go to Parliament, they will, under this Act, go to three commissioners, to be styled the Light Railway Commissioners, appointed by the President of the Board of Trade. "It shall be the duty of the Light Railway Commissioners to carry this Act into effect, and to offer, as far as they are able, every facility for considering and maturing proposals to construct light railways." The sum of £1,000,000 is to be set apart and placed under the control of the Treasury, which may advance a sum not exceeding one-fourth of the total amount required to make the proposed line, provided that at least one-half the share capital has been subscribed and paid up by persons other than local authorities. The interest on the Government loan is to be at the rate of 3½ per cent. per annum. The Treasury is to determine the conditions under which the loan is to be advanced. There is a little obscurity about this portion of the Act; but we understand its sense to be that the Treasury will advance the money on the recommendation or certificate of the Commissioners if the Board of Trade confirm the scheme. Under certain circumstances the Treasury may give money absolutely, or lend it, when it is certified by the Board of Agriculture that a proposed line would benefit agriculture, or by the Board of Trade that the line would benefit a fishing harbour. The Board of Trade is to be supreme, and the orders granted by the Commissioners are to be submitted to the Board, which may, if cause is shown, refer the proposal to Parliament. "The Board of Trade shall modify the provisions of the order for ensuring the safety of the public in such manner as they consider requisite or expedient."

A reasonable amount of precaution has been taken to prevent the Act operating harshly on landowners and others interested. But the number of authorities which can promote the construction of a line without the consent of property owners, if only it is a "light" line, forbodes trouble in this direction. The Bill is open to criticism in many respects, and will require much alteration in committee before it can be considered fairly satisfactory. Its cardinal sin is vagueness. There is no definition whatever of the term "light railway." There is no limitation as to gauge, or to the weight of the rolling stock. It is well known that a very wide diversity of practice exists. There are light railways worked by locomotives weighing only 10 or 12 tons, and light railways worked by locomotives weighing 25 or more tons. Unless the Bill defines the meaning of the word, the task of definition must devolve on either the Commissioners or the Board of Trade, for there is no jurisdiction under the Bill to deal with anything but a "light" railway. It is clear that if light railways are to be really of use they must in the great majority of cases be laid to the 4ft. 8½in. gauge. such a line may very easily become a branch or extension of an existing line, and there is no reason why the Great Eastern Company, for example, might not under the present scheme promote the construction of a series of branches, get money from the Treasury, and in a manner ride roughshod over the landowners in Essex if it so pleased. This might be a good thing or it might not—we express no opinion; but it is quite certain that nothing of the kind is contemplated by Major Rasch, and most other advocates of light railways. These gentlemen contend, indeed, that the railway companies have too much power already. The light railways might in many cases be made in competition with the main lines, but under Mr. Ritchie's Act there is no reason why the railway companies might not occupy the whole ground, to the exclusion of other promoters. It may no doubt be contended that the Commissioners would prevent anything of the kind taking place. But this places the Commissioners in a very difficult position, and their powers ought to be much more clearly defined than is the case at present. It is well that this aspect of the Bill should be very fully understood. A railway company cannot now construct a branch or extension without an Act of Parliament which entails a very heavy outlay, and the line when constructed must be worked under strict rules as to brakes, signals, &c. &c.; but let the branch or extension be called "light," and these difficulties would, under Mr. Ritchie's Act, disappear. It is well known that in Ireland the railway companies have made light lines. It seems to be the intention of the Legislature that English and Scotch companies shall do the same thing in this country. So far from the Bill excluding railway companies from its operation, it specially opens a door for their entrance. Clause 2 runs:—"An application for an order authorising a light railway under this Act shall be made to the Light Railway Commissioners, and may be made—(*a*) by the council of any county, borough, or district, through any part of which the proposed railway is to pass; or (*b*) by any individual, corporation, *or company;* or (*c*) jointly by any such councils, individuals, corporations, or companies." And Clause 17 runs:—"Where a company have power to construct or work a railway, they may be authorised by an order under this Act to construct and work, or to work the railway or any part of it as a light railway under this Act." The italics are ours. We do not say that this is a defect in the Bill, but a great many people will.

The clause providing for a free grant of money, or a special loan for a purely agricultural line, is peculiarly worded. The principal condition under which the advance will be made is that "the Treasury shall not make any such special advance unless they are satisfied that landowners, local authorities, and other persons locally interested, have, by the free grant of land or otherwise, given all reasonable assistance and facilities in their power for the construction of the railway." Presumably the Treasury is to be "satisfied" through the Commissioners, who are directed, amongst other things, to inquire whether reasonable steps have been taken to consult landowners, but it is not clear. If we are to have light railways, it is clear that no trouble should be put in the way of promoters. There is no very extended or popular cry for such lines; speculators do not pine for them. In a word, the Government must tempt people to make them. But the Bill as it stands supplies endless opportunities for red tape. Great powers are conferred on men who have no special desire for or interest in the construction of such lines, and these gentlemen can hamper and hinder in all directions. But it is not only in the preliminary steps that difficulties and troubles may arise. A line may be made, and the Board of Trade may insist on the observance of rules in the interest of public safety which will be fatal to success. Lines are worked on the Continent, for example, in a way to turn the hair of any Board of Trade inspector grey. Can they be so worked here? The Bill does not give us the least inkling as to the nature of the modifications which the Board must permit. It might very easily relax existing rules, and yet enforce regulations which would be infinitely oppressive. What, again, is to be the law as respects the use of the highway for railway purposes when a line is laid on it or beside it? How is compensation for injuries to be settled? It may be taken for granted that Mr. Ritchie's Bill as it stands is only the first of a considerable crop of Bills that will be needed for the working and regulation of the light railway. For its success or its failure it will depend as it stands on the hearty co-operation or the reverse of the Board of Trade with the Commissioners. Whether this will be obtained or not remains to be seen. The traditions of the Board are not encouraging. The Bill is, we think, an honest attempt to satisfy what the Government are told is a popular and reasonable demand. Its paramount defect is, as we have said, that although it is specially intended to facilitate the construction of light railways, it makes no attempt to define a light railway. It will puzzle the Commissioners to say where the normal or heavy line ends and the light railway begins. Possibly Mr. Ritchie has taken it for granted that every one knows the difference; but it is very unwise to frame Acts of Parliament on assumptions. It is perhaps as well, all things considered, that Clause 8 runs:—"The powers of the Light Railway Commissioners shall, unless continued by Parliament, cease on the 31st day of December, 1901,"

MILITARY HORSELESS CARRIAGES.

Among the uses to which the mechanically-propelled vehicle may be put, service in time of war should not be overlooked. The utility of light traction engines was recognised long since by the Royal Engineers; and the "steam sapper" designed by the late Mr. Thomas Aveling, of Rochester, attained such a measure of success that it is still to be found wherever the Royal Engineer corps has work to do. Again, the bicycle is now a recognised arm of the service, the authorities very prudently availing themselves of a means of locomotion superior in many respects to anything that horses can supply. But the whole ground has not been covered; indeed, it may be said that it has been little more than touched. In all civilised countries there are excellent roads, and on these roads a very considerable amount of haulage and transport work could be done by self-propelled carriages. We do not suggest that such vehicles should be used instead of horses for moving guns, because, for reasons which ought to be clear without explanation, there is no conceivable substitute for horses when guns have to be taken into positions far from roads. The value of the self-propelled carriage could be displayed on the roads of a country, and with that we might well rest content.

In all cases of warfare very large quantities of provisions, ammunition, and *impedimenta* of all sorts have to be moved and removed and moved again. When this movement is effected by horses the difficulty of transport is largely augmented. The horses must be fed, and even when compressed rations are served out they occupy much space. The horse, too, is a costly and delicate animal, and the waste of horse-life in war is enormous. Nothing does more to hamper the movements of an army than the want of baggage animals. Now, so long as there are roads of any kind available, the horseless carriage is as good in some respects, and much better in many than the horse. It will not, for example, cut up roads as will the feet of horses; it is not likely to become ill and die of an epidemic. Various types might be employed, and the staff would find in high-speed carriages a method of moving from place to place superior in various ways to horses. Anyone who has read the history of the Franco-German War can scarcely fail to have been struck by the constant employment of carriages by the generals and higher officers. The Emperor Napoleon on the one side, the German Emperor, the "Red Prince," Bismarck, Moltke, all drove along the roads in open carriages where it was possible, and so spared themselves much fatigue. On good roads a speed of sixteen or twenty miles an hour is quite possible of attainment with a self-propelled carriage. No such speed can be got with horses, save for short distances. Very few men could ride a succession of horses a distance of 100 miles in five hours; but it would be quite possible for even a field marshal to travel the distance in a suitable vehicle, if only the roads were moderately good. A dozen methods of using the self-propelled vehicle to facilitate the movement of troops will suggest themselves to our readers. It may be said that the railway will do the work better; but, in point of fact, the railway does not come in at all—it may or may not do its work. The common road operations must be carried out all the same. The horseless carriage comes in, not as a substitute for the railway, but as a substitute for the horse.

But we may go even further than this, and suggest that it may be made a substitute for the camel. We can never move troops in the desert, be the desert what it may, without camels. The horse is practically useless. If we read the accounts of the operations of the British troops in the Soudan, when the relief of Kartoum was attempted, we see that the camel was all important, and that he died whenever he got a chance. There is no difficulty whatever in designing an engine which will cross sands as fast as any camel. In a recent number we published the facsimile of a curious old document concerning the use of Boydell's engine for steam ploughing. The Boydell wheel carried the engine over ploughed ground with the utmost ease. It would cross the sand of the desert with equal facility; and it is not to be supposed that Boydell left the wheel so excellent that nothing better can be made. On the contrary, it is likely that certain defects which it manifested can be easily got rid of, now that we have such materials, in the shape of steel and india-rubber, as Boydell never dreamed of. In the construction of locomotives for use in the desert may yet be found an important industry.

We hear it argued that the scarcity of water in the desert would be fatal. The answer is simple. There is no reason why water should be used at all. Oil engines might easily be employed instead of steam. But, furthermore, there is not any objection even to the use of steam, because air condensers can be constructed which will prevent the waste of a drop of water. We have every reason to believe that in our forthcoming horseless carriage competition steam engines will take part in the trials, and that these will use air condensers at once to supply the boiler with pure water and prevent the issuing of steam from the funnel. We have made no attempt to go into detail. We think it desirable that those interested should have their attention called to every possible opening for the employment of horseless carriages; and we think that the design and construction of vehicles intended for military service is deserving of consideration.

THE MYSTERY OF COLLIERY EXPLOSIONS.

The seven days' inquiry into the circumstances of the Tylorstown explosion, while it left the exciting cause of the disaster still a matter of inference or conjecture, demonstrated one fact which is unhappily too familiar in connection with these investigations. Mines Regulation Acts may be as rigorous as engineering knowledge and philanthropic effort can make them, and the code of colliery rules so stringent as to provoke the resentment of the workmen. Their enforcement, however, must depend on fallible human agencies. The single act of a hurried or heedless miner will upset the most elaborate precautions, and destroy the effect of the best laid plan that was ever put on paper. The Tylorstown pits were fiery and very dusty in places, as was the case at the Albion colliery in the adjoining valley. To guard against the danger arising from coal dust as well as gas, a liberal supply of water was laid on in spraying pipes and open barrels, and the arrangements for watering the mine may be described as theoretically perfect. Shot firing was nominally restricted to the hours between the working shifts; the holes drilled by the colliers were only to be filled with bellite in presence of the fireman; and the fireman alone was authorised to light the fuse. But it came out in evidence that the hauliers whose duty it was to see to the watering were careless, one man holding that it was the next man's business, and this even in the headings where blasting was known to be impending. The colliers, it appears, were in the habit, when they were not under supervision, of charging the holes on their own account, in disobedience of the rule commanding the fireman's personal attention, and they merely indicated the place of the shot by making a chalk mark round it. The shot might remain unexploded for twenty-four hours or longer, and the question the coroner's inquest endeavoured to decide was whether the firing of one particular shot—as to the history of which the only possible narrator was killed—caused the catastrophe, or whether it was exploded in consequence of gas igniting in another part of the pit.

There was clear testimony that a shot had been lodged in one David Williams' stall, in No. 8 pit; that there had been for some days a slight accumulation of gas in this very spot; that it was known by the deputy fireman and several colliers, and not immediately reported, as the rules required. There were the sinister facts that Richard Evans, the fireman, had been casually told where the shot was fixed, and had let it remain there two or three days; that after the explosion it was found that the shot had been fired; and that the fireman's dead body was found within a few yards of the fall brought down by the blast. There was a conflict of evidence between Mr. D. Hannah, the general manager of the colliery, and Mr. J. T. Robson, H.M. Inspector of Mines, as to the bearing of these discoveries on the origin of the accident. Mr. Hannah inclined to the belief that there was probably an explosion some distance away from David Williams' stall, and that the heat of the timbers caused by the fire ignited the shot, in support of which theory he urged that no fireman of the experience Richard Evans possessed would have placed himself in the perilous position where his body was found. Mr. Robson, on the other hand, was convinced that Evans must have fired the shot without first testing the stall for gas; that he retreated for a minute to allow the bellite to explode; and that then, noticing something wrong or hearing the fuse splutter, he returned and tried to extinguish the fuse, only to be overwhelmed by the fiery outburst and the shattered roof.

Mr. Robson's view was adopted by the jury, but Mr. Hannah's theory remains, and creates an uncertainty which can hardly be said to be finally disposed of by the verdict. Here is a mystery which, as at the Albion colliery, and in most of the like disasters, can never be solved, since the men who knew the secret carried it with them to the grave. There is no mystery, however, as to the condition of things underground, and the testimony left no room for doubt that, although the pit was exceptionally well managed, excellently appointed, and administered under rules framed to meet every emergency, there was an amount of indifference and slovenliness among the miners which practically neutralised all the safeguards and precautions so carefully devised. One defect, indeed, must be set down to the fault of the management. The workman was not instructed as to the amount of the explosive to be used in charging a shot. According to Mr. Hannah, the miners "generally understood" that in the case of high explosives they should only use half the quantity they would of gunpowder. "The knowledge of the quantity needed," he said "was acquired by experience," which is a primitive rule-of-thumb practice that one would fain hope is not prevalent in other fiery mines. The rule-of-thumb method, however, was still more strongly marked in the proceedings of the colliers, according to their own admissions in the witness box. A man named Davies, appointed as one of the workmen's committee to report upon the safety of the workings, admitted that he took no notes, but trusted to his memory for places where he saw signs of gas. David Williams told him that there was gas in his stall, but it was not reported to the workmen's committee, "because some colliers are not true to their fellow-men." The same witness confessed that he had watched colliers filling blasting holes in the absence of the fireman, and seen shots fired without the essential preliminary of watering the air and walls of the heading. Asked why he did not report these breaches of the rules, he could only reply that he made a mistake; and it is one of the typical mistakes timid or reckless miners are making every day in every coal-field in the kingdom.

The scientific evidence at the inquest threw some light on two points which have recently been engaging the serious attention of mining engineers. It was stated by several of the expert witnesses that the most complete system of watering yet introduced had not proved successful in preventing or even materially checking the ravages of an explosion. As Mr. W. Jenkins, M.E., of the Ocean collieries, remarked, "We are all trying to water the best we can, but explosions will take place, and in many instances extend much further through the workings than they used to." That led to the other proposition, paradoxical as it may seem, that the very abundance of the ventilation is a source of additional danger, as the strong currents carry the destructive blast to the furthest recesses of the mine. At Tylerstown 250,000 cubic feet of air per minute passes through the two down-cast shafts. Mr. Robson and his assistants described that supply as ample, though the inspector suggested an improvement in the distribution of the air below. The conflicting position in which the coalowner and mining engineer find themselves is that they are constrained to send as much air as possible through the galleries of the pit, and yet the greater the velocity with which the air courses through the workings, the greater also is the destructive force and range of the fiery torrent when an explosion takes place. It is easy to say that measures ought to be taken to make explosions impossible. But how? If the number of Mine Inspectors were doubled, and workmen Sub-inspectors were appointed to every colliery, they could not be at the elbow of every collier filling a shot-hole, or every fireman as he lighted the fuse. So far as the mystery of the Tylorstown disaster can be said to be revealed, it is attributable to the act of one man—the fireman Richard Evans—and while human nature remains what it is among working colliers, it seems vain to hope that the Richard Evans who perished is the last of his type and class.

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AMERICA'S STEEL PRODUCTION.

NOTHING more distinctly emphasises the revival which has of late occurred in the American iron and steel industries than the statistics just to hand of the Bessemer steel make of that country last year. From these it appears that last year the United States steelmasters turned out over 4,100,000 tons of Bessemer ingots, compared with 3,571,000 tons in 1894, or a growth in one short year of no fewer than 1,337,000 tons. Here is something of which our friends across the water may well be proud. But the tale is not ended. During the past ten years their make has more than doubled itself. In 1886 the output was less than 2,270,000 tons. With the exception of last year the largest production of any one year during the complete decade was in 1892. In that year the output was 4,168,000 tons. When we state this, it will be readily understood that last year's make has never before been touched, and that it stands alone in the history of American metallurgy. It is interesting to ascertain what proportion of the ingot output noted last year reappeared in the form of rails. Happily the information to enable this comparison to be made is furnished. The make of Bessemer rails for 1895 then was 1,266,000 tons, against 904,000 tons in the year previous, 1,036,353 tons in 1893, and 1,458,732 tons in 1892. This last year's rail output was an increase on the immediate preceding year of 362,000 tons, and on two years previously of 130,000 tons, but there was a drop contrasted with 1892 of 192,732 tons. Pennsylvania, of course, still leads the list of the various States engaged in steel manufacture in America. Its share in the total ingot turnout last year was within 21,000 tons of 3,000,000 tons—a production which entirely dwarfs any other State in the Union. Of rails, it rolled 837,000 tons, against 324,00 tons by Illinois, and 105,000 tons as the aggregate of the remaining steel mill States. So far we have confined our attention solely to the results achieved by the Bessemer practice in America last year. The exact figures relating to open-hearth production are not yet available, but an estimate has been formed of at what they are likely to come out, and from this calculation the judgment is believed to be pretty correct which puts the open-hearth production down at over a round 1,000,000 tons. Thus, with a Bessemer roll of 4,909,000 tons, the completed turnover, in ingots, of United States steel production for 1895, measures something over 6,000,000 tons. Considering that our own steel production in this country has never exceeded 4,000,000 tons, it is easy to see how America has shot ahead of all the countries of the Old World. Remembering, however, the immensely different conditions that prevail in the two continents, as concerns, at any rate, ourselves and the States, in the matters of the mileage of railway track constructed and population, this is not to be wondered at, and British steel makers have no reason to feel ashamed in the contemplation of the statistics we have sketched.

GLASGOW HYDRAULIC POWER SUPPLY.

THE Glasgow Corporation Water Department, through their engineer, Mr. James Gale, has issued a pamphlet containing a list of consumers already availing themselves of the city's hydraulic power supply, established over a year ago; a chart of the city showing the streets along which the special mains are laid from the central power-house in High-street, also details as to the charges made for furnishing supplies and regulations connected therewith. From the booklet it appears that the supply has already been taken advantage of for simplifying the working and adding to the convenience of hoists, cranes, &c., and for lifting, pressing, and other purposes, at about fifty of the railway works, hotels, warehouses, and large buildings generally throughout the city. For ordinary work, it is pointed out, the normal pressure of 1000 lb. per square inch simplifies the working of hoists, cranes, &c., and of pressing; while for heavy packing for shipment, a further pressure of 2½ tons or 3 tons per square inch can be obtained by the use of an intensifier, consisting of a cylinder with differential rams. The supply is also useful for driving pumps and small machinery of various kinds where intermittent power is required. Starting with a minimum charge of £1 4s. per quarter for 3000 gallons or under, the scale shows a graduation until £42 10s. is reached for a supply of 300,000 gallons. Water taken in excess of that quantity for hydraulic purposes is charged 2s. per 1000 gallons, and in cases where 500,000 gallons and upwards per quarter are taken the special terms are:—For a minimum of 500,000 gallons 2s. per 1000 gallons; for 750,000 gallons, 1s. 9d.; for 1,000,000 to 3,000,000 gallons, 1s. 6d.; and for 3,000,000 to 4,000,000 gallons, 1s. 5d. The meters by which the charge is made are provided and maintained by the Corporation.

LITERATURE.

The Holloway-Longridge Process for Extracting Gold from Auriferous Antimony Ores, and the Longridge-Holloway System of Smelting Antimony Ores. By CAPTAIN C. C. LONGRIDGE, M.I.M.E., A.I.C.E., &c. London: E. and F. N. Spon. 1896. 8vo., 32 pp., and 2 plates.

THIS pamphlet is devoted to an account of the ways and means devised by the joint patentees for the extraction of antimony from its sulphide ores—stibnite—and incidentally removing any associated gold; to a description of one of the ordinary processes of antimony smelting; and to computations in reference to both processes, in which the new process does not show to any disadvantage. The solubility of gold in molten stibnite is utilised to extract the gold from the ore; auriferous antimony ores too poor in antimony for direct liquating are treated in a bath of molten stibnite, whilst the subsequent removal of the gold from the stibnite is effected by agitation with molten metallic antimony in which the noble metal is still more soluble; the same lot of metallic antimony is to be used for abstracting gold from several successive lots of sulphide. The process is to be conducted in furnaces arranged in series and connected by a covered conduit for the flow of molten metal or sulphide from one furnace to the other. Producer gas is to be used for heating, and attention is given to the suppression of volatilisation and oxidation. The scheme advanced is to melt the ore and extract the gold in the first furnace, to mix the molten sulphide with molten antimony—already present or produced or added—in the second, and there agitate by means of stirrers or a rotary furnace; to reduce the sulphide — impoverished of gold—in the third by means of iron; to refine and star the metallic antimony in the fourth and fifth furnaces respectively; whilst to provide for the antimony when it is sufficiently enriched with gold, there is a subsidiary chamber connected with the second furnace, and then the gold is to be recovered by "oxidation, electrolytic or chemical means." The treatment has, in the patentees' tests, given a mean extraction of 82·2 per cent. of the gold present in the ore, although for their calculations they take 60 per cent., and is delivered in the proportions of 50 oz. of gold to the ton of antimony, which may be regarded as a very good concentration, more especially when ores containing only pennyweights per ton are in question; but there would have been further cause for gratification had they also come to some conclusion as to the most economical method of treating this auriferous antimony. As regards the antimony in the ore, they claim to recover 80 per cent., which would be very good were it achieved on a large scale. We must say, taking into consideration *inter alia* the method of firing, the ready volatility of antimony in a reducing or an oxidising atmosphere, its penetrating powers as regards furnace linings, &c., we cannot but regard the computations on page 30 as somewhat sanguine and slightly premature, considering no experiments on a large scale appear to have been made.

Nevertheless, the process as described is both ingenious and systematic, and based as it is on theoretically good chemical lines, may be regarded as a step in the right direction, that by development may perhaps prove to be a solution of the troublesome question of the successful smelting of auriferous antimony ores.

A Treatise on Mine Surveying. By B. H. BROUGH, F.G.S. Fifth edition, revised. Crown 8vo., pp. 334. London: C. Griffin and Co. 1895.

THE fact of this book having reached a fifth edition in less than eight years since its first appearance is sufficient evidence of its utility and value. Originally designed as an assistance to students when the author was engaged in teaching the practice of underground surveying at the Royal School of Mines, it has continued to receive a considerable share of his attention since his removal to another field of work, so that new problems and matters of interest as they arise are noticed in due course. Among these may be specially mentioned the regulations adopted in foreign and colonial mining regions for the survey and registration of prospecting and discovery claims, which, on account of the large existing and constantly increasing interests of capitalists in this country in foreign mines, are matters of considerable importance, and it is, therefore, well that the student's attention should be called to them betimes, as much of our younger mining talent must necessarily look for occupation beyond the seas—in fact, we should like to have seen more space devoted to this part of the work. For a similar reason it would be a good thing for the author in a future edition to give some attention to the subject of field sketching, reconnaissance, and mapping generally, which, although not strictly falling within the limits of mine surveying considered merely as a means of representing actual workings, are among the most necessary requirements of the travelling expert of modern times. A statement in the preface that "no mine surveys in this country approach in accuracy those of the collieries of Pennsylvania or those of the metalliferous mines of the Hartz," although perfectly admissible as a rhetorical flourish, must not be taken too absolutely. We should be inclined to think that there is a strong presumption the other way, when it is remembered that no country in the world has more perfect geological maps than the 6in. surveys of the midland and northern coal-fields of England, and their construction has only been possible by utilising the enormous stock of information contained in the existing colliery plans, which cannot, therefore, be so very bad. The lead mining district of the North of England was also, to our knowledge, in its more active time, distinguished for the high quality of its mining plans, a result largely due to the excellent work of the late Mr. T. Sopwith, F.R.S., in that district, and the surveyors trained by him.

SHORT NOTICES.

Sell's World's Press and Advertisers' Reference Book.—This volume contains 1250 pages, including advertisements. It supplies all the information than can be reasonably demanded concerning the newspaper world. It contains several useful articles, notably one on the law of libel for the guidance of newspaper proprietors. The directory which follows is very complete. It gives a short statement descriptive of each paper named, its politics, and its special features. This is accompanied by its price advertisement rates, dates of publication, &c. Where country papers are named information is supplied concerning the towns or districts in which they circulate, and in many cases a small map is added. In this way intending advertisers are enabled to select their journal with some confidence that their money will be well spent. The general arrangement of this volume is satisfactory, and its pages are easy of reference. This is the sixteenth year of publication, and it seems impossible to suggest any prominent feature in the book that needs improvement.

"The Electrician" Electrical Trades Directory and Handbook for 1896. Fourteenth year. London: Offices of *The Electrician*. 1896. Price 7s. 6d.—This is the fourteenth year of the publication of the "Electrical Trades Directory and Handbook for 1896." It furnishes wonderful evidence of the extent of electrical industries at the present time. It consists of over five hundred pages of handbook matter, and nearly seven hundred pages of directorial information, but it is a pity the publishers continue to give the users so much trouble to refer to it for any information. This trouble is caused by the insertion of pages of advertisements between the divisions and subdivisions of the handbook, and in front of and after the title page. It is a bewildering thing to refer to in spite of the coloured pages used. All the advertisements might go at the end. They are very useful, and would be equally useful there. The handbook information is well selected, and the tables, including those of resistances, equivalents, and those of information concerning electric supply stations of the United Kingdom, are valuable, and make the volume, with its very extensive directory, a requisite of every electrical engineer and manufacturer, but surely it is time to cease to occupy space publishing biographies of questionable taste with bad engravings.

Electric Light for Country Houses. A Practical Handbook on the Erection and Running of Small Installations, with Particulars of the necessary Cost of Plant and Working. By John Henry Knight. With Illustrations. London: Crosby, Lockwood and Son. 1895. 1s.—Every day increases the numbers of those who want to know something of the requirements for lighting country houses by electricity without having to learn a lot of electrical lore to arrive at this knowledge. Mr. Knight's book will satisfy most of these. After an introductory chapter he devotes the second to some generally useful information on electricity as applied to lighting, and in the third describes the dynamo, and gives useful hints as to its purchase. This is followed by a chapter on motive power, reference being specially made to such motors as may be used for lighting country houses of a rental of from £80 upwards. The oil engine, as one specially suited on account of the easy supply of its fuel, and its economy, is particularly described, and the cost given for engine, dynamo, lamps, and other fittings. The cost of fittings and their installation are given in Chapters V. and V., and a useful chapter follows on accumulators. Instructions for working a dynamo are given in an appendix. It is a useful and very cheap book for those for whom it has been written.

Cycling. Nutshell Series. By C. W. Brown. London: Iliffe and Son. Price 6d.—This is a useful little handbook for the many cyclists who are not mechanicians, and who require some instruction as to the form and functions and proper methods of adjustment of the different parts of the bicycle. The author's instructions and descriptions are generally clear, easily understood, and correct, and, if carefully read by the ordinary cyclist, will be the means of preventing much of the bad treatment now so common with cycles at the hands of the ordinary unmechanical rider. There is one little bit of instruction given on pages 57 and 58, with respect to detaching cranks and knocking out the taper pin which must be referred to. The author tells his readers to use a round-ended punch guided by the nut partly off the screwed end of the pin. We must warn the cyclist against the rounded end of the punch, which should be flat. In other respects the instructions are satisfactory, but it should be remarked that the solid body H should be a rather heavy piece of metal. One other remark as to the punch, which should be cylindrical instead of flat-sided, and it must be noted that most of the drawings which Mr. Brown gives are as drawings inaccurate. Spindles are invariably shown as neither in elevation or in section; and we cannot help noting the difference between the drawings by the author and those of others, such as the sectional views of tires, the views of the Wood's valve. In the prefatory historical pages the author is not in all respects correct, for Mr. E. A. Cooper should be Mr. E. A. Cowper, and Mr. Cowper was not the inventor of rubber tires, and he was not the inventor of suspension wheels.

BOOKS RECEIVED.

The Modern Office Building. By Barr Ferree. Reprinted from *Journal*, Franklin Institute. New York: 231, Broadway. 1896.

Attack or Defence. Seven Military Essays. By Captain Maud, P.S.C., late R.E. 1896. London: J. J. Keliher and Co. Price 5s.

The Holloway-Longridge Process for Extracting Ores from Auriferous Antimony Ores. By Captain C. Longridge. London: E. and F. N. Spon.

Pumps and Pump Motors. A Manual for the use of Hydraulic Engineers. By Philip R. Björling. Vols. 1 and 2. London: E. and F. N. Spon. 1895. Price £3 3s.

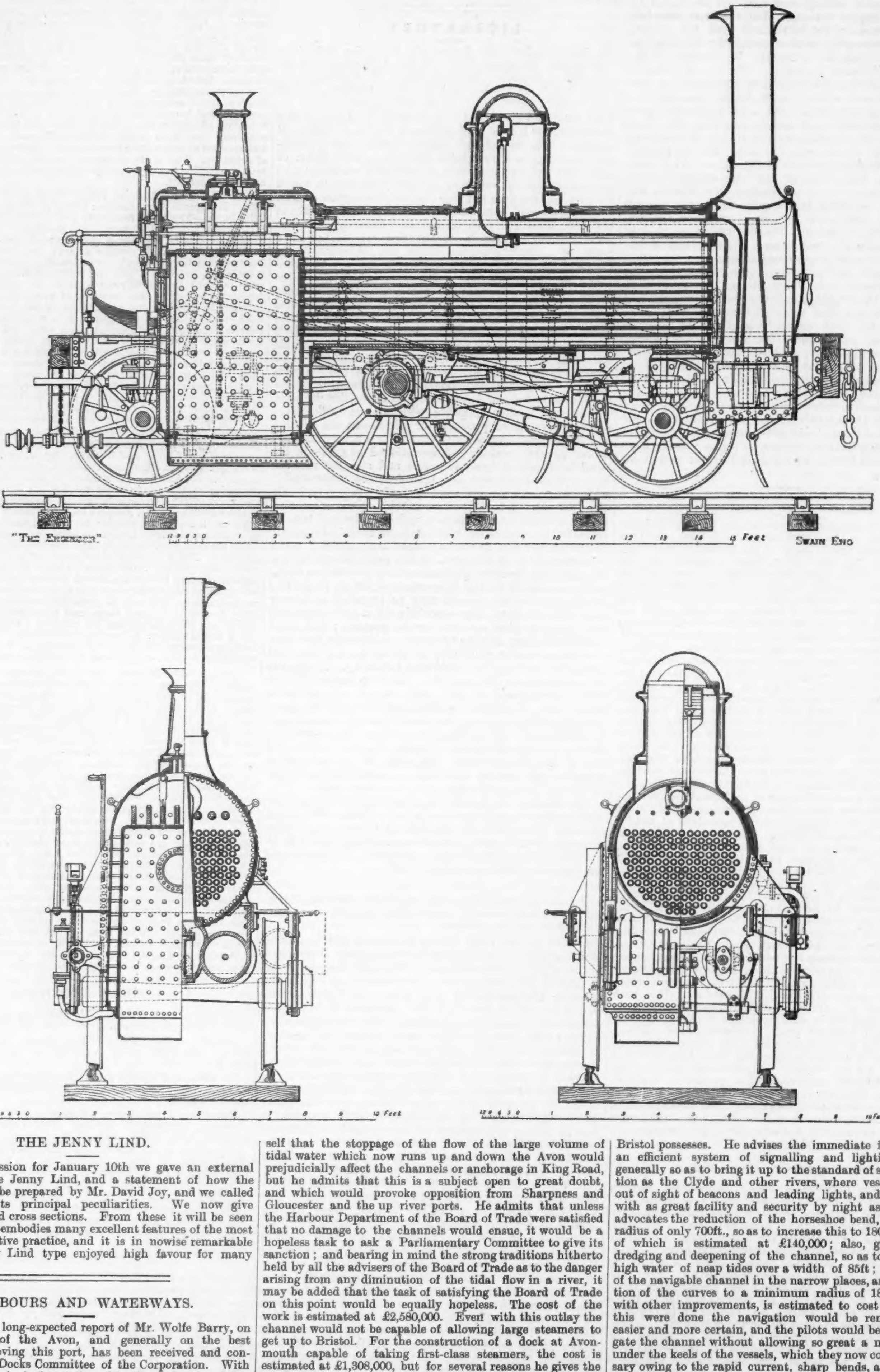
Proceedings of the Incorporated Association of Municipal and County Engineers. General Index to Vols. 1 *to* 20. London: Thos. Cole, Assoc. M.I.C.E., secretary, 11, Victoria-street. Price 6d.

Aluminium: Its History, Occurrence, Properties, Metallurgy, and Applications, including its Alloys. By Joseph W. Richards, A.C., Ph.D. Third edition, revised and enlarged. Illustrated by forty-four engravings and two diagrams. Philadelphia: Henry Carey Baird and Co. London: Sampson Low, Marston, and Co., Ld. 1896.

THE INSTITUTION OF CIVIL ENGINEERS: ASSOCIATION OF YORKSHIRE STUDENTS.—An ordinary meeting of this Association was held on Thursday, the 20th ult., in the Law Institute, Albion-place, Leeds. The chair was occupied by Mr. A. T. Walker, M. Inst. C.E., vice-president. A paper was read by Mr. F. Grover, A. M. Inst. C.E., of the Yorkshire College, on "The Effects of the Products of Combustion in a Gas Engine Cylinder." The lecturer referred to the great increase in the thermal efficiency of gas engines which has been effected in recent years, and described a series of experiments carried out by him at the Yorkshire College, by which some very remarkable facts were ascertained. It was shown that when the proportion of air to gas in the explosive mixture exceeded about ten to one by volume, the maximum pressure was raised considerably, and was attained much earlier in the stroke if the excess of air above ten to one were replaced by its own volume of burnt gases from previous explosions. The weaker the explosive mixture, the more marked was this effect. Mr. Grover exhibited some excellent diagrams illustrating very clearly the results of his investigations. A discussion followed, in which the chairman and Messrs. Holgate, F. L. Watson, C. J. Rafarel and Durley took part.

PASSENGER ENGINE, MIDLAND RAILWAY, 1848

MR. D. JOY, ENGINEER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THE JENNY LIND.

In our impression for January 10th we gave an external elevation of the Jenny Lind, and a statement of how the design came to be prepared by Mr. David Joy, and we called attention to its principal peculiarities. We now give longitudinal and cross sections. From these it will be seen that the design embodies many excellent features of the most modern locomotive practice, and it is in nowise remarkable that the Jenny Lind type enjoyed high favour for many years.

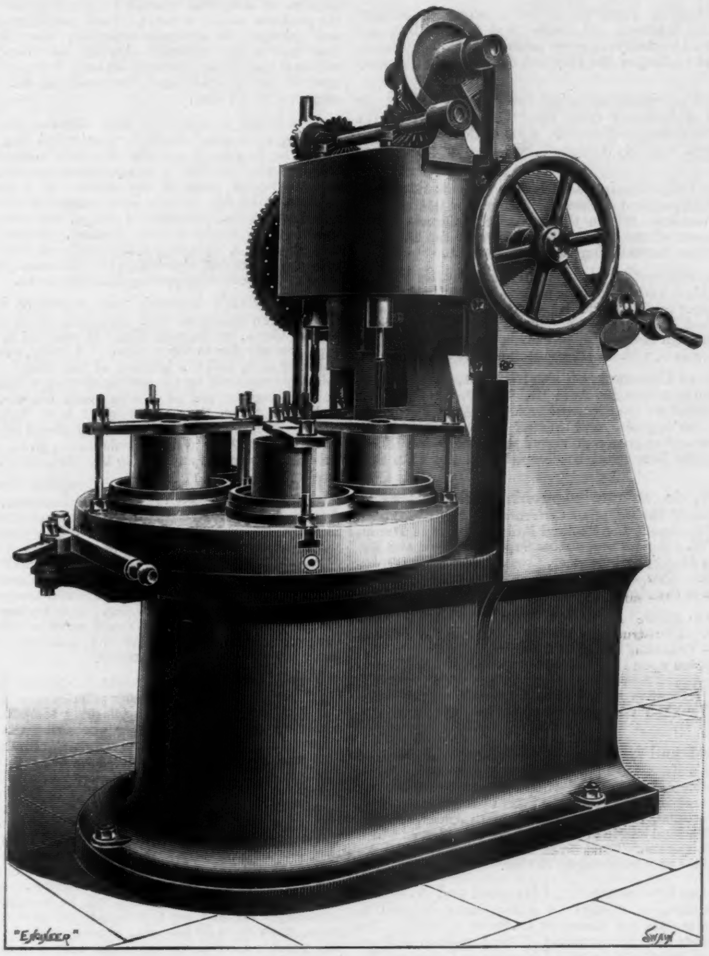
HARBOURS AND WATERWAYS.

Bristol.—The long-expected report of Mr. Wolfe Barry, on the dockising of the Avon, and generally on the best means of improving this port, has been received and considered by the Docks Committee of the Corporation. With regard to the principal question, Mr. Barry is of opinion that from an engineering point of view the dockising of the Avon is practicable, although he considers that it is a work that would require great care and cost in its execution. It would entail the diversion of the sewage of Bristol from the river, which alone would be a formidable matter; and the impounding of the waters of the Avon and Froom would involve considerable difficulties in dealing with the drainage of districts already liable to severe floods, and open up great responsibilities as to the management of the impounded river when floods occur. Mr. Barry does not consider himself that the stoppage of the flow of the large volume of tidal water which now runs up and down the Avon would prejudicially affect the channels or anchorage in King Road, but he admits that this is a subject open to great doubt, and which would provoke opposition from Sharpness and Gloucester and the up river ports. He admits that unless the Harbour Department of the Board of Trade were satisfied that no damage to the channels would ensue, it would be a hopeless task to ask a Parliamentary Committee to give its sanction; and bearing in mind the strong traditions hitherto held by all the advisers of the Board of Trade as to the danger arising from any diminution of the tidal flow in a river, it may be added that the task of satisfying the Board of Trade on this point would be equally hopeless. The cost of the work is estimated at £2,580,000. Even with this outlay the channel would not be capable of allowing large steamers to get up to Bristol. For the construction of a dock at Avonmouth capable of taking first-class steamers, the cost is estimated at £1,308,000, but for several reasons he gives the preference to Portishead for the construction of this dock, where, owing to better soil for the foundation and other causes, the cost would be £852,000. To each of these estimates has, however, to be added £320,000 for a first-class low water pier at Firefly Rock. Having disposed of the larger schemes prepared, Mr. Barry turns to the present condition of the navigation, and states that he was much struck with the almost total want between Avonmouth and Bristol of the ordinary navigable conveniences to be found in nearly all tidal rivers, and especially the absence of leading lights, which he considers a great drawback to the geographical advantages which Bristol possesses. He advises the immediate installation of an efficient system of signalling and lighting the river generally so as to bring it up to the standard of such a navigation as the Clyde and other rivers, where vessels are never out of sight of beacons and leading lights, and can navigate with as great facility and security by night as by day. He advocates the reduction of the horseshoe bend, which has a radius of only 700ft., so as to increase this to 1800ft., the cost of which is estimated at £140,000; also, generally, the dredging and deepening of the channel, so as to give 26ft. at high water of neap tides over a width of 85ft; the widening of the navigable channel in the narrow places, and the reduction of the curves to a minimum radius of 1800ft., which, with other improvements, is estimated to cost £93,000. If this were done the navigation would be rendered much easier and more certain, and the pilots would be able to navigate the channel without allowing so great a margin as 5ft. under the keels of the vessels, which they now consider necessary owing to the rapid current, sharp bends, and uncertain condition of the river. The Committee of the Corporation, after considering the report, have recommended that the improvement of the river as suggested, exclusive of the alteration at the horseshoe bend, at a cost of £93,000, should be taken in hand at once, and the larger scheme left over for further consideration.

The London Docks.—From the reports of those companies which have been issued, trade does not appear to have been very good during the last half-year, the chairman of the East and West India Dock Company complaining that, while the railway companies were feeling the benefit of improving trade

MULTIPLE BORING AND DRILLING MACHINE

MESSRS. CUNLIFFE AND CROOM, MANCHESTER, ENGINEERS



the receipts of that company had been less, and it was only possible to pay the interest on the first debentures by taking £10,500 from the reserve fund. The London and St. Katherine's Company, although having a better record, yet pay a less dividend than for the corresponding half-year. The net earnings of the committee of the joint companies shows an increase of £12,200 in the total earnings, but owing to increased expenses the net result shows a decrease of £2200, this being chiefly accounted for by an increase in the charge for labour of £20,000. The quantity of goods landed was 44,317 tons greater than in the corresponding period, chiefly owing to the great increase in the import of foreign meat; but the quantity of goods in warehouses was 24,463 tons less, the rapid means of transit and facilities for quickly obtaining goods from abroad having a tendency to reduce the stock held in hand. The East and West India Dock only gets 31 per cent. of the committee's joint earnings. Although the total tonnage which entered the docks of London in the past six months was 85,000 tons larger than in 1894, the proportion received by the docks under the control of the committee was about 20,500 tons less. The enormous outlay at Tilbury of nearly three millions, or more than two and a-half times the amount originally estimated, and the unsatisfactory amount of the traffic there, has proved a great drawback to the prosperity of the East and West India Company.

The Tyne.—The report of the Tyne Commissioners for last year shows a surplus of receipts over expenditure of £27,222. The receipts, however, are £23,721 less than in the previous year, and the expenses are in excess by £10,880. The quantity of coal and coke shipped amounted to 11,351,693 tons, a decrease of 803,972 tons as compared with 1894. The total number of vessels entering and leaving the port was 13,710 of 7,566,602 tons register; of these 222 entered for shelter. The dredging operations during the year have been carried on more extensively than in former years, the quantity of material removed amounting to 2,126,932 tons, or nearly double that of the previous year, at an average cost of 6·92d. per ton.

The Tees.—In this Trust the receipts are about the same as in the previous year, although a larger rebate has been allowed to traders than in previous years. The gross revenue of £80,717 is the largest on record. The whole of the dredging is now paid for out of revenue, and absorbed £16,420 last year. The largest vessel that entered the port carried 7355 tons, and six had an average carrying capacity of 6604 tons. The Commissioners intend to give further facilities for the large vessels coming into the river. A turning berth is to be provided at Stockton, and the navigable channel deepened 2ft. A new graving dock of large dimensions is to be constructed by Sir Raylton Dixon and Co. near Cargo Fleet.

Leith.—The revenue received during the past year, £72,466, shows a slight increase of £204 over the preceding year. The total number of vessels which arrived during the year was 5372, of a total tonnage of 1,631,730 tons, a decrease of 198 vessels, but an increase of 13,441 in tonnage. It is expected that the new dry dock will soon be ready for use, as the masonry and concrete is practically completed, and most of the pumping machinery is on the ground. More than three-fourths of the new sea wall is already completed. It is expected that it will take three years before the new wet dock will be ready for use.

Burntisland.—This port has not yet recovered from the great coal strike of 1894. The coal shipments, although less by 45,200 tons than in 1893, show an increase over the previous year of 246,000 tons. It is proposed to improve the harbour and give deeper water, so as to permit vessels of the largest class to enter the port. A Bill is to be promoted for the necessary power to construct a new dock, 650ft. long, with 28ft. of water on the sill. The amount proposed to be raised for these works is £300,000.

Ardrossan.—Trade at this port has been favourable during the past year, enabling the directors of the company to declare a dividend at the rate of 4½ per cent. in the preference stock, and 2 per cent. on the ordinary stock, for the year. All disputes with the contractors have now been settled, and the amounts due to Lord Elgin's executors had been paid.

Manchester Ship Canal.—The half-yearly report of this company shows that the weight of merchandise paying tolls for the past six months has increased, over the corresponding period of 1894, from 555,692 tons to 758,775 tons, or over 30 per cent. The gross receipts show an increase of £20,844, the total amount being £74,437, and the expenditure, including maintenance, £59,320, leaving a balance of £15,117, to which has to be added the profits from the Bridgwater Canal, £25,057—a total of £40,174. A credit balance was brought forward from last half-year, making a total of £81,428 available towards the payment of debenture interest, or about half the amount required to pay in full. The traffic is rapidly growing. The import of cotton from Egypt is satisfactory, and a large trade in frozen meat and other merchandise is now being regularly carried on.

Forth and Clyde canal.—The scheme for constructing a canal across Scotland between the Forth and the Clyde, which was brought forward about five years ago, has recently been revived by its promoter, Mr. T. Law Crawford, who has forwarded us a copy of the pamphlet formerly issued, and asks us "to urge the Government in connection with the forthcoming scheme for the further strengthening of the national defences, to order a survey, and thereafter, if found expedient, to include in the scheme the opening-up of the ancient tidal channel between the rivers Forth and Clyde, and that to an extent which will admit of the rapid passage of British warships from one side of the island to the other, which would enable the eastern and western defending squadrons to aid each other in resisting sudden attacks and attempts to land troops on any part of the coasts of Great Britain or Ireland." It will be remembered that during the ship canal agitation of a few years ago two routes were suggested for a ship canal across Scotland: one advocated by Mr. Stevenson, who proposed a route commencing at Alloa on the Forth, where vessels were to be raised by a lock to the level of Loch Lomond, 13ft. above high water, which would be the summit level of the canal; thence along the valley of the Forth to Loch Lomond, and thence to the Firth of Clyde at Helensburgh, or else to Loch Long. The estimated cost of this scheme was £8,000,000. The other route was that advocated by Mr. Crawford, by which it was proposed to follow very nearly the route of the present canal from the Forth to the Clyde near Glasgow. This route would be 30 miles long, or 27 miles shorter than the other; but, on the other hand, the height to be surmounted would be 150ft., which it was proposed to overcome by the same design of locks as proposed by Col. Blackman for the Nicaragua Canal, the locks being of sufficient dimensions to enable the largest vessels to be raised by a single lift. One of these locks was to be placed at each end of the canal. Another plan, however, allowed for twelve locks of the ordinary type. It is claimed that the physical features of the country lend themselves in a remarkable way to the achievement of the work along this route. An examination of the strata has shown that there is a deep trough cut in the rocks between the two estuaries filled with sand, gravel, and boulder clay, the bottom of which is 118ft. below sea level. The estimated cost of the canal was put at £7,000,000, but as this amount was based very much on the estimated cost of the Manchester Ship Canal at £9,812,000, or about two-thirds of its actual cost, and that for the Nicaragua Canal at about £6,000,000, or about one-fifth of what the last Commission put the amount at, the estimate does not appear very trustworthy. The canal, if made, would unite two seas much frequented by national commerce, and would, no doubt, be of great service in the event of war. The average distance saved between the East and West Coast ports would be about 500 miles. The scheme is much more feasible than that for connecting the Mediterranean with the Bay of Biscay, which has been so persistently advocated by some French authorities, and, from the point of national defence, as serviceable as the Baltic Canal will be to Germany, but its prospects as a commercial undertaking would be very doubtful.

The Hooghly.—The condition of this river is causing a great deal of inconvenience to the shipping and of anxiety to the authorities. The absence of the Ganges floods, owing to the comparatively small rainfall in the Upper Ganges watershed, has considerably affected the condition of the navigable channel at Diamond Harbour. During the past thirty years the floods have never been so small as now, the consequence being that the depth over the bar decreased from 10ft. at low water to 7ft., and as the rise of the tide varies from 12ft. to 16ft., the channel was closed for some time to all but light draught vessels. More recently, owing to freshets, the water over the bar has deepened, the depth, according to the last soundings, varying from 13ft. to 13½ft. at low water. It is expected that the present depth is likely to be maintained for some time. For some years past the navigation of this river has been becoming more difficult and troublesome. Recently the Bengal Chamber of Commerce called the attention of the authorities to the recent temporary closing of the channel for all but small vessels, and suggesting that systematic dredging should be undertaken. Mr. Apjohn and the responsible officials consider that to expend money in dredging would be useless. One scheme for avoiding the difficulty which finds some favour is the construction of a ship canal to Mutlah, and by this means avoiding the shoals.

Kurrachee.—A recent survey of this harbour by the port engineer shows that at the entrance there is now a through navigating channel of not less than 24½ft. at low water of spring tides. The width between the 20ft. contours is now 256 fathoms, as compared with 1400ft. twelve months ago. The official notification gives the available depth of water in the entrance channel at 32½ft. at high water mean spring tides, and 29ft. at neap tides, and the maximum draught allowed has been fixed at 26ft. during the south-west monsoon and 28ft. in the fair season. Nearly three-quarters of a million tons of material were dredged during last year. Blasting operations are to be continued until vessels can enter or leave the port at any state of the tide.

ON the 28th ult., Mr. Jesse Collings, M.P., at the Home-office, presided over the twelfth meeting of the Committee of Inspectors and Manufacturers engaged in drafting proposals for the removal of the existing anomalies under the Weights and Measures Act.

MULTIPLE DRILLING AND BORING MACHINE.

THE accompanying illustration shows a specially designed multiple drilling and boring machine, patented by Messrs. Cunliffe and Croom, of the Broughton Ironworks, Manchester. The main object for which the machine has been constructed is for boring and reamering two pulleys at one operation, and it consists of a circular table 36in. diameter, provided with bolt grooves, for securing the fixings to it, and accurately divided into five divisions so that when the table is rotated, and the stop peg pressed home into the conical steel bush, the boring tool and reamer are in their exact positions for operating in a combined manner upon the work to be done, the boring tool to bore the pulley, and the reamer to finish it. When the drill headstock is in its highest position of adjustment, objects 12in. deep can be rotated on the table, allowing for thickness of cramps, and a twist drill 1¼in. diameter and of the standard length. The extent of self-acting down-feed is adjustable to a maximum of 10in., and the headstock can be adjusted vertically to compensate for the shortening by wear and tear of twist drills, &c., and still give the same amount of down-feed and clearance under the drills. The space between the uprights is 20in., the depth between the table and the cross-beam 14in., and the machine occupies a space of 5ft. 4in. by 3ft. 9in. by 6ft. 7in., with a weight of about two tons. By the above arrangement the machine is enabled to work continuously, the only time lost being the few seconds required to rotate the table to the next division. The machine illustrated, as already stated, has been designed for two spindles. The number of spindles can, however, be increased to three, four, five, or six, according to the space occupied by the article to be operated upon.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Staff engineer: Thomas H. Hyde, to the Impérieuse. Chief engineers: Francis T. George, to the Pembroke, additional for the Diana; Alfred Hart, to the Surprise; William J. Black, to the Racoon; and Walter Brown, to the Vivid, for the Shannon. Engineers: John T. H. Ward, to the Hibernia, additional for the Sandfly; David Peacock, to the Victory, additional for gunboats at Haslar; Frank D. Thompson, to the Pembroke, additional for the Spitfire; George S. Holgate, to the Northampton; William W. Lawrance, to the Wildfire, additional for the Dragon; and Frederick C. Davis, to the Impérieuse. Assistant-engineers: George H. Jeffery, to the Northampton; John B. Huddy, to the Warspite; Alfred E. Everitt and William B. Hale, to the Impérieuse; and Richard C. Cleave, to the Impérieuse.

KING'S COLLEGE ENGINEERING SOCIETY.—On Friday, the 28th ult., Mr. Robinson read a paper on the "London Water Supply." Commencing by showing the necessity of pure water, and mentioning towns which had been supplied with impure water, and consequently had been decimated with fevers, he proceeded to give a brief outline of the ancient Roman system, and the system employed at Carthage. The author then dealt with the London companies, viz., the New River Company, the Kent Waterworks Company, the Chelsea Company, the Lambeth Waterworks Company, and the East London Waterworks Company, giving the source from which the water is obtained, and the quantities supplied daily. He next considered how the water is purified, dealing with the question in some detail, and criticising the various methods. The filter beds were described, and drawings showing their action were also shown. A discussion followed, and the meeting adjourned with a vote of thanks to Mr. Robinson for his interesting paper.

RAILWAY MATTERS.

The scheme of railways sanctioned last session for South Africa has been tendered for by the Grand Junction Railway Company—the body in view when the Act was passed. The *Times* Cape Town correspondent says theirs is the only tender received.

The Corporation of Portsmouth have lodged a petition against the London, Brighton, and South Coast Railway Bill, and Mr. Hulse and Mr. Drucker have given notice of their intention to oppose the second reading of the City and South London Railway Bill.

It is proposed to construct a light railway of 3ft. gauge from the centre of Bideford Quay into Westward Ho on the Clovelly side. The scheme includes the construction of a harbour on the Abbotsham side of Westward Ho, at a cost of about £20,000.

Amongst the Bills which have failed to pass Standing Orders are the Blackpool and Fleetwood Tramroads Bill and the Cork Junction Tramways Bill on the ground of failure to secure the requisite assent of the road authorities, and the Bills will accordingly go before the Standing Orders Committee.

The new line connecting Liverpool with North Wales, *viâ* Hawarden Bridge, has been opened for goods traffic, and will be opened for passenger traffic on the 1st of April. Passengers may leave Liverpool, and crossing the Cheshire peninsula, travel over the Dee Bridge through Hawarden, Wrexham, and Ellesmere, then on the Cambrian system, with direct connection with South Wales.

In the House of Commons on the 27th ult. Mr. Curzon stated, in response to a question from Mr. J. A. Pease, that steps were being prosecuted for the construction of the Uganda Railway. Mr. Whitehouse, the engineer, and his staff arrived at Mombasa on December 11th, and at once commenced preliminary operations. It was hoped that the line would be completed in less than four years.

The Khedive, in acknowledgment of the attention shown to the pupils of the Egyptian Government who have been placed from time to time in the Midland Railway works at Derby, has made Mr. S. W. Johnson, Locomotive Superintendent, and Mr. W. L. Mugleston, Line Superintendent, Commanders of the Order of the Medjidieh. Two other Midland officials have also been appointed officers of the same Order.

Mr. Bartley gave notice for Monday, March 2nd, to move that it be an instruction to the Committee on the London County Council (Vauxhall Bridge Tramways) Bill to take the evidence of the police upon the desirability of constructing tramways over the proposed new bridge, and the probable effect the working of such tramways would have upon the traffic. The Southwark and Vauxhall Water Bill came before the examiners on March 2nd.

The cog-wheel and rack railways of the world include seventy lines built since 1812; and of these seventeen are in Switzerland, fourteen in Germany, twelve in Austria-Hungary, four in France, and three in Italy, the others being in England, Spain, Greece, Portugal, the United States, South America, Asia, and Australia. The total length of these lines is 500 miles, of which 188 are on the Abt system. These lines are worked by 300 locomotives, the heaviest of which weighs 70 tons.

On Monday the line connecting Liverpool and N. Wales *viâ* Hawarden Bridge, was opened for goods traffic, and will be followed by arrangements for passenger traffic on April 1st. The capital arrangements and developments of the Cambrian Railway will then admit of passengers leaving Liverpool and crossing the Cheshire peninsula, proceeding over the bridge through Hawarden, Wrexham, and Ellesmere to the Cambrian system, with direct connection with South Wales as well as the North.

The Government of India are again being urged to sanction the immediate construction of a chord line between Baroda and Godhra which would reduce the through distance to Bombay from Godhra and stations to the north of it by about thirty miles. The line will be about forty-two miles long, and is estimated to cost about thirty lakhs. *Indian Engineering* says the scheme offers many advantages, and will greatly benefit Bombay and the Bombay-Baroda and Central India Railway.

It is stated that the East Indian Railway Company is quite ready to take up the construction of the Palamau branch line from its junction with the already sanctioned Moghal Serai-Gya line to the coal-fields of the Palamau district, as soon as the Government of India accorded formal sanction to the enterprise. This is of considerable importance indeed, and the opening up of the vast coal beds, which underlie the Palamau district, is now dependent on the Government of India, to whom those concerned in the important industries which are so rapidly making headway in Upper India must, the *Indian Engineer* says, in future address themselves in order to expedite the placing of the mineral, so necessary to the industries, within easy reach.

The Snowdon Railway from Llanberis to the summit is almost completed, and an experimental trip was made on the 27th ult., a number of guests being present on the invitation of Messrs. Holme and King, the contractors. Though the weather was boisterous, the journey was made without hitch, the ascent taking one hour and twenty minutes, and the descent half an hour less. The intention to work the trains by electricity has been abandoned for the present, but the engineer, Sir Douglas Fox, has stated that he is satisfied that by storage of the mountain torrents ample power could be generated. During construction some remarkable marine shells were discovered near the summit. It is expected that the railway will be open for traffic at Easter.

The air is again thick with rumours, one in Cardiff being a probable amalgamation between the Great Western and Taff Vale Railways. A good many are disposed to think that there is no truth in it, but a sound local authority, not given to undue exercise of the imaginative powers, places some degree of faith in it, arguing that if the Rhymney and Bute interests are blended, nothing will be more likely than a coalition, or at the least a working arrangement between the two. Hitherto the Great Western and Rhymney have worked together, but when the Rhymney interests are governed or directed by the Bute Company, nothing will be likelier than for the Great Western to try and get its own line to the coal and iron interests in the hilly districts.

At a meeting on the 27th ult. of the Lancashire, Derbyshire, and East Coast Railway Company at the Westminster Palace Hotel, Mr. Emerson Bainbridge, M.P., in the chair, said it might be remembered that when the Bill to authorise the construction of this line was brought before Parliament the idea of the extension of the coalfield to the east of Tuxford was somewhat ridiculed by the opponents of the Bill. He gave evidence to the effect that the coalfield would extend to a distance considerably further to the east than the commission appointed about twenty years ago to inquire into the matter thought it would. That opinion had now been confirmed by the sinking of the Warsop main colliery; and recently the Duke of Newcastle had leased an area of 30,000 acres to a company which would lay down a large and important plant for the development of a colliery near Tuxford. He had lately received an important telegram stating that at his Cresswell colliery a section of coal had been found at a depth of 470 yards of a thickness of 5ft. 11in. As most collieries had to depend on a thickness of not more than 3ft., this discovery might, he hoped, be regarded as an augury that from that point eastward there existed an important section of coal.

NOTES AND MEMORANDA.

In a paper on "The Combustion of Acetylene," M. H. Le Chatelier recently stated in the *Comptes Rendus* that mixtures of acetylene with air containing less than 7·7 per cent. of acetylene burn completely to water and carbon dioxide, for proportions of acetylene between 7·7 per cent. and 17·4 per cent., the products consist of water, carbon monoxide and dioxide, water, and hydrogen, in mixtures containing more acetylene than this free carbon and unburnt acetylene are found. With oxygen, mixtures containing anything between 2·8 per cent. and 93 per cent. of acetylene will catch fire; with air the limits are 2·8 per cent. and 65 per cent.

In a paper in the *Comptes Rendus* on "Walking and Running *en flexion*," by MM. Comte and Regnault, the author gives the results of a study of a new method of walking and running called *en flexion*, on account of a sudden bend of the knee at a particular point of the stride. It is shown that in this method, which has already been proved to be of great practical advantage in the movement of troops, the vertical oscillations of the body are rendered more gradual, besides being reduced in magnitude. A dynamographic study of the variations of the pressure on the feet also brings out the same point, sudden variations of pressure disappearing from the curve.

A coroner's inquest was recently held upon three victims of an acetylene tank explosion, which took place in New Haven, Conn., on January 21st. It resulted in a finding that the explosion was due to the rupture of a valve, causing gas to escape from the tank, and the ignition of the mixed gas and air. The valve was ruptured by the machinist using a 30in. wrench upon it. Gasoline engines are as safe as steam engines, but the gasoline tank from which they are supplied is as dangerous as a steam boiler. Such a tank, the *Engineering Record* says, exploded in the office of the *Daily News* in Salamanca, N.Y., on January 27th, wrecking the engine and setting the office on fire.

In a recent paper in the *Comptes Rendus*, on "The Mechanical Production of Extreme Temperatures," by M. E. Solvay, the author refers to the liquefaction of air in quantity recently achieved by M. Linde. M. Solvay observes that he used the same principle, the successive expansions of the same quantity of gas, in 1886, but, having imposed on himself as practical conditions that the pressure must not exceed 5 atmospheres, and not take more than 15-horse power, the lowest temperature he actually reached in this way was − 95 deg. It is further pointed out that inversely the same principle would serve to reach extremely high temperatures, were it not for the fact that these can be more easily attained by electrical means.

The Masut oil fuel consists of various hydrates, including distilled products of Russian petroleum, and a residuum from the distillation of shale. The flashing temperature of the oil is, according to a German paper quoted by the *Army and Navy Gazette*, between 200 deg. and 300 deg. C., so that it can be stored on board without danger, except in the case of a shell bursting into one of the reservoirs, by which oil might find its way to the stokehold and cause an explosion. The heating power is much greater than that of the best coal, inasmuch as while a pound of the latter will vaporise from 4½ to 5 kilos. of water, the Masut fuel will vaporise from 8 to 9 kilos. Its specific gravity is also much less, but its greater heating power will necessitate thicker boiler plates. It will be stored on board in tanks or in the double bottom, and will be brought by pipes to the furnaces. Another advantage claimed is that fewer stokers will be required. In short, the advantages claimed for this liquid fuel over coal are:—A lower price, from 40 to 50 per cent. greater heating power, less weight and greater facility of handling, with a consequently reduced number of men in the stokehold. Some of these figures would appear to be based on belief rather than practical experiment.

The work of clearing the *débris* on the Island of Philæ so as to permit a thorough examination of the ancient monuments, which was entrusted by the Egyptian Government to Captain Lyons, R.E., will probably be completed next month. The satisfactory discovery has been made that the foundations of the main temple of Isis are laid upon the granite rock, being in some places over 21ft. in depth, and the temple has nearly as much masonry below ground as above. The south-eastern colonnade has also its foundations upon the granite, and, so far as excavated, they are curious if not unique in design. They consist of parallel cross walls some metres high, but varying according to the slope of the rock surface, with large stone slabs placed horizontally upon their tops, and the pillars forming the colonnade are erected upon the slabs. The nilometer is marked in three characters—Demotic, Coptic, and another much older, probably Hieratic, of which a copy has been sent to Berlin for decipherment. A stela was found bearing a trilingual inscription in hieroglyph. No traces have been discovered of any buildings anterior to the Ptolemaic periods. The *Times* Cairo correspondent says, M. de Morgan, Director-General of the Antiquities Department, is engaged upon repairing the great hall of columns at Karnak.

Writing on deep soundings, and mentioning the deepest yet known, in *Nature*, October 3rd, 1895, Mr. W. J. L. Wharton mentioned that H.M.S. Penguin, Commander A. F. Balfour, R.N., had found in the Pacific Ocean deeper water than any yet known in lat. 23·40 S., long. 175·10 W., but had failed to reach the bottom owing to breakage of the wire at 4900 fathoms. He now writes to say that Captain Balfour has been enabled to try again, and has announced three satisfactory soundings of over 5000 fathoms. The deepest trustworthy sounding heretofore known is 4655 fathoms near Japan, obtained by the U.S.S. Tuscarora in 1874. The deepest of the Penguin's casts is 5155 fathoms, or 500 fathoms (3000ft.) deeper; but it is especially remarkable that the three casts now obtained are not in the same hollow, but are separated by areas of considerably less water, the two extreme soundings being 450 miles apart. The usual abysmal red clay was brought up by the sounding-tube on two occasions; on the third the wire broke. Mr. V. Thorpe, surgeon of the Penguin, reports that a microscopic examination of the specimen from 5147 fathoms shows that the remains of siliceous organisms are almost, if not entirely, absent. The mineral particles are in a minute state of disintegration, and consist of exceedingly fine flocculent matter, mixed with pumice and other glossy volcanic products, green crystals of augite and reddish crystals of pelagonite.

The materials employed in making the envelope of an incandescent lamp are thus referred to in a recent patent specification:—The materials generally employed in incandescent gas-lighting have the disadvantage that they "emit a peculiar greenish-white coloured light, and that they are extremely fragile." The patentee employs: "oxide of thorium, 96—98 per cent.; oxide of didymium, 1—2 per cent.; oxide of lanthanum, 1—2 per cent.;" and compounds the mixture into a dough with any suitable cementitious material, such as liquid glue. By means of a press the dough is forced out as threads; these are afterwards woven into a netting, and from the netting cap-like bodies are constructed. Supported upon suitable moulds of platinum or fire-clay, so that they may retain their shapes, these bodies are dried and incinerated, and are then ready for use. "They can be handled, for fixing on the burner, without falling to pieces." According to the patentee, the "yellow warm tint of daylight, pleasing to the eye," which is characteristically produced by his incandescers, is due to didymia, but the percentage of this oxide must not exceed 5 per cent., or too yellow a light will be produced. Thoria gives "resistance and durability." Lanthana, the *Journal* of the Society of Chemical Industry says, "may, however, be wholly or in part substituted therefor without sacrifice of the advantages"; *e.g.*, a mixture composed of Lanthana 98 per cent., and didymia 2 per cent., may be employed.

MISCELLANEA.

The Russian naval authorities have carried to a successful issue an experiment for conveying torpedo boats by rail from St. Petersburg to Sebastopol. The Black Sea flotilla will consequently be strengthened by others in the same way.

It is stated that the United States Projectile Company is engaged on an order for 32,000 shells for Hotchkiss rapid-firing guns. They have also secured a contract for 4400 semi-armour piercing 8in. projectiles for the United States Navy; the price to be paid for these projectiles is 27¼ dols. each. President Cleveland's message blows somebody good, at all events.

The Nevada County Electric Power Company has completed its works on South Yuba River, and is now supplying power for operating, hoisting, and milling works of gold quartz mines, and also supplying incandescent and arc lights for Nevada City and Grass Valley, Cal. Two 500-horse power Stanley dynamos are used and are operated by a pair of Pelton water wheels running under 210ft. pressure. Water is conducted by a large flume from the river at a point three and a-half miles above. The dam at the head of the flume is constructed of cement, wood, and iron, and is 250ft. long and 35ft. high.

The Phosphor Bronze Company is calling attention to a series of white anti-friction metals which they are making for bearings and other naval applications of white metals, and in three classes:—(*a*) White bronze alloys containing tin as their chief and characteristic ingredient. (*b*) White brass alloys containing zinc as their predominant or characteristic element. (*c*) White antimonious alloys in which antimony forms the hardening substance. White bronze alloys, the best known among which is a Babbitt's metal, is made by them of several brands, one of which corresponds closely with the composition of the original alloy as described by Babbitt.

At the Society of Arts on Wednesday evening a lecture was given by Mr. A. A. C. Swinton on "Röntgen's Photography of the Invisible." The lecture also related to the new power of seeing direct the effects of the *x* rays by means of a screen of fluorescent substance, as also the superior effects of Crookes' tubes when furnished with an internal small platinum reflector, by which the rays are thrown off more nearly, as it were, from a point, the definition of the results being thereby greatly improved. The mode of rendering visible to the eye the shadows cast by the Röntgen rays through the substances exposed in thin parts as, practised by Professor Salvioni, of Perugia, was also demonstrated.

The Executive Committee of the City and Guilds of London Institute have awarded the second Salters' Company's Research Fellowship for the encouragement of Higher Research in Chemistry in its relation to manufactures to Sidney Williamson, Ph.D., F.I.C., F.C.S., who was for two years a student at the City and Guilds Technical College, Finsbury, and subsequently for three years at the City and Guilds Central Technical College. The fellowship is tenable at the latter, and Dr. Williamson proposes to work on some questions bearing on food-stuffs generally, more particularly the examination of some definite albuminoids, with the ultimate object of ascertaining the influence of various manures on the growth of crops in so far as quality of produce is concerned.

The Plumbers' Registration Bill has been issued, and is about to be introduced in the House of Commons. It is one of those measures which are of importance, though the general public take no interest. And yet its operation will benefit every living inhabitant of the United Kingdom. The object of the Bill is to make it illegal for an unauthorised plumber to call himself a registered plumber, apparently a very small thing, but involving a great deal. Plumbers have been examined in their craft, and when found efficient have had their names inscribed upon a register. But as anybody can at present call himself a registered plumber without incurring any punishment for fraud, this registration has not proved much of a safeguard. It is hoped that by the passage of this Bill better work will be ensured than is obtained from many of those called plumbers. And it is proposed that any registered plumber convicted of bad work shall be struck off the register. Of course, the jerry builder and others are opposed to anything that is likely to put an end to their present irresponsible state.

A lecture on "Flight and Flying Machines" was given by Dr. G. H. Bryan, F.R.S., on the 28th ult., before the Royal Artillery Institution at Woolwich. The lecturer dwelt upon the difficulties of learning to fly, supposing the apparatus for the purpose to exist. He illustrated this point by reference to the flight of insects and that of birds, showing that the difficulty increased with the size of the flying body. This applied equally to mechanical apparatus, and he had deduced an approximate rule connecting the size with the horse-power required to lift it. This might be thus expressed:—The power required per unit of weight varies as the square root of the linear dimensions. Dr. Bryan concluded that as Mr. Maxim had raised a large machine off the ground by means of aëroplanes, therefore a small machine capable of carrying one person could also be sustained in flight by mechanical means. The difficulties which remained to be solved were connected with the stability and control of the machine. Herr Lilienthal, in Germany, and Mr. Pilcher, in Great Britain, had for some time past been practising in this direction, making short soaring flights with artificial wings from eminences. The lecturer looked forward with confidence to a combination of the skill attained by Lilienthal and Pilcher in manipulation with the mechanical ingenuity of Maxim, which would, at no distant date, solve the problem of artificial flight.

The 48in. steel water supply conduit of Newark, N.J., is to be paralleled by another 48in. steel main for the first five miles from the Macopin intake to Pompton Notch, and by a 42in. main for the remaining sixteen miles to the Belleville service reservoir near Newark. This is the result of numerous conferences between the officials of the City of Newark and those of the East Jersey Water Company, since the original pipe line was found to be insufficient in capacity. The agreement has yet to be confirmed by the directors of the company and embodied in a contract. The conditions of the preliminary agreement are that the 42in. section shall be of sufficient strength to deliver water through the present 36in. steel branch line, five miles in length, to the South Orange high service reservoir, at a pressure equal to an elevation of 300ft. above sea level. The city agrees to accept the present 36in. steel main between the two reservoirs as complying with the contract requirement for a delivery of 25,000,000 gallons a day, and to pay the company 10,000 dols. in cash. The latter sum was agreed upon in this way: The company proposed, had the above agreement not been made, to lay a 42in. and 36in., instead of 48in. and 42in. pipe, for five and sixteen miles respectively. It offered to build the larger conduit for the difference in cost. Mr. Clemens Herschel, M. Am. Soc. C.E., chief engineer of the company, estimated this as 133,000 dols., and Mr. Morris R. Sherrerd, engineer of the Newark Water Company, estimated it at 107,000 dols. The company finally agreed to call the difference 110,000 dols. and to knock off 100,000 dols. from this if the city would accept the 36in. line to high service, notwithstanding its deficiency of 2,500,000 gallons. It will be noted that the carrying capacity of the 36in. line, five miles in length, is deficient by only 10 per cent., whereas the first 48in. main, twenty-one miles long, was deficient nearly 30 per cent. The company states that it has let the contract for the second line under heavy guarantee that it be completed by November 1st, 1896. *Engineering News* understands that the plates are to be made by the Carnegie Steel Company. The contractors for the pipe line are Gillespie Bros., of Pittsburg.

LAUNCHES AND TRIAL TRIPS.

On Saturday, the 29th February, the s.s. Tropic, built by the Tyne Iron Shipbuilding Company, of Willington Quay-on-Tyne, for E. C. Thin, of Liverpool, went her trial trip. The steamer has been specially designed to meet the modern demand for high-class light draught steamers, and carries a large deadweight on moderate draught. She is 350ft. by 47ft. by 28ft. 3in. moulded, and has powerful engines 25½in., 41in., and 68in., by 48in. stroke, supplied by the North-Eastern Marine Engineering Company, of Wallsend-on-Tyne. The vessel has three high-pressure multitubular boilers, so as to give her a good rate of speed, and on her trial trip she attained a speed of 12½ knots on the run between Tynemouth and Newbiggin, and afterwards proceeded on her voyage. During construction the vessel has been under the supervision of Captain George Lodge, the owner's representative, and Messrs. Irwin, Atkinson, and Young, of Liverpool and London.

On Tuesday, the 3rd inst., there was launched from the yard of the Tyne Iron Shipbuilding Company, of Willington Quay-on-Tyne, a steel screw steamer, built to the order of Messrs. Burrell and Son, of Glasgow, and of the following dimensions, viz., length 365ft., breadth 47ft., depth 29ft. 9in. moulded, and to class 100 A1 at Lloyd's on the three-decked rule. This vessel has water ballast fitted right fore and aft on the cellular system, and is also fitted with all modern improvements for the rapid loading and discharging of cargo, including seven double-cylindered steam winches, direct-acting steam windlass, large donkey boiler, steam steering gear by Messrs. T. Caldwell and Co., and Hastie's screw gear aft. The engines, which are to be supplied by Messrs. the North-Eastern Marine Engineering Company, are of the triple expansion type, having cylinders 27in., 43in., and 72in., by 45in. stroke, and working at a pressure of 170 lb. On leaving the ways the vessel was named the Fitzpatrick by Mrs. Roland Philipson, of Tynemouth.

On Saturday afternoon, February 29th, Messrs. Craig, Taylor, and Co. launched from their Thornaby shipbuilding yard, Thornaby-on-Tees, the Clarence, a handsomely modelled steel screw steamer to the order of Mr. F. le Boulanger, of Swansea. The dimensions of the vessel are 254ft. by 37ft. by 18ft., and she is to the highest class in Lloyds'. She is built on the web frame principle, and has raised quarter deck, bridge, and topgallant forecastle. She is fitted for water ballast in double bottom fore and aft, and also in peaks. The engines are being constructed by Messrs. Westgarth, English, and Co., Middlesbrough, and are of the following sizes, viz.:—19in., 31in., 51in. by 33in. stroke, with two large boilers to work at 160 lb. pressure. She will be equipped with four large double-powered steam winches, and patent steam steering gear by Messrs. R. Roger and Co.;' patent direct steam windlass by Messrs. Emerson, Walker, and Thompson Bros., and all the latest improvements for rapid loading and discharging. The hull of the vessel has been built under the superintendence of Mr. George Eldridge, whilst Mr. Conway has superintended the construction of the machinery. The vessel was named by Mrs. le Boulanger, the wife of the owner.

On Tuesday, the 25th inst., the s.s. Fau-Sang, which has been constructed by Messrs. Wigham, Richardson, and Co., to the order of the Indo-China Steam Navigation Co., of London, went for a very successful trial trip off the mouth of the Tyne. The steamer is built of steel, and of a fine model. She is 290ft. in length by 40ft. beam, by 25ft. depth, and is rigged as a two-masted schooner. She is very completely equipped for her special trade in the East, having all the most modern and improved appliances for working both the cargo and the ship with both despatch and economy. She has also comfortable accommodation for a few European passengers, and a large number of native passengers. The engines and boilers have also been constructed by Messrs. Wigham, Richardson and Co., and they have been designed to enable the vessel to maintain a good speed on her service. On the trial trip the machinery worked without the slightest hitch, giving the greatest satisfaction to all concerned, and propelling the vessel at a mean speed of eleven and a-half knots. On the trial trip the owners were represented by Mr. Cheyne, the secretary of the company, Mr. Buchanan, their superintendent engineer, who has superintended the construction of the vessel assisted by Mr. Duncan.

On the 28th inst. Messrs. Ropner and Son, of Stockton, launched a steel screw steamer of the following dimensions, viz.:—Length between perpendiculars, 270ft.; breadth, 39ft. 6in.; depth moulded, 17ft. 6in.; which they have built for Norwegian account. The steamer is built off the part awning decked rule, having poop and raised quarter deck; the deadweight carrying capacity being 2600 tons on 16½ft., the saloon and cabins for the captain and officers are fitted in the poop, whilst the engineers are accommodated in iron houses placed on the awning deck near the entrance to engine room. She is built on the web frame principle leaving the holds entirely clear for cargo, and carries her water ballast in a cellular bottom, and in the after peak; all labour-saving appliances are fitted for the economical working of the steamer, and also for the expeditious loading and unloading of cargoes; she has steam steering gear admidships, and screw gear aft, four powerful steam winches, a large multitubular donkey boiler, direct steam windlass, stockless anchors, &c. The engines will work up to about 700 effective horse-power, and are by Messrs. Blair and Co., having cylinders 19½in., 32½in., by 52½in. by 36in. stroke. Steam is supplied by two large steel boilers working at 160 lb. pressure. The steamer was named the Talisman by Mr. C. A. Bushell, of Newcastle-on-Tyne.

On Tuesday, March 3rd, Messrs. Furness, Withy and Co. launched from their yard at Hartlepool a large steel screw steamer, built to the order of Messrs. Bennetts and Co., Grimsby. She is a fine type of a modern cargo boat, measuring over 340ft. in length, and built throughout of Siemens-Martin steel, with a large measurement and deadweight capacity, and built to the highest class at Lloyd's. The vessel is of the spar-deck type, with poop, bridge and forecastle. The holds are fitted with iron grain divisions, and all decks, deck erections, skylights, bulwarks, bulkheads, &c., are constructed of steel and iron; cellular double bottom all fore and aft for water ballast, the after peak being also available as a tank. The greater portion of the plates are in 24ft. lengths, making the structure of the ship very strong. Four steam winches, one donkey boiler, patent steam steering gear amidships, with screw gear aft; direct patent steam windlass, stockless anchors hauling into hawse pipes, and other modern appliances, are fitted for the handy working of the vessel. The saloon and cabin providing accommodation for the captain, &c., is handsomely finished in polished hardwood, with painted panels executed in an effective style by the staff of ladies employed by the firm. The steamer will be rigged as a two-masted fore and aft schooner, and has been constructed under the personal supervision of Mr. Squires. She will be fitted with triple expansion engines by Messrs. W. Allan and Co., Limited, Sunderland. On leaving the ways she was named Thrunscoe by Miss Squires.

There was launched from the shipbuilding yard of Messrs. Robert Stephenson and Co., Hebburn-on-Tyne, on February 27th, an iron towing hopper barge, built to the order of the South Shields Corporation. This barge has been specially designed by C. H. Tate, naval architect, Newcastle-on-Tyne, for the removal of the town refuse of South Shields. The hopper is of large capacity, to enable her to take to sea 350 tons of this refuse. She is fitted up with powerful winches for hoisting the doors, and a special arrangement of slipping gear for letting the doors fall. We may mention that this type of craft is becoming very popular with other corporations situated near the sea-board. South Shields is following the lead of the Gateshead Corporation, who in this district were the pioneers of this mode of disposal, and who had a similar craft built some four years ago which has proved a great success, this craft being of similar design to the one just launched: the quantity of refuse per annum disposed of by them in this manner amounts to about 50,000 tons. We understand that other corporations are now adopting the same principle, which no doubt will become quite general, the expense as compared with the destructors being enormously to the advantage of the disposal of refuse by the barge at sea. Before the launch the vessel was inspected by the Committee of the South Shields Corporation, including Alderman Redhead—ex-mayor—Aldermen Eltringham, Rennoldson, and Lawson, who expressed themselves highly satisfied with the workmanship and design. On leaving the ways the vessel was named the Shadwell.

A few days ago the s.s. Greylands, a fine steel screw steamer, built by Messrs. William Gray and Co. for Messrs. Robert Hardy and Co., of West Hartlepool, left that port for her trial trip. The vessel has been built to Lloyd's highest class, and is of the following dimensions:—Length over all, 324ft.; breadth, 44ft.; and depth, 23ft. 3in.; deadweight over 4100 tons on a draught of about 19ft. The deck erections consist of a poop, bridge over machinery space, and topgallant forecastle. A handsome saloon and cabins for officers, &c., are fitted in the poop, the engineers' rooms are in the bridge, and the crew's accommodation forward. The hull is built on the web frame system, with a cellular double bottom, large hatchways, powerful steam winches, steam steering gear amidships, hand screw gear aft, patent donkey boiler, patent direct steam windlass, boats on beams overhead, shifting boards throughout, stockless anchors, two masts with schooner rig, and a complete outfit for a first-class cargo vessel. The engines are of the Central Marine Engine Works' well-known triple expansion type, having cylinders 23in., 36in., and 62in. in diameter, with a piston stroke of 39in., and are supplied with steam by two large boilers working at a pressure of 160 lb. per square inch. After some hours' manœuvring in the bay the vessel was brought to off the headland to receive a party of inspecting engineers and visitors, amongst whom were Mr. Robert Hardy, managing owner; Mr. Gates, inspecting engineer for the company; Mr. Matt. Harrison, Mr. C. A. Forslind, Mr. Chalton, Mr. Jacob Hessler, Mr. Jos. Merryweather, Captain Bacon, and Captains T. and W. Watson, visitors; Captain Murrell, on behalf of the shipbuilders; and Mr. Lindsay, representing the engine builders. The engines were now put full speed ahead with the log overboard, when it was found that she averaged a speed of 11 knots. The engines ran with perfect smoothness and without a hitch, the trial being in every respect a highly satisfactory one. The Greylands proceeded direct to Tyne Dock, where her visitors were put ashore, and the vessel will load for Genoa.

THE INSTITUTION OF CIVIL ENGINEERS.

LITTORAL DRIFT: IN RELATION TO RIVER OUTFALLS AND TO HARBOUR ENTRANCES.

At the ordinary meeting on Tuesday, March 3rd, Mr. W. H. Preece, C.B., vice-president, in the chair, the paper read was on "Littoral Drift: in relation to River Outfalls and to Harbour Entrances," by Mr. W. H. Wheeler, M.Inst.C.E.

The author pointed out that the success or failure of works projected for the improvement of navigation on coasts subject to littoral drift depended on a correct application of the laws which governed the movement of sand, shingle, and alluvial matter. It was shown that the supply of drift was limited and within control; and that the vast beds of sand with which the sea-bed was covered, and the deposits of sand and shingle found on many parts of the coast were due to causes which occurred in remote ages under entirely different conditions to those now prevailing. Instances were given to prove the impossibility of these accumulations having been formed by existing agencies. The drift which now travelled along the coast and the movable sand beds were shown to be due to the erosion of the cliffs, and as coming from the waste of the land and not from the sea bed.

It was stated that the generally accepted theory, that the travel of drift along a coast was due to and was in the direction of the prevailing wind, was contrary to fact. In England the prevailing winds were from the south-west; whereas the travel of drift on the east coast was southwards, on the south coast from the westwards, and on the west coast northwards, in each case being in the same direction as the flood tide. Round bays and estuaries, frequently within a very limited area, the travel was in three or four different directions. Numerous examples of drift in England and other countries were given, and in every case the continuous and regular travel was in the direction of the flood tide.

The author had been unable to find a single instance where the regular and continuous travel of drift along a coast was in the opposite direction to that of the flood tide. Storms which blew in an opposite direction to the flood tide arrested the progress of the drift, and even for a time caused it to travel against it; but these were only occasional, and on their cessation the normal direction of travel was resumed. While winds and waves were the agents which operated in eroding cliffs and producing the supply of drift, the continuous progressive movement of sand and shingle along the sea coast was caused by the wave action of the flood tide, which was increased when the wind blew in the same direction as the flood tide. The action of the flood tide making along a coast did not consist in a gradual swelling or raising of the water, but a series of small waves were given off from the main tidal wave, which broke on the shore in an oblique direction, the crest running up and partly lifting and partly pushing the stones forward and onward to the height reached by the wave, and consequently several feet above high-water mark. The retiring wave descended down the line of quickest descent, or that normal to the beach, and carried with it the greater portion of the material lifted up, leaving the remainder behind. The crest of the wave being wedge-shaped, the thin film of water at the top, as it retired, was incapable of carrying back the larger stones driven up by the momentum of the body of water behind, and these were left near the top of the bank. The number of wavelets varied between ten and twenty per minute, making, with the smaller number, 7200 impulses on the flood tide in the course of a day, and consequently capable of elevating and transporting a large quantity of material in the course of a year. The weight of the stones moved by these tidal shore waves in calm weather varied between a fraction of an ounce and 5 lb. or 6 lb. when out of the water. The shore waves of the ebb tide struck the beach at the same angle of those of the flood, and the tendency was therefore to prevent any retrogressive movement.

With regard to alluvial matter in estuaries, it was shown that this was derived from detritus brought down by rivers, and did not come from the sea, and that it was not supplied from the waste of clay or chalk cliffs along the sea coast. The only current along the coasts of England which could transport material in suspension was that due to the tidal wave, which travelled each way for about six hours at the rate of between 2 knots and 2½ knots. The greatest distance material could be carried in one direction in suspension was therefore 15 miles, and, as the material eroded from the cliffs was not reached until some time after the tide had been running, it would be carried a shorter distance toward the mouth of an estuary on the flood than away from it on the ebb, and with each tide would become more and more diffused over a great volume of water. It was contrary to all known laws of tidal action in rivers for material in suspension to be carried upwards for any great distance above the mouth of a river or estuary. The tidal wave propagated up a river created only an oscillating current, and the same quantity of tidal water which went up returned on the ebb, with the addition of the current produced by the fresh water; the tendency of movement was therefore downward, and not upward. As a further proof that solid matter in suspension could not be carried up a tidal river for any great distance, the salt from the sea, which was far more readily diffused than solid matter, penetrated only the lower reaches, the water entirely losing its saline properties as the tidal current progressed upwards.

Except in very heavy gales, submerged sand beds were not subject to alteration. So long as the natural conditions remained unaltered and the set of the tides was not interfered with, the equilibrium originally established between the several contending forces would remain. The effect of wave-action diminished rapidly as the depth increased, and while this action was only occasional, the tidal currents were continuous. When a channel was sufficiently deep to resist the surface action of the winds, the tidal currents would maintain it. Numerous examples of the permanency of natural channels passing through sand beds were given, and it was pointed out that the improvements which had been effected in dredging by means of sand pumps rendered it practicable to permanently deepen the channels of the outfalls of rivers in sandy estuaries and the estuaries to harbours. The results obtained by dredging in the harbour of New York, on the Mersey Bar, across the Stroombank at Ostend, and across the Charpentier Bank at the mouth of the Loire, were sufficient to show that it was practicable to improve the approach to harbours on sandy coasts by suction-dredging without the aid of training walls, and at considerably less cost.

Applying these facts, the following principles were deduced as essential in the construction of harbours on shingly or sandy coasts:—(1) That piers running out from the coast should be so projected as not to derange the main set of the tidal stream, and be so designed as not to cause an eddy-current at the entrance to the harbour; (2) that the entrance to a harbour should be sufficiently large to prevent any strong set into it on the rising tide, and to allow of its being filled with a current of lower velocity than that of the flood tide past the front of the entrance; (3) that the piers should project out from the coast into water of sufficient depth to be free from the action of littoral drift, and beyond the local influence of matter in suspension derived from the waste of cliffs or detritus brought down by rivers. Several examples of harbours were given which had been successful or otherwise, dependent upon compliance with these principles in their construction.

Municipal Engineer, Singapore.—Mr. Sam Tomlinson, Water Engineer, Bombay, has been appointed to the post.

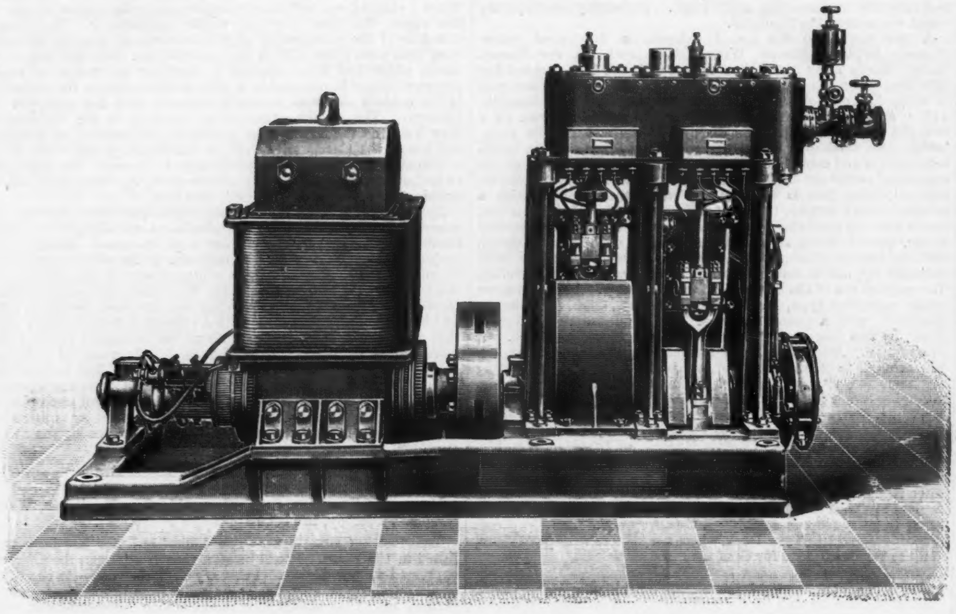
Traction on Highways.—The following letter has been published in the *Times*. It will be seen that it endorses the views we expressed in our issue of February 28th:—"Sir,—As one of an agricultural community, five or six miles from the nearest railway station, may I lay before your readers, with little comment, some long-considered ideas on the above subject? I hold that a modification of the new automotor car, by construction or adaptation of existing types of vehicles, would almost entirely obviate such a doubtful benefit as a light railway—for the following reasons:—(1) The automotor car has its roads ready, so that any district may take up the system at once. (2) As to the expense, £1500 per mile is stated to be the cost of construction of light railways. This should supply ten cars per mile, probably twice as many as required. In case of failure, too, but little would be wasted. (3) Transhipment of goods twice saved at least, and every chance afforded the producer of getting into direct communication with the consumer. Moreover, the important detail of door-to-door collection of goods can be easily carried out, thus reducing the farmer's expense generally. (4) Private enterprise, so frequently better than Government, could so easily and quickly assist this system. In conclusion, I would state that this system appears to me—perhaps too like an enthusiastic beginner—in its various adaptations to be capable of becoming England's salvation.—Ombersley."

Proposed Canal from Lockfyne to Crinan.—On this subject the *Glasgow Weekly Herald* says:—"We understand that a number of influential gentlemen in Glasgow and the West Highlands are at present contemplating the formation of a ship canal parallel with the present Crinan Canal for the accommodation of vessels of 1000 tons burden, and some progress has already been made in the promotion of the scheme. Some time ago an eminent firm of engineers took the matter on hand, and they have now prepared and submitted plans of a comprehensive undertaking which, if carried out, would prove of immense value to shipping and to the district. According to the plans it is intended to dredge a waterway along the shore from Ardrishaig to Lochgilphead, where it is proposed to begin the canal proper in the neighbourhood of the Corran, and form it in as straight a line as possible to Barnakill, from whence a channel will again be dredged to old Crinan. The scheme, which is estimated to cost about half a million sterling, also includes the formation of a large storage reservoir at Crinan, and the reclamation of the extensive ebb at Lochgilphead, with the construction of wharves and other accommodation for vessels at Lochgilphead, Bellanoch, and Crinan. It is anticipated that, in addition to the smaller craft which use the present Crinan Canal—now 100 years old—vessels trading between Glasgow, Liverpool, and the north-west coast of Europe, the large West Highland steamers, and all classes of yachts, would take advantage of the new route, which would undoubtedly be a shorter and safer one in all weathers."

The Electric Lighting of Islington.—The public supply of electricity is being taken up to an increasing extent by municipal authorities, and Islington, the largest parish in the United Kingdom, has not been slow in following the lead of St. Pancras and so many provincial towns. The new station for the supply of electricity is stuated in Eden-grove, Holloway-road, N., and it was formally opened on Wednesday last by the Lord Mayor, accompanied by the Lady Mayoress. There was a very large attendance. The Rev. Dr. Barlow, J.P., vicar of the parish and chairman of the Vestry, along with the members of the Electric Lighting Committee, received the Lord Mayor's party. Others who were present were Sir Albert Rollit, M.P., Mr. G. C. T. Bartley, Mr. Lough, M.P., and Mr. B. L. Cohen, M.P. The Vestry-Clerk, Mr. W. F. Dewey, read an address in which a description of the undertaking was given. The cost of the whole work may be put down at about £81,354. The architect has been Mr. A. Hessell Tiltman, F.R.I.B.A., the resident engineer is Mr. Albert Gay, M.I.M.E., and the contractors Messrs. Adamson and Co. The system is that of high tension alternate current with transformers. The area now supplied with current is the road which begins at the Angel, Islington, and leads to Finsbury Park Station. The station itself has been built so as to allow of considerable enlargement, and at present it consists of an engine-room, in which are installed four engines and four dynamos capable of supplying the equivalent of 15,000 lamps of 8-candle power; a boiler-house containing four Lancashire boilers and two Babcock and Wilcox boilers, and also workshops and offices. Within the area over which the Vestry has jurisdiction, fourteen miles of pipes and twenty-five miles of cable have been laid, and there are now in use ninety-eight arc lamps each of 2500-candle power for public lighting. After the party had inspected the works there were various votes of thanks, and the Lord Mayor spoke, commending the public spirit of the parish. Mr. Gay, the electrical engineer, stated that already there were applications for current for private lighting which far exceeded the amount which could at present be devoted to this purpose. The Lord Mayor then turned a switch, which set the whole of the machinery in motion, and lighted up all the arc lamps in the streets. We may state that the work was authorised by Provisional Order, and this was confirmed by Act of Parliament in 1893. In the evening the Electric Lighting Committee celebrated the event by a banquet at the Holborn Restaurant, where Mr. Samuel Lambert presided. The toast of the evening, "Success to the Electric Lighting of Islington," was given by Sir Albert Rollit in an eloquent speech, and acknowledged by Mr. T. W. Vine. An address and a purse of gold were presented to Mr. Lambert in acknowledgment of his services as chairman of the Electric Lighting Committee; and the work of the architect, electrical engineer, and contractors was also acknowledged. We hope very shortly to put our readers in full possession of details of this new station.

COMPOUND ENGINE AND DYNAMO

MESSRS. J. P. HALL AND CO., OLDHAM, ENGINEERS



COMBINED COMPOUND ENGINE AND DYNAMO.

MESSRS. J. P. HALL AND Co., of the Black-riding Ironworks, Werneth, Oldham, who make a speciality of electric lighting plant, particularly for steamship purposes, have recently designed an improved arrangement for combining compound engines and dynamos upon the same bed in a remarkably compact form. The illustration we give is taken from a photograph of their latest design of this kind, and shows clearly the general construction and arrangement. The engines are constructed to give 25 indicated horse-power at 300 revolutions per minute, with 120 lb. steam pressure, when exhausting into the atmosphere, and the cylinders, which are provided with spring relief valves as well as the ordinary drains, are 5in. and 8½in. diameter, by 7in. stroke, with the low-pressure valve between. All the moving parts are made as light as is consistent with the required strength, the pistons, which are dome-shaped, being of steel, and the crossheads of cast steel, lined with magnolia metal, whilst the connecting-rods, which are of the ordinary marine type, are of forged steel, lined with phosphor bronze. Each line of moving parts is separately balanced with weights forged on the crank shafts, and the cranks are placed on opposite centres, so that the engines may be balanced and run without vibration.

The engines are fitted with the firm's patent automatic expansion type of governors, of which an illustrated notice appeared in these columns some time ago, and by which the stroke of the excentric is varied from 2in. to 1in. These governors are very quick to act with any small variation in load, the engines governing to within 2 per cent. between no load and full load. The engine beds are, as will be seen from illustration, made with an extension for carrying the dynamo, the main bearings being cast on and all bored in position, and bushed with phosphor bronze, the bush at the fly-wheel end being double length, as it has to carry the weight of the armature and fly-wheel.

The dynamo itself is of the ordinary slow-speed type made by the firm, with drum bar armatures, and developes 120 ampères at 100 volts, with a maximum temperature rise of 60 deg. Fah., after six hours' run with full load, whilst the magnet coils are wound on sheet iron bobbins, with teak flanges for carrying the terminals. The lubrication throughout is continuous, ample provision being made for catching the waste oil.

THE PROPOSED LANCASHIRE PLATEWAY.

A SINGULAR scheme for obtaining cheaper rates of carriage for goods is being talked of in Lancashire, not for the first time. Its title is somewhat archaic, being nothing more or less than "The Lancashire Plateway Scheme." In principle it may be described as a system of goods tramways of a very comprehensive kind, and a line from Liverpool to Manchester is recommended as the best to make a start with. Long plates of iron or steel, with a flange on the inside to keep the wagons on the line, would be laid down on a substructure sufficiently strong to carry light locomotives. Very slow speeds would be run, but the essential point of the thing is that the wagons could be taken on by horses straight from the plateway terminus to the mill or works or wharf they were intended for. By these means, enormous and costly goods stations, and the expense of collection and delivery, with the double handling they imply, are to be done away with. The wagons or "lurries" would have loose wheels on fixed axles, and be in general, no doubt, much like those sometimes used on the common roads in connection with traction engines. In fact, the system would be a compromise between railway transport and steam road traction, with a little of the light railway element thrown in. The projectors of this somewhat crude idea consider that the crying evil of modern goods rates is the terminal charges, and that if these can be largely reduced a commercial millennium will infallibly result. The plateway is especially designed to grapple with this subject, and is considered to afford a better solution of the difficulty than canals or anything else yet thought of can possibly do. Part of the superior economy over railways is expected to arise from the slow speeds, which certainly means less wear and tear, and part from the superior lightness of the wagons in proportion to their paying load. The saving of time in loading and unloading at the termini will, it is thought, quite make up for the low rate of speed on the plateway itself, and with the very short distances of South Lancashire this will not, perhaps, greatly matter. An average rate of about one penny per ton per mile, with an extra charge of ninepence per ton at each end to cover, we presume, the cost of horse transit when the company provides it, is talked of as being probably about the expense to the trader of getting goods from Liverpool to Manchester, or *vice versâ*. The Manchester Ship Canal is not considered likely, by the supporters of the plateway, to effect any considerable or permanent reduction of rates in the district it traverses, and so the system of transport we have been discussing has been brought forward once more. It was more seriously discussed some fifteen years ago, before the canal was thought of, than we believe it will be now. Not only are the railway rates lower than they were then, but the complete financial failure of the canal for the present is likely to make Lancashire folks very chary indeed of embarking in any scheme of improved transit which has been so insufficiently thought out as this new one. Neither mechanically nor economically does it appear to afford much chance of relief from a considerably exaggerated evil, and, after all, it should be considered that the railways have largely made Lancashire what it is, and that they have decidedly a moral right to be allowed to live in it.

HORSELESS CARRIAGE NOTES.

WE hear from our American correspondent that the management of *The Cosmopolitan*, a monthly magazine, is offering £600 in premiums to be awarded to horseless carriages presenting the greatest number of points of excellence, as exhibited in a trial trip to be made on May 30th. This trip will be from the City Hall Park, in New York, to Irvington and back, a total distance of 52 miles. The award will be made upon the following points, the maximum aggregate being 100:—Speed, 50; simplicity and durability of construction, 25; ease in operating, and safety, 15; cost, 10. The route will be along Broadway, through Central Park and over the Washington Bridge, thence along the main road to Yonkers, where the course will include five miles of asphalt paving, and then on to Irvington, on the Hudson River, 26 miles. There is a good road for the entire distance.

A GASOLINE carriage built after the style of a park phæton, but having a complicated and cumbersome mechanism, was built and operated by Mr. Harris, at Baltimore, U.S.A., in 1891. A large gasoline tank was mounted on the front of the carriage, and the motor and controlling apparatus were placed beneath the body. The carriage had accommodation for fifteen persons, and was very heavy.

A NEW style of wheel for horseless carriages is being used by Mr. J. B. West, of Rochester, U.S.A., a thin web plate of steel replacing the usual arrangement of spokes. This is used on a single-seat carriage weighing 600 lb., and fitted with a gasoline motor of the same weight.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

LARGE attendance on 'Change. Steam coal in good demand, and prices steady. House coal shipments continue without change in demand or price. Tin-plates show no improvement in demand.

Prices of manufactured iron and steel advancing. Coal: best steam, 8s. 3d. to 8s. 6d.; seconds, 8s.; best house coal, 10s. 3d. to 10s. 6d.; dock screenings, 5s.; colliery small, 4s. 6d. to 4s. 9d.; smith's coal, 6s. 9d. Patent fuel, 10s. 3d. Pig iron: Scotch warrants, 47s. 8d.; hematite warrants, 49s. 4d., f.o.b. Cumberland; Middlesbrough No. 3, 38s. 10d., prompt; Middlesbrough hematite, 46s. 7d. Iron ore: Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel rails, heavy sections, £4 15s.; light, £5, f.o.b.; Bessemer steel tin-plate bars, £4; Siemens tin-plate bars, best, £4 5s.; all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel, coke, 9s. 1½d.; Siemens coke finish, 9s. 4½d.; ternes, per double box, 28 by 20 C., 21s. to 22s. Pitwood, 15s. 6d. London Exchange Telegram:—Copper, £45 18s. 6d.; Straits tin, £60 13s. 9d.; freights easier.

TRADE AND BUSINESS ANNOUNCEMENTS. — The office of the *Engineering Review* has been removed to the Outer Temple, 222-225, Strand, W.C.—The business of Messrs. J. Jessop and Son, of Leicester, and that of Messrs. Appleby Bros., of London, have been amalgamated, and will henceforth be carried on under the style of "Jessop and Appleby Bros. (Leicester and London), Limited."—The retirement is announced, owing to advancing years, of Mr. James H. Tozer, senior partner in the firm of James H. Tozer and Son, as from January 1st last, and the admission into partnership of Mr. S. Thornely Mott and Mr. George Frederick West, both of whom have been associated with the firm for many years past. The style of the firm remains unaltered.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

THE home trades outlook is improved by the statement as to the new naval programme and by the second reading of the Light Railways Bill, both of which matters should result in benefit to various trades in this district. At the same time information just to hand as to enormous American steel production is eloquent of Transatlantic prosperity, and of consequent improved orders for various British manufactures. Steel angles and tees are quoted £5 10s. to £6; plates, £5 15s. to £6 5s.; and blooms and billets, £4 7s. 6d. to £4 10s. In the finished iron trade, inquiries are coming to hand for next quarter's supplies, and quotations are firmly upheld. Marked bars continue £7 as the basis price. Merchant bars are £6 5s. to £6 10s. In the sheet trade the mills are well engaged, and it is surprising where all the output goes to. Japanners' steel sheets are quoted about £8 to £8 2s. 6d. for doubles, and £8 15s. 6d. to £8 17s. 6d. for lattens. Hoops are selling at £6 5s. to £6 7s. 6d., and nail rods at £6 10s. In the pig iron trade Northampton and Derbyshire sorts are still 42s. to 43s.; all mine Staffordshires 55s., and medium forge 42s. to 43s. 6d.

The new naval programme, involving the expenditure of £14,000,000 on new works, is regarded with considerable satisfaction in this district by marine engineers, and, indeed, in the numerous trades which contribute various naval requisites in iron and steel—among others, in the chain cable trade. At the present time all the requirements of the Admiralty for chain-cables, &c., are contracted to be supplied from the South Staffordshire and East Worcestershire districts. Gradually, but surely, have South Staffordshire and East Worcestershire become the principal seats of this important industry, there being now in existence only three cable-making firms of any magnitude outside this locality, namely, one at Pontypridd, one at Chester, and one at Gateshead-on-Tyne. About 20,000 tons of iron are annually consumed in the South Staffordshire and East Worcestershire districts in the manufacture of chain cables and chains. Interesting information with regard to this industry has just been laid before the South Staffordshire Institute of Iron and Steel Works Managers by their president, Mr. W. B. Rubery, who is connected with the works of Henry P. Parkes and Co., of Tipton. The first known chain cable was made in 1808, in a small shop in Bell-street, North Shields, by Robert Flinn, an Irishman. In Staffordshire small chain making had been an industry for many years, when in the year 1820 the first chain cable was made by the late Noah Hingley. It was 1½in. diameter, and considered a big undertaking in those days. Chain cables were first made by the late Henry Pershouse Parkes in the year 1825, although he had been engaged in the small chain trade from its beginning. The price obtained for cables in 1825 was about £40 per ton, and gradually went down till in 1850 they were reduced to £12 per ton, and with the reduction in price it is generally admitted that a corresponding falling off in quality took place, very much jeopardising the general adoption of chain cables. It was this deplorable state of things which induced the late Henry Pershouse Parkes to commence welding links on the side instead of on the end or crown of the link, and to use a superior quality of iron in the manufacture of his chains. In the year 1875 the firm of Noah Hingley and Sons, who introduced the cable trade into the midlands, commenced welding links on the side. In the year 1849 chain cables were first made at Saltney by Henry Wood and Co., and they continue making them to this day. Up to about ten years ago no firm in the South Staffordshire and East Worcestershire districts had successfully made cables under contract for the Admiralty, this particular class of work having been principally performed by Brown, Lenox, and Co., of Pontypridd; Henry Wood and Co., at Saltney; and Hawks, Crawshay, and Sons, Gateshead-on-Tyne, when, in the year 1888, the Lords Commissioners of the Admiralty entrusted a five years' contract with the Tipton Green Chain and Anchor Works, which contract was renewed for a further term of five years in 1892, and at this latter date the Admiralty gave a contract to the Round Oak Works, Limited, for the supply of chain cables, &c. In the course of the discussion it was generally considered that fibrous high-class iron would continue to be used for this class of work rather than steel; but some of the members expressed the opinion that steel would take the place of cast iron for the studs which connect the two sides of the links. The above-mentioned body have forwarded to the Board of Trade a resolution in favour of legislation against the use of bogus test certificates being extended to all chains where human life is involved, and not restricted to ship chains only.

A good order for fifteen boilers for Sydney is in course of execution by Mr. Edwin Danks, of the Oldbury Boiler Works, near Birmingham. Five of these have just been shipped, a special train being chartered for their transit to London. The other ten will be forwarded shortly. Each boiler of those completed was 30ft. long by 8ft. diameter, and constructed to a working pressure of 120 lb. per square inch, under the supervision of the Manchester Steam Users' Association. The shell plates were bent up to the extreme edge in vertical rolls, so that there could not be any injury and strain upon the material. All the holes were drilled through the solid after the plates were bent in position. The planing of the shell plates was done in circular form in special horizontal lathes; this method of planing after the bending and drilling avoids the destroying of the bevelled edges, and makes a true lap. All the flue sections were drilled with the two flanges and strengthening ring in position, perfect accuracy of each hole being thus ensured. The thinning of the plates and butt straps was done by special machinery to prevent local heating of the material. The flanging was done by hydraulic pressure at one heat, and the riveting by hydraulic power, and the boilers when finished were tested up to 200 lb. on the square inch. Each stage of manufacture was witnessed by a representative of the Manchester Steam Users' Association, the result being that the boilers were perfect in finish and first class in every respect. The mechanical appliances at these works are exceptionally efficient, and it is conceded by all experts who have visited the establishment and inspected the plant that it cannot be excelled. The success Mr. Danks has attained in the manufacture of high class boilers is indeed well known.

With regard to the Tipton district engineering scheme of the South Staffordshire Mines Drainage Commissioners, the chief engineer, Mr. Edmund Howl, reported to a meeting of that body on Wednesday that negotiations for the sites of engines, wayleaves for hydraulic pipes, and for the driving of underground levels, are still being vigorously pushed forward, and twenty-five draft agreements are in progress. The local authorities had now all intimated their general approval of the scheme with respect to laying hydraulic mains, and in a short time, no doubt, the necessary official consents will be forthcoming. It is hoped that private owners, now that they see the scheme only waiting for the legal agreement to be executed, will render every facility in this direction. The Commissioners' seven engines during the four weeks ending February 26th dealt with a rainfall of ·71 of an inch. There has been a slight increase in the water pumped, but practically it remains at the same low figure at which it has stood for some time past. The seven engines have raised 7,778,166 gallons every twenty-four hours, or 34,721 tons. A comparison of the water pumped in the corresponding month of last year shows a diminution of over 2500 gallons per day.

Good progress is being made with the work of improving the railway approaches into New-street Station, Birmingham. Some delay, however, has occurred in settling certain matters between the London and North-Western Railway Company and the Midland Railway Company, and though these matters are now adjusted, it will be impossible to finish the work by Easter, the time at which it was hoped that everything would be ready. The laying of the permanent way on the new portion of the line known as the Derby deviation has commenced, and trains will be running over it between Saltley and Lawley-street in a few weeks, though they will for some time longer run from the latter point over the old line and through the old tunnel into the station. A slip, the only one of any magnitude since the works were commenced, has occurred in the new embankment near Lawley-street, but this is rapidly being made good with concrete, and the general progress of the work will not be affected.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—At this time of the year there is usually some slacking off, and considering the heavy buying going on recently, it is not at all surprising that there should be a lull with regard to new business just now coming forward. It is also possible that the next few weeks may bring about some slight weakening in prices, at any rate for raw material. It is true that pig iron makers, with very few exceptions, are fully sold, and as I have previously intimated, the bulk of the buying has been for actual requirements. There is, however, always and inevitably a certain amount of over-speculation, and in some cases buyers are already failing to take their full deliveries, with the result that a good deal of iron that has been actually sold is here and there beginning to accumulate in the hands of makers, and it may possibly before long have to be put upon the market. This would, of course, tend to bring prices down, and such a result is in some quarters being looked forward to. The position, taking it all through, is, however, so strong that any downward move in prices could scarcely be more than temporary, and in all probability not to any material extent. Pig iron makers have not been so well sold for many years past, the representative of one large firm, which does a considerable trade in this district, informing me that every portion of their plant was now in full operation—a position they have not been in for many years past; finished iron makers have not had their order books so full for the last four or five years, whilst engineers would probably have to go back over a similar period to find themselves equally well supplied with orders already in hand, and with further new work in prospect, as they are at present.

There was about an average attendance on the Manchester Iron Exchange on Tuesday, with a fair amount of inquiry and a moderate business doing. Prices for the most part were steady at recent quotations, although in some cases not quite so strong at the maximum figures that makers have been asking, whilst amongst merchants there is still underselling. In pig iron buying continues to quieten down, the large users being now generally well covered, and merchants have apparently bought quite as much as they are at present in a position to take. Lancashire makers are, however, selling readily at their recent slight advance, and have no difficulty in getting 46s. 6d., less 2½, for No. 3 foundry qualities, delivered Manchester. The somewhat prohibitive prices that have recently been quoted for district brands are scarcely being maintained, and in Lincolnshire iron 42s. is now in some cases being taken for forge and 44s. for foundry, which is 6d. under the maximum quotations, whilst Derbyshire foundry is, if anything, a trifle easier, and does not average under 46s. to 47s., net cash, delivered Manchester. For outside brands offering here prices continue firm, and moderate transactions are being put through. Makers' quotations for good-named foundry Middlesbrough remain at 47s. 4d., with G.M.B.'s about 46s. 10d., net cash, delivered Manchester. Scotch iron is still quoted on the basis of 47s. 9d. for Eglinton, delivered Lancashire ports, but, as I pointed out last week, the business is steadily drifting from the ports on the Mersey to the Manchester Ship Canal, and for delivery dock quays, Manchester, 50s., net cash, is about the average quotation for Eglinton, whilst for Middlesbrough, which is also being forwarded in considerable quantities by the canal—a cargo of about 1000 tons having come up during the past week—45s., net cash, is quoted delivered at the docks.

In the finished iron trade the position remains much as reported last week; although local makers are, perhaps, not in all cases getting their full recent advance upon bars, it is only on special sales that they make any concession, and they are mostly so well sold as to be indifferent about orders. Delivered Manchester district, £5 12s. 6d. is their minimum quoted prices, with North Staffordshire bars firm at £5 12s. 6d. to £5 15s. per ton. Sheets remain at £7 10s. to £7 12s. 6d.; hoops meet with only a moderate demand, but there are expectations of American orders again being booked in this district, and Association list rates are steady at £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths, delivered Manchester district, with 2s. 6d. less for shipment.

A continued strong tone prevails in the steel trade, with a gradual hardening in prices. Hematites are in fair request at 57s. 6d. to 58s., less 2½, for good foundry qualities, and ordinary billets are quoted £4 7s. 6d. to £4 10s., net cash, delivered Manchester district. Steel plates and bars are almost 2s. 6d. per ton higher, boiler plates now averaging £6 7s. 6d. up to £6 10s., and bars £6 2s. 6d. to £6 5s., delivered in this district.

In the metal market there has been a good deal of buying during the week, in anticipation of a further upward move in prices. An extra weight of orders has come forward on all descriptions of manufactured goods, and this has been followed by an advance on list rates of ¼d. per lb. all round. This upward move has for the moment acted as a check upon further business, but manufacturers are very firm at their advanced rates, which for delivery Manchester district are as under:—Solid drawn brass boiler tubes, 6½d.; solid drawn brass surface condenser tubes, 8d.; solid drawn copper tubes, 7¾d.; brazed copper gas and steam tubes, 7½d.; brazed brass gas tube, 7¼d.: brazed brass machine tube, 7d.; brass wire, 5¾d.; copper wire, 6¾d.; rolled brass, 5¾d. per lb.

The position throughout the engineering industries of this district continues much the same as I have reported recently. From what I can gather, a considerably increased weight of new work has been given out amongst boiler makers recently, so that in this very important branch of Lancashire engineering establishments must now in most cases be tolerably full of work. Machine tool makers continue to report new work coming forward freely, and the leading firms are full of orders for some time to come, both in heavy and light departments, these including some special tools which are being made for gun work, and water tube boiler construction, whilst Messrs. William Muir and Company, of the Britannia Works, Manchester, who have previously sent out a large number of machine tools to Afghanistan, have just secured further large orders for general tools for the Ameer's arsenal and workshops. These machine tools, some of which when put together are of considerable weight, have, as I have mentioned in referring to previous similar orders, to be specially constructed, so that no single piece shall weigh more than three hundredweight, or be more than 9ft. in length, to meet the requirements of transit over the difficult mountainous country which has to be traversed on the road to Cabul.

I noticed at an exhibition of cycles, held during the past week in Manchester, an ingenious contrivance for operating a pneumatic brake and alarm signal from the steering handle of the machine. This has been brought out by "La Modela" Pneumatic Frame Cycle Company, of Blackburn, and the brake is arranged so that the inflators form part of the handle, the connecting tube running inside the tube of the frame to the back wheel, and reaches to the shoe, where the brake is put on immediately the rider applies his hand to the bulb. The alarm bulb is fixed on the other side of the handle. By the above arrangement the brake and alarm can be used together or separately at the will of the rider, who can put the brake on and sound an alarm simultaneously, without relaxing his hold of the handle, thus satisfying an essential requirement in connection with cycle brakes—that they should be applicable without taking the hands off the handles or the feet from the pedals.

No material change has taken place as regards the coal trade here, except, perhaps, that the position grows worse rather than better. House-fire qualities of round coal have been in rather more active request during the last week or so, but the weight of business doing still falls far short of what is usual at this season of the year, and supplies are plentiful, with prices scarcely more than maintained. Common round coals for steam and forge purposes continue a drug, and are pushed on the market at excessively low figures. Quoted rates are nominally unchanged, but to get rid of surplus supplies representatives of collieries ease down in their prices, and the general tone is weaker. Best Wigan Arley remains at 10s. to 10s. 6d.; Pemberton 4ft. and seconds Arley, 8s. up to 9s.; common house coal, 7s. to 7s. 6d.; and steam and forge coals, about 6s. per ton at the pit mouth. Engine fuel moves off fairly well, so far as the better qualities are concerned; but common sorts continue a drug, and very low in price. Best slack still averages from 4s. 6d. up to 5s.; but inferior descriptions can be bought from 2s. 6d. and 3s. up to 3s. 6d. per ton at the pit.

For shipment there is a moderate inquiry, but only a very limited business doing; with 6s. 9d. to 7s. still about the average figures obtainable for common steam coal, delivered Garston Docks, the High Level, Liverpool, or the Manchester Ship Canal.

Barrow.—Much more life is shown in the hematite pig iron trade, and business during the week has been brisk. Pig iron is going more fully into consumption, and there is a growing demand on the part of users. There is also a large demand on speculative account, but that cannot receive much attention, as makers have not much iron they can dispose of for prompt delivery. Business is likely to increase. Thirty-eight furnaces are in blast, compared with sixteen in the corresponding week of last year. Prices are higher and firmer. Warrant iron is at 49s. 1d. net cash sellers, 49s. buyers, while makers quote nominally 49s. 6d. to 50s. 6d. per ton net f.o.b. for mixed Bessemer Nos.

Iron ore is in better trade. There is a good demand for native qualities, and a comparatively large consumption of Spauish ores for mixing purposes. The latter are quoted at 12s. 9d. per ton, delivered at West Coast ports, and native ores are at 10s. per ton for ordinary, and 12s. 6d. for best descriptions.

Steel makers are busy on rails, hoops, plates, tin bars, and heavy castings. There is an especially brisk inquiry for plates and rails, and orders are already well held.

Shipbuilders and marine engineers are very busy, and are expecting new orders, although during the past few weeks no new contracts have been booked.

The coal and coke trades are more actively employed, and prices are firmer and higher.

There is a proposal, which is gaining much public favour, for the construction of a new light railway up the course of the Duddon from Foxfield on the Furness Railway up to Seathwaite, a distance of eight or nine miles.

Shipping is not very brisk. Exports of hematite pig iron from West Coast ports during last week reached 6836 tons, and of steel 7386 tons, compared with 9034 tons of pig iron and 12,187 tons of steel in the corresponding week of last year, a decrease of 2198 tons of pig iron and 4801 tons of steel. The full shipments of pig iron to date total up to 53,019 tons, and of steel to 67,042 tons, compared with 44,346 tons of pig iron, and 63,114 tons of steel, an increase of 8673 tons of pig iron and 3928 tons of steel.

THE NORTH OF ENGLAND

(*From our own Correspondent.*)

IN every branch of the iron and allied industries there is a steady improvement in progress, and work is now plentiful in most departments, with good prospects of keeping so, taking account of the inquiries that are received and the anxiety that consumers show to purchase. All prices are tending upwards. For pig iron makers the worst part of the year is now practically over, and the spring demand is already setting in freely, as it is apparent that buyers are not likely to better themselves by waiting. Not only are shipments of pig iron good, but there is an increasing consumption at the local and inland works—in fact, it is several years since there was anything like so large a local consumption; and the proposed reopening of idle works will tend to increase the requirements still further. It is very satisfactory to find so pronounced an improvement in the industries allied to the iron trade. The turn for the better was generally delayed for some time beyond its appearance in iron and steel, but now that it has come it is progressing pretty quickly. More especially is this so in the engineering and bridge-building trades; and some firms have never been more fully supplied with orders than they are at present. The extra work given out has made the competition less keen, and there is now some chance of more favourable prices being realised.

Cleveland pig iron prices have been further advanced this week, No. 3 by 6d. per ton, and the commoner qualities by 3d. per ton. Business in No. 3 g.m.b. pig iron for prompt f.o.b. delivery has been generally done at 38s. 6d. per ton, and it is not much that can be bought at that figure now. This represents an advance of 2s. 6d. since the worst price of the year was reported, viz., in the early part of January, and the price is now only 1s. below the best price of last year. For April delivery, 38s. 9d. is readily paid, and some of the leading brands are realising fully 39s. No. 4 Cleveland foundry pig iron has been raised to 37s. 3d., grey forge to 36s. 9d., mottled to 36s. 3d., and white to 35s. 9d., all for early delivery. Cleveland warrants have improved in value very satisfactorily, Wednesday's price being 38s. 8d. cash sellers. The stock of Cleveland pig iron in Connal's stores at the end of February was 185,510 tons, the increase for the month being 4717 tons, whereas in January the increase was 9093 tons, and in December 15,352 tons. Of hematite pig iron Messrs. Connal and Co. hold 145,396 tons, an increase of 3814 tons. No. 1 Cleveland pig iron is only 1s. dearer than No. 3, whereas formerly it was 2s. 6d. to 3s. 6d. dearer. Mixed numbers of East Coast hematite pig are realising 47s. for this month's delivery, and 47s. 6d. for April. Rubio ore is in better request, and 12s. 9d. per ton delivered at wharves on the Tees has to be paid for it.

The February statistics of the Cleveland Ironmasters' Association were quite as satisfactory as had been looked for. It was estimated that there would be an increase of 20,000 tons in the stocks of Cleveland pig iron, and the actual figures are 19,657 tons, the total stock held of that description being 351,854 tons, which is nearly eleven weeks' make. Of this the makers held unsold 111,013 tons—2907 tons increase; in their stores were 30,511 tons—10,133 tons increase; in the North-Eastern Company's stores 24,820 tons—1900 tons increase; and in Connal's 185,510 tons—4717 tons increase. The most noticeable feature is the large increase in makers' stores, there being an increase of 50 per cent. This represents iron that has been bought and paid for by consumers and merchants, and it is kept in makers' yards until the buyers can take it out. Two furnaces were blown in during the month—one at Messrs. William Whitwell and Co.'s Thornaby Ironworks, and one at Consett Works, both to produce hematite iron. Of the 96 furnaces in operation at February 29th—two more than at January 31st—there were 52 making Cleveland pig iron and 44 making hematite, &c. Altogether 134 blast furnaces are built in the North of England, against 141 a year ago. The production of pig iron was 130,001 tons Cleveland iron, 12,315 tons decrease on January; and 124,779 tons hematite, basic, and spiegel iron, 12,100 tons decrease on January; total, 254,780 tons, decrease 14,415 tons. The shipments of pig iron from the Cleveland district amounted to 69,264 tons, a decrease of 476 tons in January, but an increase of 20,432 tons, as compared with February, 1895. Last month's shipments included 7465 tons of hematite, &c., whereas in January 8406 tons were despatched.

The finished iron and steel trades are active, and business steadily improves. Heavy steel rails are firm at £4 15s. net at works, and this is the lowest price that is allowed by the combination to be accepted for home and colonial orders, where foreign competition does not come in. Where, however, there is foreign competition, manufactnrers get what price they can. The North-Eastern Steel Company's rail mills at Middlesbrough have been idle for a month, not because of any lack of orders, for these were never more plentiful, but because of the alterations that are being carried out at the works. These alterations have been in progress for several months, but it has been found necessary during the last month, active though trade undoubtedly is, to altogether close the establishment, in order that the extensions and alterations may be completed. The production of the mills hitherto has been about 2500 tons per week, but the improvements will enable the firm to increase this by 25 per cent., and will bring about a considerable saving in labour.

The directors of Messrs. Bolckow, Vaughan, and Co., have declared a dividend for 1895 of 3 per cent., as compared with 2½ per cent. for each of the previous three years, 6 per cent. in 1891, and 6 per cent. in 1890. The amount of profit available for distribution, after providing for depreciation, is £160,015 19s., and with the amount brought forward from 1894, there is £174,636 7s. 2d. available for the shareholders. Of this £120,891 is paid to them, £15,000 is to pay for new blast engines for the hematite furnaces, £25,000 is added to the reserve fund, and £13,743 is carried forward. The directors state that the condition of trade during the first seven or eight months of 1895 was rather worse than in 1894, prices being even more depressed, and orders more difficult to obtain. Towards the autumn an improvement was experienced in the demand for pig iron and finished steel, the trade outlook became brighter, and under these influences prices rose. Although pig iron did not quite maintain its position, and coal never shared in the otherwise general improvement, the year closed with better prospects for the future than has been apparent for a considerable time.

The shareholders of the Tees side Iron and Engine Works Company, Limited, Middlesbrough, have ratified the agreement which the directors have made to sell the whole of their works to Sir Christopher Furness. He has now paid the required deposit, and has taken possession. What chiefly caused the directors to sell were the losses that have been made in carrying on the works. At the end of 1894, according to the balance-sheet, the balance against the company on profit-and-loss account was £13,135 3s. 7d., and last year's operations resulted in a loss of £7894 12s. 3d., which, with the interest on loans, £3102 1s. 8d., made the deficit for 1895 no less than £10,996 13s. 11d., and altogether the profit-and-loss account was £24,131 17s. 6d. against the company. The agreement is that Sir C. Furness shall take the works, plant, tools, materials, stores, work in progress, and debts owing to the company, altogether valued at £144,000, and he pays the liabilities of the concern £105,611, and gives the preference shareholders who have paid 20s. each for their shares 7s. 6d. per share if they require it in cash, or 10s. if they take it in preference shares in any company or companies which Sir Christopher may form to work the properties. This means £33,000 if all the shareholders elect to have cash for their shares, or £44,000 if they take shares. The new company or companies are to be formed by May 15th, and each preference shareholder must then say whether he will accept cash or shares for his holding.

In connection with the disastrous boiler explosion which occurred on June 14th last at the Redcar Ironworks, when twelve men were killed and nine more injured, there has arisen some dispute as to the compensation due under the Employers' Liability Act, which may lead to the whole case being fought over again in the law courts. Messrs. Walker, Maynard, and Co. have paid over to the men's representatives the sums which have been agreed upon, and these sums they ask the accident insurance company with whom they were insured to refund. The insurance company, however, hold that they are not liable, for, although the Coroner's jury found that the explosion was an accident, the Board of Trade representatives held that it was not an accident, "and the verdict of Government officials of course overrides that of the Coroner's Court." Messrs. Walker, Maynard, however, contend that even if this were so they are entitled to the compensation, as their policy covered the negligence of their servant.

Mr. E. T. M. Cowburn, of Hull, has been appointed manager of the Stockton Corporation Quay, vice Mr. Ballon, who has been appointed dock superintendent of the North-Eastern Railway Company's Dock at Middlesbrough. There were about 160 applications for the post.

A company is being formed for the purpose of laying down a railway between Chathill, on the North-Eastern Railway and Seahouses, North Sunderland. The line, which will be single, will be about four miles long. The proposed Durham Coast Railway is practically in abeyance at present, the Town Clerk of West Hartlepool having received information from the general manager of the North-Eastern Railway that it was impossible to make any progress, as the parties interested in the coal borings apparently were not yet prepared to proceed with any works connected with mining operations. The Town Clerk, however, calls attention to the evidence given before the Committee of the House of Commons that such operations would not be commenced until a railway was provided, and that this was the generally accepted view. The directors are, therefore, to be urged to reconsider their determination.

The question of the shipwrights' wages on the North-East Coast has not yet been settled, but another conference of employers' and men's representatives is to be held, and meanwhile the men are continuing at work. The employers offered 5 per cent. advance.

A new departure in marine engineering has been made at West Hartlepool, where the Inchmona, a new screw steamer, is to be fitted with the first set of Mudd's patent five-cylinder and four-crank engines, with boilers working at a pressure of 255 lb. per sq. inch under induced draught. Mr. Thomas Mudd, the inventor, is the Mayor of Hartlepool, and is the managing director of the Central Marine Engine Works, which will supply the engines. The object of the invention is to obtain a greater economy of fuel than has been possible with the triple-expansion engine. It is little more than thirty years since the introduction of the compound engine with a boiler pressure of 65 lb.

At Elswick on Friday Sir W. G. Armstrong and Co. launched the Japanese battleship Yashima, the largest vessel ever constructed on the Tyne, having 12,300 tons displacement, and thus being 1000 tons heavier than H.M.S. Victoria, which was also built at Elswick. The Yashima is 412ft. long over all, has a maximum breadth of 73ft. 6in., and a depth of 43ft. 7½in. The armour belt is 226ft. long by 8ft. deep, and the maximum thickness is 18in. All the thick armour is face-hardened on the Harvey principle. The estimated horse-power is 10,000, indicated with natural draught, and 13,500 with forced draught, the corresponding speeds being 16¾ and 18¼ knots.

At the annual meeting of Smith's Dry Dock Company a dividend of 5 per cent. on the preference shares and 10 per cent. on the ordinary shares was declared. The company did 25 per cent. more work in 1895 than in 1894. The number of vessels docked was 130 last year against 112 in 1894, and 108 in 1893. A new pontoon dock will be launched this month, which it is expected will be at work in three or four months.

The coal trade is showing a slight improvement. The Executive of the Durham Mining Federation Board have issued a circular to the men asking them to reconsider their decision for the abolition of the Conciliation Board.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE short spell of cold weather experienced at the beginning of last week beneficially affected the house coal industry. The improvement was not great enough, however, to make much alteration in the working of the pits. At the time accumulations were very large, and the extra consumption only served to reduce in a small degree the heavy stocks. Several threatened strikes have for the present been averted, although it is not unlikely that more serious complications must inevitably ensue before long. The demand for coal, particularly in the household sorts, is, with rare exceptions, most unsatisfactory. The South Yorkshire pits are not, as a rule, working more than three or four days a week, the latter being the exception. A week or two of cold weather would have made all the difference in house fuel. Several gas coal pits are well employed. There has been a good deal of speculation recently in coal buying by merchants. Their operations, which have been in steam coal for export, have had further depressing effect upon values.

The metropolitan and southern markets are taking but a moderate tonnage, London agents reporting only a quiet business. An average quantity of both gas and house fuel is being forwarded to the eastern counties as well as other markets. Prices have an upward tendency in gas sorts, although very little change has occurred up to the present. Quotations are as follows:—Silkstone coal is purchaseable at 8s. 3d. to 8s. 9d. per ton for best qualities, and 7s. to 7s. 3d. for secondary sorts. Barnsley house fuel is at 7s. 6d. to 7s. 9d. per ton at the pits, with thin seam coal hard to sell at 6s. to 6s. 3d. per ton. The steam coal trade remains in practically the same condition.

Trade is quiet, with stocks rapidly accumulating. The business done at Hull and the other Yorkshire ports has not been equal to the figures of the previous year, notwithstanding that many of the leading colliery owners in this district are transacting a large trade. Values range from 6s. 6d. to 7s. per ton. The various railway and other companies are taking an average tonnage on contract account. Small coal and slack are moving rather more freely than they did a week ago; supplies, however, are still abundant, and prices remain stationary. Best screened slack is obtainable at from 3s. 6d. to 4s. 3d., with ordinary pit slack at 2s. 3d. to 2s. 6d. per ton at the pits. Coke is in better request, which is due to an improvement in the smelting industry, and an increase in the number of furnaces in blast in North Lincolnshire.

In the iron trade there is a decidedly firmer tone, both at Glasgow and in the hematite market. Hematite pig iron is offering this week at Sheffield at 58s. per ton for West Coast, and 55s. to 56s. per ton for North-East Coast. Lincolnshire forge iron, 39s. 6d. net cash; bar iron, £5 10s. to £5 12s. 6d. at makers' works. Siemens-Martin steel, average quality, £7 10s.; Bessemer billets, special carbons used in the Sheffield trades, make £5 12s. 6d. to £6.

The heavy industries are full of work in every department. The armour plates now being produced under the Spencer programme will keep the three works well employed into next year, and the establishments will have added to these the plates required for the five battleships of the Renown type which form the chief feature of the Goschen programme. The cruisers and the torpedo craft will furnish further work for this district. Armour is also being made for Japan, and other foreign Governments are making inquiries which are pretty certain to lead to extensive business. Makers of gun forgings and the lesser calibres of shot and shell are in receipt of fair orders, though not equal to the powers of output. The orders for the larger descriptions of armour-piercing projectiles do not come in, and the new work required under the Naval Estimates is eagerly looked for.

The railway material trade is exceptionally brisk, the home orders being heavy, while satisfactory orders have been booked for the Indian State Railways, the West Indies, and on foreign account. Prices are tending upwards for tires, buffers, springs, axles, and locomotive wheels. The machine department, which has been the last to show much animation, is now promising, local houses having received some remunerative work during the last few days. Manufacturers of boilers, &c., report a good business. All classes of castings are freely inquired after, and many houses find it extremely difficult to supply their customers as early as they desire. The makers of the steel portions of dynamo and other electrical appliances are full of work, and likely to be so for some time to come.

An improvement has to be noted in the lighter trades, although it is not to be compared with the advance in the heavy industries. It is expected that the next quarterly return of exports from this district to the United States will show an increase on the figures for the corresponding period of 1895. The British Government contract for tool steel, which is an important item, has just been placed with a Sheffield firm for three years. The edge tool makers are well off for work. Some complaint is heard in the cutlery and electro-plating departments, but the leading houses have no cause of complaint, as they are generally making full time.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has been a firmer tone in the iron market in the last few days. The conditions of business are all favourable, and a variety of considerations serves to give a cheerful aspect to the trade. Shipments of pig iron from the Scottish ports were again better than usual this week, although it is still observable that the increase is rather in the coastwise than in the foreign department of the trade. It is possible, however, that this branch may make some forward movement ere long. The substantial improvement in the manufacturing trades gives the assurance of a steady consumption of raw iron for a considerable time to come. Both English and Scotch pigs are more in request. Ordinary Cleveland iron will be more wanted presently, and the imports into Scotland are already much greater than at this time last year. For hematite pigs the demand is also increasing, and there is a steady advance in prices. The great demand for rails and other articles has had a good effect on the market. Large orders have just been placed with Clyde shipbuilders and engineers, who had already a good supply of work, and the announcement of the new naval programme has tended to confirm and support the general improvement.

The pig iron warrant market has been fairly active, but there has not been so much speculative business as might have been anticipated. Indeed, the favourable state of matters which now exists appears to have been largely discounted by speculators; and, indeed, the prices of iron already show a substantial advance from the lowest level. Business has been done in Scotch warrants up to 47s. 8d. cash and 47s. 10d. one month. Cleveland warrants were done at 38s. 9d. cash, and 38s. 11d. one month; and Cumberland hematite, 49s. 2d. cash and 49s. 4d. one month.

The consumption of hematite pig iron is steadily increasing, both Scotch-made and Cumberland iron being in increasing demand. The current output of Scotch hematite is from 2300 to 2500 tons per week larger than it was at this time last year. Great activity exists in the ore import trade, as may be inferred from the fact that at Ayr Harbour alone upwards of 8000 tons were discharged in the course of the past week. The arrivals at the other Clyde and Forth ports are proportionately increased.

There are 35 furnaces making hematite, 41 ordinary, and 3 basic iron, the total number now blowing in Scotland being 79, against 74 in the corresponding week of last year.

Prices of makers' special brands of pig iron are steady to firm. Govan, Monkland, and Carnbroe, Nos. 1, are quoted 48s.; No. 3, 46s. 6d.; Clyde, No. 1, 50s. 6d.; No. 3, 47s. 6d.; Gartsherrie, Calder, and Summerlee, No. 1, 51s.; No. 3, 48s. 6d.; Coltness, No. 1, 53s. 6d.; No. 3, 48s. 6d.; Glengarnock, at Ardrossan, No. 1, 50s. 6d.; No. 3, 46s. 6d.; Eglinton, No. 1, 48s. 6d.; No. 3, 46s. 6d.; Dalmellington, at Ayr, No. 1, 48s.; No. 3, 46s.; Shotts, at Leith, No. 1, 53s.; No. 3, 49s.; Carron, at Grangemouth, No. 1, 53s.; No. 3, 49s. 6d.

The shipments of pig iron from Scottish ports in the past week has been 7691 tons, compared with 5062 in the corresponding week of last year. There was dispatched to Italy 350 tons; Germany, 440; United States, 25; Holland, 480; Canada, 25; France, 50; Australia, 10; Belgium, 750; Spain, 39; China and Japan, 288; other countries, 225; the coastwise shipments being 5009, against 2665 in the same week of last year.

The present improved prices of pig iron stimulate the production, and are leading to some increase in storing; but the current requirements of the trade are such that there is not much likelihood of the stocks being very largely augmented.

In the steel trade there is great activity, with a certainty of busy trade for a long time. Finished iron is active, with a firm tone. The different engineering and manufacturing branches are astir with increasing business, and the outlook altogether is very encouraging.

The coal trade has exhibited no real improvement. Shipments and home consumption are fair, but supplies are heavy, and the prices continue at the lowest point. Coalmasters are obliged to reduce the colliers' wages, which is now being generally done, and great dissatisfaction is thereby being caused among the men.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

ANOTHER good coal week has been experienced at Cardiff, the total exports for the past week reaching 315,000 tons. It was stated on 'Change, early in the week, that March promises to be one of the busiest months in the year. Newport, Mon., total, coastwise and foreign, was a fair average. Swansea a little below the average, its French trade as usual prominent. American trade not quite so good as usual in respect of coal.

I referred last week to the stoppage of the Aberdare-Merthyr Colliery, and the possibility of a reconstruction of the company and a restart. An indirect reply to this "hope" is given by a semi-official announcement that nothing of that kind will come about unless royalty owners very considerably reduce the terms upon which the colliery has hitherto been worked. "Given a substantial reduction of royalties, reconstruction may be possible, not otherwise."

Mid-week on the Cardiff Exchange the coal market did not show any great activity, due principally to the storms. Best steam coal was quoted at 10s. to 10s. 3d.; seconds ranged from 9s. 6d. to 10s.; and drys from 9s. 3d. to 9s. 6d. Best Monmouthshire was rather dull at 8s. 6d.; seconds, 8s. One of the principal "grumbles" was at the stagnation of small coal. Best sold for 4s. 6d.; seconds, 4s. to 4s. 3d.; drys from 3s. 6d. The stormy weather, and consequent delay in arrival of tonnage, told badly the beginning of the week upon house coal. The last prices, Cardiff, were as follows:—Best, 10s. 6d. to 10s. 9d.; No. 3 Rhondda, 9s. 6d. to 9s. 9d.; brush, 7s. 9d. to 8s.; small, 6s. to 6s. 3d.; No. 2 Rhondda, 7s. 6d. to 7s. 9d.; through, 6s. to 6s. 3d.; small, 4s. to 4s. 3d. Swansea prices are:—Steam, 9s. 6d. to 10s. 3d.; seconds, 8s. 9d. to 9s. 3d. House coal: No. 3 Rhondda, 10s. to 10s. 6d.; No. 2, 8s. 9d. to 9s. 6d.; anthracite, 8s. to 11s. 6d., according to quality.

Coke at Cardiff is in good demand, and last prices are firmly maintained. Satisfactory accounts are to hand of the patent fuel trade. Cardiff and Swansea prices are from 10s. to 10s. 3d. Swansea's export last week was 5546 tons. On 'Change, Swansea, this week it was reported that the finished iron and steel trade was fairly busy; and that home, colonial, and foreign rail business is tolerably hopeful. On the 28th ult. 500 tons went to London, and on March 3rd 300 tons to the same destination, both from Newport. Swansea quotations this week were as follow:—Pig iron, 4d. per ton advance from previous week; Glasgow warrants, 47s. 7d.; Middlesbrough No. 3, 38s. 8d.; hematite, 46s. 6d.; Welsh bars, £5 10s. to £5 15s.; sheets, iron and steel, £6 12s. 6d. to £6 15s.; steel rails, heavy sections, £4 10s. to £4 15s.; light, £4 17s. 6d. to £5 5s. Sleepers, angles, channels, &c., according to specification. As regards railway steel, I may state that 350 tons railway chairs came to Swansea this week from Middlesbrough for the Rhondda and Swansea Bay Railway.

Bessemer steel is quoted at £3 17s. 6d. for bars, and Siemens best for £3 18s. Tin-plates figure in quotations at the usual low rates. Bessemer cokes at 9s. 1½d. to 9s. 3d.; Siemens, 9s. 3d. to 9s. 4½d.; ternes, from 17s. 6d. to 22s. 6d.; best charcoal, 12s. 6d. to 13s. 6d. In the prosperous days of Melingriffith charcoal plates sold for £2 2s. a box, and the proprietary stocked them if prices fell, just as Crawshay did his puddled bars when markets drooped.

I have still little encouraging news about the tin-plate trade. According to leading authorities one third of the trade has fallen away from Wales. Exports last week, if a shade better, were very insignificant. The total shipped was 18,496 tons, and the receipt from works 33,090 boxes. Stocks are creeping up, totalling now 33,090 boxes. The great falling off is in the American trade; continental business being still satisfactory. Newport is shipping substantial "parcels" to London. I note amongst a crowd of bad signs, a few good ones, such as Gwendraeth difficulty is over, after a stoppage of two months, and a restart is preparing. The leading opinion is that some little time must pass before any improvement sets in generally.

Prospects of the pitwood trade are not encouraging; quotations are fixed in Cardiff at 15s. 3d., but I am assured by one engaged in the business that sales are generally at 15s., and he prophecies that they will be down to 14s. 6d. before a month is out.

Amongst the arrivals from America last week was a steamer with a part cargo made up of 900 tons slates, and the rest made up of oil and grain, and yet it is said that North Wales slates are amongst the best in the world. A quick sail from St. John's, New Brunswick, was noted a few days ago at Cardiff. It was done in seventeen days.

Iron ore is brisk, prices firm. Dowlais received three cargoes one day this week, and the import into Swansea last week amounted to 4750 tons.

In their new water scheme the Newport, Mon., Committee have gone the right way to work. They have consulted an eminent geologist, who has recommended the practicability of the works at Wentwood, and in accordance the Committee now recommend the Corporation to take up the undertaking. It is estimated that the extra work will cost close upon £50,000.

The local relief fund at Tylorstown acknowledges the receipt of £1345 in aid of the widows and orphans from the late explosion.

A conference of the Sliding-scale Committee is announced for Saturday at Cardiff, when the discharge note question is to be threshed out. The opposition is spreading. The feeling appears to have been intensified by the Plymouth lock-out, which continues as gloomy as ever. The discharge note principle is that unless colliers have their notes of discharge from last place of employment, no one will employ them, as it is then assumed that they are either men out on strike or are locked out. At Ebbw Vale this week very strong speeches were made against the system, and the tendency there and elsewhere is to give a month's notice unless the plan is withdrawn. I am still inclined to think that the sliding scale will settle the difficulty amicably.

I note that in the House of Lords on Monday the Cambrian Railways Bill, the Taff Vale Railway Bill, Windsor Dock (Cardiff) Bill, and the three Great Western Railway Bills were read a second time.

An excellent authority tells me that there is something in the rumour of a great industry being transferred to the marshes at Barry, but that facts, names, dates, &c., are not allowed to come out yet. Public opinion has been inclined to the belief that one of the Welsh iron works was about to slide down from the hills. This, however, is stated not to be the case. The industry is an English one.

Trouble is threatened at the Hardy Colliery. Lately a labour dispute occurred there, which was submitted to arbitration, but the "rippers" refused to abide by the decision. There is a fear that if this cannot be arranged, a stoppage will take place which will involve 1500 men. There used to be a rule amongst the more thoughtful of the colliers not to raise dangerous points when labour was abundant, as is now the case, with several large collieries stopped; but this seems to be overlooked, and in the face of a good demand for coal, the men in many parts of the district are agitating.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE reports that come in from the different iron markets are of an encouraging character. Trade is generally becoming more favourable as the year progresses, nearly all branches of the iron and steel industry experiencing an improvement in demand, while prices for most articles increase.

A good business is done on the Silesian iron market, both as regards raw and manufactured iron. For steel and general hardware there is likewise a healthy demand coming forward, and quotations are reported to be firm.

From the Austro-Hungarian iron market improving accounts are being received, especially with regard to the malleable iro department, where numerous inquiries have been coming in upon the week. Girders are in particularly good request; also for railway and engineering requirements a brisk demand is experienced, and in agricultural implements a good business is anticipated for the next month. Official quotations are, on the whole, unchanged; only here and there a slightly improving tendency has been perceived.

There is a better tone on the French iron market, owing to the lively inquiry that has been coming in for most articles last week. A Bar and Girder Convention, of which there has been much talk for some time past, has at last been formed for a period of five years, twenty-three mills belonging to it. The following figures show French business in coal and coke during the last three years:—

Import.

Coal.	1895. Tons.	1894 Tons.	1893. Tons.
From England	4,290,186	4,218,516	3,973,518
From Belgium	3,868,650	3,851,057	4,117,965
From Germany	581,959	663,139	691,737
From other countries ..	7,812	2,894	2,377
Totals	8,748,607	8,735,606	8,785,597
Coke.			
From Belgium	431,300	470,032	513,727
From Germany	973,300	1,044,820	896,920
From other countries ..	8,350	15,130	33,172
Totals	1,412,950	1,529,982	1,443,819

Export.

Coal.	Tons.	Tons.	Tons.
To Belgium	430,780	327,869	343,340
To Italy	17,810	26,434	31,896
To Switzerland	203,710	197,459	204,216
To Turkey	4,440	10,674	11,062
To Egypt	250	294	6,290
To Algiers	8,390	14,860	4,266
To other countries	155,650	170,735	214,076
Totals	821,040	748,336	815,146
Coke	84,580	57,031	58,606

In Belgium the iron trade is moving on briskly. Demand is active for most sorts of iron, and prices are, on the whole, pretty satisfactory, although, of course, there is still much left to be desired. Foundry pig is in particularly good request, and No. 3 is scarcely obtainable at 47f. p.t. Rails, too, have been realising better prices lately.

The condition of the Rhenish-Westphalian iron market is much the same as last week, an improving tendency prevailing in all departments both with regard to prices and inquiries. Buyers come forward freely with their orders, perceiving that waiting longer means paying higher prices. A fair amount of work has consequently been booked upon the week, and a cheerful tone is everywhere noticeable. Iron ore is very lively, and purchasers had to agree to advances in quotations in a number of cases. Officially M. 8·60 p.t. is quoted for spathose iron ore, roasted ditto fetching M. 11 to 12·70 p.t.; calcined iron ore costs M. 12 to 14 p.t. For Nassau red iron ore, 50 p.c. contents, M. 9·30 p.t., free Dillenburg, is paid. There is a brisk business doing in the better qualities of Luxemburg-Lorraine minette to Westphalia and the Rheinland, minor sorts going to Belgium and the Longwy district. Quotations are, for red minette, 40 p.c. contents, M. 3·20 to 3·30 p.t., the 37 p.c. quality being sold at M. 2·40 to 2·70 p.t., net at mines. In the pig iron trade the business done upon the week has been altogether a satisfactory one. All sorts of crude iron are in good call, basic being particularly well inquired for, and there is a tendency upwards in prices. Last week's quotations were, for spiegeleisen, 10 p.c. to 12 p.c. grade, M. 54 to 55 p.t.; forge pig, No. 1, M. 49 to 52 p.t.; No. 3, M. 42 p.t.; hematite, M. 65 p.t.; foundry pig, No. 1, M. 65 p.t.; No. 3, M. 56 p.t.; basic, M. 52 p.t.; Bessemer, M. 54 to 55 p.t. at works. Luxemburg forge pig is quoted M. 56·50 p.t. free Luxemburg. All the branches of the malleable iron industry have continued healthily occupied, but, as prices for raw material are steadily increasing, those realised for manufactured iron still leave very little or no profit, and makers justly complain of the low rates they are forced to accept. In bars a particularly brisk business was doing last week, and hoops and girders have also been in fair inquiry. In the plate and sheet trade demand is active, but quotations remain low, although for the last-named article an upward inclination can be perceived. Drawn wire has improved in price as well as in demand. The situation of the tube foundries is pretty satisfactory, prospects for spring business being much more favourable than was at first anticipated; M. 110 p.t., free at works, may be considered as basis price. Machine and construction shops are irregularly occupied, but there is an improving tone noticeable nevertheless. The wagon factories are well situated, with very satisfactory prospects.

Latest list quotations, per ton at works, are as follows:—Good merchant bars, M. 115; angles, M. 120 to 125; girders, M. 85, free Burbach; hoops, M. 123 to 125; billets, in basic and Bessemer, M. 83 to 85; heavy plates, for boiler-making purposes, M. 160; tank ditto, M. 135 to 140; steel plates, M. 130 to 135; tank ditto, M. 115 to 120; sheets, M. 140 to 150; drawn wire in iron or steel, M. 118 to 135; iron wire rods, common quality, M. 118; wire nails, M. 127 to 130; rivets, M. 155 to 160; complete sets of wheels and axles, M. 270 to 280; axles, M. 200; steel tires, M. 195 to 200; Bessemer rails, M. 108 to 110; steel sleepers, M. 106; fish-plates, M. 112 to 120; light section rails, M. 95.

In last week's letter we gave the figures of German import and export for 1895; we are now enabled to state the value of German foreign trade for the same year. The difference against 1894 is put in parentheses:—

	Import. M. 1000.	Export. M. 1000.
Iron ore	26,424 (-1021)	7,440 (- 228)
Pig iron	8,783 (- 722)	7,035 (- 1,014)
Angles	12 (- 11)	17,118 (+ 4,198)
Fish-plates, sleepers, &c. ..	60 (- 19)	4,562 (+ 228)
Rails	146 (- 137)	9,680 (- 231)
Bars	2,818 (- 28)	27,827 (- 2,222)
Plates and sheets	565 (+ 71)	16,417 (+ 4,498)
Iron wire	1,770 (+ 200)	25,945 (- 384)
Iron manufactured goods	8,426 (-1208)	107,580 (+ 9,002)
Hardware	6,655 (+ 66)	68,980 (+21,602)
Locomotives, traction engines	1,902 (- 509)	8,887 (+ 2,417)
Other machines	28,420 (+2195)	86,777 (+ 8,560)

According to the *Vossische Zeitung*, no less than 526,785,000 pud coal were produced in Russia in 1894, against 367,204,000 pud in 1890; in 1885 only 260,578,600 pud were produced. In iron ore 102,140,000 pud were produced in 1893, and 128,010,000 pud in 1894. Output of pig iron in Russia was, for 1894, 80 million pud, against 40 million pud in 1893. Out of these 80 million pud crude iron, 30,090,000 pud steel and 27,574,000 pud malleable iron were made.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

19th February, 1896.

3769. Warp Beaming Machines, B. Norcross, Manchester.
3770. Lamp for Fumigating Purposes, P. H. V. Hammersley, Manchester.
3771. Pencils, H. C. Booth and J. L. Appleton, London.
3772. Door Stop, H. Lombard, London.
3773. Leather, J. B. Scammell and E. A. Muskett, London.
3774. Gas Tube, A. E. Bowles, London.
3775. Kid Gloves, A. Jones, London.
3776. Brakes, G. H. Fish, London.
3777. Exhibiting Photographs, H. W. Short, London.
3778. Copying Drawings, F. W. Bentall, London.
3779. Moulding Food Substances, G. E. Larkin, London.
3780. Fog Signalling Apparatus, A. H. Rackliffe and C. Campbell, London.
3781. Taps, R. E. Young, London.
3782. Strainers, H. J. Rogers, Watford.
3783. Labels, F. E. Harvey, Surrey.
3784. Wearing Apparel, R. R. Bruce, London.
3785. Railways, J. G. Dixon, London.
3786. Tire for the Wheels of Cycles, A. A. Crosier, London.
3787. Chain Gearing for Cycles, J. F. C. Abelspies, London.
3788. Chain Wheels for Cycles, J. F. C. Abelspies, London.
3789. Building Bricks, W. M. Hazel, London.
3790. Clamp, B. J. Falk, London.
3791. Phenetidine, G. B. Ellis.—*(La Société Chimique des Usines du Rhône anct. Gilliard P. Monnet and Cartier, France.)*
3792. Bearings for Carriage Axles, C. de Coëffard, London.
3793. Lasting Jacks, R. Whitton, London.
3794. New Motor, H. W. Tanner and W. Porteous, London.
3795. Woven Fabrics, L. Haslam, London.
3796. Machinery for Cutting Coal, C. W. Atkinson, London.
3797. Imitation Waterproof Hats, R. Verdier, London.
3798. Machine Ploughs, J. Carpenter and L. F. Allen, London.
3799. Artificial Stone, W. P. Thompson.—*(La Société Anonyme la Néo-Litho, Belgium.)*
3800. Artificial Stone, W. P. Thompson.—*(La Société Anonyme la Néo-Litho, Belgium.)*
3801. Filters, R. Bradshaw, Manchester.
3802. Absorbent Balls of Clay, R. Bradshaw, Manchester.
3803. Cartridges and Projectiles, G. Y. Cooper, Birmingham.
3804. Advertising, &c., Device, G. Sculpher, Liverpool.
3805. Shoe for Bath Waste Pipes, W. A. Walker, Manchester.
3806. Cleaning Tramway Lines, W. H. Rymer, Liverpool.
3807. Gauge Glass Protector, F. W. Golby.—*(R. Bach, Germany.)*
3808. Book Clasp, F. W. Golby.—*(A. Gamper, Germany.)*
3809. Electric Lamp Sockets, J. F. C. Snell, A. H. M. Francis, and R. S. J. Spilsbury, London.
3810. Rack for Cycles, A. J. Boult.—*(H. Westphal, United States.)*
3811. Pneumatic Tires, W. E. Crowther, London.
3812. Strainers for Sink-pipes, &c., J. Gowland, London.
3813. Case for Manifold Books, F. G. Fender and W. E. Coleman, London.
3814. Damping the Strings of Zithers, P. Renk, London.
3815. Ovens for Baking Bread, &c., G. Huber, London.
3816. Steam Generators, J. Sampson, London.
3817. Necktie Retainer, A. Brendler, London.
3818. Securing Covers of Ships' Hatches, T. Lloyd, London.
3819. Tap Wedge, A. C. Mann and L. R. Harrington, London.

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3820. Cruet Frame for Bottles, J. Harrison, Birmingham.
3821. Carrying Sacks of Coal, &c., A. Jackson, Glasgow.
3822. Method of Controlling Engines, H. Swanton, London.
3823. Electrical Lamps, L. P. Foster, Halifax.
3824. Heating Apparatus, J. Quarmby, Manchester.
3825. Helmets or Head Coverings, E. R. Vaughan, Sydenham, Co. Down.
3826. Tool Case or Wallet for Cycles, L. F. Banks, Dublin.
3827. Indicating Shafting, W. Chadburn, Liverpool.
3828. Tile Angle-finder, J. Connor, Ipswich.
3829. Fastening Tires to Cycles, A. E. Hall and J. W. Sadler, York.
3830. Dyeing Fibrous Material, W. Leach, Bradford.
3831. Street and Yard Gullys, J. Willoughby, jun., Plymouth.
3832. Oil Motors, W. H. Casley and A. F. Woodman, Exeter.
3833. Treating Lentils and Peas, J. and W. Dunn, Glasgow.
3834. Seats for Wheeled Carriages, T. Smith, Glasgow.
3835. Lease-taking Reed for Warping, G. Walker, Halifax.
3836. Cycle Handle-bars, A. W. McMurdo, Dunoon.
3837. Controlling Propeller Shafts, W. H. Lindsay, Bristol.
3838. Magazine, &c., Cameras, W. Griffiths, Birmingham.
3839. Ash Shoot, G. F. Robins, Banbury.
3840. Toy, O. Hanks, London.
3841. Arc Lamps, F. M. Lewis, Leeds.
3842. Cranes, H. Berry, Leeds.
3843. Signalling on Railways, T. Horrox, Manchester.
3844. Spinning Fibrous Materials, F. Prestwich, Manchester.
3845. Self-reversing Gear for Engines, G. W. Thompson, Birmingham.
3846. Electrical Generators, T. Harden and S. Glover, St. Helen's.
3847. Reversing Electric Currents, T. Harden and S. Glover, St. Helen's.
3848. Picking Mechanism of Looms, J. Haythornthwaite and B. Duckworth, Burnley.
3849. Head and Back Supports, C. F. von Wolff, Glasgow.
3850. Driving Gear for Cycles, A. M. Strathern and J. Donald, Dublin.
3851. Bottles, J. A. Gaunt and M. Harvey, Birmingham.
3852. Self-setting Mouse or Rat Trap, G. V. Garrett, Ipswich.
3853. Securing Hardened Steel Rolls, C. H. Darbishire, Liverpool.
3854. Dress Band or Belt, M. Mahner-Mons, Glasgow.
3855. Draught Generating Apparatus, I. Herrmann, London.
3856. Picture Suspenders, H. Munslow, London.
3857. Picture Hooks, H. Munslow, London.
3858. Typewriters, F. W. Hillard, London.
3859. Evaporating Vegetable Matter, A. Ludwig.—*(S. Moser, Germany.)*
3860. Oil Stoves, W. W. Graham, London.
3861. Paint-mixing Machines, W. H. Raine and V. Wells, London.
3862. Mounting Cycle Handles, M. H. and S. S. Galsworthy, Birmingham.
3863. Roofing Tile, R. G. Kinsky, Birmingham.
3864. Electrical Thermometers, C. D. Barker, London.
3865. Billiard Cues, H. Fletcher, London.
3866. Aquariums for Containing Live Fish, F. J. Millard, London.
3867. Fluid-pressure Engines or Motors, C. H. Beadle, London.
3868. Cutting Tubes, S. Schreiber, London.
3869. Manufacture of Ferrocyanides, J. T. Conroy, F. Hurter, and J. Brock, London.
3870. Novel Puzzle, F. J. Measures and F. Adams, London.
3871. Lubricators, J. E. Olsson, London.
3872. Triplicate Manifold Judging Book, W. H. Turner, London.
3873. Ruling Oblique Lines on Sheets, &c., J. Hess, London.
3874. Punkahs, J. Canese, London.
3875. Automatic Storage Water Reservoir, R. Miles, London.
3876. Dust Catcher, A. B. Soar, London.
3877. Wheel Guard, A. L. Pither, London.
3878. Utilising the Heat of Lamps, Falk, Stadelmann, and Co., Ld., and H. Crowhurst, London.
3879. Wooden Rims for Bicycle, &c., Wheels, C. R. Peterkin, London.
3880. Walls, &c., R. Walker, Essex.
3881. Cog-wheels and Coupling Gear, R. M. Daelen, London.
3882. Automatic Photographing Machine, H. H. Lake.—*(E. N. Dickerson, United States.)*
3883. Wheels for Vehicles, J. W. Boardman, Liverpool.
3884. Cording Method, M. Darimont, Belgium.
3885. Sheet Metal Casks, E. Redman, London.
3886. Coupling Bicycles Together, C. Morel and H. Gérard, London.
3887. Machine Guns, W. E. Simpson, London.
3888. Safety Bank Checks, &c., M. Leventritt, London.
3889. Controlling the Grinding of Flats, H. H. Lake. – *(J. E. Prest, United States.)*
3890. Purification of Saccharine Liquids, E. Bert, London.
3891. Controlling Traffic on Single-line Railways, W. H. Deakin, London.
3892. Violins, I. B. Poznanski, London.
3893. Sewing Machines, A. B. Peters, London.
3894. Locomotive Engines, E. T. Preece, London.
3895. Printing Machines, P. A. Newton.—*(R. Hoe, United States.)*
3896. Photographic Shutters, G. C. Downing.—*(N. Hansen, France.)*
3897. Sprocket Chains, B. F. Sparr and F. K. Partric, London.
3898. Coin-freed Apparatus, G. Knight, London.
3899. Blind Bracket, L. R. Harrington and A. C. Mann, London.
3900. Exercising or Gymnastic Apparatus, F. Hulsmann, London.
3901. Preservation of Leathers, F. B. O. Hawes, London.
3902. Photography by Rontgen's x-Rays, S. D. Rowland, London.
3903. Skirts, F. A. Johnson and C. Haas, London.
3904. Stools for Counters, A. H. Davison, London.
3905. Game Boards, V. K. Coffill, London.
3906. Making Zinc Oxide, W. Hampe and C. Schnabel, London.
3907. Range Finders, A. E. Butcher, London.
3908. Electrical Communicating Apparatus, A. E. Butcher, London.
3909. Pins and Combs, A. C. Young, London.
3910. Regulator for the Carbons of Arc Lamps, F. Klostermann, London.
3911. Wine, Spirit, and other Filters, R. Rendle, London.
3912. Puzzles, A. J. Boult.—*(W. G. Adams, United States.)*
3913. Rail Fasteners, C. G. Chamberlain, London.
3914. Insect Traps, H. W. Matthews, London.
3915. Coupling Railway, &c., Vehicles, A. Briggs, London.
3916. Coupling Railway, &c., Vehicles, A. Briggs, London.
3917. Cycle and Similar Saddles, A. F. Taylor, London.
3918. Recovering Metals from Ores, A. J. Boult.—*(H. Eichbaum, France.)*
3919. Pocket Compasses, J. Hewitt and F. R. Baker, London.
3920. Belt Attachment, J. Hewitt and F. R. Baker, London.
3921. Fastening for Packing Cases, G. Vogelaar, London.
3922. Drawing Pins and Tacks, W. Burton, London.

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3923. Sprocket Chains, B. F. Sparr, London.
3924. Watchmakers', &c., Eyeglass, J. W. Stevenson, York.
3925. Fuel Economiser Scrapers, A. and H. Roberts, Southport.
3926. Appliance to Heat an Oven, M. Butcher, Hartlepool.
3927. Securing Railway and other Spikes, E. Logier, Dublin.
3928. Lids of Teapots and Culinary Utensils, M. Sibbring, Liverpool.
3929. Fire Escape, G. H. Pocock, Bristol.
3930. Coin-freed Mechanism for Gas Meters, D. Blackie, Glasgow.
3931. The Burgonet Gas Controller, A. Ingram, London.
3932. Cigar and Cigarette Holder, E. Gunter, London.
3933. Flavouring, &c., Meat and Fish, P. Walsh, Dublin.
3934. Cinder Sifter and Dustbin, E. A. Attwood, London.
3935. Burglar-proof Letter-box, W. F. Human, London.
3936. Etching, &c., Solid Wood Surfaces, E. Milo, London.
3937. Producing Artificial Light, W. Rockliffe, Newcastle-on-Tyne.
3938. Method of Raising Sunken Vessels, T. Pearson, Newcastle-on-Tyne.
3939. Pneumatic Tires, S. Austin and A. Farnhill, Manchester.
3940. Sliding Windows, J. Wilkie, Glasgow.
3941. Metal Note Sheets, J. B. Howard.—*(O. Helbig and ——, Germany.)*
3942. Removing Ashes on Ships, J. B. Howard.—*(H. Wehner, Germany.)*
3943. Securing Lids of Boxes, &c., J. Dowling, Liverpool.
3944. File-cutting Machines, L. and O. Erlenwein, Glasgow.
3945. Tobacco Pipe Cleaner, W. H. Mash, Waltham Cross.
3946. Scissor Sharpener, J. Miller, sen., Blackburn.
3947. Bicycle Handles, C. E. and M. E. Stewart, London.
3948. Automatic Game, &c., Trap, J. Davidson, Holkham.
3949. Camera for Lantern Plates, R. D. Smith, London.
3950. Covering for Water and Steam Pipes, F. Dye, London.
3951. Printing on Fabrics, F. D. Haddon and A. A. Kuenemann, Manchester.
3952. Bearings of Washing Machines, W. L. Bradford, Manchester.
3953. Plough, J. Mulcahy, Cork.
3954. Prize Programme, H. Mandell, London.
3955. Saw Stop and Protector, W. J. B. Woodrow, London.
3956. Motor-driven Velocipede, J. J. H. Sturmey, Coventry.
3957. Tubes, E. J. West, Coventry.
3958. Candlestick, W. Lincicum and C. F. Lewis, London.
3959. Bell-actuating Brake for Cycles, W. A. Hay, London.
3960. Railway Vehicle Couplings, J. H. Senger, London.
3961. Protective Cover for Cycles, L. H. Fitzgerald, London.
3962. Protecting the Screwed Ends of Pipes, R. Telford, Glasgow.
3963. Saddles for Cycles, &c., W. Brampton, Birmingham.
3964. Saddles for Cycles, &c., W. Brampton, Birmingham.
3965. Tube for Cycle Frames, C. H. Brampton, Birmingham.
3966. Colouring Matter, O. Imray.—*(The Farbwerke vormals Meister, Lucius, and Brüning, Germany.)*
3967. Self-closing Stopper for Bottles, J. Knowles, London.
3968. Clogs, J. Harvey, London.
3969. Gridiron and Gridiron Stand, W. G. Davies, London.
3970. Net, S. O. Cowper-Coles, London.
3971. Indicator for Coin-freed Apparatus, J. O. Tonkin, London.
3972. Artificial Stone, S. Neffgen, London.
3973. Driving Chains, J. Braun, London.
3974. Toy, G. Schröder, London.
3975. Astronomical Dial, F. Topic and A. Mach, London.
3976. Match-boxes, A. W. Brittain, London.
3977. Folding Boats, E. T. Hughes.—*(F. Heather, United States.)*
3978. Traps, T. W. Fletcher, London.
3979. Envelope, H. G. Nicholls, London.
3980. Windows, W. Youlton, London.
3981. Novel Puzzle, F. J. Measures and F. Adams, London.
3982. Incandescent Gas Lamps, &c., E. J. Shaw, London.
3983. Fire-arms, J. Carter, London.
3984. Ore Concentrator, V. I. Feeny.—*(The McGlew Ore Concentrator Company, United States.)*
3985. Cement, A. Cléry, London.
3986. Teapots, W. C. Fordham, London.
3987. Obtaining Acetic Acid, W. P. Thompson.—*(C. von der Linde, Germany.)*
3988. Elevators for Machinery, J. Higginbottom, Liverpool.
3989. Sleeve Links, H. H. Champness, London.
3990. Knife Cleaner, T. H. Fleming, London.
3991. Dyeing Machines, H. H. Lake.—*(J. C. Blundell, United States.)*
3992. Locks, B. T. Newnham, London.
3993. Artificial Stone for Building, W. F. Williams, London.
3994. Water Back, A. M. Bushell, London.
3995. Musical Apparatus for Trained Dogs, J. Patterson, London.
3996. Plug Tobacco, E. J. Kennedy, London.
3997. Photographic Plates, I. N. V. Bablon, London.
3998. Aldehydes, A. J. Boult.—*(G. Barthel, Germany.)*
3999. Oil Stoves, &c., A. J. Boult.—*(G. Barthel, Germany.)*
4000. Incandescence Bodies W. Nicholls, London.
4001. Warp Guides, J. Walker, J. Bryant, and H. Kelly, London.
4002. Hook and Eye Fastening, J. P. Winning, London.
4003. Means for Fastening Casements, R. Strauwald, London.
4004. Writing Case, H. E. Bauer, London.
4005. Bicycles, W. E. Bargery, London.
4006. Screw Nails, J. Martin.—*(C. N. Buller, Cape Colony.)*
4007. Screw-drivers, J. Martin.—*(C. N. Buller, Cape Colony.)*
4008. Dress Collar, A. L. Guye, London.
4009. New Life-saving Apparatus, A. Dexter, London.
4010. Advertising, A. E. Farrants, London.
4011. Fastener for Ladies' Dresses, J. Tufnail, London.
4012. Brooms, W. Hawes, London.
4013. New Spigot or Valve for Casks, O. Cook, London.

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4014. Metal Dowels for Patterns, J. W. Phillips, London.
4015. Regulating Waste of Water, J. Atkinson, Marple.
4016. Watering Spout, G. L. Lavington and E. A. Wright, London.
4017. Working Fishing Gear, E. Bacon and W. J. Wood, Grimsby.
4018. Swing Boats, J. Turner and W. Elliot, Derby.
4019. Lavatory Stands, G. D. Innes, Manchester.
4020. Indicators, J. P. Milbourne, Manchester.
4021. Fog Signalling, F. Glover, Leeds.
4022. Photographic Prints, W. Schmeer, Bradford.
4023. Vacuum Bulbs, A. W. Porter, London.
4024. Picture Frame, E. Gerard, Liverpool.
4025. Scenic Effects, J. B. Niblett, London.
4026. Tables, A. W. and F. Brook, Huddersfield.
4027. Pumps, A. Webster, Liverpool.
4028. Ammeters, T. J. Baker, Warwickshire.
4029. Gulleys, T. H. Elms, London.
4030. Lamps, W. Evans, H. and G. O. Lewtas, Manchester.
4031. Boot Tree, J. D. Cookson, Manchester.
4032. Boats' Davits, A. A. Dieriex and W. Jordan, Southampton.
4033. Electric Lamps, J. A. Sinclair, London.
4034. Inner Sole for Boots, W. Wagner, Brussels.
4035. Changing the Speed of Velocipedes, F. Rossion, Brussels.
4036. Chainless Cycles, L. Bonnaud, Brussels.
4037. Tripod Head for Hand Cameras, G. Houghton, London.
4038. Valves for Pneumatic Tires, W. Brookes, Manchester.
4039. Cop Tube, A. Wright, Manchester.
4040. Stoppering Jars and Bottles, J. Milnes, Levenshulme.
4041. Window Sashes, W. Johnson, London.
4042. Making Stair Rod Eyes, E. Cox and E. Cox, jun., Birmingham.
4043. Pneumatic Tires, W. G. Wrench, Glasgow.
4044. Fixing Rain and Soil Pipes, A. Shackleton, Burnley.
4045. Safety Lamps for Paraffin, &c., J. J. Grant, London.
4046. Automatic Fire Alarm, A. B. P. Mowat, Liverpool.
4047. Stem-winding Watch Mechanisms, T. Elsasss, London.
4048. Submarine Torpedo Boats, &c., R. Rutley, London.
4049. Land Cultivators or Harrows, A. J. Keeble, London.
4050. Pneumatic Tires for Wheels, A. H. Crockford, London.
4051. Making Loaf-tins, W. Morris and L. Wilkinson, London.
4052. Pipe Joints, J. Duckett and Son and F. S. Button, London.
4053. Apparatus for Synchronising Clocks, E. Giles, London.
4054. Frying Pans of Fish Shops, &c., J. J. Malkin, London.
4055. Windows, S. Bastow, London.
4056. Postal Envelopes, H. M. Potter, London.
4057. Belting and Boot Sole Material, F. B. O. Hawes, London.
4058. Cardboard Cases, R. Dalton and H. Mardon, London.
4059. Wrought Iron Spoke Wheels, H. Ehrhardt, London.
4060. Boot Lace Fastening, B. Leslie and A. R. Phillips, London.
4061. Engines, G. F. Lawrence and W. A. Vignoles, London.
4062. Artificial Fur Manufacture, J. Biermann, London.
4063. Flushing Cisterns, B. S. Wagstaff, London.
4064. Pieces for Playing Games, D. Joy and B. C. Joy, London.
4065. Barrel Slide for Carts or Vans, J. A. Evans, London.
4066. Speed Gear for Velocipedes, B. Woodward, London.
4067. Motive Power Engines, E. L. Burne, London.
4068. Cooking Stove, E. Schmidt and J. Kiemer, London.
4069. Oil Engines, E. J. Clubbe and A. W. Southey, London.
4070. Self-propelled Road Vehicles, E. J. Clubbe and A. W. Southey, London.
4071. Building Blocks, A. J. Boult.—*(M. R. G. Löschke and A. Opelt, Germany.)*
4072. Cycle Gear Cases, F. Easom, S. Ranford, and Humber and Co., London.
4073. Amalgamating Ores, A. J. Boult.—*(J. T. Penny and W. H. Richardson, Australia.)*
4074. Cans, R. W. Barker.—*(W. Lichtenberg, W. N. Anderson, and R. Lichtenberg, United States.)*
4075. Condensing Towers, W. P. Thompson.—*(The Thonwaaren fabrik Bettenhausen Drs. Plath, Staeb, and Piepmeyer, Germany.)*
4076. Lamps, W. P. Thompson.—*(Porzellanfabrik Kahla Filiale; Hermsdorf-Klosterlausnitz, Germany.)*
4077. Sheaves, R. B. U. H. J. Duncan, London.
4078. Railways, G. Wood, Manchester.
4079. Surgical Instrument, H. Windler, Liverpool.
4080. Grafting, C. Hammond, Brentwood.
4081. Pistons, J. and E. Wright and J. Amos, London.
4082. Lamps, W. Ackroyd and W. Best, London.
4083. Packing, J. McCulloch, London.
4084. Blouses, F. Williamson, London.
4085. Water Pipes, E. W. Beech, London.
4086. Sight Changes, J. T. Lawrence, London.

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4087. Cycle Rests, W. P. Thompson.—*(D. G. Ross, South Africa.)*
4088. Torpedo Boat Destroyers, &c., J. Donaldson, London.
4089. Preventing India-rubber from Breaking, E. J. J. Ranger, Surrey.
4090. The Briton Cycle Stands, R. Nixon, Prestwich.
4091. Machine for Killing Poultry, C. Groombridge, London.
4092. Mops for Cleaning Purposes, F. N. Ault, Derby.
4093. Decorating Tiles, G. H. Grundy and G. A. Lingard, Derby.
4094. Shirt and Collar Studs, R. Martin, Glasgow.
4095. Preparing Pork, E. W. B. Hobling and W. R. Hawken, Bristol.
4096. Device for Shifting Railway Points, J. Highet, Glasgow.
4097. Sliding Window Sashes, J. Shaw, Willington-on-Tyne.
4098. Safe Deposit Letter Box, G. R. McKenzie, London.
4099. Cycle Bell and Brake, C. Lea, Staffordshire.
4100. Ventilation of Coal Mines, R. Roseby, Whitehaven.
4101. High-pressure Bib Cocks, W. Scriven, Brighton.
4102. Collapsible Umbrella, M. J. Chapman, Hastings.
4103. Method of Stripping Flats, W. Philipson, London.
4104. Controlling Auxiliary Engines, A. Blechynden, Liverpool.
4105. Making Brick Tiles, D. Doyle and T. Farrell, Youghal.
4106. Manufacture of Netting, W. G. Ackerman, Bridport.
4107. Flushing Water-closets, H. Hartley, Staffordshire.
4108. Wheel, W. J. Lloyd and J. W. Hoddell, Coventry.
4109. Tire Repairing Device, D. H. Cox, jun., Glasgow.
4110. Photographic Cameras, H. C. Parkinson, Bristol.
4111. Candlesticks, H. Jelley and J. G. Sills, Loughborough.
4112. Measures for Liquids, A. E. Hancock, Birmingham.
4113. Pulleys for Winding Purposes, T. Gregory, Bristol.
4114. Pneumatic Tires, J. W. Coltman and W. H. Chanter, Bradford.
4115. Bobbins for Spinning, R. Riley and T. Hoghton, Burnley.
4116. Marker for Games, A. R. Knapp, London.
4117. Oil Cans, S. Green, Mossley.
4118. Slate, M. Lavy, Berlin.
4119. Noiseless Flushing Apparatus, A. Eschelbach, Brussels.
4120. Burners for Hand, and Table Lamps, A. J. Stonely, Tonbridge.
4121. Scissors and Shears, B. Belfitt, Sheffield.
4122. Cinder Sifter, A. E. and E. Pearson, Stockport.
4123. Automatic Fire Alarm, A. B. P. Mowat, Liverpool.
4124. Tires, R. Carter, London.
4125. Watch, Card, and Cigarette Cases, J. Bray, London.
4126. Propulsion by Means of Oil Engines, A. G. New, London.
4127. Protecting Tips, F. Kaiser, London.
4128. The Cyclists' Watch and Speed Indicator, H. C. Smith, London.
4129. Eyelet Fasteners, &c., S. Learoyd, Huddersfield.
4130. Printing Presses, T. E. James, W. Porteous, and A. Meunier, London.
4131. Locking Loose Stocks of Anchors, F. A. Dixon, London.
4132. Bicycle Locking Devices, J. R. V. Derveer, London.
4133. Enamel, H. J. Haddan.—*(Patent Leather Protector Company, United States.)*
4134. Metal Polish, H. J. Haddan.—*(L. Bodvis, France.)*
4135. Process for Washing Bones, J. Fels, London.
4136. Driving Mechanism, T. Hann, W. Bromley, J. Price, A. H. Smith, and D. E. Redclyffe, London.
4137. Treating Fatty Acids, A. G. Brookes.—*(H. T. E. Kirkpatrick, Belgium.)*
4138. Fatty Acids, A. G. Brookes.—*(H. T. E. Kirkpatrick, Belgium.)*
4139. Stearic Acid, A. G. Brookes.—*(H. T. E. Kirkpatrick, Belgium.)*
4140. Bleaching Oils, A. G. Brookes.—*(H. T. E. Kirkpatrick, Belgium.)*
4141. Sugar Paint, C. H. Owen, Kingston-on-Thames.
4142. Disruption of Quartz or Gangues, &c., F. Eben, London.
4143. Filters, W. P Thompson.—*(D. F. Maxwell, Canada.)*
4144. Flues, W. Railton, R. Campbell and S. G. Railton, Liverpool.
4145. "Saw Set," H. W. Daws, Shanklin, Isle of Wight.
4146. Wheel Tires, A. J. Boult.—*(J. Hübner, Germany.)*
4147. Rotary Cutting Tools, &c., C. L. Goehring, London.
4148. Gauges, C. L. Goehring, London.

4149. Strengthening the Waists of Boots, A. Harrison, London.
4150. Lamps, D. Calvert, London.
4151. Valves, A. Müller, London.
4152. Sawing Machines, R. Cox, London.
4153. Gas Engine, S. S. Bromhead.—(*A. Niel, France.*)
4154. Machinery Combs, The Rosemount Comb Manufacturing Company and H. T. Worling, London.
4155. Lifting Heavy Bodies, C. C. Longridge and A. A. Suggate, London.
4156. Cooling the Air in Chambers, H. R. Struck, London.
4157. Projectile Fuses, H. V. Keeson, London.
4158. Closing of Jars, F. Joynson and W. Harrison, London.
4159. Engine Valve Mechanism, C. W. Thompson, London.
4160. Ruling Paper on Both Sides, F. Kirby, London.
4161. Reducing Vibration on Vehicles, M. R. Ward, London.
4162. Covers for Hay, &c., J. and G. D. Brendon, Callington.
4163. Impervious Puncture Tire, F. Gray, London.
4164. Cornice Pole Rings, A. B. Reeves, Birmingham.

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4165. Extracting Gold from Ore, E. L. Oppermann, London.
4166. Exhibiting Photographs, &c., H. W. Short, London.
4167. Expanding Cork for Flasks, W. S. Melville, London.
4168. Reproducing Stage Performances, R. W. Paul, London.
4169. Lamps, W. and J. Turner, Rochdale.
4170. Regulating Flow of Gas, T. Kirk and A. G. Johnson, Birmingham.
4171. Refrigerating Chambers, E. T. W. Hall, Derby.
4172. Securing Corks in Bottles, T. W. James, Moseley.
4173. Inspection Chamber for Drains, R. Thompson, London.
4174. Fixing Caps to Electric Lamps, J. A. Sinclair, London.
4175. Switch, J. A. Fisher, Birmingham.
4176. Protecting Plants from Insects, S. Learoyd, Huddersfield.
4177. Shop Windows and Show-cases, S. Learoyd, Huddersfield.
4178. Eyelets and Fasteners, S. Learoyd, Huddersfield.
4179. Vehicles Actuated by Electricity, T. Machin, Birmingham.
4180. Shortening Driving Ropes, S. J. Rivett, Manchester.
4181. Gas Burners, J. Redman, Burnley.
4182. Astronomical Model, H. Wyles, Leeds.
4183. Gas Engines, W. Rowbotham, Birmingham.
4184. Gas Engines, W. Rowbotham, Birmingham.
4185. Bedroom Door Safety, E. Payne, Pembroke.
4186. Tube Stopper for Boilers, E. Henderson, Hartlepool.
4187. Whist Marker, J. Goulstone, Bristol.
4188. Steam Boilers, J. Haythorn, Glasgow.
4189. Oven for Burning Lettering, F. Albrecht, Manchester.
4190. Preventing Derailment of Trains, H. Biermann, Liverpool.
4191. Driving Spindles of Spinning Frames, P. Bazin, Manchester.
4192. Gas Heating and Lighting, A. Morgan, London.
4193. Means for Stoppering Bottles, M. L. Orr, Birmingham.
4194. Machines for "Lapping" Cotton, S. Hulme, Glasgow.
4195. Humidifying of Factories, S. Hulme, Glasgow.
4196. Transmitting Heavy Bodies, J. M. Henderson, Glasgow.
4197. Rotary Gear, W. E. Flint and F. C. Sydney, London.
4198. Cupboard Door Fasteners, W. Hougham, London.
4199. Machinery for Treating Skins, &c., J. Hall, Hull.
4200. Dressing and Polishing Stone, J. M. Ross, Glasgow.
4201. Broom Handles, J. Aspinall, Barnsley.
4202. Securing Broomheads to Handles, J. Aspinall, Barnsley.
4203. Cigarettes, B. Baron, London.
4204. Miniature Toy Shops, E. S. F. Mann, Birmingham.
4205. Means for Playing a Game, T. A. Cooper, London.
4206. Traps for Destroying Rats, G. H. Laxton, London.
4207. Electric Currents, W. Thomson (Baron Kelvin), Glasgow.
4208. Boilers, W. Griffiths and V. C. Read, London.
4209. Damping Adhesive Substances, A. Dawson, London.
4210. Casks, J. T. Trench, London.
4211. Eyelets for Lace Holes, C. Sandez, London.
4212. Saddles, F. W. Mayhew, London.
4213. Cycles, D. Schwarz and G. Luxeder, London.
4214. Posters and Advertisers' Tablets, J. Nadler, London.
4215. Feather Bone, C. B. Weeks, London.
4216. Stiffening Fabric, C. B. Weeks, London.
4217. Differential Speed Governor, S. I. Bird, London.
4218. Infallible Cowl, J. H. Bonehill, near Birmingham.
2419. Pumps, W. D. Hooker and W. Voit, London.
2420. Brushes, A. W. M. L. Keen.—(*A. F. Kinney, United States.*)
4221. Mud or Earth Scoop, J. Eddy, Devonshire.
4222. Globe or Incandescent Burner, W. A. Perry, London.
4223. Buffer Arresters, J. G. Lorrain.—(*J. A. Weber, United States.*)
4224. Deposit Certificates, J. G. Lorrain.—(*C. W. and W. L. Walters, United States.*)
4225. Hydrostatic Power Multiplier, W. Agar, London.
4226. Toasting Fork, H. W. Doudney, London.
4227. Hat Pins, O. J. Jones and M. B. Kerr, London.
4228. Night Commodes, A. and C. E. Lane and C. Watson, London.
4229. Boot, &c., Boxes, T. S. Mason and S. F. Perry, London.
4230. Salvomotive, J. P. Bridgwater, Birmingham.
4231. Pegging Machines, H. H. Lake.—(*Davey Pegging Machine Company, United States.*)
4232. Scutcher Feeding Mechanism, W. R. Buckley, Manchester.
4233. Boots and Shoes, H. H. Lake.—(*F. W. Merrick, United States.*)
4234. Electric Lamps for Vehicles, J. Zimmerman, London.
4235. Coverings of Cycles and Cyclists, B. Ljungstrom, London.
4236. Cycles, S. Hole, London.
4237. Electric Motors, J. Devonshire.—(*E. Thomson, United States.*)
4238. Dynamo Armatures, J. Devonshire.—(*W. H. Knight, United States.*)
4239. Pencils, H. H. Seaman, London.
4240. Coin-freed Gas Meters, R. T. and J. G. Glover, London.
4241. Drying Apparatus, C. G. J. Möller and P. Pfeifer, London.
4242. Making the Front Forks of Cycles, R. W. Smith, Birmingham.
4243. Chain Padlocks, D. Waine and I. Waine, Birmingham.
4244. Chromo-photography, C. D. Ahrens, Hampton Hill, Middlesex.
4245. Gas or Oil Traction Cars, H. P. Holt, London.
4246. Speed Governors for Steam Engines, J. Dow, London.
4247. Apparatus for Visible Signalling, L. Sellner, London.
4248. Tempering of Armour Plates, H. V. Holden, London.
4349. Paint Removing Compounds, W. P. Thompson.—(*C. S. Bailey, United States.*)
4250. Collapsible Boats, M. T. Reade, Liverpool.
4251. Cycle Saddles, S. Bernstein, Liverpool.
4252. Water-tight Revolving Doors, P. Arschauloff, Liverpool.
4253. Compressing and Storing Air, E. C. Nichols, London.
4254. Driving Band Chain or Belt, A. J. Caronni, London.
4255. Steam Engines, H. J. Haddan.—(*The Prosser Steam Engine Company, United States.*)
4256. Jumping Pipes, E. Neumeister and R. Sobotka, London.
4257. Liquid Dispensing Apparatus, W. M. Fowler, London.
4258. Operating Tables, R. Kny, London.
4259. Vehicle Propulsion, E. J. Clubbe and A. W. Southey, London.
4260. Coffee Pots, H. Nicholson, London.
4261. Electrical Lamp, H. J. Dowsing and J. S. Keating, London.
4262. Fish Hooks, F. M. Robinson, London.
4263. Device for a Bottle Neck, C. C. Brown, London.
4264. Cycle Stands, E. A. Lefebre, jun., London.
4265. Cycle Locks, C. H. Reed, London.
4266. Evaporative Condensers, &c., H. J. Fraser, London.
4267. Ladies' Cycling Skirts, W. Fletcher, London.
4268. Vehicles, M. R. Ward, London.
4269. Working Parts of Road Vehicles, M. R. Ward, London.
4270. Artificial Stone Slabs, &c., K. Erdmann, London.
4271. Handles and Handle-bars of Cycles, F. E. Strangward, London.
4272. Bronzing Machines, S. N. Freeman, London.
4273. Window Blind, W. McLaren, London.
4274. Railway Carriages, J. J. Needham, London.
4275. Folding Cards, W. A. S. Hickson and E. D. Ward, London.
4276. Metal Roofing, B. Silbersztein, London.
4277. Tea Pots, Coffee Pots, &c., A. T. Hollely, Sheffield.

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4278. Gripping Power of Pulleys, A. J. Hunter, London.
4279. Sash Holder, J. Webster, J. T. Woodhouse, and F. J. Bramwell, Sheffield.
4280. Permanently-lined Tennis Court, G. B. Willis, Birmingham.
4281. Fountain Penholder, H. Andrews, Birmingham.
4282. Sewer Entrance Covers, W. H. Morgan, Birmingham.
4283. Making Bottles, J. Meadowcroft and W. Meadowcroft and Son, Ld., Halifax.
4284. Surface Condensers of Engines, J. Rhodes, Halifax.
4285. Method of Burning Acetylene Gas, J. R. Wigham, Dublin.
4286. Making Photographic Plates, C. O. Weber, Manchester.
4287. Cycle and Carriage Bracket, G. R. Knight, Southsea.
4288. Writing Tablets for Schools, W. Smithies, Birmingham.
4289. Questioning Machine, H. Newman, Birmingham.
4290. Articles of Jewellery, W. Needham, Birmingham.
4291. Golf Clubs, W. L. Bullows, Birmingham.
4292. Grinding Machines, R. F. and H. S. Pochin, Leicester.
4293. Operating of Churns, H. Gallagher, Glasgow.
4294. Scraping Pipes, H. J. I. Bilton and T. Timmins, Birmingham.
4295. Clock Frames, S. M. A Jeantet, Manchester.
4296. Manufacture of Boots and Shoes, H. Stevenson, A. W. Stevenson, and J. Gerrard, Manchester.
4297. Attaching the Flanges of Warpers' Beams, J. Mills, Manchester.
4298. Sanitary Pipes, C. R. Soar, Derby.
4299. Tool for Splicing Ropes, &c., C. Bottomley, Glasgow.
4300. Articles of Sheet Metal, W. H. Wood, jun., and W. T. Scrivens, Birmingham.
4301. Spouts of Tea Kettles, &c., G. G. Ford, Neath.
4302. Trunk Appliances, E. A. Ricketts, Wolverhampton.
4303. Domestic Baths and Basins, T. B. Ralston, Glasgow.
4304. Combined Bottle Stopper, F. F. Measures and F. Adams, London.
4305. Ventilation of Vans, &c., J. G. L. McLachlan, Glasgow.
4306. Alarm for Prepayment Gas Meters, S. H. Chidley, London.
4307. Hammocks, G. Perry, Birkenhead.
4308. Perambulators, W. D. Rowlingson.—(*F. von Zawalzky, Germany.*)
4309. Boot Trees, O. Stuart and T. H. Ashcroft, Liverpool.
4310. Motor Engines, C. G. Morgan and H. E. Coulson, London.
4311. Tires, H. Godsal, London.
4312. Loom Shuttles, T. Stones and J. Stead, London.
4313. Finding the Pick in Looms, C. W. Parratt and C. Fell, London.
4314. Gas Meters, F. Moore, London.
4315. Form of Propellor for Vessels, G. C. J. Topp, London.
4316. Pegs, A. A. King, London.
4317. Spiral Railways, G. Zahikian, London.
4318. Pipe Cutters, F. Tyers and S. Barnsdale, London.
4319. Foot-pads for Pedestrians, E. H. and A. J. Watson, London.
4320. Eye-glasses, C. Zapp, London.
4321. Combined Belt and Suspender, A. Haynes, London.
4322. Adapting Vehicles to Run on Rails, E. Perrett, London.
4323. Supplying Feed-water to Boilers, E. Petersen, London.
4324. Combined Ruler, E. T. Hughes.—(*E. P. Davies, United States.*)
4325. Air Displacer for Cycles, &c., W. Carr, London.
4326. Armour Plates, J. H. Dickinson, London.
4327. Blotters, J. Temler, London.
4328. Fusing Substances, H. H. Lake.—(*D. N. Maxon, United States.*)
4329. Precipitating Gold from Solutions, W. L. Holms and T. Dobbie, London.
4330. Hand-cords for Staircases, A. Moldenhauer, Liverpool.
4331. Felt Hats, G. Baty and L. Thornley, Manchester.
4332. Water Cocks and Stop Valves, H. Grace, Liverpool.
4333. Joint for Connecting Pipes, &c., T. Crapper, London.
4334. New Toy, T. E. Taylor and J. R. Collings, London.
4335. Fishing Tackle, A. G. Jardine, London.
4336. Non-slipping Boots and Shoes, Z. J. Francis, London.
4337. Driving Gear for Cycles, &c., J. Finlayson, London.
4338. Mechanical Toy, H. H. Fletcher, London.
4339. Knitting Machines, G. F. Grosser and J. Foster, London.
4340. Making Oxygen, G. Munroe and J. W. Kelley, London.
4341. Bracelet Fastening, T. G. Hull, London.
4342. Automatic Guns, H. S. Maxim and L. Silverman, London.
4343. Pneumatic Tires for Vehicles, R. and J. Gibbs, London.
4344. Handle-bars of Cycles, A. J. Boult.—(*C. F. Svendsen, Denmark.*)
4345. Production of Gas, J. H. Dunn and R. G. E. Dalrymple, London.
4346. Pneumatic Tires and Wheels, &c., F. King, London.
4347. Cork Extractor, J. F. O'Brien, London.
4348. Combined Glove and Purse, R. V. Sankey, London.

27th February, 1896.

4349. Charging Cartridges, C. Salmon and H. Bishop, Belvedere.
4350. Imitation Coloured Glass, &c., M. E. Norris, London.
4351. Tobacco Pipes, S. Bott and C. Turner, Birmingham.
4352. Water-tube Boilers, H. McIntyre, Glasgow.
4353. Suspending Trousers to Braces, C. Steer, Bristol.
4354. Two-speed Driving Gear, &c., T. Lambert, Plymouth.
4355. Pneumatic Tires, S. Austin and A. Farnhill, Manchester.
4356. Boiler Tube Stopper, T. Heron and W. Wilson, Newcastle-on-Tyne.
4357. Mud-guards and Chain-guards, W. Liggins, Coventry.
4358. Indicator for Nuts and Screws, H. Ringwood, Dublin.
4359. Steam Engines, J. Holloway, Smethwick.
4360. Hors[illegible]eins Holder, F. Jacks and A. Lazarus, Liverpoo[illegible]

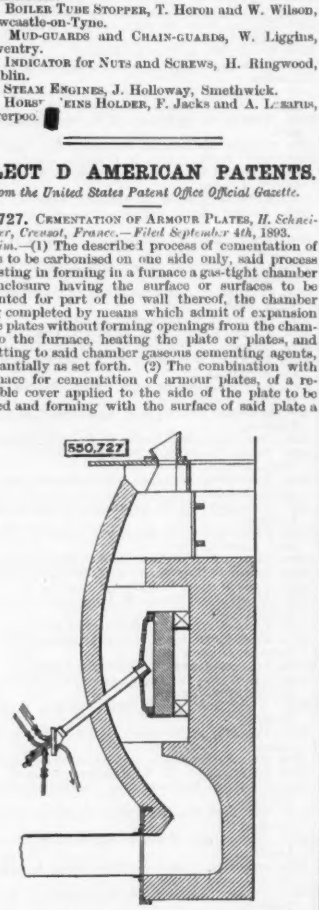
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

550,727. Cementation of Armour Plates, *H. Schneider, Creusot, France.—Filed September 4th*, 1893.

Claim.—(1) The described process of cementation of plates to be carbonised on one side only, said process consisting in forming in a furnace a gas-tight chamber or inclosure having the surface or surfaces to be cemented for part of the wall thereof, the chamber being completed by means which admit of expansion of the plates without forming openings from the chamber to the furnace, heating the plate or plates, and admitting to said chamber gaseous cementing agents, substantially as set forth. (2) The combination with a furnace for cementation of armour plates, of a removable cover applied to the side of the plate to be treated and forming with the surface of said plate a closed gas-tight chamber, and pipes for conveying gaseous cementing agents to and from said chamber, substantially as described. (3) The combination with the cementation furnace, and with the cover or device forming part of a gas-tight cementation chamber in said furnace, of supply and exit pipes communicating with said cementation chamber, and provided with means for regulating the supply and pressure, and with means for preventing deposits of carbon in said pipes, substantially as described. (4) The combination with the cover or device adapted to form part of a cementation chamber, of gas inlet and outlet pipes connected with said cover or device, and a tube or water jacket surrounding said pipes and provided with water inlets and outlets, substantially as described.

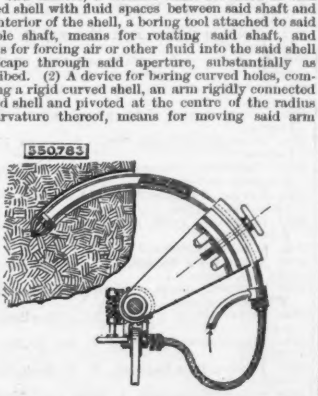
550,727



550,783. Drill for Boring Curved Holes, *R. H. Elliott, Birmingham, and J. B. Carrington, Jasper, Ala.—Filed February 28th*, 1895.

Claim.—(1) A device for boring curved holes, comprising a curved rigid shell, with apertures near the front end thereof, a flexible shaft mounted in said curved shell with fluid spaces between said shaft and the interior of the shell, a boring tool attached to said flexible shaft, means for rotating said shaft, and means for forcing air or other fluid into the said shell to escape through said aperture, substantially as described. (2) A device for boring curved holes, comprising a rigid curved shell, an arm rigidly connected to said shell and pivoted at the centre of the radius of curvature thereof, means for moving said arm about its pivot, a flexible shaft mounted in said shell, a boring tool attached to said flexible shaft and larger in diameter than said shell, and means for rotating said shaft, substantially as described. (3) In a mining drill, the combination with a curved rigid shell, a holder for said rigid shell, pivoted at the centre of curvature thereof, a worm wheel on said holder, and a worm engaging in said worm wheel mounted in said shell, a boring tool attached to the front end of said flexible shaft and larger in diameter than said shell, and means for rotating said flexible shaft, substantially as described.

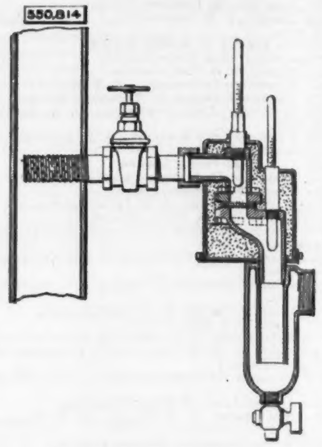
550,783



550,814. Steam Calorimeter, *G. H. Barrus, Boston.—Filed June 14th* 1895.

Claim.—(1) A steam calorimeter comprising a heat measurer or wire drawing device having means for direct connection with a steam service pipe, and a drip chamber or separator attached to the discharge pipe of the said heat measurer, said parts being relatively arranged so that the steam is caused to pass first through the heat measurer and then through the separator, substantially as and for the purpose set forth. (2) A steam calorimeter comprising a heat measurer or wire drawing device having means for connection with a steam service pipe, and a drip chamber or separator arranged to receive the steam after its passage through the said heat measurer, said drip chamber or separator having an adjustable restricted water outlet, and a free steam outlet open to the atmosphere, substantially as and for the purpose set forth. (3) A steam calorimeter comprising a heat measurer or wire drawing device having means for direct connection with a steam service pipe, and a vertical drip chamber or separator arranged to receive the steam after its passage through the said heat measurer and provided with an interior inlet tube extending from its upper end nearly to its lower end, an adjustable restricted water outlet at its lower end, and a free steam outlet open to the atmosphere at its upper end, as set forth.

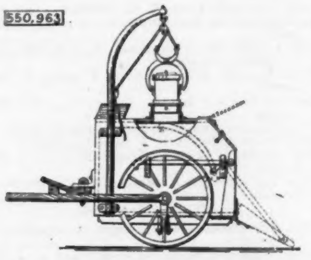
550,814



550,963. Apparatus for Removing Garbage, *W. Goetz, New York, N.Y.—Filed February 2nd*, 1895.

Claim.—(1) An apparatus for removing garbage, comprising a wagon body formed in its upper part with a receiving spout, a davit made in two parts, of which the lower part is rotatively mounted in a vertical position on one side of the wagon body, and provided with bifurcations at its upper part, and the upper part is pivoted at its lower end between the lower portions of the bifurcations of the lower part of the davit, and adapted to be folded down sidewise against the side of the wagon body, and means for holding the upper part of the davit in an erect position when in use, substantially as described. (2) An apparatus for removing garbage, comprising a body having a receiving spout in its top, a slide extending across said spout below the top of the same, and adapted to be removed through an opening in the side of the spout, a box having an open lower end and provided with a projecting exterior flange adapted to rest on the upper edge of the receiving spout, doors hinged at opposite sides of the open lower end of the box, and adapted to fold centrally to close the same, the ends of said doors being arranged to overlap when closed, and a pin removably arranged across said box below said overlapping portions of the doors, and adapted to support the doors in their closed position, substantially as shown and described.

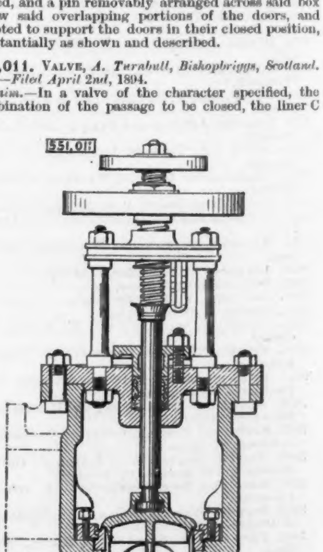
550,963



551,011. Valve, *A. Turnbull, Bishopbriggs, Scotland.—Filed April 2nd*, 1894.

Claim.—In a valve of the character specified, the combination of the passage to be closed, the liner C fitting in said passage and forming a valve seat, and the connections for securing the liner in position, consisting of the fixed lugs E, bolts D, nuts F, and ring *c*, formed on the liner, substantially as and for the purposes set forth.

551,011



RAILWAY ECONOMICS.

No. I.

In the recently published report of the delegation organised by the British Iron Trade Association to visit the Continent, the conclusion arrived at with regard to British and Foreign railway rates is expressed in the following terms:—"Undoubtedly the greatest factor in favour of the foreign producer is the much larger cost of carriage in this country." That such is a fact there is little doubt; and it is probably equally true that this arises from causes which are altogether beyond the control of the railway companies in the United Kingdom. Comprised as they are of a large number of different companies keenly competing for the carriage of the raw materials and manufacturing products, it would indeed be strange if they did not frame their rates on as low a scale as possible, consistent with remunerative business. It will be conceded on all hands that railway companies exist as commercial, and not as philanthropic enterprises; and that the investors in such enterprises are at least entitled to a reasonable return for their expended capital. Here comparison with many continental railways ceases; as, in the case of the latter, State aid and relief are given in various ways, whilst in this country no assistance is in any degree afforded, if we except the contributions towards the light railways of Ireland, which are of so trifling a character that they may be ignored.

It has probably never yet been stated that the railways of this country are not worked as economically as those on the Continent or in America, or that British engineering and administrative skill have to rank as one whit inferior to that of any foreign country. For the purpose of seeing how the financial returns of the United Kingdom stand, we have made a comparison based on the figures supplied by the Board of Trade in July last for the year 1893, as far as they relate to those countries entering strongly into commercial competition with this country. It may be urged that the result in 1895 would be more satisfactory for the United Kingdom, but the increased receipts of to-day are so nearly balanced by the additional expenditure which has had to be incurred, that for all practical purposes matters exist much as they did in 1893.

The progressive development of manufacturing industries has not been confined to one country, and the consequent increased transport receipts may be considered as common to all. If it be admitted that an equitable return should be forthcoming for invested capital, that the working expenditure is judiciously and economically controlled, and if it is found that the dividend result is not higher in the United Kingdom than on the Continent or in America, it would appear that the rates and fares which produce the British receipts are not higher than they should be, having regard to the conditions under which the railways have been established and worked in the various countries. It would be much more satisfactory if the relative earnings of passenger, goods, and mineral traffic could be separately compared; but this is not possible, for, whilst particulars of the separate receipts are obtainable, there are no available data for determining the expense of collecting, hauling, and distributing each class of traffic. The continental railways which have been taken for comparison are Norway, Sweden, German Empire, Saxony, Wurtemburg, Baden, Bavaria, Holland, Belgium, France, and Switzerland, and these are placed side by side with those of the United States and the United Kingdom.

From all that has been frequently reiterated, it would be expected that in the percentage of net receipts to the cost of construction of the several railways, this country would rank amongst the highest; but it is found that, whilst in the United Kingdom it was only 3·6, in Europe generally it was 3·87, in the German Empire 4·34, and in the United States 4·9, and that in Belgium, of which so much has been said and written, the percentage was 4·52. This result clearly demonstrates that British railways have been seriously handicapped by their cost of construction, which per mile of railway was in the German Empire, £20,358; Holland, £22,864; Belgium, £26,611; France, £27,375; or for Europe generally, £21,666, against only £11,343 in the United States, and the high figure of £47,047 for the United Kingdom. It may be contended that much of this abnormal outlay should have been saved, but the money has been raised and circulated here, and has been and continues to be available for the development of other industries, for the carriage of whose traffic a high tariff has become imperative.

The whole tendency of our Imperial and municipal legislation has continuously been in the direction of increased working cost; and the safety, convenience, and expedition of passengers and goods have been amongst the first considerations, not only of the Board of Trade, but of the executive officers of the various railway companies. The vexed question of terminal charges was much in evidence in the recent Railway and Canal Act inquiry, which showed how largely the convenience of the manufacturing public had been considered in this country; and whilst no statistical comparison can be shown as to the relative expenditure for warehouses, crane power, and freight sidings in the United Kingdom with that of the Continent or in America, there is abundant ocular demonstration that in this respect the capital outlay for British railways in this direction has been well to the front. The earnings of any railway company, whether here or elsewhere, primarily rest with its locomotive power; and it will hardly be asserted that modern British locomotives are not equal in haulage efficiency to those on any foreign railway. But even with the higher rates for carriage ruling here, the gross earnings per locomotive per annum is only £4471 in the United Kingdom, against £4358 in the German Empire; whilst in the United States, with longer-paying distances, slower speeds, and consequently heavier-paying loads, the earnings per locomotive per annum are £6992.

Still keeping in mind the higher British rates, it is instructive to find that the earnings of the total rolling stock per vehicle per annum are yet less in this country than elsewhere, the receipts being for the United Kingdom, £123, for the German Empire, £200, and for the United States, £210. The greater carrying capacity of many of the American vehicles explains the high earnings of that country, but the close approximation of the earnings of the German vehicles clearly proves how fully loaded they must have been, compared with the partially loaded vehicles on the lines of this country. Incidentally it may be remarked that much of the success of any development of the proposed light railways for this country will largely depend upon the co-operation of those farming and other industries, in whose interest they are projected, in ensuring as far as possible full loads for each vehicle which is hauled, thereby not only reducing the capital outlay in the provision of rolling stock, but in a still greater degree lessening the working charges incurred in the hauling of trains in which the tare weight of any wagons is double or treble its net or paying load.

The prompt despatch of the partially loaded wagons of the goods of an individual consignee, whilst of considerable advantage to the trader, can only be met by the multiplication of trains, which not only increases the hauling but the marshalling and shunting charges; and this is seen by the number of miles of railway to each locomotive, which in the United Kingdom is only 1·14 miles, against 1·72 in the German Empire, and 4·87 in the United States. Reversing this order, and considering it from the number of miles run by trains over each mile of railway, the necessity for the expenses of train shunting in this country is still more marked; for, whilst in the United States the miles run were only 5069, and in the German Empire 7775, they reached in the United Kingdom a total of 15,637 miles. In consideration of these various points, it is open to question whether the existing rates for conveyance on British railways can, consistently with the lawful interest of their varied ownerships, be brought to a much closer approximation with the charges prevailing on foreign railways, with which their initial expenditure and rolling-stock earnings have been compared.

CORDITE.

Cordite is an intimate mixture of nitro-glycerine, gun-cotton, and mineral jelly, or vaseline. The thorough blending of the two main ingredients is promoted by the addition of acetone, a substance in which both are soluble, during the process of incorporation. The mineral jelly acts merely in the way of restraining the violence of explosion, and serves also to produce a little smoke, which acts usefully as a lubricant to the bore of the gun. The curious effect of the intimate mixture of nitro-glycerine and gun-cotton is to modify their characters and properties altogether. The former substance is an unstable liquid, which decomposes with explosive force on account of the mobility of its molecules; while dry gun-cotton behaves in the same manner because of its highly porous nature, which permits ignition to take place almost simultaneously throughout its mass. Cordite, on the other hand, is a horny substance, which burns only on the surface even under the severe heat and pressure obtaining in guns, as is demonstrated by the fact that partially consumed cords, blown out of guns, retain their shape though reduced often to extreme tenuity. The consequence of this property is that the rate of explosion can be regulated by varying the proportions of surface to volume; thus cords of smallest diameter burn more quickly than the larger sizes, and by slicing up the material into very thin discs, and omitting the vaseline, explosion, having almost the rapidity of detonation, can be produced. It thus becomes easy to adapt cordite to any nature of gun. The service pistol, for example, takes cords of ·01in. diameter, cut to short lengths, forming, in fact, a fine powder; while the new 12in. wire gun takes bundles of cords ½in. in diameter and 14in. long.

Like nitro-glycerine and gun-cotton, cordite is sensitive to heat and light. Exhaustive experiments have shown that it is not expedient to expose it constantly to a higher temperature than 100 deg. Fah., although it suffers no change if occasionally heated as high as 130 deg. Fah. Long exposure to temperatures above 100 deg. Fah. leads, however, to no danger, but may occasion a very slow decomposition of the material, an effect which will show itself in the ballistics obtained from the guns it is fired from; but no change of this nature has as yet been actually observed. The finer the subdivision of the explosive, the more susceptible it naturally is to heat.

Experiments carried on during a whole winter in Quebec have demonstrated that the ballistics are not affected by extreme cold; but experience, even in this country, shows that cordite transferred suddenly from a very cold room into a warm one, will occasionally extrude a minute portion of its nitro-glycerine, which appears as a very light dew upon its surface. But this exudation is gradually reabsorbed as the material gets warm; and in any case it is not a source of danger, nor does it affect the shooting qualities of the material.

Prolonged trials in India have also demonstrated that cordite does not suffer from exposure to the extreme temperatures of a tropical climate, and as magazines can always be arranged not to have a temperature higher than 100 deg. Fah., there seems to be no reason why large quantities should not be stored for a considerable number of years. The occasional exposure to much higher temperatures in the pouches of the soldiers, and the limber boxes of the guns, does not produce any deleterious effect. Direct sunlight quickly turns cordite into a very dark-coloured substance, and diffused light has the same effect only after very much longer exposure. Direct light causes slow decomposition; but sticks exposed for several years to diffused light, though very much darkened in colour, show no measurable chemical change. Owing to the total absence of dust, cordite is a remarkably safe explosive to manipulate. It can be exploded by a severe blow, as, for instance, by striking with a hammer a cord laid on an anvil; in such case the portion immediately under the hammer explodes, but the explosion is not communicated to the cord on both sides of the hammer.

When fired in the open, or even when enclosed in the 100 lb. service cases, it only burns with a fierce flame even when in considerable masses. Thus, a bonfire made round eight cases piled up against each other only fired the contents of the boxes in succession as the wood of the boxes burned away, and not only was there no explosion, but the lids of the boxes were merely forced open enough to let the products of combustion escape. Again, a temporary magazine in which two tons of cordite were distributed on reticulated shelves was kept at 100 deg. Fah. a fortnight and then fired. There was no explosion. The slate roof was lifted off by the rush of gas and deposited on the ground beside the building, no more injured than would be accounted for by its fall; the windows in the brick gables were not broken, and the door had to be unlocked to give access to the firemen.

There is, indeed, some difficulty in igniting cordite even when it forms the charge of a gun, and primings of gun-cotton or black powder have to be used in the case of cannon, while in small arms the percussion caps have to be charged with composition which will give a good flash. When, however, the priming is sufficient, misfires and hangfires are rare.

The volume of the chamber of a gun compared with the weight of the charge is a matter of great importance. On account of the relatively large volume of gases given out and their high temperature, compared with the products of combustion of black powder, the density of the charge must be much less. Solid cordite measures 17¾ cubic inches to the pound, and if fired in a chamber of that capacity would give a pressure of at least 120 tons to the square inch, which would, of course, be destructive to any gun. If a density of 54 cubic inches be assigned, as is the case in some of the larger quick-firing guns, a pressure of 40 tons to the inch might be realised, and is nearly the maximum which can be obtained with black powder; whereas, if, say, 100 cubic inches to the pound be the density, as is the case in many guns, the pressure can never rise above 20 tons to the inch; consequently it is found that in guns with high density charges the pressure and velocities are much affected by climatic changes, and by the conditions of the bore and of the shot. But even under such unfavourable conditions of density, the regularity of shooting is quite equal to that obtained with black powder.

The diameter of the cords is proportioned to suit the bore of the gun, the capacity of the chamber, and the length of travel of the shot. Up to the present the sizes made range from ·01in. diameter for the service revolver to ·5in. diameter for the new 12in. naval gun.

With respect to erosion, it may be said that it certainly is not greater than that arising from the use of black powder, and it is of a much more favourable kind. Black and brown powders scoop out and plough rough, irregular channels in the bore, whereas cordite appears to wash away the surface in a uniform manner. This effect is probably due to the absence of solid or liquid particles in the products of combustion, and to the presence of a large proportion of carbonic oxide at a high temperature. The erosion extends for only a few calibres along the bore, and owing to these circumstances expanding gas checks on the driving bands of the shot enable the gun to shoot well longer than when powder is used. It should be borne in mind also that the ballistics obtained by the use of cordite are very much higher, as a rule, than with black powder; in the case of the 12in. naval gun, for example, the energy imparted to the shot is 1·8 times greater than in the old service gun, consequently increased wear must be expected.

The manufacture of cordite is extremely simple. The nitro-glycerine and the dried gun-cotton are mixed together in accurately weighed proportions. The liquid is poured over the gun-cotton, and mixed with it by hand till the nitro-glycerine is completely absorbed, and the resulting mass looks like a quantity of dirty white moist sugar. This mass is then placed into kneading machines with a proper proportion of acetone, and is incorporated for three and a-half hours, when about 5 per cent. of vaseline is added, and the kneading continued for another three and a-half hours. The mass then becomes a stiff dough, not unlike raw Jamaica sugar in appearance, and about the same colour, and is ready for squirting into any size or form that may be needed, for unlike the old powders, the composition of cordite is the same in every variety of size produced.

The squirting machines consist simply of vertical cylinders of various sizes, into which the dough is placed. They are fitted at their lower ends with one or more removable dies, and provided with pistons actuated by screws or by hydraulic cylinders. In the former case the pressure of the screw is transmitted through a hydraulic cushion which gives the means of noting the pressure and also of relieving it when excessive. For the small sizes used in rifle ammunition, the cords are wound automatically as they issue from the dies on to reels holding about 1 lb. each, these are blended together in tens on to a single reel, and six of the latter are combined on one reel, from which the sixty strands are fed into the cartridges. The larger sizes are either wound by hand on to reels, whence they are cut off in lengths, or they are delivered by the press on to an endless band to which knives are fastened at the required distances. The cord lies over the knives, which passing under a small roller cut through the cord, and leave it ready to be picked off by boys, and arranged in shallow trays. The small-arm reels and the trays of cut cord are placed in stoves, in which they are dried by exposure to currents of air warmed up to 100 deg. Fah., and in this process all the acetone is driven off. When dry the cut cords, like the cordite on reels, is blended so as to make uniform samples.

The danger of the manufacture is confined to the production of the nitro-glycerine and the drying of the gun-cotton. As soon as the two explosives are mixed together they appear to be incapable of explosion, except when confined in a gun. At Waltham Abbey, some years ago, a gun-cotton drying stove caught fire, from some cause which has never been ascertained, as there was no one near it at the time. The material was perfectly dry, for the stove was just going to be emptied, yet there was no explosion and no one was hurt; the fire was, however, exceedingly fierce, and any one in the stove would certainly have been destroyed. The accidental explosion of a large quantity of nitro-glycerine, though attended with lamentable loss of life, also showed that the damage done was very local, apparently much more so than the destruction which a corresponding quantity of black powder would have produced. We have very little doubt but that fuller experience will show that our War Department has made a wise selection in adopting cordite as the explosive best suited for our guns.

MECHANICAL ENGINEERS' ESTIMATING.

In these days of competition and mechanical progress engineers' estimating—especially with firms of moderate size manufacturing stationary engines and boilers for land use—is not the comparatively simple matter it used to be in days gone by. Then if a customer wanted, say, an 8-horse power portable, he said so; and it did not require very much knowledge on the part of a clerk to pick the correct price from the firm's price list, and send a quotation. If the inquiry was not quite so straightforward, the partners talked the matter over at their leisure; perhaps consulted one or two of their foremen, and a price was arrived at without going into any very abstruse calculations over the matter. We have even heard that in cases where the machinery required was of anything like a special nature, it was not always the custom to quote a price beforehand; but the purchaser had to wait until he received an invoice worked up from the actual cost, after delivery of the goods. This was no doubt a very sensible, if not a very satisfactory, mode of procedure, but, for all that, would hardly satisfy present day customers.

These methods are no longer in vogue; they have been found inadequate. Inquiries of the 8-horse power portable nature are in the minority, and are not thought so much of as they used to be; whilst those requiring careful consideration and long calculations represent the greater portion of modern work. It is only necessary to read through a printed official specification for the electric lighting of some town or district, with the numerous schedules and conditions attached, to get some idea of what modern engineers' estimating is, and to realise the responsibility that rests with the estimating clerk.

It will be inferred from the foregoing that an estimating clerk, if he wishes to get on, and to discharge his duties well and quickly, which latter qualification is most essential, must, besides his commercial training, have a very fair technical knowledge, and be thoroughly well acquainted with the construction of the machinery turned out by the firm he happens to serve. He must also be able to read drawings, and run out quantities from them; and in short, exemplify the somewhat unique combination of an engineer, a draughtsman, and a commercial man well versed in all the wily ways of the mercantile world. In many cases the estimating clerk has in addition, the responsibility of inditing and supervising the specifications sent out with his estimates, so that he must be able to describe correctly and concisely the machinery for which he is tendering.

As regards the system of estimating, and the books kept in connection therewith, no precise rules can be laid down. This will depend upon the nature and extent of the work turned out, and upon various other considerations. However, a few general remarks on this point may be useful. It is a very convenient thing to have two separate estimate books running at the same time; one a general book, in which all estimates made upon the basis of charging prices taken from standard price lists are entered; and the other a special book, in which are booked such estimates as are worked up from the prime cost of materials and labour. Of course a note should be made in the general of all entries in the special book for convenience of reference, so that the former will serve as a daily record, or journal, of all estimates submitted.

The following example of the working of this system will make matters clear:—Suppose a compound vertical engine of 200 indicated horse-power is being quoted for; and presuming it is a standard engine, for which there is a fixed charging price, or, at any rate, so near a standard size that a charging price can be arrived at by comparison, the entry would take something like the form of the tables in the next column.

The entry in the special book would be of a more complicated nature than in the case of the vertical engine. To begin with, the heading of the estimate should contain all the principal particulars of the boiler, including heating surface, grate area, thickness of plates, &c., for future reference; then would follow a list of all the materials used in the boiler, such as plates, rivets, angles, bars, tubes, &c., with the weight appended to each item of the list, with the exception of the tubes, against which should be placed the total length required. The costs of these would be run out at so much per ton or per foot run, giving the total cost of materials used in the boiler; the cost of making would then be added, and finally the cost of the fittings and cost of putting them on. The total estimated cost in the shops would thus be arrived at, and the estimate completed by adding for trading expenses, cost of carriage, and last, but not least, the profit.

On whatever system the book-keeping of the estimating department is carried out, it should be one giving every facility for ready reference. The estimating clerk will find it very convenient to have two indices to his books, one for the names of the firms quoted, and the other wherein to note any special machinery the price of which might be useful to him for future estimates. As an example, suppose a quotation is sent to Jones and Co. for a triple expansion vertical engine of unusual size; then in the first index under J the name of the engineers would be indexed, and in the other, under S, would be noted the size of the engine in question, with reference to the page where the estimate would be found. This will, no doubt, appear a small matter, but when all his books for years past are indexed in this manner, the estimating clerk will find them wonderfully useful works of reference when getting out fresh estimates.

1895.

Dec. 2	Brown and Co., Ld., Hull.	Rate.	£	s.	d.	£	s.	d.
	One compound vertical engine, 15in. and 26in. by 24in., 200 I.H.P., 100 revols., 130 lb. initial, condensing, fly-wheel 12ft. diameter, outer bearing		—	—	—			
	Jet condenser and air pump, driven by means of rocking levers from L.P. crosshead ..		—	—	—			
	Speed counter and driving gear		—	—	—			
	Grooving fly-wheel for five 1¾in. diameter ropes, at per groove		—	—	—			
			—	—	—			
	Less trade discount		—	—	—			
			—	—	—			
	Cost of delivering f.o.b. London		—	—	—			
	Packing for shipment		—	—	—			
	Total of tender				£	—	—	—
	Terms of payment							
	Time named for completion of order							

The next entry might be as follows:—

1895.

Dec. 3	Robinson and Co., Liverpool.							
	One marine return-tube boiler, 7ft. diameter by 7ft. 6in. long, 160 lb., Lloyd's rules. For details see page 300, Special Estimate Book No. 8				£	—	—	—
	Terms of payment							
	Time named for completion of order							

It is more usual to work up boilers in detail than engines, for the simple reason that the quantities of a boiler can be readily run out from a drawing, and the cost of manufacture is easily got at, being practically confined to one shop; whereas in the case of an engine, the drawing will take a considerable time to prepare in the first instance, and getting out the quantities and cost of making is no small business, on account of the variety of materials used, and the number of shops through which an engine has to pass. When time is short—and this is more often the case than not—it will be found very useful to take the prime cost of similar machinery and see how much it runs out at per ton; then estimate as near as possible by comparison and judicious use of the rule-of-three the weight of the new work, and run out at the same or a proportionate rate. It is necessary, however, to be very careful, especially in estimating for engines in this way, as some extra fittings or difference in design may easily make the cost of the engine taken as an example come out considerably more per ton than it would in the ordinary way. The estimating clerk should make it a rule to compare his estimated prices as often as possible with the prime cost. No matter how carefully or at what length an estimate has been prepared, it can never be taken as a perfectly sure precedent; while the prime cost being based on hard fact, and not conjecture, is generally a pretty sure point to start from.

There is another matter well worthy of consideration, especially in these days of specialities in steam fittings, metallic packings, steam traps, and such like; and that is, the estimating clerk will find it necessary to have by him a large quantity of price lists in order to be able to deal at once with inquiries comprising some such speciality. Now, even a moderate collection of lists of the nature above referred to means a good deal of paper, and, if not arranged according to some system, the lists are practically useless for ready reference. A set of pigeon holes in which they can be placed in alphabetical order, will be found useful; and a scrap-book, in which the more commonly used lists, say, of pulleys, belting, tubes, &c., can be pasted, will be found most convenient. In this book each list should of course be numbered and indexed for easy reference, and any notes concerning same could be made on the blank pages.

Besides his systematically arranged tables of prices, which are a *sine quâ non* to him, the estimating clerk should have a properly arranged dimension book, with all possible details and dimensions of the machinery made by his firm. He should leave ample space in this book in which to note results of engine and boiler trials, particulars of special machinery manufactured, and a thousand-and-one little details, which are sure to be of use some time or another; for although the estimating clerk is not in the ordinary course of things called on to decide upon technical matters of moment, yet he very often has to settle technical details of less importance, and he can never tell, when, through the absence of some of his chiefs, he may be called upon to give his decision in matters of consequence.

Finally, it will be seen that the post of estimating clerk is a very responsible one, as on him depends to a great extent whether the firm obtain orders or not, and if obtained, whether sufficiently profitable or not. In fact, the success of a growing firm of engineers will often depend to a considerable degree on the ability and knowledge of the man who rules the destinies of their estimating department.

THE PADDLE STEAMERS KONINGIN WILHELMINA, KONINGIN REGENTES, AND PRINS HENDRIK.

The Fairfield Shipbuilding and Engineering Company, Limited, of Glasgow, has recently built and engined the three above-named swift steel paddle steamers for the Zeeland Steamship Company, to take part in that company's admirable passenger service between Queenborough and Flushing. Our illustrations show in elevation and plans the form and arrangements of these fast and commodious steamers, as well as the general appearance of their powerful engines, as viewed from the after-end of the engine-room.

The principal dimensions of the Koningin Wilhelmina and her two sisters are 320ft. by 35ft. 6in. by 24ft. deep to the uppermost or awning deck. The hull is in each case carefully subdivided into water-tight compartments by eight steel bulkheads efficiently stiffened, which extend to the main deck, as well as several other bulkheads reaching as high as the lower deck. Ample provision has, therefore, been made against such a contingency as one or more compartments being penetrated by collision. The materials in the structure have also been most judiciously distributed in order to provide the greatest strength where it is most needed and to have a sufficiency everywhere. All the supports to engines and boilers have been given the form of continuous longitudinal girders, and by effectively incorporating them with the framing and plating of the hull proper they have been enabled to form the double purpose of keelsons and of engine and boiler bearers. Special attention, too, has been given to the construction of the massive entablature supporting the crank shafts, which is attached to a thick transverse bulkhead, and supported by a series of vertical girders that act as web stiffeners to the bulkhead. In view of the great engine power this was a wise arrangement, and the massing of so much material at that part of the vessels has been amply justified by the freedom from vibratory movement experienced when running at their highest speeds.

Of course, the Fairfield Company had the advantage of considerable experience of the Zeeland Company's requirements, having previously contributed no less than seven steamers to its excellent fleet. It happens that for a considerable fraction of the total distance of 110 knots separating Queenborough from Flushing the steamers are in shallow water, and consequently the resistance to fast steaming is greatly increased at that part of the route. The drag upon a vessel in shallow water is, of course, so great that it practically fixes a limit beyond which fast steaming is impossible. The object in view with these vessels was to cover the 110 knots in about six hours; but to do this it became necessary to attain, if possible, a speed of 21 knots in the deep water of Wemyss Bay, where the preliminary trials were run. The builders were so far successful in their efforts that in each case the 21 knots were slightly exceeded, the mean result being about 21¼ knots per hour. With this deep-water speed in them, the vessels have been enabled to fulfil their requirements on the Queenborough and Flushing route.

As will be seen by our illustration, the engines supplied to these vessels are triple expansion, diagonal, surface condensing, and their three cylinders are placed side by side to work a three-throw crank shaft. They are, in fact, the most powerful triple expansion engines fitted to any paddle steamer yet afloat. The Zeeland Company adopted this style of engine in the new vessels with a view to maintaining the reputation they already enjoyed among the travelling public for affording smooth and easy motion without vibration when running at a high speed, and at the same time to secure economy of fuel consumption. The cylinders are 51in., 75in., and 112in. in diameter, with a 78in. stroke. The high-pressure cylinder has a piston valve, while the intermediate and low-pressure cylinders each has a flat slide valve, all being worked with the usual double excentrics and link motion valve gear. Both the crank and paddle shafts are of mild steel manufactured by Sir Joseph Whitworth and Co., the crank shaft being connected to the paddle shaft by flanged couplings and bolts. Between the cylinders and the supports for the crank shaft the condenser is placed, which is of cylindrical form and constructed of boiler plate, the necessary condensing water being supplied by a large centrifugal circulating pump worked by two independent steam engines. A feed heater, feed filter, an evaporator, and all other such modern appliances are also provided in the engine-room. The starting and reversing of the main engines is effected by a steam and hydraulic reversing engine. The whole of the paddle-wheels, including the floats and feathering gear, are of Siemens-Martin steel, and the floats are formed with a curved surface.

There are two stokeholds in the vessels, one before and one abaft the engines. In each stokehold there are three large single-ended boilers of the ordinary "Scotch" type, and fitted with forced draught. As each boiler has four furnaces, there are consequently twenty-four furnaces in the vessel. The working pressure is 170 lb. per square inch, and the horse-power upwards of 9000 indicated.

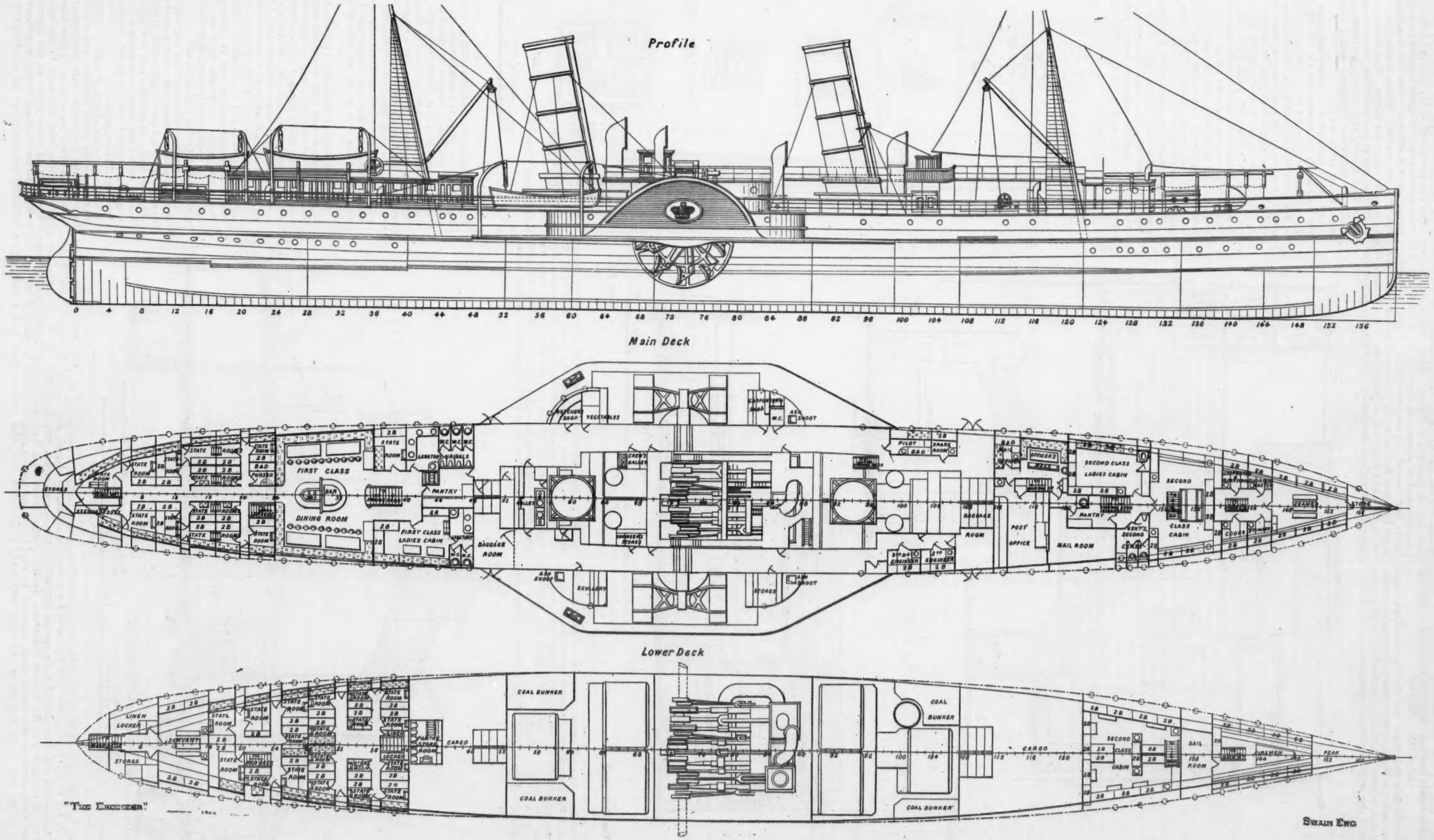
Being for cross-channel passenger service, and intended for a run of about six hours, one would suppose that the accommodation provided would for the most part be that of a daylight trip. This is to some extent the case; but, nevertheless, the state rooms afford sleeping accommodation for 180 first-class passengers and 72 second-class, the former being berthed at the after, and the latter at the fore part of the vessel. The full accommodation for passengers is provided on three decks. At the after part of the uppermost deck is a large deckhouse, at the middle portion of which is a spacious entrance for first-class passengers, this part being framed and panelled in teak and maple. A very large state room, framed and panelled in mahogany of different shades of colour, and most elegantly fitted, with a view to being used by distinguished or titled personages, communicates with this entrance, as also do four deck cabins. The remainder of the after deckhouse contains the smoking room, two deck cabins, and the "well" for light and ventilation to the dining saloon. The upper deck entrance opens to a large stairway leading to the main deck, where are situated the dining saloon and the ladies' cabin. The former is framed in mahogany and satinwood, the panels being pictures specially painted for the purpose by Dutch artists. The ladies' cabin has panels of lincrusta-walton, with framing coloured in delicate tints. A corridor extends aft from the dining saloon, framed and panelled in teak and maple, having passages on each side leading to the first-class sleeping cabins, the most of which are situated here and immediately below on the lower deck. At the forward part of the upper deck is another deckhouse, having an entrance which leads to the second-class accommodation, consisting of a dining saloon and ladies' cabin on the main deck and an apartment on the lower deck fitted up with berths or sofa beds.

On the starboard side of vessel forward are built a large mail-room and post-office, the latter being fitted with sorting table, racks, and pigeon-holes complete, for the sorting of letters *en route*. An adjacent apartment is provided for the mail officer. Everywhere in the vessel provision is made for heating with steam, and the details for ventilation have been most carefully and satisfactorily attended to. It need hardly be said that there is also an installation of electric lighting provided. Hold space is provided for cargo, and steam winches fitted for loading and discharging the same. Steam pipes for extinguishing fire are fitted in the holds. Both hand and steam steering gear are provided, also a steam capstan windlass forward, and a steam wharfing capstan aft. Six boats are hung in the davits, and all the other life-saving appliances provided, as required by our Board of Trade. The vessels have been specially surveyed during construction by Lloyd's surveyors for the A1 class for Channel service.

PADDLE STEAMER KONINGIN WILHELMINA

THE FAIRFIELD SHIPBUILDING AND ENGINEERING CO., GOVAN, BUILDERS AND ENGINEERS

(*For description see page 256*)


Profile
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84
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96
100
104
108
112
116
120
124
128
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136
140
144
148
152
156
Main Deck
STORES
STATE ROOM
FIRST CLASS
DINING ROOM
BAR
PANTRY
LAVATORY
URINALS
W.C.
FIRST CLASS LADIES CABIN
BAGGAGE ROOM
BUTCHER'S SHOP
VEGETABLES
CARPENTER'S SHOP
ASH SHOOT
SCULLERY
STORES
CREW'S GALLEY
ENGINEERS' STORES
PILOT
SPARE ROOM
BAD
2ND ENGINEER
3RD ENGINEER
BAGGAGE ROOM
POST OFFICE
OFFICERS
SECOND CLASS LADIES CABIN
PANTRY
MAIL ROOM
SERV'T'S SECOND CLASS
SECOND CLASS CABIN
COOKS
STEWARDS
FIREMEN
STORE
Lower Deck
LINEN LOCKER
STORES
SERVANTS
STATE ROOM
LOCKER
PANTRY STORE ROOM
CARGO
COAL BUNKER
COAL BUNKER
COAL BUNKER
COAL BUNKER
CARGO
SECOND CLASS CABIN
SAIL ROOM
FIREMEN
PEAK

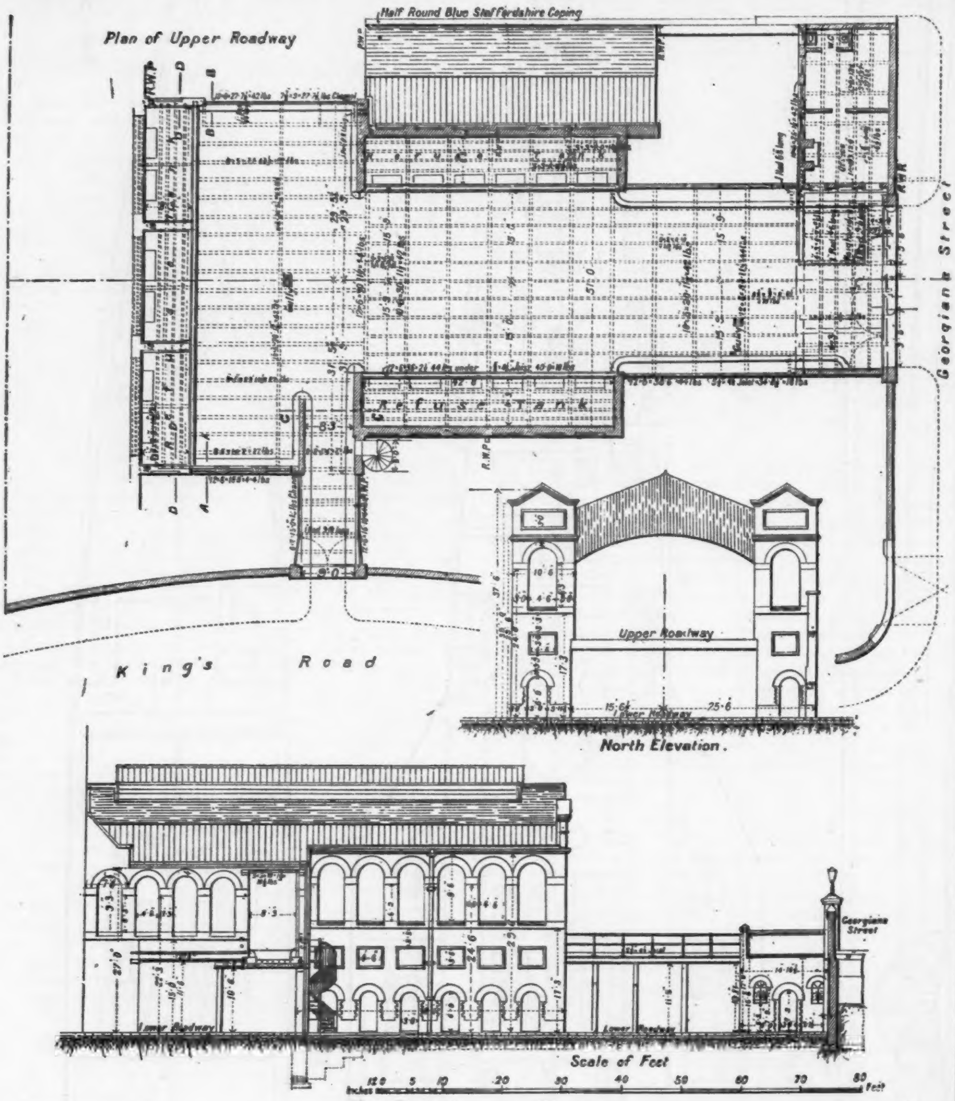
"THE ENGINEER"

SWAIN ENG

ST. PANCRAS ELECTRIC LIGHTING.

THE KING'S-ROAD REFUSE DESTRUCTOR AND ELECTRIC LIGHTING STATION.

During the last two years the St. Pancras Vestry have been constructing at King's-road, Camden Town, works which have a special interest to municipal authorities, as they combine two of the most important operations which devolve upon local authorities, namely, the destruction of dust-bin refuse and the generation of electricity for public supply. The works are erected on the same site, and the two operations can be carried on either in conjunction with one another or quite independently.



"The Engineer" East Elevation Fig 1. Swain Eng.

The question of the disposal of the dust-bin refuse in St. Pancras by means of destructors was under the consideration of the Vestry as far back as the year 1876, and for several years the matter was investigated by a special committee under the chairmanship of Mr. Nathan Robinson. In 1891 the late chief surveyor, Mr. Booth Scott, reported to the Vestry on the cost of the disposal of the refuse and road sweepings during the preceding ten years, and in that year the proposals that had been often made that the Vestry should take into its own hands the disposal of the refuse of their district assumed a definite shape, and a committee was authorised to proceed on those lines. At this time the Vestry had carried out an installation of electric lighting under Professor Robinson—as illustrated in The Engineer, vol. lxxiii.—who suggested, in view of the large demand for electricity throughout the district, that a combined electricity and refuse destructor station could with advantage be carried out for the purpose of utilising the waste heat from the destructors in connection with the boilers to generate electricity. Professor Robinson and Mr. Wm. Nisbet Blair—the then newly-appointed borough engineer—recommended early in 1893 the carrying out of a joint installation at King's-road, and a special committee — of which Mr. Dixon was the chairman — advised the Vestry to adopt this recommendation, and it was approved, a special committee being appointed to carry it out, of which Mr. Lamble was chairman. In this connection mention should be made of the late Mr. T. Eccleston Gibb, who, as vestry clerk, took a leading part, both in supporting this scheme as well as in preserving the supply of electricity as a municipal enterprise in the hands of the Vestry.

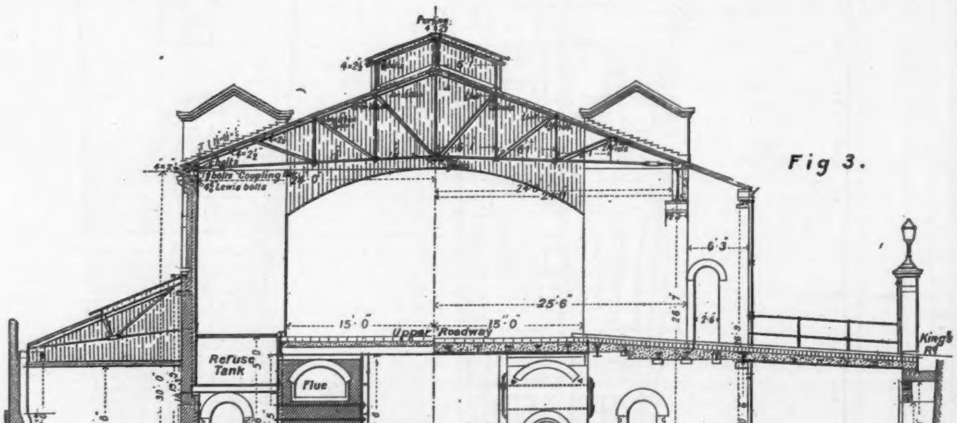


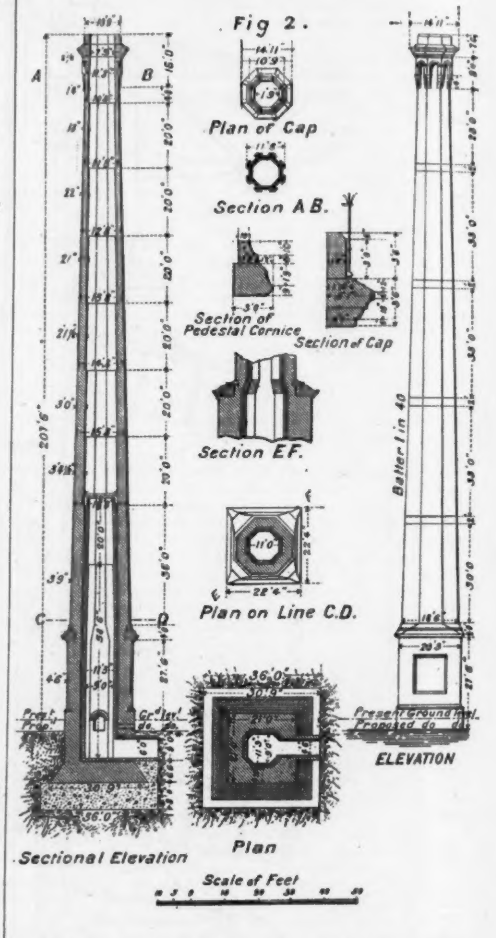
Fig 3.
Purlins
Refuse Tank
Flue
Upper Roadway
Lower Roadway
King's Rd
Flue
Half Cross section at Centre of Main Building.
Half section of Building at Exit Roadway
Scale of Feet
Inches 12 0 1 2 3 4 5 6 7 8 9 10 20 30 40 50 Feet

The site purchased by the Vestry for the combined works covers an area of 28,000 square feet, but the present works only occupy about 24,000 square feet; the remainder—being under leases not yet expired—will be available for ultimate extensions of the electricity works. There are frontages on three sides of the site at different levels, which are particularly convenient for dealing with the dustbin refuse and the clinker from the destructor furnaces. Fig. 1 shows the general arrangement of the works.

The north frontage is in Georgiana-street, at a high level affording access for the dust carts to the top of the furnaces. The south frontage is at a lower level, and provides an entrance with a short inclined roadway to the destructor yard, and also a level entrance to the engine and dynamo house. The east frontage is in King's-road, and is utilised for an exit for empty dust carts and for an entrance to the electricity works coal store. A subway 50ft. long, 11ft. wide, and 10ft. high, under Georgiana-street on the north connects the works with Bangor Wharf on the Regent's Canal.

A chimney shaft 207ft. 6in. in height—Fig. 2—was constructed to serve both for the destructor station and for the electricity installation, Messrs. Kelly Bros., of Liverpool, being the contractors.

The shaft stands upon a concrete foundation 36ft. square and 8ft. in thickness, resting upon the London clay at a depth of about 23ft. 6in. below the ground surface. From this base the shaft rises square to form a pedestal 21ft. wide each way, the brickwork of which is 4ft. 6in. in thickness. From this pedestal an octagon shaft is carried up to an ultimate height of 231ft. above its foundation. The shaft is built with stock bricks and Ruabon red brick quoins and strings. The capping is formed of Derbyshire stone, three courses in depth and eight stones in each course, which are all cramped together with copper cramps. For a height of 80ft. from the bottom of the flue the shaft is lined with firebrick, between which and the main structure a 3in. cavity is left, ventilated with openings from the outside, to prevent the heat being communicated to the main brickwork of the shaft. The diameter of the flue is 9ft. at the base and 7ft. 9in. at the cap.



The main block of destructor buildings is 80ft. in length by 51ft. in width, and 30ft. above the ground to the eaves, forming two stories, the lower one containing the furnaces and the refuse tanks, together with passages between them giving access to the furnaces, the upper storey consisting merely of a paved roadway 30ft. wide, by which the vans bringing the refuse have access to the refuse tanks, one of which is situated on each side of this roadway, and three smaller tanks at the south end of the block. The roadway is on a level with Georgiana-street, and at the entrance is placed a 10-ton weighbridge, by Messrs. Avery and Co. An additional exit for the empty vans is provided on the east side, leading down a short incline to King's-road.

The destructor plant consists of eighteen furnaces, together with the necessary flues, both above ground and under ground, to conduct the hot gases where required, and eventually to the chimney shaft. It includes also the refuse tanks and provisions for all the machinery required in the depôt. This work was carried out by Messrs. Goddard, Massey, and Warner, of Nottingham.

Six furnaces are placed on each side of the main building and under the upper roadway, and six more are placed in pairs at the south end of the block, all the furnaces being connected to the refuse tanks by iron hoppers, by which the refuse passes from the tanks to the back of the furnaces. The form of construction of the furnaces is not that to which Messrs. Goddard, Massey, and Warner's name has been attached for some years, but is a design of the borough engineer's—see Figs. 3, 4, and 5—based upon examination of various forms of furnaces. He has aimed at avoiding disadvantages in other arrangements, and in securing as far as possible the greatest efficiency in the working of the furnaces by consuming as much refuse as possible without causing a nuisance, and in producing a continuous high temperature.

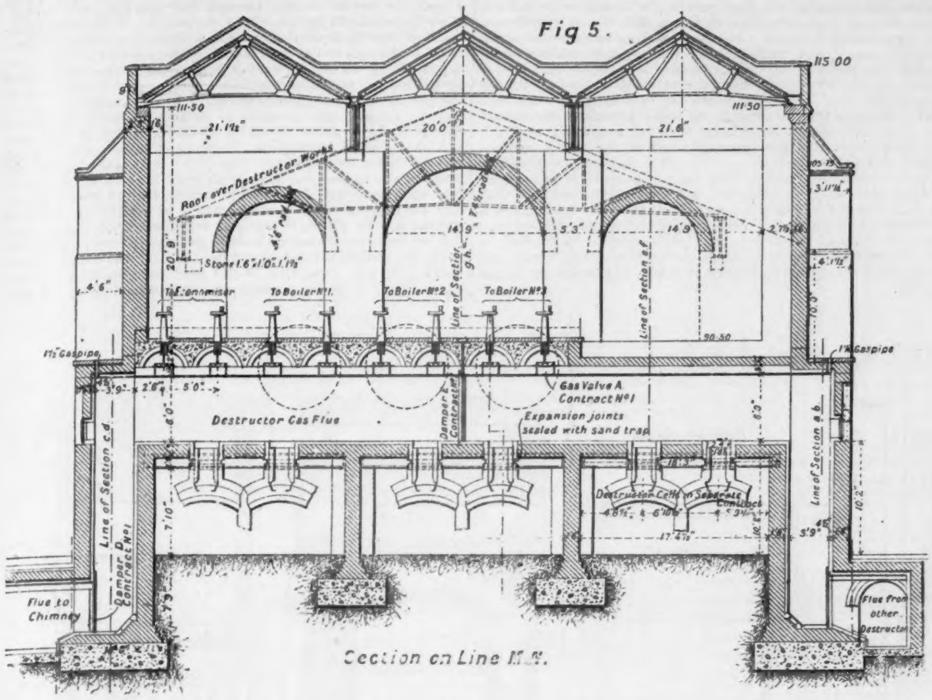


Fig 5.

115 00
111·50
111·50
9"
21'1½"
20'0"
21'6"
Roof over Destructor Works
Stone 1'6"×1'0"×1'1½"
20'9"
14'9"
5'3"
14'9"
2'1½"
105 75
3'11⅛"
4'1½"
4'6"
To Economiser
To Boiler Nº1.
To Boiler Nº2
To Boiler Nº3
Line of Section g.h.
Line of Section e.f
10'3"
90·50
1½" Gaspipe
1½" Gaspipe
3'9"
2'6"
5'0"
Gas Valve A Contract Nº1
Expansion joints sealed with sand trap
Destructor Gas Flue
Damper E Contract Nº1
6'0"
6'0"
Line of Section c.d
Damper D Contract Nº1
7'10"
Destructor Cells in Separate Contract
4'8½"
6'10"
17'4½"
3'9"
Line of Section a.b
10'2"
Flue to Chimney
Flue from other Destructor

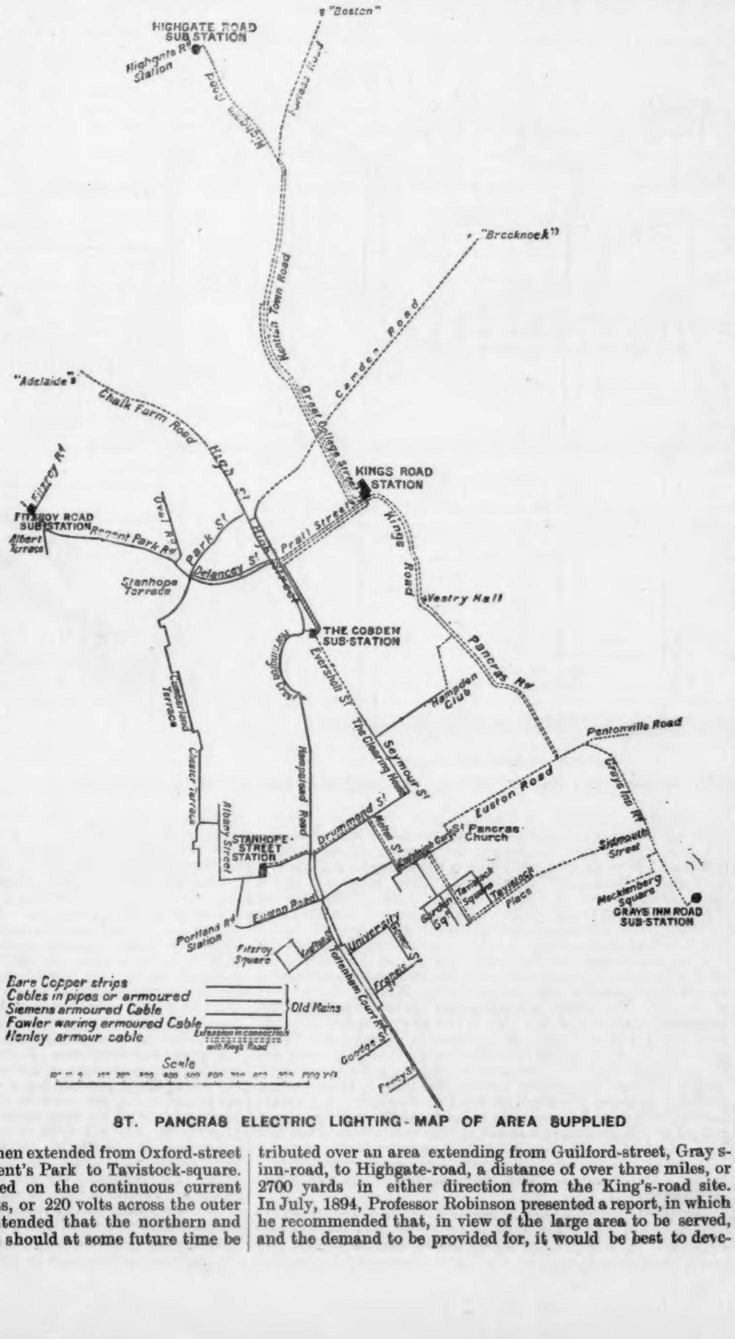
Section on Line M.N.

He also avoids as far as possible the manipulation of the refuse in the fires, by the adoption of the Healey mechanical stoking fire-bars. The principal points with reference to these are—that every alternate bar moves continuously upon a cam shaft at the back end of the cell and slides on a dead plate at the other end, the object being to carry forward the refuse at a rate found suitable to the consuming capacity of the furnace. Into these bars there are coupled—by knuckle joints—shorter bars at a steeper inclination, and placed at the bottom of the hoppers. These bars also assist in carrying the material forward to the furnaces. The intermediate bars of both the front grate and the back grate do not move.

The moving fire-bars of twelve cells are operated by shafting from the engine-room, where the source of power is a 24 indicated horse-power Chandler's silent engine, which also drives two mortar mills and a stonebreaker for breaking up into macadam any old granite setts that are unsuitable for redressing. The remaining six cells at the south end are served by a small donkey engine.

The engine-room also contains two small vertical engines of Goddard, Massey, and Warner's make, provided to drive separately two Sturtevant blowers, which supply forced draught to twelve furnaces. These blowers are set below the floor level, so that the delivery from them may pass in a straight line to 18in. pipes laid underground without any bends. The air is supplied to the furnaces by means of ports on each side of the ashpits, the ports being provided with shutters to stop the draught during the process of clinkering the furnaces or clearing out the ashpits.

Professor Robinson completed the first electric installation in 1891, and the Vestry commenced the supply of electricity in November in that year, when they opened their first central station at Stanhope-street, Regent's Park. A description of this appeared in The Engineer of February 19th and 26th, 1892. The district supplied then extended from Oxford-street to Park-street, and from Regent's Park to Tavistock-square. The electricity was distributed on the continuous current three wire system, at 110 volts, or 220 volts across the outer conductors. It was always intended that the northern and eastern portions of the parish should at some future time be supplied from one or more additional generating stations, and the King's-road station just completed is in conformity with this. The general outline of the scheme was indicated in two joint reports by Professor Robinson and Mr. Blair, issued in February and March, 1893. The principle of the scheme having been approved by the Vestry, a sub-committee was appointed to consider where the new mains should be laid, and what their capacity should be. This sub-committee took a broad and comprehensive view of the matter, and presented a report advising that provision should be made for supplying 10,800 lamps of 16-candle-power simultaneously in use, distributed over an area extending from Guilford-street, Gray's-inn-road, to Highgate-road, a distance of over three miles, or 2700 yards in either direction from the King's-road site. In July, 1894, Professor Robinson presented a report, in which he recommended that, in view of the large area to be served, and the demand to be provided for, it would be best to develope the three-wire system into the five-wire system, and to distribute the current at 440 volts instead of 220, as in the original scheme. This was adopted, and the works have been carried out on those lines.


"Boston"
HIGHGATE ROAD SUB STATION
Highgate Rd Station
Highgate Road
Fortess Road
Kentish Town Road
"Brecknock"
Camden Road
"Adelaide"
Chalk Farm Road
High St
Great College Street
KINGS ROAD STATION
Fitzroy Rd
FITZROY ROAD SUBSTATION
Albert Terrace
Regent Park Rd
Oval Rd
Park St
Delancey St
Pratt Street
Kings Road
Stanhope Terrace
Vestry Hall
THE COBDEN SUB-STATION
Harrington Cres
Eversholt St
Pancras Rd
Hampden Club
Cumberland Terrace
Chester Terrace
Hampstead Road
The Clearing House
Seymour St
Pentonville Road
Grays Inn Rd
Euston Road
Albany Street
STANHOPE-STREET STATION
Drummond St
Melton St
Euston Sq
St Pancras Church
Sidmouth Street
Mecklenburg Square
GRAYS INN ROAD SUB-STATION
Gordon Sq
Tavistock Square
Tavistock Place
Euston Road
Portland Rd Station
Fitzroy Square
University
Gower St
Francis St
Tottenham Court Rd
Goodge St
Percy St
Bare Copper strips
Cables in pipes or armoured
Siemens armoured Cable
Fowler waring armoured Cable
Henley armour cable
Old Mains
Extension in connection with Kings Road
Scale
100 yds

ST. PANCRAS ELECTRIC LIGHTING-MAP OF AREA SUPPLIED

Figs. 6 and 7 show the arrangement of buildings containing the generating plant. The contractor for the buildings was Mr. J. O. Richardson, who also erected the destructor buildings, with the exception of the underground condenser water tank, which was constructed by J. W. Killingback and Co. under a separate contract. The tank measures about 53ft. by 32ft. in plan over all, and 20ft. 3in. in height. The depth of water is 16ft., and the capacity 115,000 gallons. The tank was built before the chimney in order to avoid deep excavations near the base of the latter. The covering of the tank is a coke breeze concrete floor 1ft. thick carried on rolled steel joists arranged to suit the flues above. Sections of the tank appear in Figs. 5 and 7.

(*To be continued.*)

THE TUNNEL UNDER THE THAMES AT BLACKWALL.*

By Mr. Alexander R. Binnie, M. Inst. C.E.

During the past ninety years many proposals have been made for crossing the Thames below London Bridge, where the port of London, with its river, ships and docks, forms a barrier to vehicular or pedestrian traffic between its opposite banks. The first work of the kind attempted, but not completed, was Vayes' tunnel at Limehouse in 1805. We then have Brunel's tunnel, 1825 to 1841; then the Tower Subway for foot passengers, 7ft. in diameter, carried through the London clay, in 1869-70, by Messrs. Barlow and Greathead; and finally, the late Metropolitan Board of Works obtained an Act in 1887 to construct a tunnel under the Thames at Blackwall, six miles from London Bridge. This tunnel crosses the river one and a-half miles below Greenwich and three miles above Woolwich, and will bring these growing and populous places into direct communication with Poplar and the East and West India Docks on the north side of the Thames. The section of the tunnel—see diagram No. 2—shows that at this point the river is 1200ft. in width and 46ft. in depth at high water; and borings revealed the fact that although the London clay was present on both banks of the river, yet that the tunnel must pass below it into the sands and clays of the Woolwich series, and for a considerable distance through a bed of gravel which apparently filled an older and deeper river bed. Not only had the river to be passed under, but it will be noticed that it is unbanked, and that what were the old marshes on each side are below the level of high water in the river. Further, it will be observed from the section that the soil of these marshes, to a depth considerably below that of low water in the river, consists of vegetable soil, peat, sand and gravel, all of them highly charged with water. Under this is the London clay with its base beds of impure limestone full of fossils, and then the sand, clays, &c., of the Woolwich beds. All these beds were under the full pressure of water due to the varying tidal level, and in their natural state so saturated were some of the beds of sand as to connect them with quicksands.

But undoubtedly the most serious obstacle was the large deep bed of coarse gravel with but little sand. This gravel was open and fully saturated with the river water, and as the bottom of the tunnel was to be 80ft. below high water, it was certain that a pressure of about 35 lb. on the square inch would have to be encountered. This, however, was not the only difficulty, for it was clear that if the water could find an easy entrance to, and flow among the gravel, air would also as easily escape from it. It was obvious therefore from the outset that the tunnel would have to be constructed under difficulties never before contended with either in the construction of Brunel's tunnel at Rotherhithe or elsewhere. Moreover, it was evident that no ordinary mode of tunnelling could be adopted, and that some description of shield would be required.

Again, from the difficulties met with by Brunel at the much easier site at Rotherhithe, that some more than ordinary measures would have to be resorted to to keep out the inflow of water in passing under the river, and through the gravel bed above referred to. It was consequently determined to use compressed air, as had been first suggested in his patent of 1830 by Admiral Lord Cochrane—Earl Dundonald—and which had been successfully used under Lake Michigan and the Hudson River at New York, as well as at the tunnel under the Saint Clair river, and on a portion of the City and South London Railway at Stockwell. After consultation with Sir Benjamin Baker, and Mr. Greathead, the final design was determined upon, and the contract was let by the London County Council to Messrs. S. Pearson and Son for £871,000 early in 1892. The whole work is 6200ft. in length, the incline on the south or Kent side of the river is on a gradient of 1 in 36, and has a run of 2408·6ft.; the portion under the river for a distance of 1212ft. is level, and the north or Middlesex incline has a gradient of 1 in 34 for a length of 2579·6ft. In other words, the inclined approaches will not be so steep as parts of St. James'-street and Regent-street, and very much less so than the east side of Trafalgar-square, opposite Morley's Hotel; they will, however, be about equal to that of the Haymarket. The work may be divided into three portions—open approaches with side walls, cut and cover arched over with brickwork, and tunnel proper composed of cast iron rings lined and concrete faced with white glazed tiles, all the other parts of the work being faced with white glazed bricks. The lengths of the various portions, including the shaft, are as follows:—Open approach, 1735ft.; cut-and-cover, 1382ft.; cast iron tunnel, 3083ft.; 6200ft., or a total of a little over one mile. To facilitate the work, so as to permit of altering its direction, which it would be difficult to do by means of a long curve in a tunnel of this description lined with cast iron, and to secure ventilation, there are four shafts, varying in depth from 75ft. to 98ft., and having an internal diameter of 48ft.

The tunnel proper is circular, in cross-section 27ft. outside diameter, or 6ft. larger than that of St. Clair—the largest hitherto constructed—built up of fourteen cast iron segments and a key-piece; each complete ring of segments is 2ft. 6in. in width. The thickness of the cast iron is 2in., the flanges are 12in. deep, measured from the outside, and each segment weighs about one ton. All the joints are brought to a true and even surface by machine planing, and the whole are bolted to each other and to the adjacent cast iron rings by wrought iron bolts and nuts. To ensure that the cast iron plates have a firm abutment upon and against the surrounding earth, there is a hole near the centre of each fitted with a screw plug, through which grout is forced, as will be presently described. The internal edges of the flanges of the plates for a depth of 2in. are recessed, and after they are fixed in position and bolted together, this recess is filled and caulked with rust joint cement, composed of iron filings and sal ammoniac. The space between the flanges, and for a distance of 4½in. beyond and around them, is filled up solid with Portland cement concrete, faced with white glazed tiles, so that the effective diameter of the tunnel is 24ft. 3in. Within this the road of 16ft., with two footpaths each 3ft. 1½in. in width, is formed, resting on an arched subway 12ft. in width and 5ft. 6in. in height, for the reception of water pipes. There are also proper drains for the road and channels for smaller pipes for road cleansing, &c. This road of 16ft. will be of the same width as parts of Little Queen-street, Holborn, and King-street, Westminster, and of a greater width than parts of Drury-lane, Fetter-lane, Upper and Lower Thames-street, London Wall, Lombard-street, and Threadneedle-street, and as there will be no occasion for stopping at shops, houses, and street corners, it should be ample for two lines of the largest vehicles. Should the traffic, however, increase beyond the capacity of the tunnel, land has been secured for the construction of another and parallel line of tunnel. The road will be paved with asphalte in the level portion under the river and with granite laid in tar and pitch on the inclined approaches. The whole work underground will be lighted by three rows of incandescent 32-candle power electric lamps, placed alternately 10ft. apart on the common centre line, no gas being admitted to any portion of the tunnel.

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* Discourse, Royal Institution of Great Britain, Friday, 6th March, 1896.

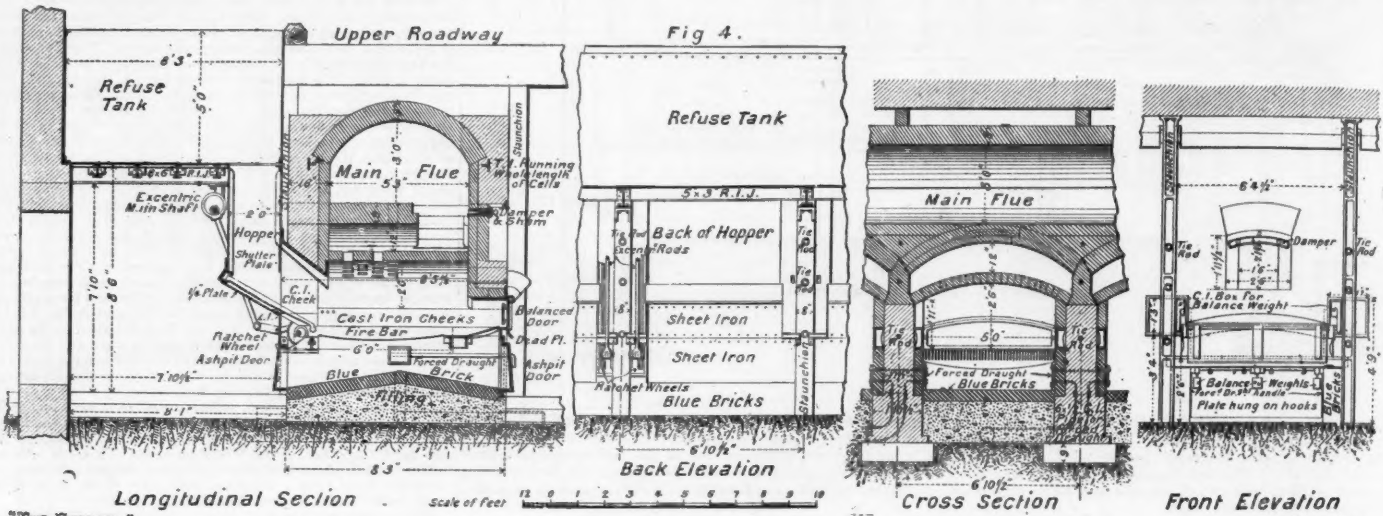
The cut-and-cover portions of the work are formed of brickwork varying in thickness from 18in. to 2ft.; this is covered with 1½in. of asphalte, and backed with 2ft. of Portland cement concrete, so that the thickness at the thinnest part is 3ft. 6in. Internally the cut-and-cover portions will in all respects resemble that of the tunnel proper formed in cast iron. The open approaches as above described are flanked with inclined retaining walls faced with white glazed bricks carrying a high fence wall with stone coping.

At each extremity the tunnel will be approached through an arched gateway supporting the lodge-keeper's house; there will also be stairway access at the junction of the open approach with the cut-and-cover, as well as stairways down one of the shafts on each side of the river; the other shaft near the river on the south side being in private property, is domed over and a ventilating chimney carried up from it; the similar shaft near the river on the north side being devoted to administrative and working purposes, such as pumping, elevating, lighting, &c. Each shaft is of the shafts so as to prevent the floors from being blown upwards under an air pressure of 4000 tons.

I think that I have now in its main outlines described the principal features of the work, and must proceed to give some account of the mode of its construction. In doing this I shall have first to describe the shield, and then the mode of working it under compressed air—*see* THE ENGINEER, 27th December, 1895. The shield as shown on the diagrams and in the model on the table is a structure of steel, cylindrical in shape, 19ft. 6in. in length and 27ft. 8in. outside diameter. It is stiffened by two circular partitions 3ft. apart, and its forward or working face, which presses against the material to be excavated, is divided into twelve pockets or cells by three horizontal and three vertical partitions. It is within these spaces, which are 6ft. in height, that the men work. Between the two circular stiffening partitions are formed air locks and shoots for passing out the excavated material. Arranged round the inner circumference of the shield, and attached to it and the circular partitions, are disposed twenty-eight hydraulic rams 8in. in diameter, for the purpose of pressing or pushing the shield forward. In the rear of the shield, or that portion of it which faces the completed tunnel, is a space which is merely enclosed within the outer skin of the shield; this space is called the tale of the shield. It always overlaps by 2ft. 6in., or one cast iron ring, the last completed portion of the tunnel, and within it is built up the various rings of iron with which the tunnel is lined.

know that it has bulk, for if we invert a tumbler in a basin of water, there will still be a space filled with air into which the water cannot enter. If we try the experiment, we shall find that this air space will be larger or smaller, depending on the depth to which we immerse the tumbler; consequently, we see that air is an elastic body. By properly constructed air compressing pumps we can force air down into a diving bell until all the water is expelled from it and the surplus escapes through the open bottom of the bell. If we then measure the amount of compression of the confined air we shall find it equivalent to the weight of a column of water equal to the area of the open bottom of the bell and as high as the depth of the water. It having been decided to use compressed air to keep out the water from the tunnel during its construction, the question arose what, having regard to the health of workers, was the greatest safe pressure to be adopted, as on this clearly depended the greatest depth to which the bottom of the tunnel and shafts could be carried. In going into the matter it was evident that it would not be a case of one or two men occasionally going down to perform some temporary work, but that gangs of from sixty to eighty men would have to be kept at work night and day for many months, consequently a safe maximum had to be arrived at. In places in America men had worked under a pressure of 48 lb. per square inch above the atmospheric pressure, that is 63 lb. absolute—at Stockwell, on the City and South London Railway, it was about 15 lb.,—and after many inquiries 35 lb. per square inch, or 50 lb. absolute, was determined upon. I have stated it in this way because in addition to whatever artificial pressure we may apply it must be borne in mind that we always have the initial pressure of the atmosphere to work under, which is about 15 lb. per square inch. In what follows, however, I shall speak only of the artificial pressure, leaving it to be understood that we always have the natural pressure in addition.

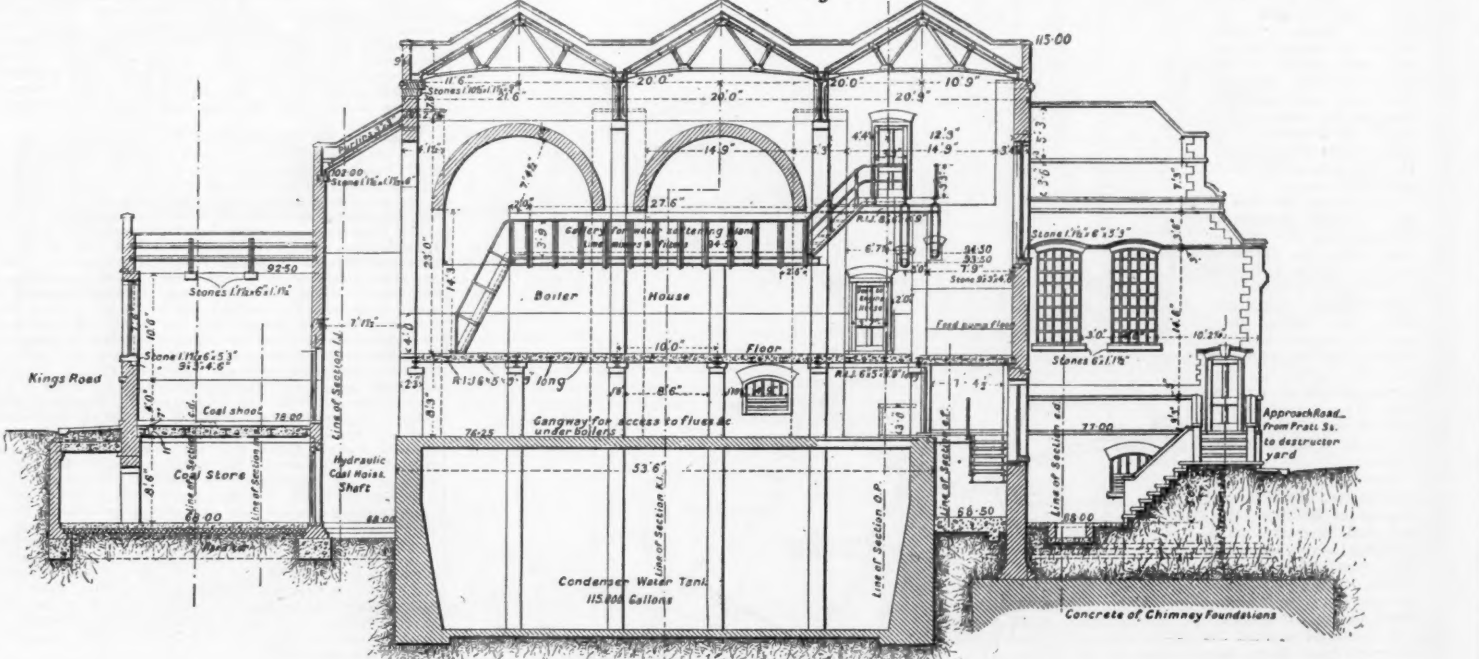
Fig 4.



Longitudinal Section Back Elevation Cross Section Front Elevation

"THE ENGINEER." SWAIN ENG.

Fig 6.



Section on Line G.H. Fig. 6.

ST. PANCRAS ELECTRICITY WORKS—SECTION OF REFUSE DESTRUCTORS AND OF MAIN BUILDINGS

58ft. outside and 48ft. inside diameter, and is formed, as it were, of two skins of riveted wrought ironwork; the two skins are braced and held together by wrought iron struts and ties, the space between them being filled in solid with Portland cement concrete. Near the lower extremity of each shaft its side walls are perforated by two openings 29ft. 4in. in diameter. These openings are for the purpose of forming junctions with the tunnel, and were temporarily fitted during the time the shafts were being sunk by means of large wrought iron plugs. At a distance of 8ft. from the bottom the inner skin is bent outwards to join the outer skin, and together form a comparatively sharp cutting edge. All the shafts will be lined, when finished, with white glazed brickwork.

The shafts were sunk in the following manner:—Having been built up to a considerable height above the surface of the ground in the positions they were to occupy, the earth, clay, sand, &c., were excavated within the circumference of the shafts from below the cutting edge, and as this process of excavation proceeded the shaft sank into the ground, partly by its own weight, and in some cases assisted by additional weight placed upon it. When the final level was reached, the bottom for a depth of 13ft. was filled in with concrete, in which, and attached to the walls of the shaft, was fixed a water-tight wrought iron floor. As the junction between the tunnel and shafts nearest to the river had to be made under compressed air, provision was made for fixing temporary air-tight floors at a level of a few feet above the crown of the tunnel. These air-tight floors were held down by wrought iron girders 12ft. in length and 4ft. in depth, secured to the sides

Attached to the back or rearward part of the two circular stiffening partitions, and projecting into the tail of the shield, are two hydraulic erectors for placing the segments of the rings in position. There are two vertical rams which cause a rackwork to move up or down in a vertical direction. These racks gear into a pinion which carries an arm. Consequently, the vertical motion of the rack causes the arm to move through an arc of a little over 180 deg. This arm carries another ram by which the arm can be lengthened or shortened as desired. In working, the end of the arm can be attached to the lug or projection cast on the centre of the inner side of each segment, where, by the turning and lengthening motion of the arm, the segment can be placed in any desired part of the ring. This shield, weighing about 250 tons, was built in an excavation at the top of shaft No. 4, and when completed its ends were closed with timber to make it water-tight, and it was floated into shaft No. 4, which had been filled with water. The water was then pumped out of the shaft, and as the water fell, the shield, floating on its surface, gradually descended until it rested on the bottom. As above described, it will be noticed that the twelve working cells or pockets are open in front, and the shield is so used in hard or stiff ground, but in the gravel beds the working face has, except when the excavation is in progress, to be very carefully closed with the wrought iron shutters, secured with screws—as shown on the section—the mode of working which will be presently described.

Compressed air.—We all know that air at the sea level presses with a force of from 14¾ lb. to 15 lb. per square inch, and can support a column of mercury of from 30in. to 31in. in height. We

If the extreme safe pressure be fixed at 35 lb. per square inch, it follows that the bottom of the tunnel must not go much lower than 60ft. below high water mark. This being settled, the next point to be decided was how large could we make a circular tunnel so that it did not project upwards through the gravel into the river. In other words, what was the safe minimum amount of cover that could be allowed over the top of the tunnel and between it and the river bed. This, after much consideration, was provisionally fixed at 8ft.; but in construction, as will be seen on the section, the least depth was somewhat less. It was due to these considerations, coupled with the widths of the busy streets above spoken of and the size of the largest vehicles, such as furniture vans, &c., that the outside diameter was fixed at 27ft. Having now described the work and some of the main conditions under which it has to be constructed, you will have noticed that to keep out the water compressed air is employed, and that to drive the shield forward hydraulic pressure is used, the machinery for which requires a few words of description. For the purpose of air compression, six steam engines and air pumps are provided, and these are situate on the south bank of the river, near shafts Nos. 3 and 4. They have a united capacity of 1500-horse power, but only about 1000-horse power to 1200-horse power are used continuously, as one engine has to be kept idle in case of accident or breakdown. When working at 1000 to 1200-horse power these engines and pumps force into the tunnel about 8000 cubic feet of air per minute, or 17 tons weight per hour. The air from these various engines is first conducted into a wrought iron reservoir 28ft. in length and 7ft. in diameter, formed like a steam boiler. The first effect of compression, it is needless to say, is to raise the temperature of the air very much—in fact, to about 90deg. or 100deg. Fah.; consequently before it can be conducted into the tunnel it has to be cooled by passing it through a series of smaller tubes surrounded with cold water, like the surface condenser of a steam engine. From these coolers it is led in pipes down shaft No. 4 and along the tunnel, through the air-tight bulkhead, presently to be dealt with, to the working face.

In describing the shield I mentioned that it weighs about 250 tons, and that it has to be thrust forward as the excavation is completed, and each ring of plates, 2ft. 6in. in width, erected by the twenty-eight hydraulic rams, which abut or press upon the last completed ring of the tunnel. To produce the necessary total pressure of about 2800 to 3000 tons, a hydraulic pressure up to 2¾ tons per square inch has to be maintained. This is developed by two hydraulic engines of 70-horse power, is transmitted in hydraulic pipes down shaft No. 4, along the tunnel and through the air-tight bulkhead to the working face. I have previously spoken of a certain structure which I have called the air-tight bulkhead. This I must now describe. It is clear that if we are to use the compressed air in the tunnel to press against the working face and keep out the water, it must in some way be confined, or it would rush out backwards and escape up the shaft. To confine the air in the tunnel temporary air-tight walls or partitions called bulkheads are built across it. As these have to bear an outward thrust or bursting pressure of about 1000 tons, they are formed of massive walls 12ft. in thickness, built of brickwork in Portland cement. It is, however, obvious that they must not be solid, but must have means of access formed to allow of entrance and exit both for men and materials. To permit of this access air locks have to be formed through the bulkhead. These are for a similar purpose and act in a like manner to the locks on a canal, the difference being that in one case we have to overcome a difference of water level, and in the other a difference of pressure between that of the ordinary atmosphere outside—15 lb. per square inch—and the working pressure produced by the air compressing engines inside the bulkhead, be it 20 lb., 25 lb., or 30 lb. per square inch. The air locks consist of wrought iron cylinders 15ft. in length and 6ft. in diameter, securely built into the brickwork of the bulkhead. There are two of these air locks at the level of the road near the bottom, each provided with two doors 5ft. by 4ft., fixed at either end of the lock, and opening inwards towards the pressure inside. There is another but smaller air lock placed near the top of the tunnel to permit of escape in case of accident. Supposing you wish to enter, the outer door is open, but the inner one closed and pressed against by a force of, say, 30 tons. It is clear that you cannot open this door until you have equalised the pressure on both sides of it. To do this you enter the lock and close the outer door to prevent the escape of air, after which a tap or cock is opened, which permits the compressed air from inside to rush into the lock until the pressure within it is equal to that on the inner side of the bulkhead. As soon as this equality is established, the inner door can be opened, and you step into the working pressure.

Visit to the tunnel.—In attempting to describe the work of construction, I do not think I can do better than in imagination to conduct you over the work during a visit of inspection. It is first necessary for ladies and gentlemen alike to put on waterproof boots, woollen overalls and caps, so as to keep dry and clean; these are in readiness for the purpose at the tunnel. Descending by the steps at the end of the open approach on the south side of the river, we pass for over 300 yards through the finished cut-and-cover portion of the work, and have an opportunity of noticing what will be the general size and appearance of the interior of the tunnel, and that, although it is all below high water mark, and its lower end beneath the level of the bed of the river, yet it is quite dry and dusty under foot. On reaching the bottom of shaft No. 4, the large steam pumps for lifting out the water during construction will be noticed, for it must be remembered that although the work when finished will be quite dry and water-tight, yet during construction, even with the use of compressed air, a large volume of water enters the work and has to be got rid of. This mainly arises from the fact that the difference in hydrostatic external pressure due to the 27ft. in height of the shield amounts to about 9 lb. per square inch; so that if the full air pressure due to the external hydrostatic pressure at the bottom of the shield and working face were always kept up, much of it would escape in too large volumes from the top of the excavation and through any porous soil. In fact, to prevent this too rapid escape of air through the gravel, as well as to weight the material over the shield, where the covering was least in thickness above it, clay, as shown on the section, was deposited in the bed of the river for a width of 150ft. and from 10ft. to 15ft. in depth, immediately over the part of the tunnel under construction. While the tunnel was being formed beneath the river, there was always a very large escape of air which boiled up through the water, and also came up in some places inland at a distance of 800ft. from the working face. Notwithstanding all the precautions taken, the air pressure on two occasions blew up the bottom of the river, and once the surface water rose to a height of 25ft. over a diameter of 50ft. Any water, therefore, which enters the tunnel between the working face and the air-tight bulkhead is forced out through pipes which extend from the working face through the air-tight bulkhead to the bottom of shaft No. 4, the superior air pressure within the working part of the tunnel being used for the purpose, and from the bottom of shaft No. 4 it is raised by steam pumps to the surface.

Passing from the bottom of shaft No. 4 down the incline to shaft No. 3, the visitor may observe the cast iron rings of which the tunnel is built up quite uncovered, as the inner lining of concrete has not yet been inserted. It will be noticed that the work is lighted by means of incandescent electric lamps, which give sufficient light to see that as fixed the plates are quite water-tight, and but for appearance sake require no internal lining. After passing the bottom of shaft No. 3, which is domed over, we enter on the portion of the tunnel below the river, and most probably soon after hear a loud rumbling roaring noise. This is caused by the escape of the compressed air from one of the air locks as some men or materials are being locked out. Arriving at the air-tight bulkhead, we enter the lock, close the outer door, and turn on the compressed air, which enters from the working space beyond the bulkhead. The effect of so doing is at once apparent, for the noise of the inrushing air is as loud as that of the steam escaping from some large steam boiler, and quite drowns the voice and renders hearing impossible. At the same time every one feels a more or less acute pain in the ears, caused by the increased pressure of the air on the outer surface of the drum of the ear; this can in most cases be removed by equalising the pressure through the Eustachian tubes, which communicate with the middle ear; this is effected by swallowing and blowing into the nose when it is pinched with the fingers, but if the pain becomes and continues very acute, the person suffering should at once leave the air lock. As the air in the lock becomes more compressed, the temperature rises rapidly; this is due to the compression, and only lasts while in the lock, for as soon as equalisation is established, and the inner door is opened, and you step into the working space, you find the temperature falls to about 60 deg. to 65 deg. Fah.

I am often asked what it feels like in compressed air. This, I think, must in all cases be a personal matter. But summing up the result of my many weekly visits to the tunnel during the past two years, I should say that I feel no difference from that when under the ordinary atmospheric pressure. There is a very slight feeling of exhilaration if the pressure is over 20 lb. per square inch, probably caused by the larger amount of oxygen absorbed by the lungs; everyone appears to speak with a nasal intonation; you cannot whistle, and the skin acts more freely than at the same temperature under normal conditions. I should here note that no one becomes ill from the effects of compressed air while under its pressure; the baneful effects, if experienced at all, usually show themselves on coming out of it. But I have arrived at the conclusion that, among otherwise healthy persons, some can and some cannot withstand air pressure, and I have had the pleasure of conducting many persons over the works, from little girls of thirteen up to gentlemen of over seventy years of age, who have not felt the least ill effects from compressed air. Passing on to the shield and the working face, we see the two main operations in progress—(1) excavating, and (2) erecting the cast iron rings of the tunnel.

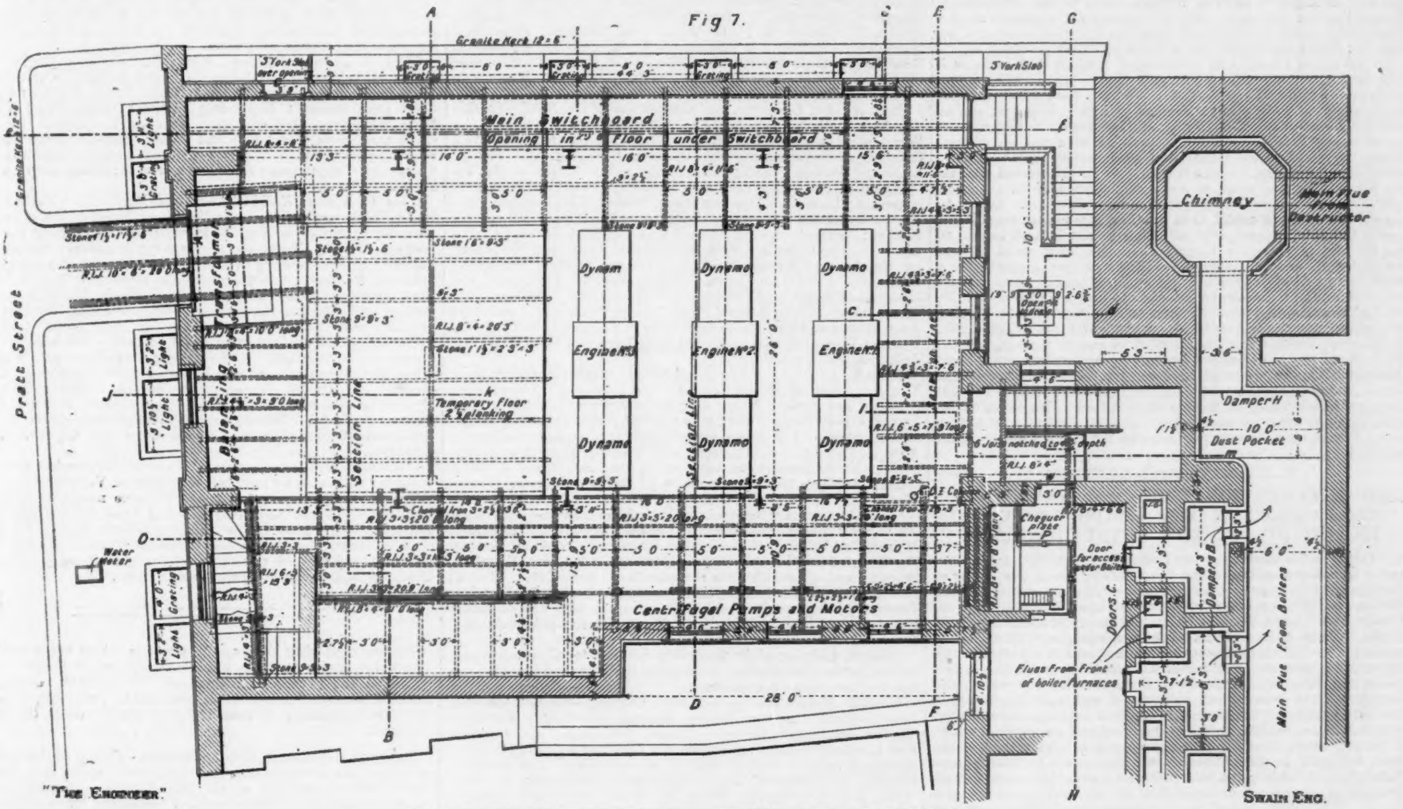
Excavation.—As to the excavation, the mode of conducting it will depend on the kind of ground being pushed through. If it be hard or stiff enough to stand with a vertical face when pressed against by the various partitions of the shield, the men simply dig or pick it away in front for a few inches or a foot or two, passing the excavated material out to the stage behind the shield, from which it is tipped into wagons and removed. After a sufficient amount has been cleared and loosened in front of the shield, the latter is by the hydraulic jacks pressed forward, it may be a few inches or perhaps 2ft. 6in., the distance depending on the nature of the ground. Each ring displaces 54 cubic yards, and progress has varied from 1ft. up to 10ft. a day. If, however, the material be gravel, the progress is very slow, as this material will not remain vertical when dug into, but runs down as fast as it is excavated. Besides which, so rapid is the escape of air that, if precautions were not taken, it would pass out in dangerous quantities. To obviate this, and to support the face, the front of each pocket or working face is closed with three wrought iron shutters, pressed forward by powerful screws, and all the joints luted with clay. In these circumstances the excavation is made either by raking out the gravel through holes in the shutters, or by drawing them back one at a time, digging out a small portion, and then screwing up the shutter again. When all the shutters have been screwed forward the shield is pressed, and as the screws are so arranged as to allow of their slipping through the nuts attached to the shield, the result is that it moves forward past the shutters which remain in the positions into which they have been screwed. It need not be said that this is slow and tedious work, requiring great skill and patience.

Erecting the rings.—After the shield has been pressed forward so as to leave a clear space in the tail of 2ft. 6in., the erectors are brought into work, and, as before described, the various segments and the key piece erected. It will be noticed that as the tail of the shield overlaps the last finished ring of plates it leaves an annular vacuity, 4in. in width, between the back of the plates and the natural ground. This space is made solid by the injection of grout under pneumatic pressure by means of the contrivance patented by Mr. Greathead. This consists of a closed horizontal cylinder, in which lime or cement can be mixed to the consistency of thick cream by a horizontal spindle with arms which pass through it. The upper side is furnished with a pipe, through which air pressure can be applied to the surface of the grout, and from the lower side the grout is conveyed in another pipe to the holes in the plates, through which it is forced by the air pressure. To provide against accidents, two precautions are adopted in case of an inrush of water. One is an elevated temporary wooden gangway or path extending from the shield to the upper escape air lock in the air-tight bulkhead. The other is a fixed curtain of wrought iron, which descends to the semi-diameter of the tunnel, so that in case of an irruption of water it would not fill the entire tunnel, but a certain portion of compressed air would be trapped between the curtain and the air lock, and so form a kind of elongated diving bell. Having now viewed all that is to be seen in compressed air, we return to the air lock for the purpose of passing out. This is in some respects different from passing in, and is an operation requiring some little time and caution, as the removal of the artificial air pressure and the return to normal conditions is more than equivalent to an ascent beyond the tops of the highest mountains on the earth, as the artificial pressure may be 30 lb. per square inch, all of which has to be removed before we return to the normal 15 lb. As to sensation, no difficulties about the treatment of the ears is experienced, as the compressed air in the middle ear gradually and naturally discharges itself with a not unpleasant crackling sound. Owing, however, to the expansion of the air in the lock, the temperature falls rapidly, so much so that the invisible aqueous vapour contained in the air is deposited, as a thick damp fog and a chill is experienced. Beyond this there is nothing particular to notice.

From the tunnel we ascend the shaft No. 4, and in the cabin at the top take a cup of hot coffee, which slight stimulant is sufficient to restore the system to its usual condition. I am frequently asked if we have found any objects of interest or antiquity in our various excavations; but as most of our work has been through the tertiary beds of the London clay and Woolwich series, nothing but the fossils peculiar to these formations have been met with. On the table will be found specimens of the base bed of the London clay, and of the conglomerate bed which lies just below it. These two formations have also been met with on other works, as at Abbey Mills and the Beckton Gas Works. There is also a specimen of the shelly clay of the Woolwich series. In the superficial gravel, part of an elephant's tusk was found on the south shore of the river; a similar tusk was also found on another work in the gravel beds near Abbey Mills, at Stratford. On the north side of the river at Blackwall Cross, about 8ft. below the street level, a human skeleton was found, and as a stake was also found which appeared to have been driven through the body at the time of burial, in all probability the remains were those of some poor suicide, who had been interred with all the superstitious rites of our ancestors. Beyond the above I do not think anything of interest has been discovered.

Experience of compressed air.—In some previous works carried out under compressed air much illness and some deaths had occurred. The illness of the more frequent, though not serious, consequence is violent and acute pains of a neuralgic kind generally in the limbs, and which is experienced at the time of, or shortly after, coming out of compressed air. The more serious, and in some instances fatal, cases took the form of vertigo and paralysis, usually of the legs. Consequently, at an early period, the London County Council adopted every precaution; they obtained Parliamentary power to compensate persons permanently or temporarily injured, and they appointed a resident medical officer, Dr. Snell, whose duty it was not only to attend to cases of illness, but to see that none but healthy men were allowed on the work, and to keep

Fig 7.



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ST. PANCRAS ELECTRICITY WORKS—GENERAL PLAN OF BUILDINGS a watch on all the men employed in compressed air, besides which he was instructed to note from a medical point of view and make a study of all the conditions of the problem. We have now been at work under compressed air for about two years; we have had no deaths, and only one case of permanent injury—a case of Menier's disease, due to rupture of the semi-circular canal of the inner ear. It had often been noticed on previous works that illness was most prevalent when the work progressed most slowly, and that it decreased as the progress became more rapid. We now believe from our experience at Blackwall that this was due to the larger amount of air pumped down during rapid work. Without for a moment wishing in any way to forestall Dr. Snell, who will no doubt make public the result of his observations at the proper time, we believe that up to a pressure of from 30 lb. to 35 lb. per square inch healthy men can work with almost an entire absence of illness, if a sufficient amount of compressed air, say 8000 to 9000 cubic feet per hour, be supplied to each man.

Conclusion.—In drawing this discourse to a conclusion, I feel that I have but very imperfectly performed the duty which I have undertaken. We have now completed all the work on the south side, the river has been passed, and we are working up the incline near shaft No. 1, and if all goes well we hope to complete the whole by about March next year. In contemplating the work at Blackwall, it is interesting to compare the progress in engineering work during the past fifty years. Brunel's tunnel was of about the same length as the portion under the river at Blackwall, and it took about nine years, with many long pauses, to complete; the portion of the Blackwall Tunnel under the river between shafts 2 and 3 was tunnelled in about thirteen months. The cost of Brunel's tunnel was at the rate of about £1300 per yard, while that at Blackwall averages £550 per yard. This is most gratifying after the gloomy forebodings by which we were met before we commenced the work—it was at that time predicted, and I was personally warned by members of my own profession, that if we succeeded at all, it would only be by chance, and at the cost of much suffering and death. The success that has attended us is due to all who have been engaged upon the work, and particularly to the skill and untiring energy of three gentlemen, the two resident engineers, Messrs. Hay and Fitzmaurice, and to Mr. Moir, who acts as engineer for, and representative of, the contractors, Messrs. Pearson and Son. But in claiming for ourselves at the present time credit for the success that has attended our efforts, we must not forget the honour due to those who have preceded us.

No one can in a large and complicated modern work such as I have been describing claim for himself the exclusive credit for the whole or any important part of it. We have been using a shield under compressed air, pushed forward by hydraulic power, and at once the names of Bramah, Brunel, and Dundonald remind us that we are largely indebted to them. Much has been said and written about the shield we have used, and some names have been associated with its design. I wish it clearly to be understood that no one has any right to do so, as it is a combination of all the good points in many previous efforts in the same direction. But if to anyone is due more credit than another, it is to that remarkable genius the elder Brunel, who, although he was himself unable to use his own invention, saw clearly how the work could be best accomplished, and as far back as 1818 took out a patent for a shield and mode of constructing subaqueous tunnels. As described in and shown on the drawings attached to his specification of 1818, we find a cylindrical wrought iron shield, divided into working cells or pockets, the tail of which overlapped a tunnel some 20ft. in diameter, which tunnel was formed of cast iron rings, and the whole shield was to be pressed forward by hydraulic jacks. From Dundonald's specification of 1830, we get the mode of making a tunnel under compressed air, and to Bramah is due in a great measure the invention of the hydraulic press. Therefore, in this as in so many other of our works, it is seen that we owe a deep debt of gratitude to our predecessors for the success we have attained.

THE INTERNATIONAL HORSE AND HORSELESS CARRIAGE AND ROADS LOCOMOTION EXHIBITION AT THE CRYSTAL PALACE.

ON Friday last a meeting of the Honorary Committee of Advice—under the chairmanship of the Lord Mayor, who is the Master of the Ancient Company of Coachmakers—took place at the Mansion House. After some observations by the Lord Mayor on the connection between the Mansion House and the great exhibitions held at the Crystal Palace, Sir David Salomons proposed the following resolution:—"That, having regard to the great and daily increasing interest taken in the revival of self-propelling traffic on common roads, and the great magnitude of the industries involved in the manufacture of horse-drawn vehicles, as well as to the fact that the introduction of mechanically-propelled carriages is calculated to revolutionise modern modes of transport and travel, the present is an opportune time for organising upon a large scale—on the lines indicated in the announcement just read—an international Exhibition of both horse and horseless carriages, together with everything pertaining to locomotion of all kinds upon common roads. That on account of its size, the extent of its grounds, and its position in regard to the metropolis, the Crystal Palace is the most suitable *locale*. That the holding of such an Exhibition in London, and at this period, would be highly advantageous to the industries involved, including as they do not only the manufacture of light road carriages suitable for private users, professional men, and the trading classes generally, but also of mechanically-propelled vehicles suitable for the economical transport of agricultural produce. That, being calculated to stimulate the engineers of this country to greater efforts in improving and perfecting the motors and mechanical arrangements of self-propelling vehicles, the Exhibition is eminently worthy of influential support." In proposing this resolution he drew attention to the importance and interest attaching to the proposed exhibition, especially with respect to the horseless carriage industry, which will, no doubt, rapidly reach great proportions. Some remarks were made on the necessity for an early repeal of the existing restrictions at present preventing the use of horseless carriages, and on the difference between the position of the users and builders of these vehicles on the Continent and in this country. The industry in horseless carriage and trading vehicles had already become an important industry in France, while in England, where nearly sixty years ago a considerable degree of perfection in steam carriages had been reached, there was no such industry. This resolution was seconded by Mr. George J. Jacobs, president of the Institute of British Carriage Manufacturers, and it was unanimously agreed to.

Mr. Samuel Green then moved the appointment of the honorary Executive Committee for horse-drawn vehicles.

Mr. Vaughan Pendred seconded this motion, and dwelt on the importance of some of the points raised by Sir David Salomons. He also spoke of the offer by the proprietors of THE ENGINEER of prizes to the value of one thousand guineas with a view to stimulating the design of and industry in mechanical road carriages in this country.

On the motion of Major Flood Page, seconded by Captain Simonds, chief of the Metropolitan Fire Brigade, the honorary Executive Committee for mechanically-propelled vehicles was appointed.

The Executive Committee includes the following:—Horse-drawn vehicles: Mr. Robert Alford, Mr. Charles Thomas Bartlett, Mr. Andrew W. Barr, Mr. Frederic Chancellor, Mr. George N. Hooper, Mr. George J. Jacobs, Mr. Peter De Lande Long, Sir John B. Monckton, Colonel James Peters, Mr. Percy Preston, Mr. John Philipson. Mechanically-propelled vehicles: Sir Frederick Bramwell, Bart., F.R.S., Sir David Lionel Salomons, Bart., Sir Douglas Galton, F.R.S., Sir Henry Trueman Wood, Mr. Andrew W. Barr, Mr. W. Worby Beaumont, Professor Vernon C. Boys, Mr. James Dredge, Mr. Walter Hancock, Dr. John Hopkinson, F.R.S., Professor D. E. Hughes, F.R.S., Mr. Edmund Macrory, Q.C., Mr. A. R. Sennett. Mr. A. R. Sennett, Assoc. M. Inst. C.E., was appointed honorary executive commissioner; Mr. Henry Gillman, the manager of the Crystal Palace, having the general management of the whole exhibition.

The prospectus of the International Exhibition now being organised by the Crystal Palace Authorities, aided by the large committee of advice and executive committees representing the many numerous interests which such an exhibition will comprise, has been issued. The exhibition will be held under very influential patronage, and will be opened in May.

The prospectus mentions that there exists at the moment in this country an industry—that of the manufacture of self-propelling vehicles for use upon common roads—which is scarcely yet beyond its nascent condition, but which is far more advanced, and indeed has assumed considerable magnitude, in other countries, and in regard to which proper publicity and demonstration cannot be given in this country under existing legislation, except in extensive private grounds such as those attached to the Crystal Palace. It is intended that concurrently with the exhibition and demonstration of the most modern applications of science to mechanical locomotion upon common roads, there will be an exhibition of all kinds of animal-drawn road vehicles and carriages of both historical and current interest, including illustrations of ancient modes of travel, and of road conveyances now displaced by the introduction of railways. The Crystal Palace Authorities will also be aided by the practical assistance of the City Companies, the Worshipful Company of Coachmakers, the Institute of British Carriage Manufacturers, as well as private owners, who are lending their valuable and unique collections.

The exhibition is divided in to twelve sections, which are again subdivided into Classes:—Section I. (Classes A, B, and D), Fine Art, Literature, Sculpture, Antiques and Curios, and Illustrations of Primitive Modes of Travel. Section II. (Classes B and E), Ancient and Modern Harness. Section III. (Classes C and D), Ancient and Mediæval Carriages. Section IV. (Class D), Ancient and Modern Carriage of the Mails. Section V. (Classes E, K, L, P, and Z), Accessories to Modern Travel and Sport. Section VI. (Classes G and H), Coaching. Section VII. (Classes F, G, and H), Modern Carriages. Section VIII. (Classes H, J, and Z), Modern Transport. Section IX. (Class Y), Military and Cycle Transport. Section X. (Classes M, N, O W, and X), Material, Plant, and Machinery. Section XI. (Classes Q, U, V, and Y), Mechanical Road Locomotion. Section XII. (Classes R, S, and T), Horseless Carriages.

The following is the classification of exhibits:—

Class A. Art, Literature, and Journalism of the Road.—In this class are included the valuable collection kindly lent by the Worshipful Company of Coachmakers and the Institute of British Carriage Manufacturers. Oil Paintings; Engravings; Prints; Etchings; Models; Casts; Bronzes and other Works of Art relating to Horsemanship, Coaching, Vehicles, Travel, and Transport generally; Books and Treatises upon Roads; Road Construction; Horses and Mules; Harness, Ancient and Modern; Saddlery and Bitting; Driving; Cycling; Coach and Carriage Design; Coaching; Coach and Carriage Building; Special Plant and Machinery for Coach and Carriage Building; Civil and Military Transport; Mechanical Road Locomotion; Steam, Electric, Petroleum, and other Road Motors and Carriages; Man-propelled Vehicles; Cycle Construction; Cycle Makers' Special Tools, Plant, and Machinery; Journals devoted entirely to the Road, to Coaching, to Civil and Military Transport, and to Mechanically Propelled Road Vehicles; Ordnance and Road Maps.

Class B. Antiques and Curios.—Ancient, Mediæval, and Antique Trappings and Caparisonments; Antique Lorrinary; Ancient Bits, Stirrups, and Spurs; Whips used by celebrated Coachmen; Celebrated Coach Horns; Old times Coaching and Travelling accessories; Mediæval Harness and Trappings; Antique Saddlery; Antique Carriage Laces; Regal and Queenly Travelling Equipments; Heirlooms and Souvenirs of the Road and Travel in olden times; Antique Carriage Heraldry; Antique Harness, Chased Work, and Heraldry.

Class C. Ancient Conveyances and Modes of Travel.—(*a*) Wheelless: Snow Shoes; Snow Skates; Skees; Sledges; Toboggans; Man-carried Litters; Horse-carried Litters; Palanquins; Sedans. (*b*) Wheeled: Wheeled Sedans; Ancient Chariots; Egyptian, Roman, and other Chariots; Carouches; Cabriolets; Chares; Berlines; Post Chaises; Chariots (four-wheeled); Curricles; Tilburies; Buggies; Coaches; Whiskeys; Carrioles; Buckboards; Barouches; Vis-à-vis; Dandies; Dandy Horses; Velocipedes; Bone-shakers.

Class D. Carriage of the Mails.—Is devoted to all things appertaining to the Carrying and Delivery of the Mails and Parcels Post, and to Travelling with the Mails.

Class E. Modern Harness and Horse Clothing.—Modern Harness, Four-in-Hand, Tandem, Single, Racing, and Heavy Haulage; Quickly Detachable Harness, Collars, Pole-chains, and Gear for Fire Engines; Saddles; Safety Saddle Bars and Releasing devices; Stirrups; Spurs; Collars, stuffed, spring-packed, and metallic; Farriery and Farriers' Tools; Horseshoes, hand-made, machine-made, and anti-slipping; Horseshoe Nails; Removable Roughs; Whips; Whip Sockets; Rein-holders; Breaking-in and Training Appliances; Mechanical Jockeys; Veterinary Appliances; Medicines; Foods; Horse Clothing; Monogram Loin Covers; Pack-horse Trappings suitable for the Colonies.

Class F. Modern Animal-drawn Vehicles (Two-wheeled Pleasure Conveyances).—This class includes Gigs; Dogcarts; Village Carts; Pony Carts; Buggies; Stanhopes; Irish Outside and Inside Cars; Mail Carts; American Trotting Buggies; Private Cabs.

Class G. Modern Animal-drawn Vehicles (Four-wheeled Pleasure Conveyances). This class includes Mail Coaches; Four-in-Hand Pleasure Coaches; Private Omnibuses; Sociables; Broughams; Landaus; Landaulettes; Victorias; Spider Phaetons; Ladies' Phaetons; Mail Phaetons; Wagonettes; Tea Carts; Pony Chaises; Dogcarts (four-wheeled).

Class H. Modern Animal-drawn Vehicles (Public and Trade Conveyances.)—(*a*) Four-wheeled: Omnibuses; Drags; Char-à-Bancs; Cabs (public); Trade Vans, &c. (*b*) Two-wheeled: Cabs (public); Tradesmen's Delivery Carts, &c.

Class J. Modern Animal-drawn Vehicles (Heavy Haulage and Special Transport Conveyances.) — Town Wagons; Tumbrils; Trollies; Lurries; Drays and Vehicles for general Merchandise; Special Vehicles for Timber, Metallic Girder, Water Main, Stone, Plate Glass, and Liquid Haulage; Wheeled Fire Escapes and Fire Engines; Agricultural Carts and Wagons; Wagons specially adapted for use in Mechanical Haulage.

Class K. Coach, Carriage, and Hunting Accessories.—Coach and Carriage Lamps, internal and external; Mats; Rugs; Umbrellas; Foot Cosies and Warmers; Electric and other Heaters; Travelling Outfits and Containers; Splash-board Clocks; Carriage Clocks; Coachmen's Communicators and Indicators; Velocimeters: Cyclometers; Coach Horns; Warning Bells and Syrens.

Class L. Coaching, Driving, and Equestrian Tailoring.—Coach-Guard Uniforms; Coachmen and Footmen's Liveries; Livery Hats; Cockades; Monogram and Coat of Arms Buttons; M.F.H. Huntsmen's and Whips' Caps; Buckskins; Cords and "Pinks;" Jockeys' Outfits; Special Driving and Covert Coats; Top-boots; Ladies' Habits —Cycling Costumes for both Ladies and Gentlemen; Hunting and Driving Waterproofs; Travelling Clothing for all climates.

Class M. Coach and Carriage Builders' Material.—Coach and Carriage Leathers; Coach Laces; Lining Cloths; Brocades; Genoas; Tabarets; Velvet Piles and other Lining Materials; Budget Trimming; Curtains; Tassels; Trimming Material and Gimping; Spring and Roller Blinds; Buttons; Communicator Cords; Speaking Tubes; Colours; Oils; Varnishes; Painting Material; Lining Tools; Candles; Lamp Oils.

Class N. Coach and Carriage Builders' Parts.—Hand-made and Machine-made Wheels; Heavy Haulage Wheels; Channel Felloe Wheels; India-rubber Tire Wheels; Pneumatic Tire Wheels; Metallic Boxes; Roller and Ball Bearings; Axles; Springs, Elliptic, Metallic C, and Strap Suspension; Body Parts; Shafts; Forgings; Bolts; Nuts; Washers; Pins; Door and Window Furniture and Fittings; Self-Acting Door Opening and Closing Gear; Material and New Inventions connected with Springs, Axles, Boxes, Wheels, Tires (metallic and anti-percussive), Poles, Shafts, Fore-Carriages, and Carriage Constructional parts generally.

Class O. Coach and Carriage Builders' Plant and Machinery.—Machine and Hand Tools used in coach and carriage building; Special Wood-working Machinery used in body-making; Wheel-making Machinery; Spoke and Copying Lathes; Tire Rolling, Drawing, Spinning, Fitting, Removing, and Shrinking Machinery; Shaft-making and Bending Plant; Window Glass Bevelling and Embossing; Pneumatic Spray Painting Plant.

Class P. Stable and Harness-room Fitments and Equipment.—Metallic Stalls; Loose Boxes; Mangers and Fittings; Racks; Special Pavings; Cornbins, rat proof and metallic; Harness Brackets; Jacks and Lifting Gear; Mechanical and Electric Horse Groomers and Clippers; Carriage and Stable Utensils of every description.

Class Q. Modern Muscularly Propelled Vehicles.—Cycle Chaises; Cycle Cabs; Special Gear Cycles; Cycle Fire Engines; Cycle Tradesmen's Carts; Cycle Parcels Deliveries.

Class R. Horseless Carriages. — Mechanically Self-propelling Passenger Carriages (public or private) of all kinds driven by Electricity.

Class S. Horseless Carriages. — Mechanically Self-propelling Passenger Carriages (public or private) of all kinds driven by Springs, Caustic Soda, Ammonia, Gas, CO_2, and either Spirit or Petroleum, ignited within the cylinders.

Class T. Horseless Carriages.—Mechanically Self-propelling Passenger Carriages (public or private) of all kinds driven by Steam, Compressed Air, Compressed Gas, Hot Air, Petroleum used as an evaporative fuel for boiling either water or spirit, and all Motors actuated by the expansion of gases but in which no ignition takes place within the cylinder.

Class U. Mechanically-Propelled Road Vehicles.—Mechanically Self-propelling Goods-carrying, Composite, or Haulage Vehicles driven by Electricity, Petroleum, or Steam, or other motive power.

Class V. Motors and Gears.—Steam, Electric, Compressed Air, Spirit, and all kinds of Motors suitable for Mechanically Self-propelling Road Vehicles, together with the various and special Gears for use in conjunction with them.

Class W. Autocar Builders' Materials and Parts.—Light Steel Construction Tube; Aluminium Castings; Metallic Wheel Rims; Wire Spoke or Suspension Wheels; Light Spoke Wheels; Heavy Road Loco Wheels; Expanding Wheels; Boxes Sheet Metal; Deep Stampings, hot and cold Pressings; Sprocket Wheels; Chain and Tooth Gear; Ball and Roller Bearings; Balls; India-rubber and Pneumatic Tires; Armoured Tires; Pneumatic Tire Valves and Compressors; Special means of mounting and removing Pneumatic Tires.

Class X. Autocar Builders' Plant and Machinery.—Machine and Hand Tools used in Autocar Building; Metallic Wheel-making Machinery; Metal-working Machinery; Lathes, Shaping, Drilling, Milling, Slotting Machines; Contouring Machines; Rubber and Pneumatic Tire-making Plant; Tire, Rolling, Drawing and Spinning Machinery; New Inventions relating to Auto-Carriage Construction; Electro-Silver and Nickel-Plating Plant; Grinding, Buffing, and Polishing Machinery; Electric Welding, Bending, and Setting Plant.

Class Y. Military Locomotion and Transport.—Military Traction Engines; Gun Carriages; Army Service Corps Transport Wagons; Hospital Corps Ambulances (wheeled) Panier Ambulances, Army Medical Department Transport of Material; Mule Transport; Devices for attaching Guns and Carriages to Mule Saddles; Cycle Corps Equipment; Mechanically Propelled Gun Carriages and Transport Wagons; Cycle Machine Guns and Light Ordnance Carriages.

Class Z. Miscellaneous.—Special Vehicles for the live and dead transport of Horses by road and rail; Special Vehicles for the rail transport of Cycles; Ambulances; Humane means of despatch; Life-boat Transport Carriages; Board of Trade Rocket Apparatus Transport Carriages; Stable Slinging Gear; Marine Transport Slinging Gear; Stag and Hound Carts and Vans; Home Exercisers for both Saddle and Cycle; Coaching and Hunting Trophies; Challenge and Competition Cups and Shields.

PORTSMOUTH NEW DOCKS.—In our account of these works in THE ENGINEER of the 21st ult. we mentioned the names of the makers of the Portland cement used. We omitted, however, the names of Messrs. Charles Francis, Son, and Co., who inform us that they were contractors of from 17,000 to 22,000 tons of the cement required.

TRADE AND BUSINESS ANNOUNCEMENTS.—Owing to the falling in of a lease, the old-established business carried on for fifty years by Samuel Fisher and Co., at the Nile Foundry, Birmingham, as specialists in tube-making plant and machinery for sugar making, has been transferred to Pershore under an amalgamation with the well-known firm of E. Humphries and Co., Limited, agricultural and general engineers of that place, where in future the combined businesses will be carried on under the management of the acting partners in the late Birmingham firm.

ELECTRIC MOTOR CARS are to be tried on the Manhattan Elevated Railway in New York city. The system to be experimented with is that controlled by the Electric Storage Battery Company, of Philadelphia, in which the motor car has a storage battery sufficiently powerful to operate it for a round trip. The battery furnishes part of the current required by the motors when starting a train or climbing a steep grade, and all the current when the motor car is on the curve or on side tracks at terminals. On the other hand, when the train is running on a straight and level track the current distributing rail furnishes current in excess of that required by the motors, which goes to charge the batteries. *Engineering News* says a special advantage of this system of elevated railway service is that breaks in the line by fire or accident do not stop the operation of the whole road, as the trains can be run by battery alone over such portions of the line as are dead.

THE INSTITUTION OF JUNIOR ENGINEERS.—On Saturday, 29th ult., the members of this Institution visited, by invitation of the directors, the National Skating Palace, to inspect its engineering features, the party numbering over 150. They were shown over by Mr. A. H. Tyler, Mr. Cooper, and other gentlemen. At the conclusion of the visit, Mr. H. B. Vorley, vice-chairman of the Institution, expressed the members' acknowledgments for the special arrangements which had been made for their benefit on the occasion. The two main refrigerating engines of this installation were supplied by Messrs. J. and E. Hall, and are each capable of making 25 tons of ice per 24 hours. The electric light engines, by Messrs. Crompton and Co., are of the inverted vertical compound type, and indicate 57-horse power at 250 revolutions per minute. Three Davey-Paxman 40 nominal horse-power boilers of the locomotive type supply steam. The water is obtained from a well 353ft. deep, which was sunk by Messrs. Tilley and Sons. The steam from the main engines is condensed in jet condensers worked by the engines themselves, and that from the electric light engines by an evaporative condenser situated on the roof, the air pump being worked by an independent engine. The refrigerating engines, which are of the compound tandem variable expansion type, are worked upon Messrs. Hall's carbonic acid system—cooling a solution of chloride of calcium by the evaporation of the liquefied gas. The brine is circulated by centrifugal pumps through the entire rink floor, consisting of a series of shallow tanks, upon the upper surface of which the ice is formed. The actual skating area of the rink is 11,117 square feet.

RAILWAY MATTERS.

It is notified that the Snowdonian Railway is finished, and will certainly be ready for, very possibly, a huge summer traffic.

Although it is only seventy years since the first railway in the world was finished, four hundred thousand miles have been constructed, the British Empire accounting for about one-sixth of this.

The Madras Electric Tramway Company is making great extensions, in very striking contrast to the progression by inches, with much retracing of footsteps, that formerly made the company's early days so unfortunate.

The Indian Government has made arrangements for taking land in the Hassan district for the construction of a railway from Arsikere to Mangalore, *viâ* Habankatta, Adiballi, Bogdedudda, Hassan, Alur, Belagod, Saklespur, Hebsala, Yettiyanhalli Valley, Kempkal and Marlibid.

During the year 1895 the Baldwin Locomotive Works built 401 locomotives. The output is about 28 per cent. in excess of that of the previous year, when but 313 locomotives were built, and about 52 per cent. of the product of 1893, when 763 locomotives were sent out. Of the 401 locomotives built during the past year, 162 were for export. There are now in hand orders for 90 engines. Of the number 20 constitute the balance of the order placed some months ago by the Russian Government. These 20 engines are now about ready for shipment.

The formal ceremony of cutting the first sod of the Ahmedabad-Parantij Railway Company was performed recently by the Governor of Bombay, and in the meantime the work has been taken in hand by the disposal of the Bombay-Baroda and Central India Railway Company, who are to construct and work the line for the proprietary company. An extension of the line as far as Ahmednagar, in the Idar State, has already been sanctioned, making the total length of the line about fifty-four miles. A further extension to Oodeypore will doubtless follow at no distant rate.

The Canadian House of Commons on Tuesday night, by 55 votes to 54, threw out the Bill enabling the Chignecto-Maine Railway Company to issue further bonds and extending the time for the completion of the enterprise. Nearly £700,000 of British capital has already been sunk in the project. The members who spoke against the Bill said that they were rendering good service to investors, as the additional capital required—£300,000—would be simply thrown away, and the project would never pay. The *Times* says, "Mr. Provand, M.P. for the Blackfriars Division of Glasgow, has been in Ottawa some weeks in the interests of the railway."

A large electric locomotive, built for experimental purposes by the Baldwin-Westinghouse combination, has been shipped from the Baldwin Locomotive Works at Philadelphia to the Westinghouse Electric and Manufacturing Company, at East Pittsburgh, where the electric equipment will be put in. This locomotive is intended for passenger service and has two four wheel locomotive trucks, each with a 6ft. wheel base and 42in. wheels. It is designed for 1000-horse power, and the weight on drivers is 120,000 lb. A short line has been built near the Westinghouse Electric and Manufacturing Company's works, on which this locomotive will be tried.

The Metropolitan Traction Company of New York city reports very favourably on the substitution of mechanical traction for horses in the operation of its system of street railroads. Under the horse system operating expenses were 70 per cent. of the gross receipts, while after substitution of mechanical traction—cable and underground electricity—on 20 of the 120 miles under the company's control, they amounted to but 54·4 per cent. On the Broadway line alone, the *Engineering Record* says, operating expenses have been reduced from 66 to 38 per cent. Recent additions to the system make its mileage of single-track cable, 25·34; electric conduit, 6·78; and horses, 131·38.

The returns of accidents on Indian Railways for the quarter ending March 31st, 1895, are now published. The total number killed was eight, and fourteen were injured, against nine and twenty-six for the corresponding period of the four previous quarters. The largest number of accidents occurred on the specal gauge lines. The East Indian and North-Western Railways were responsible for five and eleven collisions respectively more than in the four previous quarters. The Southern Mahratta Railway had the largest number of cattle accidents, *i.e.*, trains running over cattle straying on the line. In proportion to train mileage run, the number of accidents was largest on the Jorehat State Railway, and smallest on the Great Indian Peninsular Railway. Among the accidents recorded, the most serious was that which occurred on March 2nd, 1895, when the down Jubbulpore mail was derailed, owing to a rail having been maliciously removed between Jubbulpore and Deoree, which resulted in the death of four railway servants, and severe injuries to three passengers and one railway servant. The *Indian Engineer* says the marvel is that the casualties were not heavier.

For some time past the question of taking some step with the view of arresting the continued decrease in the second-class traffic, which for some years has been a prominent feature in railway accounts, has been engaging the careful attention of the principal railway companies, and we are authorised to state that the directors of the Great Western and London and South-Western Railway Companies have just decided to reduce the second-class fares generally over their respective systems, to a sum equivalent to about 1¼d. per mile, in the hope that this substantial reduction may induce many who would otherwise travel third-class to avail themselves of the second-class carriages. We are also informed that with a view to securing as far as practicable uniformity in the mode of caculating the first-class fares, the directors of the above companies have now determined to reduce the first-class fares to about 2d. per mile in all cases in which they are at present in excess of that amount. The exact date on which these alterations are to take effect has not yet been finally decided, as it will take some time to arrange the necessary details for giving effect to such important changes over the extensive systems of the two companies referred to.

The Leeds express on the Great Northern Railway got off the line last Saturday night. The settlement of a newly laid piece of line after a heavy fall of rain, taken with the great weight of the engine and tender, about 90 tons, are mentioned as causes. Two people were killed. Driver Guest is one of the oldest drivers in the company's service, and was in the Hitchin accident in 1869, when the York express ran over some sleepers, and in the Essendine accident in 1881, when the same train ran into a snow plough, and he was thrown into a goods wagon on the opposite line. He said the train was travelling down the incline between sixty and seventy miles an hour, when he felt a violent oscillation, and immediately called to the fireman, "We are off the road." His fireman applied the handbrake, and he shut off the steam, the train pulling up in 990 yards. Asked as to why the vacuum brake did not act immediately, he said it did. When the last carriage went into the parapet and broke its couplings the train quivered throughout its entire length, almost stopped, and then, with the brake on, skidded down the line, greasy with rain, like a skater going over ice, the sparks flying up and making it appear as if the train was on fire.

NOTES AND MEMORANDA.

In a recent paper on radiations emitted by phosphorescence, M. H. Becquerel describes an experimental proof of the fact that light emitted by phosphorescent substances possesses the power of affecting a photographic plate through a screen which is opaque to sunlight.

In a recent number of the *Comptes Rendus* is a paper on "The Carbide of Manganese," by M. H. Moissan. This carbide, Mn_3C, which is easily prepared in the electric furnace from Mn_3O_4 and sugar charcoal, differs from other metallic carbides in the simplicity of its reaction with water.

At the last meeting of the Physical Society, Sir D. Salomons showed some experiments with incandescent lamps. A large electro-magnet is excited by means of a continuous current, while an alternating current is passed through an incandescent lamp. On bringing the lamp near the magnet the filament is set in vibration, which is sufficiently intense to break the filament, if the lamp is brought near enough. The number and position of the nodes formed in the vibrating filament are found to be independent of the natural period of the filament, but depend on the frequency of the alternating current.

Of Russia's consumption of coal, 79 per cent. is her own coal, 17 per cent. is British coal, and 4 per cent. comes from other countries. In Sweden 88 per cent. of the coal consumed is British; in France, 12 per cent.; in Spain, 50 per cent.; in Austria-Hungary less than 1 per cent.; and in Italy nearly the whole is of British origin. The number of persons employed in coal production in various countries in 1894 was as follows:—United Kingdom, 665,747; Germany, 299,627; Belgium, 117,103; France, 131,587; Japan, 1893, 30,345; the United States, 1893, 363,309: British India, 43,197; Canada, 9654; New South Wales, 9131; New Zealand, 1899; and the Cape, 1601.

A question relative to animal mechanics was dealt with in a recent paper before the Paris Academy of Sciences on "The Relation between Muscular Work and the Albuminoid Materials of the Body," by M. A. Chauveau, which is an experimental study of the question as to whether albuminoids take part in the production of external work. The results show that the amount of nitrogen secreted is practically the same whether the animal is doing external work or not, and thus confirming the conclusion drawn by the author from previous experiments, that it is by the combustion in the muscle of carbohydrates that the energy necessary for external work is produced.

In 1894 the United Kingdom produced 188,277,000 tons of coal, Germany 76,741,000, France 26,964,000, Belgium 20,534,000, Austria 9,573,000, Japan—1893—3,371,000, and the United States 152,448,000 tons. Of the British Possessions, Canada produces between three and four million tons, and in addition imports about half her total consumption, principally from the United States. New South Wales produces about three and a half million tons, but, unlike Canada, her output has been of late years practically stationary. New Zealand yields over 500,000 tons per annum, but shows little or no increase. Natal's output rose from 26,000 tons in 1889 to 141,000 in 1894. Similarly in British India the production has steadily risen from 1,316,000 tons in 1883 to 2,821,000 tons in 1894. The countries which import coal in excess of the amount they export are Russia, Sweden, France, Spain, Italy, and Austria-Hungary; and of British Possessions, Canada, Victoria, Queensland, Tasmania, New Zealand, the Cape, and British India, together with all the minor Colonies with the sole exception of Labuan—Borneo.

Among the most recent and novel applications of wire, attention is drawn in *Hardware* to the wire fly-wheel, lately erected at the Mannesmann Tube Company's works, Germany, and especially notable in view of the well-known fact that heavy fly-wheels, driven at high velocities, present such dangers of breaking asunder from the great centrifugal force developed. The wheel at the factory mentioned is described as a cast iron hub or boss, to which are attached two steel plate disks, or cheeks, about 20ft. in diameter. The peripheral space between the discs is filled with some 70 tons of No. 5 steel wire, completely wound around the hub, the tensile resistance thus obtained being found to be far superior to that of any casting. This huge fly-wheel is driven at a speed of about 240 revolutions per minute, or a peripheral velocity of 2·8 miles per minute, or approximately 250ft. per second, which is said to be nearly three times the average speed of any express train in the world. For such a constructed fly-wheel the length of wire is estimated at about 250 miles. The use of paper is also regarded with favour for large fly-wheels, the tensile strength of paper being enormous, and it is quite possible that some of the new big wheels will be built up with a paper rim.

Mr. Henry Hall and Mr. Joseph S. Martin, two of her Majesty's Inspectors of Mines, have presented a report to the Home Secretary, which has just been printed, on the visit which they paid at the end of last year to Schalke, near Gelsen-Kirchen, in Westphalia, to investigate the experiments conducted there by Herr Bergassessor Winkhaus. The report contains a detailed description of these experiments, illustrated with reproductions from photographs. The inspectors think that the experiments prove, if further proof was needed, that the use of certain safety explosives in the stead of such explosives as gunpowder, dynamite, gelatine dynamite, gelignite, &c., would substantially diminish the risk of blasting operations in coal mines. English roburite appears to have been hitherto the most successful explosive. Legislation should not only specify the kind of explosive, but should also place a limit on the amount of charge and forbid its ignition except by electricity. It cannot be said that any safety explosive is absolutely safe; either ignition should take place "between shifts," in the absence of the workpeople, or the vicinity of each shot should be copiously watered. The inspectors add that gunpowder is entirely forbidden in mines representing about 80 per cent. of the total production—40,000,000 tons—of Westphalia. They recommend that a return should be obtained showing to what extent safety explosives are already in use in England with a view to their compulsory and general adoption.

In the discussion on Mr. A. A. C. Swinton's paper before the Society of Arts, on 4th inst., on the new photography, Mr. Brooks, of Reigate, drew attention to the fact that in March, 1877, he made a communication in that room to the South London Photographic Society with regard to non-luminous actinic rays, but he had no electric appliances, and used a horseshoe magnet. By exposing plates in complete darkness to the action of the magnetic field he obtained certain images, and found that even outside that there were invisible rays by which he could photograph through blackened cards, as had been shown that evening. But when he brought this subject forward, it was pooh-poohed, and so he let it drop. He would now renew his experiments, especially as he had seen some things now which explained what he could not then understand. He found that the rays he used were not due to magnetism, although associated with it; and he also found that he could even get rays from the fingers. In those days wet plates were universal, and a friend of his asked him for some chemicals and a bath to prepare some plates; he gave them to him, but next day his friend said they were useless, for every plate fogged. He himself then excited a plate, and exposed it, and found it perfectly clear, and so he came to the conclusion that there were some effect due to his friend's personality, and he proved this to be the case; for the placing of his friend's hand on the back of a plate was enough to fog it. In those days there were no pneumatic holders, and each plate had to be held by the corner, and on investigating the matter he found that in about 2 or 3 per cent. of cases rays were given off from the tips of the fingers, which shoot out 2in. or 3in.

MISCELLANEA.

Messrs. Laird launched on the 3rd inst. the second of the four 30-knot torpedo boat destroyers which they are building for the Chilian Government.

A Reuter telegram from St. Petersburg says that the Russian Admiralty has placed an order with the firm of Friedrich Krupp, of Essen, for the armour belt of the Poltava, the plates to have a thickness of 368 mm.

Amongst the new books announced by Messrs. Crosby Lockwood and Co. is one on light railways, by Mr. J. C. Mackay, A.M. Inst. C.E., and Messrs. Whittaker and Co. announce one on "Trade in the Far East," by Mr. C. C. Wakefield, F.R.G.S.

The £100 premium offered by the Marlborough Town Council for the best drainage scheme most suitable for the requirements of the borough has been awarded to Mr. G. Maxwell Lawford, Assoc. M. Inst. C.E., Westminster, and his scheme has been selected for immediate adoption.

The Imperial Russian Government having decided to lay down a considerable number of torpedo boat destroyers of the Sokol type—built by Messrs. Yarrow and Co., of Poplar—have invited that firm to co-operate with the Franco-Russian works for the construction of these vessels at St. Petersburg.

The Marylebone Vestry have decided to light Upper Regent-street with electric arc lamps. The cost will be £180 per annum, and the light equal to 6000-candle power; the present cost of gas—850-candle power—is £150 per annum. Upper Regent-street reaches only from Oxford-circus to the Langham Hotel, but has a considerable traffic.

The price of gas in Melbourne is 4s. 8½d., as against 4s. 6d. in Sydney and suburbs. The *Builder and Engineer* says, as larger steamers were employed between Melbourne and Newcastle than between Sydney and Newcastle, the difference in freight in favour of Sydney was trifling, and more than made up by the higher price obtained for residuals in Melbourne.

It is probable that the Government Bill dealing with the water supply of the metropolis, the pilotage of which through the House of Lords has been entrusted to Lord James of Hereford, will be introduced next week. The measures promoted by the water companies are down for consideration to-day, and the Government may be expected to assent to the second reading on the understanding that they shall be referred to a hybrid committee.

The officials at Devonport have received the programme of work for 1896-97. An improved Renown will be laid down on No. 3 building slip, on which the Arrogant is now in course of construction. The *Army and Navy Gazette* says that by the end of March, 1897, the Devonport, battleship, will be advanced to the extent of £125,772. The Arrogant is to be completed and the Furious is to be advanced. The Renown is to be completed for sea by June and the Talbot by May; the other item of new construction is the completion of the machinery of the Proserpine.

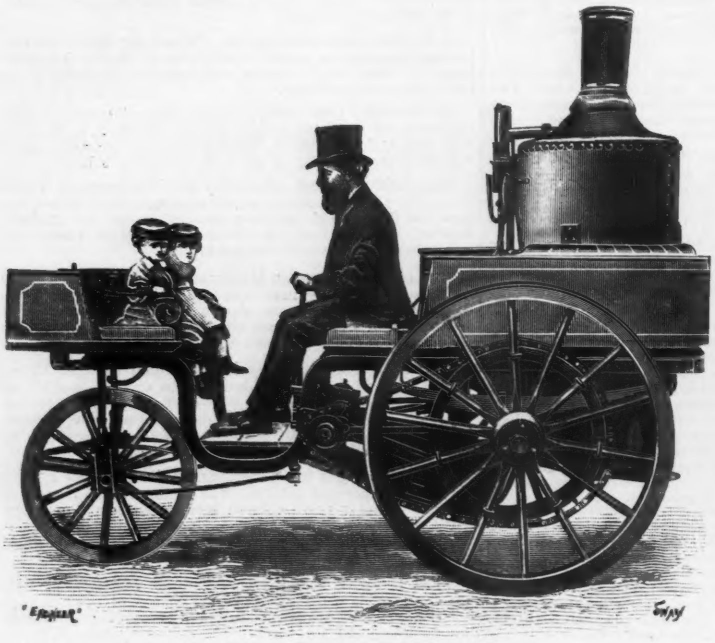
That "destroyers" of the Sokol type are finding favour with other than the Russian naval authorities, is evidenced by the fact that Messrs. Yarrow and Co. have now in hand at their works, and in an advanced state, four of that type of vessel—but somewhat larger—building for the Argentine Government. In these vessels—following the precedent of the Japanese Government—the machinery space will be partially protected by armour. All of them will be fitted with the Yarrow type of water-tube boiler. Messrs. Yarrow have also in hand at their works a number of water-tube boilers of their special type for various navies, the vessels for which are being built abroad.

The Admiralty have determined to solve the problem how to communicate effectually and promptly, not only between the bridge and the engine-room of a warship when she is steaming at high pressure, but between all parts of the ship. The *Naval and Military Record* says the service voice-pipe has long been condemned as a source of worry to all who have been called upon to use it, while the Admiralty have prudently hesitated before introducing the telephone, except in such parts of a ship as are not disturbed by the rattle of machinery or affected by electric currents. During last year's manœuvres the Homacoustic voice pipe was tried on the cruiser Fox, and although it was not a success at first, it was found that when three seamen from the deck and three stokers from the engine-room—one of each rating to serve in each watch—had become acquainted with each other's voices, the sound could be satisfactorily heard. Since then the apparatus, which has been so improved upon as to absolutely insulate the sound, has been tried with good results in the torpedo boat destroyers, and the company is now putting in an installation in the Eclipse, which is to have her trials in May. One side of the ship is to be supplied with the service voice-pipe, and the other side with the Homacoustic apparatus.

Particular attention is being drawn now to the woods of the South American colony of British Guiana, and especially to the Greenheart, which as sawn timber is being largely introduced into this country by the Berbice Steam Saw-mill Company, and used for platforms, brewery floors, and other places where the well-known weather and water-resisting qualities are of great value. Greenheart has long been looked upon as an expensive timber, but necessary to some kind of engineers' work, and it seems almost strange now to see it used for the more commoner purposes. Among other British Guiana timbers now being sent out in various sawn scantlings by the company may be mentioned Bullet Tree or Beefwood, Mora, and Wallaba, which are in some respects second only to Greenheart. Like that timber, Bullet Tree or Beefwood is very hard and durable, and is suitable for resisting great wear and tear. Mora is recommended for railway work, for wood blocks for street paving and for other purposes. In British Guiana it has been found to answer well in the construction of sleepers, having proved very durable. It costs less than Greenheart. Wallaba is used very extensively for vat making in connection with the rum industry on the sugar estates, and would, it is said, answer well for brewery vats. The Berbice Saw-mill Company have offices in London, and Messrs. Whitbread and Co. have used their Guiana timbers for several purposes.

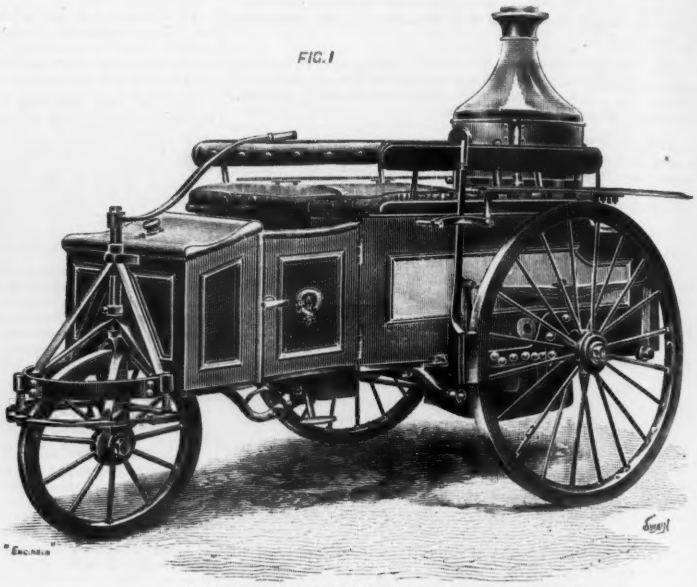
The opening ceremony of the Howrah waterworks took place on the morning of the 8th ult. The works are designed to furnish the municipal town of Howrah, having a population of 125,000, with a water supply of 10 gallons *per capita*, or a maximum of 1,250,000 gallons per day. The water is taken from the river Hooghly at Serampore, where the pumping station is located, and after passing through the usual settling tanks and filter beds is pumped into three raised reservoirs in the town of Howrah, from which it is distributed throughout municipal limits by thirty-seven miles of iron pipes varying in diameter from 16in. to 2in. The water is served to the public by 240 standposts. The supply pipes to the elevated reservoirs are so arranged that in the event of accidents or damage to any of the reservoirs, the supply to it can be cut off from the main, and continued to the distribution pipes direct by a by-pass provided with the usual fittings. The pumping plant consists of two duplicate sets of compound condensing direct-acting steam pumps of Messrs. Joseph Evans and Son's well-known duplex type. The engines for the suction and delivering into the filter beds have steam cylinders of 8in. and 14in. diameters and a stroke of 18in., while those for the filtered supply have cylinders of 11in. and 20in. diameters with a piston stroke of 12in. Steam is supplied to both sets of pumps by three Lancashire boilers.

SOME HORSELESS CARRIAGES



HOLT'S STEAM CARRIAGE, 1867

FIG. I



CATLEY AND AYRES' STEAM WAGONETTE, 1863-67

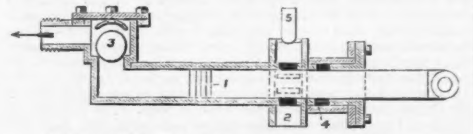
SOME HORSELESS CARRIAGES.

IN our impression of the 7th ult. a description was given of the steam carriage designed and made in 1866 by Mr. H. Percy Holt, a carriage in which there are several points of interest in connection with the engines and their gear and arrangements. This carriage was subsequently sold to Mr. S. G. Rhodes, who had previously been making a carriage which we now also illustrate. Mr. Rhodes of this carriage says it was one he "began to build in 1863," and that, "when completed, it did some very fair running. At first it was direct action on four wheels, and not satisfactory, but when altered to the form as shown in the drawing, it ran splendidly on any road and over new metal."

He also bought the steam carriage from Mr. Holt, and of this he sends us the photograph we now reproduce. Mr. Rhodes made some alterations in it, including the lap of the valves and the position of the excentrics. And writing from the works of Messrs. Rhodes Bros., mechanical and electrical engineers, Hanover Works, Leeds, Mr. Rhodes says:—"The photograph shows myself and twin sons on Holt's carriage a quarter of a century ago; Rhodes Bros. are the same twins." Referring to the pump mentioned in our notice of Mr. Holt's carriage, Mr. Rhodes sends a sketch, from which the annexed engraving is made, saying that he had previously used it on his own carriage.

In this engraving 1 is the plunger with rings on the end; 2, a cage round pump barrel over the slots with water inlet pipe 5; 3, ball delivery valve; and 4, packing, which had not any pressure to withstand.

Of this pump he says:—"This pump, when running quickly, would lift water in a state of ebullition 3ft. and force into boiler at 150 square feet. The plunger bared the slots at the end of the stroke, where it was moving slowly and coming to a stop; the pump never failed."



FEED PUMP OF HOLT'S STEAM CARRIAGE

Of his own carriage Mr. Rhodes sends the drawings, from which it appears that the two cylinders are connected to one crank shaft with cranks at right angles, and with a chain pinion on each end driving the road wheels, to which chain wheels are attached to the spokes. Both wheels are equally driven, no arrangement being provided for turning corners. Subsequently the crank-shaft was separated into two lengths, and each engine ran independently, thus allowing for corner turning. The frame was made of 4in. by ¼in. flat iron, with a 1½in. angle riveted to the top edge, and was carried on three wheels, two driving-wheels 5ft. diameter by 3in. face, and one steering-wheel 3ft. diameter by 3in. face, strongly made of oak, and steel-tired; between the driving axle and frame were long leaf springs, connected with radius rods to the engine crank shaft; the front wheel was carried by a fork fitted with sliding bearings supported on spiral springs and connected by links to the steering handle.

The boiler was 2ft. diameter by 3ft. 6in. high, and had seventeen Field tubes and thirty-six flue tubes into smokebox, and worked at a pressure of 150 lb. per square inch. The engines were placed one on each side of the boiler, and had cylinders 3⅛in. bore by 9in. stroke, and geared 5 to 1 to the driving-wheels by means of pitch chain.

The feed pump, which was worked from one of the engine crossheads, was specially designed, and probably the first of its kind, made to lift and force boiling water, and had only one valve. A feed pump made to this design was afterwards fitted to Mr. Holt's steam carriage.

Part of the exhaust steam was turned into the water-tank to heat the feed, the remainder into the chimney, and rendered noiseless by means of a double cone blast nozzle. All the machinery was completely enclosed, and the carriage ran successfully for many years without any serious accident or complaint, and would make from twelve to fourteen miles per hour with ease.

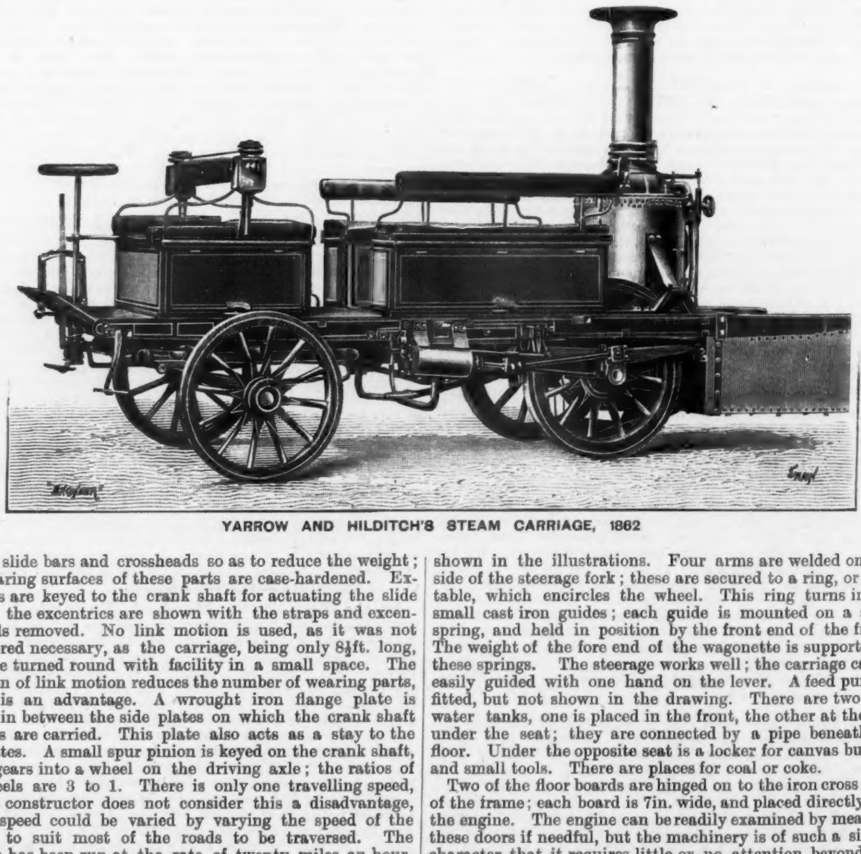
In further addition to the steam carriages which have recently appeared in THE ENGINEER, there is another of merit yet to be described. This vehicle was made in 1869, by Messrs. Catley and Ayres, who exhibited it at the Yorkshire Agricultural Society's meeting held at York in 1871, and has only been briefly referred to in any publication.* There are several interesting features embodied in this carriage deserving a full description, which at the present time cannot fail to interest many of the readers of THE ENGINEER.

The wagonette is illustrated by the above engraving from a photograph. On page 265 is a plan of the machinery, with the carriage body removed, and a side view of the same. The frame is made of bar iron 3¼in. deep and $\frac{5}{16}$in. thick, bent to the shape required, and the ends welded together. About the middle of the frame there are two pieces of tee iron, and there are transverse bars in other parts for stiffening the structure. The horn plates for the axle-boxes and the deeper plate for the cylinders are welded in the frame, as shown on page 265.

The carriage is propelled by a pair of horizontal engines, driving a short crank shaft with the two cranks placed at right angles to each other. The cylinders are 2⅜in. diameter, and 5¾in. stroke; the piston heads are forged with the rods. The pistons have grooves cut in them for two steel rings; each ring is $\frac{3}{16}$in. wide and ⅛in. thick. Wrought iron is used for the slide bars and crossheads so as to reduce the weight; the wearing surfaces of these parts are case-hardened. Excentrics are keyed to the crank shaft for actuating the slide valves; the excentrics are shown with the straps and excentric rods removed. No link motion is used, as it was not considered necessary, as the carriage, being only 8½ft. long, could be turned round with facility in a small space. The omission of link motion reduces the number of wearing parts, which is an advantage. A wrought iron flange plate is riveted in between the side plates on which the crank shaft bearings are carried. This plate also acts as a stay to the side plates. A small spur pinion is keyed on the crank shaft, which gears into a wheel on the driving axle; the ratios of the wheels are 3 to 1. There is only one travelling speed, and the constructor does not consider this a disadvantage, as the speed could be varied by varying the speed of the engines to suit most of the roads to be traversed. The carriage has been run at the rate of twenty miles an hour, and has travelled up gradients of 1 in 20.

The hind axle is 2in. in diameter; the bearings are made of cast iron sliding in the iron plates; the weight of the hind part of the carriage is passed to these axle blocks through long plate springs, as shown in the engravings. As the crank shaft and main axle are on the same horizontal centre line, the up-and-down motion of the axle caused by the action of the springs will not affect the spur wheels very much, if the movement is not excessive. An arrangement like this has been used on one maker's traction engines for many years without any serious inconvenience.

The driving wheels are 3ft. 6in. in diameter; the twenty spokes in each wheel are made of ½in. round iron, with collars forged on the outer ends faced in the lathe, and chased on the ends beyond the collars, as shown in Fig. 3. The ends of the spokes are screwed into a 2in. by $\frac{5}{16}$in. wrought iron hoop, and into the ash tire also; the felloes are dowelled together with iron pins. At this stage the wheels were sent into the foundry to have the bosses cast on, afterwards they were bored and faced in a lathe; the wood tires were also turned on the sides and on the outer edge. The outer hoop was next shrunk on; it is made of 2in. by ½in. iron. It will be seen that the inside hoop, the wood tire, and outside hoop are riveted together. This makes a light and satisfactory wheel. One of the driving wheels is keyed to the axle, the other runs loose so as to facilitate turning. The front wheel is 2ft. in diameter, and is made in the same manner as the hind wheels; the leading wheel runs in a fork, the spindle of which turns in a double guide of light wrought iron; the guide is riveted to the fore part of the frame, as shown in the illustrations. Four arms are welded on each side of the steerage fork; these are secured to a ring, or turntable, which encircles the wheel. This ring turns in four small cast iron guides; each guide is mounted on a spiral spring, and held in position by the front end of the frame. The weight of the fore end of the wagonette is supported by these springs. The steerage works well; the carriage can be easily guided with one hand on the lever. A feed pump is fitted, but not shown in the drawing. There are two feed-water tanks, one is placed in the front, the other at the side under the seat; they are connected by a pipe beneath the floor. Under the opposite seat is a locker for canvas buckets and small tools. There are places for coal or coke.



YARROW AND HILDITCH'S STEAM CARRIAGE, 1862

Two of the floor boards are hinged on to the iron cross stays of the frame; each board is 7in. wide, and placed directly over the engine. The engine can be readily examined by means of these doors if needful, but the machinery is of such a simple character that it requires little or no attention beyond the lubrication of the working parts. The driving wheels are fitted with lever hand brakes, as shown.

The boiler is of the vertical fire-tube type, constructed of Lowmoor iron plates. It is 3ft. high, and 17½in. external diameter. The shell plates are $\frac{5}{16}$in. thick, and the tube plates are $\frac{7}{16}$in. thick. A spiral tube superheater is fitted in the smoke-box made of 1½in. piping; the steam passes through this coil on its way to the engine cylinders. The iron smokebox and chimney are covered with a polished copper casing. To prevent the radiation of heat, the boiler is coated with a

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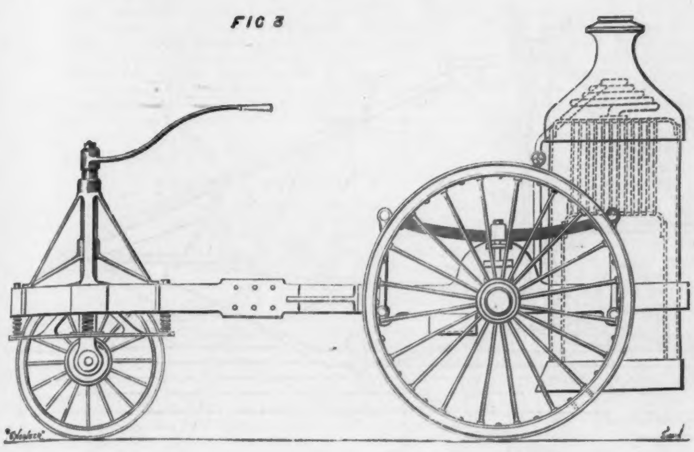
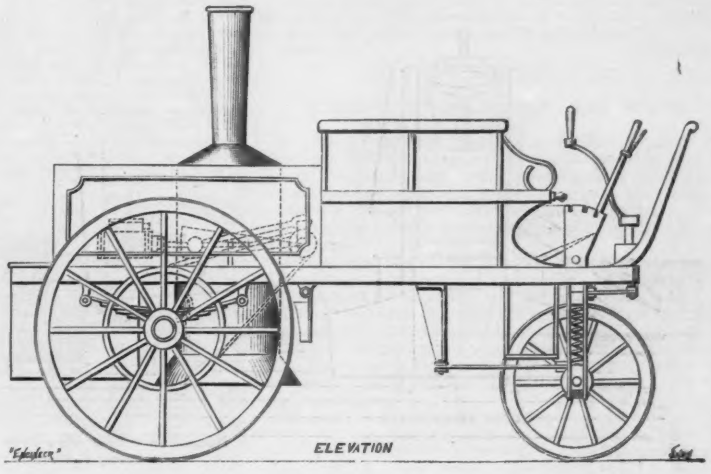
[*] "The History and Development of Steam Locomotion on Common Roads," by W. Fletcher, page 185. E. and F. N. Spon. 1891.

SOME HORSELESS CARRIAGES

FIG 3





ELEVATION

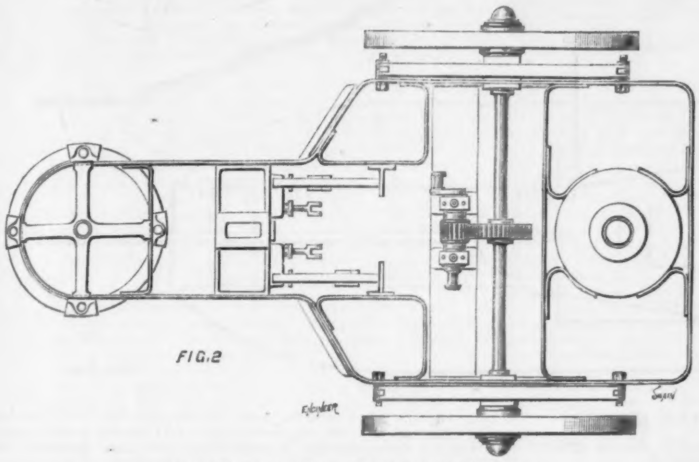
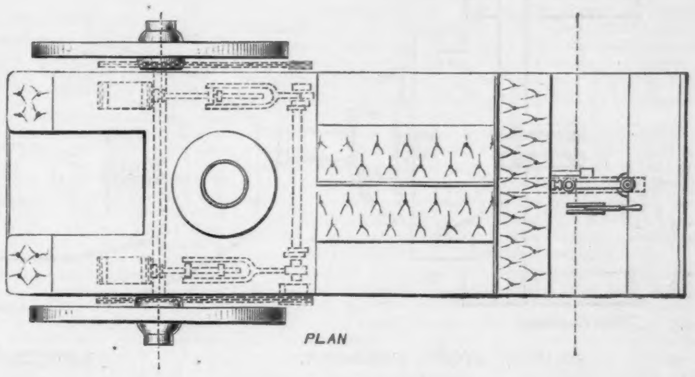


FIG.2



PLAN

CATLEY AND AYRES' STEAM WAGONETTE

RHODES' STEAM CARRIAGE

thickness of non-conducting material, and polished mahogany lagging outside. Mr. Catley tested the boiler with water up to 400 lb. pressure per square inch. The working pressure is 150 lb. By using good coal very little smoke was made, but coke could be used if required. The boiler supplied dry steam, and the engines are set to work with an early cut-off. The passage of the exhaust steam into the chimney base causes very little noise, and therefore was not suppressed. Twenty gallons of water and about 2 cwt. of fuel can be carried.

The engine made many journeys during three years, carrying four passengers for eight or ten miles round York; the speed could be increased up to about twenty miles an hour on good level roads, and slower rates of speed were attained on gradients. Little noise is made by the carriage when travelling; there is no vibration whatever, and Mr. Catley says, "The horses they met during their numerous journeys took no notice of it."

An important feature of this steam wagonette is its very moderate weight. When the boiler, tanks, and bunkers are full, ready for a run, the total weight was only 19 cwt. Among the objections urged against the steam engine for carriage propulsion the supposed weight is always dwelt upon. But this example appears to show that with careful designing a steam carriage of substantial construction, and well adapted for hard work, need not necessarily be as heavy as many that have been built. The reduction in the weight is secured by the use of light bars of wrought iron for the frame. No cast iron is employed except where it is absolutely necessary, and when it is used the parts are made as small as possible. The driving gear is simple. The use of one speed cuts down the number of parts, and although in respect of the driving of only one wheel, and in small details improvements could easily be now made, it will be admitted that Mr. Catley's carriage presents several features of interest.

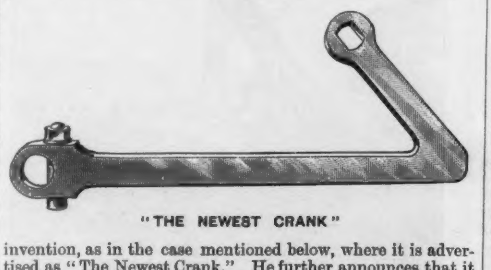
Brief descriptions and some illustrations have been published of Yarrow's steam carriage, exhibited in the 1862 exhibition by Messrs. Yarrow and Hilditch. We now publish an illustration made from a photograph placed at our disposal by Mr. A. F. Yarrow, and the following description is from a paper read by Mr. Yarrow before the Society of Engineers:—

"It is made to carry thirteen persons, including a steerer and a stoker. The steerer sits in the centre of the front seat, having one passenger on each side. Back to back with them are seats for three others, and for six more—three on each side—facing each other. By this mode of arranging the seats, it can conveniently be covered in, with a door on one or each side for entrance. The stoker is placed in the tender behind. The boiler is of the ordinary upright tubular type, the outside shell being steel. It is 2ft. diameter and 3ft. 9in. high; it has 40 square feet of heating surface, and a fire-grate 21in. in diameter. It is fitted with a perforated steam pipe round the top to reduce the chance of priming. The main framing of the carriage is ash, 4½in. deep, lined with edge plates ¼in. thick. To the outsides are bolted two iron foundation plates for carrying the cylinders, &c. On the inside of the framing are the driving wheels, which are 3ft. diameter; they have a cast iron boss similar to Crosskill's, and are both keyed on the main driving axle; on the outside of these wheels come the bearings which carry the springs; beyond these are fixed the cranks, to which one end of the connecting-rod is attached. The advantages claimed for thus arranging the parts are:—'That the gauge of the hind wheels being considerably reduced, does not necessitate throwing the inner one out of gear when turning curves; and, secondly, that direct action is obtained without having the axle cranked, which past experience has shown to be highly objectionable, as the continuous jolting very soon breaks it.'

"In order to keep the axle in its right position, a link is employed in preference to axle-box guides, as, by its use, far less friction is caused, and the distance between the shaft and cylinder is maintained precisely the same, and the action of the valves remains unaffected by the vertical play of the springs. One end of the link is connected to the axle bearings and the other to a provision on the foundation plate. The working parts are entirely boxed in to protect them from dust and grit. The cylinders are 5in. in diameter and 9in. stroke. When fully loaded the weight is 2½ tons; about 40 cwt. is carried on the hind wheels, and 10 cwt. on the front ones."

CYCLE MECHANICS.

IT has long been obvious that ordinary mechanical principles are things which many cycle inventors regard as inapplicable to cycles, and as mere trammels which prevent new developments. It is true the same inventors usually bow to these principles later, but in the meantime the public is sometimes taken into their confidence, with the result that public and inventor find out together that mechanical laws are most expensive when most ignored. It is not often that an inventor who defies these laws, so correctly names his invention, as in the case mentioned below, where it is advertised as "The Newest Crank." He further announces that it is protected, and says, "By this arrangement power usually wasted in the endeavour to get away from the centre or axle is utilised to create a circumferential movement, the efficient length of the crank is increased some 20 per cent., the traverse of the foot remaining the same. There being practically no dead centre, a perfectly even movement is obtained." We hope no steam engine makers will be caught infringing "The Newest Crank" patent.



"THE NEWEST CRANK"

SAFETY APPLIANCES FOR PETROLEUM TANKS.*

THE destruction by fire of the petroleum tank storage at Harburg in May last has directed attention to the subject of petroleum tanks, and the danger likely to accrue to the community from their situation in inhabited districts. The report on the Harburg fire, drawn up by M. Albrecht, tended, however, to dissipate the alarm at first occasioned by the catastrophe, by bringing to light the fact that the fire was not due to any specific danger inherent to the use of tanks for storage, but to defective appliances whereby a large volume of an explosive mixture of gas and air was enabled —under the favourable atmospheric conditions, viz., absence of wind, prevailing at the time—to collect above the cover of the tanks, and facilitated—or, at least, did nothing to hinder—the passage of the flames ensuing, when the mixture was ignited by lightning, into the interior, and so firing the inflammable gaseous mixture existing therein above the surface of the oil.

In considering how similar accidents can be guarded against, three main questions arise, viz., how can the tanks be protected against ignition: (1) by lightning, (2) by communicated flame from another fire, and (3) how may the danger of explosion be obviated? For the proper understanding and appreciation of the last question it must be recollected that the air space above the oil is filled with a mixture of gaseous hydrocarbons and air, the proportions of which mixture are liable to continual variation from the expulsion of mixed gas and the inflow of air occasioned by the alternate expansion and contraction due to changes of temperature. To return to the protection of tanks from lightning; it is requisite that an efficient installation of conductors must be provided. This can be carried out most suitably by the erection of four rods about 30ft. long, connected at about 16ft. above the lid of the tank by a copper cable of appropriate diameter; this will divert the course of a flash striking between the vertical rods. The system should be grounded to a network of pipes—gas or water pipes—or else to a copper plate of suitable dimensions sunk in the soil water, particular care being taken that all the connections are sound and protected by an efficient covering to shield them from atmospheric and other influences. The rods, cable, and ground plate will, of course, require to be capacious enough properly to conduct the electric current to earth, and the periodical examination of the condition of the installation is absolutely essential, especial care being needed to see that the weak points, viz., the connections, are in thorough working order. Measuring the resistance by means of the ordinary apparatus is not sufficient to detect other than large faults in this respect.

In the second point under consideration, the object in view is the prevention of the transference of flame from the external air into the gas space in the tank, and the most efficient method of effecting this is by making the ventilator tubes of a U form, the longer limb projecting through the edge of the tank lid downwards for a few feet, and being provided with three partitions of fine wire gauze—120 meshes to the square centimetre. This downward direction of the tubes will prevent the accumulation of heavy hydrocarbon gases on the cover of the tank. The ventilators will need to be of large diameter to allow ready escape of air during the filling the tank, and may conveniently be enlarged at the points where the partitions are inserted, in order to diminish friction.

The efficiency of this method of protective ventilation has been thoroughly tested on a small scale by the author, who found that the evolved gaseous mixture from petroleum heated in a current of air burned quietly away beyond the gauze interceptors, so long as there was gas to consume, but that, notwithstanding the varying proportions of the mixture—from saturation with gas down through the various degrees of inflammability and explosibility to attenuation—no lighting back behind the gauze occurred.

So far as reducing the effects of an explosion to a minimum is concerned, the chief precaution to be adopted is to make the tank cover as light as possible, and provide a liquid seal—glycerine or similar fluid—at its junction with the body, taking care that the cover cannot be carried away by the wind, and that it is in electrical connection with the lightning conductors.

The value of such appliances in the tanks as steam pipes—or, as has also been proposed, for places where steam is not available, carbonic acid apparatus—for the extinction of fire, is still problematical; but there is no doubt that the provision of a sound wall or embankment around the tanks is highly essential for the prevention of the outflow of burning oil, and not only would the risk of this be still further reduced by the introduction of a series of channels converging to a main leading to a spacious collecting basin at some little distance away, but the chances of saving a great part of the oil in case of fire would be notably increased.

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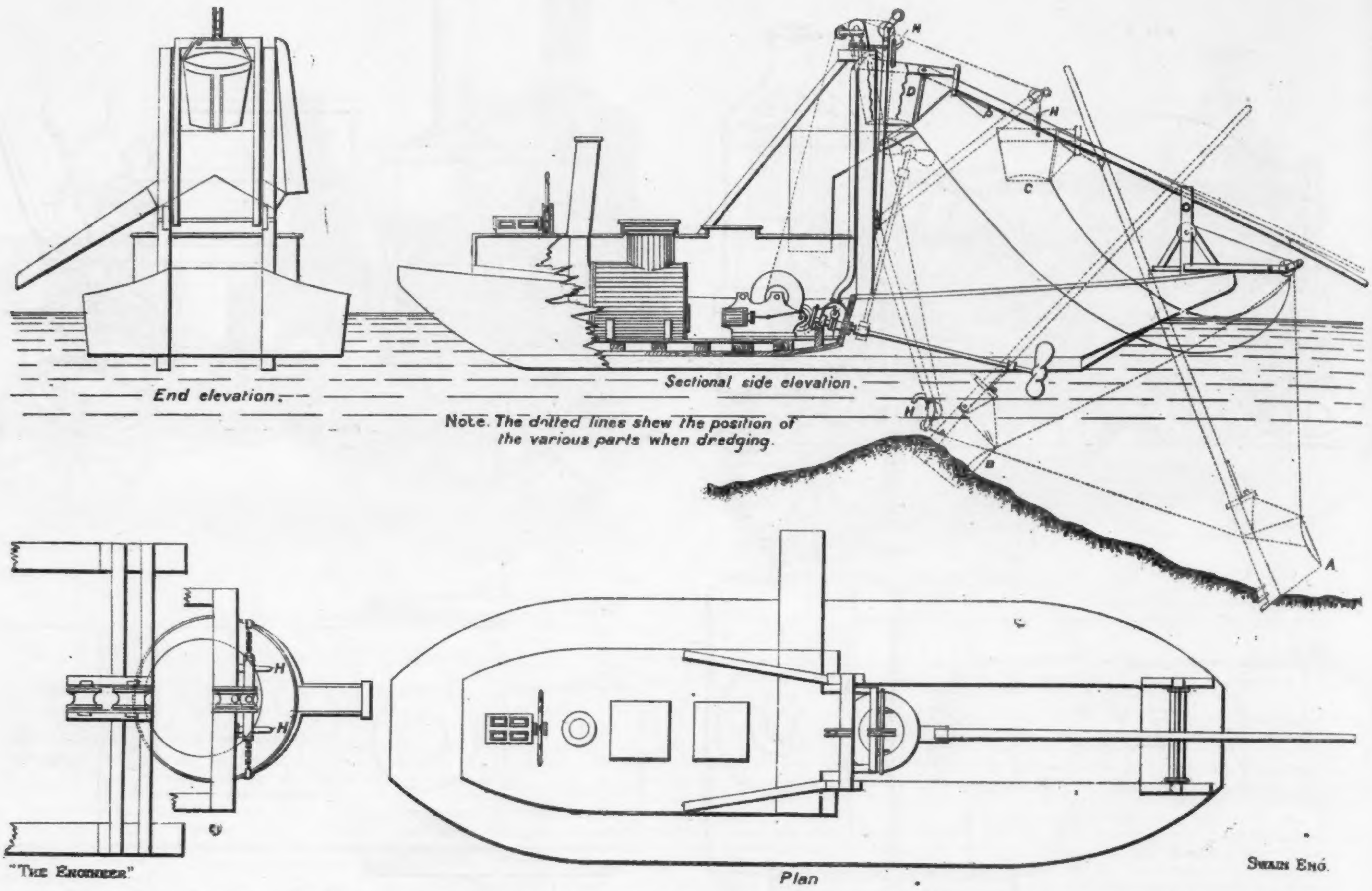
* Dr. R. Kissling, *Dingler's Polytechniches Journal*, vol. 299, page 118.

SWALES' SPOON DREDGER


End elevation
Sectional side elevation
Note. The dotted lines shew the position of the various parts when dredging.
D
H
C
B
A
O
Plan
"The Engineer"
Swain Eng.

SWALES' SPOON DREDGER.

In many situations and for some kinds of work a spoon dredger is the most effective machine. That which we illustrate by the accompanying engraving is the invention of Mr. W. Swales, Shoreham, and was used for years in connection with the Bournemouth and Boscombe sewage outfall works, for which Mr. Swales was the contractor. It was built by Messrs. Courtney and Birkett, of Southwich, Sussex.

Fig. 1 is a side elevation of the dredger, showing the bucket at various positions during the action of dredging. The dotted one marked A shows when the bucket is lowered and all ready to commence the cut. B shows the same after the end of the cut when the bucket has been hauled to the lowered gantry. C shows the bucket partly raised by the continued hauling in of the chain by the winch, and the radius described by the rising of the gantry, and at the point where the horns or projections H on the gantry are about to pass under the bridle of the bucket which keep it raised when over the shoots. D shows the whole in position ready for slacking back the hauling chain, and consequent opening of the hinged bucket bottom, allowing the discharge of spoil into the shoots. O is the chain used for holding the gantry in position when lowered. It takes the pull due to the force required to make the cut, and is worked from a roller winch controlled by a hand brake.

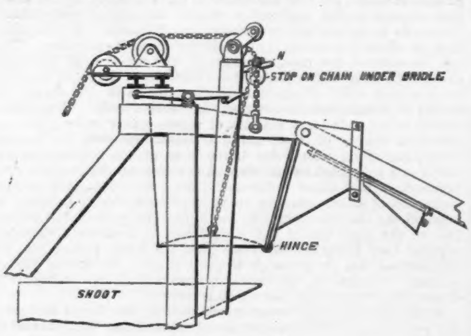


Fig. 2 is a side elevation to an enlarged scale, showing the arrangement and position of bucket over the shoots. Fig. 3 is a plan of this. Fig. 4 is an end elevation, and Fig. 5 is a longitudinal elevation partly in section of the dredger, showing the arrangement of steam winch and method of the driving screw propeller from it, and the universal joint for lowering or holding up the propeller, as may be required. Fig. 6 shows a plan of the gearing between the main winch shaft and the propeller shaft. When not dredging the dredger will make five knots an hour. It will do ordinary dredging in any depth from 3ft. to 30ft., lifting from 15 to 20 tons per hour, and discharging into hoppers or barges on either side. The water for clearing the bucket and shoots, it should be remarked, is discharged direct into the bucket by a pair of semi-rotary pumps worked by the main engine.

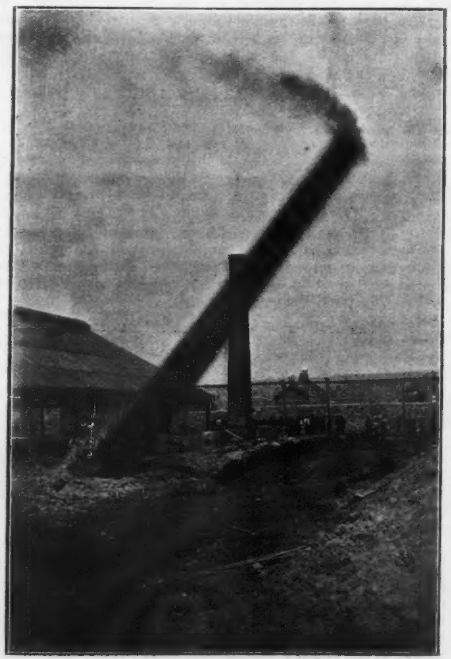
The Society of Arts.—In connection with the Indian Section of the Society of Arts a meeting is to be held at the Imperial Institute next Thursday evening, the 19th inst., when a paper will be contributed by Mr. J. H. Glass, C.I.E., on "The Great Landslip at Gohna, in Gurhwal." The chair will be taken at half-past eight o'clock by Sir Charles H. T. Crosthwaite, A.C.S.I., Member of the Council of India.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

DEMOLISHING CHIMNEYS.

Sir,—Referring to the illustrated article in your issue of February 28th, where you describe the demolition of a brick stalk in Manchester, I enclose you a photograph of a similar operation carried out by myself here in the year 1883. I proceeded in precisely the same manner in preparing the stalk as described in your article, and you will observe the smoke issuing from the top of the chimney from the fire which burnt away the supports. In these days instantaneous shutters were scarcely so highly developed as they are at present, and hence the image is somewhat hazy; the photograph was taken immediately before the final collapse took place. I did not take precise measurements at the time, but I remember remarking how small a space the fallen bricks occupied, and how suddenly the stalk collapsed and fell apparently vertically to the ground at the end of the operation. The collapse, if I remember rightly, took place at an angle only a few degrees greater than shown in the photograph. The method was not original on my part; I had heard of it being done some years before, but without details. I think that with the modern instantaneous shutter Mr. Smith might get some most interesting photographs taken at regular intervals during the falling of some large chimney. The eye is so apt to be deceived by operations of this nature which take place almost instantaneously.



I hope this photograph may be of interest to your readers.

Dumbarton, March 6th. A. Denny.

AMERICA AND THE BESSEMER PROCESS.

Sir,—Judging by the claims that have been put forward for Mr. Kelly as against Sir Henry Bessemer in the annual presidential address delivered at the recent Pittsburg meeting of the American Institute of Mining Engineers by Mr. J. D. Weeks, it would appear that this gentleman is very desirous to make amends to the Spanish nation for the action of the Americans in the matter of the Cuban revolution. Such, at any rate, must be the opinion of those Spaniards who regard their country as the birthplace of steam navigation. For if Mr. Weeks's arguments are to prevail, then the fame of Blasco de Garay must eclipse that of Robert Fulton, and with so much greater justice in this case as 260 years exceed 7, the number of years by which Kelly is said to have anticipated Bessemer's discovery.

If claims to inventions are to be wrested from those to whose names they are attached by the method of Mr. Weeks, it will fare badly with other inventors besides Sir Henry Bessemer, Kelly himself among the number. Turning, for example, to patent No. 3944 of the year 1815, we find mention of metal not being sufficiently decarbonated, or "not high enough blown," which, by the logic of Mr. Weeks, is clearly an anticipation of all subsequent pneumatic processes.

A. L. Holley's name occurs many times in the presidential address referred to, and apparently to give weight to Kelly's claim, or the claim made for him. Like other authorities, however, this one may be cited on either side. Speaking at Washington, D.C., on February 22nd, 1876, when Holley worthily occupied the very office now held by Mr. Weeks, he said to the assembled mining engineers, "Proceeding upon a chemical knowledge little superior to that of the average schoolboy, Bessemer developed his revolutionary process." No mention is made of Kelly in the whole of this address. How obscure Kelly's experiments must have been, and that they can have had no influence on the industry may be inferred from numerous references that were made as to the source of Holley's knowledge over his grave.

At the memorial session of the same Institute, now presided over by Mr. Weeks, held at Washington February 22nd, 1882, Mr. A. S. Hewitt, an ex-president of the Institute, said, "I think that I first called his—Holley's—attention to the Bessemer process, I mean to the subject of its introduction into this country. My firm had made a feeble effort within six weeks after the famous Cheltenham paper was read in 1856, to see whether pig iron could be thus converted into steel. It was three or four years, perhaps, after that that Mr. Holley's attention was called to the matter, and he went to Europe and brought back for his friends the control of that patent." It is strange Kelly's fame at this time should have been so obscure, if his achievements were what Mr. Weeks would wish us to infer.

Mr. P. Barnes, of Springfield, Ill., speaking at the same meeting, said, "My acquaintance with our good friend Holley began just before he went abroad to arrange for the definite introduction of the Bessemer process into this country, and after January, 1869, I was, until the day of his death, almost continuously employed, either as an *attaché* of his own private office, or else in local charge of some one or other of the works with which he was associated. . . ." No mention is made by Mr. Barnes, who was so intimately connected with Holley in the Bessemer industry, of any inspiration derived from Kelly.

I cannot find any reference to other than English practice as the starting point of that marvellous American development of the Bessemer industry, from which no one who is acquainted with it can withhold admiration.

At the memorial session of the American Society of Mechanica Engineers, held at Philadelphia on April 19th, 1882, Mr. James C. Bayles said, in his "tribute" to Holley, "We cannot fail to find interesting how this—present extent and prosperity of the industry—was brought about, chiefly by Holley's persistent industry and close study of details. Fully impressed with the possibilities of the Bessemer process, as he had witnessed its workings in England, he inspired others with his own enthusiasm." And again: "Early in the history of this industry Holley seems to have concluded that the best foreign practice was merely a starting point for an ingenious American engineer to work from." And yet again: "Bessemer probably has more claim to recognition as a great inventor than Holley; but if we compare the two men we see strikingly exemplified the difference between the inventor and the industrious engineer. Where Bessemer left the process which bears his name, Holley's work began. It was full of possibilities." . . . No disposition is shown by any of the speakers to give Bessemer one particle more than they thought his due, but the origin of the invention is never denied him.

Mr. J. C. Hoadley, of Boston, Mass., also said at the same meeting: "A few years later—in 1863—I met him, Holley, in London. He was seeking at that time to make arrangements with Mr. Bessemer for the manufacture of Bessemer steel in this country. With a perspicacity entirely characteristic of the man, he had perceived the transcendent importance of this invention, which was almost unnoticed by the world, and before Mr. Bessemer had ever received a shilling of legitimate compensation for his invention." And further on: "In that stage of the invention Mr. Holley, perceiving its great importance, with his own true-hearted loyalty, went directly to the man who had invented the process to get at the very limit—the utmost outpost of the invention; and we all know how much further he has carried it." Can stronger evidence be adduced in repudiation of Kelly's claim? F. J. R. CARULLA.

84, Argyle-terrace, Derby, March 10th.

RAILWAY ECONOMICS.

SIR,—Pending the further information promised by Mr. Tratman, I am content to leave the question of rail sections as it now stands in your correspondence columns; but concerning what has been called "building for posterity," Mr. Tratman sums up his view in a sentence more oracular than practical, which invites remark, particularly in view of light railways at home and new lines in external dependencies, both involving the question of State aid.

He says, "The underlying principle of colonial railways should be the construction of the greatest mileage at the least cost and in the least time; 'least cost' being, of course, considered in relation to the prospects of immediate or delayed increase in traffic."

It seems to me that the whole issue depends on the relative attention bestowed at the cutset upon immediate and delayed traffic. In the opening up of a new country the first lines constructed are likely to become the main trunks of the future, for two reasons: (1) They will, from commercial considerations, be located to serve the more developable districts, and planned to follow the easiest routes in conformity with the lay of the land. (2) The fact of their presence will stimulate activity in their neighbourhood, and create tributory traffic, and so pioneer lines will reap the advantage of being early in the field; an advantage which, in the plenitude of harvest, we may be too prone to ignore in our old country.

With these probabilities of pioneer lines becoming eventually main trade routes in a busy country, to lay them out on the principle of least cost for immediate traffic would be very false economy. A bad road cannot be transmuted into a good road easily or cheaply, and the more the necessity for reconstruction the greater becomes the difficulty of amendment as traffic increases. Initial mistakes are thus likely to be perpetuated, to the detriment, not only of the undertaking, but of the country.

This is the point which seems to be overlooked by Mr. Tratman, and generally avoided, as is, perhaps, natural when immediate dividends are the first consideration, or when capital is insufficient. It is the dividing point between true economy and makeshift expediency, and possibly also a point at which Government interference may assist commercial enterprise.

There is little fundamental difference between the economics of railways and common roads, and I fear we have forgotten the immense influence of the old coach roads made by the Romans, or after their example, in developing our own country. If our ancestors had been satisfied to let roads evolve themselves, on the principle of immediate requirements, by filling up ruts and holes now and then, there would not have been money or enterprise enough in the whole land to build the first railway. At the present time, however, the great results of this imperial interference are thought of no more than the rotation of the earth, and other familiar institutions, which in a vague way we credit to Providence, when it occurs to us to think of them at all.

The parent question concerned permanent way only, but future requirements ought to be kept in view when curves and gradients are determined for a pioneer line. With light railways having no expectation of great traffic, permanent way is, perhaps, of even greater moment as a factor in true economy, although in a rather different sense. Here the main object should be to construct a road requiring the least outlay in renewals, and the least daily attention; and therefore wood should be excluded altogether, both for sleepers and keys. For light traffic metal keys may be made perfectly efficient; and with steel sleepers and light double-head rails—with their advantage in stiffness which has been pointed out—a track may be constructed which will require the minimum of maintenance.

Whether we regard pioneer railways with their potential importance, or light lines with their slender incomes, the necessity of adequate outlay in the beginning is alike apparent if we consider economy in its proper sense. It is the duty of the State, and the policy of great corporations, to consider posterity; and the power of capital possessed by both can never be more beneficially exercised than in founding reproductive works on the ancient Roman system of doing things well. JAMES WHITESTONE,

113, Queen Victoria-street, E.C., February 25th.

ENGINEERS FOR THE NAVY.

SIR,—The 200 engineers proposed to be raised to 300 are those of the Naval Reserve—see end of paragraph 3 under the heading Royal Naval Reserve, page 5, Statement of the First Lord of the Admiralty, explanatory of the Navy Estimates, 1896-7—but as this force has been nearly stationary for the last two years, this increased number is not likely to be obtained.

The statement that the number of applicants is such as to meet the necessary requirements of the service is as inaccurate, misleading, optimistic, and at variance with the facts as official utterances on this subject usually are. At the end of the year 1894-5 the number of engineers were 773, a deficiency of 12 on the strength of the establishment. The Navy Estimates for 1895-6 provided an additional 53, bringing up the extra number required to 65.

The above statement of the First Lord of the Admiralty gives the idea that these 65 engineers have been obtained, but this is not the case; the number obtained are but 27, all assistant engineers for temporary service, entered at a greatly reduced standard. The deficiency, which at the end of 1894-5 was 12, has thus risen at the end of 1895-6 to 38. The Navy Estimates for 1896-7 provide for 850 engineers, an increase of 12 on the estimated numbers for 1895-6, and of 50 on the present numbers. The incorrectness of the First Lord of the Admiralty's statement as to engineers throws doubt on those as to engine-room artificers and stokers. If statements which can be rectified turn out incorrect, what is likely to be the case as to those whose accuracy the public have no means of testing? C. P.

Westminster, S.W., March 10th.

PRIOR PUBLICATION OR NOT.

SIR,—The further facts stated by "J. H." do not assist him. The question in the third paragraph of his letter is clearly settled by Fry, L. J., in the case quoted in my last letter in your issue of February 28th. It follows from that judgment that if the public became possessed of an invention through fraud, they cannot be estoppel of the user of the invention by them, because the means they became possessed of the invention were fraudulent and the public cannot be charged with fraud. "J. H." makes no point in the words "mere inspection," for he cannot gauge the psychological capacity of the person who inspects; the plan of the invention may flash upon one man's mind, whilst another arrives at it by a slow logical process.

In Lang *v.* Gisborne, Ch. (1862), the Master of the Rolls states, "I am of opinion that it is not at all necessary to establish the fact that one volume of that book was sold, for I think that as soon as an inventor informs the public of what his invention is and prints it in a book, which he sends to a publisher to sell, from the moment that the book is exposed for sale in the bookseller's shop, there becomes, in point of law, a complete publication of the invention." The book was written in French.

This goes much further than "J. H.'s" case. People have seen "J. H.'s" full-size working model, no one need have seen the inside of the book. But it is hardly possible in a letter to give more than general outlines of the law. Each case has some peculiar feature that is important, and which may be overlooked by the non-expert in such matters, but which would, if known, influence any opinion given. Some points in the case of Lewis *v.* Marling, 1829, are pertinent to "J. H.s" facts. But this case would have to be considered, as against this in Carpenter *v.* Smith, 1842, it was laid down, "the public use and exercise of an invention means a use and exercise in public, not by the public, and it is of no importance whether an invention has been used by one or used by five." Stead *v.* Williams, 1843.

As regards the last paragraph of "J. H.'s" letter, nothing that he states is relevant to the issue. It is of no consequence what was done by the persons after they had seen the model, as long as they establish the fact of having seen it.

As regards "J. H.'s" remarks in the fifth paragraph, that is so obviously true that it needs no comment; the case "J. H." has described stands in quite a different category.

To put the case in a hypothetical manner, A invents a machine and makes a full size working model of it, and then invites B, C, and D to inspect it with a view of purchasing the invention. B, C, and D decline to purchase. After B, C, and D have seen the full-size working model, A applies for a patent.

Now, applying the cases before quoted, B, C, and D are representative of the public, and if they were shown the invention that will be sufficient publication to invalidate the patent. A has no power to gauge B, C, and D's mental appreciation of his invention, and cannot do so. This is strictly "J. H.'s" case, and all other matters he mentions in his fourth paragraph are beside the point, and do not apply to the method of publication he sets forth.

I have not put forward my own opinion; that is of no value in such a case as this. Patent law is to a very large extent case law, and, apart from a knowledge of this consideration of "J. H.'s" facts, would be valueless. M. W. LLEWELLIN, C.E., F.S.P.A.

15, King-square, Bristol.

LIME KILNS AND LIME BURNING.

SIR, With reference to "J. F. S's." question in last Saturday's ENGINEER, I should like to say that a definite statement as to what is the best form of construction for a lime kiln cannot be made without some further particulars regarding the surrounding circumstances.

Assuming other conditions of the problem to be suitable, then the tower kiln is undoubedly preferable to any other, because its operation is continuous and the waste heat is utilised more completely than in any other form of kiln.

One ton of fuel to four tons of lime is a first-class result in ordinary tower kilns with solid fuel. I am interested in a kiln which is fired by producer gas, and eight tons of lime are being produced by one ton of fuel, and the lime is of much better quality than before the conversion of the kilns, because the fuel is not mixed with the lime at all, but is gasified outside the kiln in a gas producer. There is consequently no clinker, far less sulphur and, altogether a better product from the same stone. For metallurgical purposes the absence of sulphur is a great advantage, and it has been found that the lime will carry more sand when used for building purposes. Another great advantage is that no smoke is made by the kilns, because the fuel is properly burnt and the whole of it is utilised, whereas in the ordinary system of solid firing all the gaseous constituents of the fuel are driven off in the form of smoke before the fuel becomes hot enough to burn. About 35 per cent. of the weight of the fuel is thus wasted. If the fuel happens to be of poor quality a great deal of ash and clinker is carried down with the lime, and this has to be picked out when the lime is drawn. In the gas-fired kiln the whole of the ash and clinker remain in the producer, and are drawn by the fireman about once in twenty-four hours. Besides all this the labour entailed in charging the fuel is much less than with solid fuel put in at the top of the kiln. W. J. JENKINS.

340, Queen's-road, Cheetham, Manchester,
March 9th.

MILITARY HORSELESS CARRIAGES.

SIR,—Referring to your article in last week's ENGINEER *re* "Military Horseless Carriages," you make some remarks on Boydell's wheels being used on ploughing engines, and crossing ploughed fields with the utmost ease. That is no exaggeration; I remember my father nearly thirty-five years ago using a traction engine—by Burrell, of Thetford—for haulage purposes, only fitted with the wheels in question. There was no difficulty in the engine travelling on bad roads and soft ground, but having to run in its daily work on the hard roads, the shoes, as we called them, soon got out of repair, and after several months' running had to be discarded for smooth wheels, but after doing that, it necessitated the laying down of a narrow gauge tramway alongside the bad roads, and across the fields where the said engine could travel when fitted with Boydell's wheels.

I quite agree with you that similar wheels would enable an engine to cross the sand of the desert. The principal thing to provide against is wear and tear, which I think could very easily be done with the present experience and materials. W. COOPER.

Dublin, 9th March.

JAMES WATT AND CO., SOHO WORKS.

SIR,—The letter of your correspondent, "One of the Staff," is evidently that of a disappointed man. The fact remains that under the management of "a large and expensive office and staff with the proprietor at the head," this great business came to grief. Can it then be wondered at that the present proprietors, who are successful men of business, should exercise their discretion in the selection of the assistants they thought proper to retain?

March 9th. SOHO.

COAL PREMIUMS.

SIR,—Since my arrival in England this time I have endeavoured to steer clear of controversial questions as regards railway matters. In the first place, I have no leisure for controversy; and, secondly, experience teaches me that the discussion of such subjects is apt to arouse a spirit of virulent partisanship, which I am unable to understand and with which I have no sympathy whatever.

I feel, nevertheless, that it would be ungracious not to respond to the very courteous appeal so pointedly made to me by Mr. C. E. Stretton in your journal. I therefore desire to say that I myself am not in favour of the coal premium system.

CHARLES ROUS-MARTEN.

26, Chelsham-road, S.W.

SIR,—I am, I think, in a better position to answer Mr. Stretton's question than Mr. Rous-Marten can be. I assume that Mr. Stretton really asks for information, and does not wish to air drivers' grievances. This being so, I can assure him that the coal premium system effects such a saving that railway directors are not likely to abandon it. The drivers have as much coal as they ask for. If their trains are late, they are fined. The best drivers like it; the incompetent do not. These are the facts in a nutshell.

March 11th. A RUNNING SHED FOREMAN.

RAILWAY COACHES.

SIR,—Being much interested in the building and maintenance of railway coaches, I have long been anxious to obtain information of a sound and authentic character on the following questions, and perhaps some of your readers will be generous enough to enlighten me and your readers generally (1) as to the difference in time which an underframe of a coach will last, without and with the vacuum brake; (2) and what effect, if any, has the vacuum brake upon the bearings or brasses of a coach?

I would suggest that it would be more satisfactory, and of more practical value, if this information could be supplied as regards the actual mileage worked, rather than by a time measure.

March 10th. HEADSTOCK.

BRITISH WARSHIP BUILDING NOTES.

IN view of the new orders for battleships, cruisers, &c., which may shortly be expected to be distributed among the Royal Dockyards and private shipbuilding and marine engineering establishments, the following notes of the progress made with some of the unfinished battleships and cruisers ordered under the late Spencer programme may be of interest at this time.

Of the battleships nearest completion the first to be noticed is the Renown, an armoured steel vessel of 12,350 tons displacement, which was built at Pembroke and launched last May, and has been engined by Messrs. Maudslay, Sons, and Field, of Lambeth. The progress made—after her launch—in fitting the machinery was so rapid that she was enabled to leave Pembroke for Devonport on November 14th under her own steam. The Renown is the only ship of her design yet constructed, and it is noteworthy that the new battleships to be built under what we may now, we presume, call the Goschen programme, are all to be of the Renown type, but with some increase in displacement and armament. It is also worth noting that the time taken—six months only—in fitting the engines and boilers on board the Renown in Pembroke, where very poor facilities for such work exists, was appreciably less than in the case of the Magnificent at Chatham, and the Majestic at Portsmouth.

The next battleship in order of completion is the Prince George, an armoured steel vessel of 14,900 tons displacement, built at Portsmouth, and engined by Messrs. Humphrys, Tennant, and Co., of Deptford. The whole of this vessel's machinery, boilers, &c., is in place, but the work upon the ship has been very fitful in its progress; it is, however, so far advanced that she will be ready for steaming at moorings in May, for her official trials in July, and it is hoped she will be completed in October.

Rapid progress is being made with the new battleship Victorious, lately launched at Chatham Dockyard, and described in our columns, large numbers of workmen of all trades being employed upon her, many of them working overtime. About seven-tenths of the whole weight of the structure, including armour, has been built into her, but the casemates are rather backward, due to their armour not being delivered fast enough from the contractors.

The builders of the engines—Messrs. Hawthorn, Leslie, and Co., of Newcastle—are employing a large staff, working overtime, to get the machinery fixed in the ship as soon as possible. The main engines and boilers are now in place, and in a forward state, and the fixing of the auxiliary machinery—which includes about eighty sets of engines—is being rapidly proceeded with. The armament is being fitted in place, and the hydraulic machinery for working the 12in. breech-loading guns to be carried in the barbettes is also being steadily advanced. Every exertion is being made to have a trial of the machinery of the ship in the dockyard basin in June, and it is expected that the vessel will be able to proceed to sea for her official steam trials in July, and be finally completed next October.

The first-class cruiser Powerful, building by the Naval Construction and Armaments Company at Barrow, is rapidly approaching completion, the whole of the structure of the hull and steel work in her being finished, and the armour of the barbettes, casemates, and conning towers, in place. All decks are laid, bridges and deck houses up, masts and fighting tops stepped, and the rigging practically complete. The steering, windlass, capstan, and hoisting engines and gear, with the anchor gear and air compressing machinery, are all in place and complete. The magazines, shell and store-rooms are lined and fitted, and rapid progress is being made with the ventilating systems, electric light installations, telegraphs, &c.

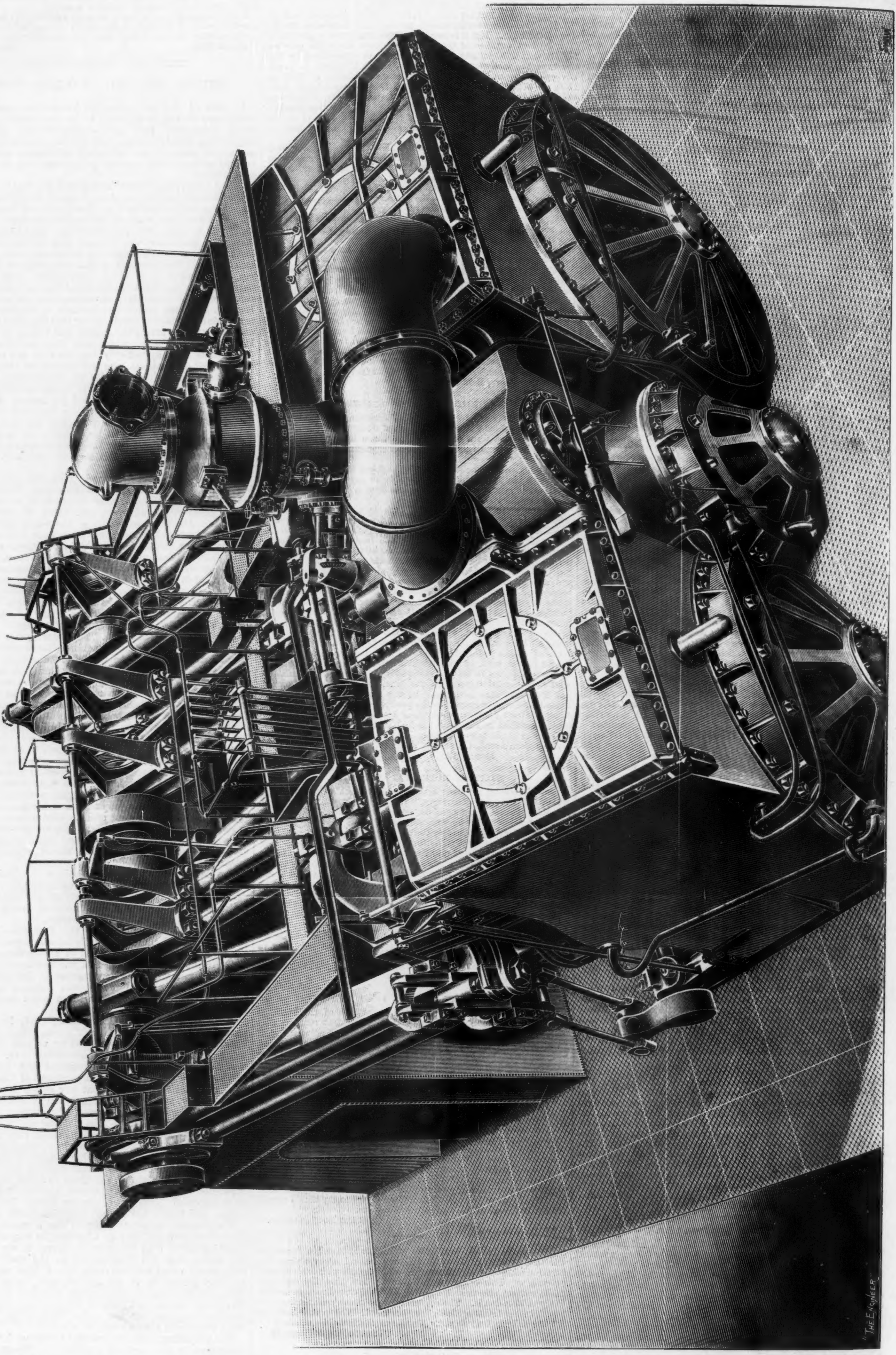
The main engines and all the boilers — which are of the Belleville water-tube type — thirty in number, are now in place, leaving only the armour gratings and casings over the boiler-rooms to be closed and finished, and it is expected to have steam up in a couple of months.

The Terrible—sister ship to the Powerful—building by Messrs. J. and G. Thomson, of Clydebank, is making very fair progress towards completion, but in consequence of the late strike in the Clyde district, and the engineers having only lately resumed work, the construction of the ship has been much retarded. As, however, the contract date for her delivery is January, 1897, this will no doubt easily be anticipated by her builders.

The work of completing and getting ready for sea the new second-class protected cruiser Minerva, whose float out at Chatham Dockyard was recorded by us last September, is being pushed along at a truly marvellous rate. This vessel, it will be remembered, is being supplied with her propelling machinery by the engineering department of Chatham Dockyard, and it being desired that her steam trials may take place in May, and her final completion be effected in July, a very large number of all classes of workmen is employed upon her with this object. The material now worked into her weighs nearly 2400 tons, including armour; the fixing of her machinery is far advanced, the work of fitting her armament on board is well forward, and her torpedo tubes are nearly complete. This vessel has a coal capacity of 550 tons, and her engines, which are of the three-cylinder inverted triple expansion type, driving twin screws, are expected to develope 9600 indicated horse-power under forced draught to her boilers, and to give her a speed with that power of 17¼ knots.

The progress of construction of the armoured battleship Illustrious, now building at Chatham, is very much behind, when compared with the celerity shown in the building of her sister ship, the Magnificent, at the same yard. The first-named vessel was laid down just a year ago, but is as yet only plated up to the armour deck, some only of the frames of the superstructure above that deck being in place. The boiler bearers and part of the auxiliary engine bearers are also in place, but the outer brackets for carrying the stern shafts will not be ready for a month.

The propelling machinery of this vessel has long since been completed by the engineer contractors—Messrs. John Penn and Sons, of Greenwich—and is waiting for transmission to the ship. It will be some considerable time before the vessel can take the water, unless a greater number of hands than is now employed is started to work upon her.



TRIPLE-EXPANSION PADDLE ENGINES, S.S. KONINGIN WILHELMINA

THE FAIRFIELD SHIPBUILDING AND ENGINEERING COMPANY, GOVAN, ENGINEERS

(For description see page 256)

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TO CORRESPONDENTS.

Registered Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and bearing a penny postage stamp, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* The Engineer, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

J. M. T. (Cardiff).—*Your feed pump will pump boiling hot water if you will raise the tank from which it draws so high that the pump barrel will fill without any suction action. Probably a head of 5ft. on the suction side will suffice.*

W. L.—*We believe that it has been stated that a steam turbine has been run up to 60,000 revolutions, but we are unable to say whether it is true or not. We are inclined to think not. Professor Unwin has registered a speed of about 31,000 per min. with a special steam turbine.*

R. H. (Heaton).—*There is no special treatise on the care and construction of the marine boiler that would be likely to suit you. If you will state on what point you want information we will endeavour to supply what you want. The subject has been dealt with in almost every treatise on the marine engine and boiler, but not, we suppose, in the way you want.*

MACHINES FOR PAINTING MOULDINGS.

(*To the Editor of The Engineer.*)

Sir,—I shall be obliged if any of your readers can give me the address of a firm that make a special machine for painting mouldings up to 6in. wide with rotary brushes.

S. A.

Bradford, March 3rd.

DRYING APPARATUS FOR ORES, CLAY, AND PHOSPHATES.

(*To the Editor of The Engineer.*)

Sir,—May we ask the names of makers of driers for roasting ores, phosphates, clay for bricks, Portland cement, towns refuse, and articles which are to be baked.

J. H.

Manchester, March 6th.

SUBSCRIPTIONS.

The Engineer *can be had, by order, from any newsagent in town or country at the various railway stations; or it can, if preferred, be supplied direct from the office on the following terms (paid in advance):—*

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Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Three o'clock on Wednesday afternoon in each week.

Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of The Engineer.

MEETINGS NEXT WEEK.

The Institution of Civil Engineers.—Tuesday, March 17th, at 8 p.m. Papers: "The Lixiviation of Silver Ores," by Mr. John H. Clemes, Assoc. M. Inst. C.E. "Mining and Treatment of Copper Ore at Tharsis, Spain," by Mr. C. F. Courtney, M. Inst. C.E. "Tin Smelting at Pulo Brani, Singapore," by Messrs. John McKillop and T. Flower-Ellis. Thursday, March 19th, at 2.30 p.m. Students' visit to inspect the Thames Ironworks, Orchard Yard, Blackwall.

The Institution of Junior Engineers.—Saturday, March 21st, at 3 p.m. Visit the electricity works of the Parish of St. Pancras.

Royal Institution of Great Britain.—Tuesday, March 17th, at 3 p.m. Lecture: "The External Covering of Plants and Animals: Its Structure and Functions," by Professor Charles Stewart, M.R.C.S., F.L.S. Thursday, March 19th, at 3 p.m. Lecture: "Masters of Modern Thought—III. Goethe," by the Rev. William Barry, D.D. Friday, March 20th, at 9 p.m. Discourse: "Immunisation against Serpents' Venom, and the Treatment of Snake-bite with Antivenene," by Professor T. R. Fraser, M.A., LL.D., F.R.S. Saturday, March 21st, at 3 p.m. Lecture: "Light," by the Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., M.R.I., Professor of Natural Philosophy, R.I.

Royal Meteorological Society.—Wednesday, March 18th, at 7.30 p.m. Lecture: "Weather Forecasts and Storm Warnings, how they are Prepared and made Known," by Mr. Frederic Gaster, F.R. Met. Soc. Illustrated by instruments, diagrams, and lantern slides.

Society of Arts.—Wednesday, March 18th, at 8 p.m. Paper: "The Bahamas Sisal Industry," by Dr. D. Morris, C.M.G., M.A. General Sir Henry W. Norman, G.C.B., G.C.M.G., will preside. Thursday, March 10th, at 8.30 p.m., at the Imperial Institute, South Kensington. Indian Section. Paper: "The Great Landslip at Gohna, in Gurhwal, and the Measures adopted to prevent Serious Loss of Life," by J. H. Glass, C.I.E., Chief Engineer, Dept. Public Works, Bengal. Sir Charles H. T. Crosthwaite, K.C.S.I., Member of the Council of India, and late Lieutenant-Governor of the North-Western Provinces and Oudh, will preside.

DEATHS.

On the 8th inst., from pneumonia, at his residence, Whiteness, Broadstairs, James Abernethy, Esq., J.P., Past President Inst. C.E., F.R.S.E., aged 81.

On the 6th inst., W. H. Le Fevre, Esq., C.E., of 26, Budge-row, Cannon-street, and 48, Argyll-road, Kensington.

THE ENGINEER.

MARCH 13, 1896.

TRIPLE CYLINDER LOCOMOTIVES.

The number of compound locomotives in the world is augmenting. The augmentation is, it is true, confined almost exclusively to the United States. It may, we think, be taken as proved that under suitable conditions a considerable saving of fuel may be effected by compounding. These conditions are, first, that the engine shall be fully loaded; and secondly, that it shall run for long distances without stopping. When comparisons are made in the United States between the compound and the simple engine, it is almost invariably the case that the latter is worked to a disadvantage. We have only to consider the enormous quantity of coal burned per mile in the United States to see that this must be so. There is little or no expansion. The engines are pushed to the last degree. The compound engine has far more cylinder capacity for a given power than the simple engine, consequently instead of exhausting at pressures of 70 lb. or 80 lb. on the square inch, the compound engine exhausts at 30 lb. or 40 lb., and so much more work is got out of the steam. But all advantages of this kind may be neutralised if the engine is not fully loaded, because then, by a well-known law, cylinder condensation is greatly increased, and the proportion which the back pressure bears to the effective pressure rises, with the result that no benefit is obtained. This is no doubt the reason why so little progress has been made in this country with the compound locomotive. On the whole our engines draw much lighter loads than those hauled in the United States. The conditions of traffic are different. They suit the non-compound engine admirably, and they have not suited the compound locomotive hitherto. It remains to be seen, however, whether changes will not have to be made in the conduct of traffic which will re-open the whole question, and in a manner force the compound system into use. The growing tendency to run trains over long distances at high speeds is slowly, almost insensibly, introducing modifications in the design of express locomotives. We have evidence of this in the Caledonian engines built by Mr. McIntosh, the first of which we illustrated last week. The fine engines built by Mr. Dean for the fast traffic of the Great Western system furnish another example. The new engines designed by Mr. Harry Pollit for the London service of the Manchester, Sheffield, and Lincolnshire Railway are different, as our readers will see next week, in several respects from their predecessors. Locomotives of greater and greater power are now turned out. The paramount difficulty lies in augmenting the steaming capacity of the boiler, without wasting coal, while coupled wheels are retained. With single drivers we may have as long a grate as a man can fire; but coupling is indispensable when very heavy trains have to be run in all weathers with certainty, and the length of the grate is limited by the space between the driving axles. It is worth while to consider whether a new departure may not be necessary. The compound system ought to work to advantage when a train of 200 tons has to be hauled at an average speed of sixty miles an hour, let us say, from London to Aberdeen, with runs of 150 miles or so without a stop. Even an increase of 10 per cent. in the efficiency of the machine would be worth having; not because of the pecuniary value of the coal saved, but because it represents 10 per cent. more work to be got out of the engine. But besides this we think we shall be able to show before we have done, that by using three cylinders instead of two, we may secure very important advantages in design, quite apart from compounding, while the conditions are such that if three cylinders are to be used, it is just as easy to work compound as simple. In a word, by using three cylinders in the way we are about to describe, an engine of greater capacity than anything hitherto built in this country may be produced.

We take, then, as a basis Webb's system, and this we do because it permits the use of four driving wheels, and yet dispenses with the coupling rods. Consequently a very long grate may be used. The wheel base between the drivers will also be long, but as the curves are all fairly easy on our great main lines, this is not an objection. But the Webb engine has probably reached its maximum dimensions. A 32in. cylinder is the largest it is possible to put between the frames, and that is, in the opinion of many competent authorities, too large to be suitable for a locomotive. It is, however, clear that the power of an engine is limited by the dimensions of this cylinder. Let us take, for the purpose of comparison, a Webb engine with two 14in. outside cylinders and one 30in. inside cylinder. The areas of the pistons are $154 + 154 + 707 = 1015$ square inches. If, now, we reverse the whole arrangement and put one high-pressure cylinder, 23in. in diameter, between the frames, and two low-pressure cylinders of the same diameter outside the frames, we then have $415{\cdot}5 + 415{\cdot}5 + 415{\cdot}0 = 1245$ square inches of piston area; that is to say, an engine over 25 per cent. more powerful than Mr. Webb's heaviest engine. It is true that larger high-pressure cylinders might be used in a Webb engine, but only by altering the proportions between the cylinders for the worse, and in the same way a larger single high-pressure cylinder might be used if necessary. The weight on each pair of drivers would be about 19 tons, and with 14 tons on the leading bogie, the total would be 50 tons. It is possible that weight might be saved if it were deemed desirable, but this is a detail. The driving wheels must be 7ft. in diameter; we do not think it would be necessary to use anything larger, but a diameter of 7ft. 6in. is available if preferred. The general lines of construction could be very similar to Mr. Webb's Marchioness of Stafford, except that the leading end would be carried on a bogie. We have here an engine with three cylinders, all of reasonable dimensions, and in many respects identical, a matter of some importance as affecting construction.

The first objection that will be urged is that the stress which the 160 lb. steam would exert on the central crank would be more than it could bear. It must not be forgotten that this stress would only be possible at starting, because when running there is always the back or receiver pressure in the high-pressure cylinder, tending to relieve the stress on the crank shaft, and the wheels would certainly slip to begin; but there would be not the least difficulty in providing a couple of fore-and-aft bearings on the central axle to give it support, identical with those used with perfect success in the broad gauge engines of the Great Western class. The single bearing was put between the cranks, and carried no weight worth mentioning; although in most cases a spring was used, carrying perhaps a ton, to hold the bearing down and keep it steady. A little scheming would be needed, but nothing to puzzle a draughtsman accustomed to locomotive work. It goes without saying that all the main bearings must be very long, just as they are in all Mr. Webb's engines.

Mr. McIntosh has shown that it is possible to get a very large boiler on to the narrow gauge. But the true measure of boiler power is, after all, the grate surface. If we take 3ft. as the maximum effective width of grate—because there ought to be always a dead bar at each side—we see that to get 21 square feet we must have a grate 7ft. long. The trailing axle may come up close to the fire-box behind, but the leading crank axle centre cannot well come closer than two feet, and so we drift by degrees into a wheel base of about 11ft. for a 7ft. grate. But a distinct advantage would be gained by pushing a little further the step grate principle adopted in some foreign locomotives with success. The back of the fire-box would be shallower than the front, and the grate bars would be at two levels with a nearly vertical portion uniting them. In this way the grate area would be augmented, and as the back part of the grate would be over the trailing axle, a wheel base less than 11ft. might be had. The centre of the boiler would in any case be high, but not higher—nor, indeed, as high—as that of some very successful fast American locomotives. The valve gear would present no more difficulties than are now successfully overcome. The diameter of the boiler must be considerable, probably nearly 5ft. and 1600 square feet of heating surface could be got in without unduly augmenting the length of the tubes. The major portion of the fire-box must have straight sides, a large tube plate being got by dishing out the front edges of the side plates in the way practised with success by the late Mr. Stroudley on the Brighton line. The tractive effort of such an engine as we have sketched would be enormous; and there is absolutely nothing in the design to prevent a very high speed from being attained. The maximum average turning effort of the high-pressure cylinder would be about equal to that of the two low-pressure cylinders, or, say, at the rail, 151 lb. per pound of effective pressure. This load of 19 tons would hold with a little aid in bad weather at starting from the sand blast.

Objection may be taken to an engine such as we have sketched. Indeed, it may be taken to any design; but if it is once admitted that an extremely powerful high-speed locomotive is wanted, it will, we think, be conceded that the way out of the difficulty which we propose is reasonable. On no other lines can the same amount of cylinder capacity be got, at the same time that enough adhesion is available to utilise that capacity. It is of no use to add to the diameter of a cylinder unless we provide adequate adhesion. We cannot get this by coupling, because we shorten the grate too much, or we are driven to use coupling rods dangerously long. In the United States a partial solution of the problem is found in raising the grates above the tops of the trailing drivers, but the scheme does not commend itself to English engineers. Mr. Webb's engines have been so successful that there is every reason to think that a locomotive such as we suggest would give satisfaction.

If the time should arrive—and it may be nearer than is thought—when a locomotive with 21in. cylinders, 26in. stroke, is required to conduct fast traffic, it will severely tax the resources of engineers to provide a boiler big enough to supply steam to such cylinders. On the Great Northern there are engines running with 19in. cylinders, 28in. stroke. Their capacity is, the driving wheels being 8ft. in diameter, very nearly 3865 cubic feet per mile. A pair of 21in. cylinders with 7ft. wheels would have a capacity of 5370 cubic feet per mile. If 1200 square feet of heating surface suffices to supply on the Great Northern 3865 cubic feet of steam per mile, then a boiler with 21in. cylinders must at the same rate have about 1700 square feet, while if a grate of 18 square feet is just right for 1200ft. of heating surface, 25·5 square feet is just right for 1700 square feet. No load can be placed on one pair of drivers competent to supply enough adhesion for a pair of 21in. cylinders. Consequently, coupling is essential, and the coupling must be at the fire-box end, because the cylinders must be outside, and we cannot couple at the leading end. Save in the way we have indicated, it seems to be impossible to provide the proper grate area, while retaining a design which, in its general features, will commend itself to English railway men.

THE ELEMENTS OF SUCCESS IN ENGINEERING AS A PROFESSION.

IN a brace of articles we have lately dealt with what we conceive to be certain elements of success. We have shown, or attempted to show, that to do a thing well is, as a rule, more paying than to do it badly or indifferently, and that, too, notwithstanding the fact that the demand does not always insist on a high standard of quality. We have also indicated that the road to success seems to us—and we believe that on this point most persons will be ready to assent—to be the highway of specialisation. We wish now to take a retrograde pace and get back to the very starting line whence runs the race for pecuniary and honourable emoluments. And this we are constrained to do from an anxiety not to raise the hopes of the younger community by making the road to fortune seem too easy and flowery. We have said that the route *viâ* specialisation is "not wholly unadorned by the *primula vulgaris*," and that it is a sure road to those who are able to set their feet in it; but we have not, we are glad to remember, forgotten to remind would-be travellers of the necessity of thick soles to their shoes; we ought at the same time to have warned the younger pilgrims that no matter on what path to success they wish to tread, certain qualifications are of vast importance. To be well shod and well knapsacked is by no means sufficient. To be supported by a good stout staff of personal or allied influence—and we do not for a moment underrate its importance—is helpful, but still not enough. It lies in a man's thews and sinews to win races, and no matter howsoever well he may be accoutred, be he knock-kneed or bandy-legged, flabbly-fleshed, or two thick or too thin or short-winded, others will be in before him.

Now, to put metaphor aside, we wish to call attention to the fact, not sufficiently grasped by very many persons, that engineering is not a profession which everyone may take up with certainty of success. There are professions, we believe, in which, with application, even the most deplorably inapt student of engineering might find distinction. The dean of a well-known London college once in an opening-day speech said that while there were doubtless some students present who would in the future be known as men of mark in the engineering world, there were doubtless others who, impelled by the ruthless hand of fate or ill-fortune, would end their days in the Houses of Parliament. He certainly knew from experience that year after year there were enrolled on the college lists names which would in the future be unknown and unhonoured in scientific circles, some too, the names of youths, who had they been more wise in the selection of professions, might have gained no little success. There is, unfortunately, a tendency among parents to consider that if a child in the nursery shows any marked propensity towards the conversion of furniture and firewood into one knows not what of marvellous machines, he is naturally predestined to be an engineer. A fatal error. As well expect every boy who plays with tin soldiers to become a general, as every child who essays to convert his father's umbrella into a flying machine to develope into a mechanical genius. It would seem quite unnecessary to insist on a point so evident. Still the most evident truths are those most often ignored.

But to carry the matter a step further towards the point on which we wish to insist. Suppose a youth really does exhibit mechanical genius, and is sent to school and college, and acquires as much as his masters are paid for or are able to teach him. Suppose, moreover, that he is backed up by a fair amount of influence, is it wise—it is a thing so often done—to prophecy his success? Undoubtedly not. Success, by which we mean pecuniary success, depends more upon a man himself than upon his genius. That is to say, there are characteristics far outside the particular feature in which any one man may be a proficient which are essential to his progress. A very capable mechanician, for example, might be so hopelessly lax or incompetent as a man of business that he would be continually hampering his own prospects. Everyone can call to mind cases which display this and the converse, only the converse is very much more rare, for a capable merchant with a smattering of science will make a fortune, when a proficient scientist, having a fair acquaintance with commercial matters will starve.

We have said at other times, in writing of the education of engineers, that a careful study of the aptitude and character of a youth should be made before he is embarked on a profession which to an incapable man is, perhaps beyond all others, disastrous. Engineering in this country is separated from other professions by insisting on no definite standard of excellence. An engineer is at perfect liberty to practice without holding any diploma. This freedom has advantages and disadvantages. On the whole, the disadvantages seem to preponderate, and though we confess to but a small belief in the value of examinations, we should like to see one of our great institutions become constituted a board of examination for engineers. The benefit would lie in the weeding-out virtue possessed by the implied education. Men who had not the sufficient courage and persistence and love of their work to live down repeated failures would give it up and try some other profession, while others who foresaw the difficulties would be deterred from attempting them if they were not very much in earnest. We do not know, however, if it is possible to design a form of examination which can be relied on as foretelling the future of the examined. We fancy not. There are points of very vital consequence to success which are undiscoverable by question and answer—the determination, perseverance, energy, the common sense and tact which are the principal ingredients of the eminently prosperous man. If a man knew all that was to be known about some particular subject, and was entirely devoid of these attributes, his chances of distinction, nay, of even comparative success, would be few. But give a man these, and but poor talents or abilities to begin on, and he may prosper in spite of the drawbacks. The number of persons who combine these necessary qualifications is comparatively small. But in a suitable combination of men they may all be found. Companies are, as a rule, floated, and partnerships joined, for capital's sake. Here, however, is another very good reason for the co-operation of two or three men, and we may say with certainty that herein is an element of success, that each by bringing certain particular qualifications not possessed by the others, and dovetailing his particular talents in with theirs, produces a composite whole equivalent to one entirely competent person.

After all, we are still on the same road—it is still specialisation, only now specialisation of intellect in a limited circle, whereas before we spoke of the specialisation of production. How far such co-operation of specialised intellect may be carried with success it is not easy to say. To a certain limited extent it is now practised with excellent results, the most patent case being, of course, the partnership of a technical with a commercial man, but it probably is capable of much further development. The one technical man may, of course, be replaced by several, each being devoted to a small section of the entire concern. This is done as a rule in very large establishments, and undoubtedly contributes to their success. In smaller places, however, it is usual for the proprietor or manager to exert control over all departments. As the knowledge required is frequently very varied, it is, from our point of view, improbable that any one man will be sufficiently expert in all branches to bring each to perfection. His control should be more largely managerial, the directing when and where to do, but leaving the doing to persons with particular experience in different matters. We know perfectly well the difficulties in the way of carrying out such a scheme to the extent we mean. A strong hand, however, overcomes all difficulties. An examination of the most prosperous establishments will show that they have been formed, as a rule, by one master, having drawn around him the talents which he lacked himself, and directed them into the channels where he saw they were needed. It has been said that there is a groove provided for every man, and if he can once get into his groove success is sure. It is part of the work of a master to get all of his subordinates into their right grooves. The groove is a specialised line. Some grooves must, of course, be narrow, but where all the grooves converge and join there is a broad and magnificent highway.

May we conclude with a word of advice to the coming engineer? Find out as early in your day as you can the groove in which you are predestined to roll, get into and let nothing put you out of it. Grooviness does not necessarily mean narrowness. The groove is small at the beginning, but it gets deeper and wider as the intellect which rolls along it increases in size. Remember, however, that success is more due to the character of a man than to his genius. Genius is a servant; character its master.

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SCOTCH RAILWAY WORKING.

THE results of the working of the Scotch railways for the last half-year are even better than those of the English lines, for two reasons. One is that they compare with the period of a strike in the corresponding six months; and the other is that there is the inclusion of the returns for a mild January—for the Scotch period terminates later than the English half-year; and the results are shown by the Glasgow and South-Western line. It paid £15,000 less for coal for locomotive power in the last six months than the preceding corresponding period—which is a large reduction from payments that were £43,353. This is one of the main causes of the reduction in the percentage of working expenditure, which fell from the high rate of 59·48 per cent. in the strike period to 51·56 per cent. for the half-year just reported on. At the same time, the reduction thus stated has been materially aided by the increase in the gross receipts from £613,000 to £701,000 for the six months—an increase that was spread over nearly every item in the receipts. There was a moderate expenditure of capital, too, on new works—the total for the six months having been about £53,923, of which £12,252 were on "lines and works in course of construction," and nearly all the remainder on lines and works open for traffic, the largest items under the latter heading being £10,043 on the engine sheds, &c., at Carlisle; and of £3432 on the engine sheds, &c., on the Paisley Canal line. In the current half-year the estimated capital expenditure is rather larger, £84,976 in the total, the increase being general, but including a proportionate sum for new working stock. The other great railways in Scotland appear to have had the same benefits by contrast with the period of the strike which forced up the price of coal, whilst it also greatly reduced the mineral traffic. The recent working has seen coal at normal prices with larger coal traffic, and a consequential increase of the earnings of the companies, both gross and net. And there is now the advantage of coal under contracts that are even lower in price, whilst the traffic shows a tendency to increase, both in passenger and goods branches. On one of the lines—the Caledonian—there is a heavy expenditure, but it has now the accompaniment of some of the earlier works being brought into operation, so that concurrently with a large capital expenditure there is an increasing income. For the present there is the prospect before the Scotch railways of full traffic and of moderately low working charges.

AFRICAN LAKE AND RIVER TRANSPORT.

THERE has just been shipped from the Clyde, per s.s. Isle of Dursay, an interesting cargo destined for South-East Africa, and thence to the interior, which in all probability will mark important fresh developments in the commercial and industrial progress of Central Africa. This comprises three steamers and two steel barges—important additions to the already numerous fleet of lake and river steamers which the African Lakes Corporation, Limited, have plying on the rivers Zambesi and Shire, and Lakes Nyassa and Tanganyika. It also includes a powerful traction engine and several goods wagons, intended to develope transport by road past the Murchison cataracts on the Shire, thus connecting the river service at present conducted below and above the cataracts. The road traction engine has been adopted pending the construction of a railway alongside the cataracts, for which the Corporation are now making surveys. Two of the three steamers are stern wheelers of similar type and of very shallow draught. One named the Princess, 85ft. long and 13in. draught, is intended to augment the Corporation's flotilla of steamers now plying on the Zambesi and Lower Shire, between Chinde, the port where cargo is received from the ocean-going steamers, and Katungas, the port nearest the cataracts where navigation is at all practicable. The second stern wheeler is intended to ply from Matope — the nearest navigable point above the cataracts — to the mouth of Lake Nyassa, in supplement to the twin-screw steamer Livingstone, already running upon the Upper Shire. The third is a screw steamer, which has been named Queen Victoria, and is intended to run upon Lake Nyassa. She will be the largest and best equipped steamer on the lake, and will materially strengthen the service which the company already maintain upon that lake with the steamers Domira and Ilala, in connection with the service which they run on Lake Tanganyika by their steamer Good News. The new steamers, which have of course been constructed in sections, have been supplied by Clyde firms—one of the stern wheelers by Messrs. Russell and Co., of Port Glasgow, engined by Messrs. John Kincaird and Co., Greenock, and the others by Messrs. Ritchie, Graham, and Milne, of Whiteinch. With the extensive and well-organised connections already established, and especially with the fresh additions to their working facilities, the company will be in a position to deliver goods to all points on Lake Tanganyika, whether in British, German, or Congo Free State territory. Travellers also to the Congo State and other parts of the remote interior of Africa, will be able to reach their destination, *viâ* the Zambesi, with a degree of comfort and speed which a few years ago would have almost seemed impossible.

MACHINERY IN THE GLASS TRADE.

A DEPARTMENT in which machinery has not made as much headway as in some other spheres of industry is the glass trade. Manual labour is still employed to an overwhelming extent. The application of machinery to glass bottle manufacture has recently formed the subject of a correspondence between the Duke of Devonshire and a representative of the trade. Machinery was some little time ago used in England which purported to produce bottles at 3d. per gross as against 3s. 6d. by the hand blowing process, to make 80 gross a day with boys only, and to save 33 per cent. in men. It seems, however, that not a single glass-blowing machine is at the present time in operation in the United Kingdom. Information is, however, this week received, which shows that if the problem of introducing machinery in this department has been given up in England, an endeavour to solve it is being continued in America. Another machine has been invented there, and has been used with success, we are told, by the Toledo Glass Company, of Toledo, Ohio, which is now building a new factory for the mechanical manufacture of the finer grades of wine and beer bottles. The machinery grasps the molten glass as a blower would, and holds it straight while the mould closes. It then revolves the pipe. The mould next opens automatically, discharges the bottle, dips itself in water, and is ready for the next lot of glass. Working on tumblers, 400 have, it is stated, been produced in one hour, and electric bulbs have also been made. There is great scope in Europe for satisfactory glass-blowing machinery. One bottle works alone in Russia—that of Prince Vjazemsky, at Gorbunova, in Vladimir—puts upon the market 1,500,000 bottles per year, and advices from Germany state that the demand for bottles is extraordinarily large, the manufacturers being crowded with orders. Apparatus for holding and operating a bottle mould is not unknown, but it is the introduction of machinery for the blowing that is the innovation.

THE SHEFFIELD CANAL.

MUCH interest attaches to the development of water communication between Sheffield and South Yorkshire and the sea. The City of Steel has lost several of its heavy industries through lack of cheaper means of transit to the port. Rails, at one time a vast industry in Sheffield, are now made on a greatly reduced scale close to the place, to be delivered on railway sections in the Midland districts. The export rail trade is now exclusively done at the coast. Ship and boiler plates have also passed to other localities, and it has long been felt that unless the waterway to the Humber, the Trent, or the Ouse, can be vigorously developed, other heavy industries must follow rails, and ship and boiler plates. A company was formed—the Sheffield and South Yorkshire Navigation Company—to take over the canals of the Manchester, Sheffield, and Lincolnshire Railway. A year has just elapsed since the new company got to work, and the results of the improved facilities are already evident. At December 31st the company, as the aggregate of ten months' working, had carried 742,000 tons of goods, being an increase of 50,000 tons over the corresponding period of the previous year. The principal cargoes were iron, coal, grain, sugar, and timber. From March to December last over 500,000 tons of coal were conveyed over the canal. The company, with a view to further vigorous extensions, has purchased the Manor Yard and the tramway line from the Duke of Norfolk, and is making important additions to the storage accommodation, and the mechanical appliances required for the effective handling of heavy goods and large consignments of manufactures and produce of all kinds. Messrs. W. France and Co., shipowners, London and Goole, intend shortly to begin a regular service of steam barges between Sheffield and Goole. One or two of these steam barges have come through now and then, but a stated service will be a distinct advance in conveyance by the water-way.

LITERATURE.

Minerals, and how to Study them. By E. S. DANA. 8vo., pp. 380. New York: John Wiley and Sons. London: Chapman and Hall. 1895.

THE author of this interesting little volume tells us in his preface, that some hours which could not be devoted to more serious labour, have been occupied in preparing it, in the hope that it might encourage those who have a desire to learn about minerals, and increase the number of students with similar tastes. With this view the subject is presented in a simple and readable form, without too much detail, and at the same time without cheapening the science; while provision is made for those deficient in essential preliminary knowledge of physics and chemistry, by the introduction of a certain amount of elementary matter on these subjects. The compilation of a properly-balanced introductory text-book upon a large subject is not an easy task; neither is it facilitated by the possession of great detailed knowledge, except a proper judgment be exercised in selecting the matter to be presented. In this instance the selection has been exceedingly well made, and the product of the author's leisure—which we are afraid has been of an enforced kind and a consequence of the severe work involved in the preparation of the sixth edition of Dana's "System of Mineralogy," published in 1892—is a welcome and valuable addition to the stock of good elementary books. In form it is a short systematic treatise on the principal physical and chemical characteristics of minerals, particular attention being given to the simpler methods of identifying them by blow-pipe examination, approximate determination of specific gravity, &c., without going too much into details of exact form and structure, which require more elaborate and expensive methods of application than are at the command of beginners. The same principle has been followed in Chapter VII., which contains notices of about 150 typical minerals, and in addition to the ordinary details as to form, composition, and occurrence, describes telling peculiarities such as the experienced observer is accustomed to rely upon, but which as a general rule are not noticed for the benefit of beginners. Much attention has been given to the illustrations; as an addition to the ordinary geometrical projections of crystals, several of a more pictorial kind drawn from actual specimens are given. These are for the most part very good, the quartz crystal on page 15 and the weathered gypsum crystals on page 256 being specially successful. The frontispiece, representing a large, irregularly-developed crystal from North Carolina, although reproduced from a photograph, is not more satisfactory, and certainly tells less than the engraving noticed above.

Refrigerating and Ice-making Machinery: A Descriptive Treatise for the Use of Persons Employing Refrigerating and Ice-making Installations. By A. J. WALLIS-TAYLOR, A.M.I.C.E. London: Crosby Lockwood and Co. 1896.

THE increase in the literature of this subject is evidence of the growth of the industrial applications of ice and cold air. There is nothing new in Mr. Wallis-Taylor's book, but it is one of the best compilations on the subject, and the value of the work is very much increased by the numerous references which the author gives to the many scattered papers on the subject with which he deals in the proceedings of different institutions and in the pages of technical journals. The descriptions of the different refrigerating machines, and the principles on which they act, are described with an intelligent appreciation of the means and the end. In a great many cases the author's composition would be improved by a little careful editing, and certain of the engravings would have been better if they had not been so much of the style affected by some patent agents; but his book may be recommended as a useful description of the machinery, the processes, and of the facts, figures, and tabulated physics of its subject.

SHORT NOTICES.

Digest of British and Foreign Patent Laws. By Alfred J. Boult, M.I. Mech. E. London: Bemrose and Sons, Ld. 1895. 8vo. Price 5s. In 385 pages, this book gives a more or less extended account of the main features, not perhaps so much of the patent laws as of the law so far as it concerns the intending patentee and the patent agent. To both of these, however, it would have been more useful if the author had not so carefully refrained from giving the Government fees for each of the countries. He does give the yearly taxes in some cases, but not in all, and although these are of interest they are not of much use unless given for all countries, and never so important to the inventor as the various Government fees of first instance. The reason for omitting these is one which defeats its own object, and if a book has not its full possible use to inventors, it is not likely to have it to patent agents.

Mechanics for Beginners. By W. Gallatly, M.A. London: Macmillan and Co., Ld., 1896. Price 2s. 6d.—This little book, with its 253 pages, is no worse and no better than the score of treatises on mechanics which are now to be had. The examples for practice are many and well selected. The diagrams are satisfactory. The author troubles himself no more than other writers of similar books with the inconsistency of his definitions. This makes matters fairly easy for the normal student, who cares nothing and is not expected to care anything about the concepts of physics. What special end a mastery of the contents of the volume is supposed to serve we have no idea, but as an acquaintance with ergs and dynes and poundals is considered in some cases to be necessary, we fancy the student may as well avail himself of Mr. Gallatly's assistance as that of any one else.

Pleasure Cycling, with Hints to Riders. By F. T. Bidlake and Sennocke. London: Iliffe and Son, 3, St. Bride-street, E.C. Price 1s. This little book deals with cycling as a pleasure, and as a recreation of the highest character. It appeals to the wealthier classes, and is a pleasant talk upon various questions which interest the cyclist. It touches on the many points that will occur to those who are considering the advantages, disadvantages, pleasures of cycling, and pains and penalties of learning. Half at least of the little book will be found useful by many for these reasons, and some of the hints on road riding, care of a machine and dress, will interest others who are already riders. With regard to choosing a machine, and also with reference to "specialities recommended," it is a pity that these should form an exact index to the machines and the specialities advertised at the end of the book. It is true that the book has been published by Messrs. Iliffe and Son for the Coventry Machinists Company, but there is nothing to show this, and it is therefore of the nature of a trade circular appearing under the guise of a book by an independent author and publisher. It is prettily, though not usefully, illustrated, and cannot be compared in utility with the little book in the "Nutshell Series" published by the same firm.

BOOKS RECEIVED.

Sewerage and Sewage Disposal. By Henry Robinson, M.I.C.E. London: E. and F. N. Spon. 1896.

An Elementary Treatise on Rigid Dynamics. By W. J. Loudon, B.A. London: Macmillan and Co., Ld. 1896. Price 10s. 6d. net.

The Number Concept. Its Origin and Development. By Levi Leonard Conant, Ph.D. London: Macmillan and Co., Ld. 1896. Price 8s. 6d.

Electric Wiring, for the use of Architects, Underwriters, and the Owners of Buildings. By Russell Robb. London: Macmillan and Co., Ld. 1896. Price 10s.

JAMES ABERNETHY.

MR. JAMES ABERNETHY, Past President Inst. C.E., died on Sunday night, at his residence, Whiteness, Broadstairs, at the age of 81. In the death of Mr. James Abernethy we have lost another of a generation of engineers of high achievements, but whose ranks have been much thinned in the past few years. Mr. Abernethy's works were chiefly of harbours and docks, and of these he has left to himself great monuments. He acquired in his long life a great and well-deserved reputation for soundness of judgment in these matters, and was held in high esteem among his professional brethren. He had retired some years from active work, but occasionally gave opinions to within a recent time. He was some years since President of the Institution of Civil Engineers, and amongst other marks of public recognition, it will be remembered he was called in as one of the consulting engineers of the Manchester Ship Canal, and of the Ribble Improvement Works. We shall say something of his works in another impression.

SOME SPECIAL FEATURES SEEN IN BRITISH WORKSHOPS.

THE following article by Professor John E. Sweet, published in *Machinery*, is one of those which occasionally come from one American to the credit of all America:—

In response to your repeated solicitation to write of my observations while in English and Scotch machine shops, I comply with great hesitancy, because I can see no advantage in saying anything about what seems to be inferior to our own practice, and so far, whenever I have told of the things that seem to me worthy of praise, it has always led to a hot-water discussion, and many times the loss of friends. I certainly shall not deviate, however, from the first idea above expressed.

Although I was in Manchester a day, I failed to see any of the wonders there, because those of my acquaintances whom I remembered there were away, and as I had no letters, supposed that application to any of the workshops without would be useless. Later I found that the English readers of American mechanical papers were numerous enough to have made my name a passport to most of the places where I would have cared to go. This leads me to make another of the hot-water remarks, and it is this, that I think of all the civilised countries there is none where the mechanics know so little about what is done in other countries in the mechanical line as we do, and this comes from two causes—we think we are the leaders in all things mechanical, and hence it is not worth while to know what others are doing, and they also think we are the leaders, and that it is worth their while to know all about it. This in a sense is complimentary, and another thing to our credit is that it is easier for a stranger to see what is done here than in other countries.

At the works of John Lang and Son, at Johnstone, Scotland, they make it their business to build lathes, and one feature is that the bed is a box casting which goes to the floor, and when such a casting is a complete box, it is a good form in which to put the metal.

About all mechanics are beginning to believe that cast iron in a machine pays good interest on the cost, and there can be but one question as to which is the best form to put it, whether in a box section of the largest size possible, which is the stiffest form practicable, or in a plain square solid beam as suggested by Oberlin Smith, which embodies the anvil principle in its most complete form. The beam will sag by its own weight the most or as much as any form of any weight, and there is but one advantage, it may be the best to prevent chatter.

John Lang and Son have a quick change of feed to their lathes that they have been using for years, which we ought to have stolen long ago; I also found there the quick stop and reverse for radial drilling machines, which I had been advocating for several years, and finally had to make for myself, and was rather taken back to find not only that, but that worm gears for rotating the arm of radial drills are old and not uncommon. After two or three years' experience with the quick stop and reverse, I am of the opinion that it is quite as valuable an improvement on a drilling machine as the quick return, and in large radial machines a worm gear adjustment for the arm must be a consolation to the operator.

One thing that particularly attracted my attention about the Scotch lathes was that the workmen could not use a fine feed, nor did they appear to want to, for they seem to shift the lever from $\frac{1}{32}$in. to $\frac{1}{4}$in. feed, where they could without being told.

In the works of the South-Western Railway Company at Nine Elms, London, many things were seen that were new and a surprise. Whatever one tells about locomotive work, if he is not a locomotive engineer, is likely to be wrong, at least in the eyes of the locomotive engineer, and in this connection I have an apt story to tell:—

Their locomotive tenders are divided differently from ours. Our tenders are fixed for holding coal in the middle, and have the water tanks around the outside. In the case of the one I saw there at least, and I think common, the water is at the bottom and the coal on top, and the partition or floor between the two, high at the back, and about 1ft. above the foot-plate; the object being to have the coal naturally work forward and be easy for the fireman to handle the fuel. That appeared to me to be a good scheme. In mentioning the fact to an accomplished Western engineer, he said it would not do in this country at all. On asking why, he said:—"Because you could not carry half coal enough." This was the first time that I was dead sure I had too much mathematics for my own good.

The fire doors of English locomotives open like sliding doors, or two sliding doors in fact, so pivoted and linked that one handle opens both. This handle is convenient to both the fireman and engineer, so that in hard work the engineer can open and close the door for the fireman with his left hand, and without looking; with this advantage helping the stoker and helping the fire, as the door is kept open but a second. This sliding door cannot be blown open when a flue gives out. Whether there may not be some reason why this door would not work in America, I do not know. Thirty years before point switches were used here, they were universal in England, and a valid reason given why they would not work in our ice and snow, and yet point switches are common here now. Perhaps thirty years more will show that coal will slide down hill, and that sliding doors will stay shut the same in one country as another.

At the Nine Elm Works, where not only the repairs of the engines of the system are made, but the new locomotives as well, the assistant superintendent paid three or four of us Americans one of the highest compliments I ever received by spending at least four hours showing the most of what there was to be seen.

Locomotive boilers made tight without caulking, in fact a boiler shop where both drift pin and caulking tool were prohibited was a new thing to me, as was the whole boiler construction. Shell joints that gave 80 to 90 per cent. the strength of the sheet in place of 55 to 60, circular joints butted together and covered with a band shrunk on, and heads riveted to solid rolled angle hoops shrunk on with all holes drilled in place, seemed like a machine job rather than that of boiler work. As one of the engines that had just come in from its run was over thirty years old, it would seem that with the South-Western they found good work worth its cost.

It will likely take the British engineers as long to be convinced that the forged locomotive frame is better than the plate one, as it has our railroad men to be convinced that there was merit in the block system. The plate frame being such an easy thing to make, and filling apparently every requirement when it is made, gives a good deal besides prejudice to overcome before they will be convinced.

At the Nine Elm Works their facilities enabled them to pile ten plates top of each other with a template on top, follow around the template with a slotting machine, cutting the pile into shape, and without unpacking, run under three radial drills and drill all the holes without moving. In this way the frames for five locomotives are finished in a lot, and all alike within the allowable limit of error.

A milling machine carrying two mills 8in. or 10in. in diameter by about a foot long, slabbing two connecting-rods at a time, appeared to be a dozen years old, and a machine for grinding the slots in case-hardened links to the proper radius, and another one grinding the two end holes perfectly without revolving the links were as good pieces of devising as one can see anywhere.

First an emery wheel, mounted on a high-speed spindle, was caused to travel like a planet within the holes; so far, that was easy enough to do, but in addition, the wheel could be set out as the stock and wheel were ground away, and that while under motion as easily as an ordinary wheel is set up to its work, the wheel travelling back and forth to keep the holes parallel.

The English seem to make a distinction between forging done by machinery and that done by hand, the former being called "forging" and the latter "smithing." Special pride is taken in the amount and perfection of the forging, pieces of all shapes being smashed into shape ready for the milling machine without any hand work whatever.

Casting the two cylinders in one casting is the practice; a double boring machine used to bore both cylinders at once; and as the two valve chests are between the cylinders—the valve seats are not over 4¼in. apart—a special milling machine is made to stand on its head, go down between and dress the faces and ports. How often we hear it said, "This is the country where the milling machine was developed," and the impression conveyed that comparatively little is done in other countries. Such a conclusion can easily be reached if one will only go in the right shop here and the wrong shop abroad. On the other hand, the reverse conclusion would be reached if the searcher for facts should go into the works of Alfred Muir in England, and in the shops of Tom, Dick, and Harry here. I have been told by Americans that in no other shop in the world, not even in the Steinlen Works at Alsace, can such a variety of milling machine work be found as in Alfred Muir's works at Manchester. I give this second-hand, but have no reason to question its truth.

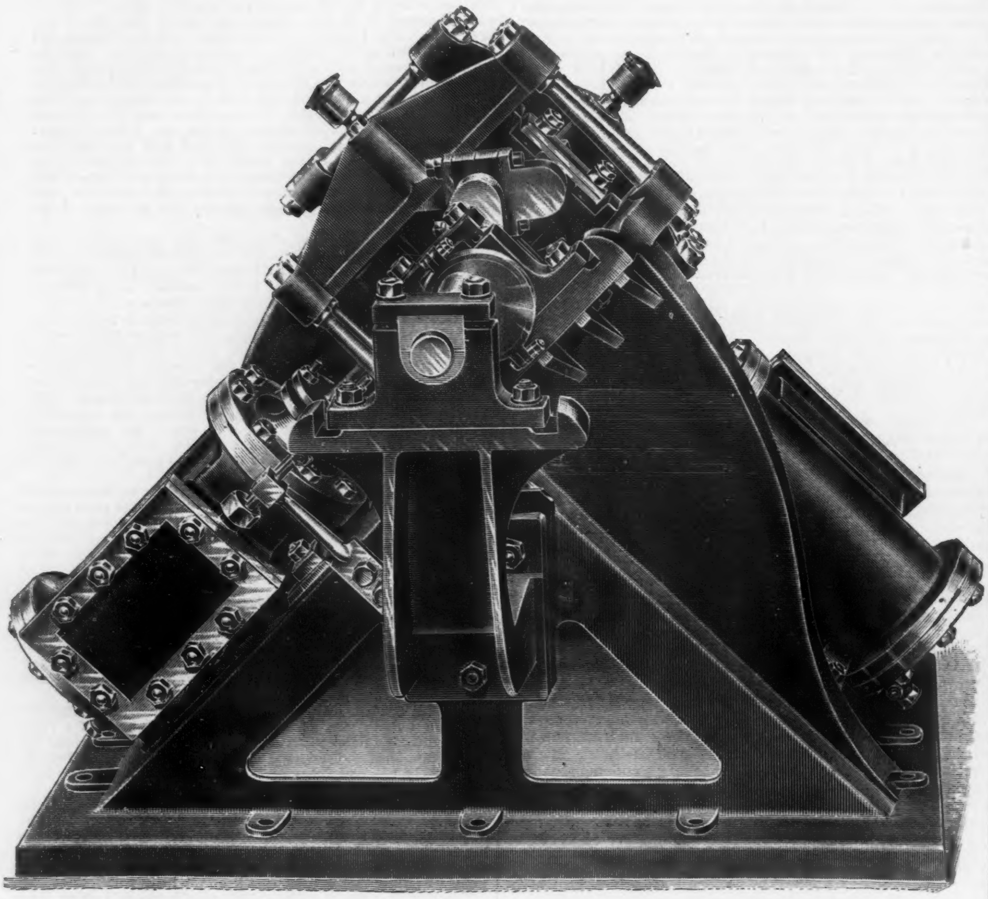
At the engine works of Willans and Robinson, Thames Ditton, two wonders await every American, except those who will not admit that anything can be done except what we do. There are a number of features about the engine that students in engineering have been taught to believe are contrary to the best practice, but experience shows that they produce the results, and the style of the engine renders good work necessary, and the good work produces results where it would be wasted on other designs.

The cylinders and steam chests are piled up one above another, and it is important that they be true and in line. These cylinders are bored, reamed and faced on an ordinary lathe, a regular English lathe, with no fixtures except a holder attached to the slide rest to carry the reamer, that is, the reamer is held and driven through the work by the slide rest and not by the tail stock. Mr. Eaton Shore—the works manager who, as well as every one connected with the company, gave me every attention, all information, and every opportunity possible to see and learn—is firmly of opinion, as I am now convinced, that the results obtained could not be continuously produced by the tail stock feed. As an example, a half-dozen cylinders some 14in. in diameter and 1ft. or so deep, with a flange outside at one end and inside at the other, were by the lathe just finished. One taken at random was sent to the testing floor and placed on an oiled surface plate. The testing plug, made like a web pulley, with about 2½in. face, was started in the cylinder and crowded down until about even at the top, when with a finger on the top at one side the plug was shown to be so free from contact with the sides of the cylinder as to spin around like a top. The man then stood upon the plug, and it carried his weight on the air. This job probably could be done in any good shop if one went at it the right way, but for one thing the castings are made from re-cast pigs, re-cast after the mixtures are made. This makes a uniform iron which is more likely to keep its shape, but is very hard, and that makes the work difficult. Such hard cylinders and the accuracy contributes to the success of the engine, but such accuracy would be of no particular advantage in an ordinary engine when the cylinders are distorted by steam in one place or on one side, and exhaust in another.

The Willans engine is, in its design, workmanship, and method of construction, so dependent one upon the other, that it is not easy to describe how things are done, and give them their due force, without describing the engine itself, and the whole would be more than a single article would cover, and I find that I must leave it. They have in use what I understand is a common thing, a flexible copper steam pipe, capable of resisting any required pressure, that bends around like a rubber hose. Not a double wire arrangement like Almond's, depending on mechanical fits, but an absolutely tight copper pipe constructed in such shape as to be easily bent around—an ideal device for an erecting floor.

It is useless to attempt a description of the interesting and wonderful things to be seen at the works of the Willans and Robinson Company, and to one who appreciates wonders some such thought as this must come to him—the death of a great engineer is a loss to the world. When Peter William Willans died, the world lost a genius.

CHAPMAN'S LINK MOVEMENT ENGINE



THE LINK MOVEMENT ENGINE.

We illustrate a curious engine patented by Mr. G. Chapman, and constructed by Messrs. John Milne and Sons, Milton House Works, Edinburgh. The object of the inventor has been to produce an exceedingly compact engine, and a glance at the engraving will show that he has accomplished his purpose. There are no connecting-rods. Roughly speaking, the two pistons move diagonally, and cross and recross midway at every stroke, a link, half the length of each, connecting them; a pin at each end of the link passing through the crossheads forms the respective cranks, and circular motions cause the rotation of the shafts, the pressure on the slippers being reduced to a minimum.

It is a known geometrical fact that any point in the circumference of a circle revolving on the inside of another of double the diameter will describe a straight line. Mr. Chapman's engine utilises this principle in a way that will be readily understood by the aid of the two small diagrams annexed.

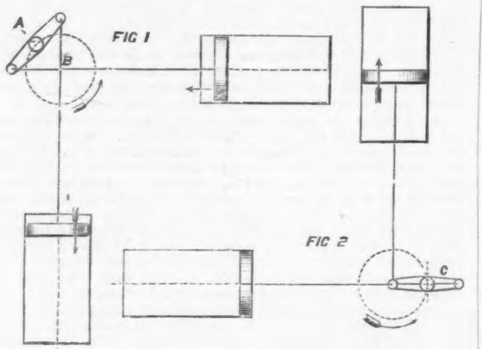


Fig. 1 shows the pistons at the ends of their strokes, and Fig. 2 shows one at half stroke. The crank length is from A to B, or half the diameter of the virtual circle within which the crank pins revolve. Any of our readers accustomed to geometrical work will see that this is an extremely pretty parallel motion without further description. The details of the engine have been very neatly worked out. It is not possible to dispense with guides, because the pressure on the pistons varies. But Messrs. Milne say that a new engine which they have tested gave about 78 per cent. of its indicated power on the brake at 180 revolutions per minute. This, for a small engine, with cylinders only 5in. diameter by 10in. stroke, is very good work.

The cranks are side by side, the flying crank C, Fig. 2, acting like an ordinary drag link. This seems to us to be a very meritorious attempt to solve a difficult problem.

COLLISIONS AT SEA.

A device for minimising the effects of collisions at sea has been described in an address delivered by His Excellency Admiral Makaroff, to the Hong Kong General Chamber of Commerce. He proposes that when a ship has been fitted with engines, boilers, water-tight doors, and everything else which cannot be damaged by water, a trial of the bulkheads should take place by filling the compartments with fresh water to the upper part of the bulkheads. This trial ought to be made in the presence of competent officials, who should certify that the bulkheads are strong enough to withstand the full pressure of water, and that they are water-tight.

Admiral Makaroff writes:—If the collision takes place upon one of the main bulkheads, two compartments are filled with water. In order to avoid this I propose that each main bulkhead should be supplied with extra small water-tight compartments at the side of the ship, from 10ft. to 12ft. wide. Then the collision would only affect one bulkhead of these small compartments, and the result would be that instead of two big compartments being filled with water only one big compartment and the little one would be flooded.

The general opinion is that the colliding blow is so very powerful that nothing can minimise the effect of it; but I can give proofs that even when the force of the blow is comparatively slight the skin of the ship is penetrated. It is a matter of fact that the vertical stem acts as a knife, and that very little energy is required to penetrate the skin of the ship which is run into.

In order to demonstrate the difference between touching the skin with a ram which is without a buffer and a ram with a buffer

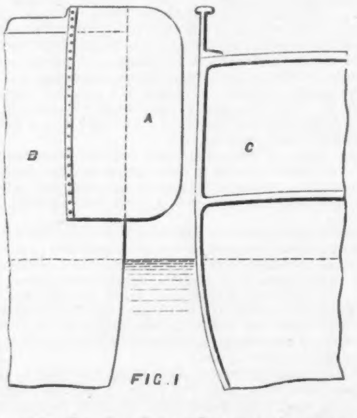
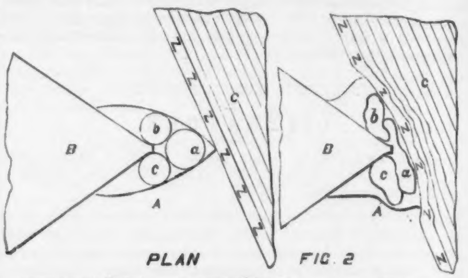


FIG. 1

I made some experiments a few weeks ago on board my flagship Emperor Nicholai. Vice-Admiral Buller, Rear-Admiral Hoffmann, Commodore Boyes, and many captains were invited to witness them. A model representing a ramming vessel was moved by a weight so as to ram a model which represented the amidship section of a ship. A small buffer of $\frac{1}{4}$in. thickness of cotton cloth was made which could be adjusted to the ram. When the blow was dealt without the buffer the ram easily penetrated the skin of the other model and the ramming vessel made an inroad of $\frac{3}{4}$in., and cut a hole 2in. in length, which in reality means 8ft. When a similar experiment was made with the buffer on the ram an inroad of only $\frac{1}{4}$in. was sufficient to arrest the progress of the vessel, and the skin was only slightly bent and not penetrated. It shows that the model experiments, if properly carried out, are very useful in testing the application of new improvements. Does it not also show that something can be done to minimise the effect of collision? What is the reason, then, that up to now nothing has been done to minimise the effect of collision?

It is impossible to build a ship with a flat nose, but the solution of the problem is to build the ship in such a way that her forepart should be sharp while she is propelled through the water, but that at the moment the nose of the ship touches the skin of another her fore part should collapse and present a flat surface. The power of the shock will consequently be distributed over a wide surface of the skin, bending inside ribs, beams, &c., without making a hole in the skin. Some part of the power of the shock will be exerted in collapsing the fore part of the colliding ship, and if this part is designed properly the collapse will absorb the greater portion of the blow. It would be most desirable that at the moment of touching the false nose should begin collapsing before the skin of the other ship begins to give way. The force required for collapsing should increase with the progress of this collapse, because more surface of the striking ship is engaged in resisting the shock—maybe it will be possible to altogether avoid damage to the vessel which is struck by so arranging the false nose that the full power of the shock will be utilised for smashing this nose. By that time the ship which strikes will lose the greater part of her speed, and the other will recede in a corresponding manner.

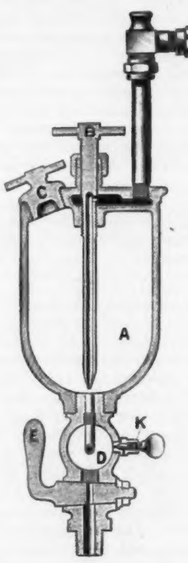


PLAN FIG. 2

Let us imagine that the nose of the ship is built as usual, and that the false nose is an additional part which can be put on or taken off when necessary. I imagine that it ought to consist of very thin sheets of steel, say one-eighth of an inch, and should run in front of the ship as shown upon the diagram. Many little ribs and stays inside ought to give enough strength to the skin to enable it to resist the force of the waves. The space between the false shell and the nose of the ship ought to be filled with some soft, fibrous substance—not powder. This substance is intended to play the *rôle* of a cushion and the shell will play the *rôle* of a pillow-case. After collision the false nose will present the appearance as shown in the diagram. The ship's nose will not be damaged, and as generally there is no cargo in the fore compartment of the ship in front of the collision bulkhead, it will be the work of a few hours to unfasten the bolts and remove the smashed false nose in order that the ship may continue her voyage as if nothing had happened.

LUNKENHEIMER'S AUTOMATIC GRAPHITE SIGHT-FEED LUBRICATOR.

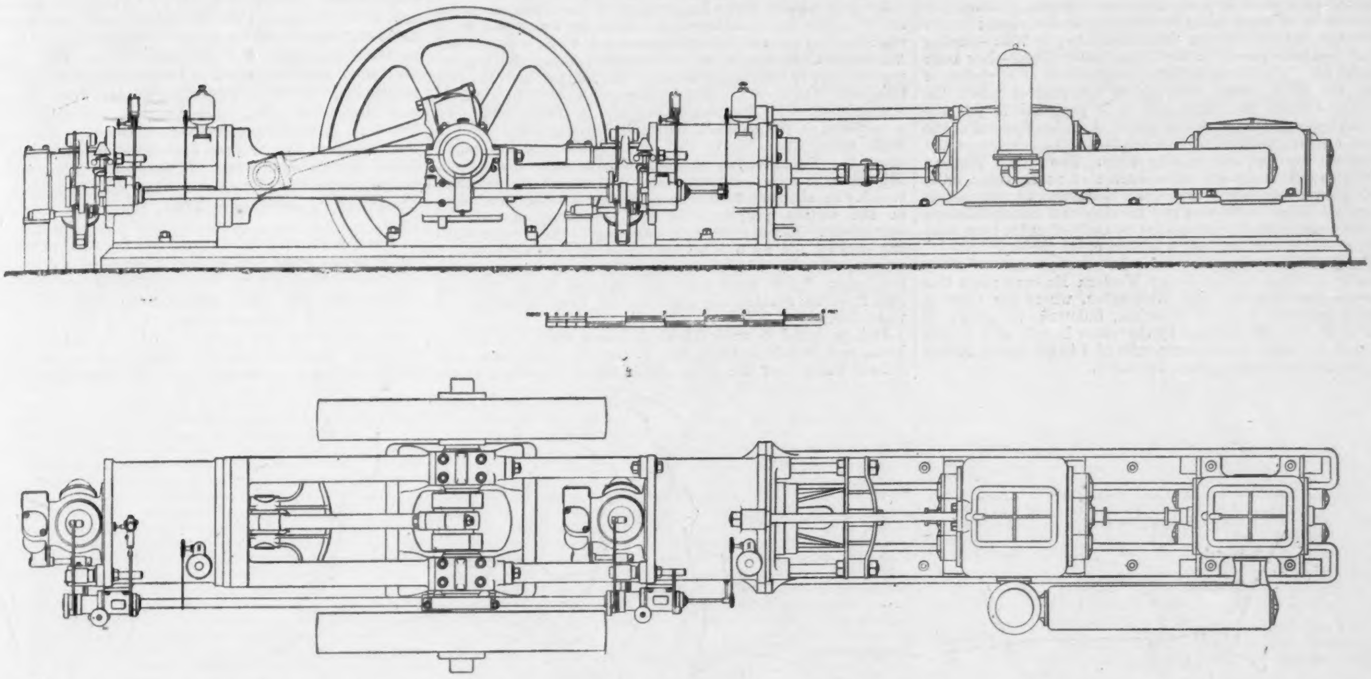
The accompanying engraving illustrates a self-acting valve for sight-feeding a determinable quantity of graphite to steam chests and cylinders, for use instead of oils for high pressures, and for lubricating where with very high pressures or with superheated steam oils are vaporised at once and do no good. The engraving shows only the section of the lubricator. In it A is the reservoir with which the graphite is filled through the plug-hole C. In the upper part of the lubricator cover is a small chamber to which steam is admitted, and from which it can only escape through the small hole leading into the tubular needle adjustable by the handle at B. When steam is turned on and the E opened, steam or water from the needle point carries the fine graphite with it through the tube into the space D, which has a small bull's-eye on either side. From the space D it passes to the steam chest. At K is a drain valve. The graphite lubricator is made by the Lunken Valve Company, Great Dover-street, London.



The Panama and Nicaragua Canals.—For the purpose of ascertaining some particulars of the reported consolidation of the Panama and Nicaragua Canal Companies, a representative of Reuter's Agency called upon Mr. J. R. Bartlett, president of the Nicaragua Canal Company, who has been engaged during the past two months in London and Paris carrying on negotiations, and is on the point of returning to New York. In reply to questions, Mr. Bartlett said:—"No such consolidation has yet taken place. But negotiations for a fusion of the interests of the two companies are in progress. As the matter has not yet received the consideration of the respective Boards, I cannot give details of the scheme. I may say, however, that the proposed arrangement includes a fusion of French and American interests, the Nicaragua Company purchasing the assets of the Panama Company, and both parties concentrating their influence and capital in the construction of a canal over the Nicaragua route, which is regarded by all parties as being the most feasible one. Such a consolidation of interests is regarded with great favour by banking interests in Europe and America, as removing every possible competition. Only one canal is needed to accommodate the maritime commerce now compelled to go round Cape Horn. As the canal is international in its scope, it will not only accommodate the ocean and coastwise tonnage of the United States, but the maritime commerce of other nations." In conclusion, Mr. Bartlett said the attitude of the various Governments concerned was exceedingly friendly.

LARGE TANDEM GAS ENGINE AND AIR COMPRESSOR

MESSRS. FIELDING AND PLATT, GLOUCESTER, ENGINEERS



200 I.H.P. GAS ENGINE AND AIR COMPRESSOR.

The above engraving shows a successful application of the gas engine to the direct driving of air compressors on a scale probably far beyond any hitherto attempted. The engine is one of Fielding and Platt's tandem pattern, and has two cylinders, their pistons being connected by a pair of side rods, the arrangement being such that an impulse to the crank at each revolution at equal intervals is obtained when working at full power. This produces very regular turning and a steady action on the compressor. Advantage has been taken of the compressed air to use a small quantity for the purpose of clearing the cylinder of exhaust gases, with very beneficial results as regards increase of power and fuel economy. The action of the scavenging arrangement is very positive, and its influence decidedly marked, when thrown into or out of action. These engines have been worked under various tests, and have, we are informed, given 182 maximum brake horse-power, at a speed of 150 revolutions per minute. This speed is somewhat excessive for an air compressor of the size in question, and, as a rule, the speed does not exceed 120 revolutions per minute. The engine is fitted with the Fielding patent self-starter, which, whilst very powerful, has the advantage of putting the engine quietly into motion before the starting explosion takes place. The engine is driven by producer gas from a 200-horse power gas plant, also made by Messrs. Fielding and Platt.

The air compressor was made by Messrs. S. H. Johnson and Co., of Carpenter's-road, Stratford, London, E. The whole plant was put in under the supervision of Mr. Howard Lane, of Birmingham, for a large metal works in South Wales, where it has been in daily operation during the last eight or ten months. Recently a number of tests for continuous working have been made with, we are informed, such highly satisfactory results as to leave no doubt as to the suitability of such an installation for work of this nature. The results as to economy must be considered to be exceedingly good. Messrs. Fielding and Platt are informed by the purchasers that they find, after long and continuous trials, that the consumption of coal is about 1 lb. per brake horse-power per hour. The coal used is anthracite from the Swansea district, and there can be no doubt that, for that neighbourhood in particular, fuel gas, and gas engines possess important advantages. The tandem type of engine appears also to be well adapted for electric lighting purposes, owing to the regularity and frequency of impulse obtained at a moderate speed. It would seem to be much better to obtain the required frequency of impulse by duplicating the cylinders than by doubling the speed of the engine. For instance, when running at 120 revolutions per minute, it will give as many impulses per minute as a single engine at 240 revolutions per minute, the wear and tear being reduced.

PROPOSED SHIP CANAL FOR CONNECTING THE BRISTOL AND ENGLISH CHANNELS.

By W. O. E. Meade-King, M. Inst. C.E.

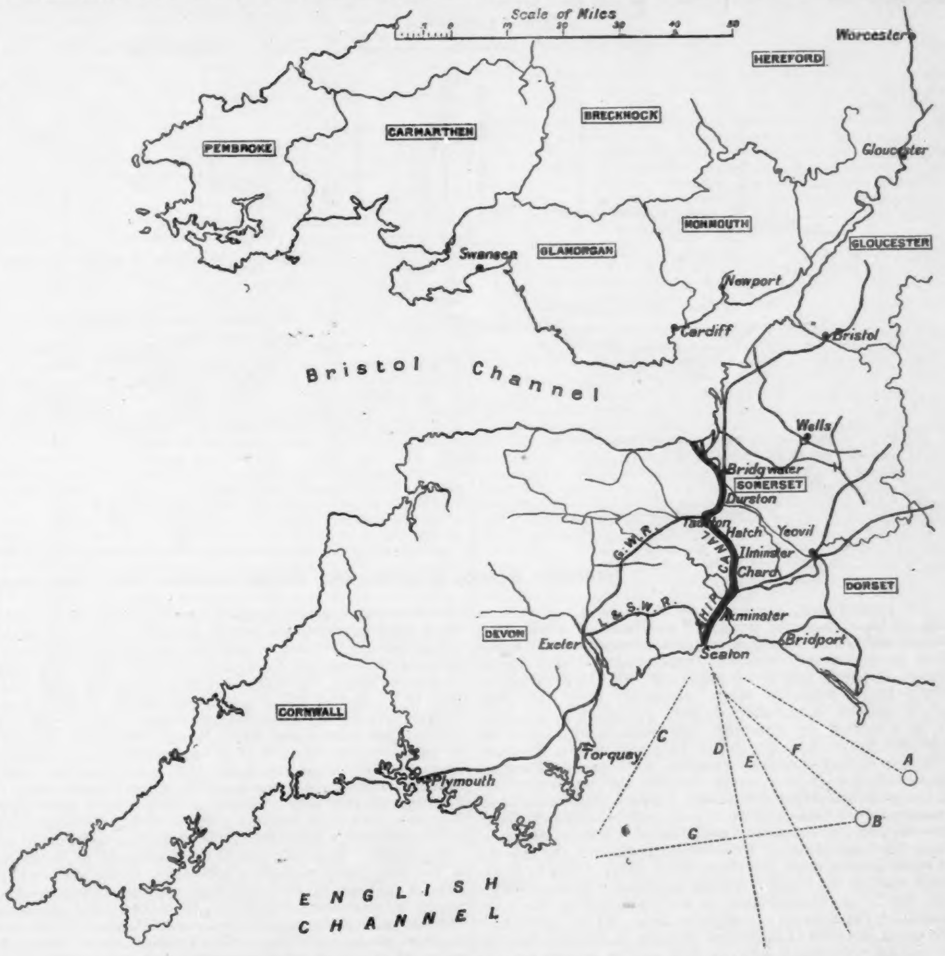
Various schemes have been suggested from time to time to connect the Bristol and English Channels by means of a waterway sufficiently large to take ocean-going vessels, but so far as the author of this communication knows, none of the schemes have ever been described in writing sufficiently fully to enable the public to judge of its practicability or financial prospects. The following description has therefore been committed to paper, and will, it is hoped, coupled with the drawings accompanying it, explain every point of interest and receive the favourable consideration of those to whom the shipping industry of the West of England is of so much importance. A certain portion of Somersetshire now drained by the river Parret and its tributaries, as is generally well known, is often subject to floods, and a portion of the canal now suggested, namely, from a point about two miles to the south-east of Taunton to its entrance in Bridgwater Bay, is so designed as to assist this part of the County in getting rid of its superfluous drainage.

Before describing the scheme further, it would be as well to point out the route it is proposed to adopt, and the reasons for selecting this position. The northern entrance to the canal would be in Bridgwater Bay, west of the point where the river Parret now flows into the Bristol Channel, and following the curve now taken by the Great Western Railway main line, would cross that railway about midway between Durston Junction and Taunton. In selecting this line, advantage has been taken of the lowest land, and also one railway crossing only is necessitated in the place of two, if the canal was made on the east side of the railway. In addition to which advantage, Bridgwater would be practically on the line of the canal, docks and wharves on which would be constructed to suit the requirements of what is at the present time an important port, how important can be seen from the shipping returns, which show total annual imports amounting to 163,645 tons, and exports, 51,194 tons, making a total shipping of nearly 215,000 tons.

About a mile from Taunton, docks might be constructed which would serve two purposes—in the first place, to take a portion of the trade of that important inland town, now wholly dependent on railways; and secondly, it would enable a sharp turn to be made in the canal, thereby avoiding high ground.

Leaving the Taunton docks, the canal would again follow the Great Western Railway, being the Taunton and Chard branch of that line, passing the towns of Ilminster, Chard, Axminster, Colyton, and Seaton. The Great Western line terminates at Chard Junction, when the line, the curve of which the canal would continue to follow, becomes the London and South-Western Railway, which would have to be crossed about two miles to the south-west of Axminster, after which the line of the river Axe might be adopted to its outlet in Seaton Bay. The total length of this canal would be about 42¾ miles, and the route selected, though rising at one part to as much as 300ft. above the sea, is nevertheless claimed as being the most direct, as well as the most practicable, that the country through which the canal would pass will admit of.

Amongst the many schemes that have been suggested, the one that has hitherto received what little favour any of them have found, was one, the line of which left the Bristol Channel east of the river Parret, thence proceeded to Yeovil, and from there to Bridport. This, no doubt, has some advantages, though outweighed by the disadvantages; whatever line is adopted, the watershed from which the rivers Parret and Axe derive their sources has to be crossed, and the lowest point is about 300ft. above the sea, and profiting by the experience gained in some of the difficulties encountered in the Manchester Ship Canal, the fewer the number of railway crossings necessitated the less the opposition to the canal in the first place; and secondly, the less the difficulties



PROPOSED BRISTOL CHANNEL AND ENGLISH CHANNEL SHIP CANAL entailed during construction. The line by Yeovil would mean at least four railway crossings, and possibly five; the line of the present scheme, only rising to the same height above the sea as the Yeovil scheme, has but two railway crossings.

Of course the height to which these railways would have to be raised depends entirely upon what headway is required by the class of vessel likely to make use of the canal; but in estimating the cost of the work a headway of 75ft.—similar to the headway given on the Manchester Canal—has been allowed for. High level bridges, composed of steel girders to carry the lines, would have to be constructed where the railways crossed the canal, and it is proposed to put the railways on embankments composed of excavation out of the canal, having gradients of 1 in 100, until the new line would strike the level of the existing lines. The Great Western Railway would have an embankment of nearly three miles in length on each side of the canal, containing approximately 1½ million cubic yards, and the London and South-Western Railway would have embankments each 1¾ miles long, containing together about half a million cubic yards.

The gradients proposed are not so steep as some of those already existing on the Great Western Railway main line between Burlescombe and Wellington, where for about a mile a gradient of 1 in 81 exists, followed by about 10 chains of 1 in 90, followed by the same length of 1 in 80, followed by rather more than a mile of 1 in 90, therefore 1 in 100 cannot be looked upon as excessive.

The river Parret, through all the low-lying part of Somersetshire, assumes very much the character of the rivers Mersey and Irwell, though on a somewhat smaller scale; it is a river having a very tortuous course, its bed and banks being composed largely of mud and silt, it is liable to heavy floods, when its banks constantly give way, very much to the detriment of the surrounding country. It is proposed to construct overflows from the canal into the Parret, and *vice versâ*, by which means the flood water can be kept under better control. Between the Taunton docks and the Great Western Railway, the river Tone—one of the principal tributaries of the Parret—would have to be crossed, and at this point it is proposed to admit the Tone into the canal by means of a weir, the water level of the latter being fixed accordingly. Once the canal was full, the amount of water passing down the Tone need never again be interfered with, as the canal would be furnished with an overflow into the Tone corresponding in level and size to the weir, admitting the Tone on the opposite side. All this portion of the canal, between 17 miles and 18 miles in length, which is to do duty during floods, as well as for inland navigation, is designed to be 100ft. wide at formation level—the remainder of the canal being 80ft. wide—and at water level a cess or benching is shown on either side, of 15ft.; therefore, if the excavation is got out with slopes of 1½ to 1, and the canal is 20ft. deep, flood water would begin to accumulate with a bottom width of 190ft., and the cutting being 30ft. deep, by the time flood water reached the surface of the land it would have a sectional area of 2050 square feet in addition to the natural area of the canal. A very considerable addition to the area now afforded by the river Parret, and by opening the sluices at the entrance to the canal in Bridgwater Bay, it would be a practical impossibility for any flood in the canal to rise to this height.

The widths given at formation level, namely, 100ft. for the northern portion of the canal from locks 1 to locks 3, and 80ft. for the remainder of the canal, are the actual widths of excavation, and as the sides would have to be protected, for preference with stone pitching, the space occupied by the pitching, say 2ft. on each slope, has to be deducted from the effective width of the channel, thus leaving 96ft. of effective width at the bottom between locks 1 and 3, and 76ft. between locks 3 and 26.

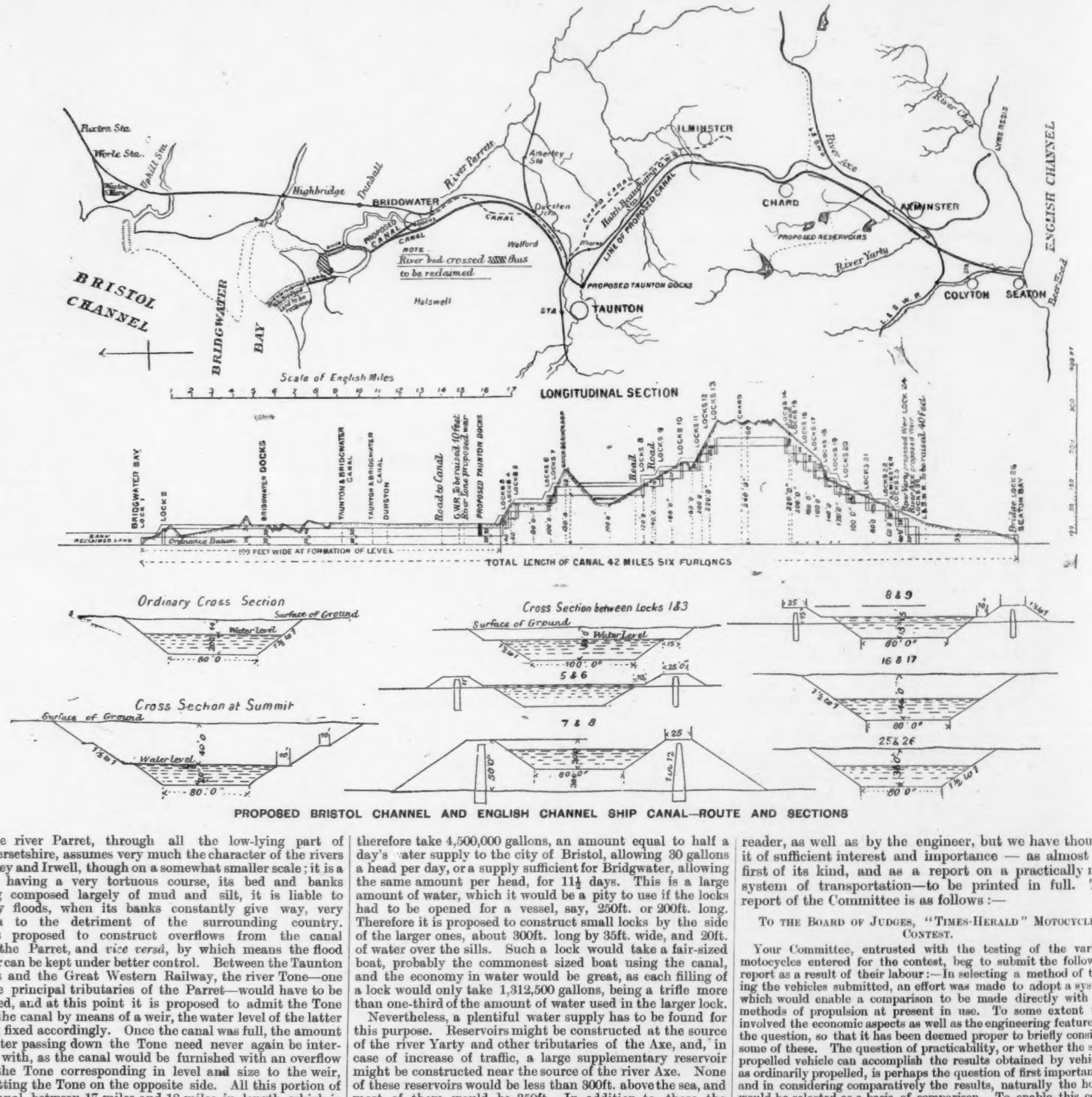
Between a point about a mile south of the Taunton docks and the other end of the canal at Seaton, the watershed, from which in this immediate neighbourhood the rivers Parret and Axe derive their supply, has to be crossed, being the highest ground already mentioned between the Bristol and English Channels; therefore the canal is reduced to 80ft. in width at formation level for economy's sake, and a cutting 60ft. deep is proposed at the summit, reducing the formation level to 240ft. above the sea. As this upper portion of the canal, about 3½ miles in length, is in deep cutting, and as any landslip would be such a serious matter if of magnitude sufficient to delay or obstruct traffic, every precaution has been taken in the section proposed for the prevention of such an occurrence. In the first place, the whole of the 60ft. in depth has been treated as if it was soft material, and as if no rock existed, the slopes being estimated for at 1½ to 1, and two benchings of 10ft. each have been allowed for as well, one 20ft. from the surface, the other at 40ft. from the surface, or water level.

It is proposed to work the whole canal with a system of locks, each lock to be 600ft. long by 60ft. wide, having at least 20ft. of water over the sills. Each filling of a lock would therefore take 4,500,000 gallons, an amount equal to half a day's water supply to the city of Bristol, allowing 30 gallons a head per day, or a supply sufficient for Bridgwater, allowing the same amount per head, for 11½ days. This is a large amount of water, which it would be a pity to use if the locks had to be opened for a vessel, say, 250ft. or 200ft. long. Therefore it is proposed to construct small locks by the side of the larger ones, about 300ft. long by 35ft. wide, and 20ft. of water over the sills. Such a lock would take a fair-sized boat, probably the commonest sized boat using the canal, and the economy in water would be great, as each filling of a lock would only take 1,312,500 gallons, being a trifle more than one-third of the amount of water used in the larger lock.

Nevertheless, a plentiful water supply has to be found for this purpose. Reservoirs might be constructed at the source of the river Yarty and other tributaries of the Axe, and, in case of increase of traffic, a large supplementary reservoir might be constructed near the source of the river Axe. None of these reservoirs would be less than 300ft. above the sea, and most of them would be 350ft. In addition to these the reservoir is still in existence which was constructed about 1848 for the purpose of supplying water to the Chard Canal, now disused. This reservoir might be brought into use again, and, considering that Somersetshire enjoys the reputation of having a greater annual rainfall than any other county of England, with the exception of the Lake district in Cumberland, there need be no fear concerning the water supply with six good reservoirs to feed the highest pond, four of which might be sufficient for the canal purposes, whilst the remaining two could be used as compensation reservoirs, if so desired.

Near Axminster the rivers Yarty and Axe would both have to be crossed, and as the canal would have to be at a considerably lower level than either of them for reasons to be explained presently, it is proposed to admit both rivers to the canal by means of weirs, thereby maintaining these rivers at their ordinary height, and also preventing their streams from carrying silt and other material into the canal.

(*To be continued.*)



PROPOSED BRISTOL CHANNEL AND ENGLISH CHANNEL SHIP CANAL—ROUTE AND SECTIONS

OFFICIAL REPORT ON THE AMERICAN HORSELESS CARRIAGE TRIALS.

In arranging for the competitive trials of motor carriages which were carried out at Chicago a few months ago, it was realised that the mere road performance of these carriages would not be a sufficient test of their comparative economy and efficiency or of their value as machines, and the Board of Judges therefore appointed a committee on tests, consisting of Mr. John P. Barrett, city electrician; Mr. John Lundie, civil engineer; and Mr. L. L. Summers, electrical engineer. These gentlemen designed the testing apparatus described and illustrated in The Engineer of November 22nd, 1895. All the carriages tested were described and illustrated in The Engineer of November 22nd, 1895, and January 3rd, 1896.

The report was only made public on February 16th, when it was published in the *Times-Herald*, as the proprietors of that paper, who originated the competition, did not wish the report issued until they were ready to print it in full in their paper. From the fact that the competition was a "popular" one, and that the results would be made known in a daily paper, the report has purposely been so written as to be understood by the lay reader, as well as by the engineer, but we have thought it of sufficient interest and importance — as almost the first of its kind, and as a report on a practically new system of transportation—to be printed in full. The report of the Committee is as follows:—

To the Board of Judges, "Times-Herald" Motocycle Contest.

Your Committee, entrusted with the testing of the various motocycles entered for the contest, beg to submit the following report as a result of their labour:—In selecting a method of testing the vehicles submitted, an effort was made to adopt a system which would enable a comparison to be made directly with the methods of propulsion at present in use. To some extent this involved the economic aspects as well as the engineering features of the question, so that it has been deemed proper to briefly consider some of these. The question of practicability, or whether the self-propelled vehicle can accomplish the results obtained by vehicles as ordinarily propelled, is perhaps the question of first importance; and in considering comparatively the results, naturally the horse would be selected as a basis of comparison. To enable this comparison to be made without involving the subject in undue technicalities, a brief digression dealing with the early investigations of the power of the horse may not be irrelevant; particularly as the horse has long been a source of motive power, and for this reason was early selected as a comprehensive unit of comparison.

The horse-power unit.—With the advent of the steam engine it was found necessary to compare the rate at which the engine could do work with the rate at which a horse could do work, in order that the purchaser of an engine could specify the power required in a unit he was familiar with. As the power the average horse was capable of exerting had been but indefinitely determined, experiments were made by James Watt to obtain definite figures, and for this purpose a weight of 150 lb. was arranged to be raised by the horse, when it was found that the weight could be raised at the rate of two and one-half miles per hour, or 220ft. per minute. Multiplying the weight in pounds by the feet travelled per minute, Watt obtained 150 × 220 = 33,000 foot-pounds per minute as the power which the horse could exert. This power could be exerted for eight hours per day, but for a fewer number of hours per day a higher rate of doing the work could be developed. Numerous experiments made since those of Watt have indicated that Watt's measurements were upon horses far above the average; the best authorities agreeing that the power of an average horse should be considered about 22,000 foot-pounds per minute. Upon this basis a table—"Trautwine's Pocket-Book"—of the pull a horse could exert and the corresponding speed in miles per hour would be as follows:—

Miles per hour.	Pull or Traction.	Miles per hour.	Pull or Traction.
Three-fourths	333·3	Two and one-fourth ..	111·1
One	250	Two and one-half	100
One and one-fourth ..	200	Two and three-fourths	90·9
One and one-half ..	166·6	Three	83·3
One and three-fourths	142·8	Three and one-half ..	71·4
Two..	125	Four..	62·5

It is evident that not only can the horse exert a heavy pull at a low speed, but that it is capable of exerting a wide range of pull, which makes it particularly suitable for the purpose of hauling vehicles. Experiments differ as to the maximum pull the horse can exert, and the conditions of footing, character of load, &c., greatly affect the results. For the purpose of determining roughly a probable value, an express horse of average type was tested by your Committee, and, without resorting to violent methods of persuasion, the maximum pull obtainable was found to be about 250 lb. It is probable that 400 lb. is about the maximum with a good horse. On the other hand, when the pull is light a considerable range of speed may be obtained, and a measure of the power exerted by the horse at all times may be obtained by multiplying the pounds pull by the speed in feet per minute. Dividing this by 33,000 gives the ordinary unit known as the horse-power. The figure of 33,000 foot-pounds per minute obtained by Watt is commonly adopted as the number of foot-pounds per minute constituting a horse-power. The determinations actually made of the pull required of a horse in pulling a vehicle are not very numerous nor authentic, as, owing to the fact that the pull is apt to be irregular, many difficulties are encountered in measuring it and no great accuracy is attainable. A comparison of the motocycle with the performance of a horse involved then a measurement of the pull the vehicle could exert and a determination of the speed the pull was exerted at. A testing machine was accordingly designed with the primary object of measuring these factors. The power of the vehicle was readily obtained from these by multiplying the pounds pull by the feet per minute travelled. This being divided by 33,000 would then give the mechanical horse-power exerted by the vehicle on the rim of the wheel at any instant. As this power measurement of the vehicle would determine its ability to propel itself under different conditions, a measurement of the fuel consumed in accomplishing this would enable the item of cost to be obtained. The net results, therefore, sought were how much power would be available at the rim of the wheels for a given expenditure of money. In the case of a gasoline engine a measurement of the gasoline consumed in a given time while the motocycle was exerting a given power would enable this cost to be determined directly. In the electrically propelled motocycle a measurement of the power consumed in producing a given power at the rim of the wheel would enable one to calculate the cost of propulsion when the cost of electrical power for charging the batteries was known. In addition to considering the cost of producing a given amount of power at the rim of the driving wheels, it was considered advisable to determine if possible the losses between the driving motor and the rim of the wheels. These determinations would show how efficiently the power generated by the motor was transmitted to the wheels of the vehicle. The various methods adopted of regulating and controlling the speed and power of the vehicle might also affect the consumption of fuel, and result in a less amount of power being available for a given amount of money expended in fuel. Very accurate data are available concerning the usual types of motors, similar to those used for propelling vehicles. These data are confined almost entirely to the use of the motors for stationary purposes, however, and very little information is extant regarding their application to vehicles.

Fuel tests.—Under these circumstances somewhat extended tests were made to ascertain the consumption of fuel and performance of the vehicles under the various loads apt to be imposed in practice. In order that the same conditions might exist for all gasoline vehicles under test, they were all supplied with gasoline from the same barrel, the density of which was found to be 0·688. No effort was made to obtain a particular density of gasoline, as it was deemed best to use that ordinarily to be obtained from the retail dealer. Cost of gasoline has been estimated at 2 cents—1d.—per pound in deducing the results shown in the appended table. The cost of electrical energy has been estimated at 10 cents—5d.—per kilowatt hour. The storage batteries are assumed to have an efficiency of about 75 per cent., making a cost per horse-power hour delivered to the motor of 10 cents.

Maximum pull of vehicles.—In order to still further compare the performance of the motocycles with that of the horse, efforts were made to determine the maximum pull which the vehicle could exert as compared to that of the horse. It is evident this would only be of interest in determining the performance of the vehicle when operating under extremely unfavourable conditions, and in this connection it is only fair to add that the vehicles submitted were all designed for a light passenger service and not to exert a heavy pull, so that a medium pull exerted at a high average rate of speed was the object sought rather than a heavy pull under adverse conditions. For determining this feature the pull on the motocycles was increased until the limiting conditions were reached, with the results shown. It is apparent that the heaviest pull exerted, viz., that with the Duryea vehicle, amounted to only 187 lb., as compared to 400 lb. which a single horse could exert. It was not possible in any of the tests made to slip the driving wheels, so that the traction in all cases was ample, and if a greater driving power had been available by means of reducing gearing or otherwise, it would probably have been possible to obtain a correspondingly high result. In the case of the belt-driven machines of the Benz type, the limit was usually reached when the belts slipped. Owing to the defective conditions of the belts on the Macy machine, which possessed one of the most powerful motors of any of the vehicles submitted, the maximum effort was not obtainable. The Lewis motocycle was equipped with a special reduction gear, enabling a very heavy pull to be produced. An effort to obtain this heavy pull from the vehicle resulted in the breaking of the driving chains. Under these conditions it is hardly fair to consider the results as the best obtainable. In the machines directly-geared, any attempt to obtain heavier pulls than those given resulted in stalling the motors. The pull obtained with the electrical vehicles is, of course, only limited by the heating effects of the excessive current required. It will be observed that there is a wide difference in the consumption of gasoline by the various engines submitted. This is naturally to be expected when the types of engines are considered. In the case of the Lewis and the Haynes and Apperson vehicles, the cycle is such as to give an explosion every revolution, the piston itself uncovering the exhaust port, this type of engine being variously known in stationary practice as the Single, Sintz, or Day cycle. The exhaust from these engines was so densely laden with unconsumed carbon that an exhaust pipe and fume blast were required to convey the fumes from the testing-room. This simply bears out the well-known fact that this type of engine, giving an explosion for every revolution, while possessing many advantages, has a very low economy, due to the improper combustion of the fuel supplied. The other motors presented were almost all operated upon the Otto cycle. In the Benz type of motor the gasoline was thoroughly carburetted before being admitted to the cylinder, while in the Duryea and others the gasoline was vaporised directly at the cylinder. The results obtained, therefore, enable a partial comparison to be made between these methods of utilising the gasoline. It is to be regretted that owing to a derangement of the igniting mechanism in the Duryea engine higher power tests were not possible with this vehicle. It is a well-known fact in gas engine operation that the economy of the engine at light loads is, if anything, inferior to the steam engine under similar conditions. In the application of the gas engine to a motocycle the economy is particularly low, for the reason that a considerable proportion of the power is sacrificed in driving the mechanism. Owing to this feature the consumption of gasoline per horse-power hour at the rim of the wheel is quite large when the motocycle is operated under an ordinary load. Thus with a load requiring about three-quarters of a horse-power for its propulsion, it is evident that as high as one and one-half horse-power may be required in the engine in order to overcome the friction of the mechanism. If the motor is designed to give three or four horse-power at the rim of the wheels, the motor is lightly loaded under the ordinary conditions, and the economy as a result is very low. In this connection the Benz type of vehicle presents another interesting feature of comparison. These vehicles are provided with but two ranges of speed when the gas engine is running at its normal speed, and in order to increase the range of control the supply and proportion of the mixture of air and gasoline is varied. This is accomplished by a regulating valve controlled from the driver's seat. The explosive force of the mixture is readily controlled in this way, and a wide range of speed is thus given to the vehicle without the necessity for complicated mechanical devices for speed regulation. This simplicity and ease of control may, however, be purchased at the expense of economy, as will be apparent from the tests at various loads. It is evident that under the best condition of load a horse-power can be produced at the rim of the wheel with almost one-fourth the rate consumption of gasoline that it can under the worst conditions. With a type of vehicle such as the Duryea, where the speed of the gas engine is maintained constant and the speed regulation is affected by changeable gearing, the economy with variable speed of the vehicle is dependent entirely upon the load carried by the engine. Under some conditions, therefore, it is possible for a motocycle to ascend grades at the same speed as upon a level road and with the same consumption of gasoline. In other words, the loading of the engine may so increase the efficiency that it will enable it to give the increased power without increase in the consumption of gasoline. As far as possible it was endeavoured to ascertain if the jolting of the vehicles using a carburetter would affect its action—in other words, if the explosive character of the mixture was varied by the effects of the vibration of the vehicle. So far as could be determined, no effect was noticed in this respect; the carburetter apparently at all times supplying an even mixture. The location of the driving engine and the method of transmitting the power to the driving mechanism greatly influences the amount of vibration there is to the vehicle. In the Benz type of vehicle the single-cylinder engine, giving an explosion at every second revolution, is mounted with the cylinder at right angles to the axle of the driving wheels. The effect is to cause considerable vibration, and unless special means are adopted for counteracting this, it is transmitted to the body of the vehicle, resulting in more or less discomfort to passengers at the time of starting, although afterwards it is not so noticeable. In the Duryea vehicle the two driving cylinders are parallel to the axle of the driving wheels, and any reactive effect from the cylinders produces a vibration transversely. The vehicle of Haynes and Apperson is provided with two cylinders, one on each side of the crank shaft, and the reactive effect is greatly diminished. From the consideration of these questions, it would appear necessary to use more than one cylinder to eliminate vibrations, and preferably these cylinders should be arranged upon opposite sides of the driving shaft in order that the reactive effect may be entirely balanced and the vehicle freed from vibratory effects when the engine is running, though not propelling the vehicle.

Electric vehicles.—In considering the electric vehicles it is evident that in using a variable current from the storage batteries as the discharge rate is increased beyond the normal, both the life and efficiency of the battery will be diminished. In the Morris-Salom vehicle the batteries were rated at fifty ampère hours, with a discharge rate of five ampères. When discharging at a rate of twenty-two ampères it is evident that the available capacity of the cells will be greatly diminished. It is perhaps unfair to assume therefore that the efficiency will remain constant. While the mechanical efficiency is higher with a heavy load, the electrical efficiency as a whole may be diminished. The correction necessary for these factors will depend so largely upon particular conditions that no allowance has been made for them. The assumption of 75 per cent. efficiency in the batteries will be a fair average for normal conditions. The cost of electrical energy will also vary with the conditions, so that both of these factors must be considered in estimating the cost of operation. The heavy depreciation of the batteries when subjected to excessive discharges will also constitute a charge against cost of operation.

Single and double motors.—An interesting comparison may be made between the Sturges vehicle and that of Morris and Salom. Both of these vehicles are equipped with the same type of motor, the Sturges vehicle being propelled by a single motor of 3-horse power, while that of Morris and Salom is propelled by two 1½-horse power motors. A single axle with the wheel solidly mounted, the carriage being carried by the journals on this shaft, after the pattern of a car journal, is the method of driving adopted in the Sturges vehicle; while in the Morris and Salom vehicle the pinion on the motor is geared directly to the driving wheels, the wheels being provided with ball bearings, and every effort being made to diminish friction. The tests indicate that with the best workmanship possible, the two motors have but a slightly higher efficiency than the single motor, though the mounting of the single motor is in a measure crude. The electrical and gear losses with two motors would, of course, be greater than with a single motor. The advantages of the series—parallel control of the motors when storage batteries are used and may be grouped to regulate the voltage, does not, therefore, seem necessarily to be a factor of sufficient importance to warrant the adoption of two motors. Apparently the only other factor to particularly commend this arrangement is the elimination of a differential gear for enabling the wheels to travel independently of each other when curves or corners are being turned. In driving with a single motor of any type it is evidently necessary to provide a means for driving the wheels independently of each other, as otherwise a binding action on curves would result. The method adopted in almost all the gasoline vehicles presented consisted of some form of differential gear, each driving wheel of the vehicle being separately connected by means of a sprocket chain to the same countershaft.

Wheel experiments.—A series of experiments was made with a view to determine the power consumed in wheel resistance, consisting of axle friction and so-called rolling friction, an effort being made to separate these elements, with considerable success. The method adopted in determining the power consumed in wheel resistance was to drive the wheels while resting on a drum of hard wood whose surface was smooth, and which was so heavy as to show no perceptible distortion under the loads imposed, the power being measured at the periphery of the drum by the product of its speed and the tension on the dynamometer, to which the axle was connected. In this connection it may be noted, as might have been expected from theoretical considerations, that the total dynamometer pull under uniform motion was found constant at all moderate speeds. In separating the effect of axle friction from that of other losses, observations were made by suspending a load from the axle of a single pair of wheels by a cradle and noting its deflections, which were multiplied by a long pointing arm, making quite a sensitive cradle dynamometer. The same cradle loads and axle were used with different wheels, and by comparing deflections under different circumstances an approximation to friction of direct or vertical bearing and friction of side thrust was obtained. The analysis of loss due to the action of other parts of the wheel than the axle is only relative, and was found by comparing the action of different tires mounted on wheels built up in the same way, having wooden hubs, spokes, and felloes.

Separation of axle and tire resistance.—In the overcoming of axle friction the leverage of the radius of the wheel compared with the radius of the bearing gives a ready method of comparing the values of different mechanical bearings and of lubricants, and in order to appreciate thoroughly the problems involved in wheel resistance, losses due to axle friction must be recognised as separate and distinct from losses due to lack of resilience in the tires and other parts of the wheels. Some writers have assumed that summing axle and resilience losses together under the term "rolling friction"—a hazy term at best—was all that could be done, owing to the difficulty of separating the two. We believe the method adopted in making the separation to be novel, and one indicating a line of future experiment in this direction, which may be of value. In discarding, then, the term "rolling friction," as indicating a compound action, the losses of power in wheels may result from the following factors:—(1) Axle bearing friction. (2) Axle thrust friction. (3) Lack or resilience of tires and other parts of the structure of the wheel. As noted above, we were unable in the limited range of our experiments to analyse the third factor as we would have liked to have done, and thus the tire determinations involve a possible factor of the resilience of other parts of the wheel. (Resilience is here considered to mean the capacity of an elastic body to store and give out work done upon it. Table No. 1 gives the actual data and reduced results of the tests.) These results may not seem to meet preconceived views, and it may therefore be well to briefly analyse the results in order to indicate what may be deduced from a close consideration of the wheel problem.

TABLE NO. 1.—*Wheel Resistance Tests.*

Number of test.	Nature of axles.	Nature of tires.	Mean dia. of bearings.	Radius of wheels loaded.	Weight of pair of wheels.	Total load, including wheels.	Pull at tire due to axle friction.	Total pull at tire producing uniform motion.
			in.	in.	lb.	lb.	lb.	
1	Collinge	Steel	1⅛	24·5	68	659	5·4	8·84
2	Ball bearing	Steel	1¾	21·75	—	452	—	2·86
3	Collinge	Solid rubber	1⅛	18·9	75	657	2·64	5·49
4	Ball bearing	Solid rubber	1$\frac{13}{32}$	24·2	—	645	—	2·36
5	Collinge	1¾in. pneumatic (inflated)	1⅛	22·5	67	657	1·78	7·37
6	Collinge	1¾in. pneumatic (deflated)	1⅛	22·1	67	598	—	10·57

Analysis of wheel resistance.—One naturally seeks an answer to such practical questions as, What kind of a bearing ought I to use? What tire is best suited for certain work? What ought to be the diameter of a wheel for efficient service? And others of like nature. The limits of this report will not permit of more than an indication of the bearing of these experiments upon such questions. The following results may, however, be deduced from a consideration of the above data:—

Table No. 2.

Pulls per 1000 lb. of total load required to overcome lack of resilience in wheels under examination. (See tests, 1, 3, 5, and 6, Table No. 1).

5·23 lb. on steel tire.
4·34 lb. on solid rubber tire.
8·5 lb. on pneumatic tires inflated.
14·6 lb. on pneumatic tires deflated.

Let it be noted that these pulls, being due principally to the material of the tire when the rest of the wheel is well made, are not reduced by leverage as in the case of axle friction, as the moment used in overcoming the resistance is the same as the moment of the resistance. As before mentioned, the axle friction, acting as it does near the centre of the wheel, is overcome by a pull which is inversely proportional to the radius of the wheel. In order, then, to properly compare axle frictions, they should be reduced to pulls at equal distances from the centre of the wheel. Deducing, then, from experiments, we have:—

Table No. 3.

Pulls per 1000 lb. of load on bearings of Collinge axles reduced to uniform radius of 12in. (See tests 1, 3, and 5, Table No. 1).

18·7 lb. with steel tires.
7·2 lb. with solid rubber tires.
5·7 lb. with pneumatic tires.

How tires affect results.—The question is naturally asked, What have the tires to do with the result? This leads to the consideration of what carriage builders call "set" and "gather" in wheels, both being designed to compensate for the distortion of a vehicle in operation. The "set" is a vertical adjustment of the axle, so that when the wheels are under working load the tread of the tire will be horizontal. The "gather" is a lateral adjustment of the axle, so that when the wheels are under average traction they will be parallel to the direction of motion of the vehicle. In the case of a steel tire, unless the axle and tire adjustment is perfect, there is induced in the axle a side thrust which accounts for the abnormal axle friction shown above with the steel tired wheels used. In the cases of the solid rubber and the pneumatic tires, the tire allows a more or less perfect adjustment to be taken naturally. The loads in tests 1, 3, and 5, Table No. 1, were practically the same and the axles were identical, and in the matter of axle-bearing friction the same coefficients apply. Thus with the pneumatic tires the coefficient of 5·7 lb. per thousand at a radius of 12in., Table No. 3, represents bearing friction and very little, if any, thrust friction. Reduced to the radius of the bearing the friction figures 120 lb. per 1000 lb., giving a coefficient of friction between surfaces not too well lubricated of 0·12, which corresponds with the result of well-known friction experiments. The difference between 18·7 lb. on the steel tire wheel and 5·7 lb. on the pneumatic, or 13 lb., represents the pull per 1000 lb. at a radius of 12in. necessary to overcome the action of side thrust. Thus the elimination of side thrust is a much greater factor in the reduction of power consumed by the wheels of a vehicle than the reduction of the friction of vertical bearing on the axle.

Proper diameter of wheels.—In the cases of tests 2 and 4, Table No. 1, it was not possible to separate axle friction and resilience, but it seems a fair deduction to draw that with tires eliminating side thrust and with well designed bearings, the power consumed in such a wheel system is principally due to resilience. This leads to the question of the determination of the proper diameter of wheels. The pull required to overcome axle friction varies inversely as the radius of the wheel. This pull may become so small with proper bearings that even doubling the radius will only reduce it a mere fraction, while reducing the radius one-half will only increase the pull by a trifling amount. The pull due to resilience does not depend on the radius. Thus economy points to a diameter of wheel which is not determined by the caprice of the maker or the notion of the purchaser. Elsewhere in this report it will be seen that other elements in the propulsion of a vehicle may outweigh the reduction of pull due to axle friction given by an increased radius of the wheels. The kind of road a wheel is intended to travel over has a bearing upon the subject. The benefit of the pneumatic tire in reducing the amount of work performed in the driving of a vehicle is treated elsewhere in this report. That it was not found in the friction tests may be disappointing to those who had preconceived ideas regarding the matter.

Energy expended in propulsion.—The resistance a vehicle offers to motion may be divided into three principal elements—viz., (1) Kinetic resistance, or that which is common to all mass moved through any given medium; (2) internal resistance, or that due to the construction of the vehicle itself; (3) road resistance, or that external resistance due to the nature of the road the vehicle travels over. The first can be calculated from known laws of kinetics; the second our experiments bears on; the third contains elements for further investigation than it has so far received. In this connection it was intended to have tests made of the resistance due to various road surfaces by measuring the energy input of the electric vehicles competing. The heavy fall of snow at the time of the Thanksgiving Day race, November 28th, 1895, interfered with these plans, and an accurate profile of the course, showing all grades, nature of paving and roadbed, which had been prepared, was rendered useless for such determinations at that time. It is to be hoped that further experiments will be made along this line to supplement what limited information is now available, and that future promoters of motocycle races will improve such opportunities for adding needed information in this and other directions. In the following brief analysis of energy expended in the propulsion of a vehicle against the three elements above noted, application of the principles involved to the case of an assumed vehicle may possibly be the best method of making the subject clear. Let us then assume a vehicle as follows:—Weight, 1600 lb., divided 1200 on drivers and 400 on steering wheels; speed to be attained, ten miles per hour, or 880ft. per minute; surface exposed to air resistance, 20 square feet; elastic tires and ball-bearing axles; motor, 3-horse power; efficiency, 50 per cent.

Taking up then the element of kinetic resistance, we divide it as follows:—(*a*) To give the desired motion to the mass: To this end a force is required which will be found by dividing the energy of direct motion—found by multiplying the mass in pounds by the square of the velocity in feet per second and dividing by twice the rate of acceleration of gravity—by the distance in which it is desired to accelerate to the required velocity. The energy of direct motion of the assumed vehicle moving at the rate of ten miles per hour is therefore:—

$$\frac{1600 \times 14{\cdot}66^2}{2 \times 32{\cdot}2} = 5340 \text{ foot-pounds.}$$

If it be desired to accelerate to this velocity in a distance of 200ft., then the applied force must be, for overcoming this element:—

$$\frac{5340}{200} = 26{\cdot}7 \text{ lb.}$$

Should it be necessary to stop the vehicle in a distance of 50ft., the retarding forces acting upon it, to give this result, would equal a force of

$$\frac{5340}{50} = 106{\cdot}8 \text{ lb.}$$

TABLE NO. 4.—*Power and Duty Tests of Motocycles.*

Motocycle.	No. of run.	Speed in feet per minute.	Pull exerted, pounds.	Horse-power exerted at rim of wheel.	Horse-power consumed in mechanism.	Total horse-power developed in cylinder.	Mechanical efficiency.	Gasoline, pounds consumed per hour.	Gasoline, pounds consumed per horse-power hour at rim of wheel.	Foot-pounds at rim of wheel per pound of gasoline.	Cost per horse-power hour at rim of wheel, cents.	Efficiency, H.P. output, H.P. input.	Heaviest pull exerted, pounds.	Remarks.		
De La Vergne R. M. Co. (Benz motor)	1	619	37	·70	·71	1·41	·50	3·24	4·63	428,000	9·26		162	—		
	2	1000	51·8	1·57	1·40	2·97	·53	4·45	2·83	700,000	5·66					
Duryea Motor Wagon Co. (Own motor)	1	432	83·8	1·10	·59	1·69	·65	4·01	3·64	545,000	7·28		187	Trouble with igniter		
	2	434	88·5	1·16	·59	1·75	·65	3·78	3·24	623,000	6·48					
Haynes and Apperson (Own motor)	1	376	23·1	·26	·61	·87	·30	5·78	21·8	91,000	43·60		119	Two cylinders in use—one only supplying power		
	2	796	39·3	·95	1·28	2·23	·43	5·75	6·04	327,000	12·08					
Lewis, G. W. (Own motor)	1	353	49·9	·53	·53	1·06	·50	3·29	6·20	319,000	12·40		109	Chain broke		
	2	491	17	·25	·65	·90	·28	3·28	12·8	155,000	25·60					
Macy, R. H., and Co. (Roger-Benz motor)	1	521	52·1	·83	1·48	2·31	·36	3·22	3·90	515,000	7·80		103·7	Belt slipped		
	2	945	87·2	2·50	2·68	5·18	·48	4·90	1·96	1,010,000	3·92					
Mueller, H., and Sons (Mueller-Benz motor)	1	423	92·1	1·18	·61	1·79	·66	3·50	2·96	669,000	5·92		135·4	—		
	2	540	42·3	·69	·77	1·46	·47	3·87	5·60	354,000	11·20					
	3	564	38·6	·66	·81	1·47	·45	3·77	5·71	347,000	11·42					
	4	984	73·4	2·18	1·57	3·75	·58	3·40	1·57	1,268,000	3·14					
	5	1168	34·7	1·23	1·86	3·09	·40	4·15	3·37	588,000	6·74					
						Total H.P. developed in motor.		Electrical input H.P.	K.W. hours supplied to batteries per H.P.H. at rim of wheel.	Foot-pounds at rim of wheel per K.W.H.				Input. Volts	Amp	
Morris and Salom (Lundell motor)	1	1025	25·5	·78	·34	1·12	·70	1·36	1·74	1,138,000	17·4	·57		97	10·5	Test ended by trouble with bearing.
	2	2015	29	1·78	·68	2·46	·72	2·90	1·68	1,215,000	16·3	·61		96	22·5	
Sturges Electric Motocycle Co. (Lundell motor)	1	370	41	·41	·21	·62	·66	·99	2·42	818,000	24·2	·41	121	85	21	
	2	892	42	1·14	·39	1·53	·74	1·94	1·70	1,165,000	17·0	·59		69	21	

Details and Dimensions of Motocycles.

Motocycle.	Weight (light).			Wheel base.	Gauge drivers	Gauge steering	Radius (compressed.		Position of drivers	Nature of tires.	Nature of bearing	Fuel or energy supplied.	No. of cylinders.	Dia. bore cylinders.	Stroke of piston.
	Driver.	Steer'ng	Total				Driv'rs	Steer'ng							
	lb.	lb.	lb.	in.	in.	in.	in.	in.						in.	in.
De La Vergne R. M. Co. (Benz motor)	1250	430	1680	66·7	—	—	23·7	18·2	Rear	Solid rubber	Roller	Gasoline	1	5·12	6·62
Duryea Motor Wagon Co. (Own motor)	729	479	1208	57·5	55	53·7	22·8	18·7	Rear	Pneumatic	—	Gasoline	2	4	4·5
Haynes and Apperson (Own motor)	829	421	1250	54	55·2	55·5	17·8	17·9	Rear	Pneumatic	Ball	Gasoline	2	4	4
Lewis, G. W. (Own motor)	900	780	1680	56	46·6	46·5	22·9	16·7	Rear	Solid rubber	Roller	Gasoline	1	5	5
Macey, R. H. and Co. (Roger-Benz motor)	1440	385	1825	67	52	52	23·8	17·9	Rear	Solid rubber	Roller	Gasoline	1	5	7
Morris and Salom (Lundell motor)	1260	390	1650	49	44·2	36·1	19·8	14·2	Front	Pneumatic	Ball	Storage battery	Two motors	—	—
Mueller, H., and Sons (Mueller-Benz motor)	1251	285	1636	73	50·2	47·8	24	18·4	Rear	Solid rubber	Roller	Gasoline	1	5·5	6·25
Sturges Electric Motocycle Co. (Lundell motor)	2085	1450	3535	65	57	57	25·1	23·2	Rear	Solid rubber	Plain	Storage battery	One motor	—	—

(*b*) To overcome the component of gravity in climbing a gradient: For this purpose a force is required which will be found by multiplying the weight of the vehicle by the sine of the inclination of the gradient—approximately the percentage of gradient. Thus our assumed vehicle would require 0·05 of 1600 = 80 lb. force to overcome the component of gravity on a 5 per cent. inclination. In descending such a gradient a pull of 80 lb. would be exerted by gravity, and if, say, only 32 lb. were required to keep the vehicle moving at a uniform speed, the brake would have to counteract the difference of 48 lb., and thus energy would have to be dissipated at the rate of 48 × 880 = 42,240 foot-pounds per minute. Thus, in descending a 2 per cent. gradient, giving a gravity pull of ·02 × 1600 = 32 lb., no energy is dissipated. In a gradient in excess of 2 per cent., part of the energy of position must be dissipated, by application of the brake, to prevent undue acceleration of the vehicle. (*c*) To overcome the resistance of the air: For this purpose a force varying as the square of the velocity is required, and for moderate velocities this is found approximately per square foot of surface exposed by dividing the square of the velocity in miles per hour by 200. This, for the assumed vehicle, not considering wind, would be

$$\frac{100}{200} = 0{\cdot}5 \text{ lb. per square foot,}$$

and for 20 square feet, the number we assume, we find 20 × 0·5 = 10 lb. pull necessary to overcome air resistance. The work done in overcoming this is wholly dissipated.

Internal resistance.—Taking up now the question of internal resistance, we subdivide it as follows:—(*a*) Friction of axle; (*b*) friction of tire skidding; (*c*) lack of resilience of tires and other parts of the vehicle; (*d*) friction of mechanism in self-propelled vehicles; (*e*) friction of brakes when applied. These elements have been made the subject of discussion resulting from the experiments made on the various vehicles submitted for test, and are more or less fully treated of in the tests and deductions presented elsewhere in this report.

Pull of assumed vehicle.—In the assumed vehicle we have a power developed at the rims of the driving wheels of 50 per cent. of 3-horse power, or $\frac{33{,}000 \times 3}{2} = 49{,}500$ foot-pounds per minute. At an assumed speed of ten miles per hour this would give a pull of $\frac{49{,}500}{880} = 56{\cdot}3$ lb. capable of being exerted. This is the pull actually given out at the rims of the driving wheels, and is supplemental to the factor of energy expended in internal mechanism and wheel resistance of drivers. It has to overcome in addition to external resistance the resistance of the steering wheels and other elements of internal resistance not involved between the motor and the rims of the driving wheels. In the assumed vehicle without going into delicate details this would be, say,

$$\frac{400 \times 10}{1000} = 4{\cdot}0 \text{ lb.}$$

It may be here noted that an excessive "gather" of the wheels will produce a component lateral skidding action of the tires, which may produce quite a large resistance.

Road resistance.—Very little accurate data on road resistance is available, but its elements may be pointed out and deductions made showing how important a factor good roads are in the consideration of economical transportation, whether by means of the motocycle or otherwise. We subdivide, then, road resistance as follows:—(*a*) Adhesion of roadbed to tires: This is appreciated when moving through wet clay, and there are good reasons for believing that on certain pavements adhesion is quite a factor in resistance. (*b*) Distortion or low resilience of the roadbed: This constitutes a large factor of resistance to the propulsion of a vehicle, as a bad road may offer ten times the resistance to motion which a smooth one will. In this connection it was expected to have obtained valuable data from observations made on the electrical motocycles and the profile of the course as before mentioned, but as this was impossible, a reference to former experiments determining total traction of wheels on different characters of roads will indicate the relative resistances between different roadbeds.

Traction on roads.—The following table is from Molesworth's "Pocket-book":—

Resistance in Pounds per ton—2240 lb.—on different roads, exclusive of Gravity.

Stone tramway	20
Paved roads	33
Macadamised roads	44 to 67
Gravel	150
Soft, sandy and gravelly ground	210

Presumably these determinations were made at low speed, so that the element of air resistance may be neglected. The table shows a pull of 9 lb. per 1000 on a stone tramway, which corresponds fairly well to the surface on which our wheel determinations were made. Undoubtedly the axles were of the ordinary type and the tires of steel; thus in this case the resistance was almost wholly that of axle friction and lack of resilience, and corresponds to results under "wheel determinations." On a macadamised road the pull as given by the table averages 25 lb. per thousand. Thus the difference between this and 9 lb., the result on the stone tramway, or 16 lb. per 1000, gives the element of road resistance on such a roadbed. Country roads on the basis of this table would probably correspond to the higher figure given for macadamised roads; this is equivalent to 30 lb. per 1000. Deducting the stone tramway result we have 30 − 9 = 21 as an approximation to the resistance per 1000 lb. of load which may be expected on the common roads. The assumed vehicle thus would have a constant road resistance to overcome, in addition to other resistances, of

$$\frac{1600 \times 21}{1000} = \text{about } 34 \text{ lb.}$$

were it fitted with steel tires and ordinary axles. But, as will be seen in the following section (*c*), the use of pneumatic tires on a rough road might readily reduce this resistance considerably, say to 20 lb.

Advantage of pneumatic tires.—(*c*) Climbing over minor obstructions on a hard road: This constitutes resistance which, while of short duration in individual cases, becomes an element of considerable importance if such obstructions are frequent. Thus a discussion of this action will make clear the advantage of the pneumatic tire. Supposing we have a wheel with a steel tire of 24in. radius and it encounters a stone 1in. in height; then it is evident, unless the stone is crushed or pressed into the tire or roadbed, the load on the wheel will have to be raised over the stone. By a simple calculation it will be seen that this involves the momentary climbing of a gradient of 1 in 3½. In the case of the assumed vehicle with a load of 600 lb. on one driving wheel, this would require a pull of

$$\frac{600}{3{\cdot}5} = 172 \text{ lb.}$$

This increased momentary pull is overcome by the inertia of the vehicle in motion. To start with such stones in front of the wheels would require perhaps more static pull than the vehicle would be capable of exerting. This is well illustrated when to prevent a vehicle running down hill comparatively small obstructions placed in front of the wheels suffice to accomplish the result. As the vehicle passes over such an obstruction the energy of position is given back partially in energy of motion; but as this is only accomplished by the action of gravity, the element of time is involved to such an extent that if the vehicle no sooner climbs one obstacle than it encounters another, energy is dissipated to a great extent. With a pneumatic tire such an obstacle would sink into the tire half an inch or more, and so reduce the momentary grade in proportion. Where a road is encountered having many such obstructions the energy saved by the use of pneumatic tires will be considerable, as not only are the momentary gradients less, but energy is stored in the tire by its elasticity normal to the direction of pressure. This must not be confused with the results showing low resilience of a pneumatic tire under tangential pull.

Resistance to motion.—We may now sum the results as deduced from the consideration of the assumed vehicle, as follows:—

	Constant.	Incidental.
Kinetic resistance—		
Acceleration	—	26·7
Max. grade, 5 per cent.	—	80
Air	10	—
Internal resistance apart from that consumed between motors and drivers	4	—
Road resistance	20	100
Total	34	206·7

We found our assumed motor to be capable of exerting at a speed of ten miles per hour at pull of 56·3 lb. at the rim of the driving wheels. Part of the incidental resistance noted above may be expected during the progress of any trip of a vehicle, and if economy is considered, it may not be advisable to purchase pull at the expense of speed, but rather to design motors for the specific work they may be called upon to perform.

Results from consolation race.—To illustrate this we might cite the run of the Mueller Benz motocycle in the *Times-Herald* consolation race of November 2nd, 1895. The distance travelled was ninety-two miles over comparatively light grades and ordinary roads, being from Jackson Park, Chicago, to Waukegan and return to Lincoln Park, Chicago. The net running time was 8 hr. 44 min., and the gasoline consumed 31·52 lb. This indicates a speed of 927ft. per minute and a consumption of an average of 1 lb. of gasoline required to run 15,450ft. In the tests shown above we found this machine at a speed of 984ft. per minute and a pull of 73·4 lb., developed 1,268,000 foot-pounds of work at the rim of the driving wheels per pound of gasoline. Again, at a speed of 1168ft. per minute and a pull of 34·7 lb. it developed only 588,000 foot-pounds. If the above economical development of energy were maintained the average pull throughout the run would be

$$\frac{1{,}268{,}000}{15{,}450} = 82 \text{ lb.}$$

If, on the other hand, the latter development of energy be assumed, the average pull would be

$$\frac{588{,}000}{15{,}450} = 38 \text{ lb.}$$

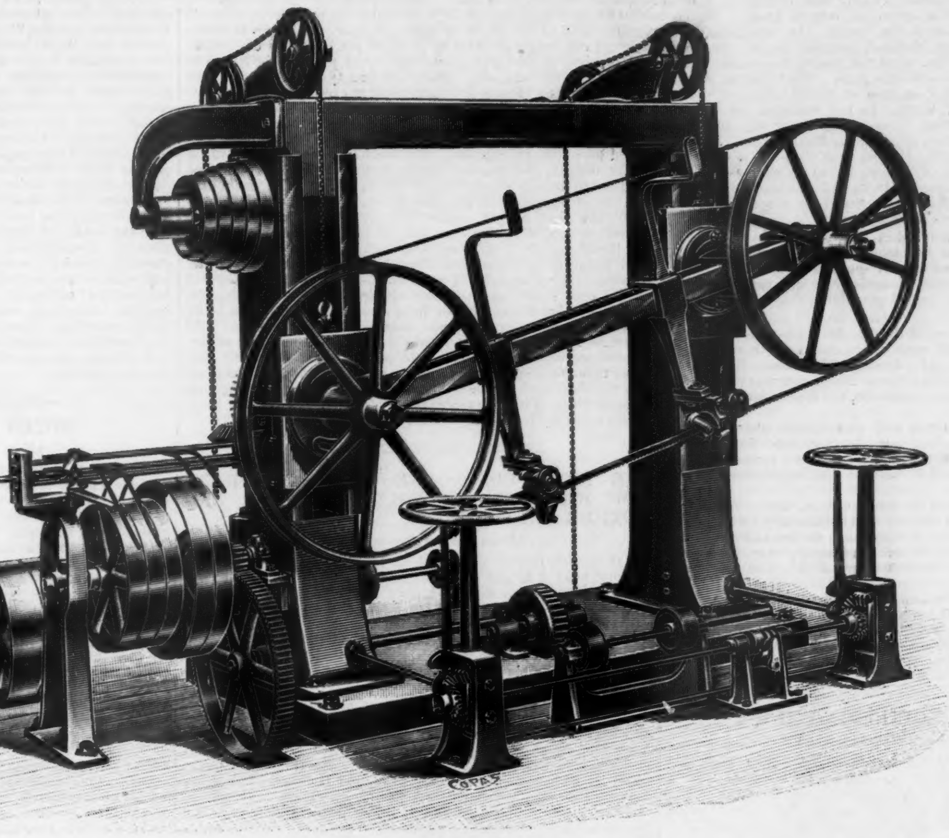
Undoubtedly something between these two possible developments of energy per pound of gasoline was given. Within certain limits, therefore, it appears that, with the type of engine used in this machine, resistance to propulsion is not an important factor in economy of fuel, as with more work to be done the fuel developes higher duty. Whether this be an argument for or against the engine is a question treated in another part of this report.

Economics.—The economics of the motocycle is a broad subject, and it does not come within the province of this report to do more than touch on economy of consumption and use of gasoline as fuel. A disregard of fuel consumption under the plea that gasoline is a cheap commodity must be considered unwarranted, when it is realised that a capitalisation of an extra amount expended for gasoline would justify a higher price to be paid for a vehicle more efficient in transferring the energy of the gasoline into propelling energy. An important factor in economy of fuel consumption is involved in control by changing the mixture of air and gasoline. It is evident that, given two vehicles possessing equal merit as regards their control, then the one accomplishing certain results with the least cost of operation represents a lower annual cost of operation than the other, and consequently a justifiable higher first cost. Aside from the actual cost of an increased amount of fuel, the disadvantages of handling or storing it is a matter for consideration, particularly if the more volatile petroleum products are used and the question of underwriters' restrictions is considered.

Use of gasoline.—For the following notes bearing on the use of gasoline we are indebted to Samuel Rodman, jun., explosive expert:—Gasoline is the lightest volatile produce commonly obtained from the distillation of crude petroleum. Specific gravity, ·660 to ·690; boiling point, 158 deg. Fah. to 194 deg. Fah. Naphtha is a lower product. Specific gravity, ·690 to ·700; boiling point, 175 deg. Fah. to 230 deg. Fah. Benzine is a still lower product. Specific gravity, ·730 to ·760; boiling point, 248 deg. Fah. to 302 deg. Fah. Petroleum, generally known as kerosene, is graded by flashing tests which run from 110 deg. Fah. to 265 deg. Fah. and over. Its specific gravity varies from about ·82 to about ·86. All volatilise more or less readily, giving off hydrocarbon vapours, which, uniting with air, form explosive mixtures. Careful investigations have been made with a view of regulating the storage and transportation of hydrocarbon oils. In the case of petroleum it has been determined

LOG BAND SAW FOR SWEEP AND BEVEL WORK

MESSRS. A. RANSOME AND CO., CHELSEA, ENGINEERS



that one volume of petroleum vapour renders 380 volumes of air explosive and 1150 volumes inflammable. A red-hot piece of metal or coal or a spark from steel or flint will not ignite an explosive atmosphere of petroleum vapour, but white-hot metal, flame, or electric spark will readily do so. Naphtha exposed to an atmospheric pressure of 30in., at a temperature of 70 deg. Fah., evaporates at the rate of about 0·09 lb. per square foot per hour. Many accidents are recorded from explosions of hydrocarbon vapours mixed with air. In the majority of those that have come under notice, vapours of hydrocarbons have escaped into the air through some leak in the receptacle or pipe holding them, and explosion has occurred on the approach of a naked flame.

In closing this report we desire to acknowledge valuable services and assistance in conducting the tests as follows:—Our thanks are due to Messrs. Samuel Rodman and C. L. Brown for assistance at the tests and subsequently in figuring out results. For special wheels prepared for test we are indebted to the Hartford Rubber Company for those having pneumatic tires, to the Rubber Tire Wheel Company for those having solid rubber tires, and to the Staver and Abbott Company, of Chicago, for those having steel tires. Through the courtesy of Mr. Frem, Messrs. Fairbanks, Morse and Co. furnished delicate scales for use in dynamometer work, and Mr. Ludlow, of the Crosby Steam Gauge and Valve Company, furnished the speed indicators used.

JOHN P. BARRETT, Chairman of Committee.
L. L. SUMMERS, } Engineers of Tests.
JOHN LUNDIE, }

RANSOME'S LOG BAND SAW WITH CANTING PULLEYS.

THIS machine, illustrated by the above engraving, was designed and constructed for Messrs. Harland and Wolff, of Belfast, by Messrs. A. Ransome and Co., Chelsea, for carrying out special work that is costly and tedious to do by any other means. It is specially arranged for cutting curves and bevels in logs and spars of any length up to 60ft., and of any diameter up to 36in. The machine, when its pulleys are in their normal position, is of the horizontal type of band saw, but to effect the necessary sweep and bevel cutting, each pulley can be lifted or lowered independently of the other, whether the machine is actually in the cut or not. Thus the blade will follow any curves or bevels that may be marked on both sides of the log. The saw pulleys are 48in. in diameter, and are arranged to rise and fall by hand wheels on either side of the machine, thus bringing them under perfect control of the attendants, one of whom would be stationed at each hand wheel to follow the necessary sweeps, bevels, and curves required at either side of the piece being sawn. The slide carrying these band pulleys is counterbalanced by suitable weights, thus making the motion easy and rapid.

Practically, the whole of the machine being above the floor line, but little expense is required in the way of foundation. The travelling table is 60ft. long, this length covering spars and logs of the maximum ordinary lengths used in shipbuilding. It is made up of malleable iron plates ½in. thick. These plates are carried on three longitudinal H beams, two of which run on suitable rollers, the underside of the third or centre one being fitted with rack. As a rule, the pieces lie on the table themselves without any fixing, being held in position by their own weight, but for spars and logs of uneven thickness, a series of dog-screws are required to prevent such pieces from moving while in operation. The table is not shown in our engraving. It is carried in the usual way, and is moved by the cog-wheel which can be seen in the centre of the space between the two standards. The feed motion is arranged with five different rates of speed. The saw guides are specially made so that the blade can be canted in the necessary direction, according to whether the cut is leading down or up in the sweep or curve. The weight of this machine is 13 tons. The average indicated power required is about 15-horses. The pulleys driving it make 400 revolutions per minute.

PRESENT STRENGTH OF THE NEW UNITED STATES NAVY.

IN August, 1882, Congress approved an Act to complete the double-turreted monitors and for the construction of a 6000-ton protected cruiser. This Act was so vague that it was not until March 2nd, 1883, that Congress appropriated 1,300,000 dols. to begin the construction of four ships. With these ships the new navy was born, and each year since it has been added to until we now have a naval list of nearly a hundred ships in commission, ready to be commissioned, or building.

Among this number are five double-turreted and thirteen single-turreted monitors, six battleships, one coast defence ship, twenty-five cruisers, one dynamite cruiser, one harbour defence ram, one naval school ship, eight gunboats, six torpedo boats—including one ram and one submarine—one survey and one despatch boat, besides many vessels of smaller build and efficiency, serving in different capacities where they are respectively stationed.

Of the enumerated vessels, the six battleships, eighteen cruisers, six gunboats, five torpedo and one despatch boat, the naval school ship Bancroft, the harbour defence ram Katahdin, the dynamite cruiser Vesuvius, and the coast defence ship Monterey are built of steel.

The eighteen armoured monitors, one cruiser, two gunboats, the survey steamer Ranger, and the ram Alarm are of iron, while the old wooden ships include six cruisers and the store ship Mohican.

The ships are divided into four classes: (1) Armoured, including the battleships, monitors, cruisers, and coast defence ships; (2) unarmoured protected vessels, including cruisers, gunboats and despatch boats; (3) unarmoured ships of iron; (4) wood, comprising vessels of the old navy.

The first-class battleships Massachusetts and Oregon are each of 10,231 tons displacement, 9000 indicated horse-power, developing a speed of 16 knots to the former, and 16·8 knots to the latter. In armament these two ships are precisely the same, carrying four 13in., eight 8in., and four 6in. breech-loading rifles, sixteen 6-pounder, and four 1-pounder quick-fire, and four Maxim guns. The second-class battleship Texas has a speed of 17 knots, with 8600 indicated horse-power, and a displacement of 6300 tons. She mounts two 12in. and six 6in. breech-loading rifles, twelve 6-pounder, four 1-pounder quick-firing, and four Maxim guns.

Of the protected cruisers, the Chicago has a displacement of 4500 tons, a speed of 15 knots and 5000 indicated horse-power. Her battery contains four 8in., eight 6in., and two 5in. breech-loading rifles, four quick-fire, and eight Maxim guns. The Baltimore has a displacement of 4413 tons and indicated speed of 19·2 knots furnished by engines of 10,750 indicated horse-power. Her battery has two 8in. and six 6in. breech-loading rifles, four 6-pounders, two 1-pounder quick fire, and seven Maxim guns. The Philadelphia, with the same displacement as the Baltimore of 4413 tons, has made 19 knots with 10,500 indicated horse-power. She mounts twelve 6in. breech-loading rifles, four 6-pounder, four 1-pounder quick-fire, and seven Maxim guns. The San Francisco has displacement of 4083 tons, a speed of 19·5 knots, and engines of 10,500 indicated horse-power. She carries twelve 6in. breech-loading rifles, four 6-pounder quick-fire, and seven Maxim guns.

The Atlanta and Boston have each a displacement of 3189 tons. The Atlanta has a speed of 15·4 knots, attained by 3511 indicated horse-power; the Boston requiring 3780 indicated horse-power to attain a speed of 15 knots. On both of these ships the batteries are the same, consisting of two 8in., six 6in. breech-loading rifles, six quick-fire, and six Maxim guns.

Of the unprotected cruisers, the Minneapolis has developed a speed of 23·073 knots, with engines of 21,000 indicated horse-power. Her displacement is 7475 tons, she carries one 8in. and two 6in. breech-loading rifles, eight 4in. rapid-fire, twelve 6-pounders, eight 1-pounder quick-fire, and four Maxim guns.

The Cincinnati and Raleigh are Government productions, having been built, the former at the Brooklyn Navy yard and the latter at the Norfolk yard. They are of 3183 tons displacement, 10,000 indicated horse-power, and a speed of 19 knots each. The Cincinnati carries one 6in. and ten 4in. breech-loading rifles, two 6-pounders, two 3-pounder quick-fire, and four Maxim guns. Mounted on the Raleigh are one 6in. breech-loading rifle, ten 5in. rapid-fire, eight 6-pounder, four 1-pounder quick-fire, and two Maxim guns.

The gunboat Yorktown, one of the first four ships authorised, has a displacement of 1700 tons, an indicated horse-power of 3400, developes a speed of 16 knots, mounts a battery of six 6in. breech-loading rifles, four 6-pounder quick fire, and five Maxim guns.

After building and commissioning the next two gunboats Machias and Castine, they were found to be too topheavy in a seaway. To rectify this defect it was decided to lengthen them. Accordingly the two vessels were cut in two amidships and rebuilt, thus righting the blunder originally made. In these two vessels there is but one point of difference, the Machias having a speed of 14·5 knots, from 1600 indicated horse-power engines, with a displacement of 1050 tons, where the Castine makes but 14 knots with the same horse-power and displacement. In armament the two vessels each carry eight 4in. rapid-fire, four 6-pounder, two 1-pounder quick-fire, and two Maxim guns. The Petrel is of 890 tons displacement, has a speed of 13 knots, engines of 1300 indicated horse-power, a battery of four 6in. breech-loading rifles, three 3-pounder quick-fire, and four Maxim guns.

The coast defence double-turreted ship Monterey has a displacement of 4048 tons, a speed of 16 knots, engines of 5400 indicated horse-power.

Mounted in her two turrets are two 12in. and two 10in. breech-loading rifles, with a lighter battery of six 6-pounder, four 1-pounder quick-fire, and four Maxim guns, mounted on the superstructure and in the fighting top.

The harbour defence ram Katahdin carries but a light secondary battery of four 6-pounder quick-fire guns. She has a displacement of 2050 tons, a speed of 17 knots, and engines of 4800 indicated horse-power. The dynamite cruiser Vesuvius has a displacement of 725 tons, a speed of 21 knots, and engines of 3200 indicated horse-power. She was designed to throw 600lb. charges of dynamite from her 15in. pneumatic guns, which are supplemented by three 3-pounder rapid-fire guns. The torpedo boat Cushing is of 116 tons displacement, has engines of 2500 indicated horse-power, and a speed of 22·5 knots per hour.

Among the vessels now building the Iowa stands first with a displacement of 10,286 tons, indicated horse-power of 11,000, and a contract speed of 16·5 knots. When ready for active service the Iowa will carry a battery of four 12in. and eight 8in. breech-loading rifles, six 4in. rapid-fire guns, twenty 6-pounder, six 1-pounder quick-fire, and two Maxim guns. The Indiana, now nearing completion, is one of the three heaviest vessels which at present are on the naval list. She has engines of 9000 indicated horse-power, a speed of 16 knots, and a displacement of 10,231 tons. In armament and construction she is the counterpart in every particular of her sister ship Massachusetts. Her battery will have four 13in., eight 8in., and four 6in. breech-loading rifles, sixteen 6-pounder, six 1-pounder quick-fire, and four Maxim guns. The second-class battleship Maine has a displacement of 6648 tons, a speed of over 17·7 knots, and engines of more than 9000 indicated horse-power. She has four 10in. and six 6in. breech-loading rifles, with a secondary battery of twelve 6-pounder, four 1-pounder quick-fire, and four Maxim guns. The cruiser Brooklyn, now on the stocks, is an improved model of the New York. She is to have a speed according to contract of 21 knots, to be of 16,900 indicated horse-power, and have a displacement of 9250 tons. Her batteries will be eight 8in. breech-loading rifles, twelve 5in. rapid-fire, twelve 6-pounder and four 1-pounder quick-fire, four Maxim guns, and two light or field pieces.

The New York has a speed of 21 knots, triple expansion engines of 16,000 collective indicated horse-power, and a displacement of 8150 tons. Her armament consists of six 8in. breech-loading rifles, twelve 4in. rapid-fire, eight 6-pounder, four 1-pounder quick-fire, and four Maxim guns. The Newark has a displacement of 4083 tons, an indicated horse-power of 8500, driving her at the called-for speed of 19 knots. In armament she is inferior to the Chicago, carrying twelve 6in. breech-loading rifles, four 6-pounders, quick-fire, and nine Maxim guns. The Charleston has a displacement of 3730 tons, engines of 7500 indicated horse-power at a contract speed of 17 knots. Mounting batteries of two 8in. and eight 6in. breech-loading rifles, four 6-pounder, two 3-pounder quick-fire, and eight Maxim guns.

In the Marblehead and Montgomery the Government contract calls for two ships of the same dimensions and armament, with displacements of 2000 tons, engines of 5400 indicated horse-power, driving the ships at a speed of 18·3 knots. The batteries of these two ships comprise two 6in. breech-loading rifles, four 4in. rapid-fire, four 6-pounder, three 3-pounder quick-fire, and two Maxim guns.

The Concord and Bennington are similar ships in all but their displacement, the latter being 1750 to the former's 1700 tons displacement, with indicated horse-powers of 3400 and called-for speed of 17 knots. In armament these two ships are identical, mounting six 6in. breech-loading rifles, four 6-pounder quick-fire, and five Maxim guns.

The Columbia has a displacement of 7475 tons, engines of 21,000 indicated horse-power, and a speed of over 22 knots. She is probably the fastest cruiser in the world. In armament the Columbia and Minneapolis are identical, carrying one 8in., two 6in. breech-loading rifles, eight 4in. rapid-fire, twelve 6-pounder, eight 1-pounder quick fire, and two Maxim guns. The Olympia, with a displacement of 5500 tons and engines of 13,500 indicated horse-power, has a speed of 20·2 knots. In her batteries she carries four 8in. breech-loading rifles, sixteen 5in. rapid-fire, fourteen 6-pounder, six 3-pounder quick-fire and four Maxim guns. Among the first of the new ships, the Detroit was built on a contract calling for a displacement of 2000 tons, driven by engines of 5400 indicated horse-power at a speed of 18 knots. She mounts two 6in. breech-loading rifles, four 3½in. rapid-fire, four 6-pounders, two 1-pounder quick-fire, and two Maxim guns.

Among the vessels commissioned in 1894 was the naval training ship Bancroft, of 838 tons displacement, with engines of 1300 indicated horse-power, developing a speed of 13·5 knots. For practice and drill her batteries comprise four 4in. rapid-fire, two 6-pounder, two 3-pounder, one 1-pounder quick-fire, and two Maxim guns.

The Dolphin, which was one of the first four ships contracted for of the new navy, is of 1485 tons displacement, with engines of 2300 indicated horse-power and a speed of 15·5 knots. She is now the despatch boat of the United States Navy, carrying but a light armament, comprising two 4in. rapid-fire, two 6-pounder quick-fire, and six Maxim guns.

Of the monitors, the Puritan, with two turrets mounting four 10½in. breech-loading rifles, four quick-fire and eight Maxim guns, with a displacement of 6060 tons and indicated horse-power of 3700, attaining a low speed of 13 knots, is the largest and heaviest of her type.

The Amphitrite, another of the monitor class, carries four 10½in. breech-loading rifles in two turrets, with a secondary battery comprising six quick-fire and four Maxim guns; she has a displacement of 3990 tons, and engines of 1600 indicated horse-power, developing a 12-knot speed, and is one of three ships of this class that stand next to the Puritan.

The torpedo boats Ericsson and the one now known as No. 2 are greatly different in size, the former having 750 tons displacement against No. 2's 120. These little fliers have a speed of 23 knots in the Ericsson and 24 in No. 2.—*Scientific American.*

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

Shunting by electricity.—At the terminals of the New York and Brooklyn Bridge Cable Railway experiments are being made with electric power for switching or shunting the trains from the arrival to the departure track, in order to replace the present steam switching locomotives. The trains are made up of four cars, each mounted on a pair of four-wheel trucks or "bogies," and each weighing 20 tons empty. The train stops at the arrival platform, and while discharging passengers the steam engine is coupled up, then hauls the train out beyond the station, and pushes it back again on to the departure track. Under the new system one car of each train will be fitted with four 50-horse power electric motors, one on each axle, which will furnish the power for moving the train out from the arrival platform and back to the departure platform. There is at present an overhead wire from which current is taken for lighting the cars, and this will be utilised for the more powerful current required for switching, the motor car having two collectors on the roof, each consisting of a contact roller, with a long arm on each side to allow for the lateral movement of the car as it passes over the curves. The contact roller and arms are on top of a jointed diamond frame, which can be extended to press the roller against the wire or depressed to bring it out of contact. The car will carry passengers, no change being made in the interior. The motors are thoroughly enclosed and the armatures are wound on the Eickemeyer system. At each end of the car is a controller, mounted on the platform, and two or four of the motors can be put in service as desired. The motors can also be utilised in assisting heavy trains up the 1 in 35 grades, and the motor cars can run across the bridge by their own power from 1 a.m. to 5 a.m., when the cable plant is stopped for examination, the steam engines being now used.

A heavy "Bank" locomotive.—On the south-west system of the Pennsylvania Railroad, near Madison, is the Madison Hill incline, rising 413ft. in 7012ft., the grade being about 1 in 20. This was built in 1841, and from 1848 to 1868 it was operated on the rack and cog-wheel system. It is said to be the steepest grade in the world on which regular through main line traffic is operated. The adhesion engine introduced in 1868 had ten driving wheels, 44in. diameter; cylinders, 20in. by 24in., and weighed 57 tons. In 1886, one pair of wheels was taken out to reduce the wheel-base to 16ft., and enable the engine to pass over the curves in the yard at Madison. It had a hauling capacity of 120 tons, and was equipped with an air-brake using air in the steam cylinders in descending the grade. This engine, after twenty-seven years' service, has been replaced by a heavier bank or pusher engine, used for helping trains up the grade. It is a tank engine, carrying about 2000 gallons of water in side tanks, and coal in a bunker behind the cab. It has cylinders 22in. by 28in., four pair of wheels—all drivers—50in. diameter, and weighs 70 tons on a wheel-base of 15½ft. The boiler has a Belpaire fire-box, and carries a steam pressure of 150 lb. per square inch. The Westinghouse-American driving-wheel brake is fitted to all the wheels, and there are also hand-screw brakes for emergency use, and the Le Chatelier brake for use in descending the grade. Sand is fed to the rail by an air jet, and compressed air is also used to ring the bell. On a wet wintry day, with the track in bad condition, the engine has pushed a train load of 150 tons up the grade by itself. In regular service, however, it will be used as an auxiliary to the regular engines.

An ocean-going tug.—A powerful sea-going tug boat of unusual size has recently been built for the Philadelphia and Reading Coal Co. for towing the great coal barges and hulks—made from dismantled steamers and sailing ships—between the different coal ports. The vessel is 171ft. long, 29ft. beam, 31ft. wide over the guards, and 18ft. 6in. depth of hold. The bow is heavily built and braced for breaking through the ice. The screw propeller is driven by a triple-expansion marine engine, with cylinders 18in., 28in., and 45in diameter, supplied with steam by marine return tubular boilers carrying 160 lb. steam pressure. The water tanks in the fore and aft compartments have a capacity of 31,000 gallons, and the coal bunkers hold 280 tons of fuel, the consumption being about 20 tons per day. The crew and firemen have accommodation in the forecastle, and a long deck-house has the engineers' and officers' quarters, a roomy enclosed chart-house and wheel-house being on top of the fore end of the deck-house. The two masts are fore and aft rigged, and carry sail enough to give steerage way in case of accident. The vessel has a sea speed of 13 knots, running light, and can tow four barges loaded with 1500 tons of coal each. Electric lighting is provided throughout, two dynamos being fitted, and there is a search-light of 10,000-candle power. The tow lines are coupled to a 1½in. steel wire cable wound on the drum of a steam towing engine, any sudden strain beyond a certain limit causing the cable to unwind, while the drum winds it back again as soon as the strain slackens. In the stern is a steam capstan, and in the bow a steam and hand windlass for the 12-ton anchor. Combination steam and hand steering engines are fitted, together with Hand's patent binnacle and compass, so arranged that all local deviations can be adjusted by compensation compasses. Powerful wrecking and fire pumps are included in the equipment, and the living quarters are heated by steam.

Large boilers.—The Queen-lane pumping station of the Philadelphia Water Works has to pump 80,000,000 gallons per twenty-four hours to a height of 250ft. This requires 3500 net horse-power, and with an evaporation of 34½ lb. of water per H.P. per hour would require a total of 120,750 lb. of water per hour. The type of boiler designed will evaporate 5000 lb. of water per hour into dry steam, with economy of fuel and labour, and could probably be forced to 8000 lb. with fair economy. There are twenty-four boilers at this station, and they furnish dry steam with not over 1 or 1½ per cent. of water. There are four batteries of six boilers, each boiler having a separate flue connecting to the main flue, which runs under the boiler room, the smoke flue of each boiler being controlled by a separate damper. The contract price was £16,940 for boilers, fittings, and non-conducting clothing. The steel used has an ultimate tensile strength of 50,000 lb. to 60,000 lb. per square inch, an elongation of 25 per cent. in 8in., and a reduction in area of not less than 50 per cent. Test pieces were bent 180 degrees without a sign of fracture on the outside. The shell plates are ⅞in. thick and the heads and combustion chambers ⅝in. thick. Each boiler is 8½ft. diameter, 20ft. long, with ninety tubes 4in. diameter, twelve staybolts 2⅝in. diameter—having nuts inside and outside each head—and two Fox corrugated flues 3½ft. diameter. Each boiler head was flanged in a machine at one stroke. The riveting was done by hydraulic riveters. Each boiler has 1200 square feet of heating surface, or 8·4 square feet per horse-power. The boilers rest on cast iron saddles on brick walls, a 48in. flue under them keeping the waste products of combustion in contact with the shell until drawn out through the damper opening into the main flue. With an evaporation of 5000 lb. of water per hour, 34½ lb. is the equivalent for 1-horse power.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

GREAT satisfaction is expressed at the improvement compared with last year of 33 per cent. in the value of the iron and steel exports of all kinds during February, made known this week. It is regarded hereabouts as a good indication of steady and substantial trade revival. Pig and puddled iron has gone up 118 per cent., bar and angle 23 per cent., railroad 135 per cent., wire 49 per cent., cast and wrought iron 46 per cent., old iron 122 per cent., unwrought steel 67 per cent., galvanised sheets 91 per cent., and unwrought tin 76 per cent. In pig and puddled iron the increased exports have been chiefly to Germany, Holland, Belgium, and the United States. The bulk of the increased shipments of railroad material has been to the British East Indies, Australasia, Argentine, Brazil, the United States, and Sweden. For cast and wrought iron the increased demand has come from Australasia, the West Indies, South Africa, Brazil, and Holland. The extra consignments of unwrought steel have been chiefly to Germany, the East Indies, and to markets of minor importance. The only decreases have been hoops and sheets 7 per cent., and tin-plates 45 per cent. As to the latter, not much trade is done from this district to America, though the district tin-plate firms do a little, but Wales is, of course, the chief sufferer. Hoop for America is, however, decidedly a Staffordshire trade, and the decrease therefore affects local interests; and so does the falling away in "sheets," which are plain ungalvanised sheets, used for tinning purposes out there. However, these unsatisfactory items are far more than counterbalanced by the numerous departments in which trade has extended, and the returns have, therefore, created a very favourable and cheering impression in South Staffordshire, as they doubtless have also in every other part of the kingdom except Wales.

With regard more particularly to galvanised sheets, which are one of the staple trades of Birmingham and the district, it may be mentioned that in addition to the 91 per cent. increase in value above mentioned, there is an improvement of about 75 per cent. in quantity. The total quantity shipped rose from 12,416 tons in February, 1895, to 21,788 tons last month; and from £134,299 to £256,978. The following are the chief cases of progress:—Australasia, from 2556 tons to 5241 tons, and from £32,638 to £68,373; India, from 3877 tons to 4859 tons, and from £38,354 to £52,604; South Africa, from 1085 tons to 2492 tons, and from £11,307 to £28,481; the Argentine Republic, from 712 to 2081 tons, and from £6765 to £22,684. We have done more also with Europe, the West Indies, Chili, and Brazil. Similarly gratifying evidences of trade revival are available also as regards the first two months of this year, compared with the corresponding period of 1895. The total quantity of galvanised sheet exports for the two months has improved from 26,068 tons last year to 40,810 tons this year, and the value from £281,816 to £477,217. The income from our Antipodean trade expanded in value from £69,498 to £120,764; Indian from £71,377 to £84,607; and South African from £28,607 to £79,106. The improvement in tonnage for the two months period was as follows:—South Africa, 2769 tons to 7007 tons; India, from 7111 tons to 7830 tons; and Australasia, from 2556 tons to 5241 tons. It has been quite three or four years since the galvanised sheet firms of this district were so busy as at present.

Marked bars this afternoon were quoted £7 to £7 12s. 6d.; merchant bars, £6 to £6 5s.; and common, £5 5s. to £5 10s. Black sheets are quoted £6 15s. for doubles and £8 for lattens. Angles are £5 15s.; stamping sheets, £9 10s.; best thin sheets, £11; hoops and thin strip, £6 7s. 6d.; tube strip, £5 10s.; nail rods, £6 10s. The quotations for steel are very firm at £4 10s. for Bessemer blooms and billets; £5 12s. 6d. to £5 17s. 6d. for angles and boiler plates; £5 15s. to £6 for bars; and £7 5s. to £7 10s. for sheets. Girders and angles of basic steel are quoted £5 10s., and boiler plates £6 5s. Galvanised sheets of 24 gauge are quoted £10 5s. to £10 7s. 6d. f.o.b. Liverpool.

Pig iron is very strong, and prices are firmly maintained at cold-blast 90s.; South Staffordshire all-mine, 55s. to 57s. 6d.; part-mine, 42s. 6d., and 36s. for cinder pig. Northampton forge is 41s. to 42s. 6d.; North Staffordshire and Derbyshire, 42s. to 43s.; and Lincolns, 44s. to 45s.

Muntz's Metal Company has made a profit on the past year's transactions of £6767 15s. This sum, added to the balance of £4450 7s. 9d., brought forward from the previous year's account, gives a disposable surplus of £11,218 2s. 9d. To this amount the directors propose to add £4000 from the reserve fund, which was created for the purpose of equalising dividends, making a total of £15,218 2s. 9d. An interim dividend at the rate of 5 per cent. per annum was paid on the preference shares to the 30th June last, which disposed of £4467 7s. 6d. It is now proposed to pay a dividend on the preference shares at the rate of 5 per cent. per annum for the half-year ended December 31st last, and a further dividend of 7½ per cent. on the ordinary shares, which will absorb £9840 2s. 6d., leaving a balance of £910 12s. 9d. to be carried forward to the next account. The stock of copper on hand is valued at £113,000, and the machinery and tools at £16,590. The directors who retire are Mr. P. A. Muntz, M.P., and Sir Henry Wiggin, Bart., who offer themselves for re-election.

The proposed combination of employers and employed in the Birmingham brass trades is rapidly becoming an accomplished fact. An important meeting of masters and men engaged in the metal-working trades, held at the Town Hall, Birmingham, on Tuesday, passed the following resolution:—"That having considered the proposed alliance in all its bearings, this meeting agrees to confirm its provisions by signature on both sides, and to establish a Wages Board forthwith; but conditionally that the provisions of the alliance shall not be enforced on either side until both parties have agreed that the combination is sufficiently strong to prevent underselling, and to place the trade on a profitable basis. Pending such decision selling prices shall not be raised, and the Wages Board shall only exist for the purpose of friendly consultation. Whenever an advance of prices is declared, it shall be with the consent of the Wages Board, and shall carry with it the bonus to workpeople provided for in the terms of the alliance." It was also resolved "That the chairman and the secretary of the Employers' Association, and Mr. W. J. Davis, on behalf of the Cased Tube Association, and Mr. S. Lakin on behalf of the Gasworkers' Union, and two operatives to be chosen by the meeting on behalf of those operatives who may not at present have joined either of the above associations, be instructed to sign the alliance on behalf of the employers and employés who have so far given in their adhesion to the scheme, subject to the provisions contained in the resolution just recorded." The gathering also decided "That this meeting of employers and employed, being parties to the alliance just signed, pledges itself to do its utmost by every lawful means to bring into the arrangement every employer and workman in the trade." This is one of the most important movements that has taken place in the Birmingham brass trade for many years.

In the South Staffordshire district a considerable record of new work has been booked during the past week. The bridge and girder makers have received further contracts, and several other important orders are under consideration. The heavy ironfounders have secured orders for some very large rolls, and inquiries are to hand for others from ship-plate, &c., works owners who will tender for the new ships to be built for the Admiralty. Rolling plant for steel works in Scotland and the North of England is inquired for as breakages, &c., are frequent from the high rate of production that is going on.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—I recently referred in my notes to the probability of some weakening in prices by iron being thrown on the hands of makers, owing to buyers not taking their full deliveries on account of contracts, and this anticipation is already, I find, to some extent being realised. It is now evident that the heavy buying going on recently has in some quarters been considerably in excess of requirements; users, in the expectation of higher prices, have bought much beyond their usual quantities, whilst merchants in not a few instances have contracted for more iron than they can take. The result is that makers, although heavily sold, are here and there finding a difficulty in getting their customers to take their deliveries according to contract, and with iron accumulating on their hands they are not quite so strong in holding out for recent maximum rates, whilst some merchants who are overbought are offering at under current rates to secure orders. This necessarily tends for the time being to weaken the market, but there is a continued sound, healthy condition of trade generally, with a confident tone as regards the future, and the very favourable Board of Trade returns just issued are a further satisfactory evidence of the well-established improvement.

Only a quiet tone was reported generally on Tuesday's Manchester iron market, with, if anything, rather less firmness in prices. For pig iron inquiries were mostly limited to small quantities, and makers in some instances were prepared to give way slightly upon recent full quotations, whilst merchants were here and there low sellers. Local makers are fully maintaining their list rates on the basis of 46s. 6d., less 2½, for No. 3 foundry, delivered equal to Manchester. Lincolnshire iron, however, is perhaps easier, and it is only in exceptional cases where more than 42s. is now being got for forge, and 44s. for foundry, although 6d. above these figures is still quoted, whilst for Derbyshire foundry the top figure is 47s. net cash, delivered Manchester, with some sellers at 6d. to 1s. less. With regard to outside brands, Middlesbrough is about 3d. easier, 46s. 10d. to 47s. 1d. net cash being about the average figures for good-named foundry qualities, delivered Manchester stations, and 45s. 9d. Manchester Docks; with Eglinton, 47s. 6d. net prompt cash, delivered Lancashire ports, and 49s. 9d. to 50s. delivered Dock Quays, Manchester.

In the finished iron trade there is a moderate business stirring, but the recent advance is not being got in all cases. Lancashire bars could now be bought at £5 10s. to £5 12s. 6d. delivered Manchester, or for export. Sheets remain at £7 10s. to £7 12s. 6d.; and the Association list rates for hoops at £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths, delivered Manchester district, with 2s. 6d. less for shipment.

A strong position is maintained in the steel trade. Hematites are firm at fully late rates, 57s. 6d., less 2½, being the minimum for good foundry qualities, and 58s. 6d. for some special brands, whilst good steel billets now average £4 10s. net cash, and boiler plates are not quoted under £6 7s. 6d. to £6 10s. per ton, delivered in this district.

In the metal market the check to further buying which followed upon the advance in prices last week has been additionally emphasised by the downward tendency in raw material, which encourages anticipations on the part of buyers of a return to recent rates. Specifications, on account of orders already booked, are keeping makers fairly busy, but very little new business is stirring, consumers holding back for lower prices where they are not absolutely compelled to buy.

The usual monthly returns issued by the engineering trades unions fully bear out the satisfactory reports I have previously given from representatives of engineering firms throughout the district as to the continued steady improvement in trade, and the encouraging outlook for the future. The employment returns show a less proportion of out-of-work members on the books of the societies than has been the case for five or six years past. The Amalgamated Society of Engineers, which last month had 5 per cent., has now very little above 3 per cent. of its total membership on the unemployed list, and in the Manchester district there has been a similar decrease, the number of out-of-work members being now only about 2 per cent. of the membership, and the local secretary is receiving an exceptional number of inquiries for smiths, pattern-makers, and in fact, for all classes of workmen, from firms in the district, the position as regards employment being better than it has been for several years past. In the Steam Engine Makers' Society the returns show an unemployed list of only one and a-half per cent. which represents a substantial reduction on last month's returns. The reports from the various districts with regard to the state of trade indicate a continued increase of activity in practically all branches, with heavy stationary engine builders especially well engaged, and in marine centres, with one or two exceptions, an improvement is now making itself felt as regards the weight of work coming forward.

The ever-increasing network of overhead telephone wires in nearly every business centre of any importance is imposing conditions with regard to the construction of fire-escape appliances, which has necessitated a considerable modification of the ordinary telescopic ladder escapes, which in many towns it would now be scarcely practicable to convey along the streets in an upright position. Some months ago I briefly noticed an exhibition by Messrs. Wm. Rose and Co., of Manchester, of their improved types of fire escapes, and during the present week they have again been showing in the large yard of the Albert-street Police-station further improvements that have since been introduced, so as to afford public authorities who may have in contemplation the re-organisation of their life-saving and fire-extinguishing appliances an opportunity of testing the latest designs. Amongst the appliances exhibited were one of Messrs. Rose's combined hose tenders and escapes, containing several improvements on the one previously exhibited. In order to demonstrate as plainly as possible the use of this machine, it was shown with the tender fully equipped with the requisite hose, stand, and branch pipes, &c., manned by the firm's private brigade, and drawn by a pair of horses. A special feature in this machine is the accessibility of the tender for the purpose of taking out the fire-extinguishing appliances, without having to detach the escape, in case the latter is not required to be made use of at a fire. Another escape of novel construction was one of their patent Metropolitan escapes, the ladders of which are made in three sections to extend to 72ft., and so constructed that three men can readily raise the ladders from the horizontal to the vertical position, and at the same time fully extend the ladders according to the height required. A specimen of the latest type of 50ft. patent sliding carriage escapes, as supplied by Messrs. Rose and Co. to the London Fire Brigade, was also exhibited; this escape, like the others, containing several improvements. There were also on exhibition two of the firm's well-known patent "Kingston" escapes, one of these being convertible for horse draught, or for being pushed by men, besides being provided with geared raising motion, the other being the ordinary "Kingston" escape with quick-action raising motion; and one of their patent curricle escapes, which, since their introduction last year, have found considerable favour, particularly with rural fire brigades, the under carriage or van having stowing capacity for a large quantity of hose and other appliances, and being easy of access, no matter in what position the ladders may be. In the fixing of the ladder rounds or treads of the first three types of escapes referred to above, Messrs. Rose and Company have adopted a device for which they claim several advantages. This device consists in attaching light metal sockets to each end, by means of which the treads are secured to the ladder sides, each socket having a rib or web on the under side, connecting it to a flange which is let into the wood. This mode of attachment enables each tread to be easily taken out of the ladder for renewal when required without having to take the ladder to pieces, besides giving great support, and therefore additional strength, to the treads, and lastly making the ladders very rigid, an important factor in the construction of fire-escapes.

At the ordinary monthly meeting of the Manchester Geological Society, held on Tuesday, a short contribution by Messrs. W. F. Holroyd and J. Barnes, was read with reference to the stratified beds of clay found in many of the valleys of Scotland, which frequently contained curiously-shaped concretions that were known as "fairy stones." These clay deposits varied in thickness from 20ft. to 90ft., and were found very regularly deposited in valleys through which the rivers had to flow. The composition of the clay seemed to be a kind of marl, containing silicate of alumina, carbonate of lime, and carbonate of iron, with probably some magnesia. These deposits extended over considerable areas, and "fairy stones" had been found resembling masses of clay twisted around each other in all conceivable forms, the origin of which had been a puzzle to geologists, but Messrs. Holroyd and Barnes attributed their presence to chemical action following upon the decay of rootlets of trees, which had grown on the surface. Mr. M. Stirrup, F.G.S., also read a contribution from Mr. G. H. Kinahan, M.R.I.A., in which he brought forward evidence in proof of a possible land-connection in recent geological times between Ireland and England. The usual votes of thanks were passed, and Mr. W. Saint, H.M. Inspector of Mines, remarked that Mr. Kinahan had been on the Irish Geological Survey for a number of years, and there was no one who could give more reliable information as to the geology of that country.

In the coal trade, except a slight stiffening tendency in the better descriptions of engine fuel, there is still no appreciable improvement to report, four days per week being the average that collieries in most cases are working, whilst for all qualities of round coal only a slow demand comes forward. The better descriptions of round coal have perhaps been moving off slightly better for domestic consumption; but the business doing is still only indifferent for the time of the year, and prices difficult to maintain. Common round coals suitable for steam and forge purposes, notwithstanding the restricted production—pits in many cases scarcely raising more than half their average get—remain a drug on the market, and extremely low in price, 6s. being about a full average figure for good ordinary qualities at the pit mouth. A fair inquiry is reported for engine fuel, and in some instances large users are showing an anxiety to enter into forward contracts. The demand, however, falls chiefly on the better qualities, supplies of which are not at all in excess of requirements, and for these an advance of 3d. per ton is in some cases being quoted, the average figures being now about 4s. 6d. to 5s. per ton; for common sorts, however, which are still plentiful, low prices continue to be taken, 2s. 9d. to 3s. 3d. at the pit representing the ordinary selling prices.

Depression still prevails in the shipping trade, and common steam coal, delivered at the ports on the Mersey, are still readily obtainable at 6s. 9d. to 7s. per ton.

Barrow.—There has been a steady tone throughout the week in the hematite pig iron trade, and orders are still liberally offered at 49s. net cash warrant sellers, buyers being at 48s. 11d., while makers quote 50s. to 51s. per ton for mixed Bessemer numbers, net f.o.b. There is next to no trade in forge and foundry qualities of metal, but Bessemer is in all-round consumption. Stocks have not increased during the week, and remain exactly as they stood last week at 302,419 tons. Thirty-eight furnaces are in blast, compared with 26 in the corresponding week of last year.

Iron ore is selling at 10s. for average qualities net at mines, and 12s. 6d. for best sorts. The trade is much better than it has been of late. Spanish ore is in fair demand, and is still largely used for mixing purposes, and is quoted at 12s. 9d. to 13s. per ton delivered at West Coast ports.

The steel trade is very briskly employed in all departments, and the outlook is bright, and better than it has been for many years past. Orders are largely held for heavy rails, ship plates, billets, hoops, and castings, while a better business has been done lately in tin bars. Steel sleepers are in good demand, and are being largely produced in the West Cumberland district. Prices are steady, heavy rails at £4 15s., and ship plates at £5 2s. 6d. net f.o.b.

There is nothing to report in the shipbuilding and marine engineering trades. Very great progress is being made with the work in hand, and anticipations are indulged in that important new orders will come to Barrow shortly to take the place of the orders which are rapidly approaching completion.

The coal and coke trades are more active than they have been for some time past, and it is evident that prices are moving upward in harmony with the improved demand. Deliveries are fuller, and local railway companies are benefiting by the improved trade doing.

Shipments continue to improve slightly. The exports of pig iron from West Coast ports during last week amounted to 5484 tons, and of steel to 11,046 tons, as compared with 3328 tons of pig iron and 5894 tons of steel in the corresponding week of last year, being an increase of 2156 tons of pig iron, and 5152 tons of steel. The aggregate shipments this year to date have reached 58,503 tons of pig iron and 78,088 tons of steel, as compared with 47,674 tons of pig iron and 69,008 tons of steel in the corresponding period of last year, an increase of 10,829 tons of pig iron, and 9080 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE reports from the various districts of the Yorkshire, Derbyshire, Notts, and Lincolnshire coal fields continue to indicate no improvement in the state of the market. Supplies are largely in excess of the demand, with the necessary issues of keen competition and declining values. In several instances where the pits are particularly well located for business, and the owners have secured good contracts, five to five and a-half days' work per week is the rule. In the great majority of instances nothing like that employment can be afforded, the average over the district being not more than from three to four days. There is rather less coal being brought to bank, the men complaining of having to wait a great deal—which, of course, reduces their wages. The short spell of cold weather had some slight effect on the house coal trade, but it has now entirely passed away—the demand, particularly for the London market, being less than usual at this season of the year, and the competition more acute than ever. Best Silkstones are now making 8s. to 9s. 3d.; ordinary from 6s. 9d.; Barnsley house, from 7s. 6d. to 8s. per ton; lower grades from 6s. 9d., while thin seam coal is obtainable at 6s. per ton and upwards. Some slight improvement is reported in the steam coal trade, owing no doubt to the prospect of an early opening of the Baltic ports. This is causing a good deal of coal to be dealt with in speculative account, with the usual result of depressing values. Steam coal is quoted at 6s. 9d. to 7s. 3d., and inferior sorts rule about 6d. per ton less. A good deal of coal at present is being delivered on account of railway contracts, the quotations ranging from 6s. 9d. to 7s. per ton, secondary qualities not making more than 6s. per ton. In gas coal there is rather less doing, values being from 6s. to 7s. per ton. Manufacturing fuel is in better demand, owing to the improved state of the iron industry. Supplies, however, continue to be very large; prices consequently rule low. Small nuts are obtainable from 4s. 6d. to 5s. 6d. per ton, screened slack from 3s. 6d., pit slack from 2s. 6d., and smudge from 1s. per ton. The coke trade is considerably better, and more ovens are being built to meet the demand at Cadeby and elsewhere. Prices rule at 8s. to 10s. per ton. There are disputes at several of the district collieries, chiefly on minor matters; and a considerable number of hands are at present out of employment.

The iron trade continues to improve; a decidedly firmer tone has been perceptible during the last week. Hematite pig iron is obtainable in Sheffield at 58s. for West Coast, and 55s. to 56s. for North-East Coast. Common forge is firm at 39s. 6d. net; bar iron, £5 10s.; Siemens-Martin steels, £7 10s. and upwards; Bessemer billets realise from £5 12s. 6d. to £6 per ton. There is every prospect of the iron trade becoming much brisker, and values advancing considerably very soon.

In railway material the principal orders recently booked have been for the Indian States Railways and several Colonial markets, while some foreign orders of consequence have also been received. These coming in at the same time as the revival in the home market, has made all our firms engaged in the production of axles, tires, springs, buffers, and similar goods, as well as in railway carriages and wagons, extremly busy. It may be doubted if at any previous time more work has been in hand in railway specialities for immediate delivery. Prices for finished productions are therefore gradually stiffening, and the amount of work on the books puts makers in a position to ask for higher values for future orders.

Marine material is also in a much brisker condition. Freights are still very low, owing to there being more ships than cargoes for them, but there is a considerable amount of new work in hand which brings employment to some of our workshops, particularly in shafting, castings, propeller blades, flues, tubes, flanged boiler end plates, &c. Messrs. John Brown and Co., who are sole manufacturers of Purves flues and Serve tubes, report a good business. They are also doing well in marine type boilers with Ellis and Eaves' suction draught. These are being made for electric light and works installations, in addition to their use for ships' boilers. One electric light company in London has fitted these boilers to its works, and a similar class of boiler has been ordered from Messrs. Brown and Co., by the Sheffield Electric Light and Power Company, and the Bradford Corporation, who have previously been customers for the same class of boiler. This company are also constructing four similar boilers for Johannesburg.

Orders for war material are not coming in, apart from armour-plates and gun forgings, with such rapidity as was expected, and even in gun forgings the powers of output of the Sheffield firms are not at all fully in operation. The smaller classes of shot and shell are being freely booked, but there is altogether inadequate work for the plant in readiness to produce the large armour-piercing projectiles. Orders for these war goods cannot be much longer delayed, and Sheffield is bound to participate in the requirements for them under the Naval Estimates. It has been stated that while three firms in France can produce any quantity of 16¼in. shells that the French authorities may require, there is not a firm in England capable of making that large shell at all. This is not correct. Messrs. Thos. Firth and Sons, Norfolk Works, can make these shells, and are ready to do so whenever the Government please to forward their orders. This firm alone could produce more of these shells, as well as 12in. and other large sizes, than the Government is likely to require.

In the lighter trades the condition of affairs is increasingly gratifying, as well as in the engineering departments and steel. With regard to the latter there is a steadily improving demand both at home and abroad for the best crucible material, as well as for Bessemer and Siemens-Martin qualities. Makers of agricultural and horticultural implements report that they are exceedingly well off, and the call for scythes, sickles, &c., for which, in spite of machinery, there is a great business in Sheffield and for miles around, is greater than ever. Cutlery is rather better than previously reported, though not so brisk as at the close of last year, while there is a distinct weakening in the demand for electro-plate and sterling silver goods. The latter feature is more evident with the smaller firms than in the large establishments. The rolling mills, which are the best key to what are known as the Sheffield trades, are satisfactorily employed, and it may, therefore, be taken for granted that good employment will continue to be given in the lighter staple industries.

The Sheffield Gas Company, at its half-yearly meeting on the 9th inst., decided to reduce the price of gas to all classes of consumers by 2d. per 1000 cubic feet. This makes the price, according to the qunatity consumed, 1s. 8d., 1s. 10d., and 2s. per 1000 cubic feet. Sir Frederick Mappin, Bart., M.P., the chairman of the company, stated that the quantity of gas consumed had largely increased during the half-year, the weight of coal carbonised being 5680 tons in excess of the quantity in the corresponding half-year of 1894. He expressed the opinion that gas was still in its infancy.

The weight of Yorkshire coal—part Derbyshire—taken to Hull in February was 153,392 tons, as compared with 143,520 for the corresponding period of 1895; for the two months, 304,336 tons against 286,096 tons. The weight exported in February was 40,117, against 32,199 tons; for the two months of the year, 96,569, against 85,972 tons. The principal customer has been Germany, with 22,953 tons, against 14,101 for the corresponding two months of 1895.

Sir P. Salter Pyne, the engineer in charge of the Ameer of Afghanistan's gun, rifle, and cartridge factories at Cabul, visited Sheffield on Monday, when he inspected the works of Messrs. Thomas Firth and Sons, steel and war material manufacturers, and Messrs. George Butler and Co., cutlery manufacturers, Trinity Works, Eyre-street, Sheffield.

The order for the whole of the tool steel required in the Government arsenals and rifle factories for a period of three years has been placed by the War-office with Messrs. Jonas and Colver, Continental Steel Works, Sheffield.

THE NORTH OF ENGLAND

(*From our own Correspondent.*)

GENERALLY a lull in business is noticeable this week, but after the activity in the demand that has been experienced for some time past this is not considered of much importance, as such periods of quietness are not unusual during the progress of all revivals. The dulness is looked upon as likely to be of very short duration, and all round prices are well maintained, because as a matter of fact manufacturers are so well supplied with contracts that they are for the present independent of the market. If they were so disposed, however, they could book extensive orders for summer and autumn delivery, and there are plenty of inquiries for iron for delivery between May and August, but the prospects are so encouraging that sellers do not care to commit themselves so far ahead. Travellers who have been on their business tours through the various iron manufacturing districts give most excellent accounts of the progress of trade; indeed, in some parts the activity was never so great, and there is every prospect of its being continued. All who are needing iron and steel are making haste to get it, as the longer they wait the more they will have to pay for it. The dullest part of the year is now ended, and if prices advance, then they may be expected to rise still further when the briskest season has arrived. Railway companies, municipal authorities, engineers, &c., both at home and abroad, are ordering freely. Almost all the manufacturers in this district have their books well filled with contracts, and the number of the unemployed has within the last two or three months very appreciably decreased; indeed, in the iron and engineering industries it is many years since employment was found for so many. Shipments are above the average. From the Cleveland district this month the exports of pig iron have been 35,592 tons, as compared with 26,027 tons last month, 23,327 tons in January, and 21,131 tons in March, 1895, all to 11th. As local consumption has also greatly increased, it is certain that the deliveries of iron this month will exceed the production, which has not been the case since last October.

Among the exports from the Tees this week has been noted some pig iron for Huelva, which is wanted for copper catching in the rivers and streams in the South of Spain. Years ago thousands of tons of Cleveland pig iron used to be sent for this purpose. It was made in smaller pigs than those usually cast, so that it could be more readily handled and carried on the backs of mules to the interior. The trade, however, ceased with Cleveland when pig iron began to be made in Spain, as Spanish pig could be supplied at a cheaper rate than English, upon which a heavy duty was levied. The shipment this week is, therefore, important, as it denotes a re-opening of the trade.

Prices of pig iron have been well maintained this week, notwithstanding the lull in the demand, and what has kept makers stiffer has been the announcement that tenders were being asked for 90,000 tons of castings for the new subway in London, which is to be lined throughout with cast iron. No. 3 Cleveland pig iron has been steady at 38s. 6d. per ton for prompt f.o.b. delivery, and makers have not accepted less, while second hands have only sold a few small lots at 38s. 4½d., and that would not be taken now. It has been difficult to meet with a producer who would even quote for delivery further ahead than the end of next month; no one, in fact, has any desire to sell ahead with such promising prospects. No. 1 Cleveland pig has been firm at 39s. 6d., and the inquiry is improving as the regular shipping season approaches. The commoner qualities of pig iron are in better demand than supply, and for No. 4 foundry the price has been advanced to 37s. 6d., while grey forge has been put up to 37s.; mottled, to 36s. 6d.; and white, to 36s., the last-named being almost unprocurable, as there is no stock, and scarcely any is made. Mixed numbers of East Coast hematite pig iron are not under 47s. with makers for early f.o.b. deliveries, but merchants have sold small quantities at 46s. 9d. and even 46s. 6d. Cleveland hematite warrants are considerably cheaper than this, but there is no speculation in them, and consumers do not care to buy them, as they may get a brand which they do not appreciate. Rubio ore is 12s. 9d. per ton, delivered at Tees wharves. The stock of Cleveland pig iron in Connal's public warrant stores on Wednesday night was 186,276 tons, an increase of 766 tons during the month. It will be noticed that the quantity going into the public stores is very small this month—700 tons per week—whereas in December it was 3700 tons. This is partly due to the larger inland deliveries and the heavier shipments, and partly to the fact that merchants just now prefer to let their surplus iron stay in the hands of the makers.

A slight lull in the demand for manufactured iron and steel is reported, but works are fully employed as a rule, and prices are firm all round. Heavy steel rails are kept at £4 15s. net at works by the syndicate, notwithstanding that orders are going into the hands of the foreigners from customers who have hitherto bought in England, but who can now buy cheaper elsewhere. For stee ship-plates £5 2s. 6d. is quoted; for steel boiler-plates, £6 2s. 6d. for steel ship angles, £5; for iron ship-plates, £5; for iron ship angles, £4 15s.; and for common iron bars, £5, all less 2½ per cent. and f.o.t.

Engineering is very brisk on the whole, some firms being better off for contracts than ever before; but prices do not seem to improve much. The shipwrights on the Tyne, Wear, and Tees have been granted an advance of 1s. 6d. per week in their wages, in satisfaction of their claim for 4s. advance. It is intimated that the engineering works of the Tees-side Iron and Engineworks Company and those of Messrs. Westgarth, English, and Co., both at Middlesbrough, and both acquired by Sir Christopher Furness, will be worked together, and will carry on a much larger marine engineering business than heretofore. Messrs. Westgarth, English, and Co. have informed the Corporation of Middlesbrough that they propose to erect a large crane on the Tees-side Wharf for shipping their machinery, but as the frontage is too short for the large modern vessels which they would have to fit with engines, they ask whether the Corporation would allow vessels to overlap their—the Corporation's—wharf. Messrs. R. Craggs and Sons are removing to the new shipyard which they acquired from Sir C. Furness, who bought it as part of the Tees-side Company's property. Messrs. Craggs and Sons propose to employ electricity as a motive power at their yard. It is being used extensively already at two establishments in the district, one of which saved £4000 last year by its employment.

The directors of the North-Eastern Railway Company have appointed Mr. James Forsyth, of the Mineral Department, Newcastle, to the position of assistant superintendent of the line—trains department—in succession to Mr. Charles Steel, who was recently appointed general manager of the Highland Railway, and Mr. W. S. Roden is appointed passenger superintendent at Leeds, vice the late Mr. Richard Chamberlain.

Sir Andrew Noble, K.C.B., of Jesmond Dene House, Newcastle-on-Tyne, of Sir W. G. Armstrong, Mitchell, and Co., has been chosen as Sheriff of Northumberland, and Major Robert Ropner, of Preston Hall, Stockton-on-Tees, the well-known shipbuilder, will occupy a similar position in the county of Durham.

The death took place on Saturday suddenly, at Redcar, of Mr. John Bowman, aged 57 years. He was a director of the Darlington Wagon and Engineering Company, and also managing director of the Low Beechburn Colliery. The death also took place of Mr. W. G. Younghusband, of Darlington, manager of the outside machinery department of the North-Eastern Railway; also of Mr. Charles Brown, of Brown Brothers, ironfounders, Portrock-lane Ironworks, Stockton.

The Middlesburgh Chamber of Commerce is instituting an inquiry as to how far foreigners have encroached upon the trade of local manufacturers during the last five years, and which are the nations which have so encroached.

The coal trade is generally quiet, the condition of business being thus the exact opposite to what is reported in the iron trade. Especially in the steam coal branch is the demand slack, and few of the Northumberland collieries are working to their full capacity, nor are they likely to do so until the Baltic shipping season opens. The exports of coal from North-eastern ports last month amounted to 1,326,730 tons, or 204,437 tons more than in the corresponding month last year, when exports were much curtailed on account of the severity of the weather. The present price of best Northumberland steam coal is 7s. 9d. per ton prompt f.o.b. delivery, and 8s. 3d. is accepted for delivery over the season. The Osmondcroft Colliery, near Winston, between Barnard Castle and Darlington, has ceased working; it is a landsale colliery, started some years ago by the late Mr. R. Teasdale, of Newsham, and latterly has been worked by the Osmondcroft Coal, Brick, and Tile Company. The Marley pit at the Hulton Henry Colliery, near Castle Eden has been closed owing to the influx of water, and will probably be idle for some months until the pit is cleared. The Longhurst Colliery, in Northumberland, has been stopped owing to the exhaustion of the coal. The Sunnybrow Colliery, in Durham, which has been idle for some years, is to be re-opened. Good Durham blast furnace coke is firm at from 13s. to 14s., delivered at Middlesbrough furnaces. Large quantities have been sold during the last fortnight at 14s. per ton.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has been less firmness in the Glasgow pig iron market this week. On Monday Scotch warrants were done from 47s. 7½d. to 47s. 3½d. cash, and 47s. 10d. to 47s. 7d. one month; the transactions having since been about the lowest rates. Cleveland iron has sold from 38s. 8d. to 38s. 5½d., and Cumberland hematite 49s. 2d. to 48s. 9½d. cash. The decline in prices is ascribed to holders selling from apprehension of a dispute in the mining industry following on the present reductions of wages. A large quantity of iron changed hands. The increased reports shown by the Board of Trade returns had only a slight and temporary influence on the market, because it was at once perceived that this increase is counterbalanced by the additions that are being made to output and stocks. The market was in the hands of the bears to a greater extent this week than for some time past. At the same time the state of the iron trade is, all things considered, not unsatisfactory; the home consumption of all kinds of pigs being on a constantly increasing scale.

Since last report an additional furnace has been put into blast at the Carron Ironworks, and the total number now blowing in Scotland is eighty, compared with seventy-four at this time last year. The output is at present larger than the current demand, so that both public and private stocks are increasing, the past week's addition to the stock in the Glasgow warrant stores being upwards of 1800 tons. These stocks are still, however, considerably smaller than the average of recent times, and the manufacture of pig iron is being conducted at so moderate a cost at present that the ironmasters are disposed to sell as much as they can at current rates for the store, adding at the same time to their private holdings. They have a better chance of selling to advantage in the future than has the speculator, who now invests in warrants, because there is a risk of prices going lower in the open market.

The following are makers' pig iron prices f.o.b. at Glasgow: — Govan, Monkland, and Carnbroe, No. 1, 48s. 6d.; No. 3, 47s.; Clyde, No. 1, 50s. 6d.; No. 3, 47s. 6d.; Gartsherrie, Calder, and Summerlee, No. 1, 51s.; No. 3, 48s. 6d.; Coltness, No. 1, 53s. 6d.; No. 3, 49s.; Glengarnock, at Ardrossan, No. 1, 50s. 6d.; No. 3, 47s.; Eglinton, No. 1, 48s. 6d.; No. 3, 46s. 6d.; Dalmellington, at Ayr, No. 1, 48s.; No. 3, 46s.; Shotts, at Leith, No. 1, 53s.; No. 3, 49s.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 49s.

There has been some disappointment that the increase that occurred in the shipments in the past two weeks has not been maintained. The past week's clearances at the various ports amount to 6517 tons, compared with 7259 in the corresponding week of last year. To Germany 575 tons were despatched; United States, 138; Australia, 305; South America, 110; India, 55; France, 25; Italy, 550; Holland, 670; Belgium, 65; other countries, 584; the coastwise shipments being 3440 tons, against 5254 in the corresponding week of last year.

In the malleable iron and steel departments there is much animation, the works being for the most part in full operation, and turning out a large quantity of material, most of which is being disposed of to home users. Prices are steady and fairly well maintained, but they are still much lower than would be desired.

The coal shipments at the Scottish ports in the past week reached 119,875 tons, against 117,180 in the preceding week, and 95,765 in the corresponding week of last year. An improvement in the Mediterranean trade has kept up the shipments, the clearances both from the Clyde and Forth in that direction forming a very considerable proportion of the whole. Business in the freight market this week would seem to indicate that the shipments to the Mediterranean in succeeding weeks are likely to be on a scale above the average. The demand for the better qualities of shipping coal is thus fairly good, but the market generally shows no improvement, and quotations at Glasgow are purely nominal. In Ayrshire the depression is severe, and prices are reduced 2d. to 3d. per ton for shipping qualities. House coal is quoted f.o.b. at Ayrshire ports, 6s. 3d. to 6s. 6d.; steam and main, 5s. 9d.; triping, 5s.; dross, 3s. to 3s. 6d. per ton.

The coalmasters of Lanark and Ayr have intimated a general reduction of 6d. per ton in the colliers' wages. This will press with much severity upon the men, who were already suffering much from partial reductions and curtailment of working time. In many places only three to four days' work per week can be obtained, and now that wages run from 4s. to 4s. 6d. per day, it scarcely requires to be explained that the men are in a most unfortunate position. Of course this is well known to the masters, by whom it is deplored; but they are not able to make the state of matters better. It is not easy to perceive how the reductions will operate. The colliers are holding meetings, protesting and threatening to resort to idle days in order to still further reduce output; but the working time is already so short that it is not easy to see how such a policy could be carried out at present.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

MARCH, so far, has kept to its old reputation for storms. Fortunately, the chief evil has been in delaying tonnage, the list of disasters having only been of small account. But for the delay of vessels and steamers coming in last week, business would have been a large one. As it was, Cardiff total coal export mounted up to 290,000 tons. At Swansea there have been great complaints of delayed tonnage, and the anthracite coal export was weakened in consequence. Altogether Swansea coal export was from only 22,266 tons, a full third of which went to France. Newport total foreign was 54,071 tons; coastwise, 14,797 tons.

Coal prices have been maintained, and a slight advance shown in small. Latest prices Cardiff indicate this:—Best steam coal, 10s. 3d. to 10s. 6d.; seconds, 9s. 6d. to 10s.; drys, 9s. to 9s. 6d.; small, best, 4s. 9d. to 5s.; seconds, 4s. to 4s. 3d.; drys, 3s. 6d. to 3s. 9d. Monmouthshire coal for shipment at Cardiff is unchanged. Best 8s. 6d.; Eastern Valley coal, 8s.

House coal has varied a good deal in demand. Sometimes an improvement sets in, followed quickly by a decline. "If this is all the winter we are to have," remarked a dealer, "it will be a poor one for house coal." This week it was reported on 'Change, Cardiff, that there is a fair inquiry for prompt shipment, and the following prices are maintained:—Best households, 10s. 6d. to 10s. 9d.; seconds, 9s. 3d. to 9s. 6d.; No. 3 Rhondda, 9s. 6d. to 9s. 9d.; brush, 7s. 9d. to 8s.; small, 6s. to 6s. 6d.; No. 2 Rhondda, 7s. 6d. to 7s. 9d.; through, 6s. to 6s. 3d.; small, 4s. to 4s. 3d. Swansea prices: Anthracite best big vein selected, 11s. to 11s. 6d.; seconds, 10s. to 10s. 6d.; ordinary large, 8s. to 9s.; small rubbly culm, 4s. 6d. Steam coal, 9s. 6d. to 10s. 3d.; seconds, 8s. 8d. to 9s. 3d. House coal, No. 3 Rhondda, 10s. to 10s. 6d.; through, 8s. 3d. to 8s. 9d.; small, 6s. 3d. to 6s. 6d.; No. 2 Rhondda, 8s. 9d. to 9s. 6d.; through, 6s. 3d. to 6s. 6d.; small, 5s. to 5s. 6d. In coke there is a steady demand. Cardiff prices: Furnace, 13s. 6d. to 14s. 9d.; foundry, 15s. 6d. to 16s. 6d.; special, 19s. 6d. to 20s. Swansea prices, 12s. to 17s., according to brand. Patent fuel is improving. Cardiff and Swansea prices firm, 10s. to 10s. 3d. Pitwood at Cardiff is a little better in demand, price 15s. 3d.

The state of unrest which has of late been exhibited in several of the coal valleys, promises to become widespread. The colliers are literally up in arms against the "Discharge Note System," and this time are championed by "Mabon," Mr. Abraham, M.P., who at a large meeting on Monday at Cardiff, attended by representatives of nearly 100,000 colliers, denounced it heartily. The opinion of the meeting was thoroughly in favour of giving a month's notice unless the discharge note system is summarily ended. On Tuesday the Sliding Scale Committee met and discussed the matter, but did not come to a decision. This is expected on Saturday. Sir W. T. Lewis, Bart., was unable to be present at the last meeting on account of a pressure of engagements in London.

There is a good deal to be apprehended when Mabon speaks out unhesitatingly, for he is a judicious and a discreet leader, and more frequently curbs in than incites to action. It is the opinion of many who usually support the coalowners, that a withdrawal of the measure would be a prudent step at present, and then, in joint committee, "owners" could frame some rule that would give the industrious and peaceable some advantage over those who habitually indulge in strikes.

The Plymouth strike, or lock-out, continues, and widespread destitution is occurring in many quarters. Some of the thrifty are, so far, unaffected, but at all of the large Welsh collieries there is a considerable number of the labouring class, principally Irish, and it is these and their families who suffer most. The impression in the district is growing that if the sliding scale cannot reach the case and bring it to an end, it is time for compulsory arbitration to be enacted. The Plymouth case is said to teem with difficulties. On the one hand it is urged that men have been able to earn good money there, and that the benefit of late has been more with the colliers than the employers. A plea was started by the men that some allowance should be made at a certain point of the work, and this was conceded, and withdrawn when the difficulties were overcome, but having had the allowance, the men insist upon its continuance, and this is refused. Such is one view of the situation; and it is believed, in sound quarters of observation, that the proprietary will support their representative to the bitter end. If it can be shown that at the late wages Plymouth collieries cannot pay to be continued, the miners' leader, one would think, should advise the acceptance of such a reduction as would warrant a continuance. The men forget that the old collieries—and a part of the Plymouth coalfield was worked 100 years ago—are handicapped by the deep sinkings of Dowlais, Cardiff, Aber, Albion, and others which are of recent date. Yscuberwen, in the Aberdare valley, after sixty years' work is to be closed, and the plant is to be removed.

The year has begun fairly well so far as iron and steel are concerned, though the totals of February, as regards exports from Cardiff, were not equal to those of January. Newport and Swansea showed better. In January Swansea despatched 8949 tons; February, 2632 tons. Newport in January sent away 314 tons, and in February 2193 tons. Swansea, in January, 130 tons, and in February 2515 tons. Llanelly sent none away in January, but 470 tons in February.

On 'Change, Cardiff, it was reported this week that numerous inquiries have been received for steel rails, and a moderate demand for steel bar at last prices, namely, Bessemer bar, £3 17s. 6d.; Siemens best, £3 18s. In merchant bar and small goods there is a tolerable amount of business being done.

The pig iron market is firm and advancing, and there is a steady demand for iron ore at the following prices:—Best Rubio, 11s. 9d. to 12s.; Tafna, 11s. to 11s. 3d.; Garucha, 10s. 9d. to 11s. c.i.f.

Swansea report is not quite so satisfactory in respect of pig iron, prices having slightly receded since last week, the quotations being a few pence less. In other branches distinct improvement is shown.

The finished iron and steel trades are very busy. The demand for steel for ship plates, boiler plates, and galvanising sheets is decidedly increasing. I am glad to learn that the orders for the latter are coming in strongly from the Colonies and India, and a large and important business is anticipated.

The Swansea Hematite Company, the Ebbw Vale, Cyfarthfa, and Dowlais Iron Company continue to be large importers of ore, principally from Bilbao. Cyfarthfa continues, notwithstanding the flagging condition of the tin-plate trade, to do moderately well in tin bar, so that should a revival in tin-plates occur the problem would be how to meet the demand. On a personal visit a few days ago I was impressed by the activity shown, the greater part of make being in steel bar. Iron and steel cargoes for the week have been small, ore went to La Guayra. Last week that fine specimen of a turret ship the Oak Branch left Cardiff with 5000 tons of coal for the Cape.

The opinion of leading men in Swansea upon the tin-plate situation is that though there may be "ups and downs," it will be hopeless to expect a steady and an improving trade, unless a systematic reduction of wages takes place. It is a matter of surprise amongst the iron workers that a leaf has not been taken from their book. In former years high wages prevailed at Cyfarthfa and Dowlais. Gradually, however, this was changed, especially when iron gave way to steel, and it is only by the adoption of the best scientific and mechanical appliances, and the introduction of cheap labour, that the "mill works" are kept going. Wages are much higher in the tin-plate works than in the general run of iron and steel works; but, as an authority remarks, if trade is to be retained with America they must be lowered.

Last week there was a better despatch of tin-plates to America; about 2000 tons. In all the shipments of plates totalled, 32,846 boxes. On the other hand, the make was 38,853 boxes, so stocks were again increased. Total stock at Swansea now consists of 190,931 boxes. Some of the works which restarted, having completed the orders obtained, are likely to stop again, and it was stated on 'Change, Swansea, this week that, if they are laid by, no restart will again be made until there has been a regular revision of wages. I hear that a restart is intended at the Avon Vale Tin Plate Works, Port Talbot, with three mills.

Iron, steel, and tin plate quotations at Swansea this week were as follows:—Pig iron, Glasgow warrants, 47s. 4½d., cash. Middlesbrough No. 3, 38s. 7d. prompt. Hematite, 46s. 2d. Welsh bars, £5 10s. to £5 15s. Sheet iron, £6 15s. to £6 17s. 6d. Steel sheets, £6 12s. 6d. to £6 15s. Steel rails, heavy, £4 10s. to £4 15s.; light, £4 17s. 6d. to £5 7s. 6d. Bessemer steel, tin-plate bars, £3 17s. 6d. Siemens, best, £3 18s. Tin-plates, Bessemer steel cokes, 9s. 1½d. to 9s. 3d. Siemens, 9s. 3d. to 9s. 6d.; ternes, per double box, 17s. 6d., 18s. 6d. to 22s. 6d.; best charcoal, 12s. 6d. to 13s. 6d.; wasters, 6d. to 1s. less. Block tin is £60 15s. to £61. In copper there has been a run down, probably due to speculative operations. Chili bars are at £44 16s. 3d. to £44 17s. 6d. Swansea Harbour revenue last year was the largest on record.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

ALL sorts of iron and steel continue in lively and regular demand, and the prices paid are on the whole satisfactory. For some articles quotations have been officially raised.

On the Silesian iron market a good trade is doing, both in raw and in finished iron. The rolling mills will be regularly engaged till far into the third quarter, orders for local as well as for foreign demand coming to hand freely. The activity in the malleable iron trade naturally has a favourable influence on crude iron, and there has been a decided improvement noticeable in the occupation of the blast-furnace works lately. There is also much briskness noticeable in the railway and engineering trade, the shops being generally employed to the extent of their capacity.

In Austria-Hungary the iron and steel industries are tolerably active. Demand on home and on foreign account is undoubtedly improving, and there is likewise an upward tendency to be perceived in quotations; sheets, for instance, and galvanised plates have been raised 50 cr. per 100 kilos. The inquiry for girders is strong, and that for bars increasing from week to week. Wire and wire nails are still extremely neglected, the advance in quotations, which was to take place on the 1st of March, having again been put off—till next month perhaps.

The reports concerning the French iron and steel trade are pretty favourable this week. Demand is good and prices tend upwards. There has not been much business done in bars and structural iron hitherto, and girders still stand on 145f. p.t., Paris, both for inland and foreign consumption; but a good spring demand is anticipated. For rails and general railway rolling stock there has been a moderately good inquiry experienced, quotations being a trifle more paying than before. In 1895 the French railways consumed 85,244 t. of steel rails, against 110,609 t. in 1894, 129,338 t. in 1893, 163,840 t. in 1892, 112,857 t. in 1891, 66,844 t. in 1890, 58,046 t. in 1889, 93,868 t. in 1888, 108,898 t. in 1887, and 170,595 t. in 1886.

The Belgian iron business is progressing favourably, demand increasing from week to week, while quotations show considerable firmness, and have even been raised in a few instances. The blast furnace works of Luxemburg have officially advanced their quotations 1f. p.t., foundry pig No. 3 now standing on 48f. p.t. Compared to October last year, prices have risen about 4f. p.t. Some pretty large export orders for bars and plates have been booked recently. Rhenish-Westphalian iron masters report themselves most satisfactorily situated with regard to employment, the amount of orders booked increasing from week to week. Quotations, though much more favourable than at the end of last year, are still, in a great many instances, far from paying. Up to the present time production has been tolerably large, in many cases exceeding consumption, which is due to the hitherto rather limited demand on foreign account. In the Siegerland the price for foundry pig has been raised M. 1 p.t., No. 3 now fetching M. 57 p.t.; forged pig was also advanced M. 2 p.t. free Siegen. The demand for malleable iron continues to show a satisfactory improvement, and prices are exceedingly firm. Inquiries for bars are very numerous, girders and hoops likewise meeting with healthy request.

The steel trade is very active, both in the merchant and manufactured branches. Plates and sheets sell briskly; prospects with regard to further employment are good, and a rise in quotations is likely to take place in a week or two. At present very little is gained, makers having to pay too much for the raw material. Especially for export to Russia very low prices have to be quoted, which in many cases not only yield no profit, but entail loss. However, the plate makers are well aware of the importance of the export trade to Russia, and will rather forego a profit than lose their customers. During the first eleven months of last year no less than 44 millions of kilogrammes of plates were sent from Germany to Russia. Wire and wire nails are in better request, but only very low prices are quoted. Total output of pig iron in Germany, including Luxemburg, was, for January, 1896, 517,988 t., of which 142,622 t. were forge pig and spiegeleisen, 31,345 t. Bessemer, 263,301 t. basic, and 80,720 t. foundry pig. Production in January, 1895, was 489,575 t., while in December of 1895 it amounted to 510,405 t.

German export in rails has, of late, decreased, as may be seen from the following official figures:—

	Tons.		Tons.
1860	1,270	1887	174,226
1870	36,000	1888	114,946
1875	132,000	1889	110,949
1880	230,204	1890	130,837
1881	250,700	1891	142,846
1882	186,054	1892	118,712
1883	176,178	1893	87,360
1884	144,464	1894	119,410
1885	164,799	1895	116,627

Export in fish-plates, sleepers, &c., has, on the other hand, developed favourably, being for—

	Tons.		Tons.
1880	8,147	1888	23,254
1881	11,982	1889	26,042
1882	11,596	1890	36,470
1383	19,230	1891	63,406
1884	17,536	1892	39,558
1885	26,929	1893	37,487
1886	22,820	1894	43,343
1887	21,553	1895	45,619

With regard to export trade in springs, axles, buffers, &c., for railway carriages, an improvement has been noticeable lately. Export was as under:—

	Tons.		Tons.
1880	18,722	1888	20,808
1881	17,084	1889	26,030
1882	11,822	1890	29,114
1883	13,050	1891	33,554
1884	10,152	1892	26,554
1885	8,603	1893	29,714
1886	12,597	1894	24,318
1887	22,447	1895	25,824

The following figures show German export in locomotives and traction engines:—

	Tons.		Tons.
1883	13,735	1890	5117
1884	9,912	1891	4174
1885	6,778	1892	4778
1886	7,953	1893	4507
1887	6,872	1894	5686
1888	7,088	1895	7988

In the year 1880 no less than 2222 railway carriages were exported, in the following year 3108, while in 1885 only 1071 railway carriages were exported. In 1890 export again rose on 3575 carriages, and was for 1894, 4667; and for 1895, 6040 railway carriages.

A HUGON GAS ENGINE.—Messrs. Richard Grice and Son, of 108, High-street, Clapham, write us that they have one of the Hugon gas engines, No. 69 of 1867, which they are now removing to provide space for other things. It is of one nominal horse-power, in working order, and would be an acquisition for an engineering museum. There is already a half-horse power Hugon engine in the Patents Department of the South Kensington Museum, but it is not fitted with the Hugon igniting arrangement, so it may be hoped that this now available specimen, as it can be had at a low price, may be purchased for some museum, rather than be put aside and ultimately to the scrap heap.

ANOTHER ECONOMICAL ENGINE.—The report of an economy test made by Messrs. Dean and Main, mill engineers, of Boston, Mass., upon a 26in. and 52in. by 72in. cross-compound Corliss engine at the Berkeley Mill, Berkeley, R.I., made by the Corliss Steam Engine Company, of Providence, showed a steam consumption of 12·86 lb. and a coal consumption of 1·39 lb. per horse power per hour. The boilers were of the Corliss vertical type. The high-pressure cylinder was jacketed with steam at boiler pressure, and the low-pressure cylinder with steam of receiver pressure. The air pump was operated by the engine. The steam supplied the engine was superheated 18 deg., and was at a pressure of 129 lb. The vacuum was 27·4in. The boiler test showed that the economiser with which the plant was equipped produced a saving of 4½ per cent. The report states that the engine was tested in its "everyday working condition, and the results, which have been seldom equalled or surpassed for economy, are being constantly duplicated in the regular operation of the mill." The best economy as known of for compound mill engines was 12·46 lb. of steam per indicated horse-power per hour, which was found by Mr. Barrus in testing the Wheelock engine at the Grosvenor Dale Mill. The *Engineer Record* says this engine was arranged on the Rockwood system; that is to say, it resembles a triple-expansion engine with the intermediate cylinder left out, and worked under a pressure of 150 lb. Mr. Dean's test of the Leavitt pumping engine at Louisville, Ky., showed a consumption of 12·15 lb. of dry steam per indicated horse-power per hour.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, March 21st.

The declining tendency in prices continues. This, with the unsatisfactory financial condition, accounts for existing dulness in trade and manufacturing circles. Good securities are in demand. Bank clearings are now one-third higher than a year ago. Railroad earnings show an improvement so far this month, 13½ per cent. in excess of same time last year. The country has lost 262,000,000 dols. within eighteen months on low tariffs and on borrowed money. The Treasury is still falling behind, and must continue to do so until higher duties are imposed. Exports at New York for February are 19 per cent. greater than last February. Iron and steel are selling about as usual, and prices are steady. Prospects for the coming season are good, and the year will probably be the best the States have had since 1892. Ship, boat, bridge, and car building, all are improving. The other industries are gaining, but low prices everywhere rather discourage enterprise. The silver question is still aggravating the public mind. Gold production in the spring will begin on a greater scale than ever. Mining enterprises are multiplying, and new fields of great value are to be opened and worked by organised companies well supplied with money. Coal is very low, and attempts are being made to restrict production.

Commercial activity in eastern and western markets have been gradually increasing, but has not yet reached stimulating proportions. Speculators are afraid. Commercial paper is scarce. The Government is hobbling along, hugging its new found gold, but financiers say, "Grover will be around again before long." The silver men in the Senate showed their teeth the other day, and let their lips drop over them until the St. Louis Republican Nominating Convention meets in the early summer. Then there will be a grand party split, a fact apparent to all but New York editors and Wall-street bankers. The iron and steel trades are active. Heavy orders are coming for wrought iron and cast pipe, for skelp iron bars, plates, and shapes. The expansion in steel making is rapid. Thirty open-hearth steel furnaces have been added within a year, more are projected. Present open-hearth capacity over one million tons per annum. Billet making capacity is being increased. Merchant iron mills are now busier than for months. Spring requirements are opening up. Building operations in cities will greatly exceed last year. Should enterprise receive any genuine encouragement, there will be a great increase in demand. Capital feels encouraged in the belief that circumstances are all favourable for a busy year. Car and locomotive builders are buying material, and many railroad companies are now asking for quotations on track material, machine shop requirements, &c. Manufacturers are anticipating a sudden demand before long for iron and material for numerous construction requirements.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

Steam coal in fair demand, but shipments are delayed by the stormy weather. House coal in moderate inquiry, with prices steady. Tin-plates without change. Manufactured iron and steel continue in good demand.

Coal: Best steam, 8s. 3d. to 8s. 6d.; seconds, 8s.; house coal, best, 10s. 3d. to 10s. 6d.; dock screenings, 5s.; colliery small, 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 47s. 6½d.; hematite warrants, 49s., f.o.b. Cumberland; Middlesbrough No. 3, 38s. 7d., prompt; Middlesbrough hematite, 46s. 4½d. Iron ore: Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel rails, heavy sections, £4 15s.; light ditto, £5 to £5 5s. f.o.b., Bessemer steel tin-plate bars, £4; Siemens tin-plate bars, best, £4 5s., all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel, coke, 9s. 1½d.; Siemens coke finish, 9s. 4½d.; ternes, per double box, 28 by 20 C, 21s. to 22s. Pitwood: 15s. 3d. to 15s. 6d. London Exchange Telegram:—Copper, £45; Straits tin, £60 13s. 9d. Freights firmer.

LAUNCHES AND TRIAL TRIPS.

The trial trip of the twin-screw passenger steamer Douro took place on Thursday last on the river Ribble. This vessel is fitted out for passenger service on the river Amazon, and is also fitted out with electric light and a powerful search-light. On a mean draught of 4ft. 6in., the speed obtained was eleven knots, the weather at the time being most unsuitable for the trial trip of a steamer having three decks and on such a shallow draught, it blowing a gale of wind all the time, but in spite of this the vessel behaved herself in every way satisfactory. She sailed for Para on the 9th inst., and is expected out there in about twenty days. Length between perpendiculars, 120ft.; beam, 26ft.; depth, 6ft. 6in. at middle.

On the 3rd inst. Messrs. Blackwood and Gordon, engineers and shipbuilders, launched from their building yard at Port Glasgow a handsome steel screw steamer for service in the cross-Channel trade between Ireland and England. This steamer has been built to the order of the City of Dublin Steam Packet Company, of Dublin, for their Dublin and Liverpool trade, and is built on similar lines to the fine steamers Louth and Wicklow, also constructed by Messrs. Blackwood and Gordon for the same owners, which vessels have become prime favourites with the travelling public, and also owners of cattle. On leaving the ways the vessel was named Carlow by Mrs. Bell, wife of Captain George R. Bell, R.N., marine superintendent of the company at Liverpool, and was afterwards taken into the builders' wet dock within their works to receive her machinery, which has also been constructed by the builders. Her dimensions are:—Length, 260ft.; breadth, 34ft.; depth, 16ft. 9in.; with long poop bridge, and forecastle and short wells filled in, and having a tonnage of 1250 tons gross register; engines of the triple-expansion type, with bronze propeller, and large boilers working up to fully 3000-horse power.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

27th February, 1896.

4361. Expanding Propeller, J. Hale, London.
4362. Sail, H. Davies, Cardiff.
4363. Well-feed Sieves, T Freeman and S. Spokes, Banbury.
4364. Brakes for Vehicles, C. Carrie, Dundee.
4365. Balloon Propeller, S. Vincent and D. T. Dyke, Salisbury.
4366. Shooting Games, O. C. Krause and F. A. Hüller, London.
4367. Soles for Boots, Shoes, &c., W. C. Rossiter, Devon.
4368. Locking Railway Carriage Doors, J. H. Exley, Bradford.
4369. Electric Cables, C. J. Wightman and A. Hudson, Bradford.
4370. Winding Yarn, J. Senior and L. C. Wallace, Bradford.
4371. Electrical Resistance, &c., A. D. Hughson, London.
4372. Belt Fasteners, I. Jackson, Manchester.
4373. Manufacture of Spirit Varnish, J. Bradley, Manchester.
4374. Bolt Belt Fasteners, I. Jackson, Manchester.
4375. Inflating Apparatus, G. D. MacDougald, J. Sturrock, and R. S. Baxter, Forfar.
4376. Set Squares, E. Bond, Glasgow.
4377. Pneumatic Tires, L. T. Darnault, London.
4378. A New Toy Camera, H. C. Braun, London.
4379. Swings, J. W. Phipps, J. F. Bullock, and J. Thompson, London.
4380. Photographic Shutters, R. J. S. Simpson, London.
4381. The Leg of Mutton Holder, R. W. Woodcock, Suffolk.
4382. Sunshades for Seats and Chairs, F. J. Millard, London.
4383. Nozzles of Pipes, H. A. Murphy, London.
4384. Bows, Neckties, &c., T. W. Perera and J. Leigh, Manchester.
4385. Advertising Tablets, &c., E. F. Lawrence, London.
4386. Travelling Wardrobes, C. M. A. Cuddon, London.
4387. Corks for Bottles, A. J. Colbert, London.
4388. Securing Condenser Tubes, J. R. Mitchell, Glasgow.
4389. A New Cover for Cycles, L. F. Arbuthnot, London.
4390. Attaching Handles to Broomheads, A. Shackley, London.
4391. Indicating the Names of Railway Stations, A. Todd, London.
4392. Steam Boiler Furnaces, J. Apsey and F. B. Hill, London.
4393. Electric Incandescent Lamps, G. Bamberg, London.
4394. Incandescent Gas Lamps, G. Bamberg, London.
4395. Manufacture of Rugs and Carpets, G. Hornig, London.
4396. Cycle Wheels, J. H. Smith, London.
4397. Means for Steering Cycles, A. W. McL. Keen, London.
4398. Mounting and Carrying of Maps, L. Bury, London.
4399. Sign Posts, A. O. Haslewood, London.
4400. Bearings for Velocipedes, J. Lofts, London.
4401. Funnels, A. O. Haselwood, London.
4402. Consuming Acetylene Gas, W. B. Kirkwood, London.
4403. A New Rest or Support for Cycles, M. Rowley, London.
4404. Switches, B. M. Drake and J. M. Gorham, London.
4405. A New Game with Cards, R. Staniland, London.
4406. Electrical Storage Batteries, E. A. McLachlan, London.
4407. Concentration of Acids, J. E. Campbell and J. Keating, Manchester.
4408. Weighing Granular Material, W. Evans, Manchester.
4409. Golf Tees, W. I. Hadden, London.
4410. Metal Loops for Leather Straps, E. T. Keeler, London.
4411. Manufacture of Rollers, &c., F. W. Oliver, London.
4412. Connections for Cranks, &c., M. D. Rucker, London.
4413. Variable Speed Gears, H. H. Griffin, London.
4414. Boats, J. H. Hutchings, London.
4415. Brewing, E. Lofts and G. H. R. Dabbs, London.
4416. Skirt Band and Belt Fasteners, W. A. Thornton, London.
4417. Applying Stay Wires to Fences, E. F. Groom, London.
4418. Evaporating Apparatus, H. H. Lake.—(*W. F. Jobbins and J. van Ruymbeke, United States.*)
4419. Making Hydrogen Gas, J. C. Hanauer, London.
4420. Furnaces, &c., T. H. Lucas and H. B. Martin, London.
4421. Incandescent Gas Mantle, J. Anderson.—(*W. Anderson, Germany.*)
4422. Zinc, The Exploring and Gold Mining Association. - (*S. H. Emmens, United States.*
4423. Cycles, J. Truffault, London.
4424. Fire Escapes, A. Paisley, London.
4425. Calculating Machines, E. Runge, London.
4426. Transmission of Force, S. Hartmann and E. Falke, London.
4427. Armatures, H. F. Parshall and The British Thomson-Houston, London.
4428. Burglar, Police, or Fire Alarm, A. Wilson, London.
4429. Cleaning the Wheels of Cycles, A. and R. Wilson, London.
4430. Machine Guns, W. Cordts, London.
4431. Suspension Lamps, O. Helfft, London.
4432. Electrical Resistances, W. J. Davy, London.
4433. Liquors, H. Dräger and R. Thiel, London.
4434. Moulds for Secondary Battery Plates, F. King, London.
4435. Knitting Machines, J. White and T. G. L. Miller, London.
4436. Looms, A. Morrison and J. Lees, Knock, County Down.
4437. Horseshoes, W. B. Bromley, London.

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4438. Bronzing Machines, O. Jäger, London.
4439. Propulsion of Autocars, &c., H. Noar, Cheshire.
4440. Cycles, T. Horton, near Redditch.
4441. Pulleys, J. B. Mackie and H. R. Sutton, Reading.
4442. Making Metal Tubing, J. H. Ball, Nottingham.
4443. A New Spile or Vent Peg for Casks, T. Hasell, Bristol.
4444. Propelling Boats, H. J. Watkins, Birmingham.
4445. Alarm Clocks, C. Rigby, Keighley.
4446. Shoes for Cycling, R. Barratt, Nottingham.
4447. Textile Spinning Mills, J. Beggs, Glasgow.
4448. Cycle Handle to Contain a Watch, E. W. Paul, Surrey.
4449. Foul Effluents, J. W. Slater and J. Parkinson, Manchester.
4450. Rulers, A. Wilkinson and J. F. Abraham, Bradford.
4451. Distributing Fluids, W. J. Orr and S. Walmsley, Manchester.
4452. Driving Gear for Cycles, W. Rhodes, jun., Manchester.
4453. Cycles, Ward and Whitham and C. Whitham, Manchester.
4454. Fittings for Waist Belts, A. Lovekin, Birmingham.
4455. Boots, H. O. Tilley and C. Jordan, Leicester.
4456. Sock or Inner Sole for Boots, E. Lightowler, Southport.
4457. Rolling Sheep Skins, E. Davies and R. A. Hall, Nottingham.
4458. Beds, T. Morton, Glasgow.
4459. Taking Down Bedsteads, J. A. Crane, Handsworth.
4460. Lamps, J. W. Lea and J. H. Perrins, Birmingham.
4461. Wings of Tower and other Bolts, F. Garland, Barnstaple.
4462. Postal Boxes, J. A. Gransden, Southampton.
4463. Noiseless Action Bracket, W. J. Clarke, Great Yarmouth.
4464. Brad for Glazing Glass, G. W. Kerwood, Southsea.
4465. Attaching Warpers' Beam Flanges, J. Mills, Manchester.
4466. Lamp Extinguisher, J. Krajka, Berlin.
4467. Safety Oil Lamp Extinguisher, H. V. Manger, Richmond.
4468. Game in a Tank of Water, A. A. Mitcherd, Dyffryn Station.
4469. Lifting Growing Turnips, A. Watt, Glasgow.
4470. Saturators, J. A. de Gruchy, Glasgow.
4471. Manufacture of Acetylene Gas, J. C. Hall, H. C. A. Dance, and A. R. Hall, Liverpool.
4472. Wearing Apparel for Cycling, J. Tenenbaum, Liverpool.
4473. Sieve Fittings for Teapots, &c., W. B. Smith, Glasgow.
4474. Fans for Ventilation, A. W. Metcalfe and J. B. Morrison, Belfast.
4475. Buckles for Harness, &c., T. E. Williams, London.
4476. Sizing or Slashing Machines, J. Duckworth, London.
4477. Machinery for Working Stone, F. Trier, London.
4478. Means for Lighting Velocipedes, W. Tice, London.
4479. Puzzle, L. Evans, London.
4480. Slide Valves of Steam Engines, L. Parker, London.
4481. Tooth-brush, E. E. B. Boehmer, London.
4482. Wheel-guard for Velocipedes, E. E. B. Boehmer, London.
4483. Absorbent Fabrics, A. Brooks and S. East, London.
4484. Curling Comb, F. G. Kraus, London.
4485. Cushions for Ships, &c., E. W. Frankenberg, London.
4486. Liquid - combustible Burner, G. Ditmar, London.
4487. Securing Hats in Boxes, &c., M. Mädler, London.
4488. Refrigerator, J. G. Davies, London.
4489. Obtaining Alkaline Salts, &c., G. Craig, Glasgow.
4490. Compensated Hot-strip Ammeter, H. B. White, London.
4491. Castors, W. G. Irish, London.
4492. Internal Combustion Engines, F. L. Martineau, London.
4493. Mandrel for Steel and Iron Tubes, C. E. Smith, London.
4494. Appliance for Cutting Thread, E. D. Swinton, London.
4495. Washing Clothes, G. W. B. Crees, R. Ord, and W. H. Brown, London.
4496. Automatic Window Fastening, H. C. Evans, London.
4497. Increasing Pliability of Paper, O. Tietze, London.
4498. Vapour Burner for Oil-stoves, J. T. Armstrong, London.
4499. Books, C. Phillips, London.
4500. Frying-pans, C. Cox, London.
4501. Writing Slates, T. Wignall, Liverpool.
4502. Ladders for Nautical Purposes, D. N. Sinclair, Liverpool.
4503. Collapsible Boats or Baths, M. T. Reade, Liverpool.
4504. Disengaging Gear for Boats, L. T. Gaskill, Liverpool.
4505. Egg-testing Device, T. Lawley, London.
4506. Fire Alarm and Extinguisher, A. B. P. Mowat, London.
4507. Head Coverings, L. Silbertson, London.
4508. Comb, L. Auerbach, London.
4509. Explosives, W. Greaves and E. M. Hann, London.
4510. Putting on Pulley Belts, R. B. Gamble, London.
4511. Lubricating Cans, C. E. Peel and E. Hughes, London.
4512. Knife Cleaner, W. A. Landau.—(*H. Rieger, Germany.*)
4513. Cultivators, J. E. Ransome and F. W. Garrard, London.
4514. Lifting Apparatus for Harrows, R. H. Fowler and T. Benstead, London.
4515. Firing Rockets, E. Beadle and R. White, London.
4516. Gulleys, J. A. Noel, London.
4517. Controlling Stock in Shops, &c., E. Küster, London.
4518. Brushes, W. Candland, London.
4519. Umbrellas and Sunshades, N. and C. Feldman, London.
4520. Packing for Joints, H. C. Platts and T. Lowther, London.
4521. Cylinder Jackets of Engines, W. Naylor, London.
4522. Railway Signalling Apparatus, J. G. Weir, London.
4523. Shields for Water Gauge Tubes, A. Spencer, London.
4524. Horseshoe, W. Chiswell, London.
4525. Bicycles, R. Grilli, London.

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4526. Cutting Potatoes and Bread, J. Shackleton, Burnley.
4527. Glass Cylinders, E. J. Shaw, Walsall.
4528. Gulley Traps, J. Staincliffe, Bradford.
4529. Method of Filling Bottles, H. O. Milnes, Bradford.
4530. Filling Substances in Packets, H. O. Milnes, Bradford.
4531. Horseshoes, W. Goudge, London.
4532. Sleeve Grip, G. Sherlock, Dartford.
4533. Swivel Shuttles for Looms, J. D. Whyte and Whyte's Patents, Bradford.
4534. Barring Engines, G. E. Coupe, Stoke-on-Trent.
4535. Heating Water for Boilers, J. Murrie, Glasgow.
4536. Tobacco Pipe Covers, W. Pearce, Birmingham.
4537. Curtain Poles, W. F. Snelling, Norwich.
4538. Oxidising Aniline Blacks, E. Weldon, Nottingham.
4539. Cycle Handle-bars, W. McLean, Glasgow.
4540. Metallic Bedsteads, J. W. Clift, Wellington.
4541. Fixing Metal Hoops to Banjos, A. Tilley, London.
4542. Carriage Shaft Points, J. W. Clift, Wellington.
4543. Drawing Straight, &c., Lines, F. R. Slack, Derby.
4544. Digestine, H. Archer, London.
4545. Polo Scarf, W. A. Tilney, York.
4546. Teaching Arithmetic, W. and M. A. Adam, Glasgow.
4547. Teaching Arithmetic, W. and M. A. Adam, Glasgow.
4548. Production of Oxygen Gas, F. J. Stedman, London.
4549. Circular Knitting Machines, W. H. Payne, London.
4550. Lubricators, W. Chattaway, London.
4551. Steam Generators, O. F. Vollhard, Manchester.
4552. Buckets, M. A. Boardman, Bradford.
4553. Securing Door-mats and Rugs, F. Hulme, Manchester.
4554. Destructors, W. F. Mason, Manchester.
4555. Mud-guards of Bicycles, P. Orlovsky, Birmingham.
4556. Protecting Basket Bottoms, W. P. Ellmore Leicester.
4557. Mechanical Stokers, J. Johnson, Liverpool.
4558. Shaft Bearings, A. M. Robinson, Liverpool.
4559. Velocipedes, L. C. Papenfus, London.
4560. Strainers for Paper Pulp, D. N. Bertram, Glasgow.
4561. Cutting and Sawing Stone, &c., N. Black, Glasgow.
4562. Incandescent Gas Burners, H. Emmett, Dukinfield.
4563. Gas and Air Engines, F. W. Turner, Bury St. Edmunds.
4564. Setter-out for Morticing Machines, W. Nicholson, Newcastle-on-Tyne.
4565. Duplex Oil and Gas Engine, H. A. Thorne, Torquay.
4566. Brass Fire-tongs, H. E. and E. O. Newey, Dudley.
4567. Tires for Bicycle Wheels, H. Edge, Birmingham.
4568. Pipe Hooks, S. Turner and A. Neale, Birmingham.
4569. Draw-benches, G. Platt, Birmingham.
4570. Pneumatic Tires for Wheels, A. J. Johnson, Birmingham.
4571. Safety Targets, E. J. B. Scratton, Glasgow.
4572. Fitting Lengths of Piping, J. B. Blair, Glasgow.
4573. Drill Plough Boards, R. H. N. Sellar, Glasgow.
4574. Soldering Wire on Pipes, R. D. Smillie and J. R. Bird, Glasgow.
4575. Water-closet Seats, F. Sharp and J. E. Leigh, Hurst.
4576. Cycles, F. E. Macmahon and A. J. Postans, London.
4577. Saddles for Cycles, S. Pattison, London.
4578. An Automatic Watch Holder, W. T. Bell, London.
4579. Spittoons for Railway Carriages, H. Walker, Blackburn.
4580. Circular Box Looms, B. Brown, London.
4581. Parcel Carrier for Cycles, &c., J. S. Sayers, London.
4582. Double-lift Jacquards for Looms, G. H. Briggs, London.
4583. Fishing Reels, G. Harrison and D. L. Pexton, London.
4584. Liquids, S. Napper and C. J. Parr, London.
4585. Axle Boxes, R. Kerr and J. N. Patterson, Liverpool.
4586. Spinning Wool, W. Benson and F. King, Manchester.
4587. Cleaning Tobacco Pipes, I. Parkinson, Liverpool.
4588. Cooking Appliance, S. von Ramin, Manchester
4589. Umbrellas and Parasols, A. Berndt, London.
4590. Leaks in Ships, J. Y. Johnson.—(*La Société Anonyme des Forges and Chantiers de la Mediterranée, France.*)
4591. Ash Pans and Fire Guards, W. Brandon, London.
4592. Ventilating Hats, C. Belcher and Messrs. Carlton and Co., London.
4593. Expanding Brace, W. Hooper and M. Martin, London.
4594. Boxes, J. Richmond, W. Whiting, N. P. Hibbit, and C. F. Bowden, London.
4595. Heat Transferring Apparatus, P. Pfleiderer, London.
4596. Swimming Dress, E. W. Frankenberg.—(*E. Frankenberg, Germany.*)
4597. Flushing Apparatus, S. S. Hellyer, London.
4598. Dry Distillation of Wood, A. Schmidt, London.
4599. Fastening Device for Wearing Apparel, E. A. Lumley, London.
4600. Save All for Candles, W. Henley, London.
4601. Refrigerators, L. Bahr, London.
4602. Facing Tiles, &c., J. Holroyd and R. Bond, London.
4603. Metallic Plates, E. G. Brewer.—(*The Société Anonyme des Plaques Lithographiques, Belgium.*)
4604. Apparatus for Evaporating Fluids, E. Theisen, London.
4605. Construction of Wheels, &c., J. R. Harper, London.
4606. Water Pipes, P. Funck and L. Schmidt, London.
4607. Appliance for Testing Milk, &c., C. Oliver, London.
4608. Reaping Machines, W. Jäger and O. Borchart, London.
4609. Tires for the Wheels of Cycles, R. Corsham, London.
4610. Apparatus for Grinding Ores, A. S. F. Robinson, London.
4611. Lowering and Raising Blinds, C. Wenck, London.
4612. Coal Screen for Coal Cellars, B. E. Ferrier, Glasgow.
4613. Boxes for Holding Pile Fabrics, J. Reixach, London.
4614. Rammer for Heavy Guns, J. Vavasseur, London.
4615. Repairing Pneumatic Tires, J. Adair, London.
4616. Tobacco Pipe, G. Goandclément, London.
4617. Electric Railways, C. Coerper, London.
4618. Petroleum and Other Motors, P. Mallet, London.
4619. Conductors of Heat, H. B. Tarry, London.
4620. Apparatus for Displaying Pictures, L. D. E. Gaillard, London.
4621. Viewing Transparent Pictures, J. Joly, London.
4622. Heating Apparatus, W. S. Wallace, Liverpool.
4623. Book Marker, F. J. Measures and F. Adams, London.
4624. Reproducing Sound Effects, M. Hoeft, London.
4625. Sowing Machines, E. Croll, London.

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4626. Preserving Dead Bodies from Decaying, D. Deiches, London.
4627. Construction of Joints, C. Phillips, Birmingham.
4628. Ratchet Braces, E. Walmsley and M. Taylor, Halifax.
4629. Advertising, J. Thornton and F. G. Thomas, Manchester.
4630. Show Card, J. Ferguson and J. H. Silburn, Newcastle-on-Tyne.
4631. Furniture, J. H. Wharton, Liverpool.
4632. Motors, F. H. Royce and E. A. Claremont, Manchester.
4633. Combing Machines, J. and C. F. Crabtree, Bradford.
4634. Gas Engines, &c., W. H. Crow, Newcastle-on-Tyne.
4635. Wire, J. C. Boswell, Norwich.
4636. Flapelle Boxes made of Cardboard, J. E. Thornton, Altrincham.
4637. Cardboard Boxes, J. E. Thornton, Altrincham.
4638. The Save All Fish Frier, J. Goldthorpe, Hull.
4639. Cycle Rest, N. Cockshutt, Preston.

4640. Joints of Pipes, G. F. L. Meakin, Kingston-on-Thames.
4641. Valves, W. D. Wight, M. B. Wild, and T. Rydea, Manchester.
4642. Gas Valve and Pilot Light, W. McCaig, Glasgow.
4643. Loading Rifles, &c., R. Prado and C. Nichols, London.
4644. Bogie Bolsters, J. A. Adey, Sheffield.
4645. Tire Bars, F. R. Booth and W. Carrier, Sheffield.
4646. Driving Gear of Cycles, &c., W. C. Morton, London.
4647. Connecting Baths, Sinks, &c., H. Enoch, Cheltenham.
4648. Box, S. and H. M. Ryder, St. Alban's.
4649. Door Handles, W. Wright and F. J. C les, Plymouth.
4650. Dresses, W. H., R. H., and A. Popplestone, Bristol.
4651. Boilers, A. T. Chorley and W. M. Llewellin, Bristol.
4652. Match-boxes, W. J. Simmons, Bristol.
4653. Grinding Colour, J. Smith and A. Hulse, Longport.
4654. Steam Generators, J. W. Reed, Newcastle-on-Tyne.
4655. Machinery for Winding Yarns, H. Balfe, Manchester.
4656. Union Nuts and Spanners for same, J. Rowse, Derby.
4657. Mining Cages and Hoists, A. and J. Green, Manchester.
4658. Counters, J. S. Howden, Liverpool.
4659. Humidifying and Cooling Apparatus, H. Biedermann, Manchester.
4660. Valves for Pneumatic Tires, A. A. Woodward, Birmingham.
4661. Well-tube Bases or Supports, J. Graham, Glasgow.
4662. Casement Frames and Sashes, F. Stoddart, Glasgow.
4663. Panoramas, I. Greenbury, Glasgow.
4664. Retaining Napkins to the Neck, M. Coles, Glasgow.
4665. Fasteners for Gloves, &c., H. W. Mackenzie, Edinburgh.
4666. Sliding Setting Platforms, W. J. Smith, Southsea.
4667. Soldering Metals, F. F. Barnes and F. Campbell, London.
4668. Transparent Parchment Slips, J. S. W. Tomson, London.
4669. Axle-box, C. Olandt, London.
4670. Spiral Cutter Blades or Edges, H. Smith, Sheffield.
4671. Nails, A. E. Gorse, G. A. Probert, and J. H. Green, Birmingham.
4672. Machinery for Making Rag-pulling Teeth, H. Moss, London.
4673. Fitting for Kitchen Ranges, F. A. Driefürst, London.
4674. Gas Generator, S. S. Bromhead.—(*A. Niel, France.*)
4675. Gear for Overside Cranes, A. H. Mitchell, London.
4676. Making Secure Sash Fastenings, H. P. Miller, London.
4677. Paper, H. Erfurt, jun., and H. Erfurt, Barmen, Germany.
4678. Producing Ornamented Columns of Iron, L. Mannstaedt, Germany.
4679. Dovetailed Joints, D. E. Hunter, London.
4680. Flushing Appliances for Urinals, &c., T. Yorke and W. Pare, London.
4681. Controlling Temperature in Baking Ovens, P. Pfleiderer, London.
4682. Furnaces, H. Kellner and A. Pechl, London.
4683. Bottle Holder, W. Otto, London.
4684. Combination Tool, A. Arnold and K. E. Edge, London.
4685. Composition, W. T. Owen and T. Thatcher, London.
4686. Projecting Kinetoscope Pictures, R. W. Paul, London.
4687. Oars and Sculls, T. Myers, London.
4688. Bolts, H. Bourne, London.
4689. Umbrella Fixtures, H. D. Sabin, London.
4690. Guns, K. Rohr, London.
4691. Pants, I. Frisch, London.
4692. Tipping Buckets, W. T. Andrews, London.
4693. Machinery for Raising and Lowering Goods, C. I. Hall, London.
4694. Furnace Grates, W. P. Thompson.—(*O. Lindner, Belgium.*)
4695. Fire-places, M. Landmann, London.
4696. Marine Steering Gear, T. G. Stevens, Kent.
4697. Coin-freed Apparatus, T. Fryer, London.
4698. Shoes, J. Dawson, jun., and N. Dawson, London.
4699. Ink Bottles, W. M. Johnsen and J. Jögensen, London.
4700. Advertising, P. Sagne, London.
4701. Targets, J. Neuhold, London.
4702. Preventing Bending of Tubes, A. Kirschbaum, London.
4703. Shoes, G. C. Marks.—(*J. Cousins, jun., United States.*)
4704. Game, J. Crabtree and C. Thomas, London.
4705. Pianos, E. Edwards.—(*J. M. Friedrichs, Germany.*)
4706. Automatically Lighting Gas Jets, J. Hombergen, London.
4707. Traction Engines, R. H. Fowler and G. W. Scott, London.
4708. Compound Steam Engines, M. H. P. R. Sankey, London.
4709. Reducing Steam, S. M. Folk and D. S. Ellis, London.
4710. Railway Axle Lubricators, W. Silver, London.
4711. Preventing Refilling of Bottles, A. Guattari, London.
4712. Sustainers for the Wicks of Night-lights, J. C. and J. Field, Ld., and J. Bateman, London.
4713. Manufacture of Alkali Cellulose, C. F. Cross, London.
4714. Substitute for Yellow Phosphorus, M. Bals, London.
4715. Tube Expanders, A. F. Yarrow, London.
4716. Printing Code Symbols, W. Donisthorpe, London.
4717. Filters, C. J. Brown, London.
4718. Treatment of Skins, C. Marter and I. Levy, London.
4719. Pipe Stoppers, J. Jones, London.
4720. Screw Propellers, C. A. F. Meissner, London.
4721. Fur Collarettes, W. Kosky and A. Kosky, London.
4722. Lighting Fires, T. Charlton, London.
4723. Preventing Accumulation of Deposits, J. Demoulin, London.
4724. Boilers, H. F. Phillips, London.
4725. Filtering Apparatus, W. L. Wise.—(*Solvay et Cie., Belgium.*)
4726. Brake Apparatus, F. Platt, London.
4727. Inflating Pneumatic Tires, E. C. Peck, Old Charlton.
4728. Locking Device for Foot Brakes, A. Hardie, West Brighton.

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4729. Learning Bicycle Riding, F. Hutchins, London.
4730. Attachment of Tires to Wheels, H. Godsal, London.
4731. Folding Writing Desk, W. C. Haigh, Manchester.
4732. Horseshoes, R. Robinson, Southampton.
4733. New Power for Driving Vehicles, W. J. Howcroft, Lye, near Stourbridge.
4734. Speaking Tubes, C. Darrah, sen., and A. Y. Reynard, Manchester.
4735. Valve for Pumps, J. Corbett and V. J. Bain, Glasgow.
4736. Vapour-pressure Motors, J. Murrie, Glasgow.
4737. Needle Threaders, J. Darling and T. Clarke, Glasgow.
4738. Washer for Lids of Churns, &c., E. B. Raper, York.
4739. Railway Coupling, W. A. Green, Aberystwyth.
4740. Metal Mouth Protector for Muzzles, W. F. and A. Weightman, London.
4741. Flying Machine, S. Dalziel, London.
4742. Railway Trucks, E. Rykovskoff, London.
4743. Nitrites of Soda and Potash, L. G. Paul, London.
4744. Stoppers for Bottles, E. Scholes and W. Hancock, Manchester.
4745. Moderator Petroleum Lamps, C. L. Charlopin, Manchester.
4746. Combined Steam Engines, &c., W. Schmidt, Birmingham.
4747. Rotary Cutter Heads, S. J. Shimer, Manchester.
4748. Arc Lamp for Optical Lanterns, &c., A. J. Beaumont, York.
4749. Purses, G. Wilkins, Kent.
4750. Fire-extinguishing Apparatus, W. Miller, Glasgow.
4751. Holder for Ring Spindles, J. W. Nasmith, Manchester.
4752. Appliance for Feeding Calves, E. A. Elliott, London.
4753. Pneumatic Tires, W. G. Wrench, Glasgow.
4754. Pumps, T. Owen, Liverpool.
4755. Inflating Valve for Tires, A. Wainwright, Leeds.
4756. Grate Bars for Boilers, B. A. Thomas, Staffordshire.
4757. Explosive Engine, T. Duffy and T. W. Newey, Birmingham.
4758. Holder, F. H. and H. Barwell, H. P. Kimberley, and J. F. Smith, Birmingham.
4759. Means for Transmitting Motion, G. Percival, Cork.
4760. Speech Instrument, E. Mulliner, Southport.
4761. Device for Fixing Lamps, F. H. Coulson, London.
4762. Hatching Chickens by Heat, R. Clark, Durham.
4763. Fostermother for Rearing Chickens, R. Clark, Durham.
4764. Driving Mechanism for Toys, C. E. Gyngell, London.
4765. Potato Diggers, J. Colquhoun, Glasgow.
4766. Compound Gas Engine, C. H. T. Alston, Glasgow.
4767. Hooks for Suspending Pictures, E. E. Cohen, London.
4768. Apparatus for Sorting Coinage, H. Broadbent, London.
4769. Pistols, H. S. Atkinson, Birmingham.
4770. Curtain Holder, T. Whittingham, Manchester.
4771. Driving Gear of Bicycles, J. E. Edwards, London.
4772. Pneumatic Tires for Cycles, W. T. Robbins, London.
4773. Electric Traction, J. Claret and O. Vuilleumier, London.
4774. Electrical Circuits, C. B. Callow and H. Bevis, London.
4775. Portable Railway Appliances, R. H. Courtenay, London.
4776. Furnaces for Heating Metal, W. H. Bailey, London.
4777. Cotton Seed Delinters, F. W. Cross, London.
4778. Method of Obtaining Electricity, B. F. da Motta, London.
4779. Double Flange Pan, W. R. Burridge, Portsmouth.
4780. Telescopic Vapour Flue, W. R. Burridge, Portsmouth.
4781. Recording Signals upon Locomotives, J. A. Meunier and Count M. G. de Bengy-Puyvallée, London.
4782. Cardboard Box Making Machine, A. Godfrey, London.
4783. Trousers, J. Meiklejohn and H. O. Tiarks, London.
4784. Mechanical Fog Signal, A. M. Cowley, Hackbridge, Surrey.
4785. Stirring Apparatus, A. Berger—*née* Andreae—London.
4786. Bottle Washing Machines, M. Donally, London.
4787. Gaiters or Leggings, O. Seefels, London.
4788. Converting Carbon into Electrical Energy, W. W. Jacques, London.
4789. Apparatus for Churning Milk, &c., J. Taylor, London.
4790. Lamps, W. Weickart, London.
4791. Harness, F. W. Billings, London.
4792. Heated Drying Cylinders, G. and R. Jagenburg, London.
4793. Card Holder, C. A. Dines, London.
4794. Holders for Conveying Ammunition, L. Silverman, London.
4795. Fire-boxes for Steam Boilers, E. Gentilini, London.
4796. Pencil Case and Sharpener, E. E. Monroe, London.
4797. Securing Hats, E. R. Standfield and W. Brew, London.
4798. Handle-bar Posts for Cycles, H. H. Lake.—(*J. P. Lovell Arms Company, United States.*)
4799. Opening and Closing Windows, J. Taylor, Manchester.
4800. Hair Brushes, H. H. Lake.—(*Florence Manufacturing Company, United States.*)
4801. Coupling Devices for Bicycles, W. W. Tucker, London.
4802. Spring Roller Bearings for Shaft Hangers, J. W. Hyatt, London.
4803. Lamps or Lanterns for Use on Vehicles, &c., B. E. P. Creighton, G. Story, and S. M. Barber, London.
4804. Thrust Bearings, F. Mossberg, London.
4805. Method of Magnetic Separation, J. P. Wetherill, London.
4806. Magnetic Separators, J. P. Wetherill, London.
4807. Electric Generators, J. Devonshire.—(*E. Thomson, United States.*)
4808. Safety Appliances for Brakes, J. Devonshire.—(*W. B. Potter, United States.*)
4809. Oil Port Lids of Axle-boxes, C. Erdbrink, London.
4810 Golf Clubs, R. Hunter, London.
4811. Means for Securing Jewellery, P. Wolfers, London.
4812. Withdrawing Beer from Casks, A. G. Hopkins, London.
4813. Type-writers, A. Winrow and F. A. Sanders, London.
4814. Safes, J. E. A. Greatorex, London.
4815. Estimating Distances, H. Trietsch and H. Berghaus, London.
4816. Stoppering Devices, J. D. Midson and F. W. Schroeder, London.
4817. Mechanism for Electric Arc Lamps, E. Lavens, London.
4818. Perforated Plates for Strainers, N. Heid, London.
4819. Ladies' Boas and Fur Collars, M. Rabe, London.
4820. Malting Grain, F. W. Golby.—(*J. Jungbluth, Germany.*)
4821. Fare Indicator, W. P. Thompson.—(*C. F. Kindermann and Co., Germany.*)
4822. Sliding Window Sashes, S. B. Cottrell, Liverpool.
4823. Vaporiser, M. Horwitz, Liverpool.
4824. Car Trucks, E. Peckham, London.
4825. Coffins, H. M. Handshy and S. L. Hain, London.
4826. Heating Water, J. S. Coe, London.
4827. Cartridge, P. A. Newton.—(*G. B. Reetz and W. M. Cooper, Australia.*)
4828. Cooling Water, P. A. Newton.—(*C. C. Worthington, United States.*)
4829. Advertising Bottled Goods, T. Heffernan, London.
4830. Cigar Moistening Device, F. J. Measures and F. Adams, London.
4831. Piston-rods, A. J. Boult.—(*R. J. Muller, United States.*)
4832. Straightening Contracted Joints, K. R. Schramm, London.
4833. Cutting Files, J. Blakey and W. Backhouse, London.
4834. Cycle Frames, Fitz-Hardinge R. B. Liebenrood, London.
4835. Shells, E. M. Johnson, London.
4836. Button, A. J. Boult.—(*O. W. Ketchum and E. A. Griffith, United States.*)
4837. Circuit Closers for Electric Bells, J. Newton, London.
4838. Preventing Refilling of Bottles, A. Guattari, London.
4839. Mechanical Milking Machine, C. B. Stróyberg, London.
4840. Index Cutting and Printing Machine, W. Corfe, Liverpool.
4841. Exhibiting Pictures, J. Y. Johnson.—(*W. Latham, United States.*)
4842. Valve Sprinkler, W. S. Stallybrass and W. Lewis, London.
4843. Thermoscopes, A. P. Harland, F. M. Wright, and D. A. Usina, London.
4844. Lamps, T. E. Adams, London.
4845. Lamps, T. E. Adams, London.
4846. Steam and Hot-water Boilers, J. Plenty, London.
4847. Boilers, E. Montier, London.
4848. Starting Gear of Tramcars, J. W. Howe and H. J. Jordan, London.

4th March, 1896.

4849. Brakes, O. H. Rieths, London.
4850. Fenders, C. E. Elfström, London.
4851. Bottles, E. Eberle, London.
4852. Hangers for Sad Iron, &c., G. H. Wagner, London.
4853. Valves, H. W. Carr, London.
4854. Skimmers, R. S. Schmidt, London.
4855. Tool, C. S. Vidor, London.
4856. Signal System, H. Schneider, London.
4857. Axle, H. Noelte, London.
4858. Sweetmeat Figures, R. Berger, London.
4859. Adjustment of Cycle Chains, R. J. Alpe and J. Wilkinson, Birmingham.
4860. Short Action Horse Rake, H. Cook, Gloucestershire.
4861. Mandril, F. Thiemicke, Leeds.
4862. Portable Cooking Apparatus, F. A. Wallis, Basingstoke.
4863. Compasses, A. W. Bevis, Birmingham.
4864. Electric Motors for Tramway Cars, F. M. Lewis, Leeds.
4865. Carding of Studs, &c., T. Morton, Birmingham.
4866. Driving and Spinning Frames, F. Prestwich, Manchester.
4867. Preventing Breaking of Busks, W. T. Pretty, Ipswich.
4868. Valves, W. Cameron and J. Cochrane, Barrhead, near Glasgow.
4869. Sleeve and other Links, G. F. Spittle, Birmingham.
4870. Forming Electrical Connection, A. Denny and J. Kempton, Dumbarton.
4871. Securing Tires to Wheels, S. Austin and A. Farnhill, Manchester.
4872. Buildings, G. Nicholls, Leicester.
4873. Valve, F. Farnworth, Ramsbottom, near Manchester.
4874. Machines for Treating Flax, A. Spiegelberg, Glasgow.
4875. Measuring and Self-registering Taps, J. Mowat, Glasgow.
4876. Chairs, A. Plant, Glasgow.
4877. Guiding Textile Fabrics, J., H. C., and W. Dalglish, Glasgow.
4878. Lace Tags, J. Smith, Manchester.
4879. Spinning Tackle for Fishing, S. Allcock.—(*A. Hintze, Russia.*)
4880. Pug Mills, T. C. Fawcett and T. C. Fawcett, Ld., Halifax.
4881. Corset Stiffeners, A. Bürger, Barmen, Germany.
4882. Holding Labels and the like, A. G. Hebblethwaite, Halifax.
4883. Reversing Motion, A. Roberts and H. Roberts, Southport.
4884. Two-bladed Bread Cutter, H. Brown, Bradford.
4885. Three-bladed Bread Cutter, H. Brown, Bradford.
4886. Rotary Kick-ups or Tipplers, J. J. Prest, Newcastle-on-Tyne.
4887. Gloves, H. Harris, Norwich.
4888. Oven Door Light, C. Skill and P. J. Skill, Nottingham.
4889. Wearing Parts of Ploughs, W. S. Richmond, Suffolk.
4890. Fixing Mordants on Fibres, A. Ashworth, Bury.
4891. Removing Wrappers, R. J. Minns and W. H. Jones, Liverpool.
4892. Built Columns, Beams, and Girders, J. A. Main, Glasgow.
4893. Pneumatic Tires, P. MacLellan and J. W. O. Walker, Glasgow.
4894. Discharge of Water from Flushing Tank, J. Jobbins, Somerset.
4895. Castors, A. E. Inman, Glasgow.
4896. Ball Castor, J. McMurray and J. C. McGavin, Kilmarnock.
4897. Chest Protector for Cyclists, S. D. Sykes, Leeds.
4898. Door Fastenings, J. Astbury and H. Vincent, Birmingham.
4899. Alloys, J. C. Bull, London.
4900. Paper Boxes, W. Love, London.
4901. Covers for Books, L. H. Bliss, London.

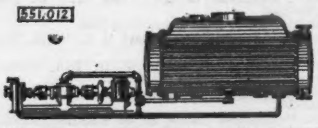
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

551,012. Method of Cleaning Surface Condensers, *E. Tweedy and T. Saunders, Danbury, Conn.—Filed March 26th*, 1894.

Claim.—The method of removing the deposit from the condensing surfaces in condensers without dismantling the same, which consists in introducing into the condenser which is to be cleaned, a liquid which is a solvent of one or more of the oleaginous, pitchy, or gummy binding components of said deposit, and in violently agitating said liquid by forcing a gas into the liquid in the condenser between the surfaces to be cleaned, thereby forming a partial solution and a partial mixture of the ingredients of said deposit with said liquid, and causing said solution and mixture to abrade said deposit, and in withdrawing the resulting fluid from the condenser without removing the surfaces cleaned, substantially as specified.

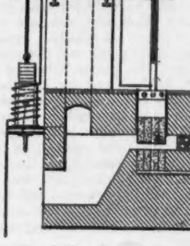
551,012



551,014. Electric Smelting Furnace, *J. A. Vincent, Philadelphia, Pa.—Filed July 18th*, 1895.

Claim.—(1) In an electric furnace, the combination of a substantially horizontal channel way for supporting the material to be smelted, two electrodes of different polarity arranged transversely to said channel way, a positively acting feeding device arranged to force the material to be treated into the channel way at one end and between the electrodes, and a discharging pit arranged at the opposite end of the channel way and opening into it. (2) In an electric smelting furnace, the combination of a substantially horizontal channel way for supporting the material to be smelted, two electrodes arranged in said channel way and constituting a part of the walls thereof, means to feed the electrodes relatively one to the other to compensate for consumption thereof and maintain them as boundary walls of the channel way, a positively acting feeding device, consisting of a screw for feeding the materials to be smelted through the channel way and between the electrodes, a hopper for containing said materials and delivering them to the feeding screw, a discharge opening from the channel way, a chimney flue to carry off the products of combustion and vaporisation, and automatic electrically-controlled devices for regulating the means for feeding the electrodes relatively one to the other.

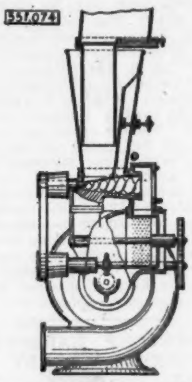
551,014



551,074. Feeding Appliance for Coal-dust, *F. de Camp, Berlin, Germany.—Filed August 27th*, 1895.

Claim.—(1) A perforated rotary distributing drum in combination with means of supplying coal-dust to its periphery, and a ventilating device operating in its interior space to mix the said dust with air and transfer it to a combustion chamber, substantially as set forth. (2) In combination with a hopper, the hinged plate *n* arranged on one side of its interior, the adjusting screw *o* acting on the said plate to control the discharge, and a conical screw conveyor having its smaller end arranged under the outlet of the said hopper, substantially as set forth.

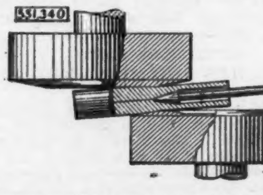
551,074



551,340. Mechanism for Making Tubes from Metallic Ingots, *R. C. Stiefel, Ellwood, Pa.—Filed October 10th*, 1895.

Claim.—(1) The combination of two parallel discs revolving in the same direction and overlapping each other, one of said discs being bevelled at its outer edge, which bevelled surface is opposed to a portion of the plane surface of the outer disc; the outer diameter of this plane surface and the inner diameter of the bevelled surface opposed to it being substantially the same and the edges formed by both diameters intersecting the same transverse plane through the pass between the discs; the angles of the opposing surfaces converging to this plane which is at the narrowest part of the pass, with a conical mandrel lying in the axis of the pass at its exit side, substantially as set forth. (2) The combination of two parallel discs revolving in the same direction, bevelled at the edges of their adjacent faces and overlapping each other so that the bevelled portion of one disc lies opposite a flat portion of the outer disc, the edges formed by the smaller diameters of the bevelled portions of the discs intersecting the same transverse plane through the pass between the disc whereby the sides of the pass first converge to this plane and then diverge beyond it, with a piercing mandrel located between the diverging sides of the pass and exactly in axial line of the pass, substantially as hereinbefore set forth.

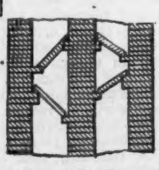
551,340



551,390. Cement Kiln, *F. M. Lande, New York, N.Y.—Filed February 16th*, 1895.

Claim.—(1) A kiln for the purpose described having one or more chambers, each chamber having a series of removable, adjustable shelves, said shelves extending from side to side of the chamber and provided with supporting lugs and openings formed by the lugs, as and for the purpose set forth. (2) A kiln having a series of shelves inclined to each other, said shelves having lugs and openings at their lower edges as and for the purpose set forth. (3) A kiln the inner walls of which have supported ledges for deflecting shelves, the upper side of the alternate ledges being removable to give said shelves an adjustable inclination, as and for the purpose set forth.

551,390



NAVAL ARCHITECTURE.—A FEW PRINCIPLES POPULARLY EXPLAINED.

No. IV.—STABILITY.

FROM the preceding papers it will have become evident that the vertical position of the centre of gravity of a ship and her cargo are of the greatest importance in the determination of her stability. It will also be easily understood that the "trim" of a vessel, or, in other words, her relative depth of immersion at the bow and stern, are influenced by the longitudinal position of the same point.

Let us now consider how the position of the centre of gravity is determined:—First, vertically; and second, longitudinally.

To ascertain the vertical distance of the centre of gravity of a ship, either from the underside of her keel or some other fixed position, we may proceed either by calculation or by experiment. The former method is the only possible one when preparing a design upon which a ship is to be built; the latter is possible only after the vessel is built and afloat. The method by calculation is open to the chances of error in regard to estimates made of the weights of the thousand-and-one items which constitute her hull and equipment, to say nothing of the constituents of her lading. But the method by experiment gives a result which is absolutely exact. Nevertheless, the method by calculation must be resorted to in designing a ship of war, especially an armour-clad, for in such vessels it is not possible afterwards to modify the position of the centre of gravity by the stowage of cargo, as in a mercantile vessel, seeing that the cargo of a ship of war consists of guns, armour plates, coals, stores, &c., the positions of which are fixed in the original design. A mercantile vessel may be unstable without her cargo, and require ballast to keep her upright when her cargo is discharged, but a modern ship of war must carry as much offensive and defensive material as possible on her displacement, and therefore has no margin for ballast. She must, in fact, be sufficiently stable as designed, and not have an excess of stability so as to cause her to roll seriously. Hence the position of her centre of gravity must be known before she is commenced to be built, and the position must be known to be a suitable one. The centre of gravity of a ship of war is therefore determined by calculation in preparing her design, and its position is afterwards verified by experiment when she is ready for sea. So carefully are these calculations made at the Admiralty office, that errors of any magnitude are rarely discovered when the vessel is built.

To ascertain by calculation the vertical position of the centre of gravity, it is usual to make the underside of keel the axis about which the moments of leverage of the materials composing the hull and equipment are calculated. It is impossible within the limits of these elementary articles to explain in detail how the weights of the several parts of the vessel are determined, or how the centre of gravity of each item is found. The way to go about each element will readily suggest itself to the average arithmetician. Suffice it to say, that by increasing the number of items the size of each is thereby diminished, and with the multitude of small calculations, it is found that small mistakes in one direction are balanced by other small mistakes in an opposite direction, and the total usually comes very near the truth.

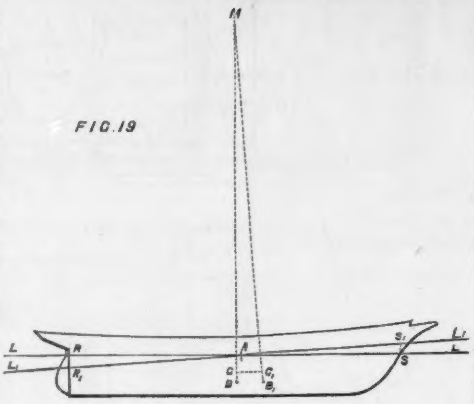
The general course of procedure is to multiply the calculated weight of each item of hull and equipment by the distance of its measured centre of gravity above the underside of keel; the product in each case gives the moment of leverage of the said item about the underside of keel as a fulcrum. The sum of the products divided by the sum of the weights gives us the height of the centre of gravity of the entire vessel above the underside of the keel.

For the longitudinal position of the centre of gravity measurements are usually taken from the plane of the midship section, or at the middle of the vessel's length. All items on the fore side of the midship section give forward moments of leverage, and all on the aft side of the midship section give after moments of leverage. The course of procedure is to multiply the weight of each element on the fore side of the midship section by the measured longitudinal distance of its centre of gravity from the midship section; and each element on the after side of the midship section by the longitudinal distance of its centre of gravity from the midship section. If the sums of these two sets of products are equal it shows that the centre of gravity of the vessel is at her midship section, or at the middle of her length. But if one is in excess of the other, as is usually the case, then the difference between them is divided by the total weight, the result being the distance of the centre of gravity either before or abaft the midship section, according to whether the excess of moment of leverage is before or abaft that plane.

When we have found the longitudinal position of the centre of gravity we have also the longitudinal position of the centre of buoyancy—for the vessel will not float in equilibrium until these points are in the same vertical plane. Hence, if the longitudinal position of the centre of gravity as calculated does not correspond with the longitudinal position of the centre of buoyancy at the designed trim of the vessel—that is to say, at the designed load water-line—some of the weights in the vessel must be shifted until the desired correspondence occurs.

In Fig. 19, L L is the designed load water-line of a vessel having a displacement in tons D. The centre of buoyancy in that condition is B and the centre of gravity is G. Suppose that a weight P already in the vessel is moved through a distance d towards the bow, thereby altering the load water-line to L_1 L_1. Let M be the position of the longitudinal metacentre at a moderate angle of inclination, such as that between the lines L L and L_1 L_1. Suppose G_1 the altered longitudinal position of the centre of gravity of the vessel due to moving the weight P through the distance D. Join M G_1, then B_1, the altered position of the centre of buoyancy, will be in the line M G_1 produced. Moreover, M B_1 is perpendicular to L_1 L_1, for M is actually the intersection of perpendiculars through B and B_1 to their respective water-lines.

FIG. 19



Let S S_1 be the alteration of trim at the stem and R R_1 at the stern post.

From the statical law mentioned in preceding papers

$$P \times d = D \times G\,G_1$$

and

$$G\,G_1 = \frac{P \times d}{D}$$

The angle of inclination being small, A the axis of intersection of the two water planes will approximately correspond with the centre of gravity of the load water plane—a point usually determined when making the displacement, &c., calculations.

Suppose a foot and a ton to be the units of measurement and weight. Then referring to Fig. 19, it is obvious that the angles R A R_1, S A S_1, and G M G_1 are equal.

And

$$\frac{A\,R}{R\,R_1} = \frac{A\,S}{S\,S_1} = \frac{M\,G}{G\,G_1}$$

$$\therefore \frac{A\,R + A\,S}{R\,R_1 + S\,S_1} = \frac{R\,S}{R\,R_1 + S\,S_1} = \frac{M\,G}{G\,G_1}$$

But

$$G\,G_1 = \frac{P \times d}{D}$$

Hence

$$\frac{R\,S}{R\,R_1 + S\,S_1} = \frac{M\,G \times D}{P \times d}$$

$$R\,R_1 + S\,S_1 = \frac{R\,S\,(P \times d)}{M\,G \times D}$$

But all the terms on the right-hand side of this equation are known, and consequently the sum of R R_1 and S S_1, which is the total alteration of trim due to shifting the weight P, is also determined.

To find the separate values of R R_1 and S S_1:—

$$A\,R : A\,S :: R\,R_1 : S\,S_1$$

$$\frac{A\,S}{A\,R + A\,S} = \frac{S\,S_1}{R\,R_1 + S\,S_1}$$

$$\frac{A\,S}{R\,S} = \frac{S\,S_1}{R\,R_1 + S\,S_1}$$

But

$$R\,R_1 + S\,S_1 = \frac{R\,S\,(P \times d)}{M\,G \times D}$$

$$\therefore \frac{A\,S}{R\,S} = \frac{S\,S_1\,(M\,G \times D)}{R\,S\,(P \times d)}$$

Hence

$$S\,S_1 = \frac{A\,S\,(P \times d)}{M\,G \times D}$$

Similarly

$$R\,R_1 = \frac{A\,R\,(P \times d)}{M\,G \times D}$$

But, as already remarked, the lengths of A S and A R are shown on the ordinary displacement, &c., calculation, and consequently the values of S S_1 and R R_1 are fully determined.

Suppose A to be at the middle of the length of the load water-line, so that A S = A R = ½ S R.

$$\text{Then } S\,S_1 = R\,R_1 = \frac{S\,R\,(P \times d)}{2\,M\,G \times D}$$

In this way is the alteration of trim due to moving a weight in a fore-and-aft direction on board a vessel determined.

It is customary to calculate the moment of leverage required to alter the trim one inch, and the result so obtained is practically correct, if used to obtain the moments for alterations up to even a foot.

In this case R R_1 + S S_1 = $\frac{1}{12}$ foot, and the equation

$$\frac{R\,S}{R\,R_1 + S\,S_1} = \frac{M\,G \times D}{P \times d}$$

becomes

$$P \times d = \frac{M\,G \times D}{12\,R\,S}$$

By substituting the values of M G, D and R S for any particular vessel, the moment P × d, required to alter the trim one inch, is at once known.

If P be in tons,

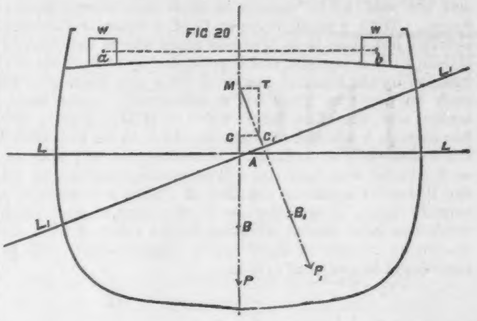
$$d = \frac{M\,G \times D}{P \times 12\,R\,S}$$

gives the distance that one ton must be moved in a longitudinal direction to alter the trim 1in., or, in other words, to increase the immersion about ½in. at one extremity of the vessel, and diminish it by about ½in. at the other extremity.

Let us now consider the experimental method of determining the vertical height of the centre of gravity. But before doing so it is perhaps desirable to remark that the longitudinal position of that point is known from the fact that it must be in the same transverse plane section as the centre of buoyancy; the plane section being, of course, perpendicular to the load water plane of the vessel at that time. Hence, when we have calculated the longitudinal position of the centre of buoyancy at any draught of water and trim by the method described in a preceding paper, we have found the longitudinal position of the centre of gravity also. This is, in fact, the experimental method of finding the position of the centre of gravity in a fore-and-aft direction after a vessel is built, afloat, and loaded.

For the vertical position:—Turning to Fig. 20, L L is the upright water-line and L_1 L_1 is the water-line when the vessel has been heeled through an angle—purposely exaggerated for the sake of clearness—due to moving a weight of a few tons from one side of the deck to the other.

FIG 20



The statical principle upon which is based the experimental method about to be described is that already referred to in the course of these papers—viz.: "If the centre of gravity of any part of a body be shifted in a given direction through a given distance, the centre of gravity of the whole body is shifted in a parallel direction through a distance smaller than the given distance, in the same proportion that the weight of the shifted part is smaller than the weight of the whole body."

Let M represent the transverse metacentre corresponding to a small angle of heel. M P is the upright axis; and consequently G, the centre of gravity, is somewhere in that line. It is required to find the distance of G below M.

Let a be the centre of gravity of a heavy body, or group of heavy bodies, of weight W resting on one side of the deck of the vessel when she is upright; and let that body, or group of bodies, be now shifted across the deck to the opposite side of the vessel, so that b is now the position of the centre of gravity of the weight W. The shifting of this weight causes the vessel to heel over to a certain angle, which is easily measured by means of a plumb line hanging through the nearest hatchway. Let P M P_1 be that angle, so that the centre of gravity of the vessel will now be in the new vertical line M P_1. Let the total weight of the vessel—that is to say, her displacement—be D.

Through M draw M T parallel to $a\,b$, and of such a length that

$$M\,T : a\,b :: W : D.$$

Through T draw T G_1 parallel to M G, intersecting M P_1 at the point G_1.

Then G_1 will be the new position of the centre of gravity. Through G_1 draw G_1 G parallel to $a\,b$, then G will be the position of the original centre of gravity of the vessel when upright.

For since M T : $a\,b$ :: W : D, therefore M T is the distance parallel to $a\,b$, through which the centre of gravity of the total weight D of the vessel is moved by shifting the weight W through the distance $a\,b$.

Also

$$\frac{M\,T}{a\,b} = \frac{W}{D}$$

$$\therefore M\,T = \frac{W}{D} \times a\,b$$

But

$$G\,G_1 = M\,T.$$

Hence

$$G\,G_1 = \frac{W}{D} \times a\,b$$

Since

$$M\,G = G\,G_1 \cot P\,M\,P_1$$

$$\therefore M\,G = \frac{W}{D} \times a\,b \times \cot P\,M\,P_1$$

Hence as W_1, D_1, $a\,b$, and the angle P M P_1 are all known, therefore M G is also determined.

In performing this experiment it is important that the vessel should be floating steadily in still water, and that the weather should be calm. If there are any portions of the vessel or her lading absent or shifted out of their true position at the time of the experiment, exact account should be taken of them and allowance afterwards made. It is also important that loose weights on board should be secured, and all water carefully pumped out of limbers, bilges, and ballast tanks. To ensure accuracy it is usual to measure the inclination of the vessel by plumb lines at fore, main, and after hatchways, and the mean inclination is used in the calculation. Pig iron ballast or cast iron blocks of equal and known weight—say 56 lb. or 112 lb.—are most convenient for making this experiment. A total weight of from 5 tons to 10 tons is quite sufficient for making the inclining experiment in an ordinary mercantile vessel, but a much heavier shifting weight is, of course, necessary when experimenting with a large armour-clad.

Usually, a weight of about 5 tons is placed on each side of the deck, so as to bring the vessel on an even keel at starting. Then the weight on one side is moved over to the other side, and the angle measured with the entire weight on that side. Afterwards the entire weight is transferred back to the opposite side, and the angle again measured. The mean of the two experiments is used for determining the position of G.

The method by experiment, as already seen, furnishes us with the distance of the centre of gravity below the metacentre at the angle of inclination due to the shifted weight. As that angle is not very great—only a few degrees—the metacentre may be considered as the fixed point referred to in Article No. II. of this series. The distance between the points M and G thus found is usually spoken of as the G M of the vessel, and it furnishes the naval architect with a very excellent criterion of her stability and rolling qualities. A large value of G M in the upright position implies a high initial stability, and, therefore, a strong righting tendency when the vessel is inclined from that position by a passing wave. Hence vessels with a large G M are quick rollers, and are said to be uneasy in their movements among waves. With a small value of G M a vessel rolls more slowly; but then if G M is too small she is deficient in stability when upright, and if propelled by sails, is readily inclined by the force of the wind until she leans over to such an angle as gives her a sufficiently higher metacentre, and, therefore, larger value of G M. Unless she has enough freeboard to allow her deck to be still above the water when so inclined, the metacentre will not rise as she heels over, and she will ultimately capsize, as did the ill-fated Captain in the Bay of Biscay a quarter of a century ago. It was the loss of that ship of war which tended to draw special attention to the value of what are known as curves of stability, a subject which will be considered in our next article.

ST. PANCRAS ELECTRIC LIGHTING.

THE KING'S-ROAD REFUSE DESTRUCTOR AND ELECTRIC LIGHTING STATION.

(*Concluded from page* 259.)

THE boiler house is built partly on the top of the tank and partly on brick piers placed between pairs of destructor cells—see Figs. 5, 6, and 8. A roadway 16ft. wide, with 9ft. headway, passes under the whole length of the boiler house at the destructor yard level, and affords access to the front of the six cells arranged on one side. The interior of the boiler house measures about 60ft. by 52ft., and is 27ft. high from the roof ties to the floor, which is 13ft. above the roadway underneath. From the bottom of the tank to the ridge of the roof is 63ft. The house is laid out for five boilers and an economiser. At present there are three Lancashire boilers and an economiser. The boilers were supplied by Messrs. Easton, Anderson, and Goolden. They are 30ft. long and 7ft. 6in. in diameter, with two flues 3ft. diameter, with six tapering cross tubes in each, and are designed for a working pressure of 125 lb. per square inch, and a test pressure—hydraulic—of 180 lb. per square inch. The shell is of steel plates $\frac{3}{4}\frac{1}{4}$in. thick, and the flues have Adamson ring joints. The setting of the boilers is peculiar, and will be understood by reference to Figs. 8 and 9. The boilers are supported on cast iron saddles resting on brickwork near the front and on cross joists suspended from the top flanges of the girders over the roadway at the back end to allow for expansion in that direction. The whole of the outside shell below the water line is exposed to one large flue—Fig. 9—thus affording the largest possible effective heating surface, ready facility for inspecting every rivet, and a reduction in the resistance to the passage of the gases. It also enables the boilers to be placed much nearer together than in the ordinary Lancashire setting—they are spaced 10ft. centre to centre—and the main flue to the chimney to be placed underneath the boilers instead of at the end. The space occupied is therefore greatly reduced without impairing the efficiency of the boilers. Careful tests have proved that the idea of any advantage being gained by passing the gases up and down the outside shell is an entire fallacy. The following are the results of the official trial of one of these boilers carried out on September 25th, 1895. A preliminary trial gave almost identical results:—

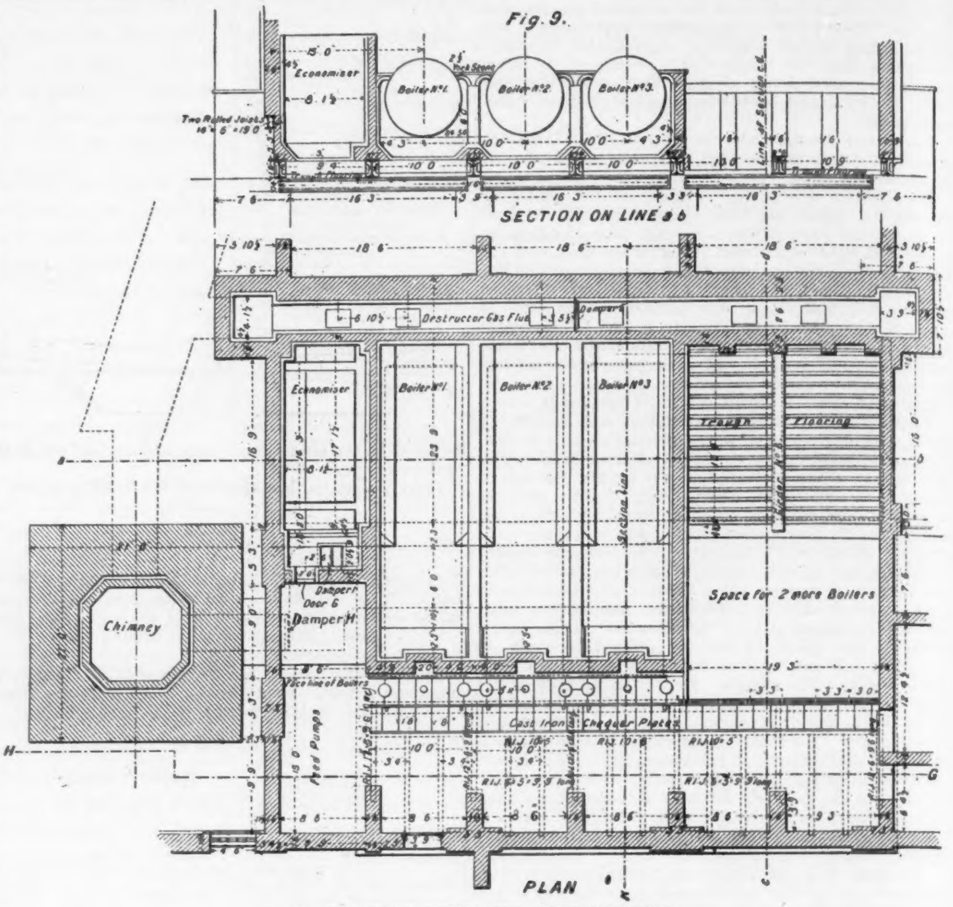
Boiler Trial, September 25th, 1895.

Data.—	
Area of heating surface	1000 sq. ft.
Area of fire-grate	22·5 sq. ft.
Ratio $\frac{\text{heating surface}}{\text{grate surface}}$	44·4
Coal used, best Welsh steam coal.	
Observations.—	
Duration of trial, 8½ hours, from which a period of 5½ hours was selected, giving the most uniform conditions of working. The following figures relate to the 5½ hour period (11.45 a.m. to 5.15 p.m.)	
Mean pressure of steam above atmosphere per square inch	123 lb.
Corresponding temperature	351·8 deg. Fah.
Mean temperature of feed	92·4 deg. Fah.
Total water evaporated	29,500 lb.
Total water evaporated per hour	5363 lb.
Total coal used	2925 lb.
Total coal used per hour	531·8 lb.
Number of times fires were stoked per hour	7
Average temperature of gases at back end of boiler flue	925 deg. Fah.
Ditto at front end (passing to chimney)	435 deg. Fah.
Average fall of temperature of gases passing along flue outside boiler	490 deg. Fah.
Principal Results.—	
Pounds of coal burned per square foot of grate per hour	23·6 lb.
Ditto per square foot of heating surface	0·532 lb.
Thermal units transmitted per square foot of heating surface per hour	6049
Amount of feed-water per lb. of coal	10·08 lb.
Equivalent water evaporated per lb. of coal from and at 212 deg. Fah.	11·76 lb.
Water evaporated per square foot of heating surface per hour	5·363 lb.
Equivalent water evaporated per square foot of heating surface from and at 212 deg. Fah.	6·262

Fig. 10 is a diagram showing the results observed throughout the trial. It will be noticed that the temperature of the gases passing away to the chimney was very much more uniform than at the back end of the boiler, and that there was always a large drop in the temperature of the gases passing along the outside flue, showing that the single flue does its duty remarkably well. The temperature at the back end was observed by means of a Schaffer and Budenberg mercury thalpotasimeter, and at the front end by a pyrometer made by the same firm. There are very few Lancashire boiler tests published which give efficiencies surpassing this case, and if the high rate of heat transmission—6049 units per square foot per hour—is taken into account, but few other tests could compare with it.

As to the dryness of the steam, no direct test was applied, but an indication of the dryness was afforded by the running with part of the steam, and at 350 revolutions per minute, a 200-horse power Belliss engine with no load. The engine ran silently throughout the whole of the test, with all the drain cocks closed. If the steam had been at all abnormally wet the presence of water in the cylinders would undoubtedly have been noticed, as the engine was watched for that purpose.

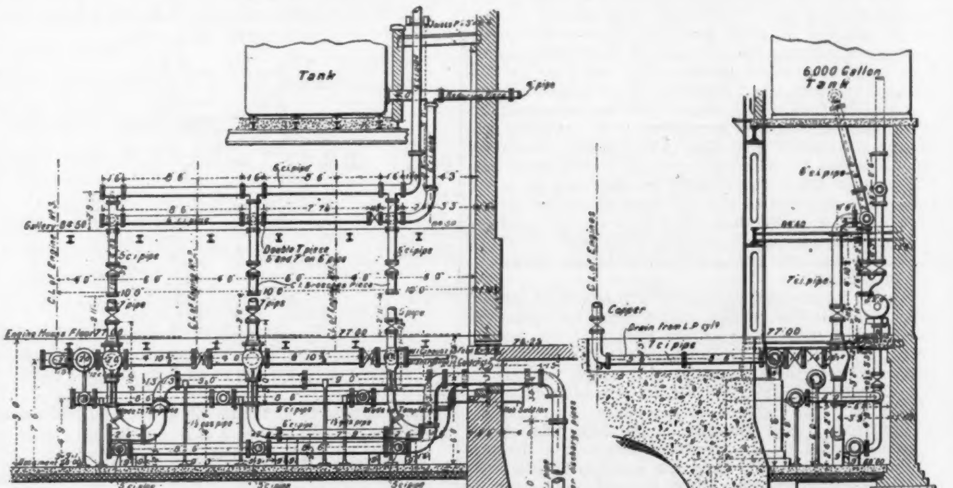
Fig. 9.



PLAN OF BOILER HOUSE AND BOILER SETTING

The boilers have been found to be capable of evaporating over 7000 lb. of water per hour when forced. The destructor gases—which can be applied to the boilers by opening valves at the back ends—pass along the large outside flue and also through the two internal flues passing out of the furnaces to 15in. diameter down pipes leading to the chimney. The furnaces and ashpits are provided with air-tight doors, to be closed when the gases are being used, and the down pipes have valves to be closed when the coal fires are in use. Grid dampers are provided at the back ends of the internal flues for regulating the draught to the coal fires while the destructor gases are allowed to pass under the boiler only. Another damper is provided at the outlet to the main flue leading to the chimney. A feature in the design of all the flues is the provision of large areas and pockets to collect the fine dust which is blown through from the destructors.

On one side of the battery of boilers is fixed a Green economiser—see Fig. 9—containing 240 tubes, each 9ft. long and 4½in. external diameter, and giving a total heating surface of 2500 square feet. A capacious pocket is allowed under the pipes for the collection of dust thrown down by the scrapers. The scrapers are worked by a belt from a Goolden electric motor fixed on a gallery overhead. The economiser is heated



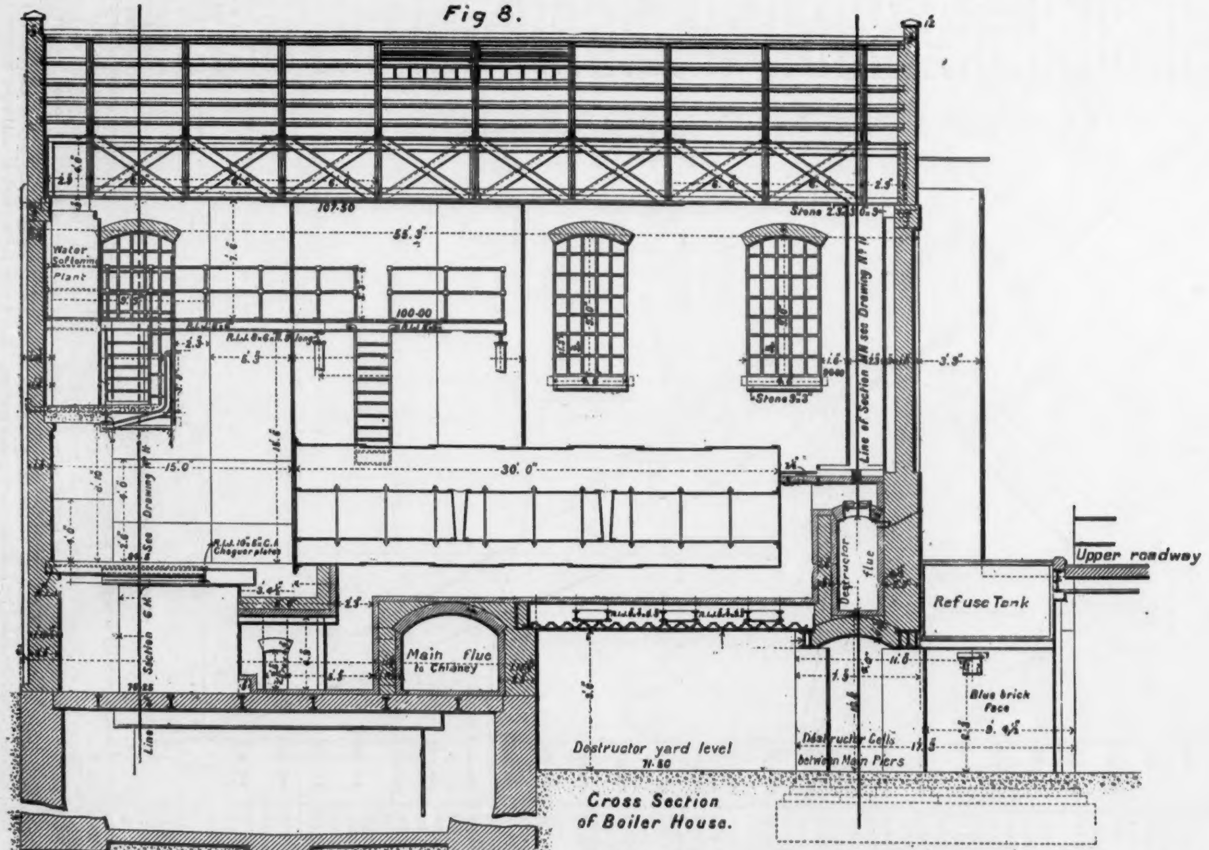
ARRANGEMENT OF PUMPS AND PIPES FOR CONDENSERS

THE ST. PANCRAS ELECTRIC LIGHTING AND DUST DESTRUCTOR INSTALLATION

PROFESSOR HENRY ROBINSON, M. INST. C.E., AND MR. W. N. BLAIR, ASSOC. M. INST. C.E., ENGINEERS

(For description see page 284)

Fig 8.


Water Softening Plant
Stone 2.3 × 0.9
Stone 9.0
Line of Section H.H. see Drawing No. H
Line Section G.H. see Drawing No. H
R.I.J. 10 × 6 C.I. Chequer plates
30. 0"
Destructor flue
Refuse Tank
Upper roadway
Main flue to Chimney
Blue brick face
Destructor yard level 71.80
Destructor Cells between Main Piers

Cross Section of Boiler House.

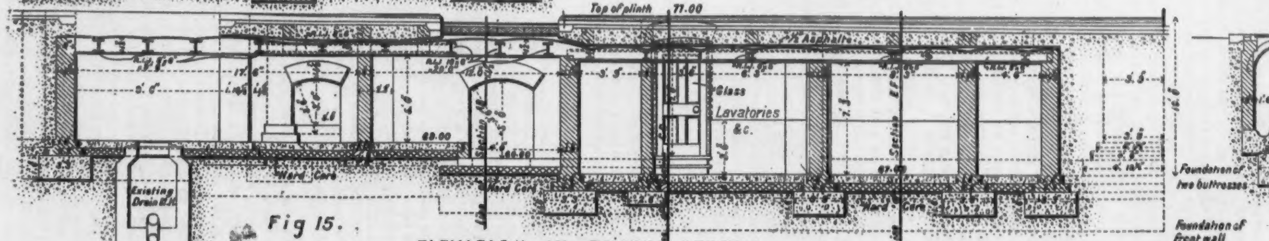
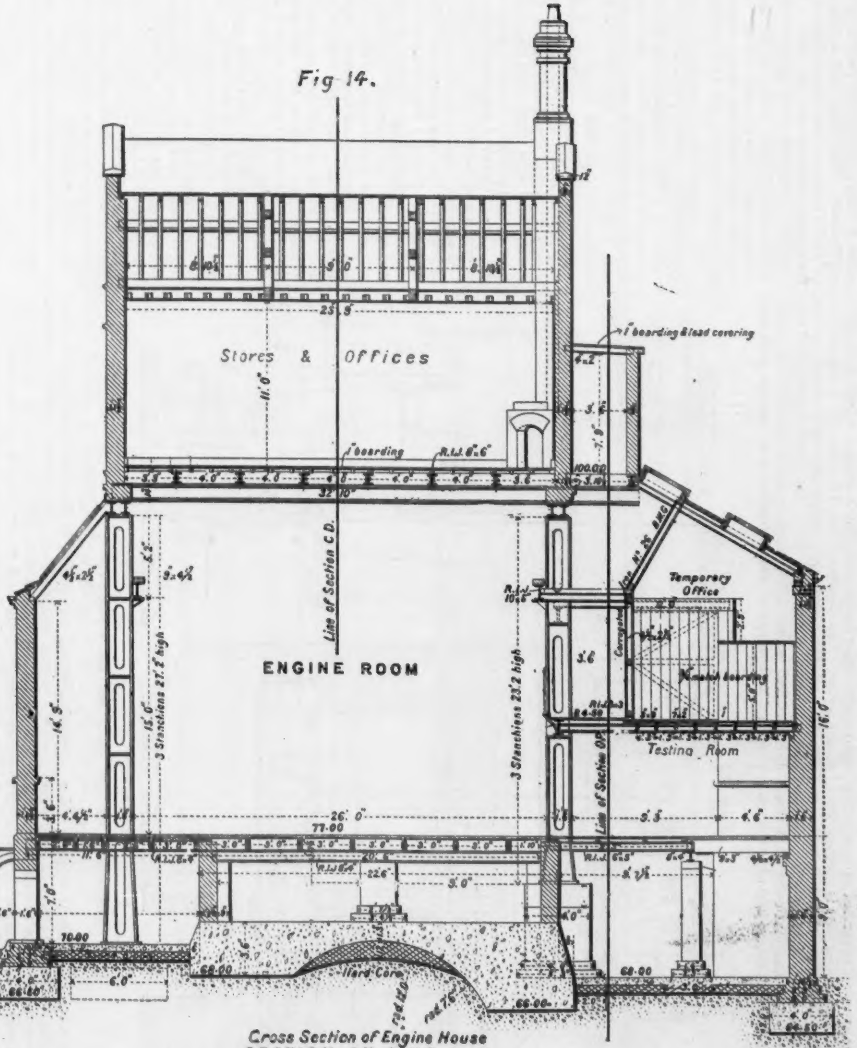

Top of plinth 71.00
Glass
Lavatories &c.
Hard Core
Existing Drain
Foundation of two buttresses
Foundation of front wall

Fig 15.

ELEVATION IN PRATT STREET and Section on Line G.H.

"The Engineer"

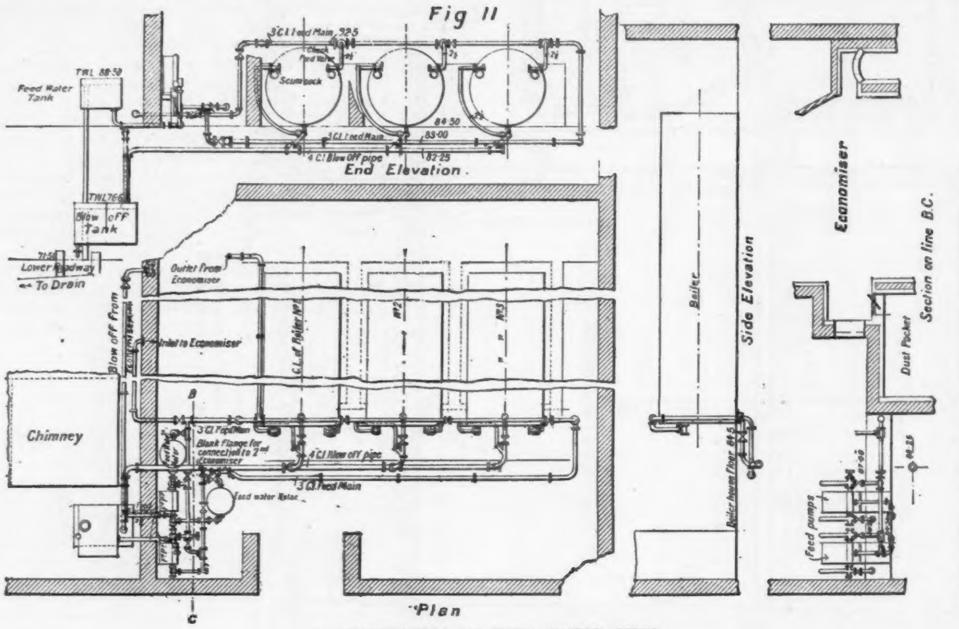
Fig 14.


Stores & Offices
1" boarding & lead covering
1" boarding
R.I.J. 8 × 6
32' 10"
Line of Section C.D.
ENGINE ROOM
3 Stanchions 27.2 high
3 Stanchions 23.2 high
Temporary Office
Match boarding
Testing Room
Line of Section O.P.
26' 0"
77.00
Hard Core

Cross Section of Engine House
SECTION ON LINE A. B.

Swain Eng.

entirely by the destructor gases, and provision is made for drawing off steam if it is produced when the amount of feed-water passing to the boilers is small. The top collecting pipe is made large—6in. in diameter—and is carried up to a steam drum overhead, and a return circulating pipe is carried from this drum to join the water inlet pipe of the economiser. The steam drum has a gauge glass, a safety valve, and an outlet for steam, which is closed automatically by a float valve when the water rises above the centre line of the drum.



ARRANGEMENT OF FEED WATER PIPES

The outlet also has a stop valve with a small by-pass, and a reducing valve to prevent the delivery of steam at a pressure exceeding 125 lb. per square inch. The circulation of the water in the economiser takes place continuously and is very beneficial, as it mixes a stream of hot water with the cold feed and ensures a warm supply to the heated pipes, and thus guards against the danger of corrosion by reason of moisture condensing on the surface of the cooler ends of the pipes.

There are two vertical duplex feed pumps made by Messrs. Mumford and Co., of Colchester, each being capable of delivering 1500 gallons of water per hour against a pressure of 130 lb. per square inch, with steam at 125 lb. An injector, capable of delivering 1000 gallons per hour, is also fixed. The feed pipes are arranged in a ring, with two water meters, and suitable valves for providing duplicate ways to each boiler from each pump, as shown in Fig. 11.

There are two outlets from each boiler, 6in. in diameter, communicating to the two 7in. main steam pipes. The usual low-water alarms, safety valves, scum cocks, and other mountings are provided. Steam can be drawn from either main to supply the feed pumps or injector, and the two mains are coupled together at the further end of the engine-room to form a ring supply to the engines. The straight pipes are of wrought iron, the bends of solid drawn copper, and the T pieces cast iron. The joints are made with corrugated brass rings and red lead. There are no expansion joints, but the arrangement of bends and straight pieces is carefully planned to permit free expansion everywhere without injury. Fig. 12 shows the arrangement of the steam piping. Drains are provided at all the dead ends of the steam pipes in the boiler-house, and at large cast iron water pockets—see Fig. 12—on the mains in the engine-house close to the first branch supply pipe. Each engine is also provided with a separator. The steam pipe drains all lead to a pair of Royle steam traps—arranged in duplicate—which lift the condensed water back into the feed tank. By-pass pipes ½in. in diameter are provided for blowing through when the traps are out of order. The valves on the steam mains are Hopkinson's parallel slide valves with internal by-passes.

At the east end of the boiler-house there is an underground coal store into which the coal is shot from carts entering from King's-road, and is raised from the store to the boiler-house by a low-pressure hydraulic hoist, having a lift of 16ft. 6in. The feed-water for the boilers is drawn from the New River Companys' mains, and is softened before use by means of lime, in an apparatus supplied by Messrs. Doulton. The lime is thrown into a cylinder, kept full of water, and stirred by a revolving mixer operated by a water wheel turned by the hard water flowing into the supply cistern. The lime water and hard water flow together through a conical shoot into a 6000 gallon settling tank erected on the roof of the engine house; the softened water passing from an outlet near the surface of the water to a pair of filters in the boiler-house gallery. The filtering material is a layer of small wood shavings, held in position by a perforated iron grid, through which the water passes upwards, and then to the feed-water tank. Either filter can be used alone or both together. This apparatus reduces the hardness of the water from 16 deg. to 6 deg. or 7 deg.

The engine-house is shown in plan in Fig. 7, page 261, and in cross section in Figs. 14 and 17, pages 285 and 287. Fig. 16 shows the west side elevation. The main roof is carried on heavy cast iron stanchions, which have brackets supporting the rail bearers of a 5-ton overhead travelling crane. The width between the stanchions is 26ft., the height from floor to ceiling 22ft., and the length about 62ft. Behind the stanchions on the west side is a space containing the main switchboard, with a sloping skylight overhead, and on the east side a larger space for the condensing plant, testing-room, men's mess-room, &c., covered by a gallery on a level with the boiler-house floor for access to the main steam valves, &c., and containing an office for the resident engineer, overlooking the engine-room. Part of the building work on the east side is only temporary, as the engine-room will be extended in that direction in the future.

Space is available at present for five large engines, set out with centre lines 10ft. apart. The engine foundation is a mass of concrete, arched in the middle, to prevent the engine vibrations setting up a rocking action—Fig. 17, page 287—and carried down 9ft. at one end and 11ft. at the other to form walls to the basements, which extend along both sides of the house. The basement on the west side contains the rheostat and other regulating resistances, and affords access to the cables connecting from the switchboard to the dynamos and mains, &c. Ample space is provided for these purposes, and plenty of ventilation from an outside area and upwards through an opening in the floor extending all along the switchboard under a step. On the east side the basement contains the condensers and their water pipes, and also the exhaust steam pipes and drains leading to the steam traps. The whole of these pipes, as well as the bolts at their joints, are therefore readily accessible at any time without taking up the floor.

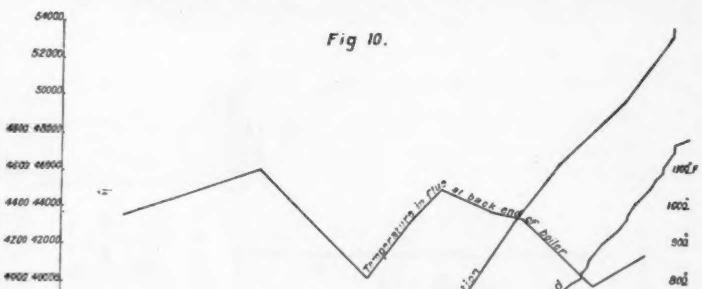


DIAGRAM OF RESULTS OF BOILER TRIALS

There are at present three sets of compound Belliss engines, each of about 200-horse power, with 12in. and 20in. cylinders by 12in. stroke, designed to run at a normal speed of 350 revolutions per minute. The working parts are wholly enclosed and lubricated by Belliss's force pump system. The engines are governed on the throttle valves. There are two dynamos to each engine, one at each end of the crank shaft, and direct coupled to the engine shaft. The dynamos are Crompton's shunt-wound two-pole undertype, with armatures having Crompton's patent hydraulic pressed twisted copper bars. Each machine is wound for a maximum load of 70,000 watts, a maximum current of 550 ampères, and a maximum pressure of 135 volts. The maximum current must be obtainable at a pressure of 112 to 127 volts. The maximum pressure must be obtainable with a current of 518 ampères. The official trial at Birmingham with a load of 133,000 watts showed a steam consumption of 19·84 lb. per electrical horse-power per hour working condensing.

Fig. 19, page 289, shows one of the engines with its pair of dynamos. The exhaust pipes from the engines are connected together by a 10in. main, running longitudinally in the east side basement, with stop valves between the engine branches. This 10in. main is connected to a 12in. vertical exhaust pipe 50ft. high through a stop valve, and also through a by-pass relief valve, to provide an outlet in case the vacuum fails at any time, and it is also connected to three condensers through stop valves and reflux valves. The condensers are of the "ejector" type, made by Messrs. Ledward and Co. They are supplied with water from an overhead tank of 6000 gallons capacity, and deliver into the large underground tank. The difference of level of the water in the two tanks is 25ft. One condenser is capable of serving one engine, and the other two are each capable of serving two engines running simultaneously. The feed pumps also exhaust into the condensers. The water to supply the condensers is drawn from the large underground tank, and pumped into the overhead tank or direct to the condensers by Gwynne centrifugal pumps, driven by Crompton series-wound electro-motors. There are three of these pumps designed to deliver 20,000 gallons per hour to a height of 25ft. The motor fields are wound on four limbs, and a switch is provided for placing all four windings in series, or two in series and two parallel. With the former arrangement the above-mentioned load is worked, and with the latter the speed and power is increased to enable the pumps to deliver 25,000 gallons per hour to a height of 40ft., to be distributed over the cooling apparatus. The current is supplied to the motors at 220 volts.

The pumps have two suction pipes and two delivery pipes—see Fig. 13—for supplying water direct to the condensers they draw from the bottom of the underground tank, but for pumping to the cooling apparatus they draw hot water from near the surface. The cooling apparatus is erected over a portion of the engine house roof—which is a concrete surface rendered in cement with a slight slope, and covers an area of about 900 square feet—see Fig. 17. The water is distributed in wooden troughs, and falls through numerous small holes on to sheets of thin galvanised corrugated iron fixed at an angle of 45 deg. on wooden trusses; it splashes down these slopes and is collected by another corrugated iron surface underneath, and carried into a trough delivering into the 6000-gallon tank supplying the condensers, which has an overflow discharging to the bottom of the underground tank. The total area of cooling surface is upwards of 2500 square feet. The arrangement of pumps and connections permits the water to be cooled on its way to the condensers, and when they require more water than the cooler can deal with, the reserve of 115,000 gallons underground can be drawn upon and cooled afterwards during the period of light load ready for the next evening's heavy load. A similar water cooling plant and storage tank have been in use at the Regent's Park Central Station with highly satisfactory results. The engines, dynamos, condensing plant, steam mains and water piping, were supplied by Messrs. Crompton and Co.

The main switchboard is designed to work on the five-wire system, with provision for coupling up to part of the three-wire system supplied previously from the Regent's Park station. Mr. Baynes, the newly appointed chief electrical engineer to the Vestry has, however, preferred to require the consumers to take their current from the King's-road station, at 220 volts instead of 110 volts, which has hitherto been the standard pressure, and he is, therefore, working the mains as a three-wire system at 440 volts, and leaving conductors Nos. 2 and 4 unused at present.

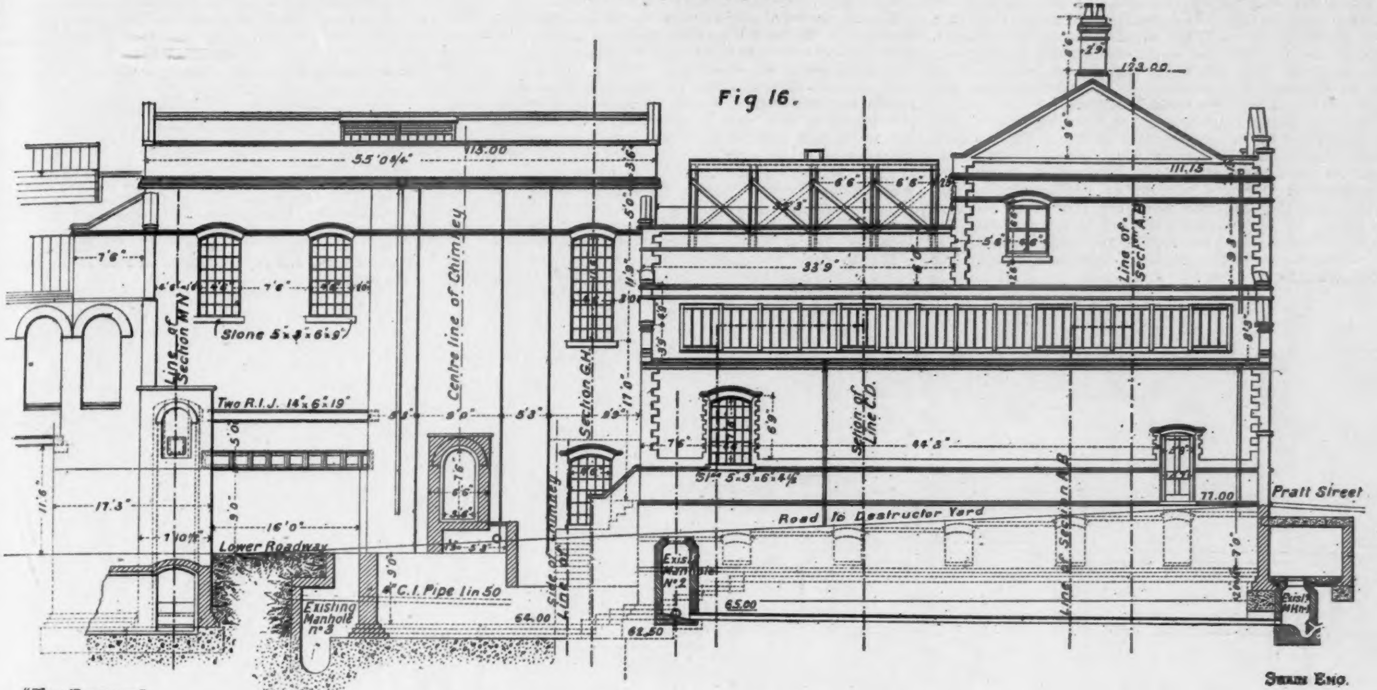
Each dynamo has a separate Aron meter, to register its output in ampère hours, fixed in the positive lead to the switchboard, and a single pole main switch is fixed in the same lead. The negative leads each have a duplicate fuse block and a magnetic cut-out to act when the current falls below twenty ampères, and also an ampère meter to show the load on the machine. Any dynamo may be placed on any circuit by inserting screw plugs in the coupling board as required. A resistance capable of absorbing about one-third of the full load of a dynamo is provided for testing purposes and for steadying the engines if necessary, when a new machine is to be switched into circuit. Five 440 volt "feeders" are connected to the board, and can be coupled by screw plugs to any one of three sets of omnibus bars, which may be worked at different pressures varying from 450 to 520 volts to suit the load. Each feeder has a volt meter and

THE ST. PANCRAS ELECTRIC LIGHTING AND DUST DESTRUCTOR INSTALLATION

PROFESSOR HENRY ROBINSON, M. INST. C.E., AND MR. W. N. BLAIR, ASSOC. M. INST. C.E., ENGINEERS

(*For description see page* 284)

Fig 16.

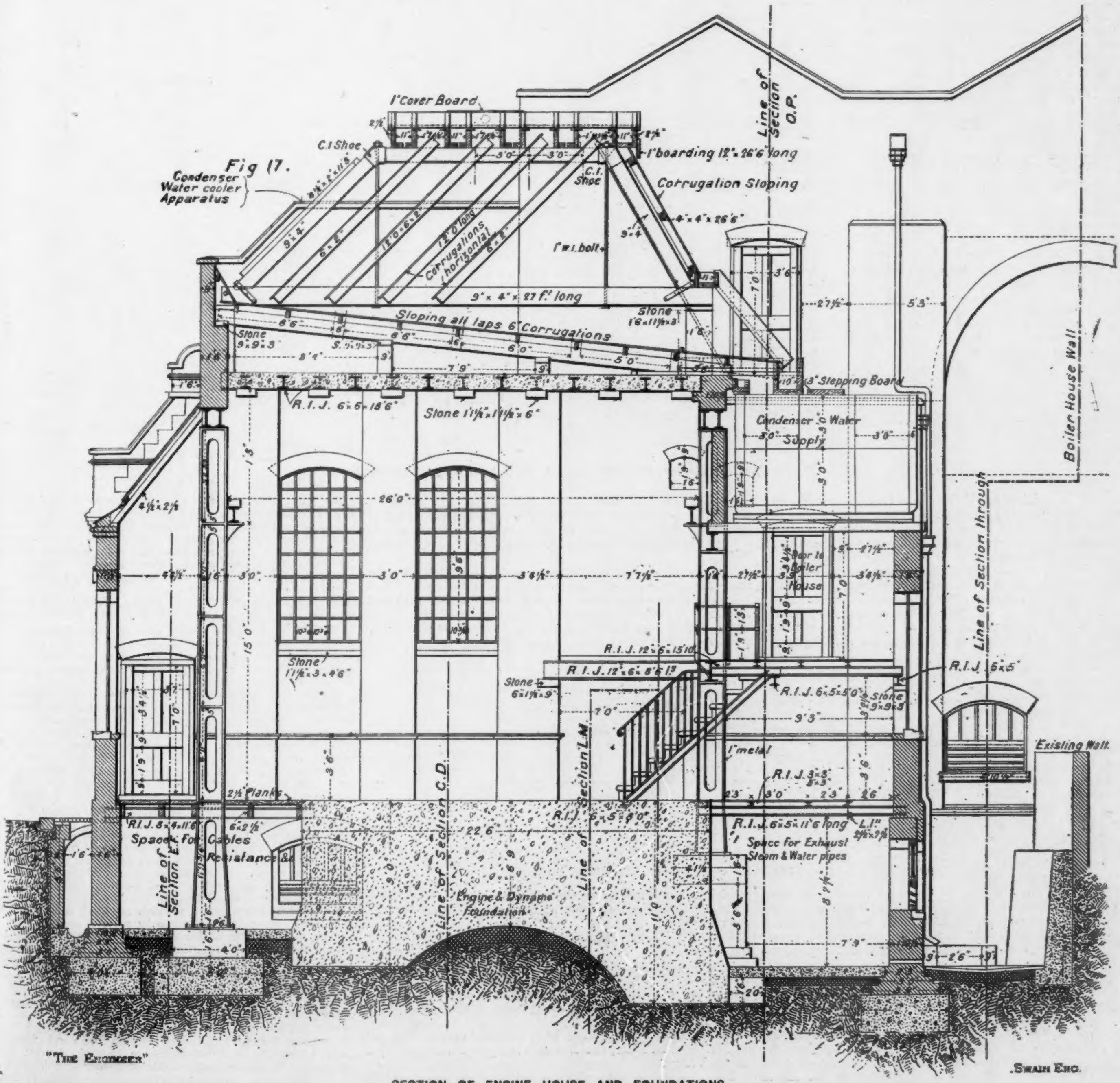


113.00
55' 0¾"
115.00
111.15
33'9"
Line of Section M.N.
Stone 5 × 4 × 6' 9"
Two R.I.J. 14" × 6" 19'
Centre line of Chimney
Section G.H.
Section of Line C.D.
Line of Sec. A.B.
Line of Section A.B.
17' 3"
16' 0"
Lower Roadway
Existing Manhole No 3
C.I. Pipe 1 in 50
Side of Chimney
Line of
Existing Manhole No 2
64.00
62.50
65.00
Road to Destructor Yard
77.00
Pratt Street
Existg. Mhole
Sill 5 × 3 × 6' 4½

"THE ENGINEER" SWAIN ENG.

WEST SIDE ELEVATION of Engine and Boiler Houses

Fig 17.



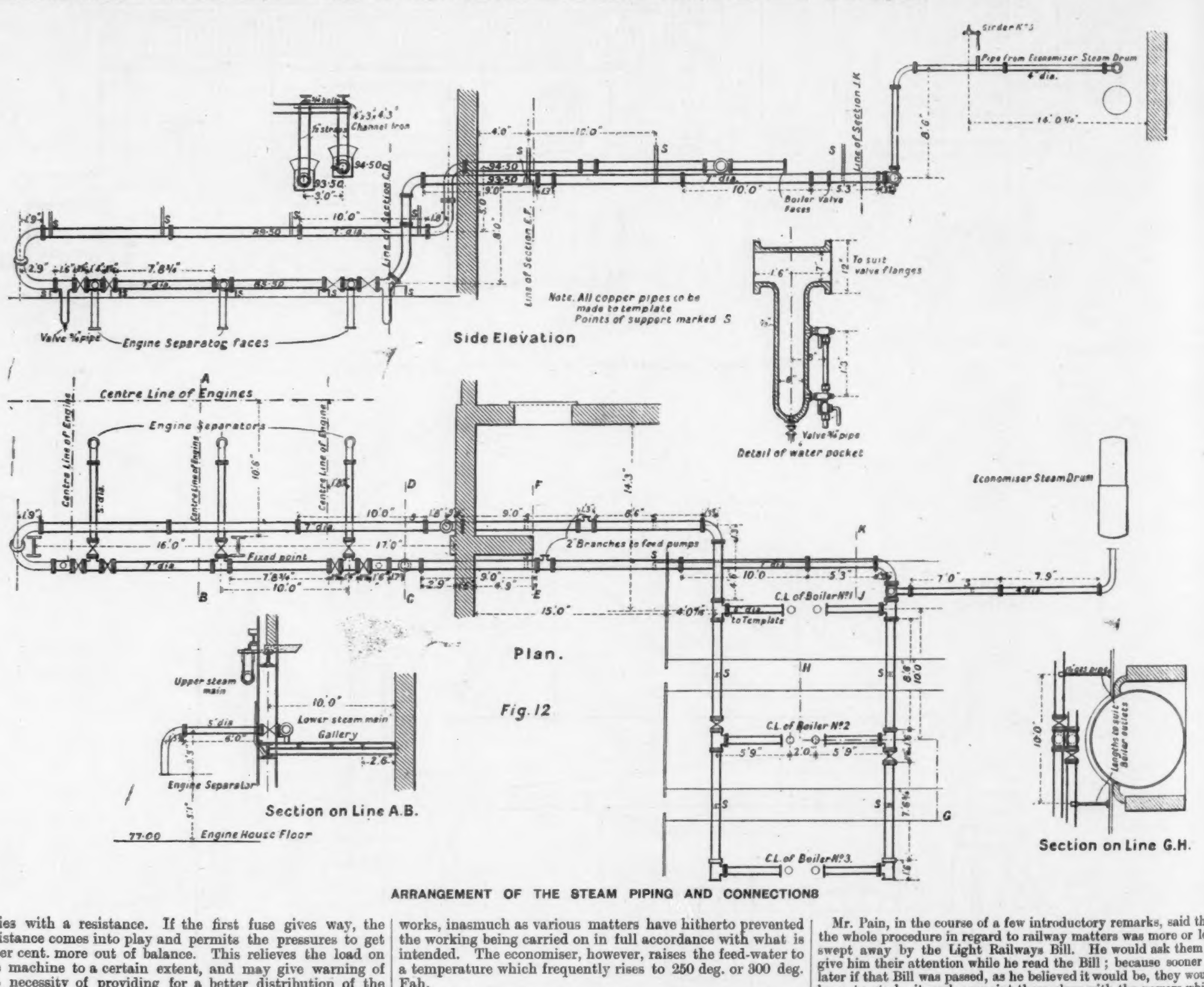
Line of Section O.P.
1" Cover Board
C.I. Shoe
1" boarding 12" × 26' 6" long
Corrugation Sloping
Condenser Water cooler Apparatus
Corrugations horizontal
1" W.I. bolt
9" × 4" × 27 ft. long
Stone 1' 6 × 11½ × 3
Sloping all laps 6" Corrugations
Stone 9 × 9 × 3
1½" Stepping Board
R.I.J. 6 × 6 × 18' 6"
Stone 11½ × 11½ × 6"
Condenser Water Supply
Boiler House Wall
Line of Section through
26' 0"
Door to Boiler House
R.I.J. 12 × 6 × 15' 10
R.I.J. 12 × 6 × 8' 6
R.I.J. 6 × 5
Stone 11½ × 3 × 4' 6"
Stone 6 × 11½ × 9
R.I.J. 6 × 5 × 5' 0"
Stone 9 × 9 × 3
Existing Wall.
1" metal
R.I.J. 3 × 3
2½" Planks
R.I.J. 8 × 4 × 11' 6
Space for Cables Resistance &c.
Line of Section L.M.
Line of Section C.D.
Line of Section L.M.
22' 6
Engine & Dynamo Foundation
R.I.J. 6 × 5 × 11' 6 long
Space for Exhaust Steam & Water pipes

"THE ENGINEER" SWAIN ENG.

SECTION OF ENGINE HOUSE AND FOUNDATIONS

an ampère meter, the latter being provided with an additional scale showing the "volts required" on the feeder corresponding to the current passing, in order to give 450 volts at the further end of the feeder. The resistances of the feeders were carefully ascertained by passing large currents out through one lead and back through the other, and observing the drop of pressure and the current with the station potentiometer. The dynamo rheostats are fixed on a table immediately in front of the feeder instruments. Switches are provided for disconnecting the various bars while the screw plugs are being shifted, and resistances are used for regulating the pressures on different omnibus bars which are served from the same dynamos.

Additional regulation is provided by balancing motor transformers placed in sub-stations and at the central stations. These machines have four armatures in series wound on two drums on the same shaft. Each armature is designed for 50 ampères at 110 volts, running at 1200 revolutions per minute, and the magnetic fields are excited in series at 440 volts. An ampère meter is fixed in circuit with each armature, and fuses are provided in the leads connecting to the mains to protect the machines from overloading. The intermediate leads have two fuses each, one of which is in series with a resistance. If the first fuse gives way, the resistance comes into play and permits the pressures to get 5 per cent. more out of balance. This relieves the load on the machine to a certain extent, and may give warning of the necessity of providing for a better distribution of the lamps. If the relief is not sufficient, the second fuse will give way and cut out the overloaded conductor, leaving the machine running on the other circuits. Two of these balancing transformers are placed in a sub-station situated about 2400 yards south of the central station in Gray's-inn-road, and two in another sub-station under the Highgate-road railway station, about the same distance north of the central station.



ARRANGEMENT OF THE STEAM PIPING AND CONNECTIONS

The main switchboard and balancing transformers were supplied by the Electric Construction Company, who also wired the central station building for lighting by incandescent lamps and several Crompton-Pochin arc lamps. The mains which have been laid in connection with these works extend over upwards of seven miles of streets, and include over 40 miles of cables, varying in sectional area from one-tenth to one square inch of copper. The cables are made with untinned copper wire, insulated with specially prepared jute, covered with lead, then served with yarn, and protected by two armourings of steel tape braided and compounded over all.

The cables are laid direct in the soil, about 4in. apart. The straight joints are made with gun-metal sleeves screwed and sweated on to the copper strands, enclosed in cast iron split boxes, which are filled up with a bituminous insulating compound. Numerous fuse boxes are placed at intervals along the mains. The cables entering these are brought through sealed terminal boxes filled with insulating compound. A gun-metal terminal is sweated on to the end of the cable, and passes through an ebonite gland into the cast iron fuse box, which has a plate-glass air-tight cover. A loose tin plate is placed over the glass to keep it clean, and a surface cover of the usual kind is provided over the fuse box chamber, but not caulked down. The condition of the fuses can be seen at once without having to uncaulk or unscrew any cover.

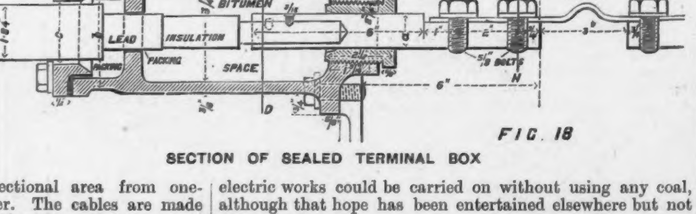


FIG. 18

SECTION OF SEALED TERMINAL BOX

Fig. 18 shows a section of a sealed terminal box. The fuses can be disconnected by box spanners inserted vertically from the surface. The insulation of the mains was tested in lengths of about 500 yards, and easily passed the specified requirements of from 1500 to 3000 megohms on such a length, according to the size of the cable, after two minutes' electrification by a 100-volt battery. On the completion of the work, the insulation of the entire system, including 41 miles of cable, with all the joints and fuse boxes, was found to be about 20 megohms. The whole of these mains were supplied by W. T. Henley's Telegraph Works Company. Fig. 15, page 285, shows a plan of the mains, the full lines being the old mains and the dotted lines those laid by Messrs. Henley.

It is too early as yet to give any reliable figures as to the result of the combination of the dust destructors and electric works, inasmuch as various matters have hitherto prevented the working being carried on in full accordance with what is intended. The economiser, however, raises the feed-water to a temperature which frequently rises to 250 deg. or 300 deg. Fah.

The standby boilers are also kept under steam without the use of any coal, while the destructors raise steam in a separate boiler which drives their forced draught fans and mechanical stokers. A great deal more will, of course, be effected when the arrangements for utilising the destructor gases are in full operation. It was never expected that the electric works could be carried on without using any coal, although that hope has been entertained elsewhere but not yet realised.

The electric works have been designed and carried out by Professor Henry Robinson, M. Inst. C.E., of 13, Victoria-street, Westminster, Mr. E. C. Thrupp being his chief assistant. Mr. J. F. C. Snell superintended the works in connection with main laying, electrical plant, &c., and he has been appointed resident engineer of the King's-road installation.

The destructor works have been designed and carried out by Mr. Wm. N. Blair, the Borough Engineer and Surveyor to the Vestry.

The electricity and public lighting department of the Vestry has been from the first under the control of a committee, of which Mr. Andrew Sweet has been the chairman throughout. Mr. Sydney Baynes is the chief electrical engineer to the Vestry, and Mr. A. E. Pycraft the chief clerk, Mr. C. Barrett being the Vestry clerk.

The total capital expended by the Vestry on electric lighting works now amounts to about £160,000, nearly all of which has been spent on work executed under the direction of Professor Robinson. The cost of the King's-road installation just completed will be about £44,000, exclusive of land. The destructor works and chimney shaft cost about £20,000.

LIGHT RAILWAYS.

At the ordinary general meeting of the Surveyors' Institution on Monday, Mr. Arthur C. Pain, C.E., read a paper on the Light Railways Bill. Mr. Daniel Watney, the President, took the chair, and amongst those present were, Sir George Leach, Mr. Alexander R. Stenning, Mr. J. W. Penfold, Mr. Harry G. Assiter, Mr. Martin Vigers, Mr. E. J. Castle, Q.C., Mr. Wheeler, Q.C., Mr. Edward Smyth, and representatives of some of the chief estates in the kingdom.

Mr. Pain, in the course of a few introductory remarks, said that the whole procedure in regard to railway matters was more or less swept away by the Light Railways Bill. He would ask them to give him their attention while he read the Bill; because sooner or later if that Bill was passed, as he believed it would be, they would have to study it and acquaint themselves with the powers which would be given them under what was an entirely new procedure in every respect.

Mr. Pain then read the text of the Bill, and added numerous criticisms upon clauses 1, 2, 3, 4, 5, 6, 7, 9, 11, 13, 15, 17, and 18.

"Clause 1: Assuming always that the Commissioners proposed to be appointed are persons skilled in the subject-matter to be inquired into, I think as an authorising body the Commission would be far superior to the County Council or Councils as proposed in the Bill of last year.

"I must, however express a doubt as to the desirability of paying only one member of the Commission, and I question whether two other gentlemen could be found with the necessary experience who would give as much time and trouble as might be necessary without remuneration. It must be remembered that an entirely new procedure is to be put in force, and it is of the utmost importance that the three Commissioners should be known to be skilled in legal, engineering, traffic, and financial questions. The same skilled professional assistance that has hitherto been engaged in railway undertakings will not be forthcoming in the projection of light railways, and it will be the duty of the new Commissioners to guide the promoters of light railway schemes in putting into shape what would probably be very crude projects. In nearly every case these light railways will join, either at one end or both, one or more of the main lines, and as the latter are managed by skilled boards of directors and officers with large funds at their disposal, considerable opposition may be expected if they think their interests are likely to be affected prejudicially. There is also sure to be some opposition from landowners, and the Commissioners will have to act the part of mediators between the conflicting interests of those who are in favour of a light railway and those who are not.

"It will be most difficult to get a rural district, and still more a County Council, to subscribe for the share capital of a light railway on the border, so to speak, of the district. Railways more often than not follow valleys, sometimes on one side of a river or stream and sometimes on the other. If, as most likely is the case, the stream forms the boundary between two rural districts, the light railway would be at the edge of each district, and the majority of the representatives of the rural council would never agree to tax themselves for the benefit of the minority. If the rural council or councils could make a special railway rate on those parishes in their district which were benefited by the railway, then, I think, in many cases a rate would be willingly agreed to and be much more popular than say a sewerage rate. I do not, however, see any provision in the Bill to meet this.

"Clause 5: This prevents the alteration of rating, which is usually made when cheap land is converted into a railway, and will work very well in helping to make lines where they will be of considerable local advantage in districts with little traffic at the moment, but which are capable of considerable development. Such places are often to be found, near the sea in particular. Sub-section (*c*) of this clause is the thin end of the wedge, and is a principle which might be extended with great advantage to all light railways. I think, however, a further useful proviso might be added, viz., that when 3 per cent. is paid for two years following on the ordinary stock, the railways should be rated in the usual way.

"Clause 9: Sub-section 3 of this clause, which provides for the rejection by the Board of Trade of a scheme for a light railway, will, I think, cause great hardships, which might in many cases be avoided if the Board of Trade, after a scheme has been put before them in general terms with the route of the line laid down on a 1in. ordnance map, would decide whether or no it is desirable that the project should go before Parliament or the Commissioners.

"Clause 11: (B) Here again the Commissioners will have most important questions of principle to decide, which must of necessity vary in every scheme inquired into, and my experience is that it is generally the public at large, and not the inspecting officers of the Board of Trade, who are so "exigeant" respecting questions of public safety. The Commissioners therefore will have to be strong men to resist the pressure of local authorities to expend unreasonable sums in costly road bridges, and of the public for expensive station buildings, signalling, &c.

"Sub-section (i.), dealing with railway rates, will also need very skilful handling by the Commissioners unless the light railways are to be worked at a loss.

"Clause 15: This provides for the expenses of local authorities in promoting schemes, and enables them to make a special rate on certain parishes. I think, as I said before, that this principle should be extended, and in all cases the parishes benefited rather than the county should be the rating unit. The question of repayment of loans dealt with under this clause is an important one. I think the repayment should not begin until five years after the opening of the line for traffic.

"Clause 17: This clause will enable many branch lines now working to get rid of most onerous conditions as to modes of working which have been forced upon them under their own Act, or under public Acts passed since they were constructed, and it will, I take it, enable the owners of many tramroads and mineral lines to get the necessary legal authority to carry passengers and goods as well as minerals, which will be of great advantage to the public.

"Clause 18: This gives power to get an amending order, which is a very useful provision, because it is generally found that as a scheme proceeds its usefulness is more appreciated, and more extended powers and a greater expenditure become necessary. In practice I think it would be found that the main line companies would be willing, under pressure of public opinion, if not of their own free will, to make grants in favour of light railways or give guarantees of minimum interest, or otherwise help in placing the necessary capital. They may also be willing to work the lines when constructed, but I cannot see any power in the Bill that would enable the main line companies to do one or more of these things simply by obtaining the sanction of their shareholders to such help being given under the terms and conditions embodied in the order. A clause to enable this to be done should be inserted in the Bill.

"I do not feel quite sure as to the powers of the Bill covering the case of an existing line being purchased by a county, district, or borough council by compulsion, and being extended or worked by the council."

Mr. A. E. Christy then read a short paper entitled, "Are Light Railways Desirable?" His arguments were, in a word, that light railways would cause a glut of produce at the great centres of population, and that the increased facilities of transport afforded to remoter districts would depreciate the value of those districts adjacent to the towns. The trains, running along the roadsides, would be dangerous to life and limb, and would injuriously affect the property near which they would pass. They would spoil the sporting and diminish the demand for horses. It was a paper which might have been listened to as usual in connection with railways sixty years ago.

Mr. J. W. Batten moved a vote of thanks to Mr. Pain, and said that pessimistic people were beginning to see that light railways would benefit the rural districts. Having spent about seven millions of other people's money in making railways, he had had opportunities of observing the effect of railways, and he had the assurance of landowners and their agents in the West of England that the rent had trebled and that the land had risen in value in the market, as the result of the rapidity with which produce—strawberries, for instance—could be put on the market. In Cornwall they might often see train after train with produce which could never have reached the London market but for the railway facilities. Wherever they got a railway they got this increase of value, which went into the pockets of the consumer. It might seem to some people a strange thing that they should have a meeting of that kind, so intelligent and so experienced, to consider the question of light railways and how to get them, when they had within 200 miles of that very door a series of railways which were second to none in the world, those in Holland, and when they had the Belgian and other systems, some of which they had probably visited. But in the matter of light railways they were in the position of lagging behind in this country, although they were the pioneers of railway enterprise. During the last few months he had travelled on these light railways—he would not call them "light," it was really a misnomer. There should be a classification, first, second, and third-class railways; and the test should be the speed and the weight upon the axle. Let the primary, the trunk, railways be inspected by the Board of Trade, *usque ad nauseam*, if they liked; let them make some relaxations when dealing with the secondary railways, those having a speed of not more than twenty miles an hour, and not more than ten tons on the axle. But let them do as they did on the Continent, if trains did not run at a higher speed than 12½ miles an hour and, had not more than eight tons on the axle, let the line be free of all control whatever. The reason why people in this country had not put their money into tertiary or light railways was the enormous expense of complying with the Board of Trade regulations as to signalling, bridges, and platforms. What are the faults of the Bill? It did not cut them entirely free from Board of Trade inspection. Then, again, there was no provision in the Bill enabling the existing railway companies to make or work the lines. It was idle for a body of promoters to plan a line if the main line with which it was to connect was apathetic or perhaps antagonistic. The Government should boldly say to the existing companies, "There are wanted in your vicinity a very large number of branch railways; if you will make those railways with your old main line rails and use your old rolling stock we will guarantee you two per cent." If the Government would guarantee a minimum two per cent. it would be worth while to make 400 or 500 miles of line each year, and with very moderate receipts the lines would prove profitable. Let them not think that 400 or 500 miles of line was a small amount to be made. During 1860-65 they were making between 500 and 600 miles a year, but in the last five or six years they were making less than 200 miles a year.

Mr. Christopher Oakley seconded the vote of thanks. He said he was not one of those who thought that the light railways would effect any very great improvement in the agricultural condition of the country, but they must not throw cold water on anything that was likely to alleviate the distress. As to some of the views expressed by the reader of the second paper, he hoped that it would not be thought that that Institution as a body held such views in regard to any public improvement. Landowners would meet such schemes in a liberal spirit.

Mr. W. W. Acworth, referring to the constitution of the Commission, said the Bill proposed to set up a court of two amateurs presided over by a gentleman who valued his professional prospects so highly that he was willing to take £1000 a year for five years, with the prospect of being cast aside at the end of the period. To do that would be merely to court failure. It was proposed to spend some millions of public money, and the only protection against the great railway companies making a hard bargain, which, in the interest of the shareholders, they must try to do, was that the Commissioners would know their business sufficiently to face the trained representatives of the great railway companies on terms of equality. The thing had been tried in Ireland with unsatisfactory results, and the same thing would happen in this country. That was the worst blot in the Bill, and he hoped it would be removed in the passage of the measure through Parliament.

Mr. P. W. Meik said that he agreed with much that had been said that evening, and he thought they must now take it for granted that light railways were desirable. He had had experience partly in the West, and also in Scotland and the North of England, and he could say that light railways were certainly desirable, and were so regarded by most landlords. Indeed, it was in consequence of that fact that he turned his attention to the matter at all. In railway matters they could not get very far without finding that a small line for two trains a day could not run without much the same regulations as the London, and North-Western Railway. That was the ruination of the smaller lines. The Board of Trade officials would not take the responsibility of allowing some of the things which they themselves considered to be reasonable. He would be glad if the Bill gave the officials more power to relax the rules. The clauses relating to capital were to his mind rather vague. It was a little difficult to understand how far Government intended to go. He gathered that the most that the Government intended to do was to subscribe the last quarter of the capital; that was to say, the promoters must first have three-fourths of it. As a rule, if they could get three-fourths there was not much difficulty about the remainder. The capital, too, was limited by the very objectionable clause requiring that the line should be worked by an existing railway company. It was, no doubt, very desirable that the lines should be worked by existing companies, but it would be highly objectionable to make that arrangement compulsory. It practically put the light railway into the hands of the adjoining railway company. Proper provision must be made to ensure the lines being kept open. Another important point was the possibility of a double inquiry in some cases. The Commission was a weak one, and the Government showed that it thought it was a weak Commission, because they could not trust it. If it was a strong body, the Government could confer upon it strong powers and finality. In several respects the method of procedure instituted by this Bill promised to be as costly as procedure by present methods.

Mr. Batten said that the clause empowering the adjoining company to work the lines was taken from the Irish Acts.

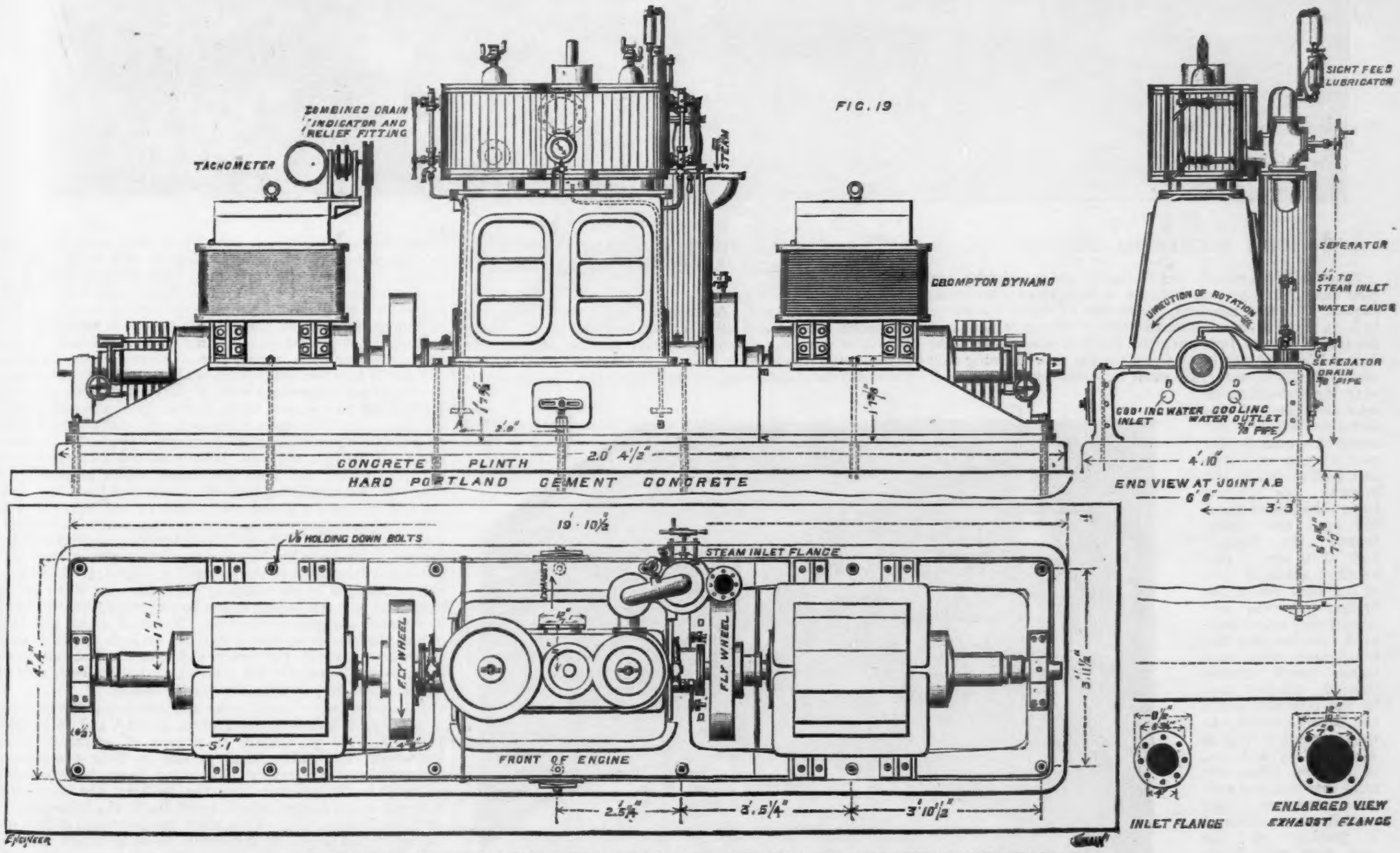
Mr. C. J. Owens said that to him, as a railway man, this was a matter of very great interest. He did not look upon light railways as the great panacea for agriculture, but he did think that they would assist the development of many quarrying districts and small seaside villages. Lines suitable for such work could be carried on with very small expense. He thought with regard to the Commission that to refer such questions to a body composed, as Mr. Acworth said, of two amateurs and a professional, would be a great mistake.

Mr. J. B. Walton said he thought that the Bill failed in two particulars. First, in regard to the Commission. He quite thought that if the Commission was to be of any practical value, the members must be men of practical experience. That was impossible for the amount put down in the Bill. The practical working of the Act would depend upon the Commissioners, and unless they thoroughly understood the work the Bill would be a failure. While the second point was, that it was doubtful which of the interested parties should take the initiative. Another blot in the Bill was, that there was no clause giving the existing railways power to subscribe to the capital of the light lines, to work them, or to give a rebate upon the traffic.

Sir George Leach said that an extensive experience with light railways in the north of Ireland, in India and elsewhere, including Bolivia, showed him that the narrow-gauge gave speedy and economical travelling. He thought, however, that the Bill should contain powers for the construction of ordinary tramways for use along the country roads.

Replying to the vote of thanks, Mr. Pain said it seemed to be the feeling of every speaker who had discussed the point that if the Government appointed really strong Commissioners, they would see a large extension of light railways all over the country. The difficulties and dangers apprehended by Mr. Christie would disappear as they did in the middle of the century.

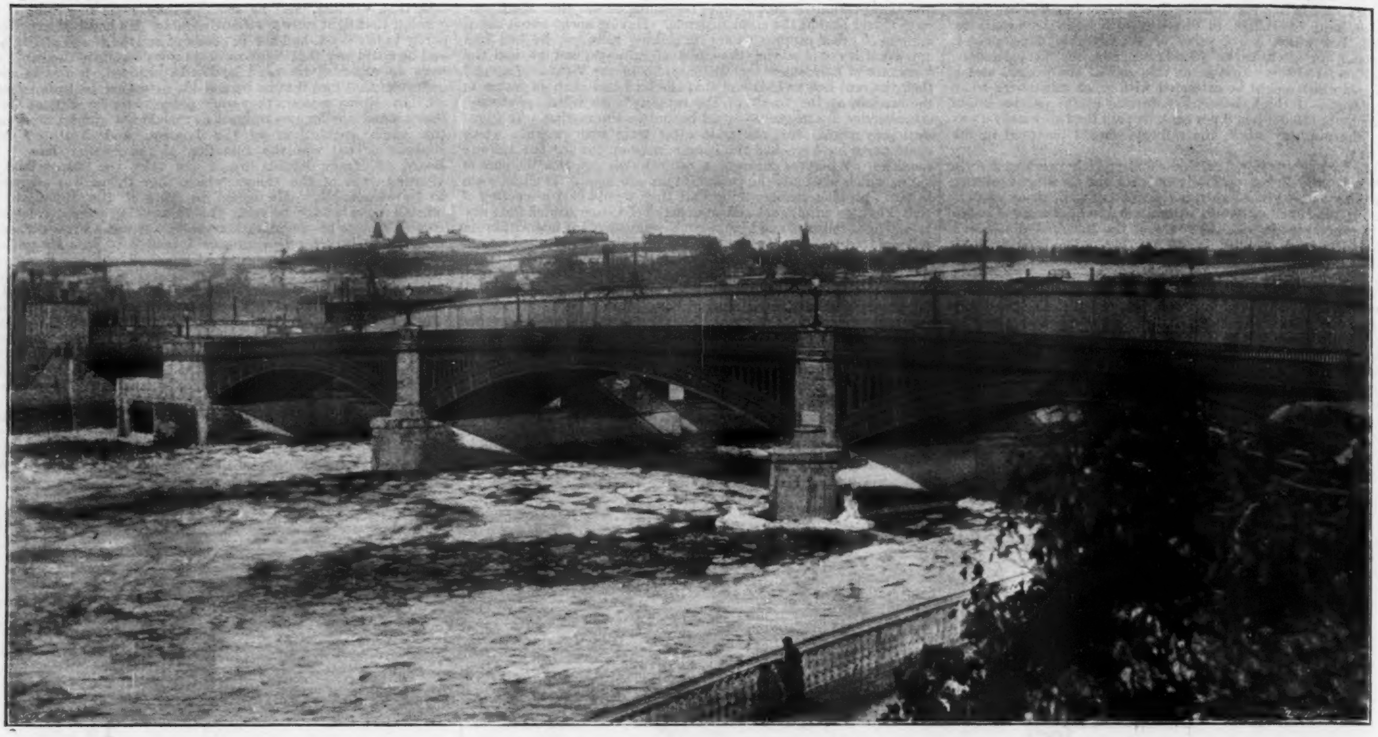
Mr. Christie having replied, the proceedings terminated.



ST. PANCRAS ELECTRIC LIGHT INSTALLATION—PLAN AND ELEVATION OF ENGINE AND DYNAMOS

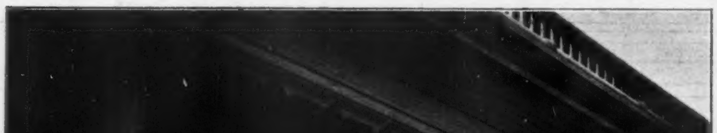
THE CAST IRON BRIDGE OVER THE MEDWAY AT ROCHESTER, 1856.

SIR W. CUBITT, ENGINEER

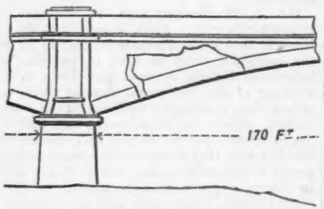


THE ROCHESTER BRIDGE.

TWICE within a month the Rochester roadway bridge has been damaged by passing lighters or by lighters attempting to pass. The first accident, the results of which are shown in Figs. 2 and 3, occurred on the 20th of February last; and the second on the 14th inst. In the first case, as the light lighter Diamond was being towed up the river, drawing only about 3ft. 6in. of water, she came into contact with the arch near the springings, as seen, and, being of considerable weight, she removed a considerable part of the cast iron arch girders before she brought up. When loaded she carries about 350 tons, and trades between the Thames and Humber. She knocked about 25 tons of ironwork out of the bridge, but was not herself very much damaged. On Saturday last two lighters which were being towed abreast through another arch by the powerful steam tug Royalist, which, like the Diamond, belongs to Messrs. Cory and Co., of London, when she came into collision with the structure, and caused some damage, a portion of the cast iron work being broken. The vessels themselves were also injured; one had all her gear swept clean off the deck. Mariners complain that the design and construction of the bridge are such as to place very great difficulties in the way of modern craft passing through the arches. We illustrate the bridge by the above engraving. It crosses the river Medway near the railway bridge, and was designed by Sir William Cubitt, and constructed under him by Mr. John Wright, as resident engineer. It connects the towns of Strood and Rochester, and was completed in 1856. It has a clear width of about 40ft., and is entirely of cast iron on masonry piers, the swing bridge at the Strood end being of wrought iron girders. The bridge is of interest as being one of the earliest examples of the Hughes method of sinking foundation cylinders by means of compressed air. The total weight of ironwork is about 2500 tons. The view at the top of this page shows the character and position of the bridge, and the enlarged view of the broken girders gives a good idea of the damage done. For the tracings and photographs from which our engravings are prepared, we are indebted to the consulting engineer to the Rochester Bridge Wardens, Mr. V. de Michele, M. Inst. C.E.



VIEW OF CAST IRON GIRDERS BROKEN BY THE "DIAMOND"



View Showing Position of Fractures

EXPRESS PASSENGER LOCOMOTIVE, MANCHESTER, SHEFFIELD, AND LINCOLNSHIRE RAILWAY.

WE have much pleasure in illustrating this week the express passenger bogie locomotive engines designed by Mr. Harry Pollitt to work the express passenger service on the new London line which is at present in course of construction. There are six of these engines running on the London service between Manchester and Grantham, and there are thirty of the same type at present being built at Gorton. The chief feature of the engine is the "Belpaire" fire-box, which Mr. Pollitt has adopted as the standard pattern for all his locomotive boilers, and the centre of gravity of the engine being pitched up very high causes the engine to ride very smoothly.

The steam sanding arrangement is Messrs. Gresham and Craven's latest pattern. As well as under the driving wheels, Timmis's springs are fitted under the trailing wheels, and Messrs. Spencer Moulton's assistant springs fitted to both. As these engines are intended for long runs without intermediate stops, a tender has been designed to carry 4080 gallons. The webs of the crank axle are made egg-shape, with the greatest width opposite to the crank pin. The usual intermediate side buffers between engine and tender are not employed, and in their place is fitted one large central spring, resting in two castings, one on the engine and the other on the tender. This arrangement is found to effectually prevent any loose or jerky motion between the engine and tender. It reduces flange friction, and entirely obviates leaky feed-water connections. By the courtesy of Mr. Pollitt, we are enabled to add the specifications for the testing of materials which he has recently got out for these engines.

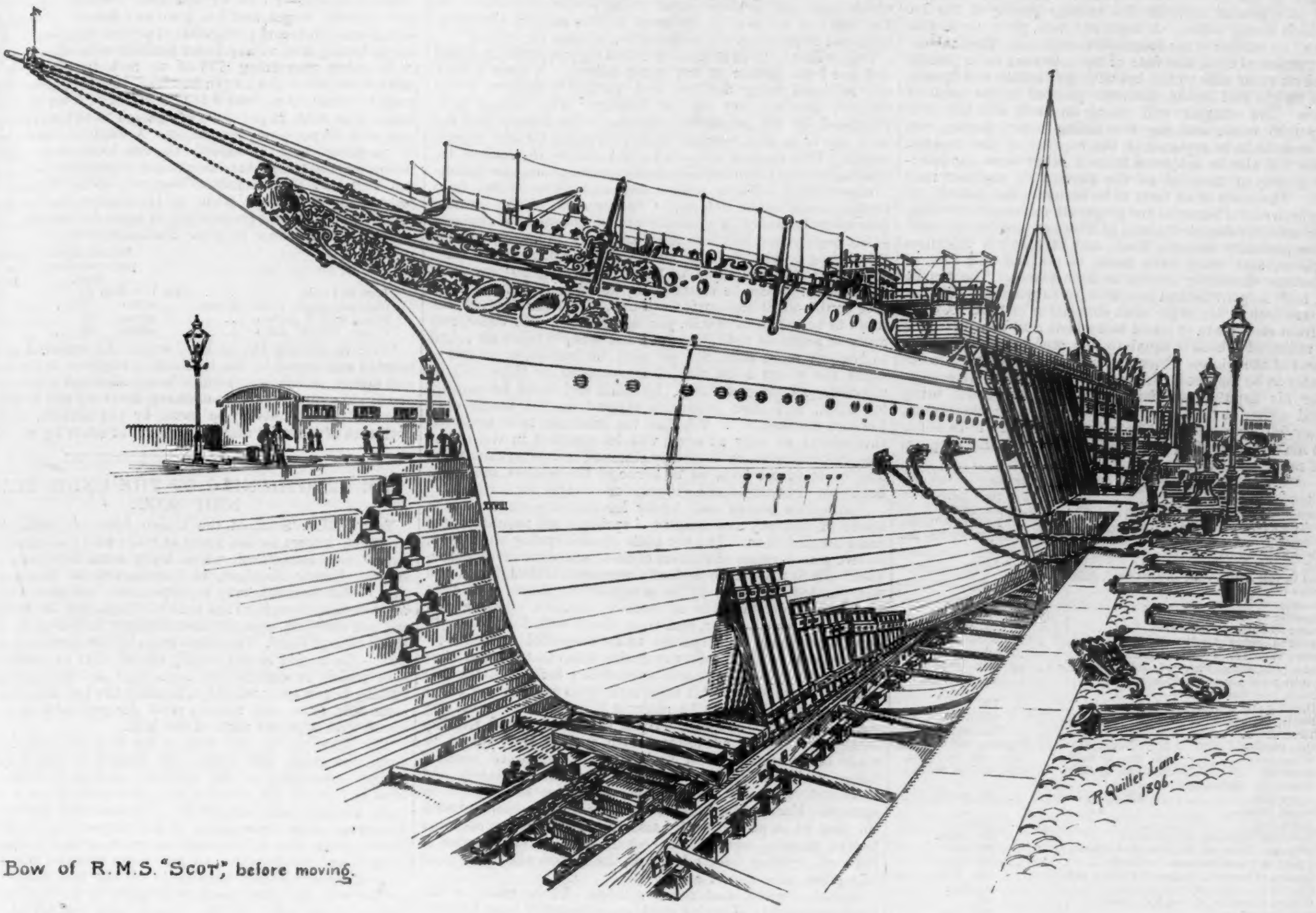
Locomotive crank axles.—The axles to be made of Siemens open-hearth steel, extra quality, and to be well annealed. An inspector will stamp the blocks in both webs before being broken out, which, after having been marked with the corresponding number of axle from which they are taken, must be subjected to the same annealing as and along with the crank. To remove the blocks, the webs must be sawn down as close as possible to a drilled hole through the web. Wedging will not be allowed. The crank pins to be rough turned—to dimensions given on tracing—before axle is annealed. All particulars of process of annealing to be furnished. Each axle must bear, both lengthwise and crosswise, a tensile strain of from 28 tons per square inch with 35 per cent. elongation, to 30 tons per square inch with 32 per cent. elongation, and a copy of the mechanical tests, signed by the makers, must accompany the test pieces from each axle, and clearly denote by number or marks the axles from which the tests have been made. A bar 1$\frac{3}{4}$in. square and 8in. long, with corners rounded to $\frac{1}{16}$in. radius, cut from the throw, either lengthwise or crosswise, to stand being doubled cold without fracture. Tensile and elongation tested with standard test bar, which is ·798 of an inch diameter, equal to ·5 of a square inch, and 2in. long. Tests to be witnessed by locomotive engineer or his deputy. Duplicate bending and tensile test pieces to be prepared and forwarded to the locomotive engineer. Each axle will be stamped by the company with the date when put to work, and any axle failing before having run 150,000 miles to be replaced at expense of makers. Name of maker and date of manufacture to be plainly stamped on both cranks of each axle whilst hot with $\frac{1}{2}$in. letters and figures. The cost of all tests to be borne by the makers, including both cost of material and preparations of same for testing.

Locomotive engine and tender straight axles.—To be made of Siemens open-hearth steel, extra quality, and to be well annealed. All particulars of process of annealing to be furnished. The makers shall provide at their own expense one additional axle in every twenty-five, or any lesser number ordered, to be selected from the bulk by the locomotive engineer or his deputy, which must stand the following test without fracture, viz.:—Five blows from a weight of 2000 lb., falling from a height of 25ft. upon the axle, which shall be placed upon bearings 3ft. 6in. apart, and turned after each blow. The test to be continued until the axle breaks. Then a tensile test piece to be taken, measuring ·798in. diameter and parallel for 2in.—the length in which the elongation is to be gauged—which must bear a strain of 32 tons per square inch with from 32 to 35 per cent. elongation, and a copy of the mechanical tests, signed by the makers, must accompany the test pieces, and clearly denote by number or marks the axles from which the test has been made. A piece, about 15in. long, showing fracture, to be slotted from the broken axle, and sent, together with a prepared duplicate test piece, carriage paid, to the locomotive engineer. Each test to be held to represent correctly the average quality of the material employed in manufacture. Each axle will be stamped by the company with the date when put to work, and any axle failing before having run 200,000 miles to be replaced at the expense of the makers. The makers' name and the date of manufacture to be well stamped in two places upon each axle whilst hot, with $\frac{1}{2}$in. letters and figures. The axles to be tested, as described, in the presence of the locomotive engineer or his deputy; and if the tests are not satisfactory, or should any defects develope during machining, power is reserved to reject any or the bulk of axles from which the tests have been made. The costs of all tests to be borne by the makers, including both cost of material and preparation of same for testing.

Locomotive engine and tender tires of Siemens open-hearth steel, extra quality.—The makers shall provide, at their own expense, one additional tire in every fifty, or any lesser number ordered, to be selected from the bulk by the locomotive engineer or his deputy, which must stand the following test without fracture, viz.:—A weight of one ton falling upon it from a height of 15ft., 20ft., 25ft., and 30ft. successively, until a compression of 2in. per foot of inside diameter is reached; or, if desirable, the same result may be obtained by hydraulic pressure; the compression to be continued until the tire is doubled up or broken. Then a tensile test piece to be taken, measuring ·798in. diameter, and parallel for 2in.—the length in which the elongation is to be gauged—which

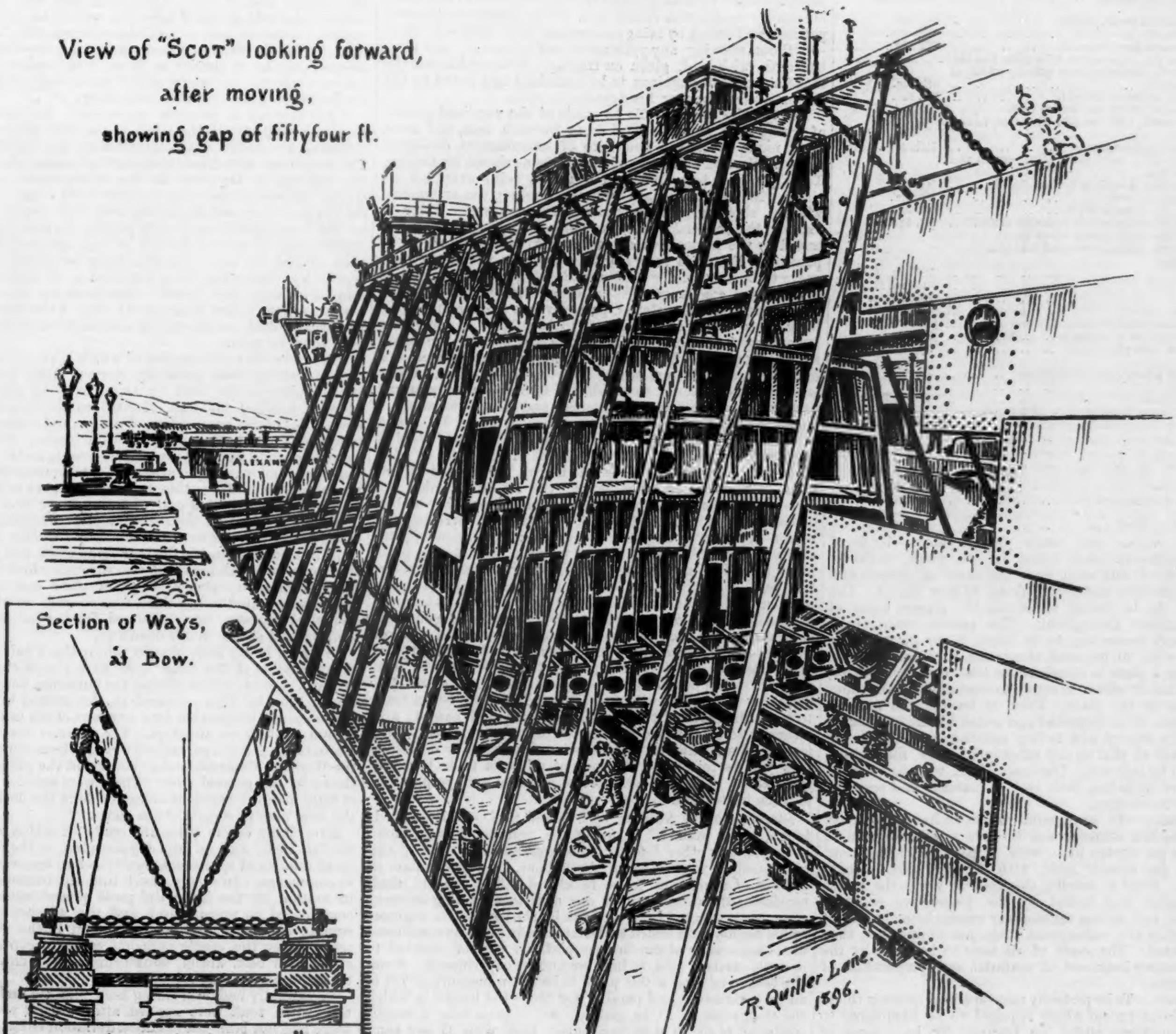
LENGTHENING THE CAPE MAIL STEAMSHIP SCOT

(For description see page 292)


SCOT
R. Quiller Lane.
1896.

Bow of R.M.S. "Scot," before moving.

View of "Scot" looking forward, after moving, showing gap of fiftyfour ft.


Section of Ways, at Bow.
0 2 4 6 8 10 ft.
R. Quiller Lane.
1896.

must bear a strain of from 48 tons per square inch, with 20 per cent. elongation, to 45 tons per square inch, with 23 per cent. elongation. If broken, a piece about 15in. long to be cut out of the tire showing the fracture, and sent, carriage paid, to the locomotive engineer. Each tire tested to be held to represent correctly the average quality of the lot from which it was taken. A duplicate test piece to be prepared and forwarded to the locomotive engineer. The makers' name, number of cast, and date of manufacture to be plainly stamped on outer edge whilst hot with ½in. letters and figures, and the weight and inside diameter painted on the inside of each tire. The company will stamp on each tire the date when put to work, and any tire failing before having run twelve months to be replaced at the expense of the makers. The tires will also be subjected to such other tests for hardness or quality of material as the locomotive engineer may require. The costs of all tests to be borne by the makers, including both cost of material and preparation of same for testing.

Boiler and fire-box shell plates of Siemens open-hearth steel.—To be perfectly smooth, level, and of uniform thickness throughout, and must have name of makers and date of manufacture distinctly shown in four places. The tensile strain, both lengthwise and crosswise, to be from 27 to 32 tons per square inch, with 20 per cent. elongation in 10in. A piece taken from each plate to stand being bent cold to a curve, the inner radius of which is equal to one and a-half times the thickness of the plate. Prior to leaving the makers' works the plates to be inspected and tested by the locomotive engineer or his deputy, and failing satisfactory results being obtained either at that or any subsequent stage, machining, &c., they will be rejected. The costs of all tests to be borne by the makers, including both cost of material and preparation of same for testing.

Dimensions of M. S. and L. Engine.

Cylinders, diameter	1ft. 6½in.
Piston stroke	2ft. 2in.
Steam ports	1½in. by 1ft. 4in.
Exhaust	3½in. by 1ft. 4in.
Lap of valves	1in.
Max. travel of valve	4 3/16in.
Lead in full gear, 1/32in.; in mid gear, 3/16in. bare	
Throw of excentrics	6¼in.
Diameter of sheaves	1ft. 5¾in.
Diameter of piston-rods	3⅝in.
Centre to centre of cylinders	2ft. ½in.
Centre to centre of valve spindles	6¾in.
Centre to centre of expansion links	5¼in.
Crank pins, connecting-rod, diameter	8½in. by 4¼in.
Coupling-rod pins, diameter	4in. by 4¼in.
Wheels, cast steel centres—	
Driving and trailing, diameter	7ft.
Bogie, diameter	3ft. 6in.
Tires	5½in. wide by 3in.

Axles, steel—	Bogie.	Driving and trailing.
Wheel seat	6½in. dia. by 6 11/16in.	8¾in. dia. by 7 3/16in.
Journals	5¾in. dia. by 9in.	8in. dia. by 9in.
Centre to centre of journals	3ft. 8½in.	3ft. 10½in.

Frames, steel—	
Thickness	1 1/16in.
Distance between, at cylinders	3ft. 11½in.
Distance between, over coupled wheels	4ft. 2in.
Front of frame to centre of bogie	5ft. 3¼in.
Centre of bogie to centre of driving axle	10ft. 3¼in.
Centre to centre of bogie wheels	5ft. 9in.
Centre to centre of coupled wheels	9ft.
Total wheel base	22ft. 2in.
Total wheel base, engine and tender	44ft. 8in.
Total length over buffers	53ft. 10¾in.
Boiler, steel—	
Mean diameter of barrel outside	4ft. 8in.
Length of barrel	11ft. ½in.
Height of centre line from rail	7ft. 11in.
Barrel plates ⅝in., smoke-box tube plate 1in. thick	
Fire-box shell, Belpaire form (steel), width at bottom outside	4ft. 1in.
Ditto, length at bottom outside	6ft. 4in.
Steam pressure, 170 lb. per square inch	
231 copper tubes, 1¾in. outside diameter, 11 and 13 B.W.G.	
Length between tube plates	11ft. 4½in.
Saddle plate ⅝in., back plate 9/16in., crown and side plate ½in.	
Fire-box, copper, length at bottom, inside	5ft. 8⅝in.
Fire-box, copper, width	3ft. 6in.
Fire-box, copper, mean depth	5ft. 5in.
Fire-box, copper, top of box to inside of shell	1ft. 5⅞in.
Tube plate 1in. thick, below tubes ⅞in.	
Back plate ⅝in. thick, crown and side ½in.	
Heating surface—	
Tubes	1209 sq. ft.
Fire-box	109 sq. ft.
Total	1318 sq. ft.
Grate area	20 sq. ft.
Ratio of grate area to heating surface	1 : 65·9
Smallest diameter of chimney	1ft. 2in.
Diameter of blast pipe nozzle	5 1/16in.
Tender—	
Diameter of wheels, cast steel centres	4ft. 3in.
Wheel base	13ft.
Capacity of tank	4080 gallons

Weights (estimated), engine in working order—	Tons	cwt.
Bogie	15	9
Driving	16	7
Trailing	15	2
	46	18
Tender in working order	40	10
Total	87	8

Locomotive engine and tender frame plates.—To be of Siemens open-hearth steel, rolled in one plate, perfectly smooth and level, and must have the name of makers and date of manufacture distinctly shown in four places. The greatest care to be taken to ensure the frames being of uniform thickness throughout. The tensile strain, both lengthwise and crosswise, to be from 27 to 32 tons per square inch, with 20 per cent. elongation in 10in. A piece taken from each plate to stand being bent cold to a curve, the inner radius of which is equal to one and a-half times the thickness of the plate. Prior to leaving the makers' works the plates to be inspected and tested by the locomotive engineer or his deputy, and failing satisfactory results being obtained, either at that or any subsequent stage, machining, &c., they will be rejected. The costs of all tests to be borne by the makers, including both cost of material and preparation of same for testing.

General plates.—To be of mild steel. To have a perfectly clean and smooth surface, and to bear a tensile strain of from 26 tons per square inch, with 20 per cent. elongation, to 30 tons per square inch, with 17 per cent. elongation in 10in. Prior to leaving the makers' works the plates to be inspected and tested by the locomotive engineer or his deputy, and failing satisfactory results being obtained, either at that or any subsequent stage, machining, &c., they will be rejected. The costs of all tests to be borne by the makers, including both cost of material and preparation of same for testing.

Copper plates.—To be perfectly smooth and of uniform thickness throughout, except where required to be hammered to shape and thickness shown on tracing. To have name of makers and date of manufacture distinctly shown in four places. On each plate a test strip to be provided, which must bear being doubled cold without showing any sign of fracture, and the plates to stand flanging without showing any defects whatever. Prior to leaving the makers' works the plates to be inspected and tested by the locomotive engineer or his deputy, and power is reserved to reject any which may not be considered to be perfectly satisfactory. The costs of all tests to be borne by the makers, including both cost of material and preparation of same for testing.

Copper bars.—To be of best soft rolled copper, perfectly round and free from surface or any other defects. A piece of each bar to stand being doubled cold until the surfaces touch without showing any sign of fracture. The testing to be witnessed by the locomotive engineer or his deputy, and the tests are to be sent, carriage paid, to him for further experiments. The costs of all tests to be borne by the makers, including both cost of material and preparation of same for testing.

Copper tubes.—To be solid drawn and perfectly free from surface or any other defects. One per cent. of the number ordered to be tested in presence of the locomotive engineer or his deputy, and the ends must stand the following tests:—Expanding: the diameter to stand enlarging 20 per cent. Flanging: the diameter to stand enlarging 30 per cent. Flattening: pieces to stand being hammered flat and bent over double until the surfaces touch. Two per cent. of the tubes to be tested to 500 lb. per square inch with water, and must be perfectly tight. If upon analysis the tubes are found to contain more than one per cent. of impurities, or fail to stand the above tests, the lot represented by them will be rejected. In tapered tubes, the thick end must be parallel for 12in., and then gradually tapered on the inside only towards the thin end. Whether the tubes are to be annealed throughout, or only at ends, will be specified in the order. The maker's name to be clearly stamped in full on each tube. The costs of all tests to be borne by the makers, including both cost of material and preparation of same for testing.

Locomotive engine and tender laminated springs.—To be made of the very best quality of spring steel, manufactured from Swedish iron. The top plate of each spring must bear, in two places, name of makers of steel and date of manufacture. Each plate to be perfectly tempered, nibbed, fitted, and well painted. Springs to be scragged six times, each time 1in. beyond loaded line of camber, without showing any permanent set whatever, and then tested with load to length given on tracing. The springs to be inspected by the locomotive engineer or his deputy during manufacture, and they must be tested under such supervision before leaving the maker's works; the whole to be strictly to tracing, and to his entire satisfaction, and he reserves the power to reject any which may not be considered equal to the stipulated requirements. If buckles are ordered with springs they are to be made of Lowmoor or best Yorkshire iron—stamped, soundly forged, with rounded corners to fit the springs accurately, and to be well secured. To be inspected before being fixed on springs. Each spring will be stamped by the company with the date when put to work; and if before the expiration of twelve months any failure occurs, the original camber is reduced, or other defects develope, the makers will be required to replace same free of cost.

Spiral, conical, and volute springs.—To be made of the very best quality of spring steel, manufactured from Swedish iron, and to bear the name of maker and date of manufacture. Section of steel to be as given on tracing, and ends to be ground off exactly square with centre line. To be perfectly tempered, painted, and tested by being compressed until solid—six times—without showing any permanent set whatever; and to be to length, with load, given on tracing. Prior to leaving the makers' works, the springs to be examined and tested by the locomotive engineer or his deputy.

Safety valve springs.—To be made of the very best quality of spring steel, manufactured from Swedish iron, and must have name of maker and date of manufacture distinctly shown. Section and ends of coils to be as shown on tracing. To be perfectly tempered, and tested by being extended six times with load, to length between hooks given on tracing, without showing any permanent set whatever. Prior to leaving the makers' works, the springs to be examined and tested by the locomotive engineer or his deputy, and to be painted. Power is reserved to reject any which may not prove to be satisfactory in all respects.

Cast steel wheels of Siemens open-hearth steel.—To be of good, tough, sound material, perfectly free from honeycomb, blow-holes, or any other defects; to be subject to annealing for at least fourteen days, and of the best possible workmanship throughout. The makers shall provide at their own expense one additional wheel in every twenty-five, or any lesser number ordered, to be selected from the bulk and tested by being raised in a running position and allowed to fall upon a solid foundation from heights commencing at 10ft., and continuing by advancing 5ft. each drop until the wheel is destroyed. Should any wheel break at either 10ft. or 15ft. drop, and develope fractures which give indications of unsuitable material or other defect, the lot from which the test wheel was taken will be rejected. From the broken wheel portions will be selected for forwarding, carriage paid, to the locomotive engineer for further experiments; and also a piece will be stamped from which a tensile test piece must be taken, measuring when finished ·798in. diameter, and parallel for 2in.—the length in which the elongation is to be gauged—which must bear a strain of from 28 tons per square inch, with 27 per cent., to 30 tons, with 24 per cent. elongation. On the rim or a spoke of each wheel a piece of suitable size to finish 1in. square must be cast, which, before being removed, must be stamped by the inspector, and then tested by being bent cold to a right angle round a bar 3in. diameter without showing any signs of fracture. No castings to leave the makers' works until inspected and passed; and although to all outward appearance they may appear satisfactory, should they on being machined prove to be defective, they will be rejected. The costs of all tests to be borne by the makers, including both cost of material and preparation of same for testing.

Steel castings of Siemens open-hearth steel.—To be of good, tough, sound material, perfectly free from honeycomb, blow-holes, or any other defects; to be well annealed, and of the best possible workmanship throughout. All particulars of process of annealing to be furnished. The makers shall provide at their own expense one additional casting in every class, to be selected from the bulk by the locomotive engineer or his deputy, and tested to destruction in any way considered necessary—some of the broken portions will be selected to be sent, carriage paid, to him for further experiments. From the broken casting a test piece to be taken measuring ·798 of an inch diameter, and parallel for 2in.—the length in which the elongation is to be gauged—which must bear a tensile strain of from 30 tons per square inch with 17 per cent. elongation to 33 tons per square inch with 15 per cent. elongation. No castings to leave the makers' works until inspected and passed; and although to all outward appearance they may appear satisfactory, should they on being machined prove to be in any way defective they will be rejected. The costs of all tests to be borne by the makers, including both cost of material and preparation of same for testing.

Steel forgings.—To be of the best Siemens open-hearth steel, soundly forged, and free from any defects. Forgings to be well annealed, and particulars of process furnished. From one in twenty-five, or any lesser number ordered, a test piece to be taken measuring ·798 of an inch in diameter, and parallel for 2in.—the length in which the elongation is to be gauged—which must bear a tensile strain of from 43 tons per square inch with 22 per cent. elongation to 45 tons per square inch with 20 per cent. elongation. A duplicate test piece to be prepared and forwarded to the locomotive engineer. Before leaving the makers' works the forgings to be inspected and tested by the locomotive engineer or his deputy. The costs of all tests to be borne by the makers, including both cost of materials and preparation of same for testing.

Tests for Lowmoor or other Yorkshire iron.—

		Tensile strain per square inch. Tons.	Elongation in 10in. Per cent.
Bars and rods	not less than	22	25
Channel, angle, T and H iron	ditto	22	23
Plates with the grain	ditto	22	16
Ditto across ditto	ditto	20	12

Prior to leaving the makers' works the material to be inspected and tested by the locomotive engineer or his deputy, and failing satisfactory results being obtained either at that or any subsequent stage, machining, &c., they will be rejected. The cost of all tests to be borne by the makers, including both cost of material and preparation of same for testing.

THE LENGTHENING OF THE UNION STEAMSHIP SCOT.

The R.M.S. Scot, of the Union Line of South African steamers, known in the trade as "the white albatross of the Cape," was considered, when built some five years ago by Messrs. Denny Brothers, of Dumbarton, to be a very long ship. However this may be, experience has proved that she was not long enough, as she is now in Belfast to be lengthened, and her carrying capacity considerably increased by Messrs. Harland and Wolff. They have engaged the Alexandra graving dock—the largest in the world, except that at Southampton—in which to execute the somewhat delicate operation of cutting her in two amidships, hauling the two halves asunder some 50ft. or so, and making good the gap between to correspond with adjacent parts of the hull.

The drawings in our issue of the 28th ult., together with those now given, will enable our readers to form a tolerably correct conception of the methods adopted by Messrs. Harland and Wolff for carrying to a successful issue a work of such delicacy and magnitude. To add still further to the somewhat brief description of the preparation for the work in our issue already referred to, we may say that after the huge vessel had been docked, the water pumped out, and due time allowed for any settlement on the keel blocks, which, by the way, had been specially prepared by having hard wood blocks, about 12in. by 12in., capped with iron plates, secured on top, work was commenced to prepare means for moving the forward half of hull. Launching ways were laid underneath, supported at short intervals on blocks of timber and wedges, extending from admidships to about 60ft. beyond her stem. After the ways had been thoroughly levelled and well greased, baulks of timber in pairs, 18in. square, were then laid as a base for the cradle which was to support and steady the hull during the operation of moving.

While this was in progress underneath, drillers were hard at work boring out all the rivets in the shell plating, frames, stringers, &c., in line with the midship water-tight bulkhead. The numerous stanchions carrying the promenade deck were also removed as far aft as the line of separation referred to, strong timber shores being securely fixed to the edge of this deck by angle bars and chains, the lower ends resting on wedges on the upper tier of small steps joining the dock altars. The lower edges of various houses on the spar deck below were then severed by all rivets, &c., being bored out, chains and screws for tightening being attached at the bottom to short lengths of angle iron bolted to the structure, the upper ends being securely bolted to the outer edge of the framing of the promenade deck, as shown in several of our views, opposite each shore or prop.

The cradle, the construction of which is very clearly shown on our drawings, was gradually erected under her, and was kept in place at the head by angle irons at top and sides, where it touched the hull, rivetted to the skin of the ship, and at the bottom by stretchers of timber, and chains made fast to eye bolts passing through the bottom binder. Strong chains were also slung from the top binder, passing under the keel as indicated, and every precaution taken to prevent the slightest lateral motion. To enable the hauling gear to be securely attached to the hull, a pair of heavy angle iron bars were bolted to her bottom near keel, almost amidship, to which massive chain cables were connected by shackles, and led forward immediately inside the launching ways, and provided at the outer end with heavy blocks, through which the hauling ropes were rove. Other straps of plate iron and double angles were bolted to her sides, four on each, to which chains and steel hawsers were attached further to assist in the hauling, and shown in our drawings.

As stated in our issue already referred to, a pair of powerful steam winches of the latest type were placed at each side of the dock gate or caisson closing the entrance, bolted to logs of timber 12in. by 12in., secured to the ground by angle bars, and rendered immovable by a few tons of pig iron before and behind, resting on the logs. The winches were supplied by steam through a 4in. galvanised wrought iron main from one of the Harbour Commissioners' boilers, in the pumping station shown in our general view. These were assisted by a couple of fully manned capstans at each side of the dock, abreast of the bow, seen in several of our views.

Everything was in place and ready for action on Saturday, the 7th inst., and on Monday morning, in the presence of a great number of spectators, shortly before ten, word was given to commence. In a very short time the immense fabric, set in motion by the hydraulic jacks placed inside amidships, commenced to move ahead, and the winches and capstans coming into play, kept her going, and in the short space of ten minutes the cradle supports came in contact with the stop blocks 54ft. ahead, thus bringing to a close an undertaking of no ordinary magnitude.

So carefully had everything been planned and carried out, that when tests were applied afterwards, it was found that there had not been the slightest deviation either horizontally or vertically in the part moved, as compared with the stern portion.

RAILWAY MATTERS.

What is probably the largest boiler of the locomotive type ever built was recently designed by Mr. F. W. Dean, mechanical engineer, of Boston. The boiler is 10ft. in diameter, has two corrugated furnaces, and has 5300 square feet of heating surface.

At a meeting last week of the committee entrusted with the scheme for promoting a tramway between Ashbourne and Derby, it was decided, in view of pending legislation with regard to light railways, not to proceed further this session with the Derby and Ashbourne Tramways Bill.

The Bois de la Cambre and Schaerbeck line of the Brussels tramways, about 5 kiloms., or three miles long, is to be worked electrically next year on the improved system of Ganz and Co., Budapest, with underground conductor, which will cost, for the two lines, about 30,000f. per kilometre, or £1931 per mile.

The new line from Connah's Quay to Bidston, which will greatly assist the mineral traffic between Wales and Birkenhead, has this week been opened for the conveyance of goods, and it is expected that by the 30th inst. it will be ready for passenger service. The journey from Liverpool and Birkenhead to North Wales will be much shortened.

Mr. Way, the chief engineer of the Assam-Burma Railway survey, has returned to Rangoon with his party. The survey shows that a line by the Hukong Valley would be cheaper and easier to construct than either the Aeng Pass or the Manipur scheme. A railway from Margherita, Assam, to Mogaung, a distance of 320 miles, would cost 400 lakhs of rupees, the only difficulty being the Patkai Range, which would have to be crossed at an elevation of 4000ft. The *Times* Rangoon correspondent says the Hukong Valley is described as a level country, well watered, but sparsely populated.

The State Railways of Massachusetts have now 1155 miles of track, and for the year ending September 30th, 1895, the total income was 13,246,371 dols., and the total expenditure was 12,595,212 dols. According to the report of the Railroad Commission of Massachusetts, the growth of business on these lines was almost phenomenal. There were carried the previous three years, in round numbers, 220,500,000 passengers; last year, 260,000,000, a larger increase than in any two preceding years combined. Of the 39,500,000 additional passengers carried, nearly 29,000,000 were carried on the railways of the eight largest established companies. Over 18,200,000 additional passengers were carried on the lines of the West End Railway, of Boston. This company carried the last year 155,231,506 passengers, or nearly 60 per cent. of the whole number carried on all the street railways of the State. The whole number of persons injured in connection with street railway operation was 1507, of whom 25 received fatal injuries.

At Rochester, U.S., there are about twenty miles of tramway track, and on this and some other lines Mr. J. Lyman made some experiments on the power required for electric traction. The Rochester track was in good condition at the time of the test. The number of cars on the road was forty, each weighing about eight tons and provided with a 15-horse power geared motor. In general the road was level, but in the heart of the town there were some gradients of from 3 to 4·7 per cent. Moving on the level, the necessary tractive power averaged 38 lb. per ton of car, and for the whole run over the four principal routes at 6·5 miles per hour, the average horse-power was 1·4 per car, and the maximum 6-horse power, this latter only being used momentarily. At Buffalo the same average power was required, but the maximum was 6·6-horse power. In a large Western city a car with the axles coupled direct to the motor, without the intervention of gearing, took 0·92-horse power per ton on the average, with a maximum of 4·7-horse power. In wet weather the tractive power required is reduced, the rain acting as a rail lubricant. Wetting of the rails round curves is particularly effective, the requisite traction power being thereby reduced by one-third. Comparative experiments made at Ithaca, N.Y., showed that on gradients the tractive force required exceeds that on the level by more than the theoretical amount.

What we believe to be the first application of polyphase currents directly to electric traction is, says the *Electrician*, now being made by Messrs. Brown, Boveri, and Co., at Lugano, in Switzerland. At this place an electric railway is being equipped with polyphase plant, and will, it is hoped, shortly be ready to start work. Preliminary trials have already been made with successful results. The power for this railway is derived from a waterfall, where a power-house has been installed with a 300-horse power turbine, driving two 150-horse power three-phase alternators. The power is generated at 5000 volts, and a portion of it is used by a chocolate factory near the power-house. The three-phase generators are of a special type, in which the only moving parts are the iron star-shaped pole cores. Both the field coils and the armatures are stationary. Three-phase current for the railway is conveyed at 5000 volts, overhead, over a distance of 12 kiloms—7½ miles—to Lugano, where it is transformed down to 400 volts by ordinary transformers. The power is there distributed to the cars by means of two aërial or trolley lines, the third conductor being supplied by the rails. Three-phase motors on the cars receive power through a double trolley-wheel apparatus; and a special form of controller is used when varying the speed or reversing the car. The motors are designed to give a normal speed of 15 kiloms—9⅜ miles—per hour. The advantages which attend the use of polyphase currents for electric traction are, principally, in enabling power to be derived from a distant source, and in allowing of the use of motors which require no commutator, collector, nor bare electrical conductor upon them. On the other hand, a double trolley line and the duplication of the trolley collector wheels are rendered necessary.

The French Society of Civil Engineers has been discussing a communication of Mr. H. de Grièges on "The Progress of Electric Traction on Railways." This related mainly to what had been done on the Chemin de fer de l'Ouest by the electric steam locomotive Fusée, and to proposals to construct a new one of much larger size. Mr. de Grièges, however, stated that besides hoping, in the course of the summer, to have two of the Heilmann locomotives at work, the company intended to start electric traction on a conductor system on a line between Saint Germain Ouest and Saint Germain Grande Ceinture. Mr. de Grièges stated that the relation between the work done on the pistons and the work returned at the draw-bar in his electric engine was 67 per cent. Mr. Key remarked that the best locomotives on the Nord Railway usually averaged about 55 per cent. Mr. de Grièges stated that the steam engine used was on the plan of the engines used in torpedo boats. Each of the six cranks was worked by a single piston-rod carrying two pistons instead of three. Mr. Bousquet said the efficiency of 67 per cent. corresponded to an efficiency of 90 per cent. for the steam engine, 90 per cent. for the dynamo, and 83 per cent. for the motors. This, however, was the efficiency at the wheel and not at the draw-bar. When allowance was made for the work done in moving the engine itself, the efficiency came down to 39 per cent. Mr. Réné Varennes said the electric locomotive contained a locomotive boiler, a steam engine with quite a number of cylinders, a dynamo, another steam engine with two cylinders used to excite the magnetic field, eight electric motors with their commutators and brushes, not to mention the bearings. It seemed to be a combination of complications, in which were united all the troubles of a fixed installation of electricity, an electric tramway, and an ordinary steam locomotive; and yet, Mr. Varennes complained, people had objected to the compound steam locomotive because it had four cylinders instead of two. After this, no one appears to have said any more.

NOTES AND MEMORANDA.

At a recent meeting of the Paris Academy of Sciences, a paper was read on "Observations on the Subject of Photography through Opaque Bodies," by M. A. d'Arsonval. In reviewing the work of M. G. Le Bon and his critics, it is shown that their results are not necessarily contradictory. The solar rays do not appear to penetrate a thin plate of metal, even of aluminium; if a plate of glass, however, especially a fluorescent glass, be placed above the metal screen, the photographic plate is affected.

None but domestic paving materials may be used in New York State if a Bill now before the Legislature succeeds in its passage. The Bill is practically aimed at foreign asphalt companies, as no other material would be affected. The foreign brands are the Trinidad, Venezuelan, and European rock asphalts, now controlled by about seven competing companies. The only American asphalts yet fully developed are those of Lower California and Utah. The foreign companies affected do not regard the Bill seriously, and look upon it as too unreasonable and unjust to pass. It is questionable whether such a statute would be sustained by the courts even if it were enacted.

A paper on the invisible radiations emitted by phosphorescent bodies, by M. Henri Becquerel, is published in a recent number of the *Comptes Rendus*. The light emitted by crystals of uranyl-potassium sulphate, $K(UO).SO_4 + H_2O$, can pass both through thin sheets of metal and also through black paper. This effect was first shown by covering a sensitive film with a metal screen, placing some crystals of the double sulphate on this, and then exposing to sunlight. But it was afterwards found that the crystals exerted the same photographic effect in the dark, a phenomenon which can hardly be attributed to phosphorescence, since $\frac{1}{150}$th of a second after exposure to light, these radiations are no longer visible.

The German manufacture of wire nails, the principal seats of which are in the Rhine Province and Westphalia, as well as at Osnabrück in Hanover, and Gleirvitz in Silesia, has so much increased during the last fifteen years that, after having met a gradually growing internal consumption, it has increased its exports by about 250 per cent. In 1880 the production was only 1645 tons; and in 1890 it had risen to 41,040 tons, while last year it attained 56,424 tons. The value of the exports during these fifteen years amounts to about 110,000,000 marks (£4,400,000). Nearly half the exports are taken by Great Britain for 14,300 tons, and Japan for 12,500 tons, while the Indian Empire absorbs 3730 tons, and Australia 2770 tons.

The recent discovery of argon in atmospheric air, by Lord Rayleigh and Prof. Ramsay, aroused such great interest, that it has been resolved, on the repeated request of the "general public," to prepare a volume containing an account of the methods of extracting the new gas from air, and of its properties, explaining, where necessary, in popular language, the basis of the reasoning employed in drawing conclusions relative to argon. The little work, which has been written by Prof. Ramsay, and will be published by Messrs. Macmillan and Co., treats of all the progress made in this fascinating branch of chemistry by a number of men, almost all of them English. *Nature* says the volume will contain portraits of Cavendish, Boyle, Lavoisier, and other early discoverers.

Considering the importance to the living of the discontinuance of the extension of graveyards and cemeteries, it is satisfactory to find that cremation as a means of disposal of the dead is steadily gaining favour. From the report of the Council of the Cremation Society for 1895, we see that 150 cremations were carried out at Woking during the year, and 58 at Manchester. When the society commenced operations in 1885, only three bodies were cremated, but this number has continuously increased since that year. At the present time, the crematorium at Manchester is the only one in operation in England besides the one at Woking. Another is, however, *Nature* says, being erected near Liverpool, and will shortly be opened for use; and last November a building, comprising a crematorium, chapel, and waiting-rooms, situated on the outskirts of Glasgow, was opened by Sir Charles Cameron.

The old view of igneous rocks as merely accidental and irregular intruders into the regular sedimentary series has been greatly modified by the results of petrological researches, and now it has been found possible, from an investigation of rock structures, to obtain a complete account of a series of events in a district by Messrs. Holland and Saise in the Giridih coalfield in Bengal. They show how a liquid rock-magma of highly basic composition was injected as a series of dykes through the rocks of this area at a temperature so high that near the dykes the coal was coked and columnar structure developed in it, while sandstones were so far fused that they came to closely resemble siliceous lavas. This magma was rich in chlorine, as the abundance of apatite in it shows, and from it thermal waters conveyed chlorides in solution to permeate the rocks around. This permeation by chlorides produced marked changes in certain more ancient igneous rocks, so that when at a later stage earth-movements crushing them led to their metamorphism and re-crystallisation, the results of that metamorphism were quite different in the areas where the chloride-permeation had and had not been effected. Where there were no dykes to supply the chlorides, hornblende-schists were produced; in the neighbourhood of the dykes, scapolite rocks were formed. These and other interesting facts, *Nature* says, are worked out in convincing manner in a paper contributed to the *Records* of the Indian Geological Survey.

At the last meeting of the Meteorological Society, Mr. Frederick Gaster, F.R. Met. Soc., of the Meteorological-office, delivered a lecture on "Weather Forecasts and Storm Warnings: How they are Prepared and Made Known," which was illustrated by numerous instruments, diagrams, and lantern slides. Mr. Gaster said that in the preparation of forecasts the position held by the barometer was so much more important than that of any other instrument, that its action must be fully comprehended if the rest of the work was to be at all clearly understood. He then referred to the use of a single isolated instrument, and showed how new light was thrown on the observer who could have telegraphed to him simultaneous observations from a large number of places scattered over a considerable area of the earth's surface. The kind of variation in the distribution was dealt with, isobars were drawn, and the phenomena which they exhibit in the way of high and low-pressure areas described. Mr. Gaster drew attention to the obvious importance of the variation in the weather over a given area caused by alterations in the position of the cyclonic and anti-cyclonic systems, and the importance of the fact that the former tended to move round the latter from left to right. This led to some remarks on the indications observed when disturbances were advancing towards our islands from different points. Attention was drawn to secondary systems, both of high and low-pressure, the forms they assume, and their effect on the weather which, but for their presence, would probably have accompanied their primaries, and the necessity for allowing for such systems in sending warnings to our coasts. The lecturer then remarked on the value of auxiliary information, such as is to be obtained from decided changes in the direction of the wind, sudden changes of temperature, the movements of clouds at different levels, observations made at high-level stations, and telegrams from the United States. Mr. Gaster next explained how the information is made known to the public. Forecasts are issued by the Meteorological-office in the daily weather report, and also communicated to the Press. Hay harvest forecasts are issued to certain selected authorities, who circulate them as much as possible in their neighbourhood. Storm warnings are telegraphed to our coasts, with instructions to hoist the cone point-up or point-down.

MISCELLANEA.

Messrs. Earle's Shipbuilding and Engineering Company, of Hull, have received an order from the Admiralty to construct two 20-knot cruisers of the Pelorus class. The machinery for these vessels will also be constructed by Messrs. Earle's Company.

In order to satisfy public opinion, the French "coast-defence" armour-clad Bouvines has undergone a further four hours' trial at Brest with full satisfaction. The *Army and Navy Gazette* says that a mean speed of 15·3 knots was attained with natural draught.

The cry of the French press with regard to the recent naval constructions is just now particularly vehement—*e.g.*, from *Le Moniteur de la Flotte*, "*A bas les superstructures!*" Of course, we quite agree. They have cost a lot of money to put up; they will now cost a lot of money to take down. Pity the French taxpayer!

At a meeting of gentlemen connected with the engineering and shipping industries of the Cardiff district, presided over by Mr. John Lowdon, J.P., of Barry, it was unanimously decided that a hearty invitation should be sent to the members of the North-East Coast Institution of Engineers and Shipbuilders, asking them to visit Cardiff and the Bristol Channel ports during the ensuing summer.

A Belvedere Tower, nearly 200ft. in height, similar to those erected at the World's Fair, Chicago, and at the Paris and Philadelphia Exhibitions, will be erected this season at the Empire of India and Ceylon Exhibition. The tower will be provided with two passenger lifts, and have several balconied storeys. The top platform will accommodate about 100 persons. The tower will, at night, be illuminated by a lighthouse lamp of 4,000,000-candle power.

For some time past the Rotherham Corporation have had under consideration a scheme for dealing with the sewage of the borough. At their last meeting the Town Council unanimously decided to retain Mr. R. E. W. Berrington, Assoc. M. Inst. C.E., Wolverhampton, as engineer to carry out the scheme in accordance with his plans and estimates. The chairman of the committee said that including land the total expenditure would approach £100,000.

The British second-class cruiser Dido, of 5600 tons, whilst being launched on the 17th inst. from the yard of the London and Glasgow Engineering Company, Govan, Glasgow, stuck at the foot of the ways and lies in a very dangerous position, about three-fourths of her being in the water and the remainder on land. The ways close to the water were apparently laid in the mud, which sank with the weight of the vessel. Attempts were made to get her off with tugs, but without success. She was, however, moved 17ft. on Wednesday, and by the aid of two powerful pontoons it was thought she would be got off yesterday.

In an interesting review of American milling in the past year, the *Milling World* says:—"There were 1387 mills built in the United States in 1895. Of these 1139 are mills to grind wheat, and the rest are corn, feed, meal, oatmeal, pearl-barley, rye, hominy, grits, and other cereal plants. The burned mills number 382, which, subtracted from the 1139 new mills, leave 857 mills as the net gain of the year. In 1894 the net addition was 670 mills. Taking into the account the enlargement of 585 existing mills in 1894, it appears that, in spite of all the adverse conditions, the past year was better than 1894, far better than 1893, and quite equal in the way of profits and development to 1892 and 1891."

With the increasing facilities for obtaining the electric current, many new applications of it have been brought forward, and among them the optical or magic-lantern form of light requires the presence of oxygen and hydrogen gases under pressure, and although of late years the apparatus employed has been greatly simplified, it is still cumbrous, and possesses drawbacks which make it compare very unfavourably with the two simple wires. A new form of lamp or regulator to furnish an electric arc light for this purpose has been invented by Mr. C. M. Hepworth, and introduced under the name of the Ross-Hepworth projection lamp by Messrs. Ross, opticians, London.

At a meeting of the Farnham Mechanics' Institution, on Tuesday, in the Assembly Rooms, Mr. J. H. Knight, J.P., gave a lecture on "Motorcycles." Mr. Knight traced the history of motorcycles, and referred to the steam carriage he invented some years ago. A series of views was shown by means of an oxy-hydrogen lantern, kindly lent by the president, and it was mentioned that in Paris motorcycles are allowed to travel at the rate of eight miles an hour. He said that probably the cost of a small car to seat two people would be £75 or £80, and it would travel eight or ten miles an hour. Mr. Knight's petroleum motorcycle, which is believed to be the first manufactured in this country to carry two people, was exhibited in motion.

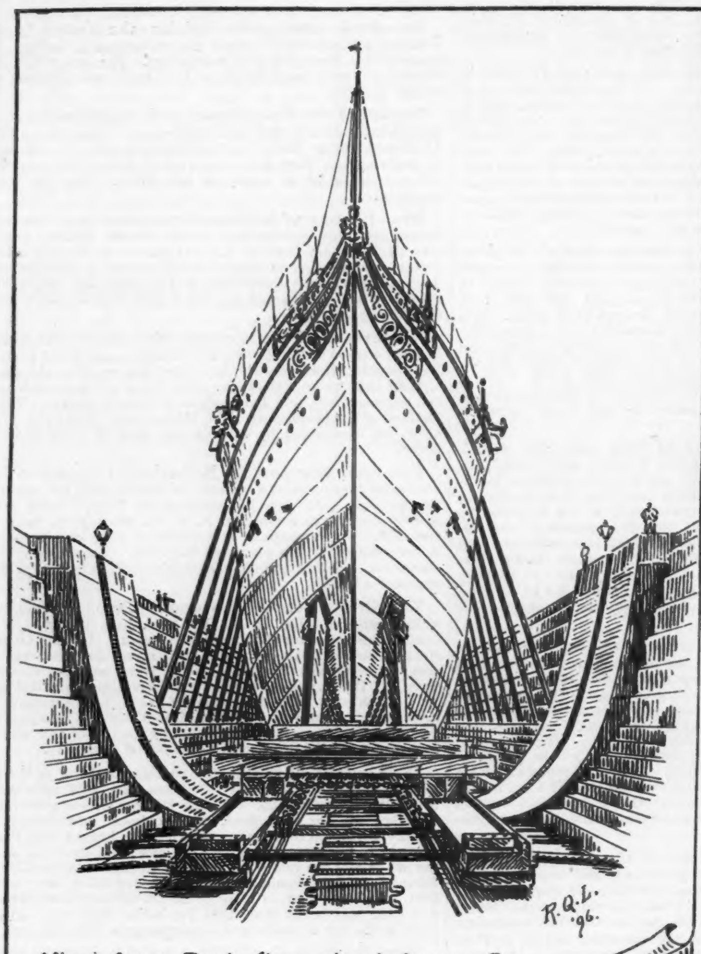
On Tuesday, Messrs. J. and H. Gwynne showed in operation one of their suction dredgers at work on the bed of the Thames at Hammersmith. The dredger is fitted with a complete set of plant, including boiler, and direct driven centrifugal pumps, and tackle for operating the dredging nozzle and delivery pipes. The dredging nozzle is of novel design, and is fitted with a number of moving louvres, so that the current of disturbing water varies as to its incidence, and increases the rate of stirring and removal of the spoil under the action of the current to the pump. The operation of the dredger was witnessed by a number of engineers, who saw it fill the central part of a ballast barge, and was much pleased with the action of all the pumping plant.

The Admiralty have sanctioned the following improved scale of salaries per annum to the engineering and constructive staff at the London establishment and at the dockyards, and these increased rates of salary will come into force on April 1st. At the Admiralty.—Director of Naval Construction's Staff: The Senior Chief Constructor, £1000 to £1150; two Chief Constructors, £850 to £1000. Director of Dockyards' Staff: Chief Constructor, £1000 to £1150; Engineer Assistant, £800 to £950. Engineer-in-Chief's Staff:—Chief Engineer and Inspector of Machinery, £1000 to £1150; Engineer Inspector for Gun Mountings, £620 to £770. At the Dockyards.—The Chief Constructors at Portsmouth, Chatham, and Devonport, £700 to £850; at Sheerness and Pembroke, £600 to £750; at Malta, £650 to £800; at Hong Kong, £600 to £750. The Chief Engineers at Portsmouth, Chatham, and Devonport, £600 to £750; at Malta, £550 to £700; at Hong Kong, £500 to £650. These officers also have Government residences.

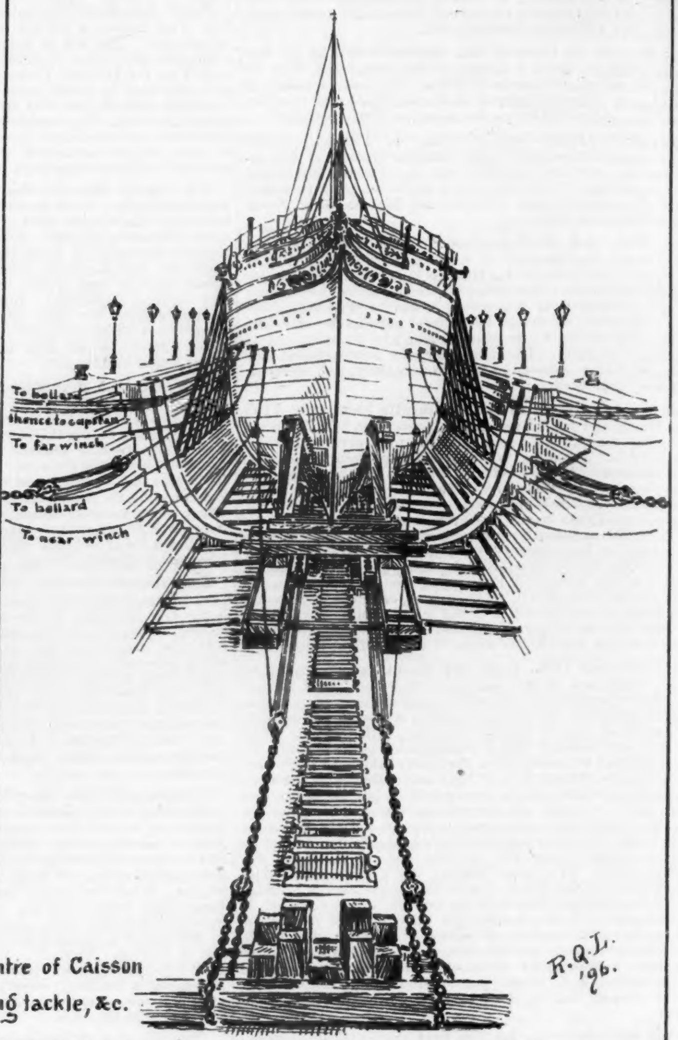
The new United States Navy, since March 3rd, 1883, has cost 110,371,710 dols., according to the late speech of Senator Proctor, of Vermont; he included in this statement all ships authorised or in course of construction. In the same time they have expended only 10,631,000 dols. on coast defences, and many millions in deepening the approaches to their harbours, and making them more accessible to an enemy's fleets. For the sum named the United States will have 8 battleships, 4 double-turreted monitors, 1 barbette coast-defence turret vessel, 1 harbour defence ram, 2 armoured cruisers, 7 protected cruisers, 6 partially protected cruisers, 20 cruisers, 17 gunboats, 1 dynamite gun vessel, 9 torpedo boats, 1 dispatch boat, and 1 naval cadet practice vessel. These ships will carry 82 8in. guns, 18 10in. guns, 12 12in. guns, 24 13in. guns, 3 dynamite guns, and 187 5in. and 6in. rapid-fire guns. Senator Proctor argued that land defences were more efficient than a navy for the protection of our coast line, and said that our navy having been well advanced, we should now turn our attention to the shore defences, as the best means of maintaining peace.

LENGTHENING THE CAPE MAIL STEAMSHIP SCOT

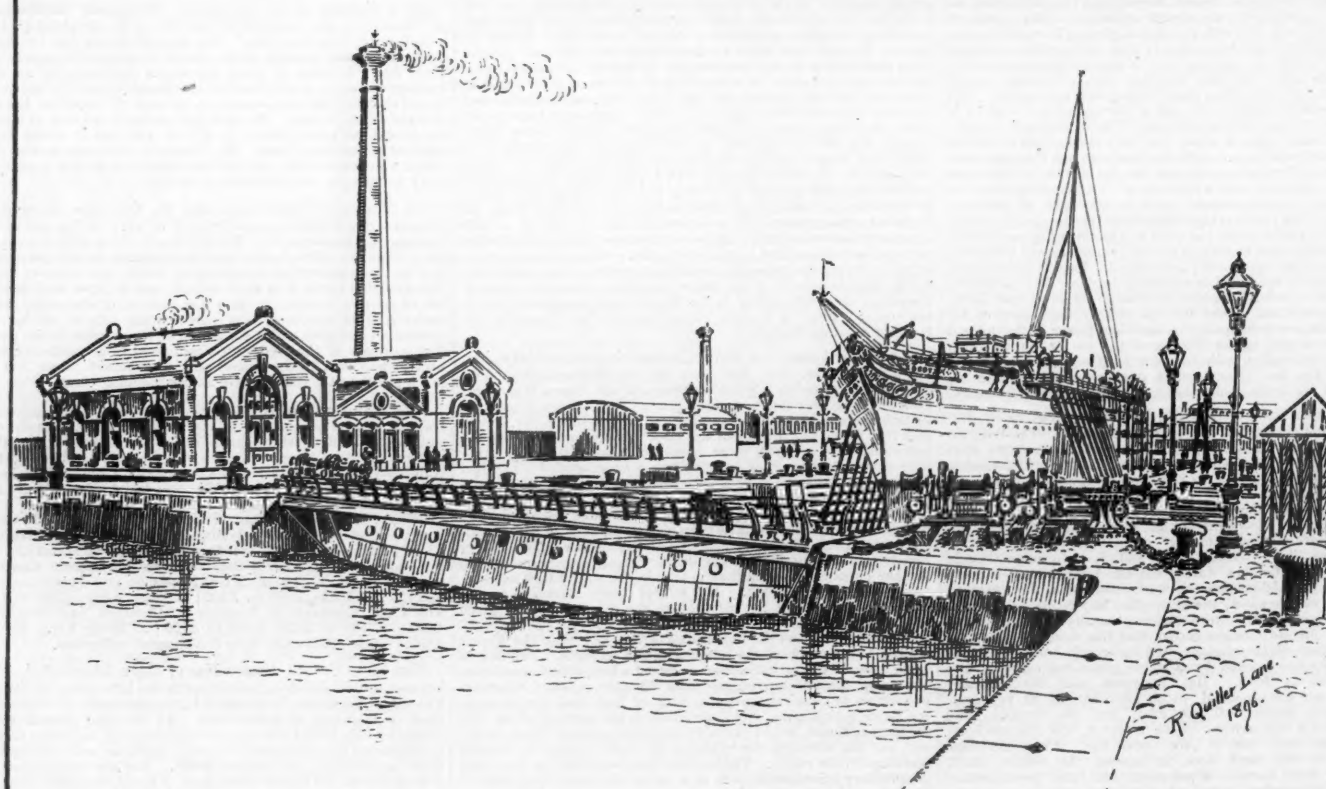
(For description see page 292)



View from Dock floor, showing ways, &c.


To bollard
thence to capstan
To far winch
To bollard
To near winch
R.Q.L. '96.

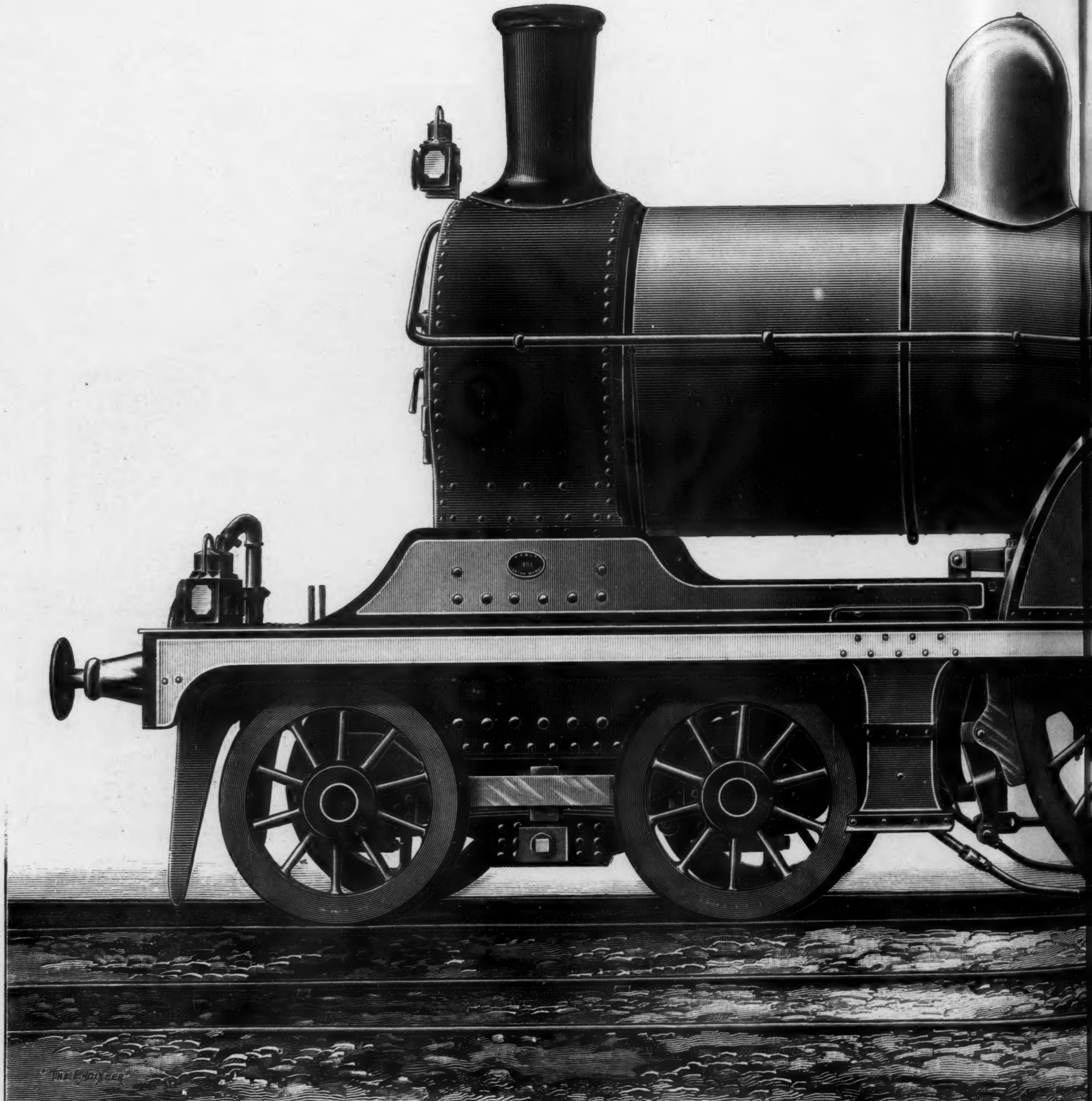
View from centre of Caisson showing hauling tackle, &c.


R. Quiller Lane. 1896.

General View of Alexandra Graving Dock with R.M.S. "SCOT."

EXPRESS LOCOMOTIVE, MANCHESTER, HEF

MR. HARRY POLLITT, ASSOC. M. INST .E., GORT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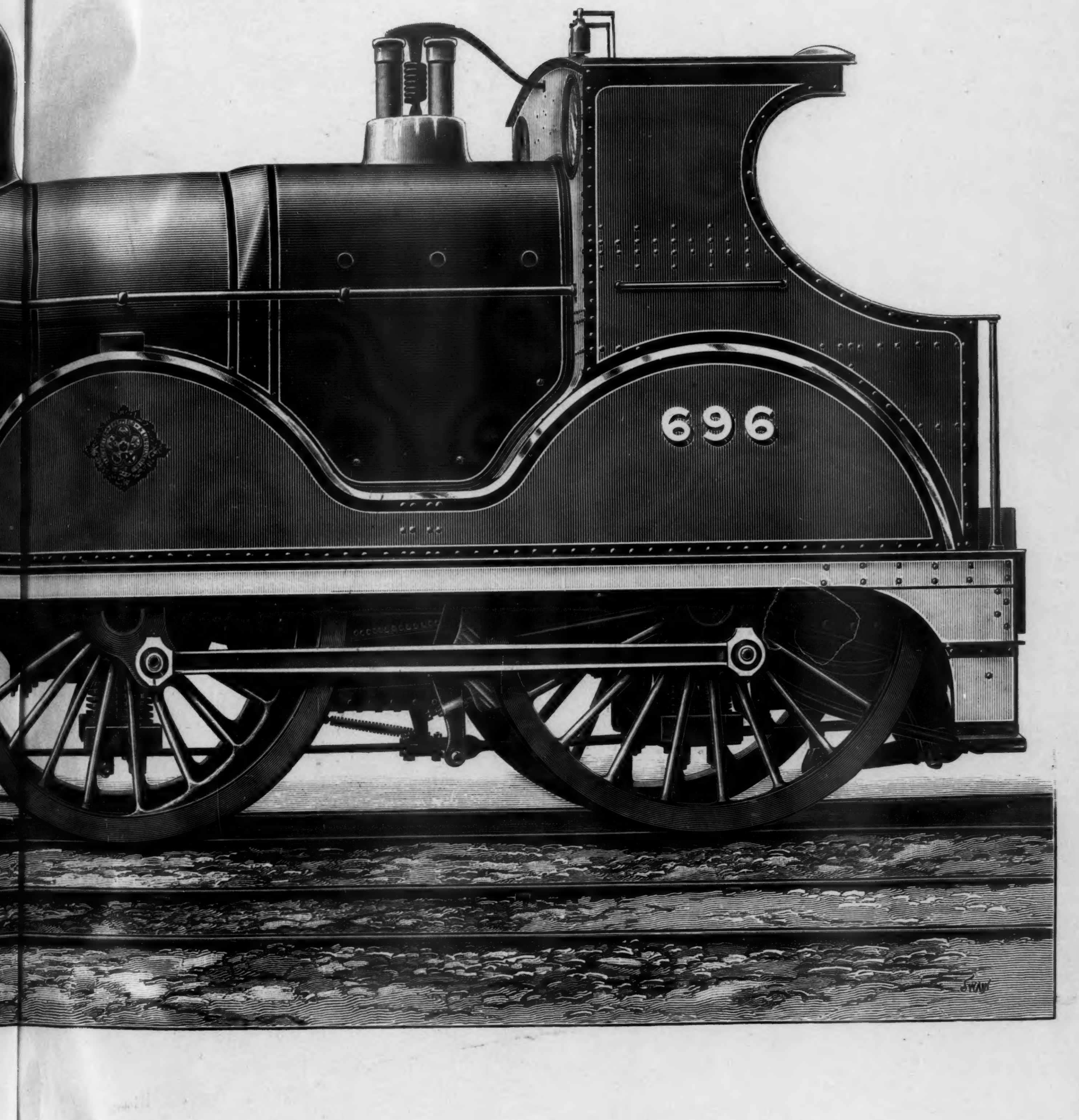

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TO CORRESPONDENTS.

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J. T. (Dalkeith.)—*To what School of Engineering do you refer?*

C. E. W. (Parel.)—*The British Motor Carriage Syndicate, 95, Billiter-buildings; 49, Leadenhall-street, London.*

R. W. H.—*We cannot recommend any makers, but you will find them in Kelly's Directory of the Engineers' Iron and Metal Trades and in the large London Postal Directory.*

D. H. W. (Denbigh.)—*We cannot give any publication to the matter you send, and cannot assist in proposals of the kind. It is a matter for advertisement.*

LOCOMOTIVE APPRENTICE.—*As almost every possible arrangement of cylinders and method of working locomotives compound has been proposed or patented or used, it is impossible to say whether your suggestion has been tried or not. We fancy it has.*

A. B.—*The following canals have been converted into railways:—Andover Canal, 22 m. 6 f.; Croydon, 9 m. 4 f.; Glastonbury, 14 m. 2 f.; Hereford and Gloucester, 34 m.; Leominster, 22 m.; Monmouthshire, part, 6 f.; Oakham, 15 m.; Somersetshire, part, 7 m. 2 f.*

F. O.—*It is a matter of indifference whether you pass the water or the steam through the tubes. It is only necessary in either case to take care that there is efficient circulation through every portion of the condensers. The water will take the line of least resistance in all cases.*

DUPLEX TRICYCLES.—*There is no maker now, as far as we know, of the duplex tricycle in this country. About a dozen years ago it was invented and patented in England by Mr. C. T. Crowden, and a four-wheeled machine for two riders side by side was patented by the same inventor, consisting of two coupled bicycles, with a connecting axle of differential gear between. Another machine, with two steering wheels in front, for two riders over one rear-driving wheel, was made by him, but the tandem machines seem to be generally preferred. The single track bicycle for two riders side by side has also been made in this country.*

CONDENSING WITH TIDAL WATER.

(*To the Editor of The Engineer.*)

SIR,—I should feel obliged if any of your readers would give me information as to the best means for condensing from 600 H.P. compound engines working on the side of a tidal river such as the Tees, Tyne, or Usk, assuming a tidal rise of 40ft. It is noticed at low tide that the water is very muddy. The water used for the boilers generating steam would be the towns supply, and, if possible, should be returned after condensation to boilers again.

Any information would be greatly esteemed. Thanking you in anticipation of insertion.

TIDAL.

Wolverhampton, March 14th.

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Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Three o'clock on Wednesday afternoon in each week.

Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

INSTITUTION OF JUNIOR ENGINEERS.—Saturday, March 28th, at 7.30—11.30 p.m. Conversazione at the Westminster Palace Hotel, Victoria-street, London.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, March 26th, at 8 p.m. Paper: "Telephone Exchanges and their Working," by Dane Sinclair, Member.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, March 24th, at 8 p.m. Paper: "The Thermal Efficiency of Steam Engines," by Captain H. Riall Sankey, late R.E., M. Inst. C.E. Friday, March 27th, at 8 p.m. Paper: "Closing a Dock-Entrance for Repairs," by Mr. Julian S. Wise, Stud. Inst. C.E. Mr. A. C. Hurtzig, M. Inst. C.E., will preside.

NAVAL ARCHITECTS.—See page 297.

SOCIETY OF ARTS.—Tuesday, March 24th, at 8 p.m. Foreign and Colonial Section. Paper: "The Colonies and the Supply of Dairy Produce and Products of Petite Culture," by Charles R. Valentine. Sir Westby B. Perceval, K.C.M.G., will preside. Wednesday, March 25th, at 8 p.m. Paper: "Our Food Supply, as affected by the Farming of the Future," by Professor James Long. Thursday, March 26th, at 8.30 p.m. at the Imperial Institute, South Kensington. Indian Section. Paper: "Kashmir: Its People and its Products," by Walter R. Lawrence, I.C.S., C.I.E. The Earl of Dunmore will preside.

THE ENGINEER.

MARCH 20, 1896.

A WATER BOARD FOR THE METROPOLITAN COUNTIES.

THE London water question is now entering on a new and remarkable phase. On Monday evening the expected Government Bill relative to this long-contested subject was presented to the House of Lords by Lord James of Hereford, and was read a first time after a brief but interesting debate. By this measure it is proposed that a Board shall be established for the purpose of dealing with the supply of water to London and the surrounding districts. It will be seen that the Government have felicitously escaped any direct dealing with the water supply, and have simply devised a plan by which a new authority will be entrusted with the task. In order that the authority thus created shall not indulge in any vagaries on the subject, the new body is simply armed in the first instance with such powers as are already exercised by the London County Council under the Metropolis Water Act of 1871. In the next place, the Board will be in a position to negotiate with the Metropolitan Water Companies, and to adopt provisional agreements respecting any matters relating to the water supply of the districts now occupied by these companies. But for the purpose of giving effect to such agreements, the Board must seek the sanction of Parliament by means of Private Bills. The Board will also have power to oppose Bills brought in by other parties relative to the supply of water to London or its environs. In this aspect the scheme looks rather weak and unnecessary; but from another point of view it has a more potent and dignified appearance. The Board is to operate not merely over the 121 square miles of inner London, but over the entire area of 620 miles constituted by the Parliamentary districts of the London Water Companies. Into the outer portion London itself is overflowing, and the Government have wisely discarded the idea entertained by the County Council, that the metropolis as at present defined by the Registration Act is to have a water supply of its own. leaving the several authorities of the 500 square miles beyond to look out for themselves. That the outer areas should be represented on the Board is perfectly reasonable, and the Bill provides an all-round system for the purpose. The London County Council will have power to appoint sixteen members. The Corporation of the City will have two. This is an awkward feature, for West Ham is to have a like number. A mere county borough—populous it is true—is raised to the same position as the ancient City, with its enormous rateable value and fabulous wealth, though having a small appearance in the census of the sleepers. The total number of members on the Board is made up to thirty, by giving two representatives each to the County Councils of Middlesex and Essex, and one each to the Councils of Surrey, Kent, Hertfordshire, and Croydon, together with one to the Conservators of the Thames, and the like to the Lea Conservators.

The Government have acted with diplomatic skill. Undertaking to deal with the water question they have avoided all risk to themselves by simply creating a Water Board to do the work. The Board may propose what it pleases, and Parliament can say aye or nay as it chooses. Neither the initiative nor the result will affect the Government. The only difficulty is in getting the Board into existence. The County Council are not likely to be satisfied with sixteen members out of thirty. Their desire is to possess the water supply for themselves, or in a slender alliance with the Corporation. But the dream may as well be dismissed. The water question has outgrown the County Council, just as London has outgrown its ancient limits, except that the process has been especially rapid in the former case. The project for bringing a supply of water from Wales is of a magnitude which would seem to agree with supplying both London and all the outer districts. Yet the most we can hear of in that direction is a supply of water in bulk. The Welsh project is weakened in the hands of the Council by the attempt to claim "London for London," leaving the outer areas to arrange as they best may. The Royal Commissioners of recent date, when inditing their report, took in all "Water London," and reckoned that in forty years' time the population of the 620 square miles would exceed 11,000,000. Herein lies the gravity of the water question, and it is this which naturally suggests the creation of a municipal authority representative of the entire area to be provided for. If there is to be a colossal scheme for bringing a supply of water from the mountains of Wales, such a project would seem to fall naturally into the hands of a Water Board charged with providing a supply for the widespread area of London and the surrounding districts. So huge an undertaking overtops a County Council designed for London alone, and itself desirous, in respect to the water supply, of possessing nothing more than the crowded and profitable area of the inner circle. The Council has professed that the outer districts did not wish for its interference, and preferred taking care of themselves. This is very likely, seeing that the outer districts send no members to Spring Gardens. But the feeling may be different when representatives from these districts take part in the deliberations of a Metropolitan Counties Water Board.

That the Government Bill will be severely criticised is inevitable. It is felt in some quarters that the City is not fairly dealt with, and that the representation granted to the London County Council is larger than it ought to be. Those who adhere to the Council object to the creation of any new authority to deal with the Metropolitan water question, considering the Council quite sufficient for the purpose. It is said that the Progressives are determined on doing their utmost to wreck the Bill. Should they succeed, the effect can scarcely be anything else than that of leaving the companies masters of the situation, though they appear to make no objection to the Bill as it stands. The companies would rather be let alone, but the prospect of escaping from the clutches of the County Council is tempting, though another power is to be brought upon the scene. To the Progressives on the Council the Bill is nothing other than gall and wormwood. It threatens, as the ex-deputy chairman declares, to diminish the attractiveness of the work carried on by the Council, so that men of ability will gradually cease to offer themselves for its service. A morning paper which speaks for the Council remarks that "the hybrid board which is to be the water authority of the future" is to absorb "at one swoop" every power the London County Council has hitherto possessed in relation to the water companies or the supply of water, except "such small matters" as the water rights of the Fire Brigade. There will still be water to put out fires, but the County Council will be left shorn of its splendour as the public authority destined to command the water supply of the greatest city in the world.

The report of the Water Committee of the London County Council advocating the Welsh scheme of supply, and recommending that a Bill should be brought into Parliament next year for carrying out a section of the undertaking, has awaited the decision of the Council for some weeks past, but is now once more adjourned, standing over until after Easter, "in view of the proposals of the Government." Six of the famous Transfer Bills, which have not yet passed the second reading, were to have reached that stage on Friday last, but the approach of the Government measure has kept them back until Tuesday next, when it will be seen what fate awaits them. But if the Water Board Bill is to meet with success, it matters little to the Council what becomes of the Transfer Bills. Sir Arthur Arnold has been negotiating with some of the companies for the purchase of their undertakings, and reports that he has "met with no material discouragement." But even should he succeed, it may prove that he has only prepared the way for the Water Board, which will be in a position to complete the purchase Sir Arthur has previously negotiated. Had the County Council been reasonable in days gone by, instead of attempting to seize the companies by the throat and dictating the most outrageous terms, the present situation might have been a different one. The Council has sown the wind, and it now has to reap the whirlwind. Of the three Bills promoted by the water companies it is to be remarked that they also await their second reading on Tuesday, but the Government appear willing that they should pass this stage and be referred to a hybrid committee, subject to conditions that no expenditure shall be sanctioned except for works which are urgently necessary.

PERMANENT WAY.

THE coroner's jury dealing with the accident at Little Bytham, on the Great Northern Railway, which took place on Saturday week, have returned a verdict to the effect that the two persons killed died from injuries caused by the train running off the line because of the subsidence of a part of the track which had been newly relaid, and that their deaths were accidental. A good deal was heard during the inquiry about ballast, and a rider was added to the verdict recommending that slow speed should be maintained until a road was fully consolidated. Thus we have an old question reopened. The relations between speed and permanent way come once more to be dicussed. Yet it might be imagined that the last word concerning permanent way in Great Britain was said years ago. But this is not the fact. The subject is one of permanent interest; questions constantly turn up for discussion, and accidents, such as that to which we have just referred, direct attention to rails, sleepers, ballast, and chairs, when controversy sleeps, and once more battles are fought, and arguments in favour of this, that, and the other are heard, and seem as fresh as if they had not served their purpose already thirty or forty years ago. In our own correspondence columns the construction of permanent way has been recently discussed by Mr. Tratman, Mr. Whitehouse, and one or two other more or less competent authorities. It will be remembered that Mr. Tratman wrote advocating the United States system of flat-footed rails resting on transverse sleepers or "ties," to which the flanges of the rails are spiked. He holds that this makes a better road than the English system provides, and he appears to say that the very high speeds recently attained by trains in the United States are largely due to the small resistance offered by the American railroad. There can be no difference of opinion as to the importance of reducing resistance on railways. It is questionable, indeed, if any expense in reason that can be incurred in improving permanent way would not pay for itself. The only point open to discussion is summed up by asking—What is the road of least resistance?

Before we can answer this question we have to ascertain in what the resistance consists. How is it set up? What is the cause of it? We may leave out of consideration axle friction, because that is quite independent of the road. The rolling friction of a quite hard and cylindrical tire on an equally hard, smooth, and level rail is exceedingly small, almost infinitesimal. If we watch the progress of a locomotive, particularly at a slow speed, along a railway, it will be seen that the rails continuously sink under it as it advances. The leading wheels are always running up hill. We see again that the rails rise behind the tender, so that its trailing wheels are always running down hill. It may be proved that a hard smooth steel roller, passing along a perfectly elastic and yielding surface, will only experience the same resistance as a similar roller would encounter in rolling over a rigid surface, the work done in deflecting the track being repaid by the rise of the track behind the roller. But the permanent way of a railway is not perfectly elastic, and the result of deflection is loss. It is not at all so easy as it appears to be at first sight to explain how deflection is brought about. The rail springs under the tread of the wheel, and the sleepers bend because the ballast immediately under the chairs, would not alone suffice to support the insistant weight; but beyond this there seems to be a process of give and take going on in the ballast, which deserves more investigation than it has received. It would probably be found that all railway tracks after being driven down by the passage of a train rise again, but not at once. It is certain that a weak road is a road of high resistance; but so long as the road is not permanently deflected downwards, the resistance ought to be the same on a stiff and a weak track. That it is not the same is, however, very well known, and it may be taken as proved that the nearer a road is to being absolutely rigid the smaller will be the rolling resistance which it will offer to trains.

On the other hand, it must not be forgotten that an absolutely rigid road would be intolerable to passengers. A certain amount of elasticity must be provided, for reasons very well understood; but where shall it be put? All modern practice says in the sleepers, or at all events in the road somewhere. Mr. Griggs, an American engineer, said thirty years ago that it ought to be be put in the wheels, and he mounted his engine tires on wood blocks. Mr. Mansel said in the wheels, and the wooden Mansel wheel is practically universal in Great Britain today for coaching stock. Mr. Bridges Adams said in the wheels, and he put a steel spring between the tire and the wheel rim. But it must be provided somewhere, and it seems to be of small consequence whether it is in the wheel or the road, provided that it is as nearly perfect as possible. The range of resiliance may be very small, and appears to be provided by the normal system of sleepers and chairs in sufficient quantity. Granting this, it follows that the stiffer the road the less will be the resistance. Now the flange rail, it is easy to see, cannot be, weight for weight, as stiff as the bullhead. The stiffness of a rail varies within normal limits as the square of its depth, but a flange rail cannot be as deep as the bullhead if the weight of the two is the same per yard. The metal of the flanges is provided at the expense of the web; the result is that the first-class roads in the United States are laid with rails weighing as much as 100 lb. to the yard, and the sleepers are broader and closer together than they are in this country. The attempt is made to compensate for the lack of vertical stiffness in the rail by using many sleepers. It is not at all difficult to see why the system finds favour in the United States. In the first place, timber is very cheap there as compared with its cost in this country. Probably if we take the whole system of the United States it will be found that sleepers cost less than one-half what they cost in England. In many districts — round New York, for example — they are no doubt expensive, but in the forest country their value is almost nominal. Again, the cost of cast iron in the United States is so considerable that chairs would probably represent double the outlay on an American as compared with an English line. We have very little doubt but that the permanent way in each country is that which gives the highest efficiency for the smallest outlay—in other words, the road which, on the whole, is found most suitable to the requirements of the traffic and the pockets of the shareholders. It must be conceded, however, that small differences in the details of construction can have little or no influence on dividends. It is not only possible, but right, to look at all questions connected with permanent way from the profit-and-loss point of view. The engineer is, of course, prone to consider the questions at issue as of mechanical or technical interest only; but this is not right. After all, that road is the best which gives the largest dividend. It is no doubt true that the better the road, other things being equal, the better the dividend, but it is not always easy to see how or why.

Fresh interest is imparted to the whole subject by the augmentation of railway speeds. It is true that a high speed is as safe, or safer, than a slow speed, but only because the fact that high speeds are possible implies that the road and the rolling stock are alike excellent. It has been stated, and no doubt truly stated, that the very high speeds attained in the United States by certain trains are brought about not only by the great power of the locomotives, but by the extraordinary excellence of the permanent way. There is not the smallest chance of a radical change being made in the construction of permanent way in this country. The cross sleepers and chairs leave nothing to be desired; but it is not to be denied that, while there are hundreds of miles of road in Great Britain superlatively excellent, there is not a little of it open to improvement, and, if very high speeds are to be regularly attained and maintained, the improvement will have to be made. In what it will consist is very easily stated. Rails must be made deeper and stiffer. In the course of a few years we do not doubt that a bullheaded rail, weighing 100 lb. to the yard, will be the standard rail on our principal lines. We do not think that any change in the sleeper will be needed, but beyond question ballasting is not what it ought to be in all cases. The question of ballast is very important. It is not often that railway companies will lead it in quantity for long distances. What is to be had in the neighbourhood is used. In one place we find excellent gravel; in another, broken stone, in another chalk, in another only inferior gravel, or sandy clay, which runs into mud in wet weather, and flies into dust in dry. The attempt to make a profusion of sleepers compensate for bad ballasting is equally common and futile. Very large sums have been expended on many English lines in improving track, but a good deal remains to be done. The advent of the steel rail enabled locomotive superintendents to place loads on their driving wheels which would have reduced iron rails to the condition of a besom in three months; but it must not be imagined that the steel rail, unless it is backed up by good ballast, can carry the load of eight and nine tons on a wheel now common enough. Shareholders may reconcile themselves to the fact that heavy trains and great speeds mean superlatively excellent permanent way; as good as can be, not only in rails, chairs, keys, and sleepers, but in the ballast, on which ultimately devolves the duty of supporting not only the train, but the sleepers and rails as well. The stiffer the rail the greater is the area of ballast over which the load is spread; but the distribution can only be got at the expense of deflecting the rail, and the more the rail bends, as we explained at the outset, the greater the train resistance. Indeed, under certain conditions, almost the whole rolling resistance is due to the bending of the rails under the load placed on them.

BEST YORKSHIRE IRON.

The announcement that the Bowling Iron Company, of Bradford, Yorkshire, have given up the manufacture of rolled iron, and are dismantling all the machinery and plant used for that purpose, marks an epoch in the iron and steel trade of this country. It is evident that there is not enough for all those—limited in number as they are—who are engaged in the trade; the "survival of the fittest" will doubtless leave sufficient manufacturing power still available. Those who remember, in the days before steel boilers, how the old specifications used to run, "The furnaces must be of Lowmoor, Farnley, or Bowling iron," will realise the change now that the use of steel is all but universal. It must not be supposed, however, that iron plates of high quality are a thing of the past. The advantages of steel over iron are superior strength, great ductility in manufacture, and cheapness. But these advantages to the maker and in regard to price to the user also, do not settle the whole question. Endurance against fire, especially in the furnace plates; resistance to corrosion from impure water, facility for repairs have also to be considered, and in these respects "Best Yorkshire Iron" still holds its own in the estimation of many well able to judge, and who back their opinion by paying the higher price of such iron over steel. In regard to bar iron, although there have been changes in the same direction, steel has not ousted iron to the same extent as in plates. For safety in welding and for resistance to sudden shocks, the iron affords a security not yet attainable from steel; and although in Germany and elsewhere steel under the euphonious name of "flusseisen," or ingot iron, is used, engineers—at any rate, British engineers—who are acquainted with its origin do not trust it. This is evidenced by the fact that for such purposes as the draw gear of railway locomotives and carriages, the parts of traction engines subject to twisting strains, stay bolts for steel fire-boxes, and the welded frames and suspending shackles of pit cages at mines, are still made of "Best Yorkshire," though it costs double the price of ordinary iron or steel. In distant countries, where the cost of freight, duty, and inland carriage and expensive skilled labour enhance the cost of forgings, the fact that the iron has in England cost 1d. per pound more than ordinary iron, is not prohibitory for forgings whose total cost is 1s. or 2s. per pound.

The method of manufacture of this iron, well known as it is to those who have occasion to visit the works, may be shortly described. The clay-band ironstone found in the "black bed" collieries between Leeds and Bradford was found as early as the beginning of this century to afford the material for rolled iron of the best quality, and at Lowmoor as well as at Farnley and Bowling a staple manufacture of great importance to engineers was established. Doubtless much of the superiority of the pig iron made from this ore lies in the fact that it is made in cold-blast furnaces, a process which rejects into the slag or dross much of the impurity which in ordinary hot-blast furnaces passes into the pig. The fact that the pig iron made by the above-named firms is sold to iron-founders, who use it for special purposes, at prices more than double those of Scotch pig iron is evidence of its value. The next stage in the manufacture is the refining, the pig iron being melted in open fires, from which it is run into shallow moulds. The boiling and aërating in these processes free the iron from silica and other impurities. The refined iron is then puddled, and there are elaborate subsequent processes of hammering, piling, and rolling. The superiority of this iron does not lie in any great tensile strength. In plates, 22 tons per square inch longitudinally, and 20 tons crossways is usual, the iron when stretched cold extending from 15 to 25 per cent. longitudinally in a length of 4in., and from 10 to 15 per cent. crossways, and showing a reduction in sectional area at the place of fracture of from 15 to 20 per cent., and 10 to 15 per cent. respectively. In bars the strength ranges from 23 to 25 tons, according to the size of section, the extension 20 to 40 per cent. in 4in., and the reduction of area from 30 per cent. in a bar 3in. diameter to 50 per cent. in a bar of 1¼in. diameter. It is this combination of ductility with strength and toughness which gives evidence of quality, and cannot be equalled except with iron smelted entirely with charcoal, and finished also with similar fuel.

In these modern days, when lofty furnaces stimulated by a high-pressure hot-blast pour out the full product of the ore, it is interesting to watch the old process which still exists. At Farnley, Leeds, within the city boundaries may be seen the ore as it is taken from the adjacent pits, the old-fashioned stone-built blast furnaces, and the whole sequence of operations down to the finished plate or bar. Messrs. Taylor Bros. and the Monkbridge Company, both of Leeds, are also makers of best Yorkshire iron, they carrying on this trade in connection with the manufacture of steel wheels and axles.

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THE COAL TRADE.

The miners' agents are consistent. They keep telling their clients, the colliers, that the coal trade is not so black as it is painted. One of them, Mr. W. E. Harvey, Assistant Secretary to the Derbyshire Miners' Association, wants to be told why Mr. Emerson Bainbridge, M.P., is purchasing every acre of coal he can come across if the coal trade is in such a bad way. Other agents are anxious to know how it is that Sir William Armstrong's firm, the Sheffield Gas Company, Messrs. Vickers, Sons, and Company, Messrs. Cammell and Co., Sheffield, and others, can pay such large dividends if the coal business is so bad? A little light on this point may be desirable. Mr. Bainbridge, who has a very large holding in coal, was clear-headed enough a long way back to see that profitable business in the future must be with the large well-equipped collieries. That accounts for his enterprise in fresh coalfields, and arranging for the bringing to bank of coal in great quantities, by means of the most improved machinery, at the lowest possible costs. There is no other secret attached to Mr. Bainbridge's action in acquiring large areas of coal for work in the future. As for Sir William Armstrong's firm and the great Sheffield establishment of Cammell and Company, the profits there are not made from coal, but from everything except coal. If it were possible to separate the results of the operations carried on in both concerns, it would be found that coal resulted in a loss, which had to be recouped from the more remunerative iron and steel industries. It is quite true that at the recent meeting of the Sheffield Gas Company, Sir Frederick Mappin, M.P., the chairman, announced that during the year the company's coal bill had been rather over £1000 less. But the Sheffield Gas Company are not coalowners, they are coal buyers, and their case is precisely the argument of the coalowners that the values have gone down, while wages have remained at the old standard. It is perfectly true, as Mr. Bainbridge says, that only one colliery out of every three in the Yorkshire and Midland districts is paying, and whatever the miners' agents may say, there must be some re-arrangement in regard to wages before the Conciliation Board can be continued. The Rosebery arrangement expires at the end of July, and if both parties to it are stubborn in declining to give and take, the Conciliation Board will come to an end. In that case, the evil of competition, which the miners' agents are so eloquent about, will be accentuated. No common agreement will then exist as to prices and wages. Each man will do the best he can for himself, and the outcome cannot possibly be for the benefit of the coal getter. He knows, or he ought to know, that the country has never yet recovered from the coal war of 1893, that contracts have gone abroad which have not returned and are not likely to return, and that although more coal is brought to bank, less men in the future will be required to get it there, for every year sees mechanical appliances perfected for the diminution of manual labour, while the people who wish to go down the pits are continually becoming a larger host. The collier, if quite content to work three days a week at 15 per cent. to 20 per cent. more than his brethren get elsewhere, will probably find, at a time not so far off as he thinks, that even that modest amount of work cannot be found for him. What then?

CALEDONIAN RAILWAY EXTENSION.

At the present time, in several respects, the Caledonian Railway Company is more active than are most of the companies in the north. It is expending a large amount of capital, both on the lines that are open for traffic and on those that are in course of construction. In its past half year, the expenditure on capital account was £357,589. The largest item was that of the expenditure on the Glasgow Central Railway, which took £154,717 out of the total just stated; and another line in course of construction—the Follcross and Newton branch—claimed a further sum of £34,358. On the lines open for traffic £36,873 were spent, and on additional working stock £103,421, whilst the amount spent on lines that are authorised, but not yet under construction, took the main part of the balance. In the current half year, an increased rapidity of construction is evident. On the Glasgow Central Railway £154,312 is expected to be spent, on the Dumbarton and Balloch line £12,000, and other works bringing the amount for lines in course of construction to

£240,154, as estimated. On lines authorised, but not yet commenced, it is anticipated that in the current half year the expenditure will be £83,968, and that there will be thus a start made with some of the deferred lines. On working stock, the estimate is that £140,447 will be spent, and, with smaller sums, the total estimate for the half year is £551,105. It will be seen that the Glasgow Central Railway is claiming a large amount of money, but it is now coming into use, the Rutherglen and Glasgow section having been used since last November for passenger traffic, whilst the Kelvindale branch has been employed for mineral and goods traffic. After the end of the current half year, the total estimated expenditure of the Caledonian Railway is put at £1,586,730. The company has still a large amount of unproductive capital, but as the branches named are brought into use, and as the other works yield a larger revenue, there will be made lucrative some at least of the large sums that have been spent in extending the Caledonian Railway in the past few years. That extension is progressing, and it should soon yield to the Caledonian an increased revenue. That great Scotch railway now more fully fills its large and varied area, and with a period for rest after the completion of the works it has now on hand, it should yield better returns to its owners even than it has done of late.

LITERATURE.

Elektrische Kraftübergung im Bergbau. 8vo, pp. 76. Siemens and Halske. Berlin: 1896.

THIS is a large pamphlet or descriptive memoir on the application of electricity to the working of machinery in mines from sources of power at a distance, as carried out by the author's firm in several mines in Germany and other countries. The descriptive part, which is essentially of a popular character, deals first with the different classes of electro-motors and generators, their characteristic advantages and defects, &c., methods of reducing sparking in reversal, &c.; and then proceeds to a description of the methods of adapting the power to the different operations of pumping, ventilating, winding, and haulage and boring. In this part the co-operation of Mr. C. Hoppe, a well-known builder of winding machinery, has been secured for many of the designs which are given in the accompanying illustrations. These include pumping plant, suitable for all kinds of work, from lifting a few gallons of water from the bottom of a dip heading to the largest deep pit work requiring 250-horse power to drive it. Among these, the working pumps, which are both of the centrifugal and reciprocating kinds, are remarkable for the ingenuity of their design. On page 45, a very compact design for a ventilating fan is given, in which the field magnets of the motors are fixed to the casing, while the armature and fan run on the same shaft. The winding machines are mostly intended for underground use, on inclines, &c., and are comparatively small, many of them being from examples actually erected, and the same may be said of the haulage plant, which includes examples of both endless rope and chain systems. The boring machines are of two kinds—one of them, for soft ground, is of the screw auger or "Ricketty" class, while the other is percussive in action, although driven by a rotary motor, with a fly-wheel. This machine is not otherwise described than by reference to an account published in the *Electrotechnischer Zeirtschrift* for 1895; but from what we can gather in the present notice, it appears to be somewhat similar in principle to the Jordan rock-drill, springs being used, instead of an air compressor, for giving the blow. The work done by this machine seems to be very considerable for a small consumption of power, from 3in. to 4in. per minute of a 1·4in. hole in hard granite or quartzite with 1-horse power effective; and, judging from the illustrations, the plant is extremely compact, the motor being enclosed in a small box, and transmitting the power by a flexible strap. The examples illustrated are to a great extent taken from photographs of the machines actually at work underground, which adds considerably to their interest and value. These are principally from installations erected by Messrs. Siemens and Halske at the salt mines of Aschersleben, which, unfortunately, have within the last year been totally lost by the swamping of the mine through an influx of water in the shaft; from Prince Hohenlohe's Pauline shaft at Kattowitz, where an extensive dip haulage plant has been erected on an inclined seam; and the Ashiel Mine in Japan. The latter plant includes a power station, with five direct current 625-volt generators, each driven by a Pelton wheel of 150-horse power, which is applied to pumping, winding, and dressing machinery, as well as furnishing the power for a locomotive haulage. Among other works in course of execution may be mentioned a ventilating fan at the Ferdinand pit at Kattowitz, which is to be driven by a motor of 110-horse power about a thousand yards away from the source of power; a power station with two 500-horse generators, giving a current of 2000 volts at the Ilse Lignite Mine and Brickworks in Lusatia; and the Rand Central Electric Works in the Transvaal. The last, which is one of the most important plants of its class, is intended to supply current to the gold mines on the Rand from a colliery about thirty miles distant. The generating station is to contain four alternators, together of about 4000-horse power, giving a current for transmission of 10,000 volts tension.

A Text-book of Gas Manufacture for Students. By JOHN HORNBY, F.I.C. Small 8vo, pp. 261. London: George Bell and Sons. 1896.

THIS work is intended to provide a manual of gas manufacture suitable to the requirements of young men starting their training in gas works, and also to serve as a text-book for the use of students preparing for the examinations of the City and Guilds Institute on the subject of gas manufacture; it being for the latter purpose made just to cover the ground included in the syllabus on which the examinations of that body are based. Keeping these objects in view, the author has classified the whole field of gas manufacture under different headings, which are systematically surveyed in a series of short chapters, starting with the composition of coal, and passing through the various operations of carbonising, condensing, purifying, working up of residuals, storage and distribution, measuring, and so on, until the consumer's requirements are studied in the forms of burners, penny-in-the-slot meters, &c. The treatment, though necessarily somewhat sketchy on account of the limited space at command, is, as a whole, well suited to convey a clear idea of the essential principles of the manufacture to beginners, and the author is to be commended for having devoted himself mainly to the more important technical points, which are, therefore, more fully described than would have been possible with a wider range of subjects. The section on condensing and purifying processes and those on the relation between temperature in carbonising and the quality of the gas and residual products are very well done; but that on the primary operation of carbonising, considering its importance, would be better for a little stronger handling, especially as regards illustrations. The figures representing retort settings and furnaces are far too small and indistinct to be of much descriptive value, and this is the more to be regretted as the illustrations in all the other parts are exceedingly good.

The quantitative analysis of gas as practised in the works is not noticed, as that has formed the subject of another book by the author, but a reference to it, as well as to the larger detailed works on gas making, is made in the introduction; and some specimen examination papers of the City and Guilds Institute in gas manufacture given in an appendix serve to complete the book, which is likely to be of considerable value to others, as well as to the class of students to whom it is specially addressed.

SHORT NOTICES.

The Wood Industries of Sweden. London: *The Timber Trades' Journal.* 1896. Price 2s. 6d. This contains articles on the saw and planed wood trade, forest exhaustion in Norland, the firewood trade, squared timber and balk trade, the joinery trade, the Gothenberg district, the Stockholm district, the small ports of Gefle, and on ten of the great timber producing districts of northern Europe.

Handbook for Laying Out Curves on Railways and Tramways. Calculated for every possible Angle and Radius. By G. H. A. Kröhnke. With one plate. London: Kegan Paul, Trench, Trübner, and Co., Ltd. Price 5s. This is the ninth edition of a book which leaves those who are acquainted with it very little or no calculation to do in setting out any curves of any length or radius.

Aluminium. Manchester: The Aluminium Supply Company.—This little book, issued by the above-named company, which is the agent of the Pittsburgh Reduction Company, is a good deal in advance of most brochures published for trade purposes. The statements of the advantages of aluminium are not grossly exaggerated, and the whole tone of the book is candid and free from objectionable puffery. It contains many useful data, which, taken generally, are reliable and rest upon modern observations, and indeed its single noticeable fault is the use of the atrocious coinage "alium"—which means garlic, if anything—as a substitute for the word aluminium.

Tabulated Weights of Angle, Tee, and Bulb Iron and Steel, and other Information for the use of Naval Architects, Shipbuilders and Manufacturers. By Charles H. Jordan, M.I.N.A. Fifth Edition. Revised and enlarged. London: E. and F. N. Spon. 1896. Price 7s. 6d. This very comprehensive set of tables now extends to 578 pages, and gives the weights and the sectional areas and all dimensions of all known forms of rolled channels, angles, bars, tees, bulbs, rails and sheets of iron and steel; and other information, including metre weights, tonnage matters, relating to equipment of steam and sailing vessels, and other collateral information, which is of frequent usefulness to those most concerned with the employment of these materials.

The Cyclist Year-Book for 1896. Edited by Henry Sturmey. London: Iliffe and Son. Price 2s. net. This year-book, of 182 pages of text and 95 pages of advertisements, is a remarkable illustration of the greatness of the manufacturing industries supported by the patrons of the cycle in different forms. It contains a *résumé* of the cycling events of the past year, records of the feats of the English and foreign amateurs and professionals, both on the path and on the road; tables of speed per hour, second and lap; particulars of the National Championship of the World, descriptions of the new things in cycle construction for 1896, shows statistics for 1895, cycle company returns, applications for cycle patents, foreign tariffs on cycles and cycle materials, trade directories, cycling clubs of Great Britain and Ireland, and cyclist sections attached to volunteer regiments. It is a year-book useful to the cycle trade and cyclists generally.

THE ELEMENTS OF FORCE IN WARSHIPS.

ADMIRAL COLOMB read a paper on the question of estimating the fighting powers of warships, in the United Service Institution, with Lord Northbrook in the chair, on March 18th. This paper we regard as very important. The author has brought together a quantity of valuable data which he has classified in various ways, and if he has presented it to us for our use before he has drawn all the lessons which he might have done in course of time had he kept it all to himself, we are all the better treated. The paper was accompanied by a number of tables showing the elements of power in various branches—displacement, number of guns, energy of fire for one round per gun, energy of fire per minute, energy per 1000 tons displacement, shell charge per round per 1000 tons displacement, inches of calibre of guns per 1000 tons, weight of metal discharged, weight of armour, coal supply, speed, &c.; and tables in which these and other elements are combined so as to give powers of offence and defence.

Admiral Colomb explained and reviewed the work which he had thus performed. He referred to an effort made by Captain Noel to assign proportionate value to many of the same elements dealt with in this paper. He considered, however, himself, that such valuation must of necessity be completely arbitrary, and probably would be agreed upon by no two competent men. Moreover, from time to time circumstances would arise which would cause more weight to be given to some in contradistinction to others. In this condition of things the author thought it best to limit his work in the main to comparing the powers of our English types in each aspect, leaving the relative weight to be given to each element open. We are glad to say that in the important matter of fire Admiral Colomb uses the same measure that we employed in an article last November; that is to say, the total energy of fire delivered per minute. It is satisfactory to find so high an authority adopting the same measure perfectly independently, probably before our article was published. The figures do not agree because he gives a greater rate of fire to the light guns, but such a difference as this is easily disposed of. Admiral Colomb also seems to consider that a given amount of shell-fire will tell more for its particular purpose of attack of lighter structures if delivered in several small shells than in one large one. The author, as noticed above, spoke of the great difficulty he experienced in endeavouring to shape and classify data, giving weight to the various elements, but many bore a certain sort of proportion to displacement. The question of the relative value of a given energy of fire delivered by a few heavy guns, as compared with the same from a number of medium quick-fire pieces, was considered, and eventually the case of two Edgars attacking one Majestic. The scope of the paper, however, was such as does not admit of doing justice to it in a short notice. A discussion followed, in which Sir John Hay and Sir Edmund Freemantle took part; but it was evident that the subject was too fresh for any mature opinions to be expressed.

INSTITUTION OF NAVAL ARCHITECTS.

THE following programme has just been issued for session 1896:—The meetings will be held as follows:—In the Hall of the Society of Arts, John-street, Adelphi—by kind permission of the Council—on Wednesday, March 25th, morning at 12 o'clock; on Thursday, March 26th, morning at 12, and evening at 7 o'clock; on Friday, March 27th, morning at 12. The Right Hon. the Earl of Hopetoun, G.C.M.G., President of the Institution, will occupy the chair.

The Council of the Institution will meet in the Library of the Society of Arts, on Wednesday, March 25th, at 11 a.m., and on Friday, March 27th, at 11.15 a.m.

PROGRAMME OF PROCEEDINGS.

Wednesday, March 25th.—Morning meeting, at 12 o'clock: (*a*) Annual report of Council; (*b*) election of the president, the officers, and Council; (*c*) address by the chairman, the Right Hon. the Earl of Hopetoun, G.C.M.G. The following papers will then be read and discussed:—(1) "Water-tight Doors, and their Danger to Modern Fighting Ships," by Captain the Right Hon. Lord Charles Beresford, C.B., R.N. (2) "Water-tight Doors," by Colonel Nabor Soliani, Director of Naval Construction, Royal Italian Navy, Member. (3) "Some Geometry in connection with the Stability of Ships," by J. G. Bruhn, Esq.

Thursday, March 26th.—Morning meeting, at 12 o'clock: (1) "The Causes of Mysterious Fractures in the Steel used by Marine Engineers as revealed by the Microscope," by A. E. Seaton, Esq., Member of Council. (2) "The Measurement of Feed and Circulating Water, &c., by Chemical Means," by C. E. Stromeyer, Esq., Member. (3) "Salvage Appliances," by J. G. Kinghorn, Esq., Member. Evening meeting, at 7 o'clock: (1) "Compound Marine Boilers," by Colonel Nabor Soliani, Director of Naval Construction, Royal Italian Navy, Member. (2) "Water-tube Boilers," by J. Watt, Esq., Member. (3) "Circulation in Water-tube Boilers," by Professor W. H. Watkinson.

Friday, March 27th.—Morning meeting at 12 o'clock: (1) "The Non-uniform Rolling of Ships," by R. E. Froude, Esq., F.R.S., Associate Member of Council. (2) "A New Theory of the Pitching Motion of Ships on Waves, and of the Stresses produced by this Motion," by Captain A. Kriloff, Professor at the Naval Academy of St. Petersburg. (3) "Notes on the Carriage of Grain Cargoes," by George Herbert Little, Esq. (4) Concluding proceedings.

The annual dinner of the Institution will be held on Wednesday, March 25th, at the King's Hall, Holborn Restaurant, High Holborn, at a quarter-past seven. Tickets 7s. 6d. each, which will be paid for at the dinner. Evening dress.

Note.—The Chairman will, if possible, arrange for an interval of about forty minutes for luncheon at each morning meeting at 2 p.m., or as near that hour as the state of business will permit.

LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—The forty-third anniversary dinner of the Association will be held in the Great Hall, Cannon-street Hotel, on Saturday evening, April 25th; chairman, Mr. John Wolfe Barry, C.B., F.R.S., vice-president, Inst. Civil Engineers.

THE BRITISH ASSOCIATION OF WATERWORKS ENGINEERS.—A full meeting of the Provisional Committee was held at the Westminster Palace Hotel, on Saturday last, for the purpose of finally revising the constitution and rules. These will be published shortly, when a general meeting of the association will be duly announced.

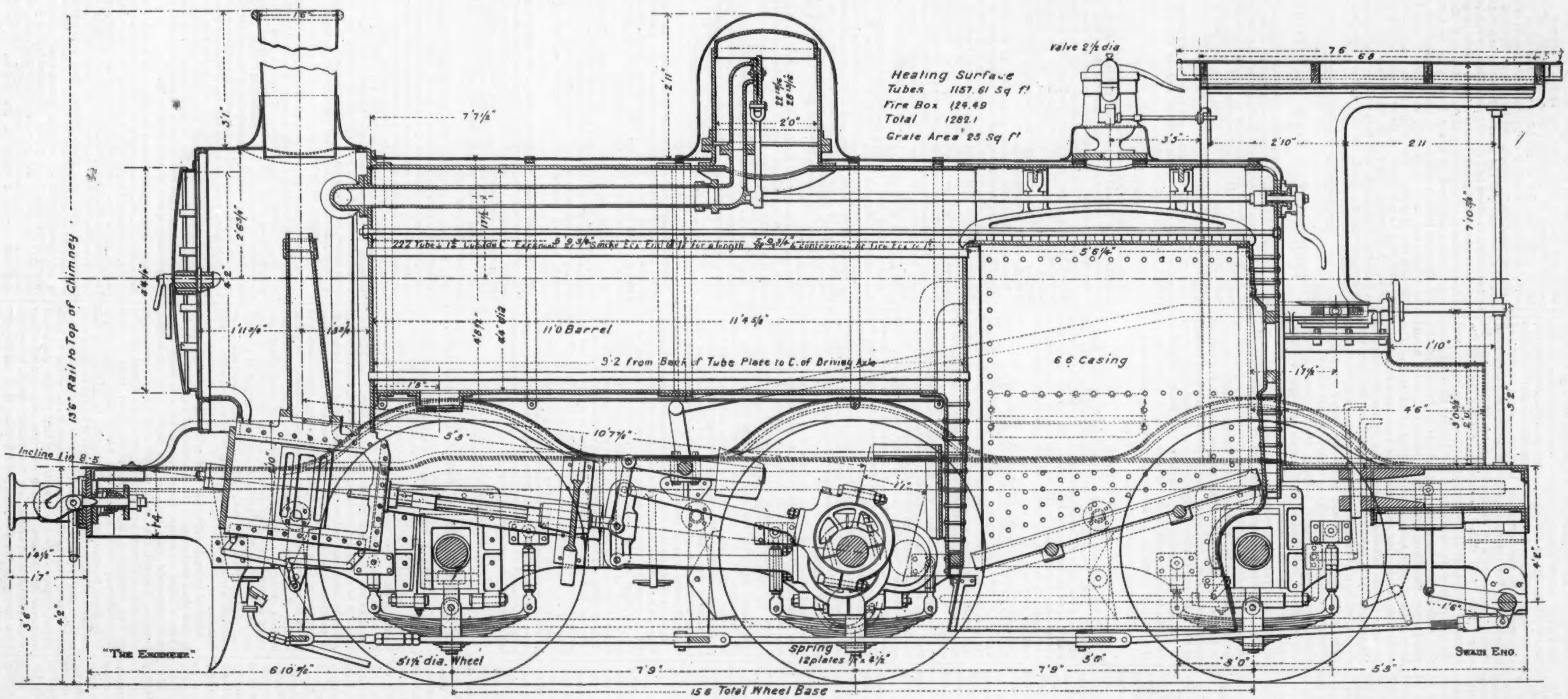
TRADE AND BUSINESS ANNOUNCEMENTS.—We learn that Messrs. William Simons and Co., Renfrew, have received an order from the Mersey Docks and Harbour Board for the construction of a large and powerful stationary barge-loading dredger, similar to the Walter Glynn recently constructed, this being the eighth dredging vessel ordered from William Simons and Co. by the above-mentioned Harbour Board.

THE FASTEST BOAT IN THE WORLD.—Messrs. Thornycroft and Co. have succeeded in producing a vessel which is not only the fastest vessel in the world, but has attained that position almost at her first effort. It is well known that as a rule fast vessels are worked up by degrees to their maximum speed, small alterations being usually required in the fitting of the valves, amount of grate, trim of boat, area of propeller, &c. But on Tuesday the Desperate torpedo boat destroyer, designed and built by Messrs. J. Thornycroft and Co., ran a preliminary trial, and obtained a mean speed, on four runs on the measured mile, of 31·035 knots, or 35¾ statute miles. The speed was taken by Admiralty officials, and is the highest on record.

THE BIRMINGHAM ASSOCIATION OF MECHANICAL ENGINEERS.—At the March monthly meeting a paper was read by Mr. A. Calvert on "Capstan Lathes, their Construction and Utility," the synopsis being plain and semi-automatic capstans, embodying a description of wire feeds, turret feeds, and chasing arrangements, &c. After giving a detailed description of the capstan lathe as an up-to-date machine tool, and explaining the various devices which have been introduced, he stated that the Americans claimed to be the inventors of these machines, but such lathes were used in the Government factories in England before they were seen in America. As an instance of the utility of these lathes, he stated that an article which he knew cost 2s. 8d. to machine on an ordinary lathe, was now done upon a capstan lathe for 4d.

KING'S COLLEGE ENGINEERING SOCIETY.—On Friday, March 13th, Mr. Sodean, B. Sc., read a paper on "Gases as Illuminants." The author commenced his paper by explaining the action which takes place in the several parts of the flame of an ordinary gas flame. The thermo-couple was explained in detail, and its use in determining approximately the ranges of temperature of the various portions. Figures were given showing these temperatures. The acetylene flame was shown, and its richness in carbon was also shown by experiments with the ordinary Bunsen burning coal gas, with varying proportions of acetylene. The manufacture of acetylene from calcium carbide was gone into thoroughly, and the cost of manufacture was discussed at some length. The paper terminated with a vote of thanks to Mr. Sodean for his interesting paper.

CONTRACTS OPEN—LOCOMOTIVES FOR THE EASTERN BENGAL STATE RAILWAY



CONTRACTS OPEN.

LOCOMOTIVES FOR THE EASTERN BENGAL STATE RAILWAY.

The Secretary of State for India in Council is inviting tenders for sixteen goods engines and sixteen tenders for same, also duplicate parts, viz., two sets of wheels and axles, with crank-pins, &c., and two sets of springs. The engines are to have six wheels, all coupled, inside cylinders, and inside frames, and separate tenders on six wheels; gauge of rails 5ft. 6in. Wherever the specification differs from the drawings the former is to be followed. The weight must not exceed 15 tons on any pair of wheels, as this is the maximum sanctioned by Government. The general dimensions and capacity of the engines and tenders are as follows:—

Engines.

Diameter of cylinder, inside	1ft. 6in.
Stroke of piston	2ft. 2in.
Centre of cylinder to centre of driving axle	10ft. 7½in.
Length of boiler barrel between tube plates	11ft. 4⅝in.
Diameter of boiler barrel outside	4ft. 5in.
Length of fire-box casing outside	6ft. 6in.
Width of fire-box casing at bottom outside	4ft. 6in.
Width of fire-box casing at centre outside	4ft. 6in.
Height of centre of boiler from rail	7ft. 10in.
Number of tubes	222
Diameter of tubes outside	1¾in.
Heating surface of tubes	1157·61 sq. ft.
Heating surface of fire-box	124·49 sq. ft.
Heating surface, total	1282·1 sq. ft.
Fire-grate area	23 sq. ft.
Working pressure of boiler	160 lb.
Length of engine frames	27ft. 7⅝in.
Thickness of engine frames	1⅛in.
Distance between engine frames	4ft. 9in.
Diameter of wheels on tread	5ft. 1½in.
Distance between centres of wheels, leading to driving	7ft. 9in.
Distance between centres of wheels, driving to trailing	7ft. 9in.
Total wheel base of engine	15ft. 6in.
Height of buffers from rail	3ft. 6in.

Tenders.

Number of wheels	6
Wheel base	12ft. 6in.
Diameter of wheels on tread	3ft. 7½in.
Distance between centres of journals	7ft. 8in.
Thickness of frames	¾in.
Length of frames	19ft. 4⅝in.
Distance between frames	6ft. 7½in.
Capacity of tank	2500 gallons
Capacity for fuel	285 cu. ft.

The frame plates of both engine and tender, and all other plates, angles, &c., also rivets, are to be made of Siemens-Martin acid steel of the best quality.

Gun-metal, when not otherwise specified, is to be composed of the following mixtures:—

	Copper.	Zinc.	Tin.
General	8·0	Nil	1·0
Axle-boxes, connecting and side-rod brasses	84·2	1·3	14·5
Slide valves	85·9	0·7	13·4
Glands and their bushes	85·3	2·7	12·0

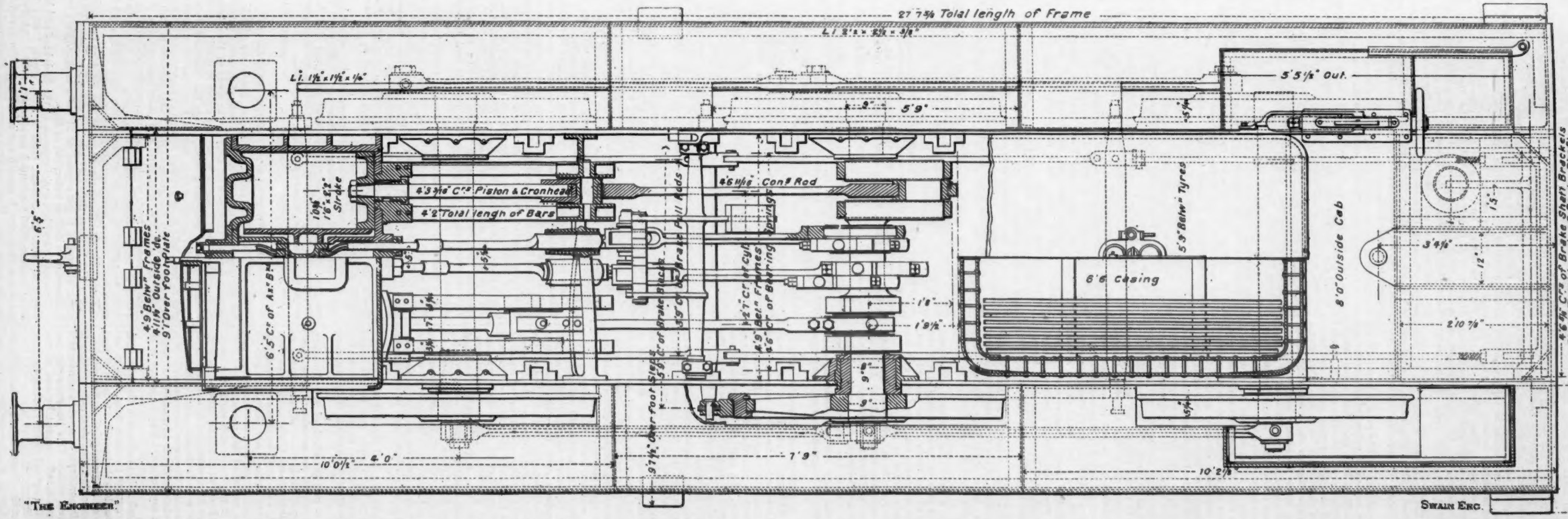
White Metal.

	Copper.	Zinc.	Tin.	Antimony.
For axle-boxes	5·8	64·8	29·4	Nil
For slide valves	7·7	Nil	82·1	10·2

The boiler steel must be capable of standing a tensional strain of not less than 25 tons or more than 30 tons per square inch, with an elongation of not less than 23 per cent. in 10in. Samples, both when cold and after heating to a cherry red and cooling in water at a temperature of 82 deg. Fah., whether cut lengthwise or crosswise, must stand bending double round a curve the diameter of which is not greater than the thickness of the test piece. A specimen for the drift test must be machined for each set of barrel and casing plates to a width of 3in., a ⅝in. hole will then be bored 1¼in. from one end and each side, and must stand drifting until the hole is 1¾in. diameter.

The dome basin is of best Yorkshire iron or mild open hearth acid steel, the flanges are to be scraped steam-tight, and the joints made with boiled oil only. The dome is of 7/16in. steel plate, butt-jointed at the back. A Ramsbottom patent duplex safety valve, with cast iron columns, and gun-metal valves and sections to be fitted to each boiler; valves 2½in. diameter. The top of the fire-box shell is round, and the top and sides are to be in one plate ½in. thick, the front plate is to be 9/16in. thick, and the back plate ½in. thick, lap of plates 3¾in. finished, 13/32in. rivets, 1⅞in. pitch. The upper part of the back plate of fire-box casing is stiffened by a ½in. steel plate, and is connected to the front tube plate by eleven longitudinal stays, 1⅛in. diameter, thickened to 1¼in. at the tube plate, and 1⅜in. at the back plate. Eight belly stays are to be rivetted to the barrel plate and fixed to the copper tube plate. The crown plate of the fire-box is stayed with eight cast steel bars, secured to crown plate by bolts tightly tapped into the roof bars. Distance pieces are cast solid with the bars, and tapped to receive the bolts, these distance pieces must be machined where they bear on the crown plate. The roof bars are to be attached to slings, each made from a single piece of mild steel, fixed to T steels; each roof bar must also stand a load of 16 tons applied on the top, at the centre of the bar, when placed on bearings at its extreme ends in their working position without any set. The tubes are No. 11 B.W.G. thick at fire-box end, and No. 12 B.W.G. at the smoke-box end, 1¾in. external diameter, reduced at the copper tube plate to 1⅝in., and expanded in the front

CONTRACTS OPEN—LOCOMOTIVES FOR THE EASTERN BENGAL STATE RAILWAY



tube plate to 1⅜in., made of a mixture of 70 parts copper and 30 parts of best Silesian spelter. All the tubes must be tested internally by hydraulic pressure to 600 lb.; the ferrules are 1¼in. long, with a taper of 1 in 20, made of best quality steel tube.

There are twenty-three wrought iron fire-bars spaced 1⅛in. apart. The ash-pan is of ¼in. plate, provided with a door at the front and back ends, both worked from the foot-plate; meeting surfaces of doors and seatings are to be machined and faced to secure an air-tight fit. The smoke-box is 5ft. 1½in. wide and 3ft. 3⅜in. long inside, it is made of ⅜in. steel; the sides of crown are in two plates; the door is of $\frac{5}{16}$in. steel with a ¼in. protecting plate. The barrel of the chimney is of ⅜in. steel plate, butt-jointed at the back, with an inside butt strip. Two of Gresham and Craven's most recent pattern of horizontal combination injectors, one No. 7 and one No. 8, made of gun-metal, with all cones made movable for renewal. The internal steam pipe is of copper, No. 5 B.W.G. thick, tested to 280 lb.; the exhaust pipe is to be made of cast iron fitted with Macallam's variable blast pipe. The frames are of Siemens-Martin acid steel, and have a tensile strength of 25 tons to 31 tons per square inch, with 20 per cent. elongation in 10in.; they are of $1\frac{1}{16}$in. in thickness, and need not be planed; all holes marked from one template.

The sand-boxes are to be of steel, the sand is to be led from the boxes by wrought iron pipes, fitted with Gresham and Holt's steam sanding gear. The slide valves are to be made of gun-metal, pistons of tough cast iron, piston-rods forged from the very best open hearth acid steel; connecting-rods are to be I section, forged solid in one length without weld; coupling-rods the same.

The axles of both engines and tenders are to be of the very best open hearth acid steel, and guaranteed to run 200,000 miles for the straight and 150,000 for the crank axles. The axle-boxes are of cast iron, fitted with gun-metal bearings with white metal let in. Axle-box guides are of cast steel; the driving and trailing axle-box guides are fitted with wrought iron wedges case-hardened.

The engine is to be fitted with the automatic vecuum brake complete, of the most recent and approved pattern. The trailing foot-plate is to be of cast iron; each engine is to be erected complete and tried in steam in the presence of the consulting engineer or his deputy. The boiler when finished is to be tested by hot water to a pressure of 240 lb. and by steam to 170 lb. The weights upon each wheel, when the engine is full and light, are to be carefully ascertained separately by a machine which the consulting engineer shall consider satisfactory; the weights must be shown on the drawings prepared by the contractor. The tender is to be filled with water and tested by hydraulic pressure to 5 lb. The remainder of the specification is as usual. No payment will be made on behalf of the contract before 1st April, 1897. Tenders are to be in by 31st inst.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE BESSEMER PROCESS.

SIR,—A Presidential address has recently been delivered at Pittsburg to the American Institute of Mining Engineers by Mr. J. D. Weeks, who has taken advantage of that prominent position to repudiate my just claims to the steel invention that bears my name, and which has been most amply acknowledged by America's most honoured scientific institutions, manufacturers, and citizens during the last forty years. I may not inaptly preface the remarks I have to make on this subject by the words of our immortal Bard:—

> "Who steals my purse, steals trash,
> 'Twas mine, 'tis his, and has been slave to thousands,
> But he who filches from me my good name
> Robs me of that which not enriches him,
> And makes me poor indeed."

A great moral responsibility is incurred by the man who, for the mere purpose of gaining a short-lived popularity, does not hesitate to blast the reputation of one who he well knows in his own heart is the real inventor of that process which has so enormously extended the trade and commerce of his own country, and for this unworthy object flatters his hearers by telling them that they owe all this to a countryman of their own; taking the opportunity of making these statements at a public meeting at which I necessarily could not be present, and relying for this monstrous accusation upon such vague testimony as he has been able to rake up from bygone transactions touching only one side of the question. Mr. Weeks well knew that a period of forty years, and the wide Atlantic, separates me from all documentary evidence on my side of the case, and which, at the period when all the facts on both sides were before the American people, they had, to their great honour, decided in my favour, and to which opinion they have adhered up to the present day. Fortunately, however, for me, some of the evidence which Mr. Weeks brings forward to support the case of Mr. Kelly, from the very nature of things, furnishes conclusive evidence against the allegations which he makes in favour of Kelly's scheme, and in order that the whole subject may be clearly understood, it is necessary for me to refer to some technical details of iron-making, showing their close analogy with the process said to have been carried out by Kelly.

For the last hundred years or more it has been the practice of manufacturers of malleable iron to operate upon the crude pig iron in a small shallow bath, known as a refinery, or "finery fire," in which the molten pig iron is subjected to a blast of air blown down upon its upper surface from three nozzles arranged along the side of the bath, or pool, of iron, the surface of which has a quantity of incandescent coke floating upon it. After this blowing operation has been continued for an hour or two, the molten matter is to some extent decarburised and partially deprived of its silicon; it is then run out and formed into thick plates, which, when cold, are very hard and brittle white iron; these plates are broken up and reheated in a reverberatory furnace, and rendered malleable by the laborious process of puddling. We hear that a Mr. Kelly was making some experiments of this kind as far back as the year 1847, and we are told by the president, Mr. Weeks, that "Kelly was a forge master making malleable or wrought iron, and it was to make this product that he pursued his experiments," so that, according to the evidence furnished by Mr. Weeks himself, Kelly did not contemplate the production, or even try to produce steel by his experiments, as that material was quite out of his line of business.

But it is cast steel, such as Bessemer invented—and perfected the process of making in every mechanical detail—that has played such an important part in the metallurgy of the present century; it was this cast steel, and not the wrought iron which Kelly was trying to improve, that has laid the 170,000 miles of steel rails like a network over the whole Continent of America; it was this cast steel made by the Bessemer process, and the machinery invented by him, with which the 4,160,072 tons of cast steel was made in America in the year 1872, and not by any plan or device originated or practised by Mr. Kelly.

Now what could be more natural for a forgemaster and manufacturer of wrought iron than to try and save some of the fuel used in the ordinary process of his trade; and what would appear more obvious than the idea that some, or perhaps all, of this incandescent coke lying on the molten pig iron in the "finery furnace" might be saved; this doubtless was the sole and simple object which Kelly had in view when he was trying experiments in his open yard, as described by Mr. Weeks, operating in a very temporary way and using the end of an old boiler lined up with bricks and containing about 500 lb. of molten iron from the blast furnace — just such a charge as when refined would be enough to make a charge for the puddling process which had to follow, and thus to make it into malleable or wrought iron, which Mr. Weeks tells us was Kelly's trade "and what he was trying to make." This was just such an experiment as might be safely made without previously taking the precaution of patenting it, as its value, if successful, would be very small. The apparatus, he tells us, was provided with a single nozzle blowing vertically down upon the metal, and which single jet of air blown down upon it would partially, though very imperfectly, refine it, as is done in the "finery fire" in common use; and when this scheme, which had long been utterly abandoned and forgotten, was investigated some eight or nine years after these experiments had been made, all the evidence which I could collect went to show beyond all reasonable doubt that Kelly was simply trying to make his "finery iron or plate metal" without the employment of any coke floating on the surface, and thus saving some fuel in preparing his metal for subsequent conversion into malleable iron.

This is the impression which was irresistibly forced on my mind at the time these questions were before the American Patent-office, and I have at this moment the most absolutely conscientious belief that Kelly was not at that period even attempting to produce malleable iron or steel in a fluid state, such as could be formed into ingots or castings.

And when we read the strongly biassed statements of Mr. Weeks, and note his all-important omissions, his own story furnishes me with an absolute denial of his most unwarrantable assertion that Kelly had originated the Bessemer process.

Now, one would have thought that if Mr. Kelly commenced his experiments in 1847, we should have heard something of this revolutionary process before the year 1856; but we are told that "as late as 1856, after nine years of work, the appliances he used were exceedingly crude." Mr. John E. Fry, who was a foundry moulder at Cambria when the first experiments were made at Johnston by Kelly, "in a conversation a few days since," thus described the first converter made in 1856, to Mr. Weeks:—

"This apparatus was a 2ft. section of a 3ft. boiler shell, lined up to about 16in. in diameter, having a paved fire-brick bottom about 20in. deep; this was put outside the door of the blast engine-room of the old Cambria blast furnace. The engines gave from 3 lb. to 4 lb. blast pressure; there was a temporary connection made from the blast pipe to this little auxiliary furnace by a gas pipe. The nozzle was a cast iron affair, such as was used at the tuyeres in those days. The tuyere was 'clayed up,' and dried and connected by a loose elbow to the pipe, so as to be swung down into the metal. The metal was melted at the foundry, and brought up in a ladle containing about 500 lb. The furnace was about 200 yards from the foundry, and the ladle was put on to a little metal hauling car, and hauled to the converter; this metal would make probably 8in. or 9in. of depth in this little pot. As soon as the metal was dumped in, the pipe was shoved down with the blast on, a cover of pieces of sheet iron was laid across the top to prevent the sparks flying too freely." And here the evidence drops short, and it is clearly not worth their while to pursue the subject any further, it would be dangerous to do so; it would, in fact, "let the cat out of the bag." These discreet witnesses have given all the very interesting details as to the "dumping" in of the molten iron, even to the kind of "little hauling car" which conveyed the metal to the apparatus; but it would have been infinitely more to the purpose if these observant witnesses had told us something about the way in which this metal was taken out again, in what state of partial or complete solidity did it result, or whether it was soft malleable iron or hard and brittle "plate metal." They have told us nothing of the use of ingot moulds, in which the molten malleable iron must be made into ingot; they have told us nothing of the treatment of the metal after it was blown. Was it taken to the puddling furnace to be there converted into wrought iron, or was it rolled into bars or sheets from ingots formed while in a fluid state? Without all these essential facts ail their testimony and affidavits are worse than waste paper, as they directly prove nothing; but the absence of these facts afford very strong circumstantial evidence that Kelly never had produced homogeneous malleable iron, and had never made an ingot by his process.

Kelly's method of operating by one tuyere only, blowing vertically downward, shows that he had never grasped the fundamental principles on which the Bessemer process is based; his nine years of failure shows that in all that time he had not mastered the A B C of the Bessemer process. Now there is such a thing as blowing and blowing, and, as we are told in the old fable, by simply blowing a man may either "warm his fingers or cool his broth."

But Mr. Kelly saw none of these nice distinctions, and to compensate for this want of knowledge, Mr. Weeks, with much perverted ingenuity, has striven to whittle down the Bessemer process until it is low enough to reach Mr. Kelly's level, and strives to impress on his hearers the idea that the Bessemer process is summed up in the words, "blowing air into iron," and Kelly, having done this, is therefore, according to Mr. Weeks' theory, on Bessemer's level. This, however, is not so; the mere blowing of air into a fluid is not a patentable suggestion, it is not a "new manufacture," and before we can obtain a valid patent we must produce something tangible, something not before produced by the same means, something which is, in fact, either of better quality or less in cost than has been produced by former methods. "I therefore claim as my invention the forcing of currents of air into and among the particles of molten crude iron, or of remelted pig or refined iron, until the metal so treated is rendered malleable and has acquired other properties common to cast steel, and still retaining the fluid state of such metal, and pouring or running the same into suitable moulds," and so obtaining a new "manufacture."

Now blowing air into a fluid mass is not a manufacture at all, and therefore is not patentable; thus, for instance, you may blow heated air into linseed oil, but that is not a new manufacture, such blowing might be simply to warm the oil; but if you blow air in a heated state in numerous divided streams upward from a perforated coil, lying at the bottom of a tall cylindrical vessel filled with linseed oil, the oil so treated will combine with the oxygen of the air and become viscid and tenacious, and will acquire the same drying quality as oil that has been boiled with oxide of lead in the usual way of making drying oils, and hence such a process of blowing air into oil by its chemical action produced a superior drying oil, and was a new and patentable manufacture; this was an invention of mine ten years before I thought of steel-making, and for which invention I reaped my reward.

Again, if you blow cold air in numerous jets upward through a vessel filled with cream, that is in itself not a new manufacture, but if your streams of air are powerful enough, and sufficiently long continued, the violent agitation caused thereby will convert the cream into butter, and result in the production of butter without churning, and thus becomes a new manufacture capable of being secured by patent. The different effects produced by different modes of blowing are well exemplified in the old Catalan furnace used in iron-making, where the tuyere is made carbonising or oxidising by merely altering the angle at which the tuyere is directed through the fuel, and by means of which adjustment of angle the workman regulates his process. Again, in the old "finery fire," the tuyeres blow down on to the metal at such an angle as will throw the metal to the opposite side of the bath, and ensure a rapid circulation of all the metal under operation, without which this old process of "blowing iron" would entirely fail. All this is mere matter of history, but, being known, it serves to show the entire want of ingenuity and mechanical skill, and the complete absence in the mind of Kelly of the most simple and rudimentary knowledge on the subject of the motion of fluids impelled by currents of air, as is clearly shown by his choice of the vertical position of the tuyere, in blowing on to or into fluid iron. Kelly appears to have adhered from first to last to this fatal mistake of using one tuyere only, and that one operating in the very worst position in which it was possible to place it; a position most certain of all others to ensure its own rapid destruction while producing the least possible circulation and effect on the metal. An enormously high temperature is necessary not only to render pure iron fluid, but an excess over that temperature is necessary to allow it to be transferred to a casting ladle, and therein be retained in a fluid state during the time necessary to quietly pour it into numerous moulds. The great problem I had to solve was how to generate and retain this enormously high temperature, for on any system of heating fluids we have two antagonistic operations going on, viz., the production of heat and its loss by radiation and absorption by the vessel in which the process takes place, and this particular case is further complicated by the rapid absorption and carrying off of heat by the incombustible portion of the air forced through the metal, hence it becomes a question of time; heat is always flowing away, and if the accession of heat went on at the same pace, we should never raise the temperature of the metal, and this points at once to the necessity for an extremely rapid production of heat; this rapid production of heat means such an intimate admixture of the combustible carbon and silicon with oxygen as will produce the necessary temperature in a few minutes, otherwise the heat would be dissipated and the fluidity could not be maintained. So intimate is the mixture of carbon and oxygen in gunpowder that its combustion becomes instantaneous and no heat is lost, and in the Bessemer converter a well-arranged set of tuyeres blowing vertically upwards produces such an intimate admixture of oxygen and carbon as to create a succession of small harmless explosions, and hence fixes a limit to the safe diffusion of these combustible elements.

A converter with a group of seven tuyeres, each having seven separate passages through them, will direct vertically upwards forty-nine separate streams of air through the metal; this air dividing itself into countless thousands of small globules rushes upward, producing a light column of mixed iron and air, while the denser portion of the iron forms descending columns and keeps up a powerful circulation, equalising the temperature and the rate of combustion, while a single nozzle pointing downward, as tried by Kelly, will not diffuse the air throughout the mass, but the air will rise up all around the nozzle and soon melt and destroy it. Air applied in this manner can never set up that amount of circulation and vivid combustion throughout the whole mass which is an absolute necessity if fluid malleable iron is to be produced and cast into ingots, conditions absolutely impossible to arrive at in a shallow open vessel with one tuyere blown downward.

Indeed, Mr. Weeks is constrained to admit that Kelly could not make fluid malleable iron in his apparatus owing to its inherent defects in principle, which Kelly had not scientific knowledge enough to perceive or mechanical skill enough to remedy.

The precise words which Mr. Weeks adopts from Mr. Holley, in this confession of the failure of Kelly to produce fluid malleable iron, are as follows:—"Mr. Bessemer's invention consists in the mechanical means for intimately diffusing the air through the mass of iron to such an extent that the mechanical changes take place with sufficient rapidity to leave the mass fluid after the carbon and silicon have been removed, while the means employed by Kelly were not adequate to carry the process to the same extent." Hence, with his one tuyere blowing downward, Kelly could not, and did not, produce fluid malleable iron; and could not, and did not, make an ingot; and could not, and did not, carry out the Bessemer process, which consists in the production of ingots of cast steel by forcing numerous streams of air upwards through the molten crude or cast iron. This failure of Kelly was the result of his entire ignorance of the essential principle on which the Bessemer process is based, viz., the rapid diffusion of minute fiery bubbles throughout the entire body of the metal under operation.

This abortive attempt of Kelly—if ever made—was by Mr. Weeks' own showing abandoned some years before I read my Cheltenham paper, having never served any useful purpose whatever.

Had Kelly patented his invention, had he read a paper on it before any scientific institution, or had he published an account of it in the public press, it might have been said that a published account of even this most unsuccessful and abortive attempt would have acted on other minds and suggested a more perfect system; but Kelly did not in either of these ways, or in any other way, make known or convey any knowledge to the outer world as to what he was trying to do, and hence his labours have not by the smallest possible increment advanced the general stock of knowledge or influenced to the most infinitesimal extent the progress of steelmaking either in America or elsewhere. All that Mr. Weeks has succeeded in doing is to show that an American citizen, if he ever had in his mind the idea that malleable iron could be produced by currents of air, could yet be so entirely devoid of mechanical skill, so hopelessly ignorant of the physical laws which govern the whole theory on which my invention is based, that, after pottering over his ill-devised schemes for a number of years, he failed hopelessly, and gave it up, having never benefited the world to the smallest possible extent. He never even thought it worth while to patent his invention during all the nine years from 1847 to 1856; but as soon as he found that my invention was agitating the whole iron trade of Great Britain, he woke up and commenced a fierce fight with affidavits in the American Patent-office, after I had already obtained my patent in America, and after all my English patents were published in Blue-books, which at the small cost of 6d. each were open to Kelly's and every one else's inspection; in them they could see every detail of my several inventions. Then it was, we are told, that "Pompey was very like Cæsar," and that there was a wonderful identity between Kelly's invention and mine, but this similarity did not come about by my patenting in America an apparatus with one tuyere blowing downwards.

Any one would have thought that a person in Mr. Weeks' position must have had the honour of his own country more at heart than to drag such a lame story from the obscurity in which, to the honour of America, it had for forty years been buried.

The fact of Kelly obtaining a patent in America after mine, rendered it necessary for all the manufacturers of steel in America to work under both patents, so all the trade knew perfectly well what Kelly's title to be called an invention really was, and with this full knowledge they unanimously joined in always calling it the Bessemer process. The Americans have, with this knowledge before them, elected me an honorary member of the American Society of Mechanical Engineers, and also an honorary member of the American Academy of Arts and Sciences, and in several parts of the United States, where Nature has richly endowed them with those aids to civilisation, coal and iron manufacturing cities have been established to which, by common consent, they have given the name of Bessemer.

Thus we have the rapidly increasing and important city of Bessemer, Gogebec County, Michigan; the city of Bessemer, Alabama, with its mayor and Corporation, its street tramways and electric lighting, and its large manufacturing works, public schools, and numerous churches. There is also the city of Bessemer, Lawrance County, Pennsylvania, the seat of the great Edgar Thompson steel works, the largest in America. There is also the city of Bessemer, Botetourt County, Virginia, and the city of Bessemer, Gaston County, North Carolina.

Nothing could more clearly show the spontaneous recognition of a whole nation of the enormous benefit that the Bessemer process has conferred on the trade and commerce of the United States.

The great wave of excitement produced on the public mind throughout Europe by the announcement of my invention at Cheltenham, soon forced its way across the Atlantic, and created a great sensation among the iron producers of the United States; among other eminent men it attracted the most earnest attention of Mr. A. S. Hewitt, whose high position is fully recognised throughout the United States, and who made the following statement in reply to Sir James Kitson, the honoured President of the Iron and Steel Institute, when Sir James was in America in 1891. Mr. Hewitt said:—"Mr. Bessemer read his celebrated paper describing the process of producing steel without fuel at the Cheltenham meeting of the British Association for the Advancement of Science in the summer of 1856. An imperfect report of this paper was published in the journals of the day, and attracted my notice. The theory announced seemed to be entirely sound, and the apparatus simple and effective. I gave orders at once, without further information than that derived from the published report, to erect an experimental vessel for the purpose of testing the possibility of producing steel direct from the blast furnace. In the same year in which this paper was read, the experiment was tried at the furnace of Cooper and Hewitt at Phillipsburgh in New Jersey, and the result served to show beyond all doubt that the invention of Mr. Bessemer was one which could be successfully reduced to practice."

Now, if Kelly's nine years pottering had created the smallest interest in America, surely a firm like Cooper and Hewitt would have known it and would not have been so anxious to prove the fact as at once to have put a Bessemer converter in operation on an experimental scale.

Mr. A. S. Hewitt, who is a past-president of the American Institute of Mining Engineers, said on the occasion of their meeting at Washington on February 22nd, 1882:—"My firm made an effort within six weeks after the famous Cheltenham paper was read in 1856, to see whether pig iron could be thus converted into steel. It was three or four years after that that Mr. Holley's attention was called to the matter, and he went to Europe and brought back for his friends the control of that patent."

So that Mr. Holley was not in any way interested in this question for some years after Kelly knew all about my several patents, and had plenty of time to shape his invention so as to square with mine, even to the making of a movable converter, which Mr. Weeks says was "an infringement on Bessemer's converter." It is something to get from Mr. Weeks the direct admission that Kelly had made an infringement of my patent. Why is he not more candid?

No sooner were Bessemer steel rails produced in Sheffield than American railway managers began to purchase them, and so important were they deemed to be that thousands of tons were sent to America, realising the almost fabulous price of £20 per ton; and when America began to make their own steel rails, thousands and tens of thousands of tons of Bessemer pig iron were sent from this country to make Bessemer steel with. This Bessemer pig was made by furnace charges invented and dictated by me, all the hematite iron previously made in England entirely failing to make workable steel.

Nor must it be forgotten that the Bessemer converter with its hydraulic moving gear, and the hydraulic casting crane and apparatus, the ingot cranes, the valvular casting ladles, pair of vessels arranged in a semi-circular pit, the conical moulds, and, in fact, the whole plant, outfit, and arrangements of the American steel works, are the patented inventions of Henry Bessemer, although somewhat modified in their mechanical details by the late Mr. A. L. Holley, so as to suit the American practice; but Bessemer's patent machinery is still used, with scarcely a deviation in detail after a period of nearly forty years in every country in Europe where Bessemer steel is made.

The British Patent-office shows all the successive steps in the development of my invention, and with these evidences of its origin and vitality scattered all over Europe and America, it is simply an outrage on the man who has done all this, and to whom America is so deeply indebted for the great extension of her manufactures, her commerce, and her prosperity, and to set up as the original inventor of the Bessemer process a man whose abortive schemes have not added one tittle to the public store of knowledge, or benefited the world or even his own country to the value of a single cent; it is nothing less than an outrage on the common sense of the scientific world. HENRY BESSEMER.

London, March 19th.

NAVAL GUN SIGHTS.

SIR,—In the article you publish in your issue of March 6th, on "Quick-fire Naval Gun Sights," you raise a question of much interest, not only to artillerists, but also to opticians and mechanicians, namely, the possibility of having a gun sight which will be at once a range finder and gun adjuster, or rather, perhaps, one should say a gun sight which will dispense with the need of knowing the actual range. You refer to the proposal to use a telescope the focussing of which would indicate the range of the object focussed. As you further refer in appreciative terms to the work done by Dr. Stroud and myself in the design of range finders, perhaps you will allow me to point out the scientific basis of the method of range finding proposed.

In the first place, I would say that the proposal is not a new one. It has often been suggested and even tried, but it can be shown that it is impossible for it to be successful as a practical range finder for such distances and accuracies as are dealt with in gunnery. If we assume that the eye had no power of accommodation, then a telescope when focussed for an object at one distance will show a well-defined object at any other distance out of focus, that is with a more or less indistinct or hazy outline; the hazy image being in fact practically a multitude of partially superimposed images, one for each point of the objective of the telescope. If, then, the objective be all covered up except two small areas, we shall have two images, and these will be separated by the maximum distance when the uncovered areas are at maximum distance; that is, when these areas are at opposite ends of a diameter of the objective.

The telescope then becomes a range finder with a base length equal to the diameter of the objective. The uncovering of the remainder of the objective only obscures the indication by adding an indefinite number of other images more nearly in coincidence—that is, filling up the space between those farthest removed from each other.

The question then becomes, What accuracy can be obtained with a base length equal to the diameter of the objective of a telescope? A diameter greater than 4in. could hardly be contemplated; let us assume that diameter. Now, as we show in the paper recently read before the Institution of Mechanical Engineers, the attainment of the accuracy aimed at involves, in a range finder with a base of 54in., the measurement of an angle of 1 sec. With a base of 4in., the angle to be indicated or read would be $\frac{1 \times 4}{54}$ sec., *i.e.*, say $\frac{1}{14}$ sec. To observe to such an angle, even assuming that one had separated images as in our range finder, would require a magnifying power of about fourteen times that used by us, *i.e.*, say a power of 400 diameters.

It is needless to say that such a magnifying power is impracticable for the purpose under consideration. A telescope such as we have assumed, magnifying 400 diameters, would give almost no illumination. On the ordinary standard for terrestrial and marine glasses a telescope to magnify 400 diameters would require an objective aperture of at least 20in. diameter to give good illumination, instead of only a small portion of a 4in. circle, as would be available for each image in the case of the telescope assumed. But, further, the two images in a telescope such as we have supposed would not be separated, but would be overlapping, and as we show—more especially in our reply to the discussion on our paper—the accuracy of observation under such circumstances is nothing like so great as with separated images.

Again, the eye, contrary to our assumption, has a great range of accommodation. Cross wires—or as you suggest a diaphragm—would therefore require to be introduced to define the focal plane, and the observation would be an exceedingly difficult one, namely, the observation of the coincidence of the two images—or if the whole objective is uncovered, the absence of haziness at the edges—simultaneously with the image being in focus with the wires. such an observation is practically impossible to make.

There is another aspect of the problem that may be referred to. Take the standard of accuracy to which we work, namely, one per cent. at 3000 yards, and assume that the telescope has an objective of 7ft. focal length—a greater length could hardly be contemplated. Now the change of focus for a change of distance from 3000 yards to 3030 yards in a telescope having an objective of 84in. focal length is only something like $\frac{1}{1500}$in. Even supposing, then, that the eye could detect this change of focus, the mechanism actuating the focussing motion of the telescope in conformity with the elevation of the gun would require to work correctly to at least $\frac{1}{1500}$in.

As a matter of fact, a single observer range finder, having a base at right angles to the line of sight, may be regarded as a focussing instrument on the lines you suggest. Thus in our range-finder we have the equivalent of a lens of 54in. diameter—with all the useless part of the lens removed—together with what is virtually an accurate means for measuring the position of the focal place, that is the plane where the two images formed by the extreme pencils of light are in coincidence.

It is difficult enough to construct a range-finder with a base of 50in. to 60in. that will measure a distance of 3000 yards within one per cent., and one may be justified in saying that the construction of a range-finder of a few inches base, for such accuracies as are required for gunnery purposes, is impossible.

The University, Glasgow, March 16th. ARCHIBALD BARR.

ENGINE POWER IN PADDLE STEAMERS.

SIR,—The very interesting particulars which you give in your last impression concerning the new Flushing steamers have stimulated in my mind a desire for more. The speed of these vessels is no doubt high, but it seems to me the power required to obtain it is also out of all proportion high. I am led, therefore, to ask for some further information from any of your readers competent to give it, for I take it for granted that on so important a subject you have given all that was given to you. This question of high-speed paddle steamers for continental and short sea routes is of very great interest, as boats of this class are greatly preferred for passenger traffic to screw steamers, which are, as a rule, dreadfully liable to vibration, as, for example, the exceedingly fast twin-screw boat, Jersey, running from Southampton.

You do not give the displacement of the Flushing boats, but it cannot well be more than 1800 tons. Yet not less than 9000-horse power is required to get a speed of 21 knots in the Clyde; not, be it observed, in shallow water, but in deep.

Contrast this with the performance of the Holyhead and Kingstown mail boat, the Ireland, built in 1885, length, 380ft.; beam, 38ft.; tonnage, 2590; indicated horse-power, 6000. The Ireland's speed was 20 knots. I myself saw on one trip 21 knots registered by the patent log. Here we have a very large wheel making few revolutions comparatively, while in the Dutch boat we have small wheels running at a high speed. Only one conclusion can be drawn.

If any one can explain why the machinery of the Flushing boats is so inefficient by comparison with that of the Ireland, or can show that the inefficiency exists only in appearance, and not in fact, I am sure that many of your readers would be interested.

The Ostend boats require considerable power to drive them, but anyone who has stood at the stern of one of them, and seen what takes place when the boats are nearing Ostend at low water, will get a lesson in drag not to be easily forgotten. Acres of muddy broken water seem to follow the ship.

I will not unduly extend the length of this letter, but conclude by asking whether 9000-horse power applied to twin screws would have been needed to give each of the Dutch boats her 21 knots?

Fenchurch-street, March 19th. SUPERINTENDING ENGINEER.

SIR,—I read with great interest your excellent description of the machinery and the accommodation of the three new Flushing steamers, which appeared in your issue of Friday last; but I must confess that I was surprised at the enormous power of 9000 indicated horse-power being required to drive them 21 knots. Surely this is incorrect, as I have before me the particulars of a steamer of practically the same dimensions, which in regular running is driven at the same speed by 5000 indicated horse-power.

If 9000 indicated horse-power be the correct power, and not a clerical error, then it would be interesting to know the displacement, the mean draught, the length and breadth of floats, the depth of the wheel race, and the height of the centre of the shaft above the water-line of these vessels when steaming 21 knots, because the question of the efficiency of a paddle-wheel engine running at 63 revolutions per minute, compared with that of a similar engine running at 40, may or may not be involved in it.

Birkenhead, March 17th. R. B. S.

MESSRS. JAMES WATT AND CO.

SIR,—As another of the former staff of Messrs. James Watt and Co., and by no means "a disappointed man," I beg leave to refer to the letter signed "Soho" in your last issue, which I cannot let pass, conveying as it does a veiled insinuation against the members of the staff of the late firm.

The letter of "One of the Staff" was merely a correction of the inaccurate statement that the old hands were at their posts, and hardly merited the tone adopted by "Soho." Of course, Messrs. Avery are quite at liberty to engage whomsoever they please; but I may remind "Soho" that many, if not all, Messrs. Watt and Co.'s old officials have found as good, and even better, situations with other firms of equal eminence, who are quite competent to judge of their capabilities.

Moreover, "Soho" should know that the staff cannot be held answerable for the misfortunes of the old firm, nor, I venture to say, do Messrs. Avery know much of the individual merits of the hands they have lost; but this I will say that, if they do not replace them by other engineers, they can never hope to make engineering as successful as scale-making. More I feel the position I held with the late firm forbids me to say, but while regretting the evil times that have befallen the historic house, I beg to assure you, on behalf of my late colleagues—as one who has served the firm for nineteen years—at Soho and in London, that no more trustworthy body of men ever found themselves on the deck of a sinking ship. All the same, Sir, most of us have found the shore.

T. H. A. BIDDLE.

146, Grange Park-road, Leyton, March 17th.

THREE-CYLINDER LOCOMOTIVES.

SIR,—Referring to your article on three-cylinder locomotives in the current issue of THE ENGINEER, may I point out that the cylinder arrangement you advocate has been published by me on several occasions during the past few years, both here and in America and India? To mention one case only, it may be found in my discussion on Mr. Edgar Worthington's paper on locomotives read before the Institution of Civil Engineers—vol. xcvi., Part II.

The arrangement is illustrated in the volumes of the Institution. The one thing difficult to understand is how any other three-cylinder design could possibly be contemplated in face of the increased complication of different sizes, &c. With all the cylinders of one diameter, manufacture can be simplified, for there need be but one pattern of piston, &c., and at the same time every ratio of cylinder capacity can be secured by suitable choice of the inside crank. Nor can a pressure of 160 lb. be looked on as excessive for even a 23in. cylinder. Both mechanically and thermally the inside cylinder ought to be the high-pressure one in a compound locomotive. Then with two low-pressure cylinders there would be less trouble with the exhaust than with the huge low-pressure cylinder of the Webb compound. And, again, with three equal cylinders boiler steam could be used in all three when taking a heavy load or a steep bank. W. H. BOOTH.

36, Rosendale-road, East Dulwich,
March 14th.

SIR,—In your issue of the 13th inst. you write a leader on the above subject, and you describe what I may call my system of compounding locomotives. I have, perhaps, considered the locomotive question as much as anyone, and concluded long ago that the two-cylinder compound system was not the best for working passenger traffic in this country. The enclosed pamphlet clearly describes and illustrates my methods. W. M. SMITH.

16, Otterburn-terrace, Jesmond, Newcastle-on-Tyne,
March 16th.

SIR,—Referring to your article in last week's ENGINEER on triple cylinder locomotives, it would perhaps interest you to know that some time since I made a drawing of a locomotive, ordinary English type, in which I got inside cylinders 22in. by 30in., and an ordinary locomotive type boiler of ample power. It is on the lines laid down in your article. I shall be pleased to send you a tracing if you wish, and you could publish it if you think it of sufficient interest to your readers. ERNEST E. BAGULEY.

Stafford, March 18th.

[We shall be glad to see the tracing.—ED. E.]

SANDY PIG IRON.

SIR,—Does the varying quantity of sand that sticks on the undersides of pig iron run from a blast furnace make any difference in the quality of the product when again melted in the founders' cupola or softened in the puddling furnace? Or is the clinging sand entirely fluxed and passed away among the slag, or does part of it, as silicon, seize upon the iron and become incorporated into the nature of it, in either puddling furnace or cupola?

I observe that imported Swedish cast iron for the purpose of making the higher grades of steel is free from sand sticking on the underside. On what material is the Swedish iron run from the blast furnaces?

It seems to me that a change is wanted in the ancient practice of running out the contents of a blast furnace into "sow and pig," whereby it will avoid the carrying away any sand sticking to it.

Does not the varying quantity of sand sticking to pig iron account for the differences of quality obtained from the same mixtures and brands of iron? W. B.

March 18th.

FAST TIME IN FRANCE.

SIR,—Possibly the following details of a run on the Northern of France Railway on Thursday last may interest some of your readers. The afternoon boat express from Calais to Paris ran from Calais-Town—to Amiens in 111 minutes, and from Amiens to Paris in 103 minutes, the distances being, I believe, 102 and just under 82 miles. The speeds were 55 miles per hour for the first run and 47 miles per hour for the second, this last including a long dead slow into the Gare du Nord. The train consisted of about fourteen coaches, weighing probably 140 tons. The engine from Calais to Amiens was one of the new four-cylinder compounds, No. 2146, and from Amiens to Paris, No. 2139 of the same class.

Paris, March 15th. R. COLLIER.

SLIDE VALVE FRICTION.

SIR,—The question of slide valve friction is rather a difficult problem to tackle. Mr. E. J. M. Davies and "C. D." both show the valve as being new and not worn. I send a sketch of what the valve wears to; perhaps some one may go into the question of the friction of a valve as shown in Fig. 1. Immediately the valve opens to port A, the pressure is relieved on more than half, and is on B only. Fig. 2 shows how a straight-edge should be held on the face of the valve to find out the wear. The sketch is purposely exaggerated; the distance from *a* to *b* in Fig. 2 may be anything from $\frac{1}{32}$in. to $\frac{3}{16}$in. Why slide valves are tolerated when piston valves can overcome the defect, it is hard to conceive. However, this is only one of the very many grave defects of our modern locomotive.

FIG 1.

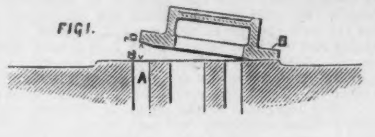
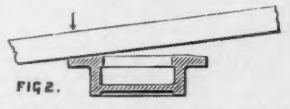


FIG 2.



JOHN RIEIKIE,
District Locomotive Superintendent
Indian State Railways.

Lahore, February 26th.

LINK MOVEMENT ENGINE.

SIR,—With reference to Mr. Chapman's ingenious arrangement for producing circular motion from two rectilinear motions at right angles to each other, you point out that it is not possible to dispense with guides because the pressure on the piston varies. I would like to point out that when either piston is at the end of its stroke and the other piston at mid-stroke, then the transverse pressure on the piston-rod of the former is equal to the total piston pressure on the latter, and hence guides would appear to be necessary. The peculiarity that the piston stroke is four times the radius of the crank may be of use in a gas engine. W. H. T.

March 18th.

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x RAYS.

SIR,—It may interest your readers to know that the authorities of Faraday House, Charing Cross-road, have placed in one of the private rooms the necessary apparatus for photographing by means of *x* rays. This has been done at the suggestion of certain prominent members of the medical profession, and already a large number of negatives have been produced. The apparatus is, of course, manipulated by the staff of the institution, but it is desirable that patients should be accompanied by the medical gentleman who is attending them. H. H. P. POWLES,
Engineer.

Faraday House, Charing Cross-road,
London, March 18th.

SWEEP CUTTING BAND SAWS.

SIR,—Referring to the descriptive illustration of a band saw for sweep and bevel work, appearing in your last issue, may I be allowed to state that this system of sawing wood was invented and patented by C. R. Western and T. Hamilton, London, in 1873, Pat. No. 3203? Several machines were constructed under this patent by Messrs. Western and Co., Lambeth, notably one for Samuda's shipyard, which was working up to a short time prior to the late sale there. *Palmam qui meruit ferat.*

W. SAMUEL WORSSAM.

28, Victoria-mansion, Westminster, S.W.,
March 17th.

THE JANDUS ARC LAMP.—We are requested to state that a company has been formed specially to deal with the manufacture of this lamp, called the Jandus Arc Lamp Electric Company, and the sole sale of this lamp for the United Kingdom is in the hands of Messrs. Drake and Gorham, Victoria-street, Westminster.

THE CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—At the ordinary meeting held on Thursday, March 12th, a paper was read by Mr. H. Coward, C.E., on "The Mechanical Handling of Goods at Riverside Premises." The paper described various old-fashioned means of raising, lowering, and conveying goods from and into ships, barges, and warehouses, and traced the gradual improvement that has taken place in the mechanical means of handling goods up to the present time. The author pointed out some of the troubles met with by those who have to deal with the apparatus that is used, and concluded by describing the Temperley transporter, an ingenious apparatus that is now being very largely used, although but recently introduced to the notice of shippers and wharfingers. Some excellent models were on view. A discussion of an interesting character took place at the conclusion of the paper, among those who took part therein being S. à Court, C. T. Walrond, E. H. G. Brewster, W. R. Hay, J. N. Cooper, W. C. Penn, and P. A. Creeke.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.—The following programme of the Midland Counties District Meeting, to be held at King's Heath, near Birmingham, has just been issued:—On Saturday, 28th March, 1896 at 12.15, the members will assemble at the Institute, King's Heath, where the chairman and members of the Rural District Council will receive them. Election of district secretary. 12.30: Paper descriptive of fourteen years' work in a Midland suburb, by Mr. Robert Godfrey, A.M.I.C.E., engineer and surveyor to the Rural District Council; discussion. 1.30: Light refreshments, kindly provided by County Councillor T. R. Bayliss, J.P., A.M.I.C.E., chairman of the Rural District Council. 2.0: Drive to Highbury, the residence of the Right Hon. Joseph Chamberlain, M.P., Secretary of State for the Colonies, who has kindly given permission for the members to visit the grounds and orchid houses. 2.30: Drive to Bournbrook, to inspect the generating station of the electric tram cars, belonging to the Birmingham Central Tramway Company, where the members will be received by Mr. Alfred Dickinson, A.M.I.C.E., the engineer. 3.0: By permission of Messrs. Aveling and Porter, the manufacturers, and Mr. Morrison, the inventor, Morrison's road scarifier will be exhibited at work. 3.30: Drive to Lifford Sewage Works, where the bacillite process of sewage treatment is in operation; fare for the drive, 2s. 6d. per member. 5.0: Arrive at King's Heath, where a cold collation will be provided by the Bacillite Syndicate. Special arrangements will be made to enable members to be at New-street in time for the evening trains North and South.

BRITISH PIG IRON TRADE ASSOCIATION AND FOREIGN COMPETITION.

THE South Staffordshire Institute of Iron and Steel Works Managers discussed at Dudley on Saturday the "Report upon Foreign Competition in the Iron Trade," which was issued some little time back by the delegates which went to Germany and Belgium, under the auspices of the British Association. An account of the document appeared in THE ENGINEER at the time of its publication. The chair was occupied by Mr. W. B. Rubery, of H. P. Parkes and Co., Tipton-green Chain Works, Tipton, as President of the Institute, and there was a good attendance. The secretary, Mr. W. H. Carder, read the principal portions of the Report. Among those present were the Chairman of the Delegation, Col. James Patchett, Managing Director of the Shropshire Iron Company, Wellington, Salop; and also Mr. W. H. D. Gladstone, of Messrs. John Lysaght, galvanised iron manufacturers, Wolverhampton, Bristol, and London; both of whom had represented on the Commission the employers of the Midland Wages Board.

The following other members of the Delegation sent letters of apology:—Employers' delegates—Mr. W. Thackray, jun., managing director of Messrs. Samuel Tyzack and Co., of Sunderland, member of the Board of the British Iron Trade Association, who represented on the Commission the North of England Iron and Steel Manufacturers' Association; Mr. C. Parnaby, manager of the mill department of the Consett Iron Company's works, representing the Board of Conciliation and Arbitration for the Manufactured Iron and Steel Trade of the North of England; Mr. J. R. Winpenny, Middlesbrough, employers' secretary to the last-mentioned Board, representing that body; and Mr. J. Stephen Jeans, London, secretary to the British Iron Trade Association. Communications were also received from four of the workmen's delegates, namely, Mr. Edward Trow, operators' secretary of the North of England Iron and Steel Conciliation Board, and general secretary of the Associated Iron and Steel Workers of Great Britain, who was vice-chairman of the Commission; Mr. James Cox, vice-chairman of the North of England Iron and Steel Conciliation Board, and assistant-secretary to the Associated Iron and Steel Workers; Mr. W. Ancott, operative secretary of the Midland Wages Board and president of the Associated Iron and Steel Workers; and Mr. P. Walls, of Workington, general secretary of the National Federation of Blast Furnacemen, and agent for the Cumberland and Lancashire district. Mr. Cox, in his letter, called attention to the second paragraph of the memorandum, with which the British Iron Trade Association had prefaced the report. That memorandum was signed for the Association by three of its chief members; and the paragraph in question stated:—"Great difficulty was found in agreeing upon the deductions to be drawn from the evidence obtained, and the report is therefore necessarily somewhat colourless." This—Mr. Cox continued—was an absolute misrepresentation of the facts, and the substitution of the word "unanimity" for "difficulty" would have more nearly represented the truth. The whole of the employers and operatives composing the delegation had been anxious that whatever the report might be, it should be in strict accord with facts as they saw and found them, and that alone was the standard of measurement to which any suggestion was subjected from whichever side it emanated. However opinions might vary as to the colour of the report, it was one founded on personal investigation by practical men—employers and employed—who determined to keep it as far as possible within the limits of their own observations and investigations, uninfluenced by outsiders, without incorporating into it the "colouring" of official German and Belgian publications, whose figures and facts they had no means of verifying. Mr. Trow in his letter confirmed Mr. Cox's assertions as to unanimity. Mr. F. Scarf, of the Bromford Ironworks, West Bromwich, held by letter that the cost of carriage occupied a foremost place in any proper consideration of the facts underlying the successful competition of German and Belgian works. The task of comparison was made more easy by the fact that the iron producing districts of those two countries were situated in what was practically an identical position with South Staffordshire, so far as the distance from a seaport was concerned. The report showed very clearly that with an equal mileage, Midland works were handicapped to something like the extent of 7s. 6d. per ton. A reduction of railway rates might do something towards removing the difficulty, but it was evident that British railway directors, handicapped as they were by immense capital charges, were, even if willing, quite unable to make the sweeping reductions in rates which would be necessary to produce anything like equality with those to which our foreign competitors were subject. The State purchase of railways, if possible, to say nothing of the doubt of its being beneficial, was too big a question to discuss there. The only other hope was water carriage. The utter failure of the Manchester Ship Canal, at any rate for the present, had discredited enterprises of that nature, and he would be a bold man who would suggest bringing a canal of that magnitude into the Midlands. But a canal capable of carrying barges of 150 tons capacity need not be expensive, and would effect an enormous reduction in the present rates. Between the cost of hauling a barge of 150 tons and one of 25 tons capacity the difference was very trifling; and by such a waterway he believed the cost of carriage to Liverpool could be reduced to 3s. 6d. per ton. In some such direction as that, he was convinced, they must look, if South Staffordshire was to hold its own in the export markets. Mr. Walls, in his letter, pointed out that in the appendix to the report, second day's proceedings, works "B," in Belgium, it was shown that when the delegates asked for the total wages cost of labour on a ton of pig iron the director of those works said it ranged from 1 fr. 85 centimes —1s. 6½d.—to 2 fr. 50 centimes—2s. 1d. But he—Mr. Walls—wished to point out, in order to prevent any misapprehension, that that only meant the work back and front, and did not include anything for blast engine men, locomotive men, boiler men, tippers, pig iron chargers, or any outside labour. Without this knowledge, the figures were calculated unintentionally to mislead.

The Chairman dwelt upon the superiority of the mechanical appliances of the Germans, and upon their improved methods of output; strikes were almost unknown; technical education was superior; and railway rates were lower. He was afraid that in England there was such a thing as an export quality of iron and steel, which was practically another name for the commonest class of material. This was calculated to do England a great deal of harm. The reluctance on the part of manufacturers to give credit to foreigners was also against the extension of our export trade.

Mr. H. M. Punnett—Punnett, Thompson, and Co., ironmasters and galvanised iron manufacturers, Regent Grove Ironworks, the Cape, Birmingham, and Stork Galvanised Ironworks, also of the Cape—said he had been asked to attend on behalf of the Midland Iron and Steel Wages Board, and he should confine his remarks entirely to finished iron and steel, and mainly to sheets. In some of the sheet mills they were rolling with very much less waste than we were accustomed to do in this country, and that was, to his mind, a very important matter, which we ought to consider most carefully in this country. At one of the works they had both soft and hard rolls. It was a habit, he believed, in Staffordshire to have hard rolls for plate mills, but not for sheet works. The American practice in sheets was to have two sets of rolls, so as to break down in one set, and finish in another. A large proportion of the sheets produced in Germany were of very high quality; some of the material produced was more like that usually turned out by a high-class steel tin-plate works. At "H" and "J" works, lattens were being rolled in a loose state. That puzzled him, and he expected it would puzzle some of the members of the Institute. He held that the report was of the greatest value. We must not suppose that other countries were not progressing. America for many years had sent scientific men all over Europe to ascertain what was being done, and England must consider it to be her duty to do the same. It was most important that we should ascertain all information possible. That Commission should be a mere preliminary to further investigations. The Commisson said there was more attention paid to quality in England than in Germany. That was true as regarded low qualities of iron, but not true with respect to the excellent material which the delegates saw at "H" and "J" works. That was basic Siemens-Martin steel, and it was not surpassed in quality by any place in the world. Samples lay in his office at Birmingham. The Commission said, "In the manufacturing departments of the works visited, the production per man did not appear so favourable as in our own industries, taking into consideration the number of men employed relatively to the average results." He thought that was a great mistake. The delegation found that the uniform steadiness of the growth of the iron industry of Germany from year to year, and the inconsiderable backward variations in the production of ores, fuel, iron, and steel, justified the conclusion that the operations of industry were carried on more steadily in that country than in our own. That might, of course, be due to greater steadiness of trade, but might also be due to the more steady-going character of the workmen employed. The delegates were informed that in Germany strikes were almost unknown. It was obvious that the steady course of industry in any country had a tendency to give stability and permanence to its operations, which could not be expected from other conditions. He thought that was a very important point, because one of our greatest difficulties in England was to get a regular steady production at the works. That was one of the things in which England was far behind Belgium, Germany, or Austria. The Commission had expressed the opinion that the success achieved by continental countries in the struggle for commercial supremacy was not so considerable as had sometimes been stated; but from that he must beg to differ. For example, take the imports into India in 1894. Iron from England amounted to 50,600 tons, and iron from Germany to 52,400 tons. Steel from England was 19,150 tons, but steel from Germany reached 28,127 tons. Then, again, the sheet iron exports from Germany to Russia rose from 6073 tons in 1892 to 12,218 tons in 1893, and to 28,026 tons in 1894. He thought that in the English iron trade it would be well if we could adopt the German method of more men and a more equable distribution of wages. America had passed through the same unrest that we were experiencing with regard to hours of labour, and America had adopted the eight hours day, and he should like the general managers of England to see whether they could not find some method by which they could adopt in England a shorter day for the more laborious kinds of work, or a diminution of hours for the individual man and a raising of the number of the total staff. That was a point of most vital importance for the well being of the trade. The eight hours day was doing great things for America. A large roller in America told him the other day that when the men were ill they fell back on the twelve hours principle from the eight hours, so that they never stopped. He—Mr. Punnett—was dead against the habit of the head man paying his own hands. Every man ought to be paid from the office direct. When the schedule of prices was drawn up some time back in the Midland sheet iron trade he was very desirous that they should go back to the old principle of paying every man from the office. It raised the men to the same level as their colleagues, and it gave the employers direct contact with every individual man. When he was a member of the Wages Board Committee who formed the Sheet List he had most of the members against him on that point, but he yet thought that he should see the day in England when that plan was generally adopted. All members of the English iron trade ought to be grateful to the commission for giving them that report. He was convinced that we had yet a great deal to do if British works were to be brought up to the high level of German works.

Mr. Ashton, Past President of the Institute, of Messrs. Noah Hingley and Sons, iron masters and chain and cable manufacturers, of Netherton, near Dudley, said the previous speaker had quoted statistics with reference to the exports of Germany to Russia and India. But he thought what concerned us even more were the imports of Germany to the United Kingdom. The exports of the leading descriptions of iron and steel from Germany to the United Kingdom had increased in quantity between 1892 and 1894 about 58 per cent. They had risen from 77,216 tons in 1892 to 90,764 tons in 1893, and again to 122,190 tons in 1894. The details were as follows for the three years 1892, 1893, and 1894 respectively:—Profile and angle iron, 18,942 tons, 31,299 tons, 41,830 tons; sleepers and fastenings, 1539 tons, 983 tons, 1155 tons; rails, 11,303 tons, 9769 tons, 14,492 tons; bar iron, &c., 4490 tons, 3886 tons, 5785 tons; plates and sheets, 480 tons, 192 tons, nil; wire, 23,200 tons, 28,687 tons, 40,230 tons; galvanised wire, 17,262 tons, 15,948 tons, 18,698 tons; totals: 1892, 77,216 tons; 1893, 90,764 tons; 1894, 122,190 tons. That was a very formidable matter for them to deal with, and the report was valuable as pointing out some of the causes of German supremacy. He did not think the reason could be found in the extra cheapness of German fuel. The average price of fuel in Germany in 1894 was 6·68s. per ton, in Belgium 7s. 5½d., and in the United Kingdom only 6·06s., so that fuel with us was cheaper than with them. Then with regard to ironstone, the ores of Germany cost, on the whole considerably more at the furnace than those used in Lancashire or Northamptonshire. Then, again, pig iron was cheaper in England than on the Continent. Foundry pig in Germany was 47·68s. per ton, and in Belgium 46·10s., against 42·8s. in Scotland, and 35·7s. in Cleveland. Forge pig was 40·77s. in Germany, and 40·1s. in Belgium, as compared with only 36s. in Cleveland. And about the same proportion between the countries existed as regarded basic pig. Then they came to the question of wages, but on this they had no exact data. The body of the report referred them to the appendix, but there they did not find adequate information for making a proper comparison, and the delegates themselves in the report admitted that. He thought it might be taken for granted that wages were lower in Germany, but then the German workmen had compensatory advantages. Theirs was what he might call the paternal system. There was no sharp dividing line between masters and men. Employers and employed formed what he might call a large industrial family. Provision was made for the physical and social enjoyment of the people, for they had their reading rooms, libraries, recreation grounds, hospitals, and so forth, and he thought their advantages in these respects were equivalent to an extra 25 per cent. upon their wages; so that they might take it that continental wages, though apparently lower, were in reality very much on a par with English. But the weak spot in our armour was the matter of railway rates. German and Belgian railway rates were only one-third of what they were in England, so that for every ½d. per mile expended in Germany we had to spend 1½d. In other words, the English manufacturer had to pay 10s. 6d. for railway facilities which his German competitor got for 3s. 6d. The English railway companies would no doubt sacrifice their millions to repel the foe if there was a German military invasion, but nothing could exceed their supineness in face of this commercial invasion. Germany's military *régime* no doubt pressed hardly upon her people, but it re-acted beneficially upon her trade and commerce by causing discipline and steadiness in work. In technical education Germany had the advantage of us at present, but we were rapidly coming up to their level.

Mr. Joseph G. Wright—of Isaac Jenks and Sons, Minerva Steel Works, Wolverhampton—said there was a time, within the memory of some of those present, when South Staffordshire was the chief iron producing district of the kingdom, and, indeed, of the world; but to-day the craft was in danger, and it behoved them to look that peril in the face and try to meet it. He was one of those who had looked to the report to help the British iron trade to meet foreign competition, but he confessed to a large amount of disappointment, and he could not but think that there was a good deal which ought to have been said, but which for some occult reason or other had not been said. One of the necessary considerations was the cost of producing iron in Germany and Belgium as compared with the cost of producing it here, but he did not find the details which the report itself spoke of as being present in the appendix. He thought the information was extremely indefinite as to wages, and he believed it to be absolutely impossible to compile from that report the complete cost of making finished iron. There was an allusion in the memorandum prefacing the report to great difficulty having been experienced in agreeing upon the deductions to be drawn from the facts obtained. Now, if there was difficulty, he thought it would have been well that English ironmasters should have been told what the difficulty was. There ought to have been a proper tabulated statement showing wages in Germany and England respectively. He understood, indeed, that such a statement was in existence, and he could not understand why it had not been published. Mr. Wright then went on to criticise the report in detail. They were informed by the report that at one of the works there were two pairs of rolls, two-high soft, and two sets of hard rolls, three-high. They were 21in. in diameter, and were running at least 110 to 120 per minute. Now when we found that in this country the speed was 40, or generally nearer 30 revolutions per minute, one could not understand how so great a speed as that named could be run. An English roller would stand aghast if you told him to put a bar 1in. thick between rolls running at that speed, and would want to know who was going to be responsible for the machinery. He could not understand how they could put a bar in with the rolls running at such a speed, without shock to the machinery and the jumping up of the rolls against their screws and chucks. Nor was any explanation given of the statement that in some of the mills there was no doubting, but that all the sheets were rolled off loose. How could they finish off lattens in such sizes, as they were said in the report to roll them, without any doubling? Then something was said in the report about the extremely strong machinery which in Germany and Belgium they employed—very much stronger than ours. It had been said that where we had housings for our sheet mills five tons in weight they had theirs weighing twelve tons. That was rather startling, though the speed of the machinery seemed to indicate that it was correct. In a treble mill at one of the works the output was only 10 tons 17 cwt. per week. Much was said about the high finish of those sheets, but he thought there must be some mistake in the output being so small. He hoped that meeting would pass some resolution on the railway rates question and forward it to the Government.

Mr. Moses Millard—also of the Minerva Iron and Steel Works, Wolverhampton—scathingly attacked the report, and thought the praise of the splendid German machinery and methods implied a serious reflection upon English iron and steel works' proprietors and managers. The report did not give any more information than was given by Mr. Thomas Morris, of Workington, thirteen years ago, when he read a paper upon the iron and wire manufacture of Westphalia.

Mr. J. W. Hall, Bilston, welcomed the report, because it showed us how we stood with regard to our competitors. It was too late in the day to retain the old idea that we were the chief manufacturing country in the world. Though an increase in the exports of iron and steel, as shown by the Board of Trade returns, must be considered satisfactory, any increase in output being an advantage, yet an examination of the figures would show how that increase had been obtained—namely, by reducing the price. Thus the average price per ton for January and February, 1893, was £8 4s. 3d.; for the same period of 1894, £8 3s. 1d.; and for the same period of 1895, £7 8s. 2d. Under these circumstances it would be easily understood why the volume of exports for 1895 showed an increase of 29 per cent. and 43 per cent. respectively over the two previous periods. It was evident that we must look to reduction of price alongside of maintenance of quality, as our only hope of success in neutral markets. We could no longer rely upon brands, trade marks, or other exploded devices.

Colonel Patchett replied on the debate as chairman of the Commission. Some of the previous speakers seemed to be labouring under a mistake as to what the object of the Commission was. The delegation arose out of a document issued by Mr. William Jacks and Mr. Stephen Jeans, who made statements that the low wages paid in Germany was the whole cause for the continental success in competition. The leaders of the British operatives, having this constantly flaunted in their faces, decided on their part to send men to Germany and Belgium to ascertain the facts for themselves. Then invitations were issued to the employers, and they consented to accompany them. He—Colonel Patchett—had nothing to do with the British Iron Trade Association, and the memorandum of that association prefixed to the report had neither the consent nor the approval of the delegation, and ought not to have been put there. The delegates did not hold themselves responsible for that memorandum which those three gentlemen had signed—namely, Sir Alfred Hickman, president; Mr. William Jacks, past president; and Sir B. Hingley, past president. But the body of the report, and also the appendix, was the truth, the whole truth, and nothing but the truth, for every word had been revised and approved by the different works themselves. Colonel Patchett proceeded to dwell upon the difficulties of the undertaking, on the absence of any programme, and the necessity for making arrangements day by day. They were well received, because they went openly and honestly to every place and told them their object plainly, which was to inquire into the relationship between masters and men. Some of the speakers seemed to have expected them to have come back laden with details about sheet iron rolling, but their object was not to go to Germany to take drawings of sheet mills. Indeed, they went out not for the sheet trade nor for any other trade in particular, but for the iron trade as a whole. He indignantly refuted the allegation that there was anything concealed. Everything was open and straightforward. As to the 110 or 120 revolutions per minute of the rolling mill, he saw it with his own eyes, and he was as astonished as anybody else, but it was a fact. Steamship rates were one cause of German superiority. The Peninsular and Oriental Steamship Company was heavily subsidised by the British Government, and yet, whilst charging only 10s. per ton for shipment from Antwerp to Bombay or Calcutta *viâ* London, it—until recently—charged 15s. 9d. to British manufacturers from either London or Liverpool. This difference of 5s. 9d. per ton above the rates paid by continental manufacturers was accountable for a good deal of our difficulty. As to railway rates, that was a difficult question. No doubt we were handicapped in that respect also, but railways were one of the best investments the public had, and the interests of the public were practically bound up in the interests of the railways. It would be a serious disturbance to commercial and general conditions to alter the railway system, whose capital was, he believed, in England about £1,000,000,000 sterling. Some people advocated the State taking over the railways, but they must be prepared if they did this to pass through the same experience as in Germany, where no dividends were paid, and where the people were practically taxed to start the railways and taxed to maintain them. German railways were carried on by military high-handedness, but ours at present were regulated by the free-handed dealings of commerce. Nothing would have been simpler than to have made a comparative table of wages in England and Germany; but nothing would have been more misleading, for such a table could not have given the conditions under which those wages were paid. In puddling, for instance, the thorough way in which that operation was conducted in England was four or five times as laborious as in Germany, so that a comparative statement of puddlers' wages would have been most misleading and unfair. The Commission was, he thought, unique, because it was the first time masters and men had gone together from this country in a friendly spirit to find out what was right and just between them; and he could say that if the delegates had not met the desires of every critic, they had at any rate, tried to the best of their ability to do what they could. The delegates compared notes every night after travelling 200 or 300 miles in the day time, and several times his morning bath, when it was brought in, found him still busy as he had been all night, making records or completing arrangements for next day. It was evidence of the good feeling that had been promoted and cemented between the two countries that Albert Hoesch, of the great Hoesch Company, Westphalia, should have written so friendly a letter about the delegation as that which was printed at the end of the report.

Mr. W. H. D. Gladstone—John Lysaght, Wolverhampton, Bristol, and London—who was another member of the Commission, corroborated Col. Patchett's opinions.

The meeting, before concluding, passed a resolution of thanks to the two last-named gentlemen for attending.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

On 'Change in Birmingham to-day—Thursday—there was, as usual towards the close of a quarter, a rather quiet tone. A few inquiries were made for quotations for next quarter, but more will doubtless be done in this respect a little later on. Prices were practically unchanged on those given last week, both in pig and finished iron.

What is believed to be the largest order ever given at one time to any company in England for carburetted water-gas plant, has lately been entrusted by the Birmingham Corporation to the Economical Gas Apparatus Construction Company. It is of the capacity of 4,000,000 cubic feet daily. It is of the "Lowe" type, embodying the improvements of Merrifield, Westcott, and Pearson. There is to be an installation both at the Windsor-street and the Saltley Works, in each case there is to be two complete sets of generating and carburetting apparatus, with ample condensing, washing, and scrubbing power; also "blowers," exhausters, engines and pumps, oil heaters, &c., each item being in duplicate, and each equal to the working of both sets of generators. At each works the capacity of the plant is to be about 2,000,000 cubic feet of gas per day, making 4,000,000 in all, or about one-sixth of the present make per day. It is, however, in contemplation to add to the water-gas plant, if satisfactory, and as the demand continues to grow, until it is equal to a third of the make. The capital outlay upon the two installations, including buildings and oil tanks, now ordered, will be about £60,000, as compared, it is said, with at least £130,000, which would be required upon the most economical lines for coal-gas plant of corresponding capacity.

The Patent Shaft and Axle-tree Company, at its annual meeting on the 13th inst., was not able to look back upon a very good year, the net profit on the year's trading being only £826, though in addition to this there was a balance of £3808 brought forward from last year. During the greater part of the financial year the best customers, the railway wagon companies, have been quiet, and have given out very few orders. During the last three months of the financial year, however, the Patent Shaft Company has been tolerably busy in supplying steel of special quality for tube making. It has also done some good work during the year, which ought to bear fruit later on. It has also abandoned old machinery in favour of machinery that is modern and more useful. Improvements have also been made in other departments. The wheel department will soon reach a point of efficiency it has never attained before, and the company is laying down a press of about 2000 tons power, from which they expect a great deal.

The well-known gas engineering concern, John Wright and Company, of Birmingham, have had an excellent year. They have made a net profit of £14,324, which, with the amount brought forward, gives a total of £17,388. They have, therefore, been able to recommend a dividend at the rate of 6 per cent. per annum on the preference shares; 10 per cent. on the ordinary shares; and have placed £6000 to the reserve fund, thus raising it to £25,000, whilst a little over £3000 is carried forward. It was stated that the large corporations of the kingdom were buying increasing quantities of gas-consuming apparatus because they were endeavouring to dispose of, for heating and other purposes, the gas which the electric light rendered unnecessary for illumination.

The competition of English and continental boilers for British Admiralty use was one of the topics dealt with at a recent meeting of the Birmingham Municipal Technical School Engineering Society, when a paper on "Steam Boilers" was read by Mr. Thomas Nichols. An interesting account was given of the author's experience in the United States and in the Argentine Republic with water-tube boilers. As such boilers had been more extensively used on the Continent and in America than in England, foreign engineers had naturally obtained greater experience in their design and construction, hence it was scarcely surprising that the Admiralty in searching for a compact boiler of light weight and great steaming power should have been led to try the Belleville boiler, of French origin. Her Majesty's first-class cruisers Powerful and Terrible are each fitted with Belleville boilers, said to be capable of producing sufficient steam to develope 25,000-horse power, and under the present naval programme a large number of such boilers will, it is thought, be adopted. In the author's opinion, however, Messrs. Yarrow and other English makers of water-tube boilers have scarcely received just treatment at the hands of the English Admiralty. Yarrow water-tube boilers are largely employed by foreign navies, but the feeling is general in engineering circles that the question of first cost frequently prevents our own Admiralty from adopting such a course in the equipment of the machinery of our warships as would ultimately be the best and the cheapest.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The quiet tone I have previously reported in the iron market here continues, and it seems not unlikely that there may be a lull as regards further buying of any moment until after the holidays. The general position of trade, however, continues good, the principal iron-using branches of industry being all well engaged, and with new work coming forward freely amongst engineers, the prospects of the future are unsatisfactory. As, however, I have already pointed out, both consumers and merchants are mostly well covered for some time forward—in many cases, in fact, considerably over-bought—and are only partially taking their deliveries on account of contracts. For pig iron there has been only a small inquiry on the Manchester Iron Exchange during the past week, and although makers' prices are without quotable change, iron held in second-hands has been offered at lower prices, and the position of makers is not quite so strong as it was a week or so back. Local pig iron makers remain firm at recent quoted rates, but district brands have lost the slight advance which makers were getting a few weeks back, and in outside brands there is under-selling. Delivered Manchester, 42s. for forge to 44s. for foundry are now the full prices obtainable for Lincolnshire; 46s. 6d. to 47s. for good foundry Middlesbrough; with Eglinton about 49s. 6d. to 50s. net prompt cash, delivered Dock Quays, Manchester.

In finished iron a moderate business comes forward which keeps forges fully going, but Lancashire bars can still be bought at £5 10s. to £5 12s. 6d., with sheets remaining at £7 10s. to £7 12s. 6d., and hoops £6 2s. 6d. for random to £6 7s. 6d. for special cut lengths, delivered Manchester district, with 2s. 6d. less for shipment.

Nut and bolt makers report a good demand generally, but any materially better prices difficult to get.

In the steel trade the tone is generally steady, and for hematites makers do not quote under 57s. 6d. to 58s. 6d., less 2½ delivered Manchester, but merchants in some cases are sellers at 6d. less. For steel boiler plates the general quotation is £6 10s. delivered here, with, however, only a small business reported at this figure.

In the metal market the further upward tendency in raw material has brought forward a brisk demand for all descriptions of manufactured goods in the anticipation of another advance in list rates, and there has been a general anxiety to cover on the part of buyers who had been holding back. During the week prices for brass and copper wire and sheet brass have been put up ¼d. per pound, and with a probability of a similar advance upon tubes there has been quite a push of orders upon this class of goods during the past few days. Delivered Manchester district, list rates are now as under:—Solid drawn brass boiler tubes, 6½d.; solid drawn brass surface condenser tubes, 8d.; solid drawn copper tubes, 7¾d.; brazed copper gas and steam tubes, 7½d.; brazed brass gas tube, 7¼d.; brazed brass machine tube, 7d.; brass wire, 6d.; copper wire, 7¼d.; rolled brass, 6d.; yellow metal condenser plates, 5½d. per lb.

The Indian Midland Railways have placed with the Vulcan Foundry Company, of Newton-le-Willows, an order for fourteen heavy goods engines with tenders, of a similar type to those which the company has previously supplied.

All descriptions of round coal continue in very slow demand, with, if anything, a lessened inquiry for the better qualities, and colliery owners find it difficult to keep their pits running more than four days per week. The increased activity in the iron and engineering trades has no appreciable effect as regards the commoner qualities of round coal for steam and forge purposes, supplies of which continue largely in excess of requirements, and prices are so extremely low that colliery owners are in various ways restricting their output as much as possible owing to the altogether unremunerative character of this branch of trade. For ordinary steam and forge coals 6s. remains about the average figure, at the pit mouth, for inland sales, but shipping orders are competed for at exceedingly low-cut figures, 5s. to 5s. 3d. at the pit mouth being not at all uncommon prices for inferior bunker coal, and 6s. 9d. to 7s. 3d. about average figures for ordinary steam coals delivered ports on the Mersey. Engine classes of fuel are showing a decided hardening tendency, especially the better descriptions of slack, and although it is difficult to get any appreciably higher prices, colliery proprietors are declining to contract forward except at some advance upon present rates. At the pit mouth better qualities of slack average 4s. 6d., with 5s. quoted for some special sorts; commoner qualities range from 2s. 9d. up to 3s. 6d. per ton.

Barrow.—The hematite pig iron trade is steady, and a good business is doing in Bessemer qualities on local, home, and foreign account. Makers, generally speaking, are well sold forward, and only deal in forward sales. Holders of stocks are very firm. An increase is noted of 610 tons in warrant stocks, which now stand at 302,029 tons. Prices are firm at 48s. 9½d. net cash sellers, 48s. 9d. buyers. Makers quote 49s. 6d. to 50s. 6d. for mixed Bessemer Nos., net, f.o.b. There are 39 furnaces in blast, as compared with 26 in the corresponding week of last year.

Iron ore is in steady demand, and good orders are being placed, but prices are unchanged, and ordinary sorts are quoted at 10s. per ton net at mines, with best descriptions at 12s. 6d.

Steel makers are very busy on rails, plates, billets, hoops, and castings, and for all these classes there is a brisk demand, with good and steady prices.

Shipbuilders and marine engineers do not report any new orders. The orders for third-class cruisers have this time passed Barrow makers. There is, however, much work already in hand, and that is being pushed forward very rapidly.

The coal and coke trades are much busier.

Lord Harris has accepted the post of chairman of the Naval Construction and Armaments Company, held till recently by the Duke of Devonshire, who felt it necessary to resign the position in view of his appointment as Lord President of the Council in the present Government. His Grace felt it necessary that his official connection with the Barrow company should cease, because of the great amount of work done in recent years for the Admiralty.

Shipping returns show export of pig iron from West Coast ports during last week amounting to 5865 tons, and 9375 tons of steel, as compared with 9015 tons of pig iron and 14,870 tons of steel in the corresponding week of last year, a decrease of 3150 tons of pig iron, and 5495 tons of steel. The total shipments this year represent 64,368 tons of pig iron, and 87,436 tons of steel, as compared with 56,689 tons of pig iron and 83,878 tons of steel in the corresponding period of last year, an increase of 7679 tons of pig iron, and 3585 tons of steel. Freights are still low.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

IN the South Yorkshire coal district no change worth mentioning has taken place. Pits are working very irregularly. Many of the larger collieries can give their men five days a-week; while, on the other hand, three days' work is all that is being afforded in the smaller concerns. Competition is excessively keen, and gets more so every week. Many pits, which are compelled to bring to bank house coal along with hard coal—the latter being chiefly in request at present—are placing the former qualities on the market at lower values. A few minor differences have now happily been settled, and with the exception of a single colliery which has been troubled with water, business has been and is now progressing very steadily, except in household sorts, which is in poor request owing to the extremely mild weather, broken only now and then by a few hours' cold. In London merchants find extreme difficulty in disposing of the weights they have contracted for, and sales are very irregular. Agents wishing to clear stocks are reported as having to sell at a very low figure. Seaborne fuel has fallen in price since last report. Of Yorkshire coal, best Silkstone averages from 8s. to 9s. 6d. per ton; Barnsley house, 7s. 6d. to 8s. 6d. per ton; Silkstone, ordinary, and Flockton, 6s. 9d. per ton; with thin seam about 6s. per ton. Steam coal is in moderate request, considering the season of the year. The amount sent to the Humber ports is about an average, the local pits taking the bulk of the business.

The demand from the home markets is about the same as usual, with prices well maintained. Quotations are as follows:—Barnsley hards, 6s. 6d. to 7s. per ton; seconds, 6s. per ton. Trade in gas coal is not so brisk as when last reported, although prices have not fallen at all. There is a steady demand all round for manufacturing fuel; notwithstanding this, values remain very much the same as when last reported, owing to the large production. Quotations are as follows:—Small nuts, 4s. 6d. to 5s. 6d. per ton; screened slack makes 3s. 6d.; with pit slack, 2s. 6d.; and smudge, 1s. per ton. An increased tonnage of slack is being forwarded to both North Lincolnshire and Northamptonshire, and an improvement in prices has taken place, 8s. to 10s. per ton being the values ruling.

The heavy trades of the city continue to steadily improve. Both Bessemer and Siemens-Martin steels are in excellent demand, and furnaces are well employed. Billets and slabs are booked in large quantities at from £5 12s. 6d. to £6 per ton, while the quotations for the latter quality range from £6 2s. 6d. to as much as £10 10s. per ton. This figure is for the highest grades, and there is a very moderate demand for this class of steel. Manufacturers are loth to order either Bessemer or Siemens far ahead at the prices now ruling. Swedish Bessemer is also well inquired after by continental and American as well as English buyers, and it is rumoured that one or two Swedish firms have offered to buy back stocks at prices largely in advance of those paid for the material. Crucible steel makers report a good business, notwithstanding the keen competition of more rapidly produced steels. A very excellent trade is at present being transacted in self-hardening and other high-class steels. The rolling mills are fully employed, and many of them are working full time.

During the week an improvement has taken place in the price of railway material. It will not be far from correct to say that nearly every class of railway material is £1 higher than the quotations ruling six months ago. The large establishments are better off for work than at any time during the last six or seven years. One branch of this business, however, has not advanced in sympathy with the other departments—that of wagon building. Complaints are freely heard from wagon builders that their business has not improved as was expected. Much more could be produced than is at present being done. Many of the larger firms engaged in making nuts, bolts, &c., have been endeavouring to obtain an improvement in prices, but with little success. Reports as to the state of the iron market are very encouraging, and in many instances better prices have been obtained.

The lighter trades have not advanced in sympathy with the heavy industries. The cutlery branch is in a puzzling condition. Some houses are very poorly off for work, while others cannot execute orders fast enough. Best table and pocket cutlery is selling in large quantities in the home market. A better business is also doing in the cheaper qualities. No improvement has taken place as yet in the American market, although an increased business is reported with both South Africa and Australia. The rupture with Germany has had the effect of many orders in the cheaper classes of cutlery coming to this country, instead of as before to the Fatherland. Celluloid is to a great extent superseding ivory in the Indian, Australian, and South African markets. It is claimed for this material that it stands heat and dryness better than the genuine article. It is being produced in black and other colours, and its uses seem to be unlimited. Xylonite is also in better request, and a better demand has set in for bone and other cheaper qualities of material of hafting. The file trade is in a good condition. Some little ill-feeling is at present existing between the masters and the men regarding wages. Should trade go on improving as at present, the employers will no doubt do something liberal for their workpeople in this matter.

Two important local companies have published their annual reports this week—Messrs. Charles Cammell and Co., Cyclops Steel and Ironworks, Sheffield, Grimesthorpe, Penistone, and Workington; and Messrs. Wm. Jessop and Sons, Brightside Works—steel, marine specialities. The latter declare a dividend of 5 per cent., which is at the same rate as last year. They report that business fell away somewhat during the middle of the year, and that the improvement now being experienced was in the latter months of 1895. At the same time the business was larger than in the previous years, although the profits were not proportionately increased. Messrs. Cammell and Co. pay 10 per cent., which is 2½ per cent. more than last year. The directors state that during the past six months a general improvement in the business operations of the company has been experienced, and the prospects for the coming year are of an encouraging character. The Solway Ironworks, Maryport, Cumberland, consisting of three blast furnaces, and their appurtenances, have been purchased by the company, who will find them a valuable adjunct to their Derwent Iron and Steel Works at Workington, as well as their hematite ore mines.

Earle's Shipbuilding and Engineering Company, Hull, the shares of which are considerably held in the Sheffield district, write to the Sheffield Press that the orders they have received from the Admiralty are for two of the third-class cruisers under the Goschen scheme, and not a remnant of the Spencer programme, as supposed by some. "These ships," it is added, "are a development from the torpedo boat catchers, or, as they are now better known, torpedo gunboats. They may, indeed, be taken as a cross between a modern cruiser and a torpedo gunboat, and are intended more particularly for service in shallow seas and in rivers, chiefly, of course, for police duties, although their armament will enable them to do good service in a fight with forts or cruisers." They are to be 300ft. long, 36ft. 6in. broad, and 21ft. 1½in. moulded depth, with a mean draught of water, when finished, of 13ft. 6in., and a displacement of 2135 tons. Their engines will be twin-screw, of the high-speed type, capable of developing 7000-indicated horse-power, which will maintain a speed of 20 knots per hour; the boilers, Thornycroft water-tube, for a working pressure of 300 lb. per square inch. For their defence, a thick protective steel deck, armoured conning tower, &c.; armament, eight quick-firing guns, and two torpedo tubes.

THE NORTH OF ENGLAND

(*From our own Correspondent.*)

A MORE active condition of trade has been reported this week than for some weeks past, and consumers generally are showing more disposition to buy. A good business is being done in nearly all branches of the iron and allied industries, and prices are again tending upwards, though they are not actually any higher now than they were last week. However, buyers more readily pay what is asked, especially where they want the iron for forward delivery, as there is no doubt that business is improving substantially. This is clearly indicated locally by the great increase in the traffic receipts of the North-Eastern Railway Company, though it is to be remembered that the figures over the current quarter have compared with a time last year when trade was hampered in an extraordinary degree by the severe weather. Making allowances, however, for that, there is a very large increase of traffic.

In addition to this the exports of pig iron from the Cleveland district are much above a March average, in fact they form a record for that month, as they will also for the current quarter, seeing that the deliveries in January and February were heavy for the time of the year. This month to Wednesday night 55,517 tons of pig iron were shipped from the Cleveland district, as compared with 42,833 tons last month, and 36,752 tons in the corresponding month of last year. Specially good are the over sea deliveries, which is due to the fact that not only has trade and consumption increased abroad, but, on account of the mild weather which has been experienced over the winter, many ports are open which are usually closed at this period of the year. It is believed that the consumption of Cleveland pig iron is now in excess of the production, and thus a decrease in stocks is expected to be reported at the close of the month. Large shipments of rails and manufactured iron from the district are reported.

The price at which the bulk of the business in No. 3 Cleveland G.M.B. pig iron has this week been done has been 38s. 6d. for prompt f.o.b. delivery, a figure which has practically ruled all the month; but there are now more buyers than sellers at the price, and more has to be given to most of the makers. Second hands are not doing much at present in the way of underselling the producers. For next quarter's delivery 38s. 9d. would be accepted by most sellers, and a considerable amount of business at that price has been done. Messrs. James Watson and Co., of Middlesbrough, have secured an order for 6000 tons of Cleveland pig iron for the East India Railway Company. Last year a similar order went to Messrs. William Jacks and Co., Middlesbrough. No. 1 Cleveland pig is at 39s. 6d. per ton, for early f.o.b. delivery. No. 4 foundry pig iron is stiffening in value because of the rapidly increasing demand for castings, and the scarcity of this quality of iron. Fully 37s. 6d. per ton is paid for it, while 37s. is realised for grey forge, 36s. 6d. for mottled, and 36s. for white, all early f.o.b. delivery. Cleveland warrants have been at 38s. 10d. cash, the best price that has ruled this year, but at the close on Wednesday buyers were offering only 38s. 6½d. cash. Very little iron is going into the public stores this month; on Wednesday night Messrs. Connal and Co. had 187,780 tons of Cleveland pig iron, the increase for the month being but 2270 tons. Mixed numbers of Cleveland hematite pig iron are obtainable in small quantities from merchants at 46s. 6d. for prompt f.o.b. delivery, but makers generally hold out for 47s. prompt and 47s. 3d. next quarter. There is, however, not quite so brisk a business doing in hematite pig as there is in Cleveland ordinary iron, and it is believed that more is being made than is required, but there are no means of verifying this belief, as no statistics of stocks are compiled, as in the case of Cleveland ordinary iron. The Tees-side Iron and Engine Works Company a few days ago blew out a furnace which required relining, but this week they have put in operation another furnace which has just been relined. Thus they have again two furnaces working, both on hematite iron.

A company, it is rumoured, has been formed for the purpose of acquiring and working the Coatham Ironworks. These are now in the hands of the National Provincial Bank of England, who offered them for sale by auction last year, but could not get a single bid for them. The works consist of two blast furnaces which have been idle since September, 1886. They were erected in 1873, when prices were at unprecedented figures, No. 3 Cleveland pig iron being at 120s. per ton—against 38s. 6d. now—and labour and materials were very far beyond their normal prices. Thus these works cost a very large sum of money. It is hardly likely that the works could be ready for commencing to manufacture pig iron for a year to come, even if preparations were at once made to put them in order. They need relining, and probably new boilers and stoves, so that a heavy sum of money would have to be spent on them. With trade so active, and prospects so encouraging, it is not unlikely that every available furnace in the district will be set to work as soon as possible.

The steel trade is very steady, and most pronounced is the improvement in the rail trade, in consequence of which manufacturers are not disposed to accept less than £4 15s. per ton net at works for heavy steel rails. The North-Eastern Steel Company, Middlesbrough, after a stoppage of five weeks, has completed its alterations and extensions, and resumed operations on Monday. It can now produce 3000 tons of steel weekly, or 25 per cent. more than previously, and the plant in Middlesbrough is capable at present of turning out 8000 tons of rails per week. The improvement in the rail trade has led to the expectation that the Darlington Steel Works, which have been idle since October, 1894, will be reopened shortly. The directors have the question under consideration.

The steel plate trade is satisfactory, though as regards demand there is rather a lull, which, however, cannot last long, taking into account the large amount of shipbuilding work that has been recently distributed, both for private owners and for the British Admiralty. Palmer's Shipbuilding and Iron Company, Jarrow-on-Tyne, has orders to build for the latter two cruisers, and Sir W. G. Armstrong, Mitchell, and Co., Elswick-on-Tyne, one cruiser, each to cost £180,000. Shipbuilders are quoting higher prices, and this is needful, as they have to pay higher wages. All the shipwrights in the North of England have had their wages advanced 1s. 6d. per week. Sir Raylton Dixon and Co., Middlesbrough, who are not connected with the Masters' Association, have had their men on strike on this question. The men wanted an unconditional advance of 1s. 6d. per week. The firm offered 2s. advance for a year, and this being refused, 2s. to the end of July and 2s. 6d. to the end of September, but the men refused to depart from the terms of the general settlement. However, they have agreed to an offer of 2s. 6d. per week advance, and they interpret this to mean 1s. 6d. advance—the same as the general advance—and 1s. bonus. That is how they get over their departure from the general settlement. The overtime dispute in the engineering industry of the Tees district has been settled, each day is to stand by itself. The general wages question among the engineers is likely to be adjusted without any difficulty. The masters' offer is now under the consideration of the men. It is reported that the Darlington Forge Company contemplate the starting of an engineering department in connection with their extensive establishment.

The Middlesbrough Exchange Company pays a dividend of 3½ per cent. to the shareholders on last year's account. One of the leading banks in the North of England—Messrs. J. Backhouse and Co.—is to be incorporated with Messrs. Barclay, Bevan, and Co.

Messrs. Charles J. Bagley, manager of the Moor Steel and Ironworks, and C. J. Watson-Munro, managing director of the Stockton Malleable Iron and Steel Company, have been added to the roll of Justices of the Peace for the borough of Stockton.

The extension of the Shildon Works by the North-Eastern Railway Company will, it is calculated, cost over £80,000, and when completed, 500 additional hands will be employed. The project is being carried out with a view to the centralisation of the wagon-building and repairing operations of the company, this work at present being distributed between York, Shildon, and Gateshead. In connection with the work Messrs. Shewell and Co., of Darlington, will supply 500 tons of steel work, and 220 tons of cast iron-work, at a cost of about £7000. The extensions include five large shops to be erected parallel with the engine-shed; a building shop, 300ft. by 60ft.; two machinery shops, 300ft. by 49ft.; an iron machine shop, 300ft. by 47ft.; and a wheel lathe shop, 300ft. by 47ft.

The death took place last Friday of Mr. George Crawshay, who for many years was head of the famous works of Hawks, Crawshay, and Co., at Gateshead. His age was 76 years. The works were founded in 1748 by Mr. Wm. Hawks, and when they were closed in 1889 covered 47 acres of ground. The firm were iron manufacturers, ironfounders, engineers, and boilermakers, builders of iron and steel bridges, lighthouses, and piers, anchor manufacturers, &c. The first Nasmyth hammer ever erected in England was put up at these works. The firm constructed the High-level Bridge at Newcastle in 1849, rebuilt the famous iron bridge at Sunderland, the Lindal Bridge at York. They erected no fewer than ninety bridges for the Caucasian Railways, the Golden Horn Pontoon Bridge, Constantinople. It is calculated that between 1848 and 1889 Messrs. Hawks, Crawshay, and Co. constructed 45,000 bridges. They also turned out fifteen large lighthouses for stations in England, Ireland, India, Australia, and the China Seas. They employed at one time 3500 workmen.

A somewhat better report is generally given of the steam coal trade, but the prices remain poor, best Northumberland being at 7s. 9d. prompt and 8s. 3d. over the season. The Durham coal trade is quiet. The Rowton Colliery, near Houghton-le-Spring, is to be closed, and in connection therewith the Marquis of Londonderry, the lessee, has taken the men into his confidence, explaining why he has been compelled to take this step. The coal is nearly exhausted, and the pit is very expensive to work on account of the great quantity of water to be pumped. It appears that last year the receipts were only £56,739, whereas the expenses were £72,380, thus showing a loss of about £15,640. The quantity of coal sold was 163,074 tons, and the loss per ton was close upon 2s. Of the £72,380 expended, £53,033 went for wages, or more than two-thirds, the cost of wages per ton of coal being 6/6·5—an exceedingly high rate. Under such circumstances, it could hardly be expected that operations would be carried on. It is believed that the North-Eastern Railway Co. will make some reduction in the dues at its Tyne Dock, to attract some of the traffic that is going to the Dunstan Staiths, which is so large there that it can with difficulty be coped with. Coke is very firm, and the supply is hardly adequate to the requirements. Middlesbrough ironmasters are paying from 13s. to 14s. per ton, delivered, for best brands.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Glasgow pig iron market opened steady, with a moderate business, about former rates. Dealers appeared to be making up their minds that a time of quiet trade and regular prices might very likely be experienced, when the news came that the ship joiners had voted by a large majority against the masters' offer of a farthing per hour advance. This occurrence immediately suggested the likelihood of a fresh strike on the Clyde and at Belfast, and a renewed serious interruption to work. The bears attempted to take advantage of the situation, and increasing quantities of warrants changed hands, with the result that the upward tendency of prices was arrested, and a reaction appeared to be at hand. While the output of iron is greater than is required to meet the current trade, and considerable additions are being made to stocks, the latter are smaller than at this time last year, and much less than has been the case in former times. Taking this into account, along with the increasing consumption of raw iron at home, a very large fall in prices is perhaps unlikely at this time, even although the strike should take place. Business was done in Scotch warrants from 47s. 4½d. to 47s. 6½d., and back to 47s. 3½d. cash. Cleveland iron varied from 38s. 7½d. to 38s. 10d., and down to 38s. 8d., while Cumberland hematite sold from 48s. 9½d. to 49s., receding to 48s. 9½d. cash.

There are 41 furnaces making ordinary, 35 hematite, and three basic iron, total 79, compared with 75 at this time last year. In the course of the past week 2000 tons of Scotch pig iron were added to the stock in Connal and Co.'s Glasgow stores, but the stocks are comparatively small, while the demand is very good on the part of home consumers.

The values of the special brands of makers' iron are steady:—Govan, Monkland, and Carnbroe, Nos. 1, are quoted f.o.b. at Glasgow, 48s. 6d.; No. 3, 47s.; Gartsherrie, Calder, and Summerlee, Nos. 1, 51s.; No. 3, 48s. 6d.; Clyde, No. 1, 50s. 6d.; No. 3, 47s. 6d.; Coltness, No. 1, 53s. 6d.; No. 3, 49s.; Glengarnock, at Ardrossan, No. 1, 51s.; No. 3, 47s.; Eglinton, No. 1, 48s. 6d.; No. 3, 46s. 6d.; Dalmellington, at Ayr, No. 1, 48s.; No. 3, 46s.; Shotts, at Leith, No. 1, 52s. 6d.; No. 3, 48s. 6d.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 49s.

The pig iron shipments from Scottish ports in the past week amounted to 7985 tons, compared with 5219 tons in the same week of 1895. The United States took 15 tons, South America 150, India 100, Australia 110, France 180, Germany 956, Holland 665, Belgium 85, Spain and Portugal 122, China and Japan 150, other countries 400, the coastwise shipments being 5052, against 3116 tons in the corresponding week.

The engineering and foundry trades are making progress in the direction of greater activity, and merchants are doing better both with manufactured iron and steel. The malleable iron and steel works are now fully occupied, and inquiries are constant and important. Sellers are not able, however, to obtain such prices as they could desire or as they really need. There is some prospect of the demand ere long overtaking the supply so thoroughly that higher prices may be obtained, and this is all the more likely because a number of the works have already reached their highest capacity of output. Steel angles are quoted £5, and ship plates £5 7s. 6d. to £5 10s. per ton, subject to 5 per cent. discount for delivery in Glasgow district.

There is no improvement in the condition of the coal trade. The shipments of the past week from the whole of the Scottish ports aggregated 104,742 tons, compared with 119,875 in the preceding week, and 118,371 in the corresponding week of last year. A brisk inquiry has lately been experienced from the Clyde to Mediterranean ports, and full advantage could not be taken of it owing to a scarcity of suitable and ready tonnage. Latest advices from Alexandria, however, are to the effect that the coal trade there is weak. In the meantime, the recent spurt has firmed up the price of better qualities of shipping coal. For other sorts the rates quoted are nominal, and concessions have to be made in order to secure contracts of any importance. There is an increasing consumption at home in the West of Scotland. In Fifeshire, trade is just a little more hopeful in some of its aspects. There are promising inquiries from Russia, but the competition with the North of England is very keen, and while the miners are restricted to two and three days a week—only having four days in some places—stocks continue to accumulate at the collieries.

The traders in coals in the West of Scotland sent a request about a month ago to the directors of the Caledonian Railway Company that the rates on the carriage of coal to Leith should be reduced by 3d. per ton. They pointed out that four boats of over 1500 tons could be accommodated at Grangemouth, while in recent years the carrying of coals had been more and more by large steamers of from 3000 to 6000 tons. The Leith Dock Commissioners are now making extensions that will admit of the accommodation of the largest steamers. No further reduction, the memorialists said, could reasonably be expected in the dock charges at Leith, which are now the lowest on the Firth of Forth, but they represented to the railway directors that the latter could afford to reduce 3d. per ton and still leave a profitable margin for their company.

The secretary to the Lanarkshire Coalmasters' Association has just received a communication from the manager of the Caledonian Railway, in which he states that, after full consideration of the whole circumstances, his directors cannot see their way to comply with the request. He adds, however, that the company is at present arranging to provide additional accommodation at Grangemouth, to admit of a considerably larger tonnage being dealt with than hitherto.

The reduction of 6d. a day has been quietly accepted by the colliers. Indeed, there was no alternative open to them, as they are without funds to enable them to present any resistance.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE "discharge note" system and the Plymouth colliers' strike form the two prominent incidents of the week. Last week I submitted in this column that, seeing the strong opposition offered to the "discharge note" by the colliers, who were stoutly supported by "Mabon" in their opposition, the Associated Coalowners would be well advised in withdrawing it, and then framing some other substitute that would give honest and industrious workmen an advantage over the idle and irregular. I am glad to note that this view was adopted at several owners' meetings of late, Sir William T. Lewis especially recommending it. Some lively times have taken place in advocacy and opposition, and at the last gathering of workmen's representatives it was decided by 63 to 53 to wait a fortnight, and see what course the Associated Owners would consent to. The minority of representatives advocated an immediate strike, and Mabon was denounced as playing the workmen false. He is one of the most judicious of leaders, and yet with the strong aggressive spirit and suspicious nature of the men he has to do with, has all his work to maintain his government. After doing admirable service on the "discharge note" system, Sir William T. Lewis, Bart., proceeded on Tuesday to a conference at Plymouth with the strikers, and, I am assured by excellent authority, laboured ably to bring about an arrangement, but ineffectually. The latest news is that both management and men continue firm. Actions are pending against the company by some of the men, and one point insisted upon by the management is that these shall first be withdrawn. In the meanwhile, the circuit for obtaining support is being widened, and public aid is not volunteered so promptly as needed, the growing opinion being that there should be a consent to an arbitration, by which both should abide.

Capt. Rosser, late deputy, has been appointed dock master at the Bute Docks in place of the late and esteemed Capt. Pomeroy, and a new appointment has been made in addition, that of superintendent of the docks and railways, a position wisely given to Mr. James Hurman, late traffic manager on the Taff Vale Railway. It was always thought that Mr. Hurman would have succeeded to the head of the Taff Vale Railway at the death of Mr. Geo. Fisher, but the ways and moods of railway directors, like that ascribed to corporate bodies, are often mysterious. Cardiff strongly endorses both appointments.

As may be imagined, the well-grounded fears of a coal strike have not been without their influence upon the trade. Mid-week it was noticeable on 'Change, Cardiff, that there was considerable anxiety shown to close for requirements. The stormy weather has also continued to tell; yet, notwithstanding, last week showed a good total from Cardiff ports of over 300,000 tons.

Large cargoes have especially been in evidence. Two 6000-ton steamers have been cleared from Newport for Bombay, and several large ones are loading at Cardiff for the same destination. One despatched, Tuesday, Knight Bachelor, carried 9000 tons.

One of the novelties of the coal shipping of late was in the shipment of coal from Cardiff for New York. This was 1952 tons in the Mexican Prince. Last year the principal coal customer with Cardiff was Genoa, taking 913,779 tons. Port Said next, 890,362; St. Nazaire third, with 402,228 tons.

Swansea coal shipments last week were again small, due principally to non-arrival of tonnage. The total was only about 21,000 tons. Newport total, 62,080 tons; foreign, 1917 tons, coastwise.

Prices remain in a tolerably firm condition, slighly varying as ill rumours are circulated or withdrawn. This week Cardiff prices are as follows:—Best steam, 10s. 3d. to 10s. 6d.; seconds, 9s. 6d. to 10s.; drys, 9s. to 9s. 6d.; best Monmouthshire, 8s. to 8s. 6d.; seconds, 8s.; best small, 4s. 9d. to 5s.; seconds, 4s. to 4s. 3d.; drys, 3s. 6d. to 4s. House coal is easier, and it was remarked on 'Change, Cardiff, this week, that a better inquiry was being made for shipment, but that inland sales were beginning the "down grade." Best coal is selling at 10s. 6d. to 10s. 9d.; No. 3 Rhondda, 9s. 6d. to 9s. 9d.; brush, 7s. 9d. to 8s.; small, 6s. to 6s. 3d.; No. 2 Rhondda, 7s. 6d. to 7s. 9d.; through, 6s. to 6s. 3d.; small, 4s. to 4s. 6d. Patent fuel: Cardiff, 10s. to 10s. 6d.; Swansea, 9s. 9d. to 10s. 3d.; trade moderately brisk. Best Monmouthshire coal is selling at 8s. to 8s. 6d.; seconds, 8s.; sale rather slow and quotations maintained with difficulty. Eastern valley coal, 7s. 9d. to 8s. 1½d.

Good news reigns at all the principal works in the finished iron and steel department. The make varies from rails, sleepers, sheet iron, and small goods, with a lessened turn-out in several quarters of steel bars for tin-plate centres. In respect of this it may be added that great care is required and exercised in tin bar transactions, one or two tin-plate works having failed with large items owing to ironmasters. At one a compromise of 5s. in the £1 was offered but refused, and the tin-plate manufacturer has filed his petition. These are matters which debtors and creditors alike deplore, but, as all admit, the wonder is, considering the times and the great difficulty in dealing with the men, that cases of the sort are not more numerous. Taking the whole district, there are a large number of tin-plate works idle. In the Llanelly district temporary stoppages have been numerous, through the lack of orders, and it is stated that prices offered are such as will not warrant a restart. A statement current is to the effect that prices offered are so low that, even if the men conceded the fullest reduction asked for, it would not be worth while for makers to keep going.

In some districts men are showing a more general desire to meet the needs and requirements of tin-plate manufacturers. At the compact Cynon Works, Aberdare, the men have been working for some time at a concession on their part of 12½ per cent. Last week a demand was made that this should be increased to 20 per cent., but this was refused. Now I hear that an amicable arrangement has been arrived at by which the works will be kept going at a 15 per cent. reduction. In the Briton Ferry district eighteen mills were at work last week, five at the Villiers, four at the Vernon, three at Baglan Bay, three at Gwalia, and three at Earlswood.

There was a little better shipment of plates last week, the total reaching 52,906 boxes, while only 43,366 boxes came from works. Stocks are now down to 181,391 boxes. The clearances were to France and other parts of the Continent, Singapore, Java, and the United States. Loadings are now going on for Russia (Batoum).

A much better make of steel rails is going on at several of the leading steel works than used to be noted. This week a shipment of rails—520 tons—took place from Cardiff to Pernambuco, and 400 tons pig iron to Hamburg.

Iron ore is in good demand, three cargoes from Cyfarthfa, two from Dowlais, and one each from Blaenavon and Ebbw Vale came in during the early part of the week. Cardiff prices are:—Best Rubio, 11s. 9d.; Tafna, 11s. 3d.; Garucha, 10s. 9d. to 11s., c.i.f. Swansea quotations are:—Tafna, 11s. 3d.; Rubio, 12s. 3d., ex ship, cash thirty days.

On 'Change, Swansea, this week, the following were the latest general quotations:—Glasgow warrants, slightly higher, 47s. 5½d.; Middlesbrough, No. 3, 38s. 10d.; prompt hematite, 46s. 4d.; Welsh bars, £5 10s. to £5 15s.; sheet iron, £6 15s. to £6 17s. 6d.; steel, £6 12s. 6d. to £6 15s.; steel rails, heavy, £4 10s. to £4 15s.; light, £4 17s. 6d. to £5 7s. 6d. Bessemer steel: tin-plate bars, £3 17s. 6d.; Siemens best, £3 18s. Tin-plates, Bessemer steel coke, 9s. 1½d. to 9s. 3d.; Siemens, 9s. 3d. to 9s. 6d.; ternes, per double box, 28 by 20 C, 17s. 6d. to 22s. 6d.; best charcoal, 12s. 6d. to 13s. 6d. Block tin, £60 12s. 6d. to £60 15s. Lead, English, £11 to £11 2s. 6d.; Spanish, £10 17s. 6d. to £11.

Swansea coal quotations are:—Anthracite, 8s. to 11s. 6d. according to quality. Steam, 9s. 6d. to 10s. 3d.; second quality, 8s. 9d. to 9s. 3d. No. 3, Rhondda, 10s. to 10s. 6d.; No. 2, 8s. 9d. 9s. 6d. Coke is in brisk demand at Cardiff, furnace, 13s. 6d. to 14s. 9d.; foundry, 15s. 6d. to 16s. 6d.; special, 19s. 6d. to 20s.

At Cardiff prices of pitwood are slightly firmer, sales are being effected at 15s. 4½d.

The Welsh plate trade threatens to be revolutionised. Mr. Thomas, of Menai Bridge, has patented an invention by which the rock can be cut into squares of any size, without blasting operations. It is claimed that the machine will, at a trifling cost, perform the work of 400 men. Present cost of labour is 35s. per ton; future cost, £1. A practical trial is stated to have been most successful, and a syndicate is to be formed.

The Barry line to Pontypridd was opened for passenger service on Monday, and all passed off well.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

SATISFACTORY accounts continue to be received from most of the iron markets over here. Trade in iron and steel is steadily improving all round, and, judging from the number of contracts that have been booked within the last few weeks, full employment is assured to the majority of the works for several months to come. Prices are very firm, and generally tend upwards.

Last week was a brisk one in the Silesian iron trade. Spring demand on local account is already setting in freely, and it is anticipated that in April or May foreign inquiries will also increase, Poland and Russia having hitherto bought only small lots. Compared to last autumn, a rise of about M. 4 p.t. is noticeable for the different sorts of malleable iron. Manufacturers give an extremely satisfactory account of their business, the orders that have been secured reaching far into the third quarter, so that, if there should be a temporary lull with regard to new work, the activity at the mills will, nevertheless, be well maintained. Local demand for plates has been exceptionally good of late, owing to the brisk employment in the enamelling industry, which has been steadily improving since July last year. Among the heavier sort of plates, those for shipbuilding and boilermaking purposes are best inquired for.

Production of pit coal in Upper Silesia is statistically stated to have been, since 1865, as under:—

	Output. Tons.	Coal-pits.	Colliers.
1865	4,250,927	87	17,059
1875	8,228,369	122	32,198
1885	12,842,128	79	40,214
1895	18,066,401	53	53,760

The Austro-Hungarian iron market is, on the whole, in a fair condition. The orders that come in for structural iron have increased in weight as well as in numbers, and there is a lively activity going on at the mills and foundries. In the railway and bridge-building department prospects are good. Official quotations do not show any alteration. According to the *Buda-Pesther Correspondenz*, the opening of the Iron Gates across the Danube will take place on September 27th of present year.

During the last weeks the firmness on the French iron market has rather increased. The demand for pig iron has been very active, and stocks are small accordingly. The condition of the iron market is generally expected to remain satisfactory for several years to come, the more so because the large Paris exhibitions always have a favourable and lasting influence on trade. Orders for the Exhibition in 1900 are being looked forward to, and it is to be hoped that the confidence in the future may not be troubled by political events.

In Belgium demand and sale on the iron market are satisfactory, both on home and on foreign account. Quotations exhibit a rising inclination. Belgian foreign trade in iron and steel during the year now past was as under:—

	Import.		Export.	
	1895. Tons.	1894. Tons.	1895. Tons.	1894. Tons.
Iron ore	1,857,623	1,942,883	328,427	258,529
Raw steel	18,605	18,518	1,316	659
Drawn steel wire	7,172	—	610	—
Steel girders	569	681	54,125	23,146
Steel rails	441	234	86,452	78,717
Bars	9,205	11,126	29,895	18,906
Steel nails	5	—	6,372	—
Manufactured steel	1,115	1,028	20,955	34,839
Pig iron	225,665	227,428	9,865	12,057
Scrap iron	28,744	24,704	12,532	8,491
Iron wire	4,684	6,335	754	1,227
Iron girders	266	696	34,968	47,108
Iron rails	38	32	133	187
Iron plates	3,079	2,136	64,068	68,561
Iron bars	9,901	11,808	170,713	162,810
Iron nails	799	683	5,396	8,017
Hardware	4,147	3,859	34,576	25,358
Castings	1,274	1,116	23,322	22,328
Rolling stock	1,418	1,785	29,266	29,729
Machines	22,660	20,349	25,288	35,611

In every branch of the Rhenish-Westphalian iron industry there is a steady improvement to be noticed. Orders are plentiful, with good prospects of remaining so through summer, and perhaps for longer. With regard to the iron ore trade, both the Siegerland and Nassau mines are in brisk activity, prices being firmly maintained. Further advances in quotations have, however, not taken place, spathose iron ore fetching M. 8·60 p.t.; roasted ditto, M. 12 to 13 p.t.; calcined iron ore costs M. 12 to 14 p.t. net at mines. Minette of Lorraine is in animated request at M. 2·50 to 2·70 and 3·20 p.t., according to qualities. The demand for raw iron has been extremely brisk upon the week, and the lately raised quotations are willingly paid. For spiegeleisen, 10 to 12 p.c. grade, M. 54 to 55 p.t. is given; forge pig, No. 1, is offered at M. 49 to 52 p.t.; in some instances M. 53 p.t. has been realised; No. 3 is quoted M. 42 p.t.; hematite, M. 65 p.t.; foundry pig, No. 1, M. 65 p.t.; No. 3, M. 57 p.t.; basic, M. 54 p.t.; German Bessemer, M. 56 to 59 p.t. at works. Luxemburg forge pig is sold at M. 46·50 p.t. free Luxemburg. Much life is shown in the malleable iron trade, and business during the week has been brisk, foreign consumers coming forward very freely with their orders. Prices, though on an average M. 5 p.t. higher than formerly, yield but little profit. In most cases the contracts secured for bars reach far into the third quarter. In girders and hoops, likewise, a rise in demand has been noticeable. Steel makers are very busy on plates, sheets, and rails, inland and foreign demand being good. Wire and wire nails are in somewhat better request at the former low quotations; rivets also show a slight improvement. The activity at the machine and wagon shops is satisfactory.

Present list quotations, per ton at works, are as under:—Good merchant bars, M 115; angles, M. 120 to 125; girders, M. 80 to 90, and higher; hoops, M. 123 to 125; billets in basic and Bessemer, M. 83 to 85; heavy plates, for boilermaking purposes, M. 160; tank do., M. 135 to 140; steel plates, M. 130 to 135; tank do., M. 115 to 130; sheets, M. 145 to 155; the same in steel, M. 135; iron wire rods, common quality, M. 125; drawn wire in iron or steel, M. 118 to 125; wire nails, M. 127 to 130; rivets, M. 165 to 170; complete sets of wheels and axles, M. 270 to 280; axles, M. 220; steel tires, M. 200; steel rails, M. 108 to 110; steel sleepers, M. 106; fish-plates, M. 112 to 120; light section rails, M. 98.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

GOOD attendance on 'Change. Steam coal in moderate demand, but shipments for the past week reached 81,000 tons; prices remain steady. House coal is without any alteration in demand or price. Tin-plates without any improvement. Manufactured iron and steel continue in good demand.

Coal: Best steam, 8s. 3d. to 8s. 6d.; seconds, 8s.; house coal, best, 10s. to 10s. 3d.; dock screenings, 5s.; colliery small, 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 47s. 2½d.; hematite warrants, 41s. 7½d., f.o.b. Cumberland; Middlesbrough No. 3, 38s. 8d., prompt; Middlesbrough hematite, 46s. 1½d. Iron ore: Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel: Rails, heavy sections, £4 15s.; light ditto, £5 to £5 5s. f.o.b.; Bessemer steel tin-plate bars, £4; Siemens tin-plate bars, best, £4 2s. 6d., all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel, coke, 9s.; Siemens coke finish, 9s. 3d.; ternes, per double box, 28 by 20 C, 21s. to 22s. Pitwood, 15s. 3d. to 15s. 6d. Freights firm.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, March 12th.

THE gross earnings of our railroad mileage in 1895 was 75,000,000 dols. over the gross earnings of 1894. This year's gross earnings, it is estimated, will be 125,000,000 dols. over 1894 at least. Traffic on railroads is steadily increasing. The increase in January gross earnings was 10 per cent. over January. 1895. Bank clearings increased 6½ per cent. last week, but were 17½ per cent. less than same time 1893. The industrial situation is not altogether gratifying. General demand is backward. Prices in iron, steel, cotton cloths, petroleum, lead, hides, tin, wheat, corn, oats, and a number of other products have declined. Movements of cotton since September 1st at all United States ports foot up 4,528,703 bales, against 5,931,689 bales last year. The present lull may suddenly disappear. The business public, however, has no faith in the present administration, and a strong movement is on foot to place in authority an administration which is in harmony with the interests of 14,000,000 voters, as against the interests of a few hundred bankers. The tendency of the steel market is downward. Very few summer contracts have been placed. A sudden upward turn of prices is probable, because of the policy of so many large consumers to defer purchasing until material is actually needed. So much American railway mileage is in a condition that will render it an unimportant factor. Needs for equipment are urgent enough, but earnings forbid buying except for most urgent wants. In two months 12,500 freight cars were ordered. Plate mills, however, are quite busy, and pipe works are sold up. The metals are dull, and copper mines are restricting. Rail mills are working to less than half capacity. Apart from present despondency over the tardy development of spring trade, there is a hopeful feeling. It is either full speed or down brakes in America. The brakes are on just now.

THE Tower Publishing Company announce the publication this week of the "Naval Pocket Book," by Mr. W. Laird Clowes, containing a description of every warship in the world.

LAUNCHES AND TRIAL TRIPS.

On the 11th inst. the official speed trials of the twin-screw barge-loading dredger St. Austell, recently constructed by Messrs. William Simons and Co., Renfrew, to the order of the Admiralty, took place on the measured distance at Skelmorlie with very satisfactory results. Six runs were made with and against the tide, when it was found that fully a knot more than the contract speed was obtained. The Admiralty were represented by Messrs. Harris, Hay, Stewart, and Scoggins. The vessel left immediately thereafter for H.M. Dockyard, Devonport, where she is to be employed.

On the 17th Messrs. Wm. Simons and Co., Renfrew, launched the first of three steam hopper barges recently ordered from them by the Admiralty for service at Devonport. Its dimensions are as follows:—Length, 160ft.; breadth, 28ft. 6in.; depth, 12ft. 6in. The vessel is capable of carrying 570 tons deadweight, and is propelled by one pair of compound surface-condensing engines of indicated horse-power sufficient to propel the vessel when fully loaded at a speed of about nine knots per hour. There were present at the launch her Majesty's surveyors, Messrs. Hay and Scoggins, under whose direction the vessel was built. The berth in the yard will be occupied by a large and powerful stationary barge loading dredger recently ordered by the Mersey Docks and Harbour Board.

On Saturday, March 14th, the steel spar deck screw steamer Chun Sang, built by Sir Raylton Dixon and Co., Cleveland Dockyard, Middlesbrough, for the Indo-China Steam Navigation Company, of London, proceeded to sea under the command of Captain Evans for her official trial trip. This vessel, which has been especially designed and equipped for the company's trade in China, is 300ft. by 40ft. by 25ft., and has a deadweight carrying capacity of about 3400 tons, with arrangements in 'tween decks for carrying Chinese passengers. The spar deck is of steel sheathed with teak, and the bridge and forecastle decks are also of teak. Engines, of the most approved triple-expansion type, are by Messrs. the North-Eastern Marine Engineering Company, Sunderland, and the boilers are fitted with forced draught on Howden's system. The hull and machinery have been constructed under the supervision of Mr. Buchanan and Mr. Duncan. Mr. James Keswick, of Messrs. Jardine, Matthieson and Co., Mr. Cheyne, secretary of the Indo-China Steam Navigation Co., and others were on board during the trial trip, which passed off most successfully.

On the 17th inst. Messrs. Ropner and Son, of Stockton-on-Tees, launched a steel screw steamer of the following dimensions, viz.:—Length between perpendiculars, 290ft.; breadth, extreme, 43ft.; moulded depth, 19ft. 9in.; which they have built for Messrs. J. S. Allison and Co., West Hartlepool. The steamer is built off the part awning deck rule, with poop and raised quarter deck, her deadweight carrying capacity being 3500 tons on 18½ft. The saloon and cabins for captain and officers are fitted in the poop, the engineers' accommodation being amidship. She is built on the webb frame principle, leaving the holds entirely clear for cargo, and carries her water ballast in a cellular bottom and in the after peak. All labour-saving appliances are fitted for the economical working of the steamer, and also for the expeditious loading and unloading of cargoes. She has steam steering gear amidship and screw gear aft, four powerful steam winches, two large donkey boilers, direct steam windlass, stockless anchors, &c. The engines will work up to about 900 effective horse-power, and are by Messrs. Thomas Richardson and Sons, Limited, having cylinders 21½in., 35in., and 59in. by 39in. stroke, steam being supplied by two large steel boilers working at 160 lb. pressure. Mrs. Allison, wife of the managing owner, named the steamer Dorothy.

The Valhalla is a fine steel screw steamer, and has been built by Messrs. William Gray and Co. to the order of Messrs. Herskind and Co., of West Hartlepool. She is the twenty-fifth vessel which the builders have supplied to this firm. Her principal dimensions are:—Length over all, 310ft.; breadth, 43ft.; depth, 19ft. 11in.; and she has been built to Lloyd's highest class. She is of the partial awning deck amidships type, with poop, raised quarter deck, and short well and forecastle, and fore and aft schooner rig. A cellular double bottom is fitted, and also an after peak tank for water ballast. The engines have been supplied by the Central Marine Engine Works of William Gray and Co., and are of their well-known triple-expansion type, having cylinders 22in., 35in., and 59in. diameter, with 39in. stroke, supplied with steam by two single-ended boilers, 14ft. diameter by 13ft. long, working at 160 lb. pressure per square inch. The vessel left the Tees, fully laden, early in the morning, and was manoeuvred in the bay for the purpose of adjusting compasses, &c., till about 10 a.m., when she was met by a tug from Hartlepool conveying the inspecting engineers and others interested. The trial which the vessel and her machinery then underwent was considered eminently satisfactory, the engines working with great smoothness, the bearings keeping perfectly cool, and the boilers maintaining an ample head of steam and remaining perfectly tight. The owners were represented by their inspecting engineer, Mr. Fothergill; the engine builders by Mr. Lindsay. After the trial the vessel proceeded with her cargo of rails on her first voyage to Bombay.

The trial trip of the steamer Golden Fleece, which is intended for the fruit trade between the West Indies and New York, took place on the 11th inst. between Blyth and the Tyne. She is a steamer 320ft. by 35ft. beam, by 26ft. depth of hold, and has just received very extensive alterations at the hands of the Blyth Shipbuilding Company, of Blyth, who have converted this vessel from an ordinary cattle-carrying boat into one of the finest and largest fruit carriers. As is well-known, the question of ventilating the holds is one of paramount importance in fruit steamers, and a new arrangement has been adopted in this vessel whereby all the air in the holds is renewed in less than one minute, and arranged in such a manner that a continuous current of air sweeps the holds from one side to another, so that no stagnant air can lodge in any particular place. Those who are acquainted with the trouble of ventilating ships are best able to comprehend what this means, and the difficulties which have had to be surmounted. The upper and lower 'tween decks are insulated all fore and aft. The complete ventilation of the holds has been effected partly by mechanical means, and partly by utilising the waste heat from the boilers, thus reducing the cost of such installations, which in this case deals with over 60,000 cubic feet of air per minute, and is believed to be the largest quantity of air dealt with in a ship up to the present date. In addition to the above, one of the holds has been fitted with a refrigerating plant on the ammonia system, which will be capable of keeping the temperature down, so as to prevent the overheating of the fruit. The alterations made in the main engines by the engineering establishment of the Blyth Shipbuilding Company have been of such an extensive character as to increase the speed of the vessel by 1½ knots over anything she has ever done before, while at the same time the alterations have tended to a very material reduction in the consumption of the fuel at former speeds. Messrs. Clarke, Chapman, and Company have fitted a complete system of electric light installation, both for the ship's use, passenger accommodation, and working of the holds. The speed which was obtained at the trial gave the owners, and the large party of invited guests, unqualified satisfaction. It is interesting to know that the first steamer carrying fruit from the West Indies to New York was built fourteen years' ago for the same owners, and had only a gross tonnage of 600 tons, while the trade has so developed since that time that the above-named steamer is now to be employed in the same service, and has a gross tonnage of about 2200 tons, being the largest steamer afloat for the exclusive carriage of fruit. The whole of the alterations above referred to, including the system of ventilation adopted in this vessel, has been made to the designs of Mr. George Walker, consulting engineer and naval architect, of London, under whose superintendence the work has been carried out. The Golden Fleece is owned by the Argonaut Steamship Company, of London, and immediately after her trial she proceeded on her voyage to Jamaica.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

4th March, 1896.

4902. Letter Card, J. S. and A. J. S. Catford, Kingston-on-Thames.
4903. Treatment of Paste, &c., Board, C. E. Preusse, London.
4904. Whip Socket, G. F. Norrington, London.
4905. Indoor Game, A. Collins, London.
4906. Incandescent Gas Lamp for Streets, J. Lees, London.
4907. Smoke-consuming Furnaces, J. Weir, Glasgow.
4908. Fur Blowing Machines, R. Robinson, Manchester.
4909. Closing the Tops of Bottles, &c., E. Pink, London.
4910. Magnetic Regulating Mechanism, R. Niewerth, London.
4911. Preserving Fruit and other Substances, H. S. Coleman, London.
4912. Wagon Brakes, E. T. Hughes.—(*L. S. Wheeler, United States.*)
4913. Electro-coating of Type, G. R. Hughes, London.
4914. Food Transporting Wagons, B. Steingröver, London.
4915. Lacing Devices for Boots, &c., E. Waterman, London.
4916. Elastic Hubs of Vehicle Wheels, C. B. Marks, London.
4917. Machinery for Shaping Corks, J. E. Howard, London.
4918. Art of Making Cement, R. A. Cheesebrough, London.
4919. The Eclipse Bed Improvement, J. E. Fischer, London.
4920. Door, &c., Hinges, Tonks, Ld., and A. G. Tonks, London.
4921. Soldering Pan, Elkinton and Co. and H. T. Fellows, London.
4922. Safety Pin, C. Bayer, London.
4923. Gas and other Hydrocarbon Engines, W. E. Simpson, London.
4924. Gas and other Hydrocarbon Engines, W. E. Simpson, London.
4925. Device for Liberating Fishing Tackle when Entangled in Trees or Bushes, C. P. Greene, London.
4926. Pneumatic Valves, W. S. Rawson, London.
4927. Umbrellas, E. Charageat, Liverpool.
4928. Gasoline Burners, J. Forshaw.—(*N. Forshaw, United States.*)
4929. Cuff Fastener or Support, M. G. Buckler, Liverpool.
4930. Fire-doors, A. Burkart-Stalder, London.
4631. Mechanical Musical Instruments, A. Junod, London.
4932. Rabbit Trap, A. H. Bremner, London.
4933. Golf Clubs, J. F. C. Hamilton and C. J. Jacobs, London.
4934. Pipes for Smoking, J. M. Jacobs.—(*W. B. Haas and Co., France.*)
4935. Cycle Gear Cases, F. Easom, S. Ranford, and Humber and Co., London.
4936. Motors and Motor Vehicles, J. W. Hall, London.
4937. Secondary Batteries, E. and W. Clark and F. King, London.
4938. Engines Worked by Combustible Gases, F. H. Wenham, London.
4939. Sewing Machines, J. Y. Johnson.—(*H. Springmann, Germany.*)
4940. Stamp Inking Pad, T. Wachsmuth, London.
4941. Laying Sight for Ordnance, H. F. Gaynor, London.
4942. Process for Phosphorescent Coating, A. Duval, London.
4943. Fireproof Building Construction, W. Youlten, London.
4944. Electric Arc Lamp, J. G. Lorrain.—(*T. M. Foote, United States.*)
4945. Furnaces for Making Glass, F. Radcliffe, London.
4946. Making Superphosphates, A. A. and C. J. Yvert, London.
4947. Puzzles, E. Baily, London.
4948. Pneumatic Tires, F. Grundy, London.
4949. Ball Bearings, E. H. Hasspacher, London.
4950. Carpenters' Squares, J. H. Welch, London.
4951. Holders for Window Sashes, E. E. Dalton, London.
4952. Corn Holders, E. C. Hamilton, London.
4953. Display Fixtures or Stands, W. H. Shrader, London.
4954. Railway Rails, L. D. Garnhart, London.
4955. Tightening Wheel Felloes, J. W. Schouten, London.
4956. Toys for Making Soap Bubbles, J. C. Daugherty, London.
4957. Mucilage Bottles, J. A. Hall, London.
4958. Bottles, S. J. Smith, E. S. Ross, G. W. White, G. Rusling, M. J. Leahy, and C. M. Carhart, London.
4959. Electric Arc Lamps, A. G. Edwards and J. Baker, London.

5th March, 1896.

4960. Rulers, A. Langley, London.
4961. Water Service Stop Cocks, J. J. Justice, Gainsborough.
4962. Lock Stud for Envelopes, R. J. Evans, Hanley, Staffs.
4963. Instruments for Laying-out Gradients, J. S. Pickering, Nuneaton.
4964. Lamp Brackets, J. Carter and W. J. Whiting, Birmingham.
4965. Heating Apparatus for Baths, A. Arbury, Blackburn.
4966. Feed Check Valves for Steam Generators, F. Wilkinson, Manchester.
4967. Shaving-stick Holders, H. Alabaster, Birmingham.
4968. Clothes Prop, A. Pinfold, Bradford.
4969. Clothes Peg, G. H. Biddles and F. W. Billson, Leicester.
4970. Typewriting Machines, A. E. Box, Liverpool.
4971. Recording the Marks given to Pupils, W. L. Sargant, Edinburgh.
4972. Mounting Screw-plates, G. and K. E. S. Walker, London.
4973. Preventing the Waste of Liquors, J. H. Kettell, Manchester.
4974. Coin-freed Automatic Machines, E. Ireland, Manchester.
4975. Making Fire-lighter Grids, B. Sutcliffe and E. L. Dutton, Halifax.
4976. Controlling the Supply of Water to Boilers, T. L. Miller, W. H. Jackson, and W. J. Thompson, Liverpool.
4977. Attaching Buttons to Garments, C. Crowther, Manchester.
4978. "The Ariel" Toy, J. E. Goddard, Barrow-in-Furness.
4979. Valves, W. Wheatley and G. Kros, Manchester.
4980. Water Gas, W. Wheatley and G. Kros, Manchester.
4981. Pneumatic Tire, O. Bullock and W. H. Forty, Boxmoor.
4982. Computing Stability of Ships, A. G. Ramage, Leith.
4983. Wheels, A. A. J. Hall, Glasgow.
4984. Transmitting Power to Wheels, M. Browne, Dublin.
4985. Pumps for Inflating Tires, E. Booth, London.
4986. Club Directory, H. Mandell, London.
4987. Pasteboard Boxes, C. D. Abel.—(*Hirschwanger Holzschleiferei und Holzstoffwaarenfabrik Schoeller and Co., Austria.*)
4988. Protection of Trousers, A. Franklyn, Manchester.
4989. Double-clocked Candlestick, S. Sakheim, London.
4990. Lamp Brackets, J. Meiklejohn and H. O. Tiarks, London.
4991. Pharmaceutical Preparations, J. Y. Johnson.—(*Vereinigte Chinenfabriken Zimmer and Co., Germany.*)
4992. Dustbins, G. C. Harrison, London.
4993. Sacks, G. C. Harrison, London.
4994. Boilers, J. Weir, London.
4995. Boilers, J. Weir, London.
4996. Jointing Boxes for Conduits, F. Bathurst, London.
4997. Making Tubes of Soft Materials, W. Love, London.
4998. Reversible Box Iron, R. Abrey and A. Tardif, London.
4999. Trimming the Wicks of Lamps, J. A. Hay, Birmingham.
5000. Cycling Shoes, H. Tunby, Manchester.
5001. Search-light Reflectors, R. B. Molesworth, London.
5002. Wheels of Children's Mail-carts, J. Priaulx, London.
5003. Pencil, R. K. Howat, London.
5004. Cooking Food by Steam, C. Merington, London.
5005. Safety Lock for Trap-doors, &c., C. A. Barnard, London.
5006. Screw Grips, J. Campbell and J. Telfer, London.
5007. Pressing Wads, The Normal Powder Syndicate, Ld.—(*L. G. Ohman, Sweden.*)
5008. Commutator Brushes, W. W. Wardle, London.
5009. Driving Gear for Motor Carriages, H. P. Holt, London.
5010. Harrow and Roller, M. Gottschall, G. Meyer, and A. Krueckel, London.
5011. Saturators, P. Duggan, London.
5012. Connection for Use with Pipes, P. Duggan, London.
5013. Bottle Stoppers, A. Coxon and R. Morton, London.
5014. Ventilating Enclosed Spaces, W. Heaton and J. Rumball, Birmingham.
5015. Candle Holders or Save-alls, H. Taylor, Birmingham.
5016. Stirring Appliance, F. Norton and F. Jackson, London.
5017. Igniting Explosive Gases, J. C. Bauer, London.
5018. Electric Bobbin, S. S. Bromhead.—(*A. Dorez, France.*)
5019. Medicinal Compound, T. Pragnell, London.
5020. Keys, H. Dexter, London.
5021. Clip, W. Howe, Clay Cross.
5022. Clip, W. Howe, Clay Cross.
5023. Electric Railways and Tramways, G. C. Fricker, London.
5024. Instruments for Drawing Maps, L. Cazes, London.
5025. Utilisation of Egg Shells, J. J. Hooker, Manchester.
5026. Road Skates, M. S. Napier and A. Ritter, London.
5027. Vulcanising Species of Dichopsis, F. Ellershausen, London.
5028. Telegraphy, G. Marconi, London.
5029. Dry Gas Meters, T. Hughes, London.
5030. Rope Grips, W. S. Dawson and D. Dishart, London.
5031. Boilers, G. Lentz, London.
5032. Tip Cats for Umbrellas, &c., F. Jackson, London.
5033. Learning to Ride on Bicycles, F. Oliver, London.
5034. Chimney Cowls, F. Rogers, London.
5035. Bicycle Saddles, A. E. Peck, London.
5036. Relief Letters, A. J. Boult.—(*E. Busath, Belgium.*)

6th March, 1896.

5037. Velocipede Driving Apparatus, A. Bodding, London.
5038. Table Corner and Side-plate, G. H. McKay, Glasgow.
5039. Separating Metals from Seeds, W. Henderson, Liverpool.
5040. Hanging Window Sashes, A. Manners, Bishop Auckland.
5041. Conductors for Telephones, J. Swinburne, London.
5042. Grip-headed Screw Bolt, J. Harford, Bristol.
5043. Cop and other Tubes, W. E. Heys.—(*E. Bruckert, France.*)
5044. Colouring Matters, I. Levinstein and Levinstein, Ld., Manchester.
5045. Time Checking Apparatus, The Brook Time Checking Clock Company, Ld., and F. Brook, Huddersfield.
5046. Cutting Cloth, T. Firth and J. Firth, Huddersfield.
5047. Joining Ends of Warp Threads, J. Kershaw, Manchester.
5048. Propelling Mechanism, Baron of Mauni, Dieppedalle, France.
5049. Collapsible Bed, Table, and Seat, J. Reid, Glasgow.
5050. Indicating Position of Signals, H. Clapham, Bradford.
5051. Enriching Coal Gas, R. G. Shadbolt and J. Wilson, Halifax.
5052. Horseshoes, G. Glossop, Leeds.
5053. Valve Apparatus for Cisterns, W. Thomson, Glasgow.
5054. Stamping Tickets in Tramway Cars, J. Burnett, Glasgow.
5055. Machine for Shaping Bobbins, J. Balderston, Glasgow.
5056. Portable Weighing Machinery, J. and T. Greenwood, Manchester.
5057. Hand Bags, P. A. Martin, Birmingham.
5058. Cigarette Cases, G. Page and The Birmingham Advertising Tablet Company, Ltd., London.
5059. Converting a Reciprocating Motion into a Circular Motion, A. J. Leaver, London.
5060. Rollers for Washing Machines, J. and R. Oliver, Manchester.
5061. Brush Head and Stave, W. Lawson, Burnley.
5062. Lifeboat Lowering Apparatus, W. W. Meek, Glasgow.
5063. Bridle Bits, J. N. Beevor, Birmingham.
5064. Metallic Packing for Piston-rods, T. Keene, Liverpool.
5065. Bottle Manufacture, A. R. and J. W. Main, Dumbartonshire.
5066. Combination Pen Wiper and Holder, R. L. Hodgson, London.
5067. Carrying Cops of Yarn, W. Hepworth-Collins, Bolton.
5068. Colouring Matters, T. R. Shillito.—(*J. R. Geigy and Co., Switzerland.*)
5069. Electric Incandescent Lamp, G. Bamberg, London.
5970. Clutches and Friction Brakes, F. H. Elliott, Aberystwith.
5071. Producing Steel Tools, C. W. Robinson, Glasgow.
5072. Assisting Combustion of Fires, W. B. Sothern, London.
5073. Fly-wheels and Anti-friction Bearings, W. J. Brewer, London.
5074. Buttons, E. Dance, Birmingham.
5075. Cigarettes, J. E. Evans-Jackson.—(*B. Baron, United States.*)
5076. Metallic Pulleys and Drums, C. H. Pugh, London.
5077. Cable Traction, G. F. Priestley and W. S. Bancroft, Halifax.
5078. Tube Bending, T. A. Woolldridge, Birmingham.
5079. "Sash Pocket" Chisel, F. W. Newman, London.
5080. Boots, P. R. J. Willis.—(*A. W. Brand and F. W. Metcalf, United States.*)
5081. Receptacles in Cabinets, E. S. Doré, London.
5082. Self-closing Comfort Chair, W. Nicholson, London.
5083. Hand Pump and Spray, A. J. Cusack. (*L. Decos, France.*)
5084. Self-oiling Journal Bearings, D. L. Altman, London.
5085. Mantle Protector for Incandescent Gas Light, M. W. Richardson-Bunbury and F. C. Drew, London.
5086. Harness, W. N. Carlisle and T. R. Barnett, London.
5087. Sulphide Ores, T. Parker and J. Pullman, London.
5088. Keys of Type-writing Machines, A. Hodgson, London.
5089. Eye-glasses, C. J. Bailey, London.
5090. Dyestuffs, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
5091. Clearing Incandescent Gas Burners from Dust, J. Moeller, London.
5092. Advertising, E. Böhm, London.
5093. Reversible Plough, G. E. Beddoes, London.
5094. Combined Sugar Tongs and Cutter, F. M. Martin, London.
5005. Sight-feed Lubricators, F. Bamford and W. Wadsworth, London.
5096. Spring Rings for Pistons, &c., W. Lockwood, London.
5097. Cistern for Drinking Water, T. Durrans, London.
5098. Electrolytic Processes, &c., G. B. Baldo, London.
5099. Brake Apparatus for Vehicles, H. Parker, London.
5100. Petroleum Lamps, C. Erber and Ungarische Metallwaaren und Lampenfabriks Aktien-Gesellschaft, London.
5101. Button for Wearing Apparel, A. Yole, Birmingham.
5102. Driving Gear for Velocipedes, G. M. Neighbour, London.
5103. Wick-tubes for Lamps, C. H. Gosling, London.
5104. Slider-boxes for Vestas, F. M. B. Bertram and G. Robinson, London.
5105. Spats, &c., F. A. Astor, London.
5106. Forming Rims for Wheels, H. Alvord, London.
5107. Can Openers, C. V. Zinn, London.
5108. Clothes-line Supports, J. B. Allen, London.
5109. Couches, R. Van Wicks, London.
5110. Cones for Water-closets, &c., S. T. Baster, London.
5111. Chaff Cutters, M. Pierce, London.
5112. Harvesters for Binding Sheafs, M. Pierce, London.
5113. Electro-plating Bath, S. Pitt.—(*W. B. Hollingshead, United States.*)
5114. Looms for Woven Fabrics, J. and H. De Lorge, London.
5115. Making-up of Packages, F. H. Fraser and W. J. Fraser and Co., London.
5116. Adjusting Devices, M. D. Rucker and F. C. Bryant, London.
5117. Batten Cleat for Ships' Holds, J. T. Oliver, London.
5118. Consolidated Fuel from Coal, H. C. B. Forester, London.
5119. Deodorising, &c., Mixture, W. Hanlon, London.
5120. Wheels for Vehicles, G. C. Marks.—(*C. Labbé, France.*)

7th March, 1896.

5121. Rouble Feather Renovator, M. R. Ruble and A. G. King, London.
5122. Fastening Pneumatic Tires, R. F. Chisholm, Birmingham.
5123. Extracting Gold, W. H. and R. Duncan, Shropshire.
5124. The Self-stopper, H. Coates, Manchester.
5125. Bottles to Prevent Refilling, D. A. Murdoch, Belfast.
5126. Multiple Stamping Hammer, F. Tremlett, Bristol.
5127. Steam Boiler Furnaces, C. Christmas, Birmingham.
5128. Pipe Unions for Hose Tubes, A. Sweetser, London.
5129. Altitude of Bodies, R. Scott, Newcastle-on-Tyne.
5130. Hat and other Pins, &c., J. A. Malan, Birmingham.
5131. Drive Chain, W. J. Fieldhouse, Birmingham.
5132. Mattress and Bedding, W. E. Clarke, Huddersfield.

5133. Separation of Oxygen from Air, L. Chapman, London.
5134. Obtaining Oxygen from Air, L. Chapman, London.
5135. Automatically Operating Cocks, L. Chapman, London.
5136. Gas Compressing Pumps, &c., L. Chapman, London.
5137. Merry-go-rounds, J. H. Blyth, Nottingham.
5138. Looms, W. T. Birchenough and A. Wood, Manchester.
5139. Picking Motions of Looms, G. Richardson, Manchester.
5140. Deep-sea Machine, C. M., H. S., and F. O. Mundahl, Newcastle-on-Tyne.
5141. Rails, N. de Gessler, London.
5142. Accord Zithers, J. Bröm, Glasgow.
5143. Driving Gear for Machinery, J. Parnall and Parnall and Sons, Bristol.
5144. Refrigerating Chambers, J. H. Spence, London.
5145. Bottles, O. Patterson, Glasgow.
5146. Apparatus for Throwing Life Lines, J. Murrie, Glasgow.
5147. Chimney Can, W. C. Faulds and G. B. Deas, Glasgow.
5148. Ascertaining Real Distances, G. Davis, Birmingham
5149. Woven Driving Belts, &c., J. C. Fisher, Manchester.
5150. Acetylene Gas Generator, J. F. Blakeley, near Dewsbury.
5151. Pistols, C. O. Ellis, E. W. Wilkinson, and F. Cashmore, London.
5152. Manufacture of Plate Springs, F. S. Bull, Sheffield.
5153. Printing, A. S. Young and W. Rumney and Co., Manchester.
5154. Laundry or Smoothing Irons, S. H. Eastburn, Manchester.
5155. Chairs for Joints of Rails, H. S. Knight, Teignmouth.
5156. Dyeing Skins, J. and H. Creamer, London.
5157. Paper-making Machines, &c., J. White, Glasgow.
5158. Looped Fabrics, H. A. Foster and R. Lee, Halifax.
5159. Cruet Stands, &c., C. T. Constantine, Birmingham.
5160. Manufacture of Gongs, E. Townshend, Birmingham.
5161. Prevention of Down Draughts, T. Smith, London.
5162. Self-acting Brake, J. H. Walton, London.
5163. Weaving Looms, W. T. and J. E. Wood, W. and J. H. Hall, and J. Thistlethwaithe, London.
5164. Shedding Motion of Looms, W. Thornton, London.
5165. Waste Salt, J. C. W. Stanley and A. W. Maxwell, London.
5166. Boiling Pans, J. C. W. Stanley and A. W. Maxwell, London.
5167. Dyeing Cotton, O. Imray.—(*The Society of Chemical Industry in Basle, Switzerland.*)
5168. Electrical Communication, A. C. Brown, R. Burn, and L. G. Tate, London.
5169. Apparatus for Superheating Steam, J. S. Booth, London.
5170. Spindles of Doubling Machinery, L. Hargreaves, London.
5171. Electric Arc Lamps, Electroliers, &c., B. R. Baker, London.
5172. Match Box Holder, D. Bridgeman-Metchim, London.
5173. Lifts, &c., H. C. Walker and C. W. Hildred, London.
5174. Apparatus for Preventing Accidents, L. Anidjah, London.
5175. Regulating Device for Boiling Pans, E. Hermann, London.
5176. Apparatus for Preventing Accidents, T. Marsden, Liverpool.
5177. Bolts for Doors, A. Hauck and H Kameke, Manchester.
5178. Locomotives, Tramcars, &c., E. Lever, Liverpool.
5179. Truss, T. Hilton, Manchester.
5180. Inflation of Pneumatic Tires, J. R. McKie, Liverpool.
5181. Tongs for Pickles, &c., J. Roberts, London.
5182. Valve, A. T. Thornthwaite, London.
5183. Holding Device for Lamp Glasses, J. L. MacLoughlin, London.
5184. Recovering Cyanides, G. P. Lewis and F. S. Cripps, London.
5185. Precipitation of Metals, R. T. Marshall and L. G. Attenborough, London.
5186. Preventing the Refilling of Bottles, H. E. Vipan, London.
5187. Stop Valves, E. Andersen and E. T. Fleron, London.
5188. Embossed Wall Paper, &c., W. Steadman, Glasgow.
5189. Attaching Twin Bedsteads, B. R. Peyton, London.
5190. Securing the Ends of Wire, &c., M. Voss, London.
5191. Electric Current Conductors, A. Petzenbürger, London.
5192. Revolvable Handles, Kuma, Ld. and S. B. Earle, London.
5193. A Lever Tool Appliance, &c., B. R. Peyton, London.
5194. Bunsen Burners, W. H. Wheatley.—(*C Schmid, Belgium.*)
5195. Production of Ozone, M. Otto, London.
5196. Explosive Motors, J. H. Richards, London.
5197. Purification of Saccharine Liquids, M. Otto, London.
5198. Fire Hose and like Couplings, A. E. Stove, London.
5199. Feeding Ruling Machines with Ink, F. Kirby, London.
5200. Collapsible Boxes, H. Norman, London.
5201. Valves for Rock Drills, T. E. Bickle, Plymouth.
5202. Steam Boiler, G. Goepel and J. Scheinhüttee, London.
5203. Igniting Devices for Gas Burners, A. Schwarzschild, London.
5204. Registering Apparatus, H. H. Lake.—(*H. Lange, Germany.*)
5205. Water-tube Steam Boilers, J. Simonis, London.
5206. Steam Generators, C. Pataky, London.

9th March, 1896.

207. Fire Grates, F. Rigby, Manchester.
5208. Head Lock for Bicycles, F. W. Doggett, Norwich.
5209. Collars for Personal Wear, W. H. J. Masding, Manchester.
5210. Window Fasteners, W. D. Pitt, London.
5211. Bottles, F. S. Willoughby and E. A. Edwards, Manchester.
5212. Paper Bag, W. C. Haigh, H. Luke, and R. McBurnie, Manchester.
5213. Steam Generators, H. Wilcke, Liverpool.
5214. Steam Traps, A. E. Jackson and J. P. Jackson, London.
5215. Stop Valve, J. C. Fountain and B. F. Schram, London.
5216. Fastening Tailboards of Wagons, S. W. Bell, London.
5217. Folding Hammock Supports, M. A. Bailey, London.
5218. Preserving Provisions, G. M. Keevil, Bath.
5219. Permanent Way for Railways, T. F. Cashin, London.
5220. Automatic Gas Meter Indicator, W. C. Warner, London.
5221. Shoes, H. S. Hadland, Bristol.
5222. Vacuum Tubes, D. Neale, London.
5223. Drying Bricks, J. Nash, Manchester.
5224. Fixing Points on Picks, &c., J. Barlow, Nottingham.
5225. Receiver, W. Hutchinson, Manchester.
5226. Mechanism for Quarrying Stone, J. Barrett, Keighley.
5227. Presses, F. Waite and Waite and Saville, Ld., Bradford.
5228. Using Water as a Prime Mover of Machinery, T. Burns, G. F. Addleshaw, and T. E. Hall, Newcastle-on-Tyne.
5229. Bedstead Joints, J. Whitehead, Birmingham.
5230. Castors, W. C. Morison, Birmingham.
5231. Liquid for Curling Hair, C. N. Walley, Manchester.
5232. Let-off Motions for Looms, R. Wilby, Huddersfield.
5233. Cycle Handles, H. Stone, Birmingham.
5234. Chimney Pots, J. H. Greenwood, Mansfield.
5235. Endless Rail, W. Gedney, Chesterfield.
5236. Opsimeter, T. C. Barfield, Leicester.
5237. Disinfecting and Deodorising Apparatus, J. T. Freestone, Liverpool.
5238. Metallic Squares, S. G. Edwards, Sheffield.
5239. Toy, J. B. Close, Sheffield.
5240. Toy Wheel, R. Dawson, Sheffield.
5241. Watches, J. Hawley, Birmingham.
5242. Button-hole for Shirt Fronts, L. W. Balck, London.
5243. Rests for Supporting Bicycles, J. Leach, Chorley.
5244. Tooth-brush Handles, G. F. Pierce and Warwick Bros., London.
5245. Bicycle Rest, T. Feran and W. J. Harley, Seaforth.
5246. Jewel Brass Polish, E. E. Edwards, Newport, Mon.
5247. Draught Muffle Furnace, J. R. Geith, Berlin.
5248. Internal Sectional Stoppers, G. Rydill, Sheffield.
5249. Drawing Boards, S. R. Mundell, Leeds.
5250. Self-threading Sewing Machine Needle, J. Gasson, Redhill.
5251. Cycle Handles, J. M. Gell, London.
5252. Securing of Bee Swarms, J. Sewell, Knaresbrough.
5253. Electro-deposition of Metals, S. O. Cowper-Coles, London.
5254. Machinery for Making Nails, O. E. Lewis, London.
5255. Clamp for Tailors' Patterns, G. E. Stanfield, London.
5256. Automatic Ignition Box, M. Robinson, Newcastle-on-Tyne.
5257. Syphon Flushing Cisterns, J. P. O'Donnell, London.
5258. Copying Apparatus, F. W. Zimer, London.
5259. Shoes, B. M. Tregaskes, London.
5260. Reduction of Refractory Ores, F. Ellershausen, London.
5261. Valve for Compressed Air Bags, J. Dormer, London.
5262. Carriers for Cash Checks, &c., H. A. Wheat, London.
5263. Electro-plating of Wood, H. A. V. Wirth, London.
5264. Toilet Requisite, A. P. A. Fincher and C. W. Burleigh, London.
5265. Manufacture of Armour Plates, J. H. Dickinson, London.
5266. Closing of Canisters, Boxes, &c., H. Mardon, London.
5267. Splint or Fracture Box, &c., T. G. Light, London.
5268. Colouring Matters, O. Imray.—(*The Society of Chemical Industry in Basle, Switzerland.*)
5269. Dog Muzzles, C. H. Lorberg, London.
5270. Glue-pots and Analogous Vessels, W. Wilson, London.
5271. Chair Bedstead, G. Stoermer, London.
5272. Combs, P. Schulz, London.
5273. Preservation of Tobacco, F. Hancock, Liverpool.
5274. Metals, A. S., T. A., R. J., and S. Smith, and T. Deakin, Birmingham.
5275. Applying Starch to Fabrics, W. A. E. Henrici, London.
5276. Pedals for Cycles and other Vehicles, R. W. Smith, Birmingham.
5277. Gas Control for Explosive Gas Motor, W. Donaldson, London.
5278. Machinery for Cutting Coal, C. W. Atkinson, London.
5279. Utilisation of Acetylene Gas, G. Ragot, London.
5280. Gulleys, W. J. Jennings, London.
5281. Traps, W. J. Jennings, London.
5282. Vehicle Shafts, W. A. Bromwich and C. A. Floyd, London.
5283. Tube, H. S. Ward, London.
5284. Beetling Machines, A. A. Whitley, London.
5285. Webs for Carrying Tea Leaf, W. Jackson, London.
5286. Women's Jackets or Coats, M. Frentzel, London.
5287. Feeding Boilers, T. A. Sergeant and G. Beck, London.
5288. Dress Fasteners, A. A. Wright, London.
5289. Pumps, S. B. Bamford, London.
5290. Pipes, J. M. Jacobs.—(*W. B. Haas and Co., France.*)
5291. Manufacture of Gas, A. Kitson, London.
5292. Locks, A. Karlik and F. Dworschak, London.
5293. Manufacture of Methyl Aldehyde, W. Gray, London.
5294. Seats for Velocipedes, H. J. B. Kendall, London.
5295. Lamps, J. A. Seaverns, London.
5296. Ammunition, W. Hope, London.
5297. Saddles for Bicycles, H. T. and F. T. Maw, London.
5298. Flash-light, Apparatus, A. J. Boult.—(*W. Bruns, United States.*)
5299. Screw-drivers, J. Reece, London.
5300. Slugging Machines, J. H. Southcott and J. Florey, London.
5301. Umbrellas, Parasols, &c., C. A. Markham, London.
5302. Catches for Retaining Handles, W. K. Birkinshaw, London.
5303. Bird Drinking Fountain, J. Popperwell, London.
5304. Cooling Serpentine with Dropping-tubes, J. H. Köhler, Berlin.
5305. Saddles, C. Szameitat, Hamburg.
5306. Preventing Glow-bodies being Damaged, F. A. F. Graefe, Hamburg.

10th March, 1896.

5307. Safety Gear for Colliery Cages, G. C. A. Dunnicliffe, Derby.
5308. Attachment for Saucepans, G. C. A. Dunnicliffe, Derby.
5309. Joints of Drain Pipes, &c., J. T. Briscoe, Enfield.
5310. Water-closet Apparatus, &c., J. Hulse, Cheshire.
5311. Fastening Parts of Cycles, A. E. Evans, Coventry.
5312. Covering Horticultural Houses, H. C. Board, Bristol.
5313. Boilers, W. N. Dack, Manchester.
5314. Insoles, R. Thomalla, Manchester.
5315. Electrically Dispatching Parcels, E. H. Seddon, Manchester.
5316. Cycle Gear Cases, W. H. Higgitt and W. Crowson, Birmingham.
5317. Boats' Booms and Lashings, W. Bell, Glasgow.
5318. Piano, A. Horobin, Colwyn Bay.
5319. Balls Used in the Game of Golf, W. L. Bullows, Birmingham.
5320. Attaching Terminal Wires, I. H. Parsons, Leicester.
5321. Steam Engines, G. Bendler, Glasgow.
5322. Water Gauge Glasses, J. A. and S. Fletcher, Manchester.
5323. Lubrication of Machinery, G. B. Goodfellow and E. A. Pickup, Manchester.
5324. Bridle Bits, J. Wedge, sen., J. Wedge, jun., and D. Wedge, Wolverhampton.
5325. Bridle Bits, A. Dewsbury, Wolverhampton.
5326. Rudders, W. Fairweather.—(*J. Ramsay, South America.*)
5327. Metallic Bale Coverings, M. A. Heath, Glasgow.
5328. Valves, C. W. Weiss and A. Meitz, London.
5329. Catches for Cages, R. Ashurst, Wigan.
5330. Moving Minerals, T. Wrigley, Todmorden.
5331. Working Friction Clutches, J. Atterton, Haverhill.
5332. Stoppers for Bottles and Jars, R. W. Rundle, London.
5333. Ventilating Ships, W. C. Morison, Birmingham.
5334. Measuring Apparatus for Liquors, H. J. S. Cross, Jersey.
5335. Imitation of Stained Glass, N. Macphail, Glasgow.
5336. Increasing Illuminating Power of Gas, R. Lavender and W. Tice, London.
5337. Handles for Metal Dish Covers, S. Worrall, Sheffield.
5338. Gear Cases for Cycles, G. E. Mansell, Birmingham.
5339. Rims and Guards of Wheels, W. H. Barton, Coventry.
5340. Photographic Camera Shutters, E. S. B. Hughes, Glasgow.
5341. Home Trainer, C. M. Farrow, Glasgow.
5342. Candlesticks or Candle Holders, W. F. Fletcher, Birmingham.
5343. Fire-escape, W. Grosvenor-Bradley, Manchester.
5344. Change of Development in Cycles, J. Bénazet, Brussels.
5345. Gramme Ring Armatures, R. Holiday and J. Freeman, Barnsley.
5246 Metal Surfacing Tools, F. H. Payne, London.
5347. Mirrors, F. Restall, London.
5348. Paper Fasteners, J. Hewitt and F. R. Baker, London.
5349. "Brillium," G. F. Pierce and Warrick Bros., London.
5350. Key-hole Guide, R. P. Cato, Birkenhead.
5351. Parlour Games, T. Thompson, London.
5352. Imitation Football, T. Thompson, London.
5353. Stone-sawing Machinery, G. and J. Rushworth, London.
5354. Indoor Games, A. C. Douse and E. Bailey, Nottingham.
5355. Cigar Holders, A. M. Hogg and J. C. T. Murray, London.
5356. Door Handles, H. Kerr, Glasgow.
5357. Machines for Topping, &c., Turnips, P. Allan, Glasgow.
5358. Treating Low Qualities of Iron, L. Pszczolka, London.
5359. Envelope Opener, H. J. Watts, M. T. Gameson, and W. Haslam, London.
5360. Ankle Supports for Skates, &c., B. A. Dorst, London.
5361. Chest Expander, E. Thomson, London.
5362. New Game of Lawn Trapette, W. J. Barrat, London.
5363. Apparatus for Rolling Cigarettes, S. P. Rose, London.
5364. Tires and Rims of Cycle Wheels, M. F. Hutton, London.
5365. Duplicate Safety Balloon, H. E. Robinson, London.
5366. Pulley for Roller Blinds, W. and J. T. Timmins, London.
5367. Centrifugal Churns, E. Fugeman, London.
5368. Incandescent Gas Burners, J. H. H. Duncan, London.
5369. Umbrellas and Walking Sticks, L. Clement, London.
5370. Sewing Machines, H. H. Lake.—(*F. W. Whitcher, United States.*)
5371. Spinning Machines, F. S. Culver, London.
5372. Advertising Devices, H. H. Lake.—(*T. G. Daly and N. Estevez, United States.*)
5373. Spike, T. McCherry, London.
5374. Brake Shoes, W. D. Sargent, London.
5375. Apparatus for Generating Gas, E. T. Turney, London.
5376. Cotton Openers, H. S. Houghton, London.
5377. Football Cases or Covers, W. K. Reid, London.
5378. Securing Cycle Lamps to their Brackets, A. J. Simpson, Birmingham.
5379. Transparent Drawing Plate, &c., G. Davis, Birmingham.
5380. Incinerators, W. Defries and V. I. Feeny, London.
5381. Disinfecting, &c., Sewage Matter, P. O Dowd, London.
5382. Safety Bit for Stopping Horses, &c., G. Nobes, London.
5383. Spray Producer, G. Nobes, London.
5384. Engines, R. D. Knight, London.
5385. Method of Making Cigarettes, L. H. Sondheim, London.
5386. Building Bricks, O. Kleinberger, London.
5387. Candle Holders, T. Woof, London.
5388. Chaff Cutters, E. E. Bentall, London.
5389. Call System for Use with Autographic Telegraph Apparatus, H. F. Jackson.—(*H. Etheridge, United States.*)
5390. Skirt Supporting Device for Lady Cyclists, F. B. Shuttleworth, London.
5391. Apparatus for Heating Water, H. McPhail, London.
5392. Producing Moire on Ready-woven Fabrics, O. Pastor, London.
5393. Generation of Motive Power, C. Guattari and The Guattari Power Syndicate, London.
5394. Velocipede Saddles, J. V. Pugh, London.
5395. Coating and Colouring Pins, J. B. Finnemore, London.
5396. Hydrants, &c., E. Hochedez and T. Faivre, London.
5397. Artificial Leg, H. Heinecke and B. Herting, London.
5398. Weighing, &c., Machine, W. H. Doble and G. W. Watson, London.
5399. Weighing, &c., Machine, W. H. Doble and G. W. Watson, London.
5400. Fire-extinguishers, W. P. Thompson.—(*W. J. Herron, United States.*
5401. Boxes for Postal Purposes, W. P. Thompson.—(*E. Blanco, Italy.*)
5402. Stencils for Painting, &c., L. Hintz, London.
5403. Draw-plate Ovens, J. Horton and W. Price, Manchester.
5404. Chimney Tops, J. Walker, Liverpool.
5405. Pneumatic Tires, W. Hughes and A. Royle, Liverpool.
5406. Manufacture of Corsets, T. W. Wyatt and J. H. Smith, London.
5407. Process for Preserving Eggs, O. Leupold, Liverpool.
5408. Telegraphic Relays, W. S. Smith and W. P. Granville, London.
5409. Furnaces, S. Pitt.—(*La Compagnie Internationale des Procédés Adolphe Seigle, France.*)
5410. Shafts for Carriages, &c., M. F. J. Willemin, London.
5411. Artificial Skins, F. C. Tussaud, London.
5412. Telephones, T. McKenna.—(*H. L. Webb, United States.*)
5413. Disinfecting Clothing, W. J. Frazer and Co. and L. McG. Frazer, London.
5414. Preventing Railway Accidents, H. Biermann, London
5415. Projecting Serpentines, A. J. Boult.—(*C. Brünot,————*)
5416. Strainers, W. Tyree, London.
5417. Copying Maps and Drawings by Hand, W. Tyree, London.
5418. Curtains, W. Tyree, London.
5119. Shearing Machines, W. Tyree.—(*J. Sands, Australia.*)
5420 Supporting Articles, W. Tyree.—(*W. Bartlett, Australia.*)
5421. Bedsteads, W. Tyree.—(*J. F. Stephenson, Australia.*)
5422. Washers for Bottle Stoppers, C. H. Gray, London.

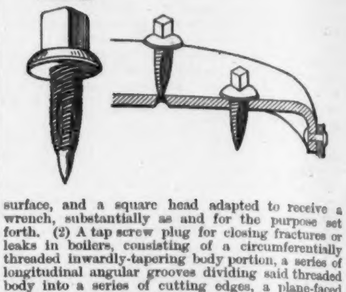
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

551,354. Tap Screw Plug, *J. Lee, Plymouth, Pa.—Filed May 31st*, 1895.

Claim.—(1) A tap screw plug for closing fractures or leaks in boilers, consisting of a circumferentially threaded inwardly tapering body portion, a series of longitudinal, angular grooves dividing said threaded body into a series of cutting edges, a plane-faced pointed inner end, a circumferential cap near its outer end having a flat under face and a convex upper surface, and a square head adapted to receive a wrench, substantially as and for the purpose set forth. (2) A tap screw plug for closing fractures or leaks in boilers, consisting of a circumferentially threaded inwardly-tapering body portion, a series of longitudinal angular grooves dividing said threaded body into a series of cutting edges, a plane-faced pointed inner end, and a circumferential cap at its outer portion, substantially as and for the purpose set forth.

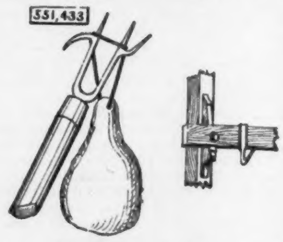
551,354



551,433. Lifting Fork, *E. A. Cozens, Toledo, Ohio.—Filed August 10th*, 1895.

Claim.—A lifting fork, comprising the handle, a two-pronged fork secured thereto, a branch projecting forwardly from one of said prongs, and a rearwardly curved branch projecting from the other of said prongs, said prongs and said branches lying substantially in the same plane, substantially as and for the purpose specified.

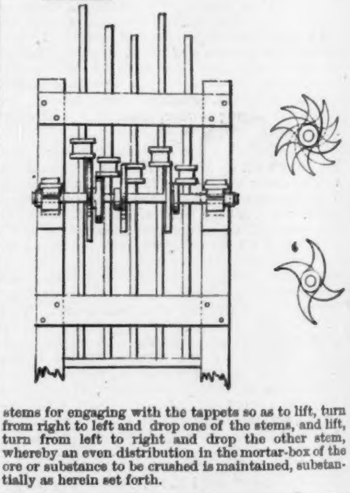
551,433



551,449. Stamp Battery, *C. Raleigh, Johannesburg, South African Republic.—Filed June 25th*, 1892.

Claim.—In a stamp battery or crushing mill, the combination, with two stamp stems and tappets mounted thereon, of a double cam between the two stems for engaging with the tappets so as to lift, turn from right to left and drop one of the stems, and lift, turn from left to right and drop the other stem, whereby an even distribution in the mortar-box of the ore or substance to be crushed is maintained, substantially as herein set forth.

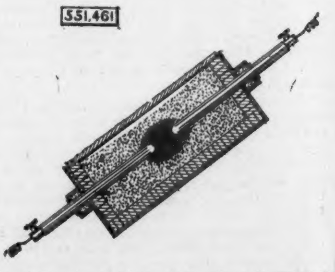
551,449



551,461. Art of Producing Carbide of Calcium, *W. C. Clarke, New York, N.Y.—Filed April 29th*, 1895.

Claim.—The hereinbefore described process of making carbide of calcium, which consists in causing current to pass between horizontally disposed electrodes, embedded in a mass of pulverised and intimately commingled lime and carbon, of such extent that a material proportion thereof will remain undecomposed by the passage of the current and gradually separating the electrodes as the material between them is reduced, so as to produce between the electrodes a body of the carbide surrounded by an undecomposed mass of the pulverulent mixture.

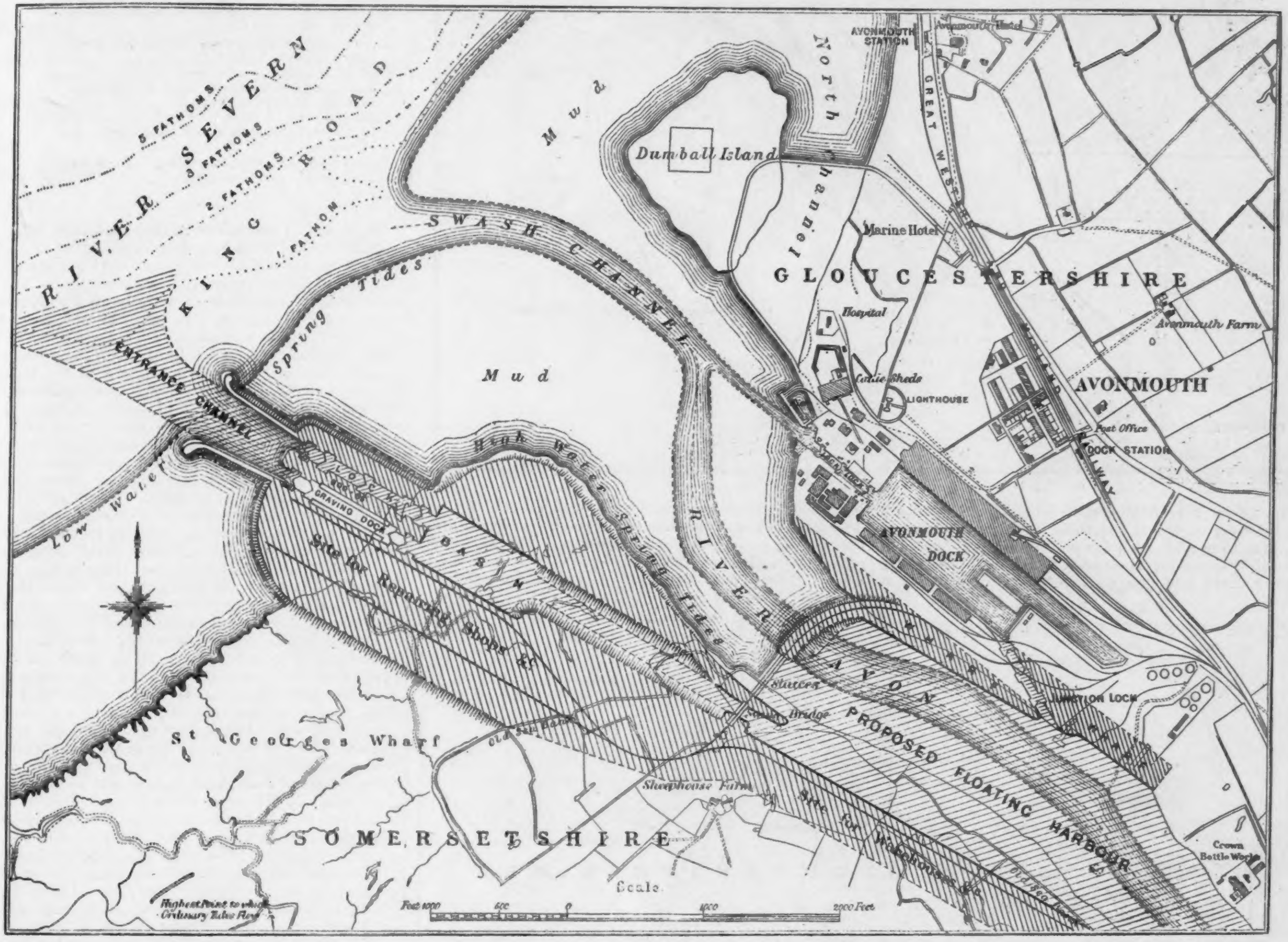
551,461



THE PROBLEM OF BRISTOL DOCKS.

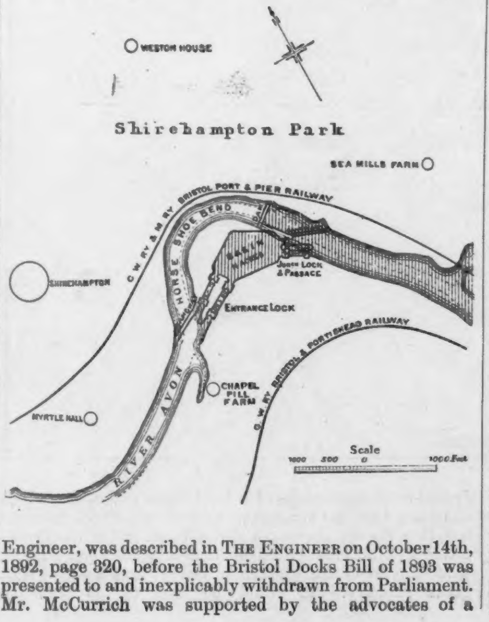
DOCKISATION OF THE AVON.

THE question still, and for many years past, pressing upon the Bristol Corporation raises problems on which one eminent engineer after another in long succession has been called upon for an advisory report; and this by no means because of want of competence or lack of confidence in Mr. J. M. McCurrich, the present Docks Engineer, or either of his distinguished predecessors. The fact is that Bristol is endeavouring to reconcile the difficulties of its position as an inland riverside town with the changed conditions of a seaborne international trade, in which the vessels are yearly increasing in size, and demanding more than ever prompt facilities for loading and discharge. One of the oldest ports in our islands, and still a thriving and expanding city, it has, relatively speaking, found itself further and further removed from free access to the ocean highways of the world. The competition of Liverpool, the vigorous and more recent efforts of Southampton, the strenuous energies of Cardiff and the neighbouring ports on the Welsh coast, have told seriously upon the whilom supremacy of Bristol in the traffic of the Western Seas. The craft bearing the argosies which used to enrich Bristol merchants must have increased fourfold in dimensions since the port authorities first began to discover that younger rivals were forging ahead at its expense. Here were sailing vessels of from 3000 to 4000 tons carrying corn from North Pacific ports, and steamers of even larger tonnage bringing over other food stuffs from Argentina, Australia, or New York. The slight and tortuous river presented them with a constant danger when its water level did not impose an impossibility. The risk of sending a laden vessel round the Horseshoe Bend of the Avon shall be left to the appraisement of the members of Lloyd's; the impracticability of towing up a large corn-laden ship is proven by current experience, as well as admitted by the engineering reports. What, then, was Bristol to do? Should the agents of commerce in the city remove themselves and their merchandise nearer to the sea? Or should the City Fathers in their wisdom cause the sea to be brought into closer proximity to their ancient wharves and warehouses? In the latter case they would have had the example of Manchester to guide them; and that cannot yet be said to be altogether encouraging. As to transporting the traffic to the borders of the sea, the experiments made by the Docks Committee in building or acquiring the docks at Avonmouth and Portishead seemed to bid the boldest of the old school of merchant adventurers to hesitate and beware.


RIVER SEVERN
KING ROAD
5 FATHOMS
3 FATHOMS
2 FATHOMS
1 FATHOM
Mud
SWASH CHANNEL
Spring Tides
Dumball Island
North Channel
ENTRANCE CHANNEL
Low Water
High Water Spring Tides
RIVER AVON
Site for Repairing Shops &c
GRAVING DOCK
Sluices
Bridge
St Georges Wharf
Sheephouse Farm
PROPOSED FLOATING HARBOUR
Site for Warehouses &c
Old Sea Bank
SOMERSETSHIRE
GLOUCESTERSHIRE
AVONMOUTH STATION
Avonmouth Hotel
GREAT WESTERN RAILWAY
Marine Hotel
Hospital
Cattle Sheds
LIGHTHOUSE
AVONMOUTH
Avonmouth Farm
Post Office
DOCK STATION
AVONMOUTH DOCK
JUNCTION LOCK
Crown Bottle Works
Highest Point to which Ordinary Tides Flow
Scale
Feet 1000
500
0
1000
2000 Feet

Between these two issues rests the rock on which the Bristol Corporation appears to be splitting, and yet these are issues on which the future welfare of the town must undoubtedly largely depend. The prosperity of Bristol is quite as much a matter of national concern as the prosperity of our own metropolis, or Glasgow, Manchester, and Liverpool. An old port which sent out Sebastian Cabot on his productive cruise, an immemorial river which was a haven for trade while most of our other ports were in their infancy, become points of quite sentimental interest at a moment when engineering science is called in to refit it, so to say, for the exacting requirements of to-day. But it is there, and on that sympathetic point, that the chief difficulty unpleasantly obtrudes itself. Bristol, at large, wants to maintain its old reputation, and resume the position in which it could distance or outrival its younger compeers. Bristol, in its dock-side community, has an idea that it would not be prudent to let its centre of commercial gravity be disturbed by an extension of its dock and wharfage accommodation towards the mouth of the river. One party is demanding the dockisation of the Avon, which would involve its dredging and straightening—to place it on a level with the approaches to the docks on the Mersey and Southampton Water. The other party desires to keep the trade concentrated in its present headquarters, on the higher reaches of the Avon, which most of us know as the site of the Bristol Docks. Both sides, one would like to assume, represent an equal amount of intelligence and an equal degree of the trading instinct. There, however, they have been at it, hammer and tongs, intermittently for a generation of normal life. There they are at it now, the Little-endians against the Big-endians. The commercial side of the controversy may be left to settle itself in the locality in which it arises. It is where the commercial men cannot agree that they have had to call in the advice of an expert engineer.

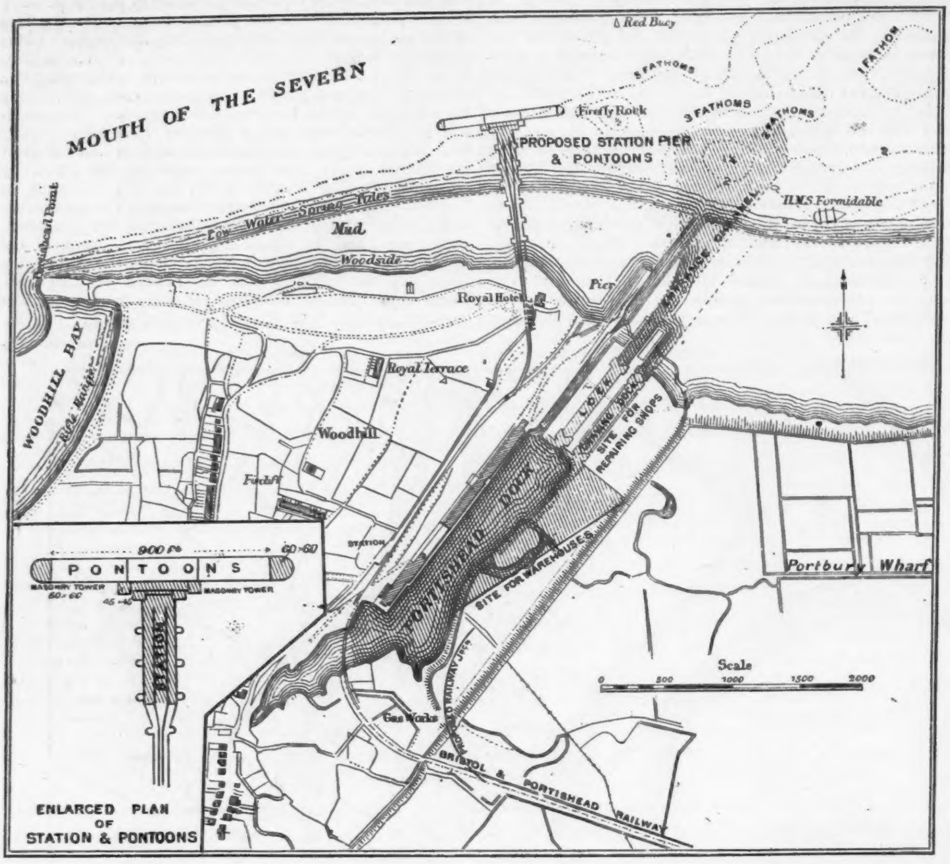
The original plan of Mr. McCurrich, the resident Docks Engineer, was described in THE ENGINEER on October 14th, 1892, page 320, before the Bristol Docks Bill of 1893 was presented to and inexplicably withdrawn from Parliament. Mr. McCurrich was supported by the advocates of a Greater Bristol. His scheme was opposed by an older fashioned set, on the ground that it would entail too vast an expense. It was under these circumstances that Mr. Wolfe Barry, C.B., was called into council, and given practically a free hand to criticise, amend, and generally advise. At the outset it has to be noted that his elaborate and instructive report, a summary of which we have already published, cuts the ground from under the feet of the gentlemen who condemned Mr. McCurrich's plans as too extravagant for immediate needs. He shows that if the Dock Engineer erred, it was in underrating the obstacles that would have to be encountered, and making his estimates out on too economical a scale. The proposals Mr. Wolfe Barry had to consider were substantially four, which may be stated in the ascending order of their importance:—(1) The improvement of the Avon by straightening and deepening it; (2) the extension of Avonmouth Dock; (3) the improvement of the approaches and enlargement of Portishead Dock, on the Somersetshire bank; and (4), which is probably the crux of the whole controversy, the plan of dockising the Avon at a point near its junction with the Severn at King-road. There is no need to compare Mr. Barry's statement of approximate cost with that of Mr. McCurrich. For the purpose of this article it is sufficient to take out Mr. Barry's figures, based upon surveys and calculations which seem to have been exhaustive :—

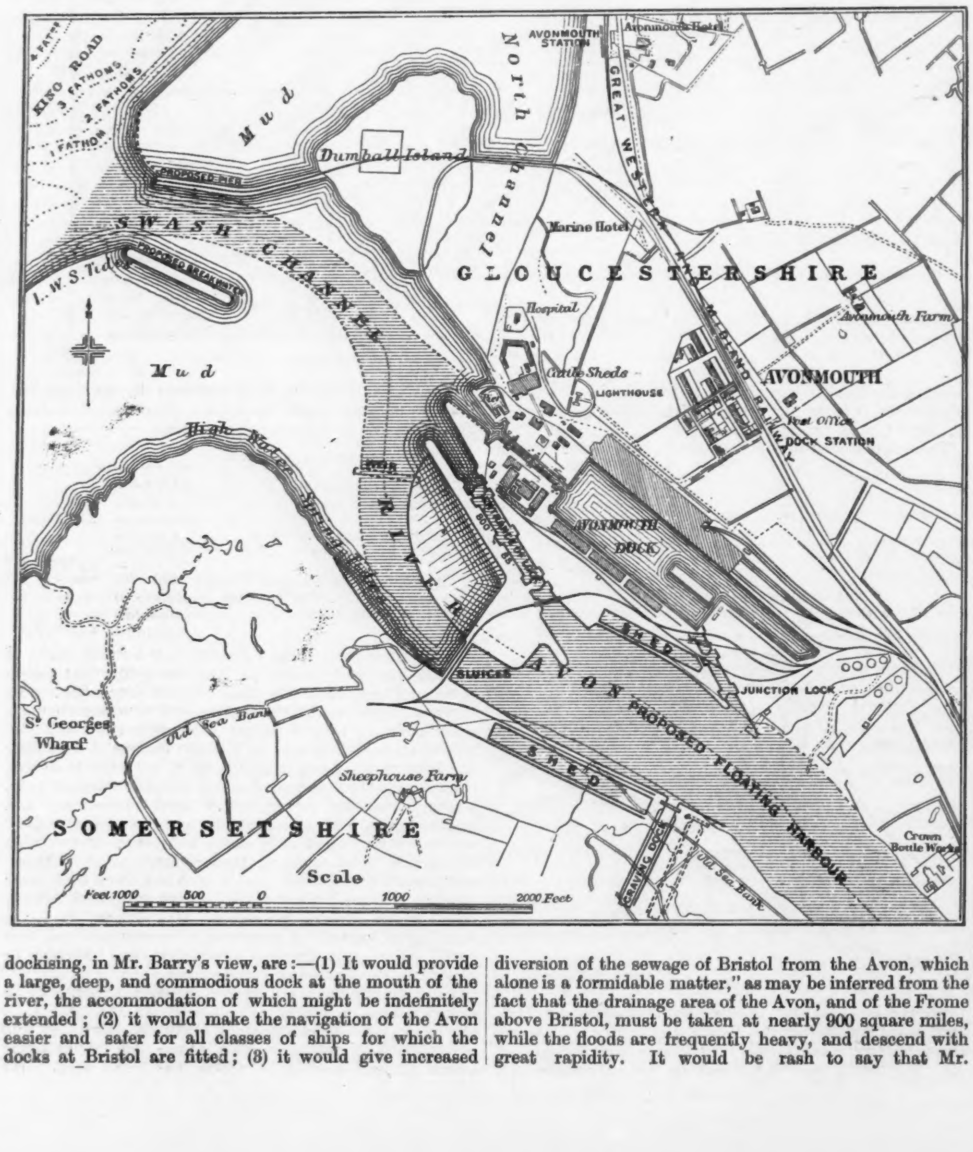

WESTON HOUSE
Shirehampton Park
SEA MILLS FARM
BRISTOL PORT & PIER RAILWAY
HORSE SHOE BEND
BASIN
JUNCTION LOCK & PASSAGE
ENTRANCE LOCK
SHIREHAMPTON
G. W. RY & M. RY
BRISTOL & PORTISHEAD RAILWAY
CHAPEL PILL FARM
MYRTLE HALL
RIVER AVON
Scale
1000 500 0 1000 Feet

Avon improvements—alternative schemes	£93,000 or £140,000	
New dock at Avonmouth	£1,308,000	
Pier at Firefly Rock	£320,000	
		£1,628,000
Improvements at Portishead ...	£852,000	
Pier at Firefly Rock	£320,000	
		£1,172,000
Dockisation—St. George's Wharf scheme	£2,580,000	
Pier at Firefly Rock	£320,000	
		£2,900,000

But in either case these estimates are not inclusive of all the necessary costs of improving the navigation between Bristol and the sea. Mr. Barry adds: "In addition to the works themselves, and whether they are undertaken or not, I should strongly recommend the immediate installation of an efficient system of signalling and lighting the Avon generally, so as to bring it in this respect up to the standard of such a navigation as the Clyde, where vessels are never out of sight of beacons and leading lights, and can navigate with as great facility and security by night as by day. I am much struck with the almost total want of these conveniences between Avonmouth and Bristol, and cannot but think that their absence is a great drawback to the geographical advantages which Bristol possesses. Gas buoys, or small fixed lights, served by reservoirs of compressed gas, are easily and cheaply provided now-a-days, and I venture to urge their early adoption on the river Avon."

Undoubtedly the most important part of Mr. Barry's report is that in which he deals with the Dockisation of the river, and in connection therewith discusses the possibilities and requirements of a profitable Transatlantic passenger and mercantile traffic to Bristol port. He


MOUTH OF THE SEVERN
Red Buoy
3 FATHOMS
1 FATHOM
Firefly Rock
3 FATHOMS
2 FATHOMS
PROPOSED STATION PIER & PONTOONS
H.M.S. Formidable
Portishead Point
Low Water Spring Tides
Mud
Woodside
ENTRANCE CHANNEL
Pier
Royal Hotel
WOODHILL BAY
Rifle Range
Royal Terrace
Woodhill
Firclift
LOCK
GRAVING DOCK
SITE FOR REPAIRING SHOPS
PORTISHEAD DOCK
SITE FOR WAREHOUSES
STATION
Portbury Wharf
Gas Works
BRISTOL & PORTISHEAD RAILWAY
Scale
0
500
1000
1500
2000
900 ft
60×60
PONTOONS
MASONRY TOWER
60×60
45×45
MASONRY TOWER
STATION
ENLARGED PLAN OF STATION & PONTOONS


4 FATHOMS
KING ROAD
3 FATHOMS
2 FATHOMS
1 FATHOM
Mud
Dumball Island
PROPOSED PIER
SWASH CHANNEL
L. W. S. Tides
PROPOSED BREAKWATER
North Channel
AVONMOUTH STATION
Avonmouth Hotel
GREAT WESTERN AND MIDLAND RAILWAY
Marine Hotel
GLOUCESTERSHIRE
Hospital
Avonmouth Farm
Cattle Sheds
LIGHTHOUSE
AVONMOUTH
Post Office
DOCK STATION
Mud
High Water Spring Tides
RIVER
ENTRANCE LOCK
800 × 85
AVONMOUTH DOCK
SHED
SLUICES
AVON PROPOSED FLOATING HARBOUR
JUNCTION LOCK
St Georges Wharf
Old Sea Bank
Sheephouse Farm
SHED
SOMERSETSHIRE
GRAVING DOCK
Old Sea Bank
Crown Bottle Works
Scale
Feet 1000
500
0
1000
2000 Feet

says, positively enough, that it is impossible "by any extension of dock accommodation at Bristol itself to provide there for such large vessels as would be required for the service. If the river were not dockised, but merely deepened and improved in respect of curves, the tidal access would still involve too much risk to large vessels to render such a scheme practicable. If, on the other hand, the river were dockised, there would be no object in attempting to provide adequate accommodation for them at Bristol by expending large sums of money in improving the town docks and quays there." The advantages of dockising, in Mr. Barry's view, are:—(1) It would provide a large, deep, and commodious dock at the mouth of the river, the accommodation of which might be indefinitely extended; (2) it would make the navigation of the Avon easier and safer for all classes of ships for which the docks at Bristol are fitted; (3) it would give increased value to much of the land bordering on the river, though of course the amount of increase would depend entirely upon the question whether and to what extent trade would be developed by the execution of the work; and (4) the dockised river could be connected with Avonmouth Dock. so that the dock would have another and improved entrance to the Severn, which would be very desirable in view of the fact that Avonmouth Dock is now entirely dependent upon one entrance. But Mr. Barry adds:—"On the other hand, dockisation would be a very costly undertaking in itself, and would entail the diversion of the sewage of Bristol from the Avon, which alone is a formidable matter," as may be inferred from the fact that the drainage area of the Avon, and of the Frome above Bristol, must be taken at nearly 900 square miles, while the floods are frequently heavy, and descend with great rapidity. It would be rash to say that Mr. Wolfe Barry urges the dockisation project; but he shows more clearly perhaps than Mr. McCurrich that the objections to it relate mainly to expense, and not to engineering difficulties in the way of disposing of sewage and flood waters, or by reason of damage to the King-road anchorage through impounding or diverting the flushing forces of the stream. His proposal—shown on the accompanying plan No. 1—differs from that of Mr. McCurrich in selecting another site near St. George's Wharf for the proposed dam and sluice, because it would give a better foundation for masonry and the rest of the engineering works. The distance from the entrance lock to the two-fathom line of the Severn on the substituted plan would be 700 yards, or less than half the distance of the lock proposed by Mr. McCurrich, and the quay frontage could be made 6600ft. instead of 3700ft., at a moderate additional cost. The lock would be 85ft. wide and 800ft. in length, with 36ft. depth of water at high-water of neap tides. A dry dock Mr. Barry insists on as an essential part of the undertaking, and that could be used as a second entrance in case of emergency. A second lock, though too small for Atlantic liners—it is 450ft. by 62ft.—is already provided by means of the existing dock at Avonmouth. We have given Mr. Barry's general statement of the cost of dockising the Avon, and here are the details of his calculation:—

Cost of the works mentioned, at the St. George's Wharf site	£1,490,000
Railway lines, minor river improvements, sheds, cranes, land, and buildings...	190,000
Cost of sewerage works, provision for Frome floods, and additional accommodation at Bristol, as in Mr. McCurrich's report	700,000
Capitalised cost of dealing with floods and working the sluices, together with repairs and depreciation, say	100,000
Sundry expenses, superintendence, engineering, Parliamentary expenses, &c.	100,000
	£2,580,000

There was an alternative and less ambitious scheme propounded by the Dock Engineer in his report of April last year. That was to construct a basin and locks at the Horseshoe Bend, and is illustrated in our sketch map No. 2. It would give a basin of eleven acres in area, with two locks 400ft. and 500ft. long, by 70ft. and 90ft. wide respectively, the gates pointing upwards and downwards on the river; while another lock 300ft. long by 70ft. wide, with a passage 80ft. wide at the upper end of the basin, was to have been constructed on the land enclosed by the Horseshoe Bend. The cost of this work was put down by Mr. McCurrich at £700,000, exclusive of the graving dock which Mr. Barry regards as a necessary complement of any of the schemes; and the estimate, moreover, did not provide for the diversion of sewage or additional accommodation at Bristol town, which items Mr. Barry thinks would involve an additional £350,000. On this scheme it must suffice to quote the opinion of the expert, that "the work would be an expensive undertaking for comparatively limited results. Even if there were no elements of cost to be considered, I do not think," says Mr. Barry, "that the advantages of this proposal outweigh its disadvantages, and I cannot recommend it for adoption."

Then it is Dockisation, or what? Mr. Barry's report enters minutely into the competing claims of the supporters of dock extension on the Gloucestershire and Somersetshire shores at the embouchure of the river. Each project, he declares, is practicable; it is chiefly a question of cost. Of the two his preference inclines to Portishead. "If any works are to be undertaken for the use of Atlantic liners, it seems to me that the proposed enlargement of Portishead dock should be selected rather than either of the more expensive projects." The proposed entrance lock at Portishead would be only 430 yards from the two-fathom line, 700ft. long by 85ft. wide; and a graving dock could be made alongside the lock to serve as a second entrance in case of need. Being in close propinquity to the Firefly rock, Mr. Barry observes, "Atlantic liners would be able to go in and out of the dock with a minimum amount of trouble or interference to shipping, which in itself would be a great recommendation." The approximate costs of the works at Portishead, described in detail, are:—

Extension and improvement of dock, including graving dock	£687,000
Roads, railways, cranes, sheds, land, and buildings	100,000
Sundry expenses, superintendence, engineering, parliamentary expenses, &c. &c.	65,000
	£852,000

or, with £320,000 for the pier at Firefly rock, £1,172,000. Moreover, at what Mr. Barry calls "a moderate cost," the sills of the Portishead dock could be placed on a lower level by 5ft. than those at Avonmouth, with greater probability of making and maintaining the entrance channel. The annexed plan, No. 3, explains Mr. Barry's views of the works required in the case of Portishead. It remains to be seen what Bristol will do in the future as the result of the mass of useful engineering knowledge and suggestions the old port has elicited from the highest authorities, among whom Mr. Wolfe Barry is the last. For the present, the City Council has contented itself with adopting the least of Mr. Barry's proposals in voting for river improvement works at a cost not to exceed £93,000, which leaves the problem of the port very much where it was before Mr. Barry was consulted.

The Hull and District Institute of Engineers and Naval Architects.—At the last meeting of this Institution, Mr. F. Somerscales, of Earle's Shipbuilding and Engineering Company, read a paper, entitled "Ships' Cabins and their Fittings," Mr. F. H. Pearson, president, in the chair. The various designs and details of construction of ships' cabins and saloons, both above and below deck, were explained and illustrated, with the reasons for each method of construction and its attendant advantages and disadvantages. Attention was directed to the practical difficulties experienced in obtaining a satisfactory design when viewed from an architectural standpoint.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE 37th annual session of the Institute of Naval Architects began on Wednesday, in the hall of the Society of Arts, John-street, Adelphi. There was an exellent attendance. The new President, the Earl of Hopetoun, occupied the chair. After the usual formal business had been transacted, Mr. Holmes, the Secretary, read the report of the Council for 1895-96. The finances of the Institution are in a satisfactory state. Much of the report is taken up with an account of the visit of the Institution last summer to Paris. We learn that the Council have received a cordial invitation from the President of the Chamber of Commerce of Hamburg, acting on behalf of a committee representing the government of the city and all its most important corporations, to hold the next summer meetings of the Institution in that important port and its neighbourhood. Encouraged by the success of their first visit outside the British Isles, the Council have accepted this invitation. The meetings will be held in the month of June, and full particulars will be published at as early a date as possible.

At the close of the Paris meeting, Lord Brassey, to the great regret of the Council, resigned the office of President of the Institution, as he was about to leave the country to take up the Governorship of Victoria. Acting under bye-law 41, the Council elected the Earl of Hopetoun, G.C.M.G., as President of the Institution till the close of the annual general meeting, and now proposed him for election as President by the members. Lord Hopetoun preceded Lord Brassey in the Governorship of Victoria. He is Paymaster-General, and represents the Admiralty in the House of Lords in the present Government. Like his predecessor in the chair, he is well qualified, both by his experience and by the deep interest which he takes in naval matters, to preside over this Institution. The Council having been approached in reference to the representation of shipbuilders and marine engineers in the technical department of the Board of Trade, and believing that their co-operation in this movement would be in accordance with the best interests of the profession, have appointed Dr. Francis Elgar and Mr. Archibald Denny as their representatives to co-operate with the representatives of other institutions and bodies for the purpose of furthering the object aimed at. The Council deeply regret to announce the death of one of the Vice-presidents, the late Dr. Peter Denny, and the resignation, through ill-health, of another Vice-president, Sir James Ramsden. The Institution has also to deplore the death of one of its members of Council, the late Sir Edward Harland. The death of Captain Le Clerc, naval attaché at the French Embassy, and one of the Associates, has caused much sorrow to his many friends in the Institution. His presence, both for his own sake and as the naval representative of a friendly Power, was always greatly appreciated at the meetings.

After the scrutiny of the balloting lists and some other business had been transacted, the President delivered his address. He began by congratulating the Council on what he might term a prosperity report. He gracefully alluded to the hospitality received in France last year, and was glad to welcome among them that day some of the gentlemen to whom they owed so much. After a reference to the death of Sir Edward Harland, Dr. Peter Denny, and Capt. Le Clerc, he spoke of the work done by Lord Brassey, and then went on to say:—It was now his duty briefly to allude to the chief events in the shipbuilding line which have taken place during the past year, or are taking place at the present time. The most striking event of the moment, and the one which must be foremost in their minds just now, is the programme of construction just made public by the Admiralty. Five new battleships are to be laid down; they are to be improved Renowns, their displacement is to be 12,900 tons. In offensive power they will be equal to the Majestic class; in speed and radius of action they are designed to have a slight advantage over that class, although their displacement will be some 2000 tons less. Some apology would be due from him for giving these figures, which must already be familiar, were it not that they recalled to his mind a very important point in the speech which their former President—Lord Brassey—delivered to them last year. He said, speaking of the Majestic class, "While fully recognising the superiority of the latest battleships, in a new programme it may not be superfluous to set forth the leading arguments in favour of keeping down dimensions, and distributing the fighting power of the fleet in a greater number of ships," and again, "as the ten ships now building are of the largest dimensions yet reached in naval architecture for war, our next batch of ten ships might well be of the type represented so admirably by the Renown." He quoted these words of Lord Brassey with the utmost respect, and it would seem at first sight as though the designs of these new ships, which we are about to build, were in some degree a concession to the views of those who advocate moderate dimension in our ships of war; but in his opinion they are a very direct and very excellent answer to those who favour a policy of building smaller ships than has been our wont of late. It is true that they are smaller by the size of a third-class cruiser than are the Majestics, but it has been necessary to make some sacrifices to attain this diminution of size. As far as he could learn, there is practically a consensus of opinion amongst naval experts, as also amongst foreign critics, that the ships of the Majestic class embody in the highest degree all that is most desirable in a British battleship; but people will say, if this is so, why not continue to build Majestics? No doubt we should do so, if the Majestics were suited to all of the multifarious duties which the British Navy has to perform. Events, however, over which we have no control, and the development of maritime powers which a few years ago were non-existent, have made it possible that our Navy may be called upon to act in waters unsuited to the great draught of the ships of the Majestic class. For these reasons it has been found necessary to design the new vessels with 2ft. less draught than the class mentioned, and with a displacement of 2000 tons less.

The four great requirements in a battleship are, without doubt, speed, radius of action, gun power, and defensive armour. History teaches us the importance which our forefathers attached to the weather-gauge. It was regarded by them as all-important to that fleet which hoped to assume the offensive; the weather-gauge of to-day is the power to out-steam the fleet of the enemy, the power to concentrate quickly, and bring on a general action at the most favourable moment. Coal supply, as limiting radius of action, is also of vital importance to the fleet which must keep at sea, and which must carry on operations at a great distance from its base. The gun power of these ships leaves nothing to be desired, as it equals that of their larger consorts. We now come to the price paid for the 2000 tons of displacement taken out of these new ships. It is a sacrifice of about 25 per cent. of defensive armour. The development of the quick-firing gun and of high explosives makes it essential that the guns of the secondary armament and their crews should be properly protected; and it has, therefore, been decided to make the reduction in the side armour, which is to be of 6in. instead of 9in., as in the Majestic class. This, then, is the sacrifice which our designers have had to make, and it is considered to be the least harmful sacrifice that could be made under the circumstances. He must not forget to mention, too, that these battleships will be the first that our Admiralty have fitted with water-tube boilers.

He then passed to the cruisers projected in the new programme, and here he felt himself in closer accord with those who advocated moderate dimensions; but, again, what are moderate dimensions? Ten years ago a cruiser of 10,000 tons would have been a monster. To-day it comes under the heading of moderate dimensions. The new cruisers are of 11,000 tons displacement; that is, about midway between the Blenheims, of 9000 tons, and the Powerfuls, of 14,000 tons. This excess of 2000 tons over the Blenheim class would seem to be devoted to the attainment of a higher continuous sea speed, a more perfect system of protection to the guns and ammunition supply, and to the sheathing and coppering of the ships' bottoms, in order that they may be able to keep the sea for a longer period without docking. The considerable offensive power which these vessels possess would enable them to cope with anything afloat save a modern battleship; and their great speed would enable them to avoid a conflict with an enemy superior to themselves. They should prove equal to making quick passages in heavy weather, and altogether they promise to be useful adjuncts to a fleet of heavy ships. He was quite aware that the wisdom of building these large and expensive cruisers without side armour at the water-line has been called into question, but he hardly thought that that was a fitting moment to discuss such a subject. After careful consideration, after exhaustive experiments, and after availing themselves of the best expert advice at their disposal, the Admiralty have for some time past deliberately elected to discard side armour in all our cruisers, and to rely on armoured decks and coal protection. In our new second-class cruisers we again find an example of the upward tendency of moderate dimensions. They are vessels of 5600 tons, which is the precise size of the Orlando class—the belted first-class cruisers of ten years ago.

The Admiralty have also the intention of building a large number of third-class cruisers of the Pelorus type—vessels of 2135 tons displacement, and with a speed of 20 knots. Although, on the whole, their design has been approved of, it has been urged that they should have greater length, in order to improve their coal endurance. He would point out that, as matters stand, they will be 20ft. longer than their prototyes—the Bellona class—and that their radius of action at 10 knots speed is calculated at 6000 miles, which may be considered entirely satisfactory for cruisers of their size, being twice that of the Bellonas. They have also a higher freeboard, and so will be better sea-keeping vessels than the Bellona, and will carry a more powerful armament. Any reference to the work in hand for the Royal Navy would be imperfect without a short notice concerning the torpedo boat destroyers built or building in private yeards for the Admiralty. They are the greatest novelty of our time, and each batch of these little vessels, when completed by the contractors, appears an improvement upon the last batch. To obtain a speed of 30 knots, or thereabouts, is such a marvellous achievement that the firms which have succeeded in accomplishing this feat deserve the highest credit, and the grateful thanks of the country.

In speaking of the work which has been done in connection with the Royal Navy during the past year, he could not help referring to the extraordinary rapidity with which her Majesty's first-class battleships Majestic and Magnificent have been built and fitted for sea. These ships were completed within two years of the date of their being laid down—a wonderful feat on the part of the Dockyard staff both at Portsmouth and Chatham. As he had already ventured to point out, these ships have won the entire approval of all naval officers, and they have exactly fulfilled the anticipations of their designer, Sir William White, who was about, he was glad to say, to return to his work restored to health after his long and serious illness. Fifty-nine ships of war, with a total displacement of 148,000 tons, were launched in 1895; of these fifty-one were built in private establishments and eight in the Royal Dockyards. These figures, of course, include warships built for foreign Governments. He did not think that there are any special features to chronicle in connection with the development of the mercantile marine during the past year; 528 steamers with an aggregate tonnage of 905,000 tons, and 53 sailing vessels with a tonnage of 46,000 tons constitute the output of the yards of the United Kingdom. The net increase during the past year in the tonnage of the world for mercantile purposes amounts to about 518,000 tons. A brief reference to the papers to be read at that meeting brought his address to a conclusion.

The first paper read was that by Captain Lord Charles Beresford on water-tight doors, which was immediately followed by another on the same subject by Colonel Soliani, one of the most eminent constructors of the Italian Navy. The papers will be found in other pages. The discussions on both papers were taken together, and were unusually interesting and amusing. They occupied the whole afternoon, to the exclusion of all other business, and were principally remarkable for the fact that they had little or nothing to do with the construction of water-tight doors; the point fought over being, first, the necessity for openings of any kind in bulkheads; and, secondly, whether the naval officers or the constructive department provided them. Admiral Wilson began. He said that he could speak with some authority, as he had commanded the Sanspareil, which is a sister ship to the unfortunate Victoria. He held that the first point to be considered was, that a ship should be able to withstand the attack of one torpedo at least. If blockading, she might very readily have a hole blown in her bottom, which would flood a compartment or two; but if she could then make for a port, she might have the hole stopped in a couple of days and return to duty. He did not believe in doors, because they never were shut when wanted. A man did not expect to be run over by an omnibus in the street, and did not provide for such a contingency. In the same way captains of ships did not provide for being rammed or blown up. He would have a ship divided into a few large compartments, between which there should be no doors. This might be subdivided, and fitted with doors in the subdivisions, but he did not think they would be needed. Thus the engines and boilers could be in one compartment, torpedoes in another, heavy ammunition in another, and so on. The great need for doors was to avoid hatchways in the armour deck. He had examined into the condition of the Sanspareil after the loss of the Victoria, and found that if she had a compartment athwartships filled with 1000 tons of water, it would sink her 2ft., but she would be upright; but if she carried half that quantity to starboard, say, it would heel her so as to sink her starboard side 6¼ft. The sub-division of a ship must be fatal. He had no doubt that the small compartments in the Victoria caused her to capsize. If the water had not all been at one side she would have floated upright, but down by the head, for a much longer time, so that life might have been saved. The Sanspareil was much safer with all four boiler compartments full than with only one full. Admiral Makaroff used tin plate models, with tin boxes to represent compartments, in studying new designs.

Sir William White on rising was received with a storm of congratulatory applause, and soon showed that he had lost none of his old power of debate. In a very amusing speech he sought to turn the tables on Lord Charles Beresford. The gallant admiral, he said, took the case of a ship with 208 water-tight doors, but after he had done all he could to get rid of them, he only disposed of nineteen. A report was drawn up by naval officers concerning the water-tight doors of the Royal Sovereign, and these gentlemen only succeeded in dispensing with one door out of a total of 200. He quite agreed that there ought to be as few doors as possible, but how few would do? It was not the construction department that provided the doors, but the naval officers who insisted on having them. He had heard what Admiral Wilson had said, but the obvious course to be adopted by Admiral Wilson or any captain was to lock any doors believed to be unnecessary, but the locking was a thing not done. He then went into the history of the whole subject, and said that history was repeating itself. Twenty years ago and more the whole subject had been thrashed out by Sir N. Barnaby, and proposals identical with those of Lord C. Beresford had been fully discussed. Officers continually demanded more and more doors; coal had to be moved; ammunition had to be moved; ventilation had to be considered. The defect of Lord C. Beresford's arguments was that they were excellent, but they did not deal with all the questions that had to be considered. As to the closing of doors, he thought Lord Charles Beresford was scarcely fair to the crews, and he believed that they really did close and fasten doors when they said they did so.

Admiral FitzGerald set his hearers laughing by a reference to our worthy contemporary *Punch*. The whole question of doors was very old. He was surprised at the line taken by Lord Charles Beresford. In the Collingwood there were very few doors provided, the bulkheads being for the most part solid, but that ship was so uninhabitable in consequence, that doorways had to be cut in the bulkheads. As for Lord C. Beresford's doors, with a little ladder at each side, they reminded him of the monkey-on-a-stick given to children, but chief engineers in the Navy were not built that way, and could not use such doors. The efficiency of a ship depended on the accumulated convenience of her internal arrangements.

Admiral Freemantle went over old ground. Proceeding, he said that the ship surgeons must have a voice in the matter, and that a ship could not be kept healthy without adequate ventilatioin and communcation. He detailed an experiment which he had carried out, which showed that, with good discipline on board a large ironclad, all doors could be closed and properly secured in one minute and a-half. He had tried Sir W. White's plan of locking certain doors in a ship which he commanded, but the exigencies of living compelled him to relax his regulations, and he had to open them.

Admiral Colomb reviewed the discussion, and then dealt with the question of bulkheads, and detailed his experience with a sluice valve in one. He was followed by Mr. Martell, who explained "Lloyd's" practice. He advocated for warships the division of the ship into large compartments, each complete in itself, without doors in the transverse bulkheads. The steam pipes were a difficulty, and he would take them up on deck from the boilers and down again to the engine-room over the tops of the bulkheads.

Mr. Seaton, as an engineer, supported Lord Charles Beresford's views, and referred to the loss of the Royal George and Admiral Kempenfeldt. That ship had no bulkheads or water-tight doors. She was lost through neglect, so might be any ship. Collision bulkheads had been fitted almost historically in merchant ships. There had been a collision between the old Black Prince and the Royal Oak about 1868; after repairs the forepeak of the latter ship had been filled with water to test the tightness of the bulkhead, and it had never been emptied, and the ship carried a couple of hundred tons of water there ever since until a year or two ago, when its presence was discovered by an inquisitive admiral who was bent on getting into the forepeak. The notion that engineers wanted doors out of pure cussedness was not true. He cited ships which he had built, with two boiler-rooms and one engine-room, all cut-off from each other completely, and he heard no complaints. He had to fit a mechanical telegraph to the boiler-rooms from the engine-room, signalling "half-speed," "full-speed," "stop," "more steam," and that was all.

Professor Biles referred at great length to the City of Paris and City of New York as Atlantic steamers, but not by name, and suggested that as the chief engineer of one was present, he should give his experience. Accordingly, the chief engineer of the City of Paris gave some of his experiences. He explained that there was no difficulty, because he had twenty-five engineers under him, including electricians. These were all divided into groups, and one group was provided for each compartment. When the chief of any group had occasion to go into another compartment, his place and authority was taken at once by the next of the group in rank, while he who visited another compartment, if of superior rank, to the man in command then superseded him for the time being. There was no friction, and no difficulty. Each group was responsible for its own compartment. In spite of the absence of bulkhead doors they managed to do very good work with great regularity. As an example of what they had to do, he might say that once, out of eight pumps which he had to feed nine boilers seven broke down, and left him with one 6in. double-acting pump, but they kept the ship going for several hours at 14 knots until they had effected repairs. It was a very anxious time, no doubt. The voice pipes from the boiler-rooms to the engine-rooms continually said, "Short of water here, sir," but they worried through. In his ship there were twenty-five engineers including the electricians; one chief—himself—three second engineers, six thirds, six fourths, and so on. The bulkhead matter, as far as regarded the engineers, was purely a question of proper organisation.

Mr. Martell called attention to the fact that there were four models of bulkhead doors to be seen by members.

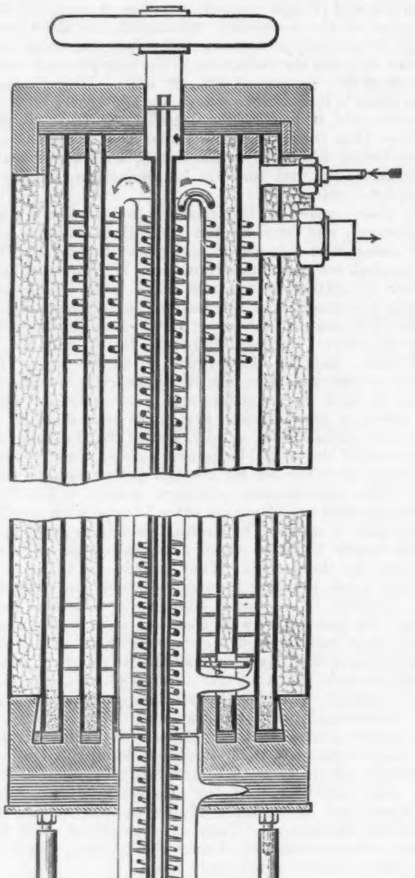
Lord Charles Beresford made a very effective and humorous speech in replying on the whole discussion. He said that as he and Admiral FitzGerald were both Irishmen, it was beyond the bounds of probability that they could agree on any subject whatever, and as to the 19 doors out of 208, these 19 doors were the essential doors. They were all low down in the vessel, a fact that Sir William White had overlooked. He held that the small doors he suggested supplied a ready means of communication by voice between compartments, and that if anyone did not like to go through them, he could go on deck out of one compartment and down the ladder into the next one. He repeated that doors never yet had been found of service when wanted, and that they had already cost the nation £3,000,000 and hundreds of valuable lives. No doubt naval officers were to blame for insisting on the use of too many doors. But it must not be forgotten that for years there had been no proper consultation between the naval officers and the constructors, and he took some credit to himself for bringing about a better state of affairs

After a brief reply from Col. Salviani, the meeting adjourned until yesterday—Thursday. We must hold over our report of the proceedings until next week.

The dinner of the Institution was held in the King's Hall of the Holborn Restaurant on Wednesday evening, the Right Hon. the Earl of Hopetoun presiding. There was a very large company present, including the Right Hon. Capt. Lord Chas. Beresford; Sir William Arrol; Sir E. Dawes, K.C.M.G.; Sir Raylton Dixon; Mons. Le Lt.-Colonel du Pontavice, Military Attaché and Acting Naval Attaché French Embassy; Mons. Emil Bertin, Directeur du Matériel, French Ministry of Marine; Mons. le Marquis de Chasseloup-Loubat; Mons. Le Comte de Bondy; Capt. G. Noel, R.N., Third Sea Lord of the Admiralty; Mons. V. Daymard, Vice-president de l'Institution Technique Maritime; Herr Dr. Sieveking, President Hanseatic Court of Appeal; Mons. G. Canet; Herr C. Ferd. Laeisy, President Hamburg Chamber of Commerce; Herr Adolph Woermann, President of the Hamburg Shipowners' Association; Ald. T. Richardson, Dr. Francis Elgar, Admiral the Right Hon. Sir John Dalrymple Hay, Bart.; Vice-Admirals G. Digby Morant, N. Bowden Smith, P. H. Colomb; Rear-Admirals Sir F. Bedford, K.C.B., Second Sea Lord of the Admiralty, Fitzgerald, A. K. Wilson, Admiral Boys; Messrs. A. E. Seaton, John Denny, M.P., J. I. Thornycroft, James Laing, B. Martell, E. Winsor Richards, J. Macfarlane Gray, A. Denny, and Prof. Biles. A letter from the Right Hon. G. J. Goschen, M.P., apologising for non-attendance, was read by the President, in which he expressed the hope of receiving another invitation from the Institution. After the usual loyal toasts, the President gave that of the "Naval and Military Forces," coupled with the name of Admiral Sir F. Bedford, who in the course of an amusing speech appealed to naval architects to leave them a little more space for exercising on the decks of warships. He spoke in high terms of the British system of training men for the Navy as opposed to foreign practice. Sir Edward J. Reed, in proposing the toast of the guests, said how glad they all were to see so large a gathering of foreign friends. This toast was responded to by Lieutenant-Colonel du Pontavice, M. E. Bertin, and Captain G. Noel. Mons. Bertin read a message from the President of the French Republic, in which the latter expressed the great interest he took in the Institution. Dr. Elgar was entrusted with the toast of the members from Hamburg, who had invited the Institution to make the town their rendezvous for the coming summer's meeting. This toast was replied to by Dr. Sieveking.

THE HAMPSON SYSTEM OF LIQUEFYING GASES.

IN our impression for October 4th, 1895, we described, for the first time in England, the remarkable system of liquefying gases invented by Dr. Linde, whose name is well known in connection with refrigerating apparatus. In a subsequent issue we dealt with the subject of regenerative cold. On Saturday last Dr. Hampson gave before several scientific men and practical engineers a demonstration of his process for liquefying gases at Brin's Oxygen Works in Westminster. It is, of course, no part of our business to pronounce an opinion as to priority of invention or the validity of patents. Dr. Hampson claims to have anticipated Dr. Linde by several months, and to all intents and purposes the apparatus which both Linde and Hampson use is identical, and the description of the Linde process, which we have already published, will apply accurately to that of Dr. Hampson, save in a few details. The nozzle used by Dr. Hampson, instead of being fitted with a regulating cone, is provided with a nearly flat valve or plate obturator worked by a screw, as shown in the accompanying engraving. In this way Dr. Hampson states that all risk of plugging with ice is avoided.



HAMPSON'S APPARATUS FOR LIQUEFYING GASES.

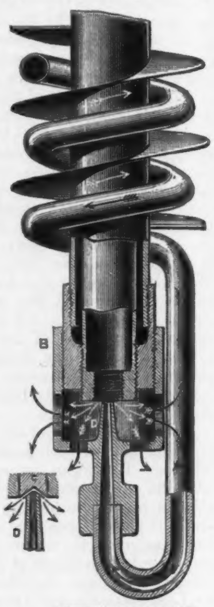
Dr. Hampson's experiments were in every respect satisfactory. We reproduce here the words of a paper which was placed in the hands of the visitors.

Oxygen is delivered to the apparatus at a pressure of 120 atmospheres, and at ordinary temperature, no carbonic acid, nitrous oxide, or other artificial cooling agent being, as heretofore, employed either inside or outside the apparatus. The gas is compressed into the apparatus and there allowed to expand, and thus become slightly cooler. This moderate refrigeration is increased by Dr. Hampson's self-intensifying process in an apparatus measuring only 28in. deep and 7in. diameter, until it is sufficient to liquefy the gas at atmospheric pressure at the rate of about seven cubic centimetres in four minutes. The process is as follows:—The whole of the gas, after being cooled by expansion, immediately surrounds the pipe through which the compressed gas is passing to the point of expansion, and so makes this gas, which is still compressed, cooler than it was itself while in compression. This cooler compressed gas consequently becomes at the point of expansion cooler than that which preceded it, and in its turn follows backwards the course of the still compressed gas, and so makes the latter cooler than ever before expansion, and, therefore, also cooler than ever, after expansion. This intensification of cooling—always assuming sufficient protection against external heat—is only limited by the liquefaction of the gas; the temperature of liquefaction being, in the case of oxygen, 180 deg. Cent.

The following striking experiments were performed with the liquid oxygen, thus rapidly and cheaply produced, which, however, are not in themselves new:—Quicksilver instantly frozen, and then hammered out flat, like a piece of lead, melted as it warmed. Ether and alcohol instantly frozen. Soft india-rubber so hardened by the cold that it was pounded into powder by a hammer, like a piece of brick. Piece of brass cooled so that on dipping it into water it immediately became thickly coated with ice, the ice-covering increased for a long time by freezing moisture out of the atmosphere.

These substances—like all others—at ordinary temperature are hot enough to boil off a quantity of the liquid oxygen, which on coming in contact with the air produced a cloud of ice-mist by freezing the moisture in the air. The lip of the vessel in which it was contained was thickly covered with hoar-frost, being hot enough to boil the liquid as it was poured over. The liquid falling on the ground, did not wet it for a moment, but darted rapidly, like quicksilver, in all directions, disappearing in a cloud of ice-mist.

Dr. Hampson holds, he states, the earliest patent for liquefaction of air. It has been found that suggestions have been made in times past of possibilities in the way of producing increased cold by means of the application of the cold produced in well-known commercial processes to the further cooling of the compressed gas, but it had never before been proposed to employ the whole of the cold of expansion of the gas to cool the compressed gas continuously and so to attain the highest degree of cooling possible to the gaseous state. This is believed to be the first complete demonstration in England of the efficiency of this process in producing a degree of cold limited only by a change of state of the gas cooled, without the aid of any extraneous artificial refrigeration Dr. Hampson's drawings and descriptions were prepared in April, 1894, and his patent is dated May 23rd, 1895. As a question of priority appears to be involved, we must content ourselves with a bare statement of the circumstances. We have already so fully dealt with the theory of the process that it is unnecessary to say more concerning it. The very simple set of apparatus which we saw at work acted perfectly. In our engravings, the large view shows the apparatus, and the above enlarged views show the central pipe and the end of the coil A, fitted with the jet piece D, which delivers the compressed gas against a flat plug on the end of a spindle, which screws in at C. The separate little view shows a different form of the jet D, and the end of the plug C.



DETAIL OF VALVE

THE MANCHESTER SHIP CANAL AND THE IRISH TRADE.

MANCHESTER has not hitherto been able to secure the advantage of direct trade with Ireland. The general merchandise traffic which passes between England and Ireland is mostly carried in steamers either owned by railway companies or worked under conference arrangements with the railway companies. The traffic is carried between interior towns in England and Ireland respectively at through rates, the amounts of the through rate being divided between the railway companies and the steamship companies under a mileage arrangement, the amounts accruing to the railway companies out of the through rates being considerably less than the rates locally charged between the interior towns and the ports.

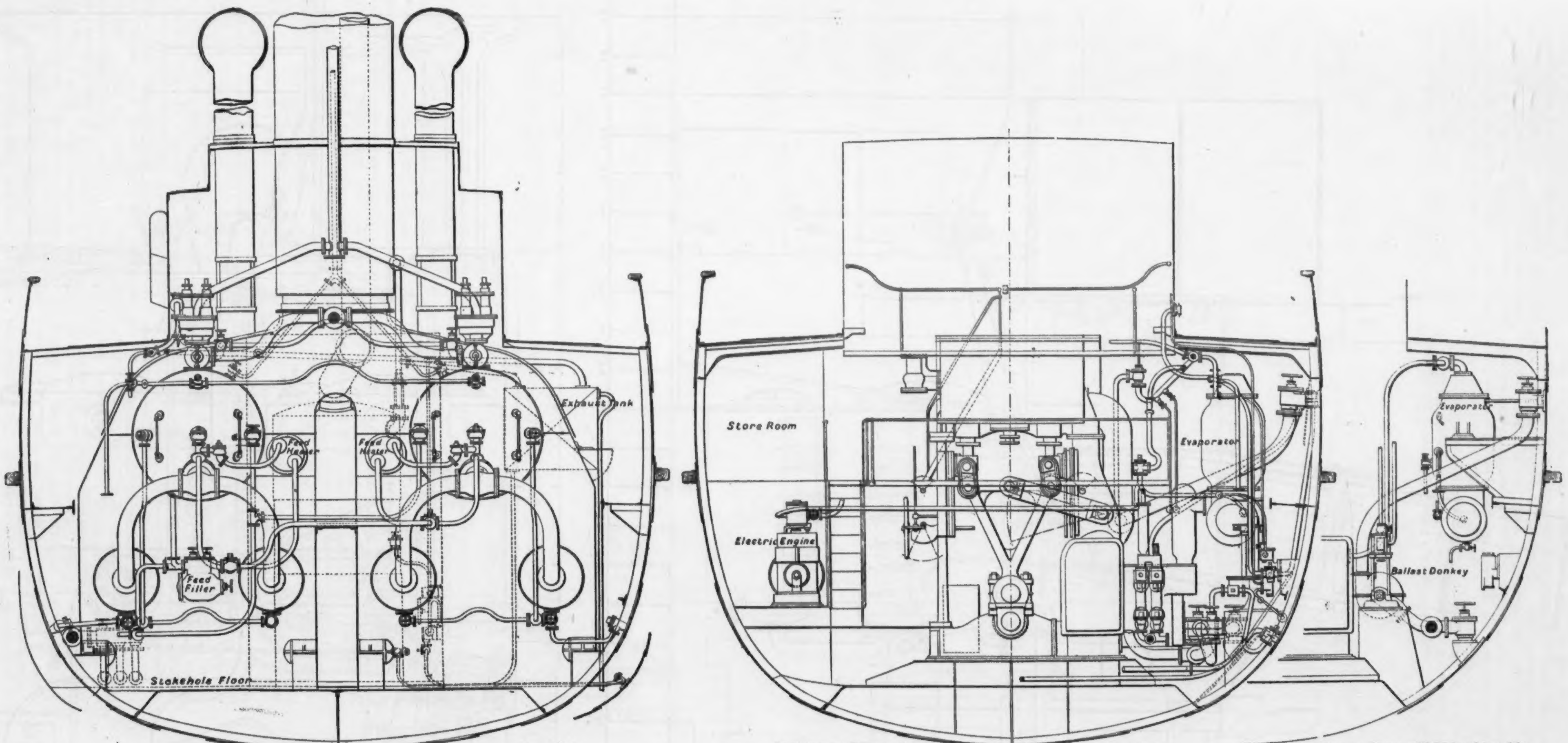
Certain steamship owners have successfully broken through this close combination by carrying traffic between Irish and English ports at greatly reduced rates; but although this has been a great advantage to the traders at the ports directly served by the opposition steamers, it has been of little benefit to the inland trader, who is denied the opportunity of participating in the advantages of the lower rate of sea carriage because the railway companies have charged their local rates to and from the ports instead of the cut rates which the steamers in the conference enjoy. The railway companies have declined to place the through rate arrangements in operation *viâ* Manchester, and consequently steamship owners in the conference who would otherwise use the Manchester Ship Canal are debarred from doing so by their conference arrangements. Some of the opposition steamship owners who are not bound by the conference terms have now, we understand, made arrangements to run to Manchester with a view of at once serving Manchester and the immediate district, and, with the help of the Manchester Ship Canal Company, of obtaining through the Railway Commissioners the advantages of through rate arrangements to and from interior towns in England and Ireland.

The new services will commence early in April, the sailings being between Manchester and Belfast twice weekly; between Manchester and Dublin twice weekly; and between Cork and Waterford and Manchester commencing with a weekly service. The Belfast line will be run by the Belfast and Mersey Steamship Company, Limited, and the Dublin and Manchester service by the Dublin and Mersey Steamship Company, Limited. It is not yet announced what steamship companies are to undertake the Cork and Waterford services.

We understand that the rates of freight which will be charged by the new services will even at the outset be much lower than the rates charged by the conference steamers.

ENGINES AND WATER-TUBE BOILERS, S.S. ABERDEEN

MESSRS. FLEMING AND FERGUSON, PAISLEY, ENGINEERS



Section at Frame Nº 34 Looking Forward

Section at Frame Nº 32 Looking Aft

Section at Frame Nº 29 Looking Aft

ENGINES AND BOILERS OF THE S.S. ABERDEEN.

WE give sectional illustrations of engine and boiler space of the s.s. Aberdeen, built by Messrs. Fleming and Ferguson, Paisley, for the Government of Canada, and intended for service on the East Coast of the Dominion. In the equipment of the Aberdeen, the Government have adopted the very latest developments in marine engineering and boiler-making practice. Engines of the builders' patent quadruple triangular connecting-rod type have been fitted. Diameter of cylinders, 18in., 28in., and 35in., by 54in.; stroke of piston, 36in.; clearance, top ½in.; clearance, bottom ⅝in.; maximum revolutions per minute, 96; indicated horse-power, with natural draught, 1510.

Steam is supplied by two of Messrs. Fleming and Ferguson's patent Clyde water-tube boilers, constructed for a working pressure of 220 lb. The diameter of tubes is 2½in. outside. The heating surface in each boiler is 1412 square feet. The grate area in each boiler is 50 square feet. The weight of one boiler complete without water is 27 tons 13 cwt. 3 qr. The weight of one boiler complete with water is 35 tons 14 cwt. 1 qr. With these boilers an evaporative efficiency of 10 lb. of water per hour per pound of coal is obtained, we are informed, with natural draught. They are especially suitable for large powers, it being possible to take as great or even greater powers than has been the practice with the cylindrical boiler, and they also obviate the sub-division of large power into a great number of boilers with their numerous fittings and details. The size of tubes is not reduced to a diameter that makes them liable to be choked, but is kept of a diameter which enables them to be readily cleaned. The drums are of a size that allows of a good supply of water always being in boilers, as well as an ample steam space, doing away with all liability to prime, and at the same time making regularity of water level a certainty. The whole of the inside of the boiler can be easily examined by taking off the ordinary manhole doors, no special jointed doors or caps being required to get inside to the tubes. There are no landings or joints in the fire, and no liability to leakage through expansion strains. In the event of any tube requiring renewal, it can be drawn into the upper drum and replaced in the same way without cutting out any of the other tubes or parts of casing. The manufacturers say they are not the lightest possible water-tube boiler, nor have they the greatest amount of heating surface, but they are fit to stand the every day wear and tear of constant service.

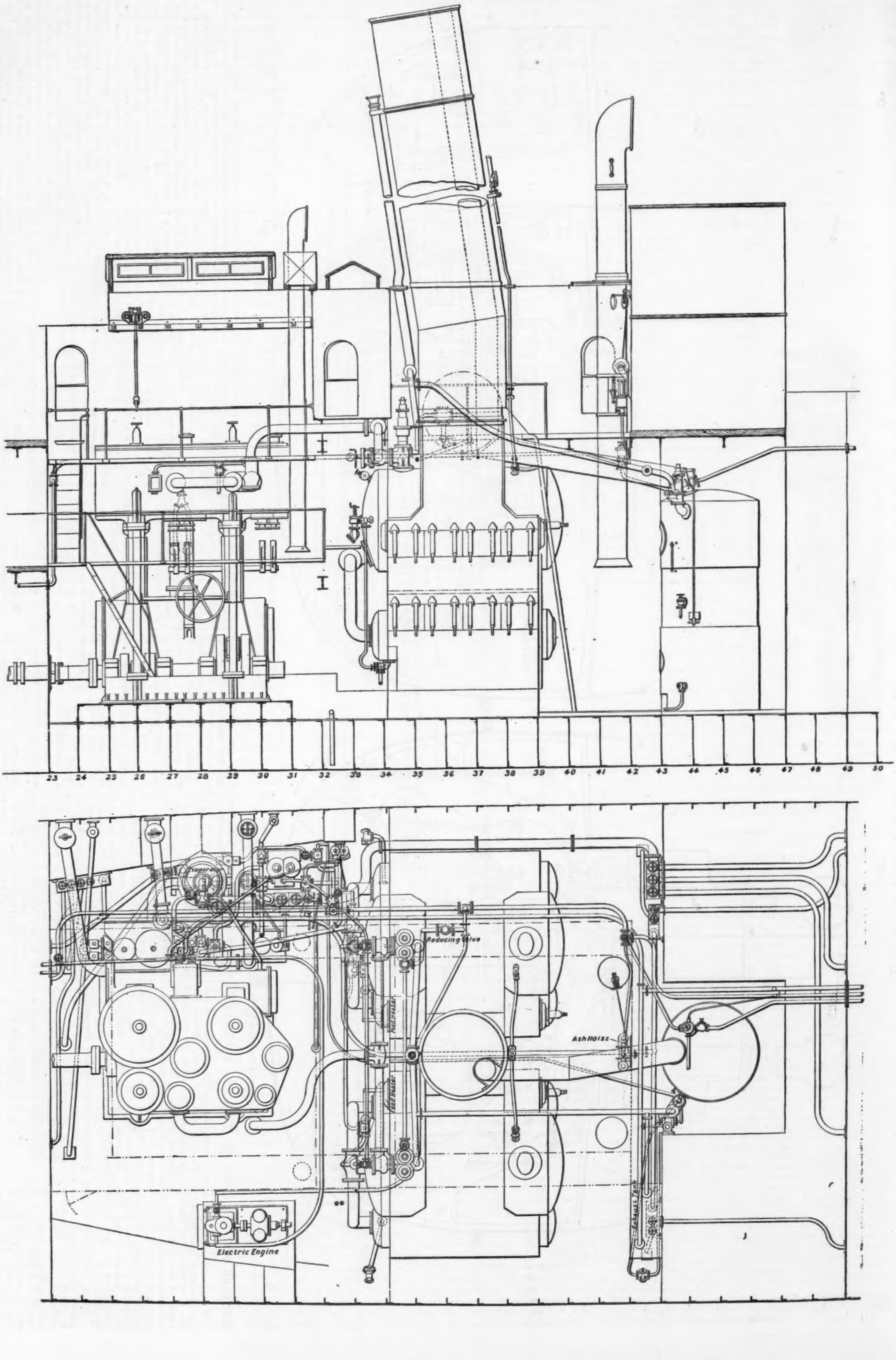
The s.s. Aberdeen is 187ft. by 31ft. by 19ft. 3in. She has been constructed to the highest class at Lloyd's, and to the requirements of the Imperial Board of Trade and Steamship Inspection Act of Canada, for the Government fisheries protection, buoy service, and lighthouse supply. The vessel has a straight stem, is fore and aft rigged, and flush-decked with large bridge amidships, under which is fitted a steering and chart-house, and on the bridge a large pilot house. A steel house aft is fitted with accommodation for the Inspector of Fisheries and Lighthouses, consisting of a large stateroom, chart-room, bath-room, lavatory, &c., and the entrance to the main saloon and officers' accommodation, which are below deck, is also in this deck-house; the accommodation for petty officers and crew is forward. The vessel is fitted throughout with the electric light, and is also supplied with a very powerful search light of Admiralty pattern to assist her in the special service for which she is designed. She has a double bottom fore and aft, divided both longitudinally and transversely, to give her extra stability when lifting large buoys, and is fitted with a very powerful steam winch and derrick to assist her in this work, and has also extra strong towing gear for salvage operations. The vessel is fitted with steam steering gear both midship and aft, a steam windlass, steam heating apparatus, and a very complete outfit of stores.

RAILWAYS AND THE COUNTRY.—While railways formed an inconsiderable item in the mass of private enterprises, while their effects on the internal traffic and intercourse of the country were partial and limited, their concerns could hardly escape being treated as the speculations of individuals, or at most as objects of a separate interest, which might be favoured or discouraged, according to the point of view from whence they were approached. As soon as their practicability was discovered, and the profits to be drawn from them became known, a kind of antagonism began to prevail; as if the nation, on one hand, and the railway capitalists on the other, were natural opponents—so that for some years, even down to the close of 1844, a notion of this implied hostility might be traced through all the public transactions on this subject. The labours of Mr. Gladstone's notable committee, and the creation of its unlucky and short-lived offspring, the special "Department of the Board of Trade," are late and prominent instances of this manner of viewing railway business. While such ideas prevailed, it was next to impossible to handle it in a comprehensive manner or a considerate temper. When the prosperity and safety of the country require that its roads shall be well and cheaply made; when the welfare of three-fourths of those who have money in the country is now directly concerned, that the hundreds of millions spent on those roads shall be fruitfully returned to them, the other fourth having an indirect interest, nearly as strong, in their success, it is high time to treat all questions which regard so important a branch of national industry, and so vast an amount of the national wealth, on the distinct ground that there can be no railway as distinguished from a public interest. What is good for the railways is good for the empire, and *vice versâ*. Hitherto the assumption has been that one could only be served by what it was able to extort from the other.—*Railway News.*

ENGINES AND WATER-TUBE BOILERS OF THE S.S. ABERDEEN

MESSRS. FLEMING AND FERGUSON, PAISLEY, ENGINEER

(*For description see page 311*)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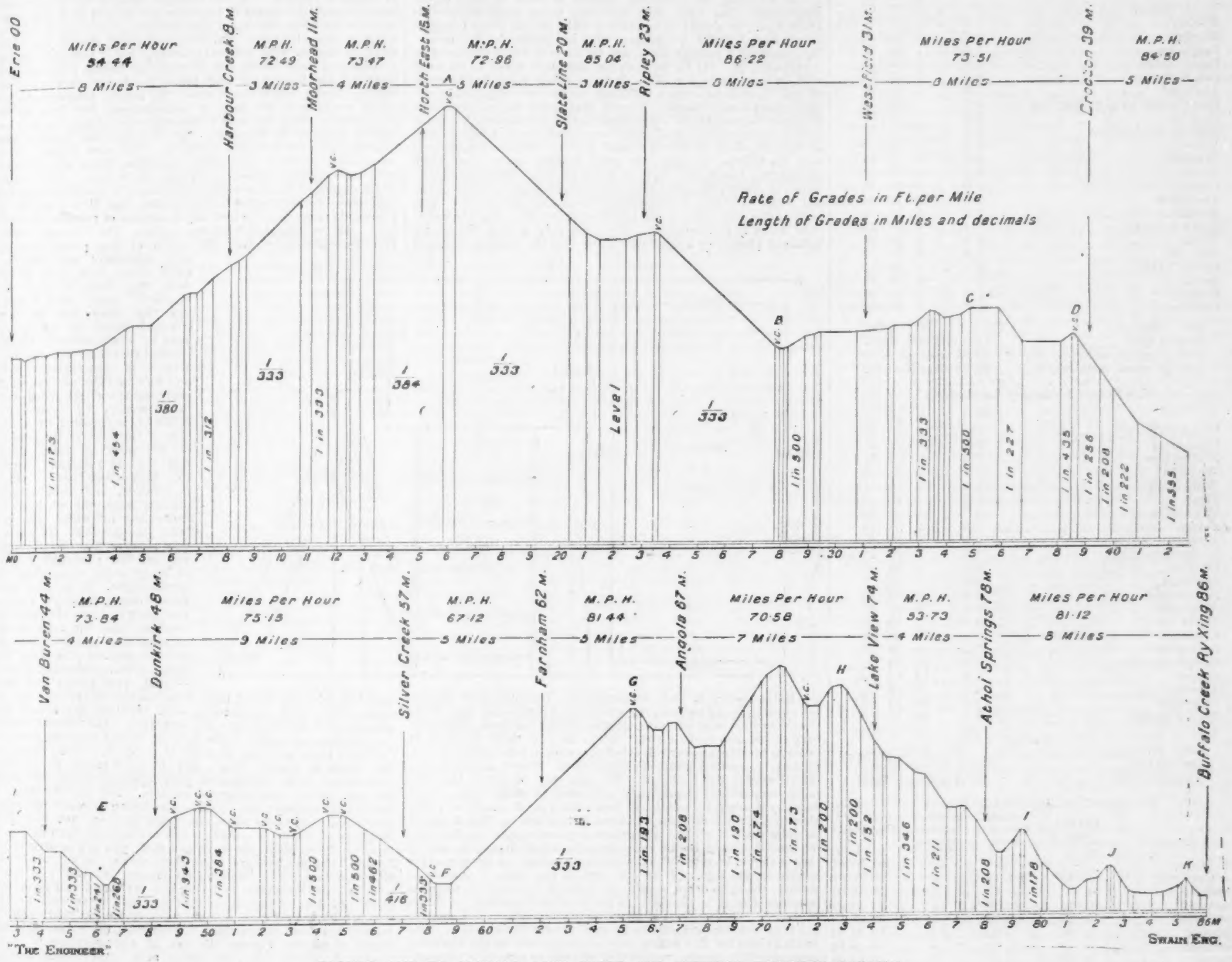
Evaporator
Reducing Valve
Feed Heater
Feed Heater
Ash Hoist
Exhaust Tank
Electric Engine

DETAILS OF THE FAST RUN ON AN AMERICAN RAILWAY.

THE wonderfully fast run made on the Lake Shore and Michigan Southern Railway in October last, which was described in THE ENGINEER of November 15th, has called forth considerable discussion as to the records of speed, and the conditions of the run, and we present herewith more detailed particulars than heretofore given. It will be remembered that the train made the run of 510 miles from Chicago to Buffalo in 7 h. 50 min. 20 sec., excluding four regular stops and one flag stop, or at the average rate of 65·07 miles per hour for the entire distance. The train consisted of three cars, weighing in all about 180 gross or English tons behind the tender.



PROFILE—ERIE TO BUFFALO—LAKE SHORE AND MICHIGAN SOUTHERN RAILWAY

The fastest running was done on the last stage of the run, from Erie to Buffalo, 86 miles, and in view of the discussion as to the records, our American correspondent has obtained from Mr. Hardy, the chief engineer of the Lake Shore and Michigan Southern Railway, the profile or longitudinal section of this division, which we reproduce herewith. On the base line are marked the distances, measured from Erie, and above are marked the stations and the distances between them. From the official records our correspondent has calculated the speeds between stations and marked them on the profile, and has also marked some of the principal grades by the system of notation more commonly used in English practice. No stops were made anywhere on the division. Grades marked "V. G." are variable, the changes being too small to be shown on the scale of the drawing.

The conditions of the run are summarised by our correspondent as follows:—Starting from Erie there is an almost continual ascent for sixteen miles—to the point marked A on the section—the greater part of the grades being from 1 in 312 to 1 in 384. Then there is an almost continuous descent for twelve miles to B, consisting of two grades of 1 in 333, each about 4½ miles long, separated by short easier grades. Then there are seven miles to C of comparatively easy ascent, with short grades of 1 in 500 and 1 in 333, broken by a short descending grade. Then come the two level stretches of a mile and a mile and a-half, separated by a down grade of 1 in 227 for one mile and followed by a little up grade to the summit D, 38½ miles from the starting point. Then come eight miles of descent to E, with grades of 1 in 208 to 1 in 333. The next 11½ miles to F comprise a long ascent, a depression, and then a long descent, the maximum grades being 1 in 333 to 1 in 500. This is followed by an up grade of 6½ miles long, 1 in 333, to G. Here commences a stretch of eight miles of broken grades, up hill and down dale, the maximum grades being from 1 in 173 to 1 in 208. This brings us to the summit H, whence there is a steady fall to Buffalo, with the sharpest grades 1 in 152 to 1 in 346. The descent is broken by easier grades, short level stretches, and three easy ascents to the summits I, J, and K.

We are also able to give herewith the official figures of the "log" of the entire run, the figures for the last part of the run being supplemented by the speed between stations, and our correspondent, who has calculated these out, states that they check very closely with the official figures for the average speed over the division. In regard to doubts which have been expressed as to the accuracy of the record, it is stated that the figures given by local papers of the towns through which the train passed tallied closely with the official figures of the train sheet, while the times of starting and finish recorded by reporters for the Chicago and Buffalo papers respectively form another check upon the actual running time. It has been assumed that the time was taken only in minutes, but this, we are told, is entirely erroneous, as shown below. There were four timekeepers, working two at a time, each holding a stop watch. The superintendent of each division called out the names of the stations as the train passed, and a fourth man took down the figures called off by the timekeepers. All the men are well known in railway and professional circles, and any talk of collusion or false figures would be absurd, while the official record was sent out over the signature of Mr. Canniff, the general superintendent of the railway, who was in the train.

The engines used on the first four divisions of the run were of the eight-wheel type—illustrated in THE ENGINEER of November 15th, 1895—having four driving wheels of 6ft. diameter, and a four-wheeled leading truck or bogie. On the last division, however, an engine of the ten-wheel type was used, having six driving wheels 5ft. 6in. diameter, and a four-wheeled leading truck. It had cylinders 17in. × 24in., and ample boiler and fire-box capacity. It weighed 113,500 lb., with 88,500 lb. on the driving wheels. One reason for using this engine was that it had a tender of greater tank capacity than the tenders of the other engines. The others carried 3100 gallons, and this one 3700 gallons of water, and the tank was practically empty at the end of the run. Each tender carried six tons of coal. This tender weighed loaded 88,500 lb., and the others 80,000 lb. The maximum speed was one mile at the rate of 92·3 miles per hour, and the average speed was 72·91 miles per hour for the 86 miles. The revolutions were 469 and 371 per minute, and the piston speeds 1878ft. and 1484ft. per minute for the maximum and average speeds respectively. The coal consumption was 3250 lb., equivalent to 37·79 lb. per mile, 2788 lb. per hour, and 100 lb. per square foot of grate per hour. The water evaporated was 30,833 lb.—3700 gallons—or 9·48 lb. of water per pound of coal. Of course this engine, not being designed or intended for such maximum long-continued speeds, could not be expected to be economical; nor was it wanted to be so, since the sole aim was to see in how short a time the run could be made. One of the eight-wheel engines—with four driving-wheels 7ft. diameter—which haul the Empire State Express of the New York Central Railway, has, our correspondent states, a month's record in 1894 averaging 32·38 lb. of coal per mile, the average speed of the train being 50·7 miles per hour at that time.

Engines with six driving-wheels are very largely used in the United Seates for heavy express trains, and are usually of the ten-wheel type, having a four-wheeled truck or bogie. Some roads, however, use the Mogul type, having a two-wheeled truck; and an engine of this latter type, used for mail and express trains on the Chicago, Burlington, and Quincy Railway, has records of 22½ miles in 21 minutes and 15 miles in 13 minutes, with a train of four cars in each case. This engine has cylinders 19in. by 24in., driving-wheels 5ft. 8in. diameter, truck wheels 3ft. 1in. diameter, and weighs 120,000 lb., of which 101,000 lb. are on the driving-wheels. Our correspondent knows of a six-wheeled switching or shunting engine with six coupled wheels 4ft. 2in. diameter, having been run at a speed of 45 miles per hour. The following is the complete "log" of the run, which was made on October 24th, 1895:—

I.—*Western Division.*

	Miles.	Time (a.m.) h.	m.	s.
South Chicago	—	3	29	27
Whiting	3·5	3	34	45
Pine	6·2	3	41	03
Millers	6·8	3	47	30
Dune Park	5·7	3	52	50
Chesterton	5·8	3	58	05
Burdick	4·1	4	01	59
Otis	3·6	4	06	01
Durham	3·6	4	10	07
La Porte	6·4	4	16	34
Rolling Prairie	7·0	4	22	56
New Carlisle	6·3	4	28	33
Terre Coupee	1·7	4	30	00
Warren	4·7	4	34	04
South Bend	6·9	4	20	24
Mishawaka	4·0	4	44	09
Oscevla	5·6	4	19	15
Elkhart	5·5	4	51	53

Total distance... ... ... 87·4 miles
Elapsed time ... ...1 hour 25 min. 26 sec.
Average speed ... ... 61·38 miles per hour

II.—*Air-line Division.*

	Miles.	Time (a.m.) h.	m.	s.
Elkhart (leave)	—	4	57	04
Dunlap	5·0	5	04	33
Goshan	5·5	5	09	05
Millersburg	7·7	5	16	26
Ligomer	7·0	5	22	43
Wawaka	5·5	5	27	32
Brimfield	4·4	5	31	39
Kendallville	7·0	5	38	06
Corunna	6·0	5	45	12
Waterloo	6·7	5	50	40

II.—*Air-line Division* (*continued*).

	Miles.	Time (a.m.)		
		h.	m.	s.
Butler	7·5	5	57	20
Edgerton	6·9	6	03	05
Melbern	5·9	6	07	29
Bryan	5·0	6	11	37
Stryker	7·3	6	18	13
Archibald	6·0	6	24	19
Lettisville	4·0	6	28	11
Wanseon	4·5	6	32	34
Delta	7·7	6	39	13
Swanton	5·7	6	44	30
Holland	9·4	6	53	09
Air-line Junction	7·1	6	59	27
Toledo	2·6	7	01	39

Total distance ... ... 133·4 miles
Elapsed time ... ... 2 hours 4 min. 35 sec.
Average speed... ... ... 64·25 miles per hour

III.—*Toledo Division.*

	Miles.	Time (a.m.)		
		h.	m.	s.
Toledo (leave)	—	7	04	07
Milbury	8·0	7	13	58
Martin	4·7	7	18	21
Graytown	4·5	7	22	26
Rocky Ridge	2·4	7	24	51
Oak Harbour	3·5	7	27	44
La Carne	5·5	7	32	21
Port Clinton (stop by flag, 2 m. 5 s.)	6·1	7	40	59
Gypsum	3·0	7	44	05
Marblehead Junction	2·1	7	45	59
Venice	4·9	7	50	38
Sandusky	2·9	7	53	13
Huron	8·9	8	01	54
Ceylon	4·0	8	06	10
Vermillion	7·5	8	12	52
Burnhelm	3·2	8	15	56
North Amherst	4·4	8	20	13
Elyria	6·4	8	26	34
Shawville	4·5	8	30	59
Olmsted Falls	6·2	8	36	25
Berea	2·1	8	39	19
Rockport	7·1	8	44	29
Cleveland	4·7	8	50	13

Total distance... ... ... 107·8 miles
Elapsed time ... ... 1 hour 49 min. 6 sec.
Average speed, including stop ... 60·96 miles per hour
Average speed, deducting stop ... 62·18 miles per hour

IV.—*Eastern Division* (*First Section.*)

	Miles.	Time (a.m.)		
		h.	m.	s.
Cleveland (leave)	—	8	51	58
Collinwood	7·5	9	01	26
Nottingham	2·0	9	03	17
Wickliffe	4·7	9	07	23
Willoughby	4·2	9	11	07
Mentor	4·3	9	14	57
Painesville	6·3	9	20	02
Perry	5·5	9	25	08
Madison	5·3	9	29	28
Unionville	2·2	9	31	19
Geneva	3·2	9	33	44
Saybrook	4·5	9	37	20
Ashtabula	4·8	9	42	13
Kingsville	5·7	9	47	29
Tower No. 2	3·0	9	49	51
Conneaut	4·5	9	53	48
Springfield	7·5	9	59	58
Girard Junction	3·5	10	02	47
Girard	1·3	10	04	04
Fairview	4·5	10	07	54
Swanville	2·5	10	10	06
Dock Junction	6·2	10	14	30
Erie	2·3	10	17	30

Total distance... ... ... 95·51 miles
Elapsed time ... ... 1 hour 25 min. 32 sec.
Average speed... ... ... 67·01 miles per hour

V.—*Eastern Division* (*Second Section*).

	Elapsed time.		Speed. Miles per hour.	Distance between stations.	Time (a.m.)		
	m.	s.		Miles.	h.	m.	s.
Erie (leave)	—		—	—	10	19	48
Harbour Creek	8	49	54·44	8	10	28	37
Moorhead	2	29	72·49	3	10	31	06
Northeast	3	16	73·47	4	10	34	22
State Line	3	53	72·96	5	10	38	15
Ripley	2	07	85·04	3	10	40	22
Westfield	5	34	86·22	8	10	45	56
Brocton	6	10	73·51	8	10	52	06
Van Buren	3	33	84·50	5	10	55	39
Dunkirk	3	15	73·84	4	10	58	54
Silver Creek	7	11	75·15	9	11	06	05
Fairhaven	4	28	67·12	5	11	10	33
Angola	3	41	81·44	5	11	14	14
Lake View	5	57	70·58	7	11	20	11
Athol Springs	4	28	53·73	4	11	24	39
Buffalo Creek	5	55	81·12	8	11	30	34
Total (no stops)	70	46	72·91	86	—		

Total distance ... ... 86 miles
Elapsed time ... ... 1 hour 10 min. 46 sec.
Average speed (no stops) ... ... 72·91 miles per hour

Summary.

	Distance. Miles.	Average running speed. Miles per hour.
Western Division	87·4	61·38
Air-line Division	133·4	64·25
Toledo Division	107·8	60·96
Eastern Division (First Section)	95·5	67·01
Eastern Division (Second Section)	86·0	72·94
Total (Chicago to Buffalo)	510·1	65·07

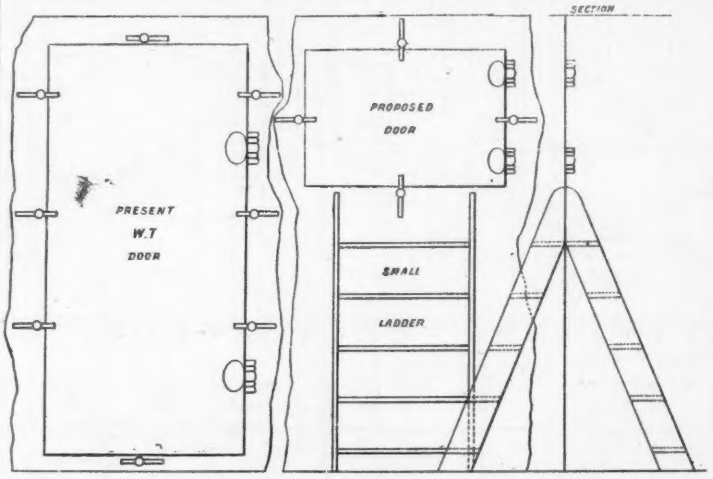
WATER-TIGHT DOORS, AND THEIR DANGER TO MODERN FIGHTING SHIPS.*

By Captain the Right Hon. LORD CHARLES BERESFORD, C.B., R.N.

IT appears to me that every effort has been made, as far as human ingenuity has gone at present, to secure a ship floating after a severe gun action, but equal attention has not, in my opinion, been paid to this consideration in the event of a ship being badly wounded by ram or torpedo. It is to reduce the probability of losing a vessel through the agency of these "elements" that I make the following proposals. A battleship is a variety of compromises, and water-tight doors form one of those compromises. The water-tight door compromise may be defined in the following manner:—It is the safety of the ship *v.* the convenience of the departments. In my opinion the safety of the whole ship is infinitely more important than the convenience of the different departments. According to the system which obtains at present we put ourselves to great trouble, inconvenience, and expense, and add enormously to the weight of our ships—a most material point—by building a large number of bulkheads athwartships, and fore and aft, to ensure her safety when wounded below the water-line. Then, in order to defeat our original object, we cut a great hole—often two—in each bulkhead for the convenience of the different departments on board, and so practically re-convert the ship into one compartment. It has so often been proved that the holes are invariably open when an unforeseen contingency occurs.

I propose to avoid the danger of that possibility by (1) doing away altogether with the greater number of the doors, and (2) by so modifying the size and position in bulkhead of some of those which remain as to prevent a sudden rush of water being immediately distributed through different compartments in the ship, as occurred in the Victoria. The total number of doors in each of the following ships is:—Magnificent, with 150 compartments, 208 doors; Royal Sovereign and Repulse, 187 compartments with 148 doors; Rodney and Anson, 121 compartments and 98 doors; Theseus and Hawke, 122 compartments and 98 doors; and the Agincourt, 29 compartments and 17 doors. The old ships have few compartments, but much less doors in proportion.

The following list gives the number of doors in ships of the Magnificent class dealt with according to my suggestions:—(1) Doors I propose should be done away with, 19; (2) doors I suggest should be modified in accordance with my proposals, 23; excepting ammunition passage doors, and (3) doors in which no alteration is proposed, 22. (1) By far the most important doors to do away with, in my opinion, are all on all decks below water-line between 63 and 105 stations—which bulkheads enclose the engine-room and boiler-room compartments. I agree that quick communication is necessary between the engineer officer and his subordinates, but quick verbal communication is all that is required; and, in my opinion, all demands could be met by a small scuttle. These compartments form the belly of the ship—the great floating power from which she gets her buoyancy. In case of one of them being flooded with water, or filled with steam from a fractured pipe, or other cause, the water or steam is immediately communicated to the whole belly of the ship owing to the impracticability of closing the water-tight doors in an emergency. Now, not only is each thwartship bulkhead pierced by a door—often two—but the midship bulkhead also has often two in each compartment. The next most important place is, in my opinion, right forward, where water-tight doors should be done away with altogether in collision bulkhead, and I think they should also be done away with in the next bulkhead abaft, in order to be still comparatively safe if the collision bulkhead gives way. In fact, no opening whatever, either sluice valve or anything else, should exist in this bulkhead. The only way to get to the foremost compartment should be by a manhole in deck above. Incidentally it might be mentioned that I think (*a*) it would be advisable to shift the collision bulkhead further aft, so that it should be quite clear of all the strengthening pieces supporting the ram; (*b*) that it should be far more strongly fitted than it is; and (*c*) that it should be rounded like a barbette instead of being at right angles to the side. (2) In the case of the doors I propose to modify, the large doors should be replaced by small rectangular openings close up to the deck, at the top of the bulkhead, as shown in sketch. This proposal is intended to allow officers and men to get from one compartment to another quickly if necessary. The merit I claim for this fitting may be exemplified in the following manner:—If a ship be wounded by torpedo or ram in a compartment below the water-line, the water will rush in with irresistible violence. With the present system of water-tight doors, where the sill is nearly level with the deck, there is nothing to prevent the water rushing to all parts of the ship at once, and it becomes impossible to close the doors. With my proposal the water meets a solid bulkhead all round the compartment to a height of five, six, or more feet, according to the height of compartments. The water is confined for some appreciable time in one space, and this gives ample time to close and secure the rectangular opening at the top of the bulkhead.



There are only seven doors in the whole ship below the water line that, in my opinion, should remain. The doors that are necessary should, I think, be improved. I cannot conceive a worse principle than is employed for closing the hinged doors in the British Navy. The hanks and butterfly nuts have each one to be secured or screwed up separately. The consequence is that in a panic or sudden emergency you invite an accident, as it is unlikely that men will remain to secure each hank and each butterfly nut, without which the door cannot be effective. I have seen many doors, a great deal better than the ones employed in the Navy, of the same weight and about the same price. The principle that should be enforced is that it should be possible to shut the door and secure it in one movement. Owing to the length of my paper, I do not propose to enter into details concerning the doors of the other classes of ships I have named; but I am most strongly of opinion that in fighting ships of all classes the suggestions I have made should be carried out in each ship building, and that ships built should be altered in the direction I advocate. It is only by using foresight that possible, and I consider probable, dangers may be avoided.

Summary.—The summary of my contentions is:—(1) Many water-tight doors can be abolished. This would add to the safety of the ship. (2) Many water-tight doors can be modified with the same advantage. (3) That where water-tight doors are necessary of their present size, they should be constructed on a better principle than those we now use. (4) That all these alterations in construction can be carried out without affecting the fighting efficiency of the ship.

My object in writing this paper is to invite discussion from those shipbuilding experts who are best able, by argument, to prove that those who agree with me on this all-important question are right or wrong.

TRADE AND BUSINESS ANNOUNCEMENT.—Messrs. W. P. Thompson and Co., Patent Agents, have removed to 322, High Holborn, from 31, High Holborn.

LEGAL INTELLIGENCE.

ROYAL COURTS OF JUSTICE.

March 10th to 20th, 1896.

(*Before* MR. JUSTICE WILLS.)

THE INCANDESCENT GAS LIGHT COMPANY (LIMITED) *v.* THE DE MARE INCANDESCENT GAS LIGHT SYSTEM (LIMITED) AND OTHERS.

THIS was an action brought by the Incandescent Gas Light Company (Limited) against the defendants, claiming an injunction restraining the defendants, their servants and agents, from infringing the plaintiffs' letters patent, No. 15,286, of 1885. The trial commenced on the 9th inst., and was continued on the 10th, 11th, 12th, 13th, 16th, 17th, 19th, and 20th.

Mr. Moulton, Q.C., Mr. Terrell, Q.C., Mr. A. J. Walter, and Mr. J. H. Gray appeared for the plaintiffs; Mr. Bousfield, Q.C., Mr. Roger Wallace, Q.C., Mr. C. E. E. Jenkins, and Mr. W. Neill for the defendants.

Mr. MOULTON, Q.C., in opening the case for the plaintiffs, said that the invention was one of those great inventions which for ever change the work of the world in the particular department to which it referred. It had changed entirely the direction and the success of the efforts of inventors and the practical user in the world in the whole domain of the chemical production of light by means of incandescence. Dr. Welsbach found that if you take a fabric of organic fibre, preferably cotton, and if you steep that in a solution of some soluble salt of refractory earths, you could get, when you had burned off that fabric, a coherent skeleton of refractory oxides, which would stand the fiercest temperatures and which would give out light by incandescence free from all the objections to which the earlier attempts were subject, but that was not the whole of the invention. Dr. Welsbach was working upon that strange class of bodies known as "the rare earths." They were a class found in very small quantities, found always allied with one another—always in groups, as it were. The mineral which contained the one would contain some or all of the others, and they were so closely allied to one another that it was almost impossible in many cases to find any difference of property by which they could be separated from one another. Dr. Welsbach for the first time discovered that the oxides of this group were not only splendidly refractory and could stand heat just in the same way that zirconia and magnesia and lime could, but that they had a most splendid power of giving out light by incandescence. He discovered that these were the finest sources of incandescent light, and he found the way you would best obtain your light-giving structure—namely, by saturating a fabric of, say, cotton by a solution of the salts of these metals or the salts of these metals and the old refractory earths, so that they were purely in solution, and then actually burning away the whole of the scaffolding by which you had built your erection. It was the only rival of the electric light, and on the Continent it had in many cases vanquished the electric light. It was also enormously used in England. Three or four times the amount of light was obtained from the same amount of gas as that obtained from the ordinary method of lighting. The reason of the success was as follows:—Using what people had never used before—a solution of some of the soluble salts of these and the other metals, such as zirconium—Dr. Welsbach got a fluid that penetrated everywhere into the structure. The learned counsel described the operation of the solution in the following terms:—"Where there are cells or pores it comes in; where there are fine fibres it encases them; and the consequence is you have everywhere, in the intricacies of your organic structure with which you are dealing, your pregnant solution. You dry it—these, of course are eminently non-volatile—the drying drives off the water, and there, everywhere where the water has been, you have your fine layer of nitrate or acetate, which are the salts that he recommends. Now, when you have got that, you are apparently no further; but you have got everywhere where you will want your structure that which by the next process you will turn into a coherent hard structure, following in every detail this layer, if I might put it so, of the nitrate that you have so successfully laid. You set fire to that when it is dry; the cotton, or whatever it be, burns; the heat of burning, dealing with the exceedingly fine layers of nitrate, exposes the salt to a temperature it cannot bear; it drives off the nitric acid, and leaves nothing but the oxide of the metal. It leaves it in a coherent form, and you get casts of every single fibril that has been twisted together in order to form the thread that made the fabric. You have got, as it were, a cast of the whole organic structure of this body; and in what form is that cast? It is a cast in which all the detail is found. The consequence is that you have in many places, probably throughout the bulk of the mass, fibrils of cellulose represented by their facsimiles in these coherent oxides, and now you expose it to a great temperature, and we know the strain that a great temperature is on all these bodies. It produces an expansion, and the cessation of the flame produces an irresistible contraction of what is no longer a solid body, where you might get fracture, but of a body built up of these fine casts of fine filaments; and it is found that you can make this and you can burn it for hours—these will last 800 and 1000 hours in some cases. You can turn it out; the shrinkage and expansion and all that is in a body built up of fibrils so small that they have an elasticity, however fragile, as it were, the material of which they are made. As far as we can make out that is the meaning of the success, and that condition of making our mantle by means of a solution of these soluble salts of the refractory metals and earths and burning them into oxides after they have soaked through and penetrated into every part of the organic structure is the essential of every successful incandescent burner of the present day. Further, an essential of it is that you use wholly or partially, either to the greater or less extent as fancy may please, these rare earths." Dr. Auer von Welsbach was dealing with the practical problem. At the date at which his invention came out these earths were known in their casual conglomerate existence as the oxides to be found in these rare minerals. They were separated only as a chemical *tour de force.* This was a practical invention. The proportions did not matter. This was not a thing in which proportions did more than give a better or a worse result—not a different one. In this great strain to which these materials were exposed, it seemed to be like soldiers under a hot fire, each man had got to stand steady, and in this patent Dr. Welsbach plainly said that any of these rare oxides with one exception—and he branded the coward—could stand the strain. Of course, when this became not a question merely of theoretical chemistry, but a great practical industry, people threw their whole force into the study of these rare earths. The sources of them were locked up. At one time it looked as though the manufacture of these mantles would exhaust the little amount of these earths to be found on our globe. Well, people now, finding that they were things of use, and things therefore of value, set out and found other sources of supply. Instead of leaving them as mere mixtures, they separated them and divided them up, and sometimes you might use for one kind of light a preponderance of one form of oxide; for another a preponderance of another. It was immaterial what mixture was chosen. Dr. Welsbach taught that all these could be used, and if the defendants chose to make subsidiary inventions by emphasising one ingredient or emphasising another it did not matter. The characteristics which would be found always in the successful incandescent—he might even say the existing incandescent—light were those two of the organic structure initiated in these hard coherent refractory oxides; and the source of those oxides, where they did not come from the whole refractory earths, was to be found in this group of strange metals which the plaintiffs were the first to use. That was the invention. Now, what had the defendants done? They were a company that had threatened to make and sell an appliance which was an infringement. Instead of taking a hood they had taken the individual threads forming a fringe. Dr. Auer von Welsbach said in his specification, "Obviously fabrics of various forms or construction may be employed according to the character of the burner to which they are applied." The defendants' fringe was applied to a bat's wing burner or flat-flame burner, and the burner played on those impregnated threads. The defendants merely changed the form. They could not change the real substance of it. You must have your thread, you must have it impregnated; you must have it impregnated with something in solution, and that something must be a soluble salt of one of these resistent earths; and if you were going to have any success at all it must include one of these rare oxides that you found in ytterite and cerite earth. When you had got that you might vary your shape as you liked. Varying the form or varying the predominance of any particular one of these almost indistinguishable substances in the actual mantles used had not taken the infringers out of the ambit of the specification; but, to use the language consecrated in many of the greatest decisions on patent law, they had taken the pith and marrow of the patentee's invention, and as such they were infringers of the patent.

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* Abstract of paper read at the thirty-seventh session of the Institution of Naval Architects, March 25th, 1896.

Evidence was then called in support of the plaintiff's case.

Professor James Swinburne said that by no experiments which he had made according to directions given in specifications prior in date to the plaintiff's had he been able to produce a coherent mantle.

Professor James Dewar said that in his opinion the process described in Welsbach's specification was novel. By the substances mentioned in the specification he understood the application of the oxides of the rare metals, or commonly called the oxides of the rare earths. As to the alleged anticipations connected with Frankenstein, the process there described would not make a practical incandescent mantle. The whole fell to pieces almost at once. There was no permanence and no cohesion. None of the alleged anticipations showed that process which was essential to success. If you took the Frankenstein method with the Welsbach materials you could not make a mantle. Looking at the Welsbach specification, in his opinion, the patentee showed that what he used were these rare oxides. In his opinion there was not yet any practical value in isolating for this purpose erbium. This group of rare earths, or the metals which formed the base of the rare earths, were very seldom found separate, and they all more or less contained one another.

Mr. W. Webber, a gas engineer of thirty years' standing and head of the editorial staff of the *Journal of Gas Lighting*, said, as regarded domestic lighting, the incandescent burner had knocked out everything else in the way of improved lighting.

Mr. John Imray said that, in his opinion, Welsbach's invention was this—to take a soluble salt of a number of metals of a peculiar kind, to soak a fabric in that solution, to dry it, to subject it to an ammonia gas, then to burn away the material which had been soaked, leaving the earth oxides standing as a skeleton. In his opinion it was a manufacturing operation—a purely physical operation. At the time of Welsbach's specification the invention was quite novel, and a total departure from anything that had been done before. From a commercial point of view Welsbach's invention was the first one which had ever succeeded in incandescent lighting. In his opinion, if threads of oxides were obtained by saturation, drying, and burning off, it was a method described in Welsbach's specification. Several other experts, including Mr. H. Ballantyne, Mr. W. R. Cooper, Mr. A. A. Beadle, Mr. Dugald Clerk, Mr. A. Pringle, and Professor C. J. Lambert were called in support of the case for the plaintiff.

Mr. Bousfield, Q.C., in opening the case for the defendants, said that the case, although it had taken some time and involved, perhaps, the consideration of somewhat recondite points in some of their aspects, was, nevertheless, about one of the simplest cases for a patent case that could come into Court. He hoped to satisfy his Lordship that the principles of construction to be applied to a specification were absolutely independent of the magnitude or the smallness of the invention. No doubt the magnitude and the importance of the invention, the amount of capital involved in it, and all those things which his learned friend had tried to put forward as to the amount of employment given in allied industries had an effect, or might have an effect, on the mind of the Court, although, strictly speaking, they ought not to be brought in. It was, perhaps, therefore, a little important to observe in this case that the plaintiffs, after all, had only taken the benefit of a long series of prior suggestions in the same department; and although, no doubt, they had been—not the plaintiffs, but Mr. Welsbach—the first to reduce this particular form of mantle to a practical form, yet, after all, the differences between what they had done and what had been done before were not much more than the differences between what they were doing now and what they were doing in 1885. In the patent Mr. Welsbach said that the compound used by him consisted of lanthanum and zirconium, and that you might or might not if you pleased use yttrium with it. He gave you the proportions when you had got the yttrium, and then he told you that if you dispensed with the yttrium you were to have half zirconium and half lanthanum. So far, there was no notion of equivalents about them. There were two necessary elements of his compound, and one optional element of his compound. Then he went on and gave you the two equivalents. He said for yttrium you might have ytterite earth, and for lanthanum you might have a certain kind of cerite earth. In this case the other side had been engaged in compounding those things which the patentee had endeavoured to separate. The defendants stated distinctly that they intended, unless restrained by order of the Court, to make mantles which should contain zirconia and erbia. If the patentee contemplated as a known equivalent at the date of his patent the use of erbia instead of yttria it would have been mentioned in the patent, but it was not put in on purpose, having regard to the fact that he must have known about erbia as well as yttria. There could not be any infringement of this patent without having the two necessary groups represented—the zirconia and lanthanum. These two things, zirconia and lanthanum, or their specific equivalents, being necessary for infringement, the defendants had not infringed, because those were the two essential elements. The yttria group was the non-essential, the optional element. The essential compound described by the patentee consisted of the two things—zirconia and lanthanum, or their equivalents. The defendants had got no equivalents whatever for the lanthanum, which, of course, was the thing which was newly introduced by the plaintiffs for the purpose of incandescence. Zirconia or zirconia and magnesia mixed, whether in complex or fine threads, were well-known incandescent bodies. That which the patentee put ultimately was a compound of the well-known zirconia used for that purpose with lanthanum, to which might be added yttria or its equivalent. Instead of having that compound—those two elements which represented the essential features of this compound—the defendants had only got zirconia, and they had no equivalent whatever for the cerite group; it was their intention to use simply erbium, which, of course, was not in that group at all. It was not one of the cerite group. It was no doubt one of the yttria group, but it was a thing as well known as yttria at the time of the patent, and if he had intended that erbia should have been an equivalent for yttria, he would most surely have mentioned it, because he knew most perfectly well of erbia and knew actually at the date when he filed that complete specification that erbia would do because he had mentioned it in a document of even date. He knew that erbia would do. He had discovered it already. But he knew that it would give a green light, and so he failed to put it in that specification and put it in another specification which he filed on the same date, or rather two days before he filed the complete specification of this patent, and it was therefore submitted that, looking at the facts, there would not be an infringement. In the present specification the claim was limited in two ways. What was claimed in the specification was "the manufacture substantially as herein described of an illuminant appliance for gas and other burners consisting of a cap or hood made of fabric impregnated with the substances mentioned and treated as set forth." It was to be "made of fabric." It was only a minor point, but it was submitted that the defendants' cap or hood—if it were a cap or hood, which was somewhat doubtful—was not a fabric at all. It was a fringe. By reference to Murray's Dictionary, or any other standard dictionary, it would be seen that it could not be contended for a moment that a thread was a fabric. Threads were the things out of which you made a fabric. The threads in the defendants' fringe were not knotted together or connected together in any way. There was simply a platinum wire on which were knotted separately all those threads. The defendants' structure had several advantages. One was that it could be turned lower or turned on full. The plaintiffs' must be either full on or it must be out. One of the great advantages of the defendants' particular form was that you could turn it up or down, which made it convenient for many purposes. It would have been easy in this specification if it had been intended to include separate threads to have put in that phrase which was put in a specification of two days before by the same inventor, viz., "instead of using a fabric a number of separate impregnated threads may be used."

Dr. Otto Hehner, past president of the Society of Public Analysts, examined by Mr. Bousfield, Q.C., said that in his opinion the cerite earth mentioned in the Welsbach specification as an equivalent of lanthanum did not contain any substantial proportion of the ytterite group, nor did the ytterite earth mentioned as a substitute for yttrium contain any substantial proportion of the cerite group. There was no indication in this specification that the ytterite group would serve as a substitute for lanthanum, nor at the date of the specification was there any common knowledge of these earths being so employed as mixtures. Nobody with the knowledge of the time would come to the conclusion that lanthanum or its equivalent might be left out altogether. When he first tried to make mantles according to this specification he was not able by following the directions to make a mantle at once without experiment.

Sir Henry Roscoe, examined by Mr. Bousfield, Q.C., said that, taking the knowledge at the date of the Welsbach specification as to these rare earths, that knowledge would not in his opinion have enabled him or a competent chemist to say that other compounds than those mentioned in the specification would serve the purposes which the patentee had in view. There was no indication that the ytterite group, or any member of that group, would serve as a substitute for lanthanum in the patentee's compound. He should not have been able to tell that a mantle made of zirconia and erbia would have the same properties as one made according to the specification.

Cross-examined by Mr. Moulton, Q.C.—Knowledge had greatly advanced since the date of the Welsbach specification. It seemed to him that the general idea of the mantle composed of knitted fibre—vegetable or animal fibre—impregnated with some salt of an earth or earthy material was known before the date of the Welsbach specification.

Re-examined by Mr. Bousfield, Q.C.—There was no doubt that the incandescence and the colour of erbia was well-known to Welsbach, and he did not understand why, if erbia was one of the class of bodies that Welsbach wished to include, he had omitted it.

Dr. A. Dupré, vice-president of the Institute of Chemistry; Professor V. B. Lewes, Professor of Chemistry of the Royal Naval College, Greenwich; and Mr. C. W. Sugg were also called in support of the defendants' case.

Counsel on both sides having addressed his Lordship.

Judgment was reserved.—*Times.*

THE PRIVATE BILLS OF 1896.

While it is satisfactory to have to record that the number of Private Bills promoted in the present session, which are of an engineering character, is greater than that of last year, it is still more satisfactory to note that the money to be spent on the projects they petition for is largely in excess of the sum applied for during the same preceding period. In the category specified are included all the Private Bills relating to railways, canals, tramways, and the supply of gas, electricity, and water. Of such the total number amounts to 157, which compares advantageously with the total of 129 of session 1895. But although the difference in point of absolute enumeration does not surpass 28, the total amount of money proposed to be raised, partly as capital and partly by loan, is not far from twice the amount asked for in the year gone by, the sums being in round numbers as 41 millions and 23 millions respectively. The comparison may be put in another manner. For instance, the average cost of the 129 Bills amount to £171,317, and that of the 157 now before Parliament to £261,593, and as the additional 28 are estimated at 18 millions, each of them runs up to the average high figure of £642,857.

Railways, either as completely new undertakings promoted by independent companies, or as extensions of, and additions to, already existing lines, still continue to head the list of the sessional programme with a grand total of 60, and a length of new line of 810 miles. This statement requires at the present moment a little explanation, which will detract something from the *couleur de rose* which surrounds it. Some secessions from the Private Bill Office have taken place, among which there is one upon a scale of magnitude which must not be passed over. Omitting the smaller fry, to which we shall draw attention on some future occasion, we allude to the defection of the London and South Wales Railway Bill, the promoters of which appear to have recanted before their full profession of faith was accomplished. It is seldom that a project of this magnitude falls through at so very an incipient stage of its parliamentary career. The principal object of the company was to run a new line from Cardiff, through Glamorgan and Gloucestershire, and effect a junction with the Metropolitan Railway Company's Aylesbury Extension line at Great Missenden, Bucks. It was proposed to raise £8,000,000 capital, £6,000,000 by shares, and £2,000,000 by loan, to construct the 164 miles of track. It is only one Bill defunct, it is true, but its decease, at any rate for the present session, reduces the railway mileage to 646 miles, and the total capital of all the projects to 33 millions.

As in former years, the lion's share of the railway undertakings falls to England and Wales, which trebles that pertaining to the land o' the leal. Ireland comes third with the modest quotum of only 40 miles. If we except the recalcitrant project, the remaining railway Bills do not ask individually for very heavy capitals. There are only two which go beyond a million. Of these, one is the Portsmouth, Basingstoke, and Godalming Railway, which proposes to construct 70 miles at a cost of £2,400,000, and the other, the Caledonian, which estimates the expenditure required for 30 miles at £1,650,000. The third place is taken by the Manchester, Sheffield, and Lincolnshire Railway with a request for one million, and the Great Western and the Midland are petitioners for exactly the same sum, viz., £800,000. It may be mentioned that there are four Light Railway Bills, one of which is in Kent, another at Yarmouth, a third at Selby, and the fourth at Bideford, comprising in all 32 miles. The capital needed for them all is estimated at £266,666, or at the rate of £8333 per mile. A somewhat new departure is contemplated by the Cork, Blackrock, and Passage Railway Company, by which it proposes to construct ten miles of new line on a 3ft. gauge, to convert their existing line to the same gauge, and to authorise the Board of Trade to modify or dispense with their usual requirements as to railways. It may be mentioned that £8333 per mile is considerably in excess of the sum light railways are presumed to cost. When the question of Light Railways—Advances—was before the House last week, the estimated expenditure per mile was put at from £3000 to £3500. If they can be constructed at this cost, then the corollary may be accepted that a "light railway is essentially a cheap railway." It is to be noticed that there are no Bills promoted in this session for any new underground railways in the metropolis. There are probably two causes which have contributed to this abstention. One is that railways of this description have not proved so successful as was originally anticipated, and the other that during several recent sessions very important Acts have been passed for the construction of underground lines in London of some pretensions to mileage.

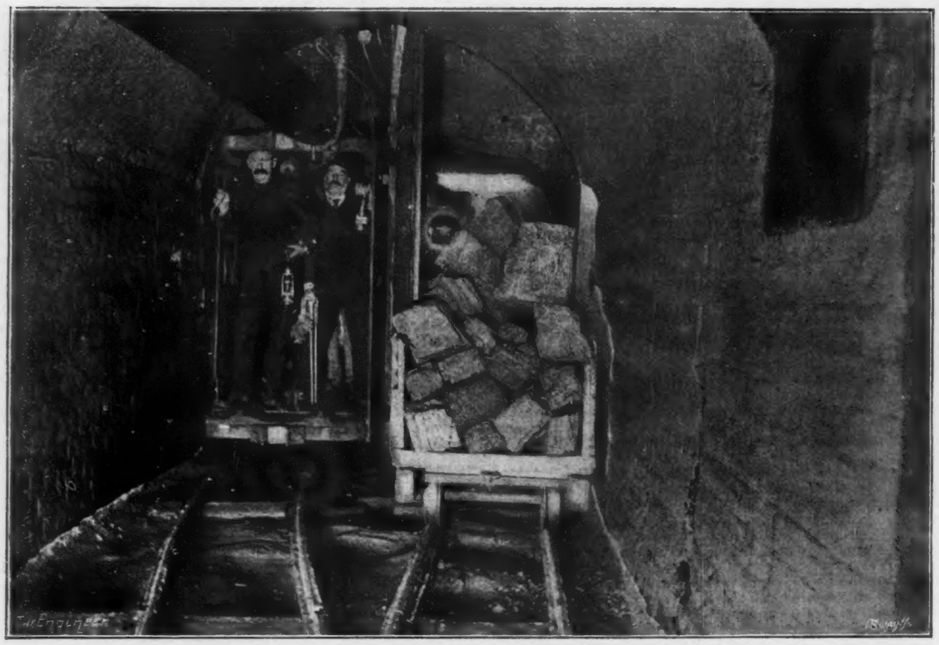
Of Canal Bills there are twenty-nine, which are usually grouped with those we have already categorised, as there is frequently a very common bond of interest between the two classes. As an instance we may select the largest and most important of the inland navigation schemes. It is that of the Bute Docks, Cardiff, which, in addition to its proposal to acquire the canal undertakings of the Glamorganshire and Aberdare Canal Companies, asks for powers to construct 50 miles of new railway, and to raise for its entire project the sum of £1,330,000. Although but a poor competitor in the department of railway extension, Ireland comes fairly to the fore with respect to tramways, quadrupling the contribution of Scotland, and taking £625,000 as her share of the total amount of capital required for the whole of the tramways. The respective mileages for the three countries are, 73 miles for England and Wales, 24 miles for Ireland, and six miles for Scotland. In this class of Bills, Sheffield is far in advance of any other town, as the efforts of two independent companies are directed towards obtaining £900,000 for the development of their two undertakings, part to be allotted to the construction of new lines and part to the substitution of whatever mechanical power may be considered the most advantageous. So far as London is concerned, the Tramway Bills in point of number are about on a par with those for underground railways. One, the London Tramways, seeks to construct about 1¾ miles of double track, chiefly consisting of the doubling of existing lines, for which no capital is asked. The remaining one, the London Council desires merely to run a tram over its proposed new Vauxhall Bridge, so as to join up the present Vauxhall and Victoria line with those on the Surrey side of the river. An important new undertaking is that of the Halifax and District Tramways. Its object is to incorporate a company for the construction of lines, to extend the time for purchase of tramways, and to raise £250,000 as new capital. Swansea, Portsmouth, Blackpool, and Fleetwood, are all investing over £100,000 in the construction or extension of the tramway system.

Under the title of Water Bills a large proportion in reality are Gas and Water Bills. As a Water Bill pure and simple, that of the New River Company heads the list, with a very large margin between it and the next comer. It petitions for further powers for the execution of new works, the purchase of additional lands and for other purposes. Notwithstanding the attack upon the "eight companies," it evidently intends to hold its own, and the couple of millions of capital it proposes to raise will, if needed, help to supply the sinews of war. The Fylde Water Company ask for nearly a third of a million, and the remaining Bills call for no especial notice, if we except that for the incorporation of the Staines Reservoir Joint Committee representing the Grand Junction, West Middlesex, and New River Water Companies. Debenture stock is to be issued to the value of £1,000,000, and the Thames, the Wraysbury, and Colne Brook are to be laid under contribution to furnish a supply. There are only two Gas Bills which can be regarded as of any magnitude, having regard to the fact that we speak of millions now in the same ready and *nonchalant* manner in which we were once accustomed to mention thousands. They are those of the Newcastle-upon-Tyne and Gateshead Gas and the Cheltenham Gas, with respective capitals of half a million and of a fifth of that sum. If we quote the Bournemouth Gas and Water Compound Bill, with its £375,000, it will close the list in this category. Electric lighting projects are nearly all included under Provisional Orders, and the three that figure as Bills belong to one Tramway and two Railway Bills, and are comparatively insignificant as public measures. We shall allude to the Provisional Orders subsequently.

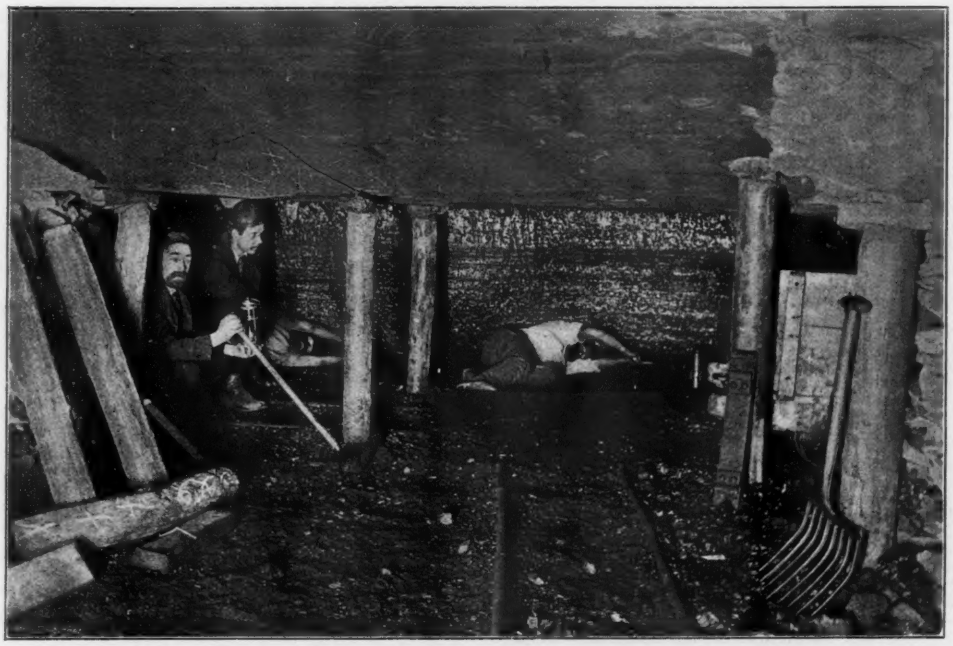
Death of Mr. John Swain, Jun.—We are sorry to have to announce the death, at a comparatively early age, of Mr. John Swain, jun. Mr. Swain has done as much perhaps as any man now alive, to develope the art of newspaper illustration. The pages of The Engineer have borne testimony week by week to his labours. As the active head of one of the largest, if not the largest engraving establishments in the world, it is beyond question that Mr. Swain's zeal and energy induced overwork, with the usual deplorable results to his health.

Death of Mr. Hackford.—We have to announce the death of Mr. George Hackford, F.S.I., of No. 6, Queen Anne's Gate, S.W., which occurred on the 25th inst., at Wandsworth, in the 71st year of his age. Mr. Hackford was born at Boston in Lincolnshire, and early in life entered the office of Messrs. Kirk and Parry, contractors, of Sleaford, and ultimately became their travelling manager. For the last thirty-five years Mr. Hackford, at Queen Anne's Gate, acquired a large practice as a quantity surveyor, very largely in connection with the Great Western Railway Company, and with other railway companies. One of the departments of his business in which Mr. Hackford's loss will be most deeply regretted is the duty of arbitrator, which he so frequently undertook, in all questions relating to contracting disputes. Mr. Hackford's great qualities were, an immense knowledge of all details of cost and construction, the independent position he held, free from all influence, and the unfailing courtesy he gave to all with whom he was brought into contact in business transactions.

VIEWS IN THE PENTRICH COLLIERIES, DERBYSHIRE



HARTINGTON PIT BOTTOM—SURVEYORS ASCENDING



GATE AND COAL FACE UNDER CUTTING

UNDERGROUND PHOTOGRAPHS.

Pentrich Collieries are situated in Derbyshire, near to the village of Pentrich, historically celebrated as the place at which the Pentrich revolution had its origin in 1818. These collieries have been worked by the present proprietor, Mr. W. C. Haslam, and his forefathers, for four generations. The present winding shafts are the Speedwell shaft, which was sunk to a depth of ninety-five yards, in 1841, to work the hard and soft coals, whilst the Hartington shaft was sunk in 1880 to a depth of 160 yards, to work the furnace and Silkstone seams.

Hartington pit bottom.—The photograph above shows the Hartington pit bottom, protected on each side by a brick arch. The cage containing the surveyors is just commencing its upward journey, whilst awaiting the empty cage is a tub of coal, marked with the figure 8, which indicates to the weighmen at surface the name of the men by whom it was cut. Running near the crown of the arch is the steam pipe, which, after leaving the boilers at the surface, traverses the shaft and supplies steam to an underground engine which works the furnace coal haulage plane. Fixed on the right-hand side of the arch, and close to where the onsetter works, is a code of shaft signals, by means of which the onsetter communicates to the engine driver at surface when men or coals are to be raised. On the back of the pit bottom the electric light is shown burning brilliantly in the underground office.

Hartington level—bringing coal to the pit bottom.—Running an angle to the pit bottom is a level along which all coal is brought to the pit bottom; it also serves as a travelling road to and from the workings, and is the principal intake airway. Near the roof is the haulage rope. The assistant onsetter is in the act of lowering the trams towards the pit bottom; behind is the under-manager, whilst in the distance is the tram coupler getting the trams ready for the different districts to which they are going.

Overcast or air crossing.—At a distance of 250 yards from the pit bottom, and forming part of the furnace coal engine plane, is an overcast, which is an arrangement common to most mines, and by which two currents of air are isolated from each other and made to travel in different directions. The intake or pure air travels opposite to the direction in which the men are coming, and after travelling in that direction 650 yards, it is split into two currents, which branch off to the right and left of the engine plane and supply the faces with fresh air. After traversing the faces, these two currents are again united, by one of such currents crossing the overcast, after which they are conveyed to the upcast. The figures shown on one of the bearers indicate when the overcast was last repaired.

Refuge place.—The furnace coal incline continues in a straight line to a distance of 720 yards, and has an average dip of 1 in 7, and, in order to comply with the Act of Parliament, places of refuge are made every ten yards, so that, should anyone be travelling on the plane when the rope is at work, they may find a place of safety near at hand until the train has passed to a safe distance. The man on the front of the drift, which consists of twelve trams, is constantly in charge of the train, and stops or starts the engine by electric signals given from any point in the plane to the driver of the haulage engine. The speed of the train is from six to eight miles per hour.

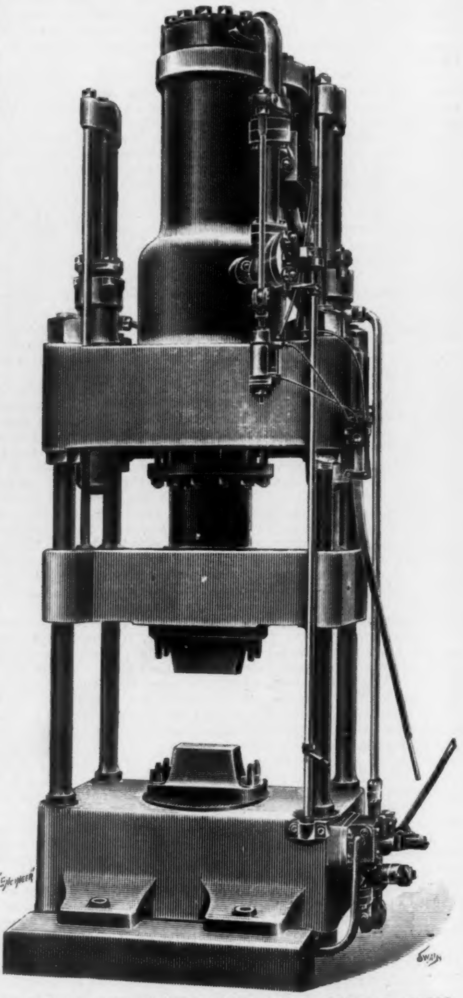
Gate and coal face.—Branching off from the engine plane, the coal face is reached at a distance of 360 yards, and each working place, called a stall, is forty yards long. The thickness of the coal is 3ft. 7in., with excellent roof but very hard floor, which necessitates the holing being done in the coal. Roadways are maintained to each working place, and these are formed by building two walls or packs in a straight line and from 9ft. to 10ft. apart. In order to obtain height for horses and men to travel along, about 3ft. of roof is blown down; such forms a gateway, as shown on photograph, which also shows the tramway along which trams pass to and from the working place. On one side is shown the fork with which the smaller pieces of coal are loaded into the trams. The prop with X marks has been broken by the weight of the roof. Behind the lip of the gateway is the coal face, showing the way in which it is timbered. The two men shown at work under the coal face are "holers," and hole the coal to a depth of 4ft. or 5ft. The working face extends to an equal distance on each side, along which trams are taken to be loaded with coal. One tram is partly shown on the right-hand side. The section of the coal face is clearly shown, and consists of 12in. of very best house coal at the top of the seam, the remaining thickness consists of a second house and steam coal. The X marks on the lip indicate to the workmen a break which needs attention. The manager, Mr. Walker, is on the left, making his daily inspection, carrying with him the most delicate gas testing apparatus in the form of Stokes' alcohol flame lamp.

Speedwell pit bottom.—Speedwell pit was sunk in 1841 to a depth of 95 yards, from which point the hard and soft coal seams are worked. These two coal seams yield excellent qualities of best house coal and best steam coal. The photograph shows the pit bottom, supported by timber, and on the right-hand side are to be seen the electric cables, signal wire, &c. The cage is shown full of men ready to ride to the surface.

For many years the water at Speedwell pit was pumped from the dip workings by a pump worked by a rope, suspended from the roof timbers, but in 1894 this arrangement was found insufficient, and to replace it an electric plant was put down consisting of a dynamo on the surface, a motor, and three-throw pump erected near the bottom of the dip workings, 450 yards to the dip, and discharge through 450 yards of 3in. pipes, with a head of 195ft., 3000 gallons of water per hour. The cables are run down the road. The electric lighting and pumping plant was designed and put to work by Mr. de Grave, engineer to Messrs. J. Davies and Son, of Derby, the photographs we reproduce being taken by the same gentleman, who is an ardent amateur photographer.

HYDRAULIC FORGING PRESS.

The press illustrated by the engraving below, is double-powered, and can be worked at either 100 tons or 200 tons power at will, the change being effected by the simple movement of a lever, so that, upon the same forging, the two powers can be applied, as required when some parts of the forging require less pressure than others, or when it is being finished the low pressure can be used for planishing. It is fitted with a pressure worked main valve, operated with ease by the workmen, who only have a small valve to move. It can be worked up to forty to sixty strokes per minute, the longer strokes being of course fewer, and in inverse proportion to the length.



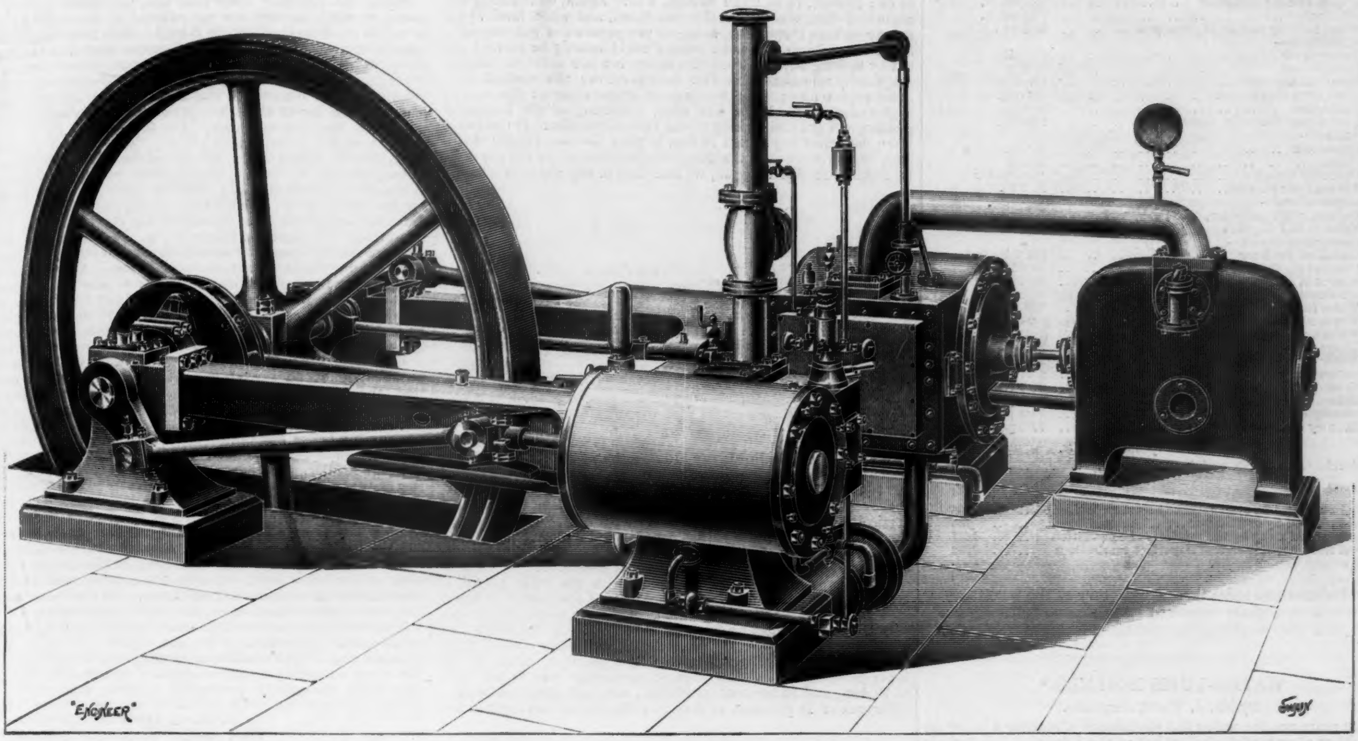
FIELDING AND PLATT'S HYDRAULIC FORGING PRESS

The total stroke of the ram is 30in., the space between the columns 4ft. 9in. by 2ft. 6in., the maximum height between the faces to which the tools are bolted being 4ft. 6in.; it is worked with the standard pressure of 1500 lb. per square inch, but can of course be modified to work at any other pressure. The press, as shown, is also fitted with a cylinder in the bottom table, this being used for some class of stamping work. It can be used not only for stamping purposes, but also for all kinds of work for which steam hammers are generally employed. It is stated by the makers, Messrs. Fielding and Platt, Gloucester, that in the majority of cases these presses will do quite twice as much work at one heat as a steam hammer of anything like equal cost.

The Bombay Municipality is at present considering whether it would be profitable to introduce petroleum automobile traction for meat and rubbish carts.

COMPOUND CONDENSING ENGINE AND MULTITUBULAR BOILER

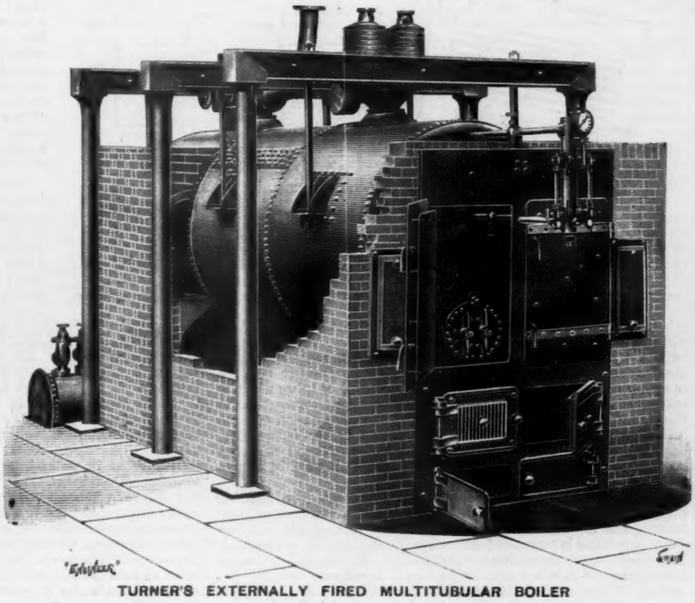
MESSRS. E. R. AND F. TURNER, IPSWICH, ENGINEERS



RECENT AMERICAN LOCOMOTIVE PRACTICE.

It would appear from an article in the *Railroad Gazette* of February 14th that some important discoveries concerning the locomotive engine have lately been made in America. They will not perhaps be considered very novel on this side, having been perfectly well-known, in fact, from periods ranging from twenty to fifty years. All the same, they are rather interesting, as showing that much careful observation is directed to locomotive working, and as confirming results obtained here long ago.

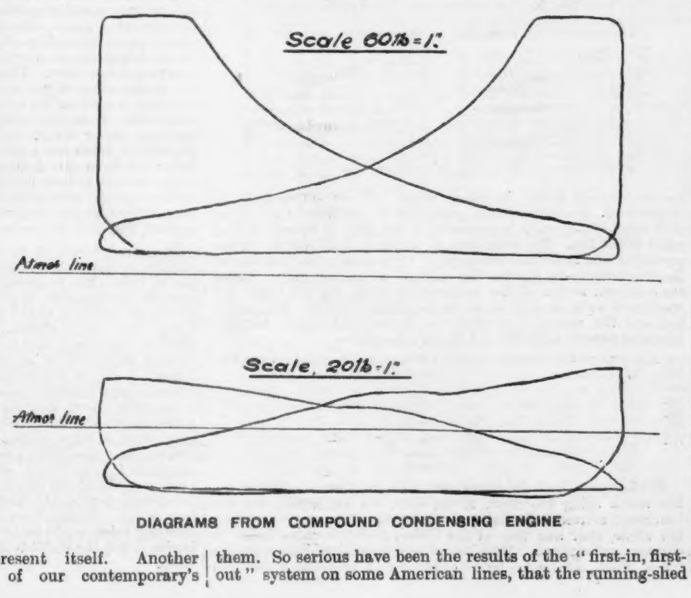
Amongst several other things it seems to have been lately found out that superfluous weight in pistons, crossheads, and other reciprocating parts is decidedly bad, and that it would be a great improvement to make them as light as possible consistent with the necessary strength. Pistons of wrought iron or cast steel, weighing about half as much as the old cast iron ones, are coming into use in America. So long ago as 1852 Mr. J. E. McConnell, then locomotive superintendent of the southern division of the London and North-Western Railway, introduced wrought iron pistons, forged solid with the piston-rod, which for lightness and strength have probably never been surpassed, whilst the steadiness of the engines fitted with them was remarkable, even at speeds closely approaching 80 miles an hour. The evil of heavy reciprocating masses has been found greatest with the very small coupled wheels commonly used under American goods engines. These wheels average probably 4ft. in diameter, and as they have to turn pretty fast to produce the most moderate speed, the action of so much dead weight, in the shape of enormous connecting-rods and counter-balances, is noticed to "take it out" of 70 lb. rails considerably. The English practice of larger wheels for goods traffic is approved by the *Railroad Gazette*, which recommends 5ft. 6in. as a suitable size. On the North-Eastern Railway Mr. Fletcher built a number of six-coupled goods engines with wheels of this size nearly twenty years ago, but the 5ft. goods commonly found in this country are constantly used for fast and heavy excursion traffic, where "Consolidation" or "Mastodon" engines, with a crowd of little wheels, would be virtually useless if the precise kind of traffic they were built for failed to present itself. Another hardly "up-to-date" discovery of our contemporary's is, that the system of giving no drivers or firemen engines of their own, but putting them instead on the first which is ready, leads to their taking no care or thought whatever of the machines. They will do no more small repairs than they can help, naturally feeling that the next set who have the engine may be credited with them if they do, whilst they leave other men to find out defects and get the blame for them. So serious have been the results of the "first-in, first-out" system on some American lines, that the running-shed expenses have increased 11 per cent. under it, whilst the mileage run by the engines between heavy repairs has decreased from 20 per cent. to 24 per cent. The method practised in England from the earliest days of railways, that of giving each driver and fireman an engine of their own, and having a certain proportion of men to take the places of others who may be off their regular turns through illness or injury, is found to be the only really satisfactory way of working.



TURNER'S EXTERNALLY FIRED MULTITUBULAR BOILER

Strange to say, even that venerable British institution, the six-wheeled tender, has been found to possess some merits, especially for express work, where the stoppages are short, and drivers having not too much time to examine their engines, can spare very little for a cumbrous affair with pivots and wearing surfaces right underneath. It is said that some American engineers are afraid of six-wheeled tenders on bad roads, but we can inform them that they very seldom get off the line unless the engine has done so first. In simplicity of construction and facility for inspection or repair, the English tender is far superior to any vehicle of the kind mounted on bogies, and we are not aware that it has been proved to require more pulling than the latter type. The friction of eight wheels, 30in. or 36in. in diameter, as compared with that of six 48in. or 54in. wheels, must quite neutralise any benefits derived from the somewhat more flexible action of the bogies of the American tender.

That single driving-wheels, upon lines sufficiently level for them, are the best for high speeds, is another tardy but recent discovery in America. As we write it is announced that the Philadelphia and Reading Company is so satisfied with the 7ft. single, No. 385, built by the Baldwin Works last year, that it has ordered another just like it. At their present rate of progress our transatlantic cousins will soon know a good deal about locomotives, possibly even to the extent of finding out that it is quite impossible to get 97 miles an hour out of a six-coupled engine.



DIAGRAMS FROM COMPOUND CONDENSING ENGINE

TURNER'S HORIZONTAL CONDENSING ENGINE AND MULTITUBULAR BOILER.

The annexed engravings illustrate a compound horizontal condensing engine and externally-fired multitubular boiler, made by Messrs. E. R. and F. Turner, Ipswich, and working at the battery of the Roodeport United Gold Mining Company, Witwatersrand, where they have been tested with the results we give below by Mr. C. T. Roberts, The engine has cylinders 14·5in. and 26in. diameter and 36in. stroke, and it is fitted with the Turner-Hartnell crank-shaft governor. It is of the girder type, and is fitted with a simple form of injection condenser. The diagrams below are from the engine, taken when the revolutions were 71 per minute, boiler pressure 116 lb., vacuum 19·5in., and barometer 24·2. The mean effective pressure shown in the high-pressure cylinder, 41·8 lb., and indicated horse-power 88·0. The mean pressure in the low-pressure cylinder is 10·4 lb., and the indicated power 70·0. The following figures are from the report mentioned:—Average indicated horse-power, 173·4; water used per horse-power per hour, including that condensed in jackets and lost by radiation between boiler and engine, 18·6 lb.; coal consumption per indicated horse-power per hour—Transvaal coal—3·47 lb.; equivalent consumption in Welsh coal, 2·12 lb.

The construction of the boiler will be gathered from the above engraving, a feature being the method of supporting it so that the brickwork of flues and furnace have none of its weight to carry, and both boiler and brickwork are freed from any of the stresses which arise from restriction of expansion and contraction movements which occur during heating and cooling. In the engraving a portion of the brickwork setting and side flue is broken away to show the method of suspension of the boiler and formation of the flue. The principal dimensions are:—Length, 16ft.; diameter, 6ft.; number of tubes, 64; diameter, 4in. The duration of the test was four hours. The boiler was supplying steam to the engine above described, which was driving seventy stamps, three pumps, two stone breakers, and two sorting trays. A Green's economiser is used for heating the feed-water. The usual rating for a boiler of this size is 100-horse power, *i.e.*, it should be capable of economically evaporating 3000 lb. of water per hour from 100 deg. to 100 lb. pressure.

The total heating surface is	1250 sq. ft.
Grate area	3·75 sq. ft.
Ratio of heating surface to grate area	33·3 to 1
Temperatures—	
External air	65·5 deg.
Boiler-house	84 deg.
Gases leaving boiler	374 deg.
Gases after economiser	236 deg.
Feed-water	70 deg.
Feed-water after economiser	203 deg.
Pressures—	
Barometer	24·2in.
Steam	112 lb.
Chimney draught	·4in. water
Air used per lb. coal	21·7 lb.
Analysis of coal—	
Carbon, ·603; moisture, ·038; ash, ·209	
Value in B.T.U., 9178	
Consumption of coal—	
Coal fired per hour	601·7 lb.
Coal per sq. ft. of grate per hour	16·02 lb.
Weight of clinker and ash produced per cent	30·6
Feed-water—	
Water fed to boiler per hour	3335 lb.
Water evaporated per lb. of coal	5·54 lb.
Water evaporated per lb. of combustible (actual)	7·01 lb.
Water evaporated per sq. ft. of grate per hour	88·8 lb.
Water evaporated per sq. ft. of heating surface	2·6 lb.
Moisture in steam	2·37 per cent.
Efficiency of boiler	61·3 per cent.
Efficiency of economiser	35·5 per cent.
Economy effected by economiser	11·6 per cent.
Efficiency of boiler and economiser combined	73·5 per cent.

Balance Sheet of Heat Units.

Calorific value of 1 lb. coal, T.U.	9178
	9178
Heat expended in evaporating the water, T.U.	5623
Heat utilised by economiser	736
Heat carried away by the products of combustion	1307
Heat lost by radiation and imperfect combustion	1512
	9178

Mr. Roberts concludes that, satisfactory as the results were, they would be slightly improved by using two boilers in place of one, and thus enabling the coal to be burnt more slowly.

WATER-TUBE BOILERS.*

By Mr. J. WATT, Associate.

SOME years ago the writer had the honour of reading a paper on the subject of water-tube boilers before the Liverpool Polytechnic Society, and, after enumerating the points which constituted a good water-tube boiler, deduced therefrom the following rules or laws which should be observed in designing a trustworthy steam generator. They were as follow:—(1) "The tubes should be arranged in a position to absorb the greatest amount of heat, by causing the flame to travel in an upward direction at right angles to their axis. (2) The tubes should be in a horizontal or inclined position, as the most efficient to emit heat. (3) The steam generated should have free and unobstructed escape to the steam receiver. (4) The circulation or supply of water to the tubes must be copious to prevent overheating. These are the theoretical, and form the essential, conditions of an efficient water-tube steam boiler. But, in addition to these, there is another not the less important which concerns the practical part or life of a boiler, viz., the facilities for inspection, cleaning, and repairing."

It is twenty-two years since the above was written, and, although old, it is quite as applicable to day as then, and, as far as the writer's experience goes, quite borne out by practice. There is, perhaps, no water-tube boiler made that will fully come up to all the requirements here laid down, but the nearer we can approach this standard, the more perfect and successful will be the boiler; and by applying this standard to any existing boiler, we are enabled to point out, not only its merits, but also its defects. It is not the writer's intention of going over the whole range of this subject of water-tube boilers, but to lay before you the result of a few experiments, which may elucidate and explain some of the many mysterious circumstances connected with this complex subject.

FIG. 1.

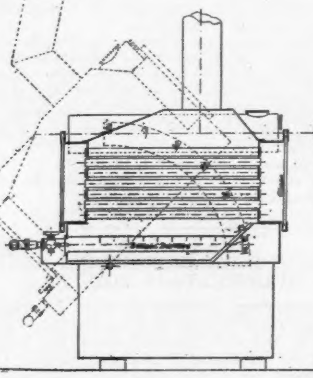
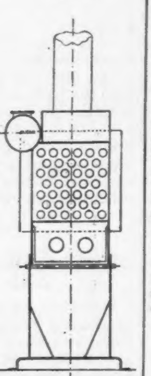


FIG. 2.



A water-tube boiler may be defined simply as an assemblage of tubes filled with water and placed over a fire. The ends of the tubes are fixed to two receivers, which combine the whole together. If the receivers be cylindrical where the tubes fit, then the tubes are more or less bent to suit; if flat, the tubes are generally straight. The advocates of bent tubes claim the bending as important in taking up or accommodating themselves to the expansion of the boiler when under steam. On the other hand, those who advocate the straight tubes find no difficulty arising from this point. Straight tubes offer the best advantages in respect of inspection, cleaning, and renewals. The experiments were made with a small model boiler—see Figs. 1 and 2—containing thirty-nine straight tubes, each ⅜in. diameter by 9in. long, containing 2·9 square feet of heating surface. The receivers to which the tubes were attached were flat, the end plates were of glass, so that the tubes could be seen right through, and the action going on inside could be distinctly observed. A steam receiver was also placed on the top, connecting the other two receivers. Heat was supplied by two Bunsen burners, consisting of two tubes with cross slots, the heating taking place being very much similar to that of an ordinary fire-grate furnace. The model was so constructed that it could be used or tried in a great number of different positions. The object of the first series of experiments was made with a view of finding out the relative value of heating surface when the tubes were angled from a horizontal position gradually to that of a vertical one, or through an angle of 90 deg. The experiments were conducted at atmospheric pressure, and commenced by first raising a given weight of water to the boiling point, and then ascertaining the amount evaporated after an interval of fifteen minutes.

After a few preliminary trials it was found that when the boiler was angled about 10 deg. from the horizontal, the evaporation was highest, viz., 8½ oz.; when the angle was increased to 15 deg., the evaporation was 8¼ oz.; 30 deg., 7½ oz.; 45 deg., 6½ oz.; 60 deg., 5¾ oz.; 75 deg., 5½ oz.; and 90 deg., 5 oz. Again, on reducing the angle to 5 deg., the evaporation was 8¼ oz., and when level 7½ oz. It may be here stated that, owing to the pressure of gas varying a little, very seldom the same results could exactly be arrived at; but by making several trials the above is a fair average. This is graphically represented in Fig. 3—top curve; the vertical ordinates representing the percentage of evaporation at the various angles at which the boiler was tried, beginning at the horizontal position and gradually rising to the vertical position. It was found when the boiler was angled 10 deg. it gave the best result; therefore, 10 deg. represents the maximum evaporation, or 100 per cent. In looking at this diagram, we find that in any water-tube boiler whose tubes are inclined, say, 10 deg., by merely increasing the angle to 30 deg., the amount of water evaporated is reduced from 100 to 85, or 15 per cent. less. If the angle be increased to 60 deg., the decrease will be 33 per cent. And at 90 deg., or the tubes vertical, the reduction is a little over 40 per cent. This compares very favourably with the old-fashioned rule employed in the ordinary steam boiler, of allowing two square feet of vertical heating surface to be of equal value to each one of horizontal.

FIG. 2A.

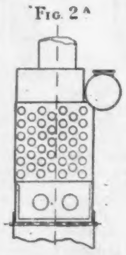
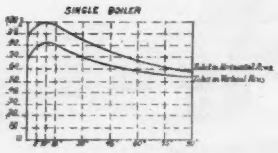
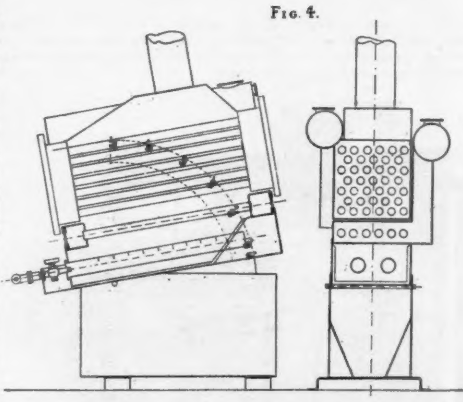


FIG. 3.



These experiments were conducted with the tubes placed in horizontal rows, so as to allow the products of combustion to travel in a zig-zag direction to the funnel. The next series were taken with the boiler turned on its sides, so as to form the tubes into vertical rows, and give the products of combustion a more direct course to the funnel—see Fig. 2A. The result is shown by the lower curve on Fig. 3. The highest percentage was 82 per cent. at 10 deg., and 53 per cent. at 90 deg., the best result showing a difference of 18 per cent. in favour of the former arrangement of tubes. Instructive as these tests may be, the next series will show still more striking results. In order to arrive at the duty performed by various tubes or rows of tubes, and more especially those nearest to the source of heat; if we take another boiler—or rather a part of a boiler representing that row of tubes which is nearest to the fire—and place the two together, as represented in Fig. 4, we have the means of arriving at the evaporation of each boiler separately. This small boiler consists of six tubes only, having a heating surface of ·44 square feet, compared with the larger one of 2·9 square feet, or a combined H.S. of 3·34 square feet.

FIG. 4.



The results of this arrangement are represented on diagram Fig. 5. The upper curve shows the combined evaporation of both boilers, and although there is an augmented H.S. of about 15 per cent., yet there is very little difference in the amount evaporated. The lower curve shows the evaporation of the original or larger boiler, and we now see that at its best it is reduced from 100 per cent. to 40 per cent. at 10 deg., and from 60 per cent. to 17 per cent. at 90 deg. On the other hand, the small boiler is represented by the middle curve, and its evaporation at its best is 60 per cent. at 10 deg., and 45 per cent. at 90 deg. The above results may be stated in other words, viz.:—That practically 60 per cent. of all the steam generated in any water-tube boiler with tubes at any angle is generated in the first or nearest row of tubes to the fire. The remaining 40 per cent. is left for the larger portion of the boiler to accomplish. By reversing the positions of the two boilers—by placing the smaller on the top of the larger one—we can arrive at the evaporation of the top row; but this was found to be so small as not to be taken notice of. The writer had not the means of testing the intermediate rows; but the following nearest table will not be very far off:—

FIG. 5.

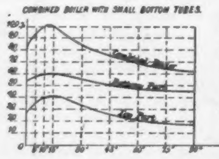
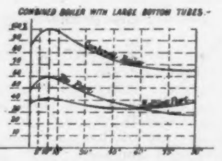


FIG. 7.

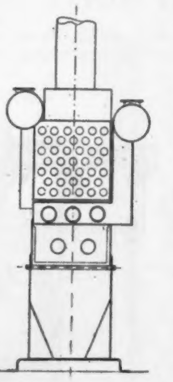


1st row nearest to the fire evaporated	60·0	p.c. of the total evaporation
2nd " " " "	24·0	" " " "
3rd " " " "	9·5	" " " "
4th " " " "	3·5	" " " "
5th " " " "	1·5	" " " "
6th " " " "	1·0	" " " "
7th " " "	0·5	" " " "
	100·0	

The importance of the above cannot be overlooked. Either the first row is doing too much or the back row too little; and the conclusion arrived at is that, practically, the first row is receiving the whole wear and tear of the boiler, therefore more liable to damage and renewals. This has proved itself in the case of copper tubes, which, although a better conductor of heat than either iron or steel, yet were unable to stand the severe work they had to perform. The danger from overheating and rupture is not only very unpleasant from a stokehold point of view, but the giving way at some critical moment demands our most important consideration; in short, it is the vital part of the water-tube boiler.

Seeing this difficulty some time ago, the writer devised some means by which the first row was relieved of this heavy duty, and more laid on those immediately behind. This is accomplished by substituting tubes of much larger diameter nearest to the fire than those which are more remote. The larger tubes contain more water, and present less heating surface for the space occupied than those of smaller diameter. The result is that the evaporation is less with the larger tubes but greater with the smaller. Fig. 6 represents the arrangement. For the six ⅜in. tubes we now adopt three ¾in. tubes in their place. The weight of water in the three tubes is double that in the six smaller ones, while the heating surface remains the same. The diagram representing the results of the trial is shown on Fig. 7, the top curve as before representing the results of the two boilers. Practically there is very little difference compared with the similar top curves of Figs. 3 and 5; if anything it is slightly in favour of Fig. 7. But when we come to compare the two lower curves with the similar curves in Fig. 5, we find that they have almost changed places. Taking the top or larger boiler, the evaporation at 10 deg. is nearly 60 per cent. of the total as compared with a little over 40 per cent. shown on the former trial, the curve dropping down at 90 deg. to 27 per cent. against 17 per cent. Taking the lower boiler, representing the three large tubes, the evaporation is reduced from 60 per cent. to a little over 40 per cent. at 10 deg. with the larger tubes, terminating at 38 per cent. at 90 deg. It will be observed that the two curves cross each other when the boiler is at an angle of about 55 deg., showing that the evaporation at this angle is about equal in each boiler. From this point on to 90 deg. the smaller boiler evaporates more than the larger; but, as the angle decreases below 55 deg., the larger boiler evaporates more than the smaller. We here see that the evaporation in the first row of tubes is very much reduced, there is less liability to overheating, and accidents are reduced to a minimum. The quantity of water evaporated by the first row of small tubes was at the rate of 5 lb. per square foot of heating surface per hour, and the velocity at the end of the tubes about 3·8ft. per second. The tubes were full of semi-steam and water, so that no light could be seen at the other end; evidently these tubes were evaporating their maximum quantity with efficiency. On the other hand, with the row of large bottom tubes, the rate of evaporation was about 3·5 lb. per square foot heating surface, and the velocity at the tube ends—steam only—about 2·9ft. per second. Up to an angle of about 60 deg. a light could be distinctly seen through these tubes, the steam occupying about one-third of the area on the top side, the water underneath presenting a clear solid mass. Above 60 deg. elevation the water and steam became more or less mixed up, so that a light could not be seen at the other end. From the apparently easy manner in which these tubes were doing their work, it was evident the maximum amount of evaporation had not been reached. There was a large reserve of solid water in the tube, and the steam appeared to pass freely away without taking any water along with it. Indeed, there could not be a strong water current, for on blocking up the bottom end of one tube to the extent of reducing its area to one fourth, there appeared to be no different result. It must be remembered that the above trials were made at a pressure of one atmosphere, where the relative volumes of steam and water are as 1640 to 1. For higher pressures a corresponding rate of combustion may be adopted.

FIG. 6.



The most vital parts in any water-tube boiler, and the most easily damaged by overheating, are those tubes in close proximity to the fire. To overcome this difficulty two courses are open: (*a*) by adopting small tubes and providing for a vigorous circulation; (*b*) by adopting larger tubes and a less active circulation. Adopting the former, there is a limit both in respect to the speed of the current and the quantity of steam in contact with the heating surfaces. According to Mr. Thornycroft's experiments, at a pressure of three atmospheres, the relative volume of steam and water passing through a number of 1½in. tubes was about 5·4 to 1, and at twelve atmospheres this would equal 1½ to 1, or three volumes of steam, at an average, in each tube, to two of water. A condition of things which presents to us two evils, one is the danger arising from the tube becoming much hotter than the temperature due to the pressure. As an instance of this, there is the failure of copper tubes in water-tube boilers to stand this excessive heat. The second evil is the slow corrosion taking place, owing to part of the steam in contact with the tube becoming decomposed at a high temperature, forming oxide of iron and hydrogen gas. Some years ago apparatuses for superheating steam were placed in uptakes; but even at this low temperature their life was three or four years at the most. By the improved arrangement of larger tubes to face the first and direct action of the fire, a larger body of more solid water is in actual contact with the heating surfaces. The liability to damage by over-heating is reduced to a minimum; the duty of the various tubes more evenly distributed, and the steam generated more freely disengaged.

In conclusion, there is one point which, during the time these experiments were being made, confirmed the writer's views more strongly of a grave defect in Belleville water-tube boilers for marine purposes, and, as this boiler is now being freely adopted by our Admiralty, his humble protest must be taken from a taxpayer's point of view. Those who are responsible for the position and arrangement of this boiler on board of a sea-going vessel have evidently not given the subject of an unsteady platform any consideration. Numerous tubes have given way at sea; not that it is the only boiler which suffers from defective tubes; but in all probability these same tubes would not have given way had the boiler not been tossed about in a sea way. In many instances these tubes have been replaced by thicker ones, and in some cases by Serve tubes, with little better results. Still the true cause of their failure is not discovered, therefore no effectual remedy applied, and thus the error is repeated.

The arrangement of all water-tube boilers, with horizontal or slightly inclined tubes on board ship, should be parallel with the line of keel. But it appears to be the rule, so far as this boiler in question is concerned, to place the same across the ship. Now, the inclination or angle of the Belleville boiler tubes is about 2 deg. or 3 deg. from the horizontal, and as, 10 deg., say, is not an uncommon angle for a ship to roll at sea, it follows that the tubes will become depressed or angle reversed to the extent of 7 deg. or 8 deg. A ship to roll from eight to ten rolls per minute is not uncommon, and therefore six or eight seconds would be the duration of one roll. Now, imagine the ship rolling, a heavy fire on the grate, and in this time these lower tubes generating, as we have seen, such a large volume of steam, which would immediately reverse the circulating current, fill the upper ends and be here imprisoned, only to be relieved by the next roll. The greater portion of the steam will now be transferred to the other end, to be again re-imprisoned, and so on till the ship gets into less turbulent waters. With reference to what the continued effect on these semi-dry tubes would be in a sea-way, or in the event of the ship having a list, the result is left for your better and impartial judgment.

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* Read at the Thirty-seventh Session of the Institution of Naval Architects, March 26th, 1896.

RAILWAY MATTERS.

Mr. Piesse has been appointed Minister of Railways and Public Works of Western Australia.

The first sod of the Ahmedabad-Prantij Railway was cut by his Excellency the Governor of Bombay at Ahmedabad, on the 15th ult.

The railway companies concerned in the Royal Agricultural Society's showyard traffic at Leicester have agreed to reduce the rates for cartage to and from railway stations and the showyard to the following amounts:—General traffic, machinery and agricultural implements, 3s. 6d. per ton; machinery and agricultural implements hauled on their own wheels, 3s. per ton.

The London and North-Western Railway Company has commenced the work of tunnelling under Crewe Station. The present station will be left free for passenger traffic only, whilst goods traffic will be conducted through the tunnel, and goods sheds will be erected at Basford Wood. Several hundred men are engaged excavating, and the work, it is said, will occupy several years.

The Kington and Eardisley Railway Company has given notice that it does not intend to proceed any further with the deposited Bill for the present session. The scheme was regarded favourably from a passengers' point of view. It was to construct over twenty miles of railway to run from a junction with the New Radnor extension to a point between Llandrindad Wells and Newton, and thus form connection with the Mid-Wales and London and North-Western Railway.

The North-Eastern Railway Company has opened a new deck at West Hartlepool for the accommodation of the timber trade of the port, the work which cost between £30,000 and £40,000, being executed by Messrs. T. D. Ridley and Sons, of Middlesbrough. The work has been going on for two years, and includes a mole upwards of 800ft. long, at which six timber laden vessels can be discharged at a time. The railway company undertook the work mainly at the solicitation of the timber importers who found their trade crippled and curtailed by want of sufficient quay space.

The Prefect of the Seine was recently applied to for permission to put horseless carriages into current use in Paris, along with the public carriages of that city. The special form of motor involved is a petroleum motor. The Chief of Police reports to the Prefect that he sees no objection to granting the authority. He believes, however, that these petroleum carriages should be placed at the end of the cab stands, in order not to interfere with the free movement of the ordinary carriages in taking their places on the cab stands, and that the two kinds of vehicles should not be mixed in the line on one stand.

All the railway carriage and wagon companies, writes our Birmingham correspondent, have found a great improvement in trade since the beginning of the year, and are busy. We understand that the Oldbury Railway Carriage and Wagon Company have some large contracts for saloon carriages and wagons for the Cape Government Railways; and also wagons—four-wheeled and bogie—for the Western Australian Railways. They are also engaged on carriages for the South-Eastern Railway, Midland and South-Western Junction Railway, and the Glasgow District Subway, as well as upon hopper wagons for Spanish copper mines.

The success of electrically welded rails was recently discussed by Mr. Robert McCulloch in a paper before the Engineers' Club of St. Louis. Some 3¼ miles of double track in St. Louis had been connected up with electrically welded joints. Out of a total of 2203 joints thus treated, 3·27 per cent., or seventy-two, have parted. The fractures occurred in two successive cold snaps of last winter. Repairs were made by casting a mass of iron around the joint. The amount of opening at the fracture varied from 2in. to practically nothing. Strange to say, the heat of the following summer caused very little variation in the width of the openings.

Shortly after the Easter recess an important report on the purchase and leasing of tramways will, according to the *City Press*, be presented by the Highways Committee of the London County Council. It will be remembered that just before last Christmas the Council discussed the advisability of coming to some arrangement with the Tramway Companies with regard to the purchase of those portions of the lines which had been reconstructed under new Acts, and which did not in the opinion of the Companies become purchasable at the time that the term for the original lines expired. Since then negotiations have been in progress, and it is likely that the report, when presented to the Council, will be an agreeable surprise to the ratepayers, and one which will redound to the credit of those who took part in the negotiations on both sides.

Two locomotive boiler explosions were reported in the States during the week before last. The first took place on the Delaware, Lackawanna and Western Railroad, near Cassville, N.Y., on February 19th, killing the engineman and fireman. The train, comprising baggage and passenger cars, was running at its usual speed. The engine was torn to pieces, and the trucks left the track, the mass of broken and twisted iron toppling over into the ditch. The cars remained on the track, and no passengers were injured. The cause of the explosion is stated to have been low water. The second explosion was on February 20th, on a freight train on the Nashville, Chattanooga and St. Louis Railway, near Bridgeport, Ala. The engine was a Baldwin consolidation, and the explosion rent it into a thousand pieces, some of which were thrown hundreds of feet. The engineman and fireman were killed.

On his arrival at Coolgardie on Monday, by the first through train from Perth, the Governor of West Australia drove the last spike in the presence of a great concourse. At the luncheon afterwards, he said the ceremony was not only interesting to those actively engaged in it beneath the burning sun and on the sandy plain, but to thousands throughout the world who had millions invested in Coolgardie and the surrounding district. The welcome news of the opening of the line would be cabled to London, Paris, Vienna, St. Petersburg, and all the great commercial centres. The event, therefore, was not merely of local, but of national, of even world-wide, importance. From what he could hear, he felt convinced of the permanence of the goldfields. He therefore expected that other railways would shortly be undertaken, probably including one to place Coolgardie in direct communication with the eastern colonies.

The present week is the busiest week of the year, from the fast train point of view, with the Manchester, Sheffield, and Lincolnshire Railway Company. During the first three days they have the Lincoln races, and during the last three days the Liverpool races, including such important events as the Lincolnshire Handicap and the Grand National. On Wednesday evening, at the close of the Lincoln races, the racing world were transferred by the Manchester, Sheffield, and Lincolnshire trains from Lincoln to Liverpool, *viâ* Sheffield. All these fast and heavy trains were worked by the new class of engine Mr. Harry Pollitt, locomotive engineer, Gorton Works, recently got out as illustrated in the special double-page supplement in last week's Engineer. At Gorton there has just been turned out the first four of the sixty-six goods tender engines being built there. These are the only goods engines with Belpaire boilers, and this feature naturally makes them conspicuous. Mr. Pollitt has used them on goods and passenger tank engines for the last two years, working night and day with unbroken success, but it is a new feature entirely, even with the Manchester, Sheffield, and Lincolnshire, to have a Belpaire box on a goods tender engine.

NOTES AND MEMORANDA.

The deaths registered last week in thirty-three great towns of England and Wales corresponded to an annual rate of 19·2 per 1000 of their aggregate population, which is estimated at 10,860,971 persons in the middle of this year. The London rate was 18·8, or lower than the average of all the great towns.

In an old MS. book referring to "Steam Ploughing with Boydell's Engine, near Louth, July 31st, 1857," the following record has been found:—"Ploughed on Mr. J. Robson's land with Burrell's double-breasted ploughs 23 acres. Ploughed one acre in 73 minutes. Cost of labour and coals per day £1 12s."

A French process for preventing rust on steel and iron is said to produce a bluish coating, which does not crack or peel off, even if the metal be bent through an angle of 45 deg. The articles are subjected to a heat of 650 deg. Centigrade in a gas retort for twenty minutes, and then hydrogen is turned on for another three-quarters of an hour. This is followed by the introduction of a small amount of naphtha for a period of ten minutes; after which the hydrogen is again admitted for a quarter of an hour. The retorts are allowed to cool down to 400 deg. Centigrade, and the articles are removed.

A paper on "The Carbides of Yttrium and Thorium" was recently read before the Paris Academy of Sciences by MM. H. Moissan and Etard. Yttrium carbide, prepared in the electric furnace, is attacked readily by the halogens, with difficulty by acids. With water the carbide yields a mixture of acetylene—72 per cent.—methane, ethylene, and hydrogen, together with a small quantity of liquid hydrocarbons. Thorium carbide produced by a similar method forms a crystalline transparent mass, and gives a mixture of hydrocarbons on treatment with water of the same qualitative composition, *Nature* says, as that obtained from yttrium carbide.

The report of the committee, appointed in May of last year, to inquire into the causes of the explosion, and the precautions required to ensure the safety, of cylinders of compressed gases, states that the risks of explosion fall into two classes, viz.:—(1) risks due to negligence in the manufacture, annealing, and testing of the cylinders; (2) risks due to neglect of precautions in filling the cylinders. As the manufacture is carried on very extensively, and is likely to increase, the committee think that the risks would be reduced if there were some control of the trade of making cylinders by official inspection. They suggest that there should be a general inspection of all factories manufacturing compressed or liquefied gases. If an inspector were satisfied that the arrangements at any factory were adequate, and that the precautions laid down in this report were being taken, a certificate would be granted authorising such factories to test and mark cylinders. It is suggested that a first thorough inspection, and an occasional inspection subsequently, at intervals of about six months, would be sufficient as a ground for granting and renewing certificates.

The report of the Board of Engineers appointed to investigate the plans and cost of construction of the Nicaragua Canal for the United States Government says the most serious problems are those involved in the heavy rainfall and consequent discharges from the lake and streams, whose variations of surface and volume must be taken into account. The rainfall record at Greytown for three years shows a mean of 267in. A record at Rivas, on the west side, for fourteen years gives a mean of 65in. In addition to these there is trustworthy information of precipitation of 3in. in an hour, of 9in. in nine hours, and 35in. in eight days. A record of nearly 25ft. of water in a year on the Caribbean coast, diminished to 5½ft. between the lake and the Pacific, indicates the important results that must ensue with reference to matters of local drainage and engineering construction. In regard to the Ochoa dam, as proposed by the company, the report says this dam is to be a rock fill across a powerful river on sand foundation. A dam so constructed, the Commission says, has no precedent, and its erection in conflict with the unknown volume of the floods presents grave difficulties. The official estimate by the company is 66,466,880 dols.; by the Commission it is 133,472,803 dols.

Thorite is a bi-hydrated silicate of thorium, lime, iron, manganese, uranium, &c., containing about 58 per cent. of thorine, or oxide of thorium; and orangite is a variety of the same mineral, still richer and rarer, a sesqui-hydrate, which contains 75 per cent. of thorium. These, the principal ores of thorium, and a few others, are special to Norway, being chiefly found in veins of pegmatite on the south-east coast between Arendal and Laurwik, although only from two to three tons were produced last year. These minerals are causing great interest on account of the important part they play in gas burners of the Auer and Welsbach type. Although probably North America will be able to send away large quantities of thorine, extracted from the monazites of that country, Norway is at present almost the only source of supplying these rare minerals. On account of their extraordinary luminous capacity when in an incandescent state, thorium ores obtain fancy prices, very pure orangite realising nearly 500f.—£20—and thorite on an average 100f.—£4—per kilog.—2·2 lb. On account of the great demand for these ores, the old felspathic tips are being picked over; and prospectors cover the region, hammer in hand, seeking for thorite in the pegmatites or their immediate neighbourhood. As the Government engineer had classed thorium among metals subjected to the domanial *régime*, reports of discoveries were numerous in the office of the engineer-in-chief, who issued several thousand provisional concessions—*mutingsbreve*—extending over an area equal in size to a small English county. Competent authorities, however, protested the assimilation of thorium to metals occurring in regular lodes, which are subject to the domanial *régime*, so that the concessionnaires, to make themselves secure, entered into agreements with the surface owners. Norwegian savants are now ranged on two sides, for and against thorite being regarded as a crown mineral; and numerous petitions have been sent in to the Chamber on the subject.

According to provisional returns published by the German official Gazette, *Deutscher Reichs-und Staats-Anzeiger*, last year's total production of coal—*Steinkohle*—was 72,605,341 tons, against 70,644,069 tons in 1894, with 270,701, against 267,424 hands; and of the above quantities the Dortmund district alone produced 41,145,745 tons last year, against 40,613,073 tons in 1894, with 154,699, against 152,638 hands. This district contains no lignite—*Braunkohle*—which, however, is contributed by the four remaining mine districts, that also produce true coal, viz., Breslau, Halle, Clausthal, and Bonn, which put out together 20,292,034 tons of lignite last year, against 17,762,572 tons in 1894, with 30,044, against 28,657 hands. The quantity of coal sold or consumed last year amounted to 70,512,916 tons, showing an increase of 1,982,353 tons, or 2·89 per cent. over the figure of 1894; while the production has increased by 2·78 per cent. and the seats of working by ten, so as to attain the number of 265. Though the number of pits producing lignite has diminished by 16, viz., from 384 to 369, the total production given above shows an increase of 14·84 per cent. over the figures of 1894, while the number of hands employed has also increased. Germany's exports of mineral fuel last year amounted to 12,873,354 tons—against 12,203,994 tons in 1894—made up of coal 10,360,838 tons, coke 2,293,328 tons, briquettes 200,374 tons, and lignite 18,814 tons, of which 24,275 tons of coal went to Great Britain and 43,637 tons of coke to Australia; while her imports last year of mineral fuel were 12,819,990 tons—against 12,149,723 tons in 1894—made up of 5,117,356 tons of coal, 461,778 tons of coke, 59,806 tons of briquettes, and 7,181,050 tons of lignite, of which 4,013,067 tons—comprising 3,972,664 tons of coal, 32,801 tons of coke, and 76,021 tons of briquettes—were sent to Great Britain. Thus Germany's exports and imports of mineral fuel last year about balance one another; the respective figures being 669,405 and 670,267 tons.

MISCELLANEA.

The sale is announced, on the 8th prox., of the plant and machinery of the Cone Paper Mill, Gloucestershire, by Messrs. Fuller, Horsey, Son, and Cassell.

The Royal Agricultural Society's trials of the Potato Planters which may be entered in competition for the Society's prizes in Class I. will commence at 9 a.m. on Tuesday, April 21st, 1896, at the farm of Mr. T. Lander, Knighton, near Leicester.

Owing to the continual washing away of the Sheppey Cliffs, the Admiralty have abandoned the coastguard station at East End-lane, Minster, about four miles from Sheerness, and have established a new station in the adjoining parish of Eastchurch.

The Lachine Rapids Hydraulic and Land Company, of Montreal, Canada, have placed an order with Messrs. Nell for sixty-six 54in. cylinder gate Victor turbines, together with all the gearing, shafting, &c., for giving the power to the electric generators. The power will be transmitted electrically into the city for street railway and lighting purposes. This, we believe, is the largest contract for turbines ever placed.

The attention of intending exhibitors at the Royal Agricultural Society's Leicester Meeting is directed to the fact that the last day on which applications for space at ordinary rates can be received is Wednesday, April 1st. All entries received at 13, Hanover-square, from Thursday, April 2nd, to Wednesday, April 8th, must be accompanied by fees at double rates, in accordance with published regulations. After April 8th, no entry can be accepted under any circumstances whatever.

The great tank of the Hessarghatta waterworks is practically completed, and the water stands about 29ft. deep, not much below the waste weir. This artificial lake has an area of about four miles square. There is a very slight leakage below the bund, but this is nothing to speak of. The approach to the left waste weir which is being cut is nearing completion. The channel has been completed up to the pumping station and even beyond. The pumping plant includes three triple-expansion pumping engines of 60-horse power each.

The celebrated works, long known as the Mersey Forge, are, it will be seen from our advertisement columns, to be let or sold. The works are amongst those of most historic interest in England, through their connection with the heavy forge work of the great steamships of from a quarter to half a century ago. In them have been carried out some of the most difficult and well executed work required for the machinery of the ships that live most in our memories, and in later years a great deal of the heavy land engine shafts have been made in them. The forge contains no less than eleven double-acting steam hammers up to 12 tons, and the machine shops contain a great quantity of machinery, principally of the heaviest kind.

The Secretary of State for Foreign Affairs has received from her Majesty's Consul at Lorenzo Marquez information to the effect that the Improvements Commission of that port will, up to the end of April next, receive plans and designs for a screw-pile lighthouse for the Cockburn Bank and for a tug-boat for the pilot service. The range of the light must be ten miles, and the lighthouse must contain accommodation for the keepers. The tug-boat must be of the compound system, 100ft. in length, 8ft. draught at stern, 500 indicated horse-power, and not less than ten miles an hour speed. The boat must accommodate captain, engineers, crew of eight, and two lifeboats. Further particulars can be obtained of the Commercial Department, Foreign-office, S.W., between the hours of 11 and 6.

In consequence of the increasingly onerous duties of the Public Works Department of the Corporation of Birmingham, a re-arrangement is proposed to the city surveyor's office in order to relieve Mr. W. S. Till, the city surveyor, of some of his at present too onerous duties. He receives at present £1000 a year, with an addition of £400 a year from the Drainage Board. It is proposed that Mr. Till should give up the work of the Drainage Board, except in a consultative capacity, and that he shall receive from the Council a stipend of £1600 a year as city surveyor, instead of the £1000 a year now allotted to him. It is further suggested that a deputy or assistant colleague shall be appointed at a salary of £800 a year, £400 of this amount to be paid by the Corporation to its assistant surveyor, and £400 by the Drainage Board to its engineer.

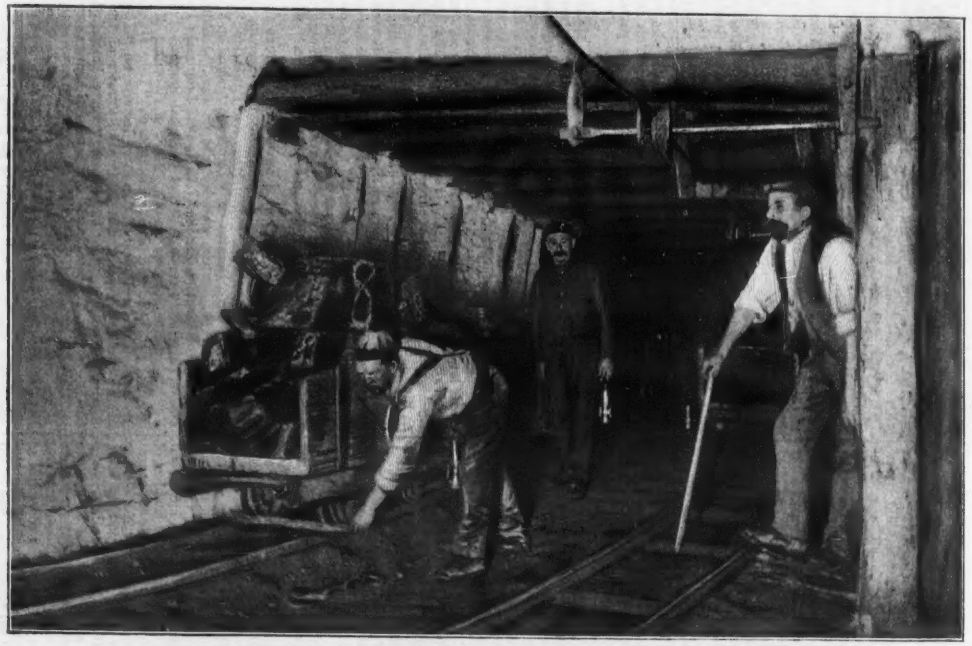
A Select Committee of the House of Commons presided over by Sir James Kitson, passed a Bill which confirms a provisional order granted by the Board of Trade to the Charing Cross and Strand Electricity Supply Corporation, authorising them to light with electricity the area of the Strand District Board of Works. The Bill has been opposed by the Metropolitan Electric Supply Company, which already supplies the Strand district, but it was put forward in evidence that, while the Metropolitan Electric Light Company uses the high-tension alternating current, the Charing Cross Company would supply low-tension direct current, which has advantages for those who require electricity for motive power and other purposes. This Bill has now received the sanction of both Houses, having passed the House of Lords before the dissolution.

The installation of the Hermite electrical sanitation process at the Victoria Military Hospital at Netley has now been working since the beginning of the year, and a visit of inspection was made a few days ago by the War-office authorities, who expressed themselves thoroughly satisfied, both with the effect on the main sewer and the effluent, and also with the remarkable improvement in the atmosphere of the various wards. The ward masters are also unanimous in their approval. The French War and Naval Departments have officially approved the system, and are considering to which of their stations it shall be first applied. The Brazilian Government have given instructions for the Marine State Hospital at Rio to be fitted with the Hermite process on the same lines as the Victoria Hospital, Netley. As to the success of the demonstrations of the Hermite process at Rio last year, it may be of interest to state that in that part of the city where the working of the plant has been continued, not a single case of yellow fever has occurred, though it is a most unsanitary spot and in previous years has suffered severely. Other parts of the city have suffered as usual from the periodical visitations of this scourge.

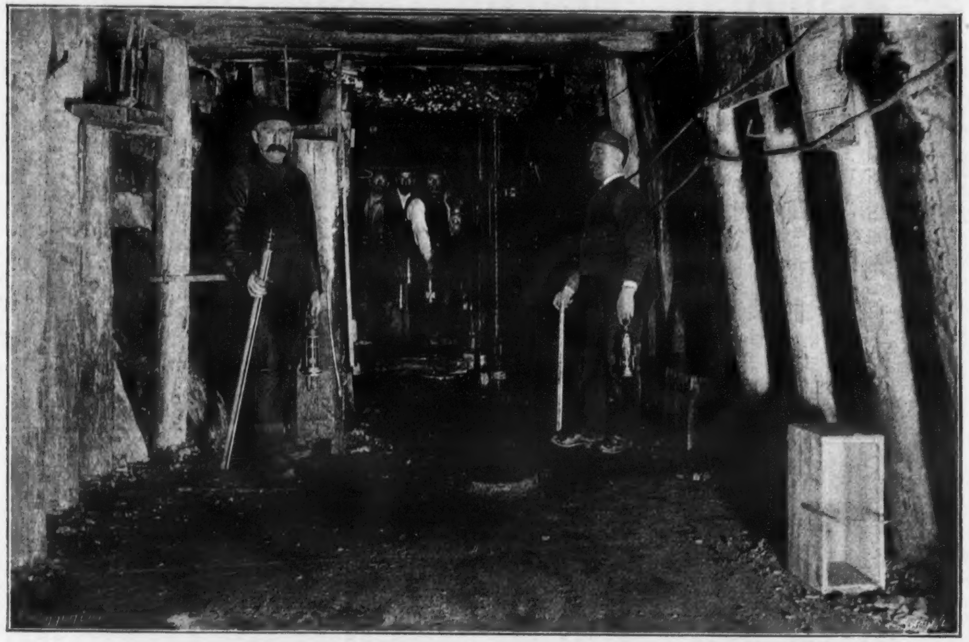
The following are the Royal Institution lecture arrangements after Easter:—Professor James Sully, of University College, London, three lectures on "Child-Study and Education;" Mr. C. Vernon Boys, three lectures on "Ripples in Air and on Water;" Professor T. G. Bonney, two lectures on the "Building and Sculpture of Western Europe" (the Tyndall Lectures); Professor Dewar, three lectures on "Recent Chemical Progress;" Mr. W. Gowland, three lectures on the "Art of Working Metals in Japan;" Dr. Robert Munro, two lectures on "Lake Dwellings;" Professor W. B. Richmond, R.A., three lectures on "The Vault of the Sixtine Chapel;" Mr. F. Corder, Curator of the Royal Academy of Music, three lectures on "Three Emotional Composers—Berlioz, Wagner, Liszt" (with musical illustrations); Mr. E. A. Wallis Budge, of the British Museum, two lectures on "The Moral and Religious Literature of Ancient Egypt." The Friday Evening Meetings will be resumed on April 17th, when a discourse will be given by Mr. G. Lippmann on "Colour Photography;" succeeding discourses will probably be given by Professor G. V. Poore, Colonel H. Watkin, C.B., Professor Silvanus P. Thompson, Professor J. A. Ewing, Professor J. A. Fleming, and other gentlemen.

VIEWS IN THE PENTRICH COLLIERIES, DERBYSHIRE

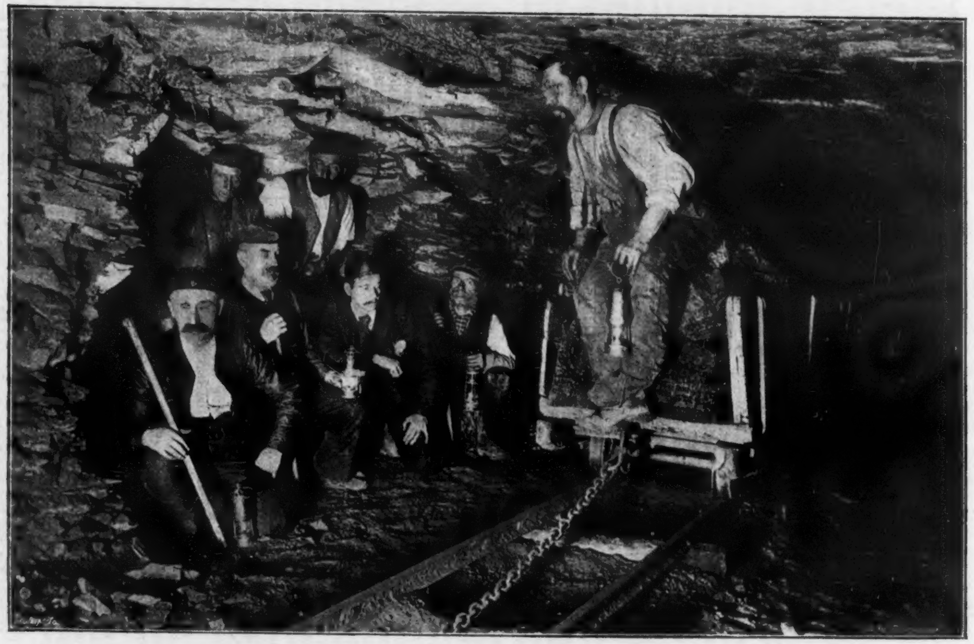
(*For description see page* 316)



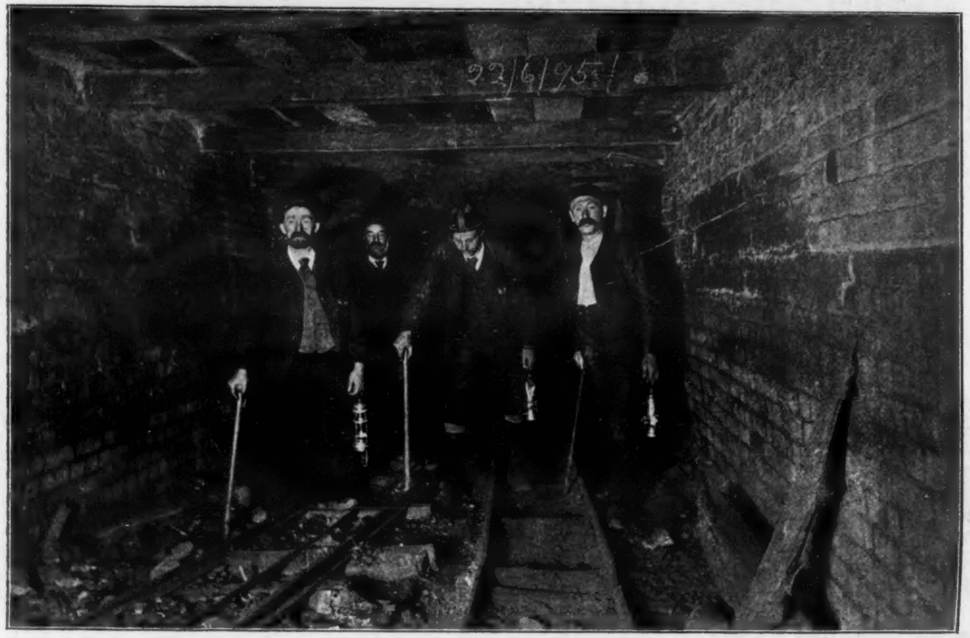
BRINGING COAL TO PIT BOTTOM



SPEEDWELL PIT BOTTOM—MEN ASCENDING



REFUGE HOLE—TRAIN OF COAL COMING UP INCLINE



AIR CROSSING

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PUBLISHER'S NOTICE.

*** *Next week* THE ENGINEER *will be published on* THURSDAY, *instead of* FRIDAY. *New Advertisements should reach the Office not later than Six o'clock on Wednesday evening; alterations to Standing Advertisements before Three o'clock on Tuesday afternoon.*

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TO CORRESPONDENTS.

Registered Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and bearing a penny postage stamp, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

W. D. F.—*See notice on page* 323.
R. H.—*Consult our advertising columns.*
W. C. (Newcastle-on-Tyne.) *No prize is offered for a wheel or for any parts as separate or apart from a complete self-propelled carriage.*
J. W.—*We have not published any account of an engine worked by ammonia gas, and we do not know of such an engine.*
E. P.—*It is impossible to answer your question without further information concerning the battery. Any of the large electrical apparatus makers in Manchester will provide you with what you require, or supply you with new dry cells, which will probably be as cheap.*

PIN-MAKING MACHINERY.

(*To the Editor of The Engineer.*)

SIR,—I should regard it as a favour if any reader would put me into communication with a manufacturer of pin-making machinery.

Newcastle-on-Tyne, March 24th. C. C.

EXTRACTING WATER FROM MILK.

(*To the Editor of The Engineer.*)

SIR,—Could you tell me where I could purchase a small vacuum still suitable for extracting water from milk? B. J.

Liverpool, March 21st.

MUSTARD MACHINERY.

(*To the Editor of The Engineer.*)

SIR,—Would you kindly give in your next issue of THE ENGINEER the address of a firm from whom I can order a mustard seed decorticator.

Dublin, March 21st. R. D. C.

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THE ENGINEER *can be had, by order, from any newsagent in town or country at the various railway stations; or it can, if preferred, be supplied direct from the office on the following terms (paid in advance):—*

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In consequence of the reduction of postage on newspapers to one uniform rate for any destination outside the United Kingdom, Foreign Subscriptions will, until further notice, be received at the rates given below. Foreign Subscribers paying in advance at these rates, will receive THE ENGINEER *weekly and post free. Subscriptions sent by Post-office Order must be accompanied by letter of advice to the Publisher.*

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*** *The charge for advertisements of four lines and under is three shillings, for every two lines afterwards one shilling and sixpence; odd lines are charged one shilling. The line averages seven words. When an advertisement measures an inch or more, the charge is ten shillings per inch. All single advertisements from the country must be accompanied by a Post-office Order in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.*

Prices for Displayed Advertisements in "ordinary" and "special" positions will be sent on application.

Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Three o'clock on Wednesday afternoon in each week.

Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, March 31st, at 8 p.m. Paper: "The Tampico Harbour Works," by D. E. L. Corthell, M.A., M. Inst. C.E.

GEOLOGISTS' ASSOCIATION.—Saturday, March 28th. Excursion to Galley Hill, near Northfleet, and Swanscomb Hill. Leave Cannon-street (S.E.R.) at 2.15 p.m. for Northfleet, arrive at 3.5 p.m. Thursday, April 2nd. Excursion to Swanage, Corfe Castle, and Kimeridge. Leave Waterloo by the 4.55 p.m. train. Excursion secretary, E. P. Ridley, F.G.S., 6, Paget-road, Ipswich.

DEATHS.

On the 20th inst., at No. 17, Holland Park-gardens, W., JABEZ CHURCH, C.E., M. Inst. C.E., of No. 55, Parliament-street, Westminster. Interment at Paddington Cemetery, Wednesday, 25th inst., at 3 o'clock.

THE ENGINEER.

MARCH 27, 1896.

THAMES FLOODS.

THE intervention of the Board of Trade has been solicited, with a view to the prevention or mitigation of the floods occasioned by the overflowing of the Upper Thames. An influential deputation has waited upon Mr. Ritchie for this purpose, and the Queen herself has addressed a communication to the President of the Board of Trade expressing her anxiety that something should be done to prevent the recurrence of these disastrous inundations, of which a notable example occurred in November, 1894. In addition, there was produced before Mr. Ritchie, by the introducer of the deputation, a letter in which Prince Christian as High Steward of the Borough of Windsor, addressed the Mayor of that town, expressing an "earnest hope" that means might be devised to remedy the evil complained of. The support of the Queen and that of Prince Christian being thus given to the appeal of a deputation itself comprised of influential representatives, it might be expected that the desired change would soon come to pass. But in the first place Mr. Ritchie explained that there was very little power at his disposal for accomplishing the purpose in view; and in the next place, the Conservators of the Thames on whose action all would depend, disclaimed the idea of being anything more than a navigation authority, pleading that they had no power to expend any money for the direct prevention of floods. If, in carrying out their proper functions, they could mitigate the severity of the floods, the Conservators were professedly quite prepared to render such service, and they were in the habit of asserting that they had already done so. Under these conditions it was obvious that the deputation had no very brilliant prospect before them. They pointed to the recommendations of a Select Committee of the House of Commons, which in 1877 was appointed to inquire into the Thames Conservancy Acts, and to report what amendments, if any, were required in order to deal more effectually with the injuries effected by floods. The Committee having carried out their inquiry, made several recommendations, and the deputation which waited upon Mr. Ritchie the other day argued that if these had been acted upon much injury would have been avoided. They now asked Mr. Ritchie, if he were able, to prevail upon the Conservators to carry out the plans which the Select Committee of nineteen years ago had thought advisable. If he lacked power for this purpose, it was asked that he would institute an inquiry into the reasons why the recommendations were not acted upon, and into the desirability of making some fresh arrangements for the control of the non-tidal portion of the Thames. The deputation wished it to be understood that they did not ask for any great drainage schemes, but they would be thankful for every inch taken off from the height of a flood.

The case was thus put in a very modest and practical form. What was the representative of the Government to say to it? Here was the Queen overshadowing all, pleading the sorrows and sufferings of the poor, as well as the effect of the floods on the general health of the district, and the fact that Eton College had to be closed for a time during the flood of 1894. The Head Master of Eton echoed this plea, and gave a graphic description of what was the result of a big flood in the Thames Valley. Mr. Ritchie was in full sympathy with the deputation, and felt the force of the royal appeal. He would make representations to the Conservators, and try the utmost of his persuasive powers in that quarter. He would try to get a member on the Board who should be independent of the navigating interest. He would give careful consideration as to whether there should be another inquiry into the question of the floods, and as to whether it was desirable to set up another drainage authority. He was prepared to admit that the Conservators were right when they said they were not a flood authority, though he was of opinion that they could do much to reduce the magnitude of the floods, by the manner in which they carried out their special functions. On the whole, we cannot gather much hope from the present state of affairs. There is one recommendation made by the Select Committee which lies out of the range of the Conservators, and for the lapse of which they are in no degree responsible. It is that for the purpose of drainage, and for the prevention of floods below Long Wittenham, the proper course would be for riparian owners and occupiers to unite and obtain powers to establish an arterial drainage authority, the work for whom, it is thought, might be conveniently carried out by the Conservators. This kind of dual control seems open to objection, as likely to result in friction and cross purposes. But the principle at the root of it is that of rates, and it is tolerably certain that if anything effectual is to be done with regard to these floods, there must be a rating power somewhere to raise the necessary funds. There has been plenty of talking, there have been sundry meetings, and there has been a sufficiency of resolutions. But nothing practical can come of it all, unless money is provided, and thus far it is the money that is wanting.

Good authorities seem to agree in the conclusion that Thames floods cannot be wholly prevented. All we can hope for is to see them mitigated. It is a problem of inches. Every inch will cost something, and a good many inches will demand a round sum. The Select Committee stated that, in order to prevent floods from submerging lands and dwellings throughout the Thames Valley, works of enormous cost and magnitude would be required. But the Conservators say that works might be carried out at a moderate cost which would undoubtedly mitigate the inconvenience and suffering caused by the overflow of the river on the adjacent lands and property, both by lessening the extent of a flood and shortening its duration. A report from Mr. Charles J. More, the Engineer of the Conservators, specifies these works, but states that they are "flood works;" and the Conservators go on to say they are "advised" that they have "no power to expend their funds thereon." Perhaps it might be urged that although the navigation could do without the flood works, yet the flood works would make it all the better for the navigation. It is not entirely clear where the line is to be drawn between one class of works and the other. Floods are often obstructive to the navigation. To get rid of them entirely is doubtless impracticable, but it must be perfectly possible to keep them within narrower limits than those to which they now extend. Flood works on a large scale are fearfully expensive. The Engineer to the Conservators states that in 1882 he reported on the works necessary to be done to relieve the lands between Staines and Teddington from the injurious effects of floods. He found that to keep even a moderate flood within the ordinary channel of the river would cost in that district alone the sum of £85,000. In 1878 Sir John Hawkshaw reported on the relief work necessary between Cricklade and Long Wittenham, and estimated the cost at upwards of £130,000, exclusive of engineering and legal expenses. This scheme, also, was only intended to deal with ordinary floods.

But while these grand schemes for controlling the river are too costly for serious consideration, it is shown that there are lesser works which are fairly within compass as a burden on the rates. If a really effective plan for reducing the level of the more serious floods demands a systematic enlargement of the sectional area of the river, by widening and deepening the channel, it is certain that no reasonable sum will pay for it. But a moderate outlay will suffice for what is described as the dredging away of local shoals in the river, the clearing out of side streams and backwaters, and the removal of many obstructions which have been deliberately placed, or allowed by neglect to grow up, at spots where provision was originally made for the free passage of flood water. Unfortunately, to deal with these matters is simply to carry out a palliative policy, and it might be urged that even some of this work properly belongs to the Conservators, though they think otherwise, or, as they say, are "advised" to that effect. The vastness of the complete problem is well shown by Mr. C. J. More. Taking his account of the matter, we might almost look upon the Thames as a natural failure. He considers the chief cause of the inundations to consist in "the insufficiency of the ordinary channel of the river to carry off an excessive rainfall." In proof of this he states that the amount of water poured into the river above Teddington, throughout its drainage area of 3800 square miles, occasionally exceeds four or five times the quantity which can be carried within its banks. Still, even this does not preclude doing what can be done. It does not appear that there is much value in the proposed telegraphic and telephonic communication between the several locks. Mill rights have to be respected, and the lock-keepers cannot begin to run the water off until it has risen above a certain level. That point being reached, as shown by a fixed mark, the lock-keeper proceeds to raise the weir sluices, and he cannot legally do so at an earlier stage. It is asserted as a matter of fact that, long before a flood has attained a level which threatens serious consequences, all the tackle at the weirs is drawn. As a general result, there seems little prospect of any marked improvement in regard to the floods, unless the Conservators are endowed with rating powers for the purpose, or unless an actual drainage authority is created with powers of that description. It is an unfortunate fact that when, in 1870, the Conservators brought in a Bill to afford them rating powers, the opposition offered both by landowners and towns was such that the attempt proved a failure. It is thought that the inhabitants of the riparian districts would be wiser in the present generation. Perhaps they would yield the point, if they saw they would thereby obtain deliverance from the calamitous floods by which they now so frequently suffer. Taking a broader view of the subject, it certainly seems far from creditable for a river like the

Thames to be so exempt from control as to create a flood by which Eton College had to be closed, and the Queen narrowly escaped being driven from Windsor Castle, while in the dwellings of many of her subjects there was neither fuel, artificial light, nor water fit to drink, gas-works and waterworks being in several places alike overwhelmed.

AMERICAN LOCOMOTIVE PERFORMANCE.

Our indefatigable American correspondent has succeeded in obtaining for us a section of the line between Erie and Buffalo Creek. This will be found on page 313. Over the 86 miles of road it is claimed, as our readers will remember, that on October 24th, 1895, the fastest run on record was made, the total time being 70 minutes 46 seconds. The average speed was 72·91 miles per hour. An examination of these sections serves to strengthen our statement that the performance sets at defiance all our preconceived ideas concerning the capabilities of locomotive engines. All that we have written on the subject we hasten to withdraw. Our calculations of work were based on the assumption that the line was either level or that the maximum speeds were in all cases attained on falling grades. This it seems was not the case. The speed up the hills was not only far in excess of anything ever touched in this country, but gradually augmented instead of falling off. Thus, in one case, the train starting at the foot of an incline, five miles long, of 1 in 333 at 67·12 miles an hour, had attained at the summit a velocity of 81·44 miles an hour. If we had not official testimony to the truth of this statement we should not believe it. Yet this, it will be seen, is only one instance of acceleration on rising grades. An engine which, with 134 tons behind it, can run up an incline of 1 in 333, five miles long, at an average speed of 74 miles an hour deserves all the attention it can receive. When, furthermore, it is remembered that it would be regarded in this country as a big goods engine, we may well stop to ask whether all our existing notions on the subject of running express trains are not wrong. Are we not justified in concluding that a small wheel is better for such work than a large one, and that the use of coupling rods is a distinct advantage instead of being a defect? On these points we shall leave our readers to draw their own conclusions, and proceed to explain a little in detail what the whole story means.

The train consisted of three cars, two of which weighed 41·3 English tons each, and the third 52 tons. The total weight behind the tender was 134 tons, with the ten-wheeled six-coupled engine, with which alone we have to do; the total weight of the engine, tender, and train at starting was 225 tons. As, however, water and coal were used pretty freely, we deduct five tons, and take the average weight, including passengers, who were few, at 220 tons. It has been estimated at the very high speeds attained the average resistance was only 15 lb. per ton. It is, of course, difficult to credit this, especially when we remember that the engine has ten wheels, and that the drivers are only 5ft. 6in. diameter, and coupled. However, at 15 lb. per ton we have a total resistance of 220 × 15 = 3300 lb. The resistance due to gravity was $\frac{492,800}{333} = 1480$ lb., and $3300 + 1480 = 4780$ lb. as the total smallest possible resistance up an incline of 1 in 333. We shall, to avoid complication, leave out of consideration the work of acceleration, and content ourselves with treating the performance as though the speed was, as we have said, 74 miles an hour, or 6512ft. per minute. To overcome a resistance of 4780 lb. at this speed demands 944-horse power, omitting fractions, which is much in excess of the figures we have arrived at in previous articles, which were, of course, based on different data. The tractive power of the engine was 116 lb. per pound of cylinder pressure, and the average effective pressure must therefore have been about 40·5 lb.; and considering the enormous piston speed attained, and the great difficulty met with under the circumstances in getting the steam out of the cylinders, the total pressure must have been very large, yet the coal consumption shows that the rate per horse was under 3 lb. But, of course, it must not be forgotten that the engine was not always working up to the power we have given. It is, however, very difficult to believe that the economic rate of evaporation could have been so high as is stated.

In order to keep criticism within reasonable limits of length we have dealt with only a few miles out of the whole length. Our readers can, and no doubt will, make calculations and draw deductions for themselves for the remaining portions of the run up hill and down dale. It does not affect the fact as a whole that we have selected the climbing of one hill only, but it will be seen that much the same work was done very shortly after this final run began. All the figures are before our readers, and they can draw their own conclusions. Take the story how we may for the rest it will be seen that as regards this particular five miles of climb we have a most astonishing and unprecedented performance, even if we take the resistance at the enormous speeds stated to have been reached at only 15 lb. per ton. It puts some stretch on our credulity, however, to believe that the resistance of the cars could have been as little as this; but we confess we cannot believe it at all as regards the engine. To avoid the chance of being misunderstood once more by our United States contemporaries, it is necessary to explain here that we are not now referring to internal engine friction, but to the resistance of the locomotive regarded as a vehicle. It is well known that coupling even two pairs of wheels augments resistance considerably; and six coupled engines with small wheels are very unfavourably placed as compared with engines with one pair of large drivers only. It seems to us to be incredible that an engine and train weighing 220 tons could be hauled up an incline five miles long at a continually accelerated speed, averaging 74 miles an hour, by a weight of 4780 lb., or little over 2 tons, pulling at a rope passed over a pulley at the summit of the incline. This is really the way to look at the question of train resistance; it clears our ideas at once. But, on the other hand, if we assume that the resistance was much greater than 15 lb. per ton, we are compelled to believe that the performance of the locomotive was truly marvellous. At a velocity of 6512ft. per minute, each 100 lb. of resistance represents about 20-horse power. If the resistance of the train were augmented by 5 lb. per ton, or 1100 lb., that would represent 220-horse power; but it is very difficult to reconcile any greater horse-power than that we have stated with the consumption of coal per mile.

It is, of course, out of the question to doubt the accuracy of the figures placed in so much detail before us by our correspondent. But we ask ourselves whether, after all, Mr. Stroudley was not right when he said that no one in this country knew how fast a locomotive with a light train could run, because no one had ever tried. He told us that on one occasion he had attained 80 miles an hour with the Grosvenor, as recorded by the speed indicator in the cab. The engine could have run faster, but no one in the cab wanted a higher speed. "Eighty miles an hour was quite fast enough for us." We do not hesitate to say that there are very few men in this country who would risk their necks by attempting to run a six-coupled goods engine at 90 miles an hour. It requires no calculation to see that every moving portion of the engine must been taxed pretty near the ultimate limit. Few of us would care to stand on a foot-plate, with side rods making nearly 500 revolutions per minute. But the experiment has been made, and no one has been a bit the worse, and we may consider what is the lesson taught. To us it seems to be simply that on which we have often insisted. The boiler is the measure of the capabilities of any locomotive. Within limits, cylinder capacity is quite a secondary consideration; but when this is conceded we have a vista of changes opened up before us. If speeds of 90 miles an hour can be got out of goods engines, what may not such single engines as those on the Great Western, Great Northern, and Midland, be able to accomplish if only we give them 1600ft. or 1700ft. of heating surface instead of 1200ft. or 1300ft.? Always provided, of course, that the augmented surface does not mean an extra foot or two of length in the tubes, which adds only little to the power of a boiler, although it promotes economy.

BOILERS AT ELECTRIC LIGHT STATIONS.

There is a cause for everything, if not a reason. It is not always easy to see what the cause may be, or to be satisfied with the reason. But the fact remains. In electricity manufactories or electric light stations, whichever they may be called, it is noteworthy that steam is generated on a system different from that which has for half a century at least satisfied millowners, and indeed manufacturers of almost all known commodities. For ordinary manufacturing purposes the Lancashire or the Cornish boiler is used almost to the exclusion of all other types. The former is no doubt an excellent example of the survival of the fittest, and its all but universal adoption is the result of a careful calculation based on commercial principles. From the first, however, the Lancashire boiler has been almost absent from electric light installations. It is only recently that it begins to be used in a tentative fashion by electric light engineers. In not only the United States, but this country as well, we find that boilers of the water-tube or locomotive type are nearly always employed to drive electrical machinery. There must be some reason for this. We do not think that it has ever been stated; but it does not seem to be far to seek, and when found it is instructive.

When electric light stations were first designed in this country the designers were in almost every case electricians, not mechanical engineers; or at least not mechanical engineers possessing any considerable commercial knowledge of the working of steam machinery. These gentlemen knew from books that high-pressure steam was more economical than low-pressure steam, in the sense, at least, that a smaller weight of the former than of the latter would give a horse-power, so it was determined that high-pressure steam must be used. But the Lancashire boiler was not deemed suitable for pressures over 100 lb., so recourse was had to water-tube boilers; and to locomotive type boilers because it was a familiar fact that on our railways pressures of 150 lb. and more were regularly carried. It is no disparagement of the water-tube boiler to say that the results of its adoption have not been uniformly satisfactory. It is, for one thing, peculiarly exigent in its demands for good water, and in the second it is very expensive to keep clean, and if not kept clean the tubes split and leak. The locomotive boiler, again, is a very admirable steam generator, but it, too, has its peculiarities. It is the full consciousness of these things that has induced millowners to resist all temptation to use any other than the double-flued or Lancashire boiler, which has been recently so proportioned that it will carry any pressure asked for. Indeed, it should be almost self-evident that if a marine boiler 15ft. or 16ft. in diameter can carry a pressure of 160 lb., there ought to be no difficulty in making a Lancashire boiler of half the diameter equally strong. The mistake committed by the electrical engineers has been in assuming that the boiler which made steam most readily, and was most economical in the consumption of coal, must be the best. It is just the species of error into which the non-commercial engineer is likely to fall. The truth is that coal represents but one item in the cost of making steam, and it is not invariably the most important item. The price to be paid for water is not infrequently very large; and even high-priced water may not suit either water-tube or locomotive boilers. Then there is the question of wear and tear, the quality of the steam produced, and many other matters which must all be considered before it is possible to say what is the best type of boiler to put down; and all this, be it noticed, has nothing whatever to do with the qualities of the boiler regarded from the theoretical point of view.

To make our meaning quite clear, let us suppose that a sum of £500 is available for the purchase and erection of a boiler. We may obtain with this a Lancashire boiler which will work well and give satisfaction for ten years, with very moderate repairs, and be nearly as good and serviceable at the end of that time as it was at the beginning; or we may get a locomotive boiler which will need heavy repairs before half that period has elapsed, and will be good for very little at the end of the term. Or a water-tube boiler, which will last for half a century, simply because it has new tubes put in, a few at a time, all the year round, every year of its life. All three may be of equal evaporative efficiency, but even if they were not, the millowner would keep to the Lancashire boiler, not only because it would, in the long run, be much the cheaper of the three, but because it would always be ready when wanted. It would seldom, if ever, be laid off for repairs. No doubt it may be urged, and urged with truth, that both the water-tube and locomotive boilers are excellent steam generators. This does not affect the question in any way. All the experience available goes to show that over a series of years the Lancashire boiler will be found less costly in up-keep, and more trustworthy than any other type of land boiler in the market; and that this truth is gradually coming home to electrical engineers is demonstrated by the circumstance that recourse is now being had to the Lancashire boiler in very important installations, to an extent, indeed, not dreamed of a few years ago—that at St. Pancras, for example, which we illustrate this week. It must be understood that in writing as we do, we are simply bringing before our readers certain considerations often overlooked, and endeavouring to find a cause, if not a reason, for the remarkable departure from normal practice which marked the advent of the electric light in this country. It can scarcely fail to strike any thoughtful man as remarkable that types of boilers scarcely known in Great Britain should have been used to the exclusion of all other types for supplying steam to electric light engines. Outside of railway shops no locomotive type boilers could be found driving stationary engines of more than a comparatively few horse-power. In factories they are practically unknown. The water-tube boiler fought for its life in Great Britain. All over the kingdom, in spinning and weaving mills, pumping stations, factories of all kinds, many rolling mills of the largest size, nothing was used but the Lancashire boiler. But with the new light all this was changed, and we had not only the electrical experiment, but the steam generating experiment as well, and it is not remarkable that the results were not always quite satisfactory.

It would not be fair, however, to attribute the adoption of the locomotive type or the water-tube boiler either to caprice or theoretical knowledge alone. No doubt installations were often constructed under circumstances that rendered it next to impossible to use anything but the water-tube boiler. There are places in the Andes where no part of a steam engine or boiler must weigh more than 200 lb. Everything has to be carried on mule back. There are places in great cities into which it is equally impossible to onvey any large structure. For such places the sectional boiler is simply invaluable. But this scarcely suffices to explain the favour which the locomotive type of boiler enjoys. It is not because only such a boiler can be forced, and other reasons must be found for its adoption. That it requires no brickwork, and is an excellent steam maker, are no doubt points very much indeed in its favour; but, when all this has been said and admitted, we have still to face the fact that for places where large demands are made for steam, day after day, nothing is so popular as the Lancashire boiler, or its modifications.

Those who can read the signs of the times know that the production of electricity on a small scale in numerous establishments will have to give way to its manufacture wholesale, on a great scale. That which has become possible at Beckton with gas may become equally possible with electricity. The question will then force itself on engineers, What is the best method of manufacturing steam? It is not wise to prophecy until after the event. Yet we are rash enough to say that probably the Lancashire boiler will be used in conjunction with mechanical stokers, the smallest possible amount of manual labour being employed. In settling this question it must not be forgotten that the demand for power becomes more and more uniform the larger the installation, and, consequently, the wider the district served. "The peak" does not occur, for instance, in all existing metropolitan installations at the same hour. This consideration will have an important influence on those who have to select the type of boiler to be used. Furthermore, the heat storage system introduced by Mr. Druitt Halpin may modify conditions of service very considerably. In saying this we do not wish, as we have said before, to be understood as finding fault with any particular type of boiler. Our object is to record what may be termed the drift of public opinion. It does not follow that we regard the water-tube boiler as inferior to the Lancashire if we state as a fact that millowners prefer the latter, and that electrical engineers in taking to the former have departed from precedent. The doubt and hesitation which exist are fairly well exemplified on a small scale at Islington, where Mr. Gay has put down both Lancashire and water-tube boilers almost side by side. It must, too, be borne in mind that nearly all the electric light stations in this country are comparatively young, and few opportunities have yet been afforded for testing the actual life of a boiler. Our purpose will have been served if we have succeeded in directing the attention of our readers interested in the manufacture of electricity to the fact that a considerable departure from normal manufacturing practice has marked the progress of the electrical engineer, and that many more things than the production of steam have to be thought of when ordering a boiler.

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COMMON SENSE IN WORK AND WAGES.

One feature of the present revival of trade in iron and steel manufacture has not received the attention it deserves. Time was when the very slightest indication of an upward trend in business was sufficient to cause the workers to agitàte for increased wages. The effect was invariably disastrous. If the employers had accepted the contracts on the basis of the existing wages arrangement, they were compelled to carry them out at a loss unless they had been successful in getting the customer to accept what is known as the strike clause. This could not always be done, as in the case of urgent work the contracting firm were obliged to have what they wanted under any circumstances. During the last quarter of a century in the Midland district an enormous amount of work was lost and jeopardised through this rash policy of rushing for an advance the moment the men knew their masters were busy, or likely to be busy. Sometimes the effect was felt in another way. The very mention of a strike or a probable strike in any particular district had the result of causing the customer to go elsewhere. He could not take any risks, and although the manufacturer might tell him that the difficulty would be tided over and the work delivered, yet the belligerent attitude of the unions concerned frequently counterbalanced the employers' assurances. In this way work was lost in many instances—work which in some departments never returned. Our artisans seem to be getting wiser. Although in regard to the coal trade they still vote *en bloc* for whatever their leaders tell them, and are quite content to go on working short time a week at a high rate of wages, the result, however, being less wage at the week-end, it is inspiriting to notice that this imprudent policy finds no favour outside the coalfield. Disputes, more or less serious, have interfered with coal getting and are still interfering, but in the great industries of iron and steel, so far as Central England is concerned, there is practically peace all along the line. The men are beginning to see, taught by a long period of depression, that England, having no longer a monopoly of the world's manufactures, must compete keenly for what is left, and lose not a point in the conflict. It is becoming increasingly evident with them that their masters' interest is their interest, and that in proportion as they can join hands with him in putting finished goods upon the market at prices which will meet their rivals' efforts, precisely in that proportion will they have work with wages to take home during the twelve months. The issue of this sensible course of conduct is clear. The employers are able to take advantage of the prosperity which is now steadily coming towards them. The workmen have faith that, if it continues, and if the value of business rises as well as the volume of it, that they will get their fair share of the flood. In one or two of the lighter industries the manufacturers have already quietly given back to their men the percentages which the men conceded when business was bad. A generous recognition of this sort tells more in the working field than any number of speeches from the glibbest orator. It is to be hoped that this pleasant feature in the iron and steel trades of 1896 may extend and become general, for whatever may be done in the way of scientific development and perfect appliances, the great point, after all, is to have a perfectly harmonious understanding between the workers of England and those who provide them with work. It is, in effect, the pacific alliance of capital and labour that will bring about the industrial regeneration of England quite as much as the most ingenious of machinery or the ablest of management.

THE ELECTRIC LIGHT IN THE PROVINCES.

ELECTRICITY as an illuminating agency is making satisfactory progress in Sheffield. The annual meeting of the shareholders of the Sheffield Electric Light and Power Company, Limited, was held on Monday, when a dividend of 5 per cent. was declared. The Chairman, Alderman George Franklin, in the course of a most interesting speech, narrated the steady growth of the company's business. Just as railway companies worked out their calculations on the basis of train mileage, so, he said, electric light companies calculated their progress by the number of eight-candle power lamps required, and the units of electricity sold. In 1892, there were 7734 lamps wired; in 1893, 8419; in 1894, 15,672; and in 1895, 25,552. The returns in respect of units sold had been equally satisfactory. In 1892, the number of units sold was 91,524; in 1893, 131,752; in 1894, 192,220; and in 1895, 302,965. During the year ending December 31st, 1895, the number of customers had increased from 170 to 249. New customers are still coming in, and no customer supplied with the light had abandoned it. The cost of production is engaging the attention of the directors. As the load increases, the cost, of course, ought to decrease. In 1893 the cost of production and distribution was equal to 5·14d. per unit; in 1894, it was 3·80d.; and last year it was 3·55d. per unit. The cost price, therefore, is a farthing less now than in the previous year. At the present time the company has 25 miles of pipes laid in the streets of Sheffield, representing something like 8½ miles of street frontage. Alderman Franklin, referring to the remarks of Sir Frederick Mappin, chairman of the gas company, said that the shareholders in electric light could have no better testimony to the security of their investment than in Sir Frederick's statement that "the electric light was with them, it was going to stay, and going to increase as gas had done." That was what the Electric Light Company had been telling the public for some years, and it was pleasant to find the gas company realising the fact. Sir Frederick Mappin had told his shareholders that electricity had been with them for some years and was quite unable to stop the increasing demand for gas. Alderman Franklin utilised this statement by telling his shareholders that although gas had been with them for eighty years, it was quite unable to stop the increasing demand for electric light. At the same time, if he were a holder of gas stock he should not be in the least alarmed, for that company had plenty of scope in the two-light meters, and in supplying gas to gas engines, grilling stoves, and other work of that kind. It was certainly a remarkable testimony to the favour with which the new light is being received that in not a single case where it has been put has it been taken out; and that, despite the bright and clear weather experienced this winter, and the absence of fogs, the supply of electricity has increased by 33 per cent. over the corresponding period of last year. The shares of the company are already quoted at a considerable premium, and a further issue now being made is restricted to the present proprietors, who are readily subscribing for them at a considerable premium.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Fleet Engineer Elijah Tricker to the Victory, additional, for the Mercury, to date March 21st. Acting Engineer Henry W. Heyes to the Wallaroo, to date December 23rd, 1895.

LITERATURE.

Attack and Defence. By CAPTAIN MAUDE, late R.E. London: Keliher and Co., 33, King William-street.

THE author in his preface tells us that he writes under the conviction that the friction of increasing trade competition must in time draw us into war, and that war will involve such injury to our ocean-borne trade as will entail suffering such as cannot fall on Russia or even France. He urges that in view of such a contingency England should be prepared to take the offensive, and not merely defend her own shores and commerce.

The first section is on field fortifications and intrenched camps, and covers ground that has been dealt with in similar works. He gives new reasons, however, for the success that has attended the use of irregular rather than permanent fortifications, and his reasoning appears to be good. Naturally the rapid construction of works argues an amount of energy and power in the force undertaking this defence that has not necessarily or generally been found in the troops defending the regular defence of fortresses. One remarkable opinion comes out in this section, and still more in that following it, namely, the evolution of modern drill-books—namely, the writer's conviction that the fire of infantry armed with breech-loading rifles is no more formidable than that of past generations. The writer says, "In Frederick's days the line stood three deep, one man to the pace, and fired six volleys a minute, or twenty-five bullets per yard of front, quite as many, in fact, as a line in single rank can get off to-day." We question this statement altogether, but admit the writer's point that the fire of a line is ruined by a "screen" of skirmishers in front, and go with him in much that he says as to the confidence imparted to men by advancing in an unbroken line. Anything that gives a sense of support should be encouraged. The fact is that in danger, when men's nerves become severely strained, the main difference between old and young troops is that the former instinctively trust to their discipline and habit of keeping together; the latter having not acquired this instinct, are tempted to trust to their legs to get away. There is much that is very interesting in this section, such as Moltke's simile of fording a river, illustrating the task of carrying a position. The author considers that no troops of the present day will bear the strain of heavy loss that was borne successfully by good troops in past generations. Space would not allow us to deal here with the attack or defence, infantry and cavalry attack, and Imperial insurance. We would commend the work to our readers as original and valuable. It is evidently based on much study of the most modern writings and facts. If there is a fault it is that so many issues with different bearings are brought before the reader that the conclusions are sometimes less distinct than could be wished. If this, however, is a fault, it is one on the right side.

Elementary Treatise on Mensuration. By B. T. MOORE, M.A. Second edition. London: George Bell and Sons. 1896.

Elementary Mensuration. By R. H. STEVENS, M.A. London: Macmillan and Co. 1895. 3s. 6d.

MR. MOORE claims that his treatise differs essentially from the usual existing treatises on Mensuration, inasmuch as all the rules and formulas employed in it are strictly demonstrated. Some of these demonstrations are very laboured, because the author wrote at a time when calculus-dodging was in vogue; but the modern technical student is no longer frightened by differentiation and integration. The answers to the examples and problems are not given. This will raise an outcry in the scholastic world; but, on the other hand, the author is doing well by compelling the student to examine his results carefully, and to test them himself by independent considerations, exactly as he would have to do in the real application of mensuration where the answers are not given. Mr. Stevens' book is more of a schoolboy's treatise. Here the answers are always given, however easy the question. The boy turns up the answer, and if his own result is 12, or 144, or 1728 times too great or too small, he knows he has forgotten to turn feet into inches, so he makes the requisite change and feels quite satisfied with himself. But what would his employer say if he brought him such preposterous answers to a real commercial question? The collection of arithmetical results in treatises on mensuration removes all sense of responsibility in the student; on the other hand, the absence of the answers makes the working tenfold more difficult. With this difference, both treatises are well adapted for their special purposes in being provided with abundant and well-chosen examples of every character, as required in surveying, gauging, taking out quantities in earthwork, and in shipbuilding.

SHORT NOTICES.

The Law relating to Factories and Workshops, including Laundries and Docks. Part I. A Practical Guide to the Law and its Administration, by May E. Abraham. Part II. The Acts with Notes, containing the Factory and Workshop Acts, 1878 to 1895; the Shop Hours Acts, 1892 to 1895, &c. With Explanatory Notes by Arthur Llewellyn Davies, of the Inner Temple, Barrister-at-Law; with an Appendix, containing a full list of Special Rules made for dangerous employments, and a complete Index to both parts. London: Eyre and Spottiswoode. 1896. Price 5s.—The incompleteness of the knowledge possessed by the owners of factories and workshops of the law that relates to their property and the operations conducted by them is ample reason for the publication of a book which forms a guide, not only for the use of those practising in this branch of the law, but for those who have to abide by the somewhat numerous Acts concerning it. Our readers are mostly concerned with those parts of these enactments which relate to factories in which machinery of any kind is employed. A very useful feature of this book is the ample reference to cases which have been settled under the several Acts, and which form precedents. We do not find, however, any reference to one or two of the cases in which the judgment had been adverse to the vexatious interference of some of the double-diligent inspectors of factories who have insisted on apparatus and precautions, which have not only been costly additions to machinery, but which have been absolute waste of money, because the machines have been unworkable with these absurd additions. Only recently, for instance, we have observed the uselessness and impracticability of some of these requirements imagined to be necessary by factory inspectors in connection with wood-working machinery. In one case the owners of hand-planing or surfacing machines were requested to fix guards above the cutter spindle. The guards were accordingly ordered, made, paid for, and put on the machines; then the workmen wanted to use the machines, and to enable them to do this the guards were taken off, and will have to remain off so long as the machines are used. Absurd cases of this kind are only too numerous, and it is only because factory owners find it less expensive to pay for these absolutely useless accessories than to waste their time and money in resisting the requirements of the inspectors that the latter are complied with. The knowledge of the several Acts, and of the cases which have been determined under them that can be obtained from this book, will be of great value to the factory owners, and the book will be at least of equal value to those who have to advise on factory and workshop inspection questions.

The Naval Pocket-book. By W. Laird Clowes With plans. Corrected to January 1st, 1896. Addenda to February 1st, 1896. London: Tower Publishing Co., Ltd. 1896. Price 5s. net.—The labour involved in the preparation of this apparently little book must have been very great. It is printed on extremely thin tough paper, and contains no less than 850 pages, besides a considerable number of advertisements, which are, to say the least, superfluous. It may be regarded as not only a concentrated essence of Brassey's "Naval Annual," but as much more. It contains the principal particulars of every warship under the sun, and of many craft which can only be called warships by an extreme display of courtesy. It is illustrated by neat little sketches. In it we find particulars of all the dry docks in the world, knot tables worked out for high speeds, of from 20 to 40 knots inclusive, an almanac and ready reckoner, and a multiplicity of miscellaneous matter. It is really a wonderful little book, just one of those which makes the possessor wonder how he has managed to live so long without it.

Engineering Estimates and Cost Accounts. By Francis G. Burton. Manchester: The Technical Publishing Co., Ltd. 1896. Price 3s. net.—The importance of systematic cost accounts and their value as means of making estimates has been increasingly recognised in the past dozen years, and many firms now spend a good deal of money to secure these advantages, and save the money which would otherwise be wasted. The little book before us will meet the requirements of many who wish to enter upon a proper system of keeping of cost accounts, and as the examples are of a thoroughly practical kind, they increase the value of a book which must teach almost entirely by example. The book is one in a field little occupied, and is one that may be commended.

Electrical Engineering as a Profession. How to enter it, and guide to the Engineering Profession. Official edition. By A. D. Loutham, A. Inst. E.E. With thirty-three plates. London: Loutham and Co. 1896.—This book contains little or no original matter. It is none the less useful. It is simply a guide to the technical schools and colleges in which education can be obtained. It is in this respect very complete and fully illustrated. It is calculated to serve a useful purpose as a book of reference.

THE HORSELESS CARRIAGE BILL.

WE give below the full text of this Bill, which was introduced in the House of Lords on Tuesday last. It will be seen that it is proposed to remove all restrictive enactments from a mechanically-propelled carriage, provided it be under two tons in weight, unloaded, be not employed in traction, and do not discharge smoke or visible vapour. Such a carriage, as might be expected, is to be subject to general regulations applicable to traffic on highways, and Section 26 of the Highways and Locomotives Act, 1878, is to apply. That section confers upon county authorities power to make bye-laws for prohibiting the use in any vehicle, whether drawn by horses or not, of wheels of unsuitable width, or having projecting studs or bars of a pattern forbidden by such regulations, and also for prohibiting the locking of a wheel in descending a hill, unless a shoe be used. We may possibly hear something more about the provisions as to wheels when the Bill gets into Committee. We have always strongly urged the importance of placing the power to make regulations for the use of these carriages in the hands of a central authority, a principle which, except as to the county bye-laws regulating wheels, is, we are glad to see, recognised by the Bill, and the Local Government Board is to be the central authority.

(1) The enactments mentioned in the schedule to this Act, and any other enactment restricting the use of locomotives on highways and contained in any public, general, or local and personal Act in force at the passing of this Act, shall not apply to any vehicle propelled by mechanical power, if it is under two tons in weight unladen, and is not used for the purpose of drawing any other vehicle, and is so constructed that no smoke or visible vapour is emitted therefrom, and vehicles so exempted are in this Act referred to as light locomotives.

Provided as follows:—

(*a*) Nothing in this section shall affect any power for the general regulation of traffic on highways, and a light locomotive is hereby declared to be a carriage within the meaning of the enactments relating to highways;

(*b*) Section 26 of the Highways and Locomotives (Amendment) Act, 1878, and the enactments relating to hackney carriages and stage carriages respectively, shall apply to light locomotives as if they were drawn by animal power, and the said Section 26, as so applied, shall extend to London; and

(*c*) So much of Section 6 of the Locomotives Amendment (Scotland) Act, 1878, and of Section 6 of the Public Health (Ireland) Amendment Act, 1879, as gives power to regulate the use of locomotives shall apply to light locomotives.

(2) The keeping and use of petroleum or of any other inflammable liquid or fuel for the purpose of light locomotives shall be subject to regulations made by a Secretary of State, and regulations so made shall have effect notwithstanding anything in the Petroleum Acts, 1871 to 1881, and breach of any such regulation may, on summary conviction, be punished by a fine not exceeding £2.

(3) If any person negligently drives a light locomotive, or suffers it to be without due control, he shall be liable on summary conviction to a fine not exceeding £10.

(4) The Local Government Board may make regulations with respect to the use of light locomotives on highways, and a breach of any such regulations may be thereby made punishable by a fine not exceeding £10, recoverable on summary conviction.

(5) This Act may be cited as the Locomotives on Highways Act 1896.

SCHEDULE.

Enactments which are not to apply to light locomotives.—The Locomotives Act, 1861 (24 and 25 Vict. c. 70); Section 41 of the Thames Embankment Act, 1862 (25 and 26 Vict. c. 93); the Locomotives Act, 1865 (28 and 29 Vict. c. 83); the Locomotives Amendment (Scotland) Act, 1878 (41 and 42 Vict. c. 58); the Highways and Locomotives (Amendment) Act, 1878 (41 and 42 Vict. c. 77) so much of Section 6 of the Public Health (Ireland) Amendment Act, 1879 (42 and 43 Vict. c. 57), as relates to the hours during which locomotives are not to pass over roads or highways.

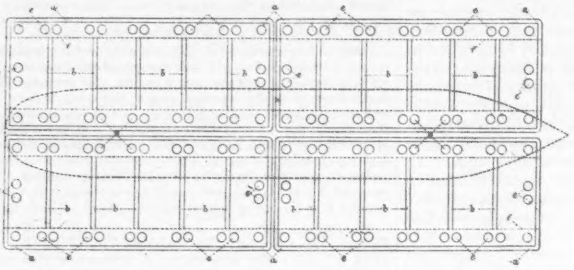
SALVAGE APPLIANCES.*

By Mr. J. G. KINGHORN, Member.

THE object of this paper is to draw the attention of the members of the Institution and nautical world to improved appliances for dealing with salvage operations, and supplying a means of grappling with the lifting and floating of stranded and sunken vessels, which, with the present inefficient plant, is in many instances impossible. The Thames Conservancy possess the best lifting camels in existence, and all vessels sunk in their waters are lifted by these camels, and even their plant was, I am informed, taxed to nearly its utmost in lifting the s.s. Durham some months ago. This steamer was estimated to weigh 1400 tons in water. The whole efficiency of the plant of the Thames Conservancy is derived from the rising of the tide, and would therefore be next to useless where there was no rise or fall of water. I will now proceed to describe the patent appliances and the mode of working. To overcome the want of adequate tidal range on some parts of our own and continental coasts, and in the Mediterranean, where there is nearly a total absence of rising water, the winch—Figs. 11, 12, and 13—has been devised, for which the following advantages are claimed:—It will grip a steel wire rope of large size at any given point; it will not injure the rope. It will heave any weight the rope can stand, slowly and steadily; will pay out rapidly, and register the weight borne by the rope on a suitable indicator gauge. It has a revolution counter, and the indications of the weights and revolutions are electrically reproduced by suitable instruments at a common centre, say a bridge-house, on any one of the camels, thus enabling the salvage engineer to have full control of the lifting power at his command, and a perfect knowledge of the strain on each and all of the wire ropes.

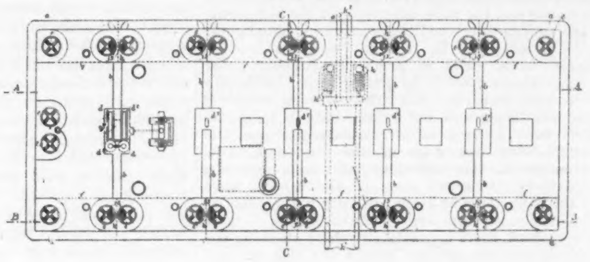
VIEW SHEWING FOUR CAMELS IN POSITION OVER WRECK
WRECK SHEWN UNDER BY DOTTED LINES

FIG. 1



DECK PLAN OF CAMEL

FIG. 4



FIGS. 5 & 6. LONGITUDINAL SECTIONS OF CAMEL, AT LINES AA AND BB FIG 4
FIG 7. CROSS SECTION AT LINE CC FIG 4.

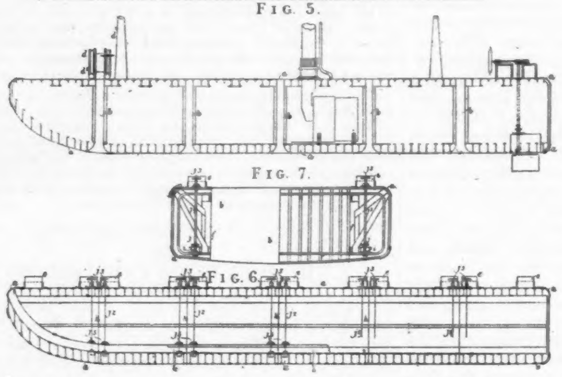
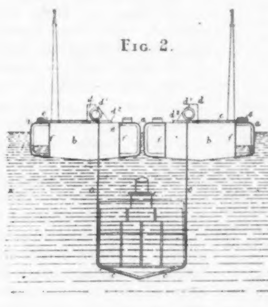


FIG. 5.
FIG. 7.
FIG. 6.

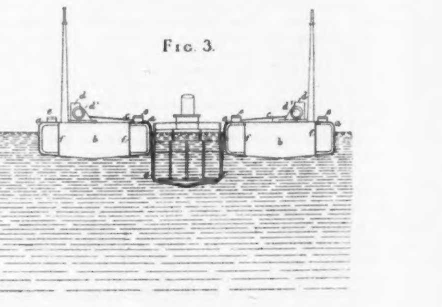
CROSS SECTION SHEWING VESSELS SLUNG READY LIFTING WITH WIRE ROPES LEADING THROUGH WELLS IN CAMELS

FIG. 2.



SECTION SHEWING VESSEL BEING LIFTED WITH WIRE ROPES OVER SIDES OF CAMELS

FIG. 3.



Now, referring to the drawings, the winch consists as follows:—On the base-plate *a* are two lower frames *b*, and two upper frames *b* 1. These frames support the ends *c* 1 of the hollow winding barrel *c*, on one end of which is a reel *c* 2 by which the unused portion of the rope is carried. The barrel *c* is worked by worm wheels *d* fixed on such barrel, and worms *e* engaging with and driving them; these worms being worked by worm wheels *f* on the shafts *e* 1, driven by worms *d* mounted on the shaft *g* 1, said shaft being rotated by a worm wheel *h* thereon, driven by a worm *i* supported in one of the flanges *b* 1, and driven by the bevel wheels *j* from the shaft *k*; this shaft being revolved by suitable power. When starting, in the lifting action of the winch, little or none of the rope will be on the barrel; while the part connected to the body to be moved would be tight, the remainder being on the reel *c* 2. The rope is passed to the reel *c* 2 from the barrel by way of a hole *c* 3 of gradual curvature, and over two grooved internal guides *c* 4 of suitable curvatures—see Fig. 4—by which, when tension comes upon the ropes, friction is created, and assistance to the holding afforded. Between the guide *c* and the reel *c* 2 there is a wire rope-gripping device *i* of a suitable kind, by which the actual holding and making fast of the rope is effected. From here the rope passes over and is wound loosely on the reel *c* 2, this being the unused portion of the rope. The lead of the rope from the barrel *c* to the reel is nowhere bent or turned at such an angle as to injure the rope; that is, the turns being easy and gentle, the rope cannot possibly be damaged by the gripping in the machine. It will be seen that, as the barrel revolves, the unused portion of the rope revolves with it.

PLAN AND SECTION OF BOLLARD KELSON AND VALVES.

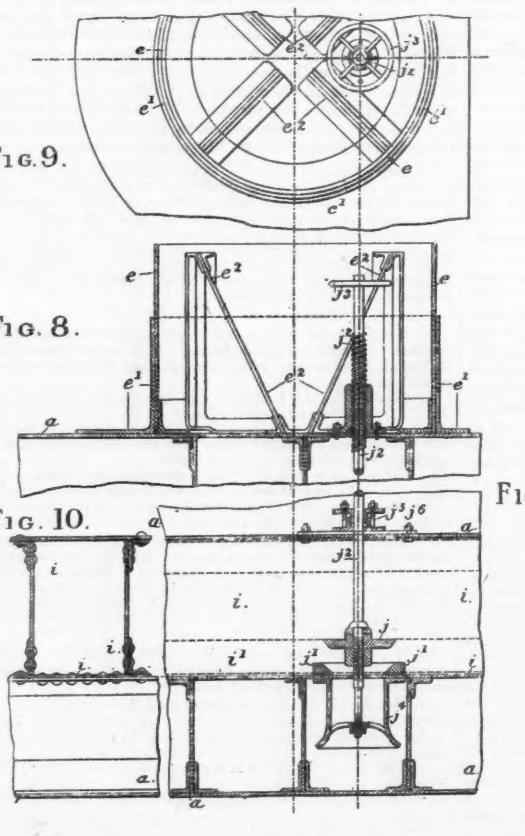
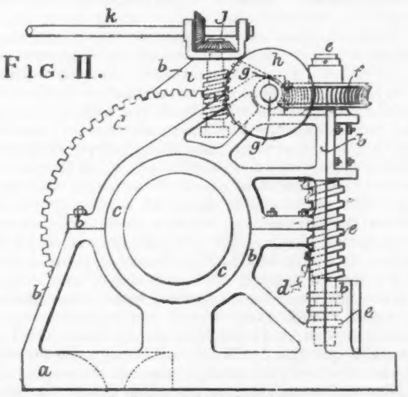


FIG. 9.
FIG. 8.
FIG. 10.

LIFTING WINCH

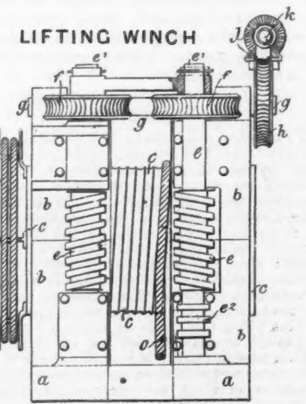
FIG. II.



SIDE ELEVATION

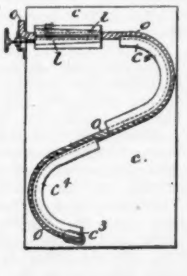
LIFTING WINCH

FIG 12.



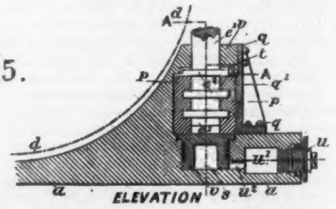
FRONT ELEVATION

FIG. 14.



HYDRAULIC THRUST BEARING

FIG. 15.



VIEW OF INTERIOR BARREL OF THE WINCH OPENED OUT FLAT

The main driving worms *e* have their shafts *e* 1 vertically mounted, and the lower ends provided with rings *e* 2, fitting in corresponding thrust block grooves in the part *b* 3 of the frames *b*. These blocks take all the strain which comes upon the worm shaft *e* 1. A modification of these supports is illustrated in Figs. 5 and 6; in these the shafts *e* are supported hydraulically, and the pressure on them indicated by an indicator. In the construction shown, the collars *e* 2 work in and are carried on a block *p*, made in halves, and prevented from rotating by a key *q* 1 on the retaining bracket *q*; and the lower end of the shaft *e* 1 and block *p* rest upon a piston *r* working in a cylinder *s* in the bed-plate *a* of the winch. The cylinders *s* are connected together. The shaft *e* is mainly kept in position vertically by the cap *v*, only a small amount of movement is allowed to the shaft *e* 1. The small amount of movement of the piston is governed by the space *t* between the upper ring *e* 2 and the metal above it. The shaft *e* 1 is raised or lowered by a screwed plug *u*, which screws in and out of the cylinder *u* 1, which is connected to the cylinder *s* by a passage *u* 2, and is filled with oil. The pressure on the shaft and piston, and so on the lifting ropes, is indicated by a suitable pressure gauge on the cylinders *s* or *u* 1, showing the weight in tons carried by the winch. By these means the pressure and strain on the two sides and shafts of a winch can be ascertained and regulated, and when several winches are used together for raising a single body of great weight, as when raising a ship, the strain on the different machines acting upon it can be seen at once by means of gauges electrically connected with the bridge-house; also gauges from the gearing on the winches would have electrical connection to gauges in the bridge-house, indicating the number of revolutions performed by each machine, thus enabling the salvage engineer in charge to have complete control of the whole lifting by the machines. The gear between the worms *e* and the motive power is not restricted to that shown, but may be varied according to circumstances; nor is the invention—although the construction shown is a convenient one, and may be used with advantage—restricted to the particular form or arrangement of parts given in these drawings.

I will now proceed to describe the camel. With reference to the drawings, Fig. 1 is a plan; Fig. 2 is a cross-section of the camel or pontoon, and of the ship to be raised; Fig. 3 is a cross-section showing the position of the pontoons for raising a ship not completely submerged, and small submerged vessels can be lifted in deep water in the same manner; Fig. 4 is a plan of a pontoon to a larger scale; and Figs. 5 and 6 are longitudinal sections, and Fig. 7

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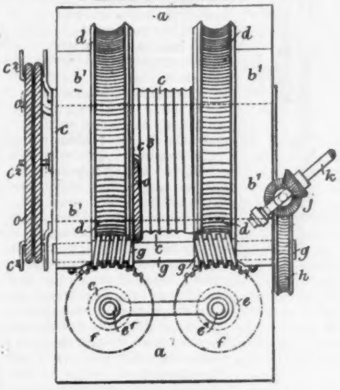
* Read at the Thirty-seventh Session of the Institution of Naval Architects, March 26th, 1896.

a cross-section of pontoon at the lines A A, B B, C C, respectively, in Fig. 4; Fig. 8 is a sectional elevation of the bollards and sluice valves; Fig. 9 is a plan of the sluice valves, and Fig. 10 a cross-section of sluice or section valves and conduit controlled thereby, connected with pumps for emptying and filling the different compartments of the pontoon. On either side of the ship to be raised we employ pontoons *a*, in most cases four, arranged as indicated in Fig. 1. According to this invention, the pontoons are provided with transverse wells *b*, running through two-thirds of the beam of the vessel, by which construction the ropes *c*, by which the vessels are lifted, can be taken up vertically from the ship to and through the pontoons, and a direct pull or strain is put upon the pontoons; and no matter what the width of the sunken ship be, the same set of pontoons can be used, and in all cases the raising ropes can be arranged truly vertically, so as to get a direct pull. And, moreover, with this direct pull the adjacent sides of the pontoons on the opposite side of the wreck do not press or bump against one another, the position of the ropes being so arranged that a sufficient distance between the pontoons is always maintained, which is very desirable. In connection with these wells, and the lifting ropes, winches—as before described—are employed, by which the apparatus is capable of raising wrecks where practically no tide exists. The type of winch used for this purpose is one whereon the ends of the ropes are not carried and held on the winding barrel; but in each case the end is held on a separate reel or barrel, which moves with the winding barrel. This method of stowing and coiling the rope is employed because only one set of coils of the rope can be coiled on the winding drum *d* 1 of the winch, it being impossible to have the coils one upon another for the purpose such as described, where the weights to be raised are enormous, as coils one upon another will damage the rope, and might render it useless for further raising purposes after one use. In the case of the ship being, say, about 2000 tons, and the four pontoons shown be used, each winch and wire rope at each side will carry 100 tons. When the ship is raised by the winches alone, they haul on the rope at both ends equally.

As regards the use of wire ropes, about 10in. or 11in. in circumference, as at present made, is considered the maximum size that can be handled by men under such conditions as wreck-raising; and therefore, practically the limit of weight which can be lifted is in this sense governed by this fact; nevertheless, the weight which may be lifted will vary accordingly as more or less ropes are placed under a ship, and the pontoons are made larger or smaller. When the ropes *c* do not pass directly through the centre of the wells *b*, the water tanks of the pontoons on the side on which the lesser strain comes are partly filled with water to keep the pontoons on an even level.

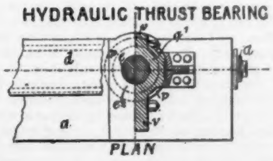
PLAN OF WINCH

FIG. 13



HYDRAULIC THRUST BEARING

FIG. 16.



When lifting ships which are not completely or deeply submerged by means of winches, the pontoons are placed as in Fig. 3, and the winches are placed on the off-side of the pontoon, to counterbalance the weight which comes upon the near side, and, if this is not sufficient, the outside compartments of the pontoons are partially filled with water. The bollards—see Figs. 4, 8, and 9—consist of large hollow steel cylinders *e*—4ft. in diameter—angle plates *e* 1 riveted to the deck and to *e*, and brackets *e* 2 riveted to the deck and to *e* and *e* 1; and they are arranged in pairs as usual, one being on each side of the bulkheads *h*. At the edge of the pontoons over which the ropes would be passed, in cases as shown in Fig. 3, suitable rollers are provided to ease the movement of the rope over the bend. The position of the winding barrel *d* 1 of the winches *d*—see winch in Fig. 4—is directly over the wells *b*, *d* 2 are bed-plated on the winches. The winches are moved as desired over the wells B, and suitable provision is made to secure them in any required position, so that the lifting ropes from them are vertical and the adjacent sides of the pontoons will not touch in the lifting operations.

Regarding the pontoons, they have a longitudinal bulkhead *f* at either side and transverse bulkheads *h* running between the ends of the wells and vessel's sides, forming the side chambers into a number of compartments, and strength is given the vessel where the lifting ropes go over the side, when lifting, as in Fig. 3. These compartments are filled and emptied as required for balancing and manipulating in the raising operations by pumps *k*—Fig. 4—through hollow box kelsons *i*, running through the vessel, and valves *j* in the kelson in each compartment. The pump discharge pipes *k* 2 and inlet pipes *k* 1 are both taken overboard on deck. The chambers between the bulkheads *f* and wells *b*, except those at the bow and stern, are used as engine, pump and boiler rooms, and men's quarters, or other purposes; while those at the ends can be filled or emptied to raise or lower either end of the vessel. The floor at the bow of the pontoons is curved up as shown, and the bow chambers are empty, and the *k* stern ones partly filled with water or salvage gear when being towed. Each valve *j* is opened and closed by a rotatable rod *j* 2, the actuating wheel of which is disposed within the hollow bollard *e*. The valve seat *j* 1 is on the bottom of the kelson *i*, and a trunk *j* 4 extends from it to empty compartments as far as required. In the cover *j* 6 over the valves *j* is a stuffing-box *j* 5. A valve *j* is provided at each end of the compartments to obtain full flow of water, and to pump the compartments dry if the pontoons are tilted.

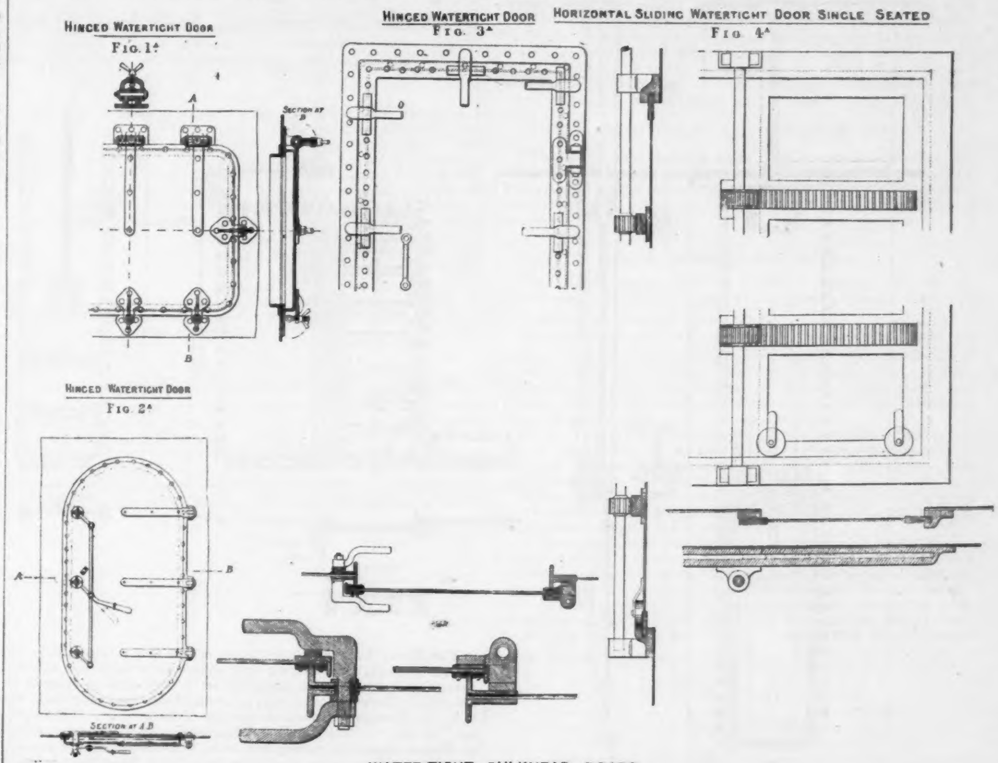
In conclusion, the proposed working of these inventions may be briefly described as follows:—The wire ropes are swept under the hull of the sunken vessel in the ordinary way, by small steamers, or by divers, the ends secured to the masts, if above water, or marked by buoys, until a sufficient number have been passed under the vessel. The camels would then be towed out and arranged in pairs, to the number required, according to the length or weight of the vessel. The end of the wire hawser would be passed on the winches, which have been placed, according to the beam of the sunken vessel, either up through the transverse wells, if a direct vertical pull is necessary, or over the rollers at the sides if otherwise, and, having been hove tight, are then secured in the compressors and the spare wire coiled on the carriers. The winches are then set in motion—the engineer in charge, having his gauges before him, regulates the speed of each winch and the weight it carries—and slowly lift the sunken vessel from the bottom until the winding reels are full. The amount of rope capacity in the winch described being about thirteen fathoms, this being the limit necessary to correspond to the width of the wells, and to ensure against any waste of force, owing to the ropes getting too much out of the perpendicular. In cases where the depths exceed thirteen fathoms, the camels with their burthen would be towed away to a place where the vessel could be safely beached, or if the distance to be towed presented serious difficulties, other ropes could be passed under the vessel and made fast to the bollards on the camels to take the weight, while the lifting ropes were regulated for a fresh heave, and so on until the sunken craft was hove close under, or up between the camels.

WATER-TIGHT DOORS.*

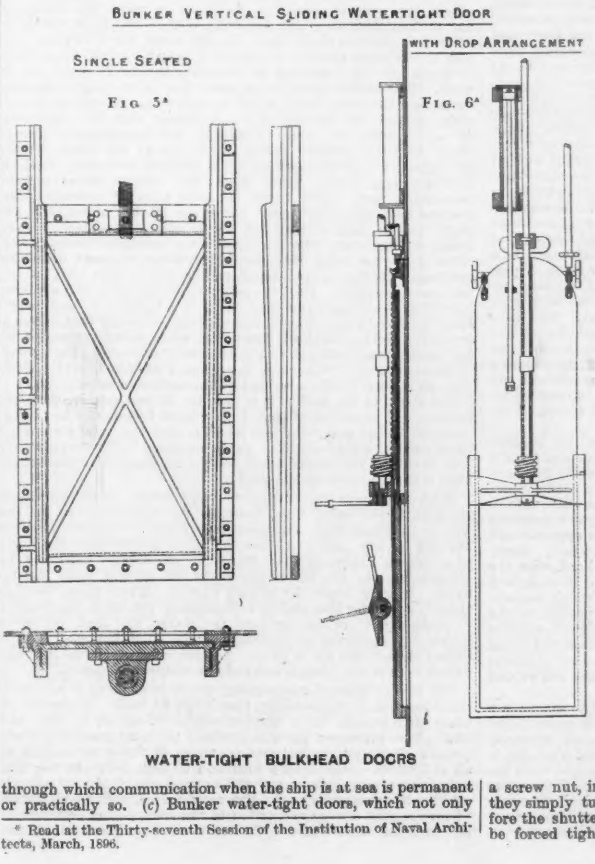
By Colonel N. SOLIANI, Director of Naval Construction, Royal Italian Navy, Member.

WATER-TIGHT doors may be divided into three classes:—(*a*) Water-tight doors, at or below water-line, which, in a sea-way, can be kept always completely shut, or if needed open it is only occasionally and for a short time, after which the doors can be restored to their shut up position. Water-tight doors well above water-line. (*b*) Water-tight doors below water-line, between compartments, such as the engines and boiler-room compartments, through which communication when the ship is at sea is permanent or practically so. (*c*) Bunker water-tight doors, which not only are to be kept open in a sea-way, but are also liable to be jammed by coal when closing.

Hinged water-tight doors.—Water-tight doors under head (*a*) do not require to close quickly, and therefore are usually made hinged, in which form a good, simple, light, and efficient water-tight door can be obtained. Figs. 1, 2, 3 show how these doors are generally made. The hinged door has all round its edge screw or lever latches to keep the door when shut well tight against the seat frame. For bunkers above protective decks screw latches are preferred, all independent and worked only from one side, as in Fig. 1. The seat frame is generally fitted with india-rubber or tuck packing, but when absolute tightness is not necessary, as is the case with coal bunker bulkheads above protective decks, or with doors well high above water-line, the packing can be dispensed with, the seat being then a simple solid frame of rectangular section, as shown in Fig. 2. These solid frames, while efficient, are economical, as they dispense with the packing, which is expensive and subject to rapid deterioration. Various packings, other than india-rubber or tuck packings, such as cotton packing in a natural condition, or well greased leather, &c., have been tried; but, so far, none of them have yet been found to combine durability, efficiency, and cheapness in the desired degree. Doors in passages through bulkheads have lever latches, workable from both sides, as in Figs. 2 and 3. These latches, when the doors are well above water-line—as passage doors on main decks—may be fitted only along the edge opposite to the hinges, and connected all to one handle, in which way they can be worked together at one time—Fig. 2. Latchless doors have also been resorted to. In this case they are double, viz., they have two shutters working opposite one to the other on the two sides of the bulkhead, so that whichever side is flooded there is always one of the two shutters pressed to close by the pressure of the water itself. Suitable springs cause both shutters to close when released after having been opened. These doors are said to be handy and efficient.



WATER-TIGHT BULKHEAD DOORS



WATER-TIGHT BULKHEAD DOORS

Sliding water-tight doors.—Water-tight doors under head (*b*) require efficiency and quickness combined. Therefore, they are usually made of the sliding form, and workable both from the door itself and from the decks above. Fig. 4 shows an ordinary horizontal sliding door, as usually fitted on board ships. The lower side of the door frames of sliding doors, when grooved to form a guide to the shutter, is liable to get chocked with dirt, and to prevent this the guide is usually covered with a lid, which opens automatically when the door is closed. To avoid the necessity of this cover, the lower side has generally no guide. If we turn a horizontal sliding door 90 deg. on its plan, we have a vertical sliding door needing no alteration for its working. However, with vertical sliding, the gear, instead of a rack and pinion, is generally a fixed vertical screw shaft working in a nut attached to the door—Fig. 5. With this arrangement the movement of the door is slow both when opening and closing. Such slowness is not convenient, especially when closing, which operation, in time of emergency, ought to be as quick as possible. To secure this result various devices have been resorted to, a usual one being an excentric or some similar apparatus by which the nut is thrown out of gear when the door is to be shut. Then the shutter falls down quickly by its own weight—Fig. 6. This implies, of course, that the door is closing when the shutter is lowered, as is generally the case.

The disengaging gear, as above described, is open to two objections:—(1) When released it leaves the door free to fall suddenly, and gives no means of checking or regulating the descent; therefore it is dangerous, as the door may be released just at the moment a person is passing through. (2) When the shutter is down it is sometimes not easy to put the nut in gear again to force the shutter well against the seat frame. To avoid these defects, in lieu of the nut a brake is fitted to the door, as in Fig. 6, or two worm wheels with locking brake are fitted, embracing the screw shaft—Fig. 7. These wheels are locked fast when the shutter is raised, but can be made loose at any convenient degree when the shutter is lowered. When locked they act like a screw nut, in which a screw shaft is revolving. When loose, they simply turn freely and glide along the screw shaft. Therefore the shutter can be regulated at will on its descent, and can be forced tight against the seat, when down, by simply tightening the locking brake when the screw shaft can be used to force the shutter.

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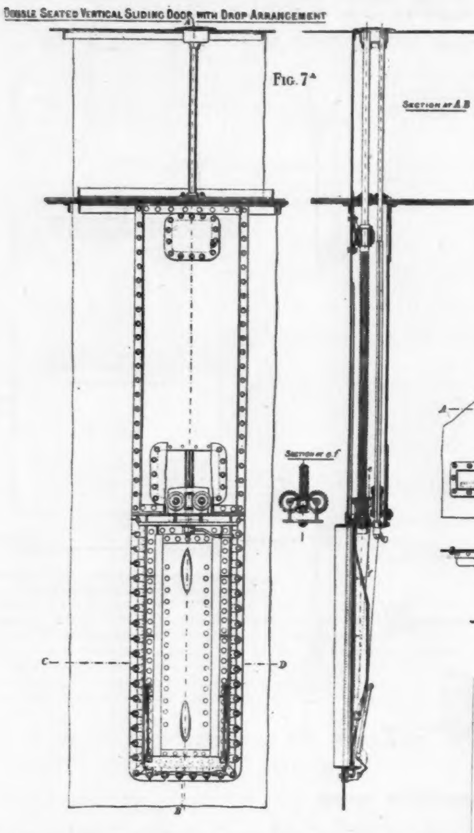
* Read at the Thirty-seventh Session of the Institution of Naval Architects, March, 1896.

The tightening brake can be locked both from below and from above deck, as convenient. The gear, whether rack and pinion or screw shaft and screw nut, is usually worked by hand; but now that electric power is generally available on board ships, the said manœuvre can easily be made by a small electric motor fitted to the hand shaft of each door, as shown in dotted lines on Fig. 8. This arrangement, which has already been fitted on board ships of the U.S. Navy, has two advantages. (1) The door can be opened and shut instantly by the person who wants to pass through, simply by making and reversing an electric contact. (2) The closing of all doors that might happen to be open in time of emergency can be effected by a single person—by the officer in command on the bridge. The electric arrangement does not impair the efficiency of the hand gear—which is needed all the same, should the electric current fail—as, when the electric current is interrupted, the electric motor offers but little friction, which can easily be overcome by the hand gear itself.

Possibly the same advantages might be secured in a more reliable and efficient way by using hydraulic instead of electric power. A simple, small, hydraulic cylinder, with reversing valve fitted to each sliding door, and connected to a pipe carrying the compressed water, would be all that is necessary. The force for working a water-tight door being comparatively small, a small quantity of water at a very moderate pressure, such as is available on the feed pipes of the boilers of the ship, would be sufficient for the purpose. And, as in a sea-way the feed pumps are always at work, the feed water pressure for working the water-tight door would be always available and ready.

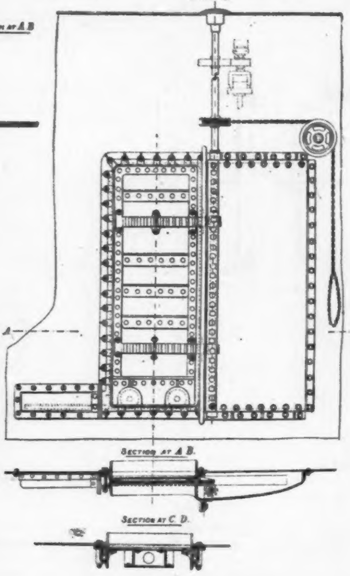
DOUBLE SEATED VERTICAL SLIDING DOOR WITH DROP ARRANGEMENT

FIG. 7A

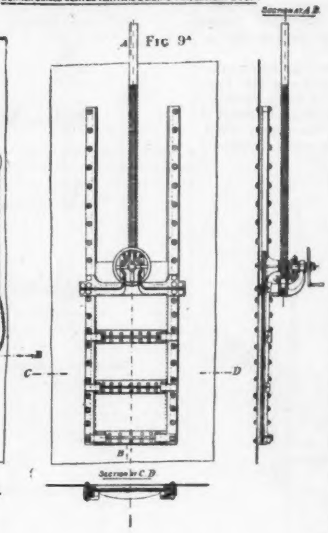


DOUBLE SEATED HORIZONTAL SLIDING WATERTIGHT DOOR

FIG. 8A



BUNKER SINGLE SEATED VERTICAL SLIDING WATERTIGHT DOOR.



The advantages above enumerated are, in my opinion, worth consideration. In fact, why are water-tight doors objectionable? Principally because they are kept open. And why are they kept open? Simply because the operation of opening and closing them is tedious and slow and fatiguing. Reverse this condition, give the man who wants to pass quickly through a door the means of opening it rapidly by simply pulling a small lever, let the lever, as soon as it is released, go back automatically and close the door after the man has passed, and then, I think, you will see the sliding water-tight doors fulfilling their important function of allowing a free communication between the main compartments of a ship, without impairing the safety of the ship. This refers to passage water-tight doors. For bunker doors, which are necessarily kept open at sea, the difficulty would also be overcome by the hydraulic arrangement, as by handling a simple main valve the officer in command would be able to close, in a few seconds, all water-tight doors that might be open at the time. A difficulty would still exist, to a certain extent, on board warships, where the bunker holes on protective decks are kept shut. In these ships the coal trimmers, on closing the doors, would be practically shut in the bunkers with no possibility of escape; a condition not very pleasant. And it is this fear of being so imprisoned that has prevented the success of all schemes for suddenly closing bunker doors, as the coal trimmers, to avoid such an awful fate, contrive means for jamming the doors to prevent them being shut. Therefore, should any arrangement for closing suddenly the bunker doors be resorted to, it ought to be completed by giving proper means of escape to the coal trimmers.

The sliding shutters of water-tight doors, whether for bunkers or for passage through compartments, when shut are usually forced and kept tight against the seat of the door by means of inclined guides or wedges. This arrangement is open to objections, as the wedges are needless when the pressure of the water acts to keep the shutter self-tight against the seat, and they are generally inefficient when the water pressure acting on the opposite side tends to force out and detach the shutter from the seat. Moreover, the guide wedges, to be efficient, must press hard, with the result that the door is then hard to open. To avoid these defects double-seat water-tight doors may be resorted to, which are self-tight, whichever of the two sides of the door is pressed by the water. Figs. 7 and 8 show two double-seat water-tight doors, one vertical and one horizontal sliding, as fitted on board the Royal Italian cruiser Elba. Figs. 10, 11, and 12 show the same principle carried out for bunker water-tight doors, of which more will be said hereafter.

Bunker water-tight doors.—Bunker water-tight doors are generally vertical sliding, single-seated, screw-shaft geared, and close as usual, downwards—Fig. 9. These doors are generally acknowledged to be defective, on account of the coal that lies on their threshold when open and which opposes an obstacle when the shutter is lowered to shut. Moreover, the pressure of the water inside the flooded bunker tends to open the door, which therefore is scarcely water-tight, specially at the bottom, where there are no wedges or guides to keep the shutter well pressed against it. Both objections would, in my opinion, disappear if the door be made double-seated and close upwards, as then it will always be self-tight, whichever side of the bulkhead is flooded; and the coal that might lie on the threshold would fall down by itself in the stokehold or in the bunker when the shutter is being raised.

The author showed a working model of such a door. As will be seen, the door is double-seated and closes upwards, the shutter, when the door is opened, being lodged in a box at the bottom, and filling with its upper edge the threshold groove. Nay, this upper edge forms the bottom of a frame cast solid with the shutter, and which fills the grooves of the door all round, and keeps them clear.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

THE HAMPSON LIQUID OXYGEN PROCESS.

SIR,—On Saturday Dr. Hampson, at Brin's Oxygen Works, Westminster, gave a demonstration of his process. He produced liquid oxygen without the aid of any cooling material whatever, save some water from the street main; and liquid air, with the assistance of a small quantity of powdered ice and salt. He delivered, I am informed, a little lecture explaining his process. Ostensibly the process is the same as Dr. Linde's, which has been fully described in THE ENGINEER. As to the name of the first inventor, it is not for me to speak. Indeed, my sole object in writing now is, with your permission, to call attention to a very curious episode in Saturday's proceedings. I refer to a remarkable argument made use of by Dr. Hampson to prove the novelty of the process. "Here you see," he said, "a very simple and inexpensive little apparatus, doing all that an apparatus costing hundreds, if not thousands, of pounds can effect. Many men of science have been labouring for years at the liquefaction of gases. If they had invented any such process as mine, is it not certain that they would have used it? Professor Dewar and the continental scientists knew nothing of this process of mine, or assuredly they would have used it." This is a very powerful, indeed conclusive argument. The point to which I wish to direct attention is that no doubt Professor Dewar and others were quite familiar with the facts on which Dr. Hampson has worked, but they did not believe that the facts could be utilised to produce liquid gas. In one word, the Hampson process or the Linde process, whichever it may be called, apparently is opposed to the teachings of thermodynamics. It ought not to work. The more carefully a man has been taught thermodynamics, the more likely is he to regard the process as impossible; and at this moment it is not certain that Dr. Hampson, to say nothing of those present at his experiments, understood why the process works. It is one of the great defects of dogmatic science teaching that it stops progress. Certain laws are laid down. From these the teacher draws certain deductions, and backs them up with piles of formulæ. He teaches that these deductions cover the whole ground, and his pupils believe him, and do not try to advance further. A man comes on the scene who possesses some scientific training, but either it has not been dogmatic, or he refuses to accept dogmatic teaching. He has an open mind, and he quietly does what he was told was impossible. Then the professor comes along and explains how it has been done, and that there is nothing new, and so on. Here we have a man who is not a professor doing that which a number of the best trained men in the world never attempted to do, because they believed that it was really opposed to the laws of thermodynamics. What was the ground of this belief? With your permission I will endeavour to answer it very briefly.

The object of the process is to produce intense cold by the compression and expansion of air. I must insist first on one fact being accepted before going further, which is that the total amount of energy in any given weight of gas is measured by its temperature, and, of course, its specific heat; but for my purpose at present we have nothing to do with specific heat.

If we compress a gas we raise its temperature. If by any means the heat is prevented from accumulating, the energy in the gas will be the same after compression as before. The usual way of drawing off the heat is to allow the air to pass through the tubes of a surface condenser; the whole of the energy expended in compressing the air will re-appear in the cooling water, but no more. It is necessary to be very explicit on this point, because there is a popular idea that in refrigerating machines the heat is "squeezed out" of the air into the water, and that the air is cooled in consequence. Nothing of the kind happens. As a matter-of-fact the air is rather warmer after it leaves the condenser than it was when it entered the compression pump.

The whole object of compressing the air is to bring it into such relations with its surroundings that it can do work. There are so many foot-pounds in a hundredweight of air at 62 deg. and atmosphere pressure; there is precisely the same number of foot-pounds of energy, no less and no more, in the same weight of air at 2000 lb. on the square inch and 62 deg. Fah. In the first case, it was impossible to get the energy out of the air without altering its environment. In the second case, without alteration of environment a large proportion of the energy can be got out of it, converted into work, and the result will be a great fall in temperature; but there can be no fall in temperature unless there is a loss of energy, and there can be no loss of energy unless heat is abstracted or external work is done.

Now, in the Hampson apparatus air is compressed and expanded, and a very small amount of reflection will show that no energy can escape from the apparatus. We have seen that none of the intrinsic energy of the air is carried off by the cold water. It is obvious that no heat can escape from the apparatus. It is most carefully felted and protected to prevent external heat from getting in. It is clear that no external work of any kind is done. Under these circumstances it is self-evident that no energy can get out of the apparatus, and that no cooling can take place. All this is perfectly sound thermodynamics. There is no flaw anywhere. No wonder, then, that neither Professor Dewar, nor Mr. Oselewsky, nor anyone else steeped in thermodynamic lore could originate such an apparatus, an apparatus all wrong from first to last.

But Schröefer showed last year that an apparatus from which there was no perceptible mode of escape for energy could work, and to explain how we are told that it is all due to what is known as the Joule effect. Joule found that when air is allowed to expand slowly and steadily through a small orifice it is slightly cooled, when hydrogen is so treated it is slightly heated. Scientists availed themselves of this fact, or assumed fact—for the experimental investigation is extremely delicate, and very open to error—and said that this is the reason the Linde process works. As a matter of fact, however, the Joule effect is quite unnecessary, while its amount is so insignificant that months, if not years, would be expended in making a quart of liquid oxygen by its aid.

The true theory of the Hampson process is very curious. In point of fact there is no loss of energy or heat from the apparatus at all as a whole, but there is brought about a peculiar distribution of energy within it. To make this clear let us suppose that we have a tube 10ft. long filled with air at 62 deg. The intrinsic energy of the tube and its contents is, say, 500 foot-pounds. Now we can fancy a means provided by which the temperature of the air at one end of the tube will be 500 deg. Fah., and at the other end zero, the intrinsic energy of the whole remaining unaltered. This is what Dr. Hampson and Dr. Linde do. They take a given weight of air at, say, 1500 lb. on the square inch, and they alter the distribution of energy in it. We have the oxygen at a high temperature in the compressing pump, and we have it at −180 deg. say, in the glass receiver, in which the liquid oxygen is collected, but at any given minute during the working of the process the total energy, the total heat in the apparatus, is the same as at any other minute. There is no change of energy until we stop the machine, and take out the beaker of liquid gas.

The cooling is produced not by Joule's effect at all, but by the expansion of the compressed gas in a way so well understood that it needs no explanation. The gas on expanding does work, and is cooled, but all the heat is restored again. In Clark-Maxwell's words, "The sum of the intrinsic energy and the product of the volume and the pressure, remain the same after passing through the orifice, provided no heat is lost or gained from external sources."

In the Hampson apparatus the temperature is lost in one part of it and restored in another, and the continual flow of the cooled gas to the hot pump evidently powerfully tends to prevent the transmission of heat from the hot end of the apparatus to the cold end. It is clear now, I hope, that Mr. Hampson may take any given weight of oxygen and convert a portion of it into a liquid, and yet never abstract any heat at all from the apparatus. All that he does is to localise cold in one place and heat in another. No heat whatever is taken out of the gas as a whole. Indeed, it may be shown that as we go on liquefying portions of the gas, the remainder may become hotter and hotter by the accumulation in it of the heat given up by the portion liquefied. It may be that this rise in temperature would under certain conditions be carried off by the cooling water, but such conditions never occur in practice; the weight of liquid present at any one time being comparatively small as compared with the weight of air, because the process is continuous.

We see here that, arguing on a thermodynamic basis, it is, first, impossible for any energy or heat to escape from the apparatus; secondly, if no heat escapes then no cooling can be produced; thirdly, therefore, an apparatus from which no heat escapes will not produce liquid gas; fourthly, it would be waste of time to attempt to produce liquid gas in this way. Such, no doubt, was the reasoning of any well-grounded dogmatic man of science. Dr. Hampson says in effect: "All this is perfectly true. But its truth is nothing to the purpose. It is possible to make a machine in which by 'regenerative' or 'degenerative' action I can localise all the heat at one end of a tube and all the cold at the other end, and I can make the cold end cold enough to give me liquid oxygen."

The process must not be confounded with that of the Giffard or other refrigerating machines, because in them the air to be cooled does external work, and so there is a direct loss of energy from the apparatus. The principle is apparently the same; it is actually quite different.

Finally, I have only to direct attention to the fact that the thermodynamic laws are not affected in any way; only Professor Dewar and others limited their application, and so missed inventing an exceedingly beautiful process. ZERO.

Westminster, March 23rd.

TRIPLE CYLINDER LOCOMOTIVES.

SIR,—In your leader of the 13th inst. you place before your readers suggestions for a new type of engine to cope with the anticipated and ever increasing heavy traffic of the future, which deserve very careful consideration. It has always been apparent to me that for working fast trains, the speed and weight of which are constantly being augmented, an engine of either the Webb type, or one constructed on similar lines, will have to be employed. It will, I think, be generally conceded that the cylinder capacity of simple locomotives will soon reach its limit—if, indeed, this is not already the case—and for this reason, if for no other, the adoption of the three-cylinder plan will be almost imperative. Following the same reasoning, it is not too much to say that compounding will also become expedient, since it will be practically impossible to have a boiler sufficiently large to supply live steam to three cylinders. Taking, therefore, the locomotive of the future to be of the compound type, and the conditions of working in every way suitable, there seems no valid reason why, even at the present time, such engines should not be used on all lines where heavy loads and long runs are the principal factors to be considered. In other words, there is no reason why there should not be compound locomotives for the heavy express work, just as there are goods engines for goods trains and tank locomotives for slow and intermittent traffic. Seeing that the Webb compounds are equal to taking loads of 300 tons and over without assistance at an average speed of fifty miles an hour, it is difficult to see in what manner these engines have been as unsuccessful as is popularly supposed.

Much has been said at various times as to the additional first cost of a three-cylinder compound and the extra expense of up-keep, but when by the use of such powerful locomotives double engine running is reduced to a minimum, it is surely more economical and satisfactory to use three sets of motion than to employ a pilot, whereby there is the wear and tear of four sets of motion and two boilers. Double fuel consumption and the wages of the extra men must also be taken into account. The cost of running is in every way increased; it is wholly unsatisfactory, and often dangerous. While one engine is inadequate, it generally happens that the pilot and train engine are together more than sufficient for the work to be done.

The great feature of the engine you sketch, as with Mr. Webb's compounds, is the elimination of coupling-rods, not only because a larger fire-box can be got in, but because an exceedingly powerful locomotive, adapted to all the requirements of a coupled engine combined with the advantages of a single, is secured. The success obtained with the Webb type so far has clearly proved to my mind the superiority of the three-cylinder over the two-cylinder plan of compounding. It is, therefore, perfectly reasonable to assume that engines on much the same lines will in the future be found to be the most powerful and, in proportion to the extra work done, the most economical. If so, judging by what has already been done by the Webb engines, the prejudice and apathy which at present seem to stand in the way of a fuller development of the compound principle should be removed. F. W. BREWER.

London, N., March 21st.

SIR,—A compound locomotive designed by M. Jules Morandiere, having three cylinders—one inside the frames and two outside—the inside cylinder being high-pressure and the outside low-pressure, the high and low-pressure cylinders being arranged to drive independent axles, was illustrated in your contemporary, *Engineering*, in the year 1866, that is, thirty years ago. Your correspondent, Mr. Smith, calls it his system; so it would be interesting to learn where his system was previously described.

I quite agree with your contributor as to this being the rational system of constructing a compound locomotive, but would at the same time point out that the simple engine has not been developed completely in regard to its economical capabilities. On the Paris and Orleans Railway are seventeen locomotives fitted with Corliss valves, one at each cover of the cylinder, the two upper valves being for admission and the lower ones for exhaust. The admission valves are worked in a semi-independent manner by the same link motion as works the exhaust valves, the result being that, compared with similar engines fitted with the ordinary slide valve, a saving of 15 per cent. in fuel is obtained, which is quite as much as compounding at present gives. If this construction of cylinder was used for the high-pressure of a compound, I have no doubt that another 10 per cent. would be obtained, while at the same time the engine would be enabled to deal with any range of loads or speeds required—a feature at present impossible. I might add that no complicated trip gears or accessories of that nature are used on the engines I mention. J. DUNLOP.

206, Gorton-lane, Gorton, Manchester,
March 23rd.

SIR,—I have perused your able article in your issue of March 13th, on "Triple Cylinder Locomotives," with the greatest interest, and it has once more brought an idea to my mind which first struck me on reading Mr. Rous-Marten's description of his ride on the foot-plate of Mr. Webb's Greater Britain, which appeared in THE ENGINEER of August 25th, 1893. I was particularly impressed by his remarks on the fine steaming qualities of the long boiler, with its combustion chamber. It appeared to me then that for express engines of the most powerful type this long boiler was the right thing, and I am still of that opinion so long as a combustion chamber is used, as it seems to stand to reason that fuller use of the products of combustion is made with a boiler like Mr. Webb's than is possible with the ordinary short boiler.

Now, if a three-cylinder compound locomotive were built on the lines you laid down, with the long fire-grate and bogie, I would suggest the long boiler also.

There is a large waste space in front of the smoke-box on all bogie engines, and why should it not be utilised? I would bring the smoke-box forward to the same position with regard to the buffer beam that it occupies on an engine with only one pair of leading wheels, and lengthen the boiler barrel proportionately. The high-pressure cylinder would remain in the position you suggest, over the centre of bogie as usual, and the alteration would only mean that it would be outside the smoke-box casing as well as the two outside low-pressure cylinders—which would be so in any case—and that all three cylinders were somewhat further from the smoke-box than usual. There are some objections to this, I am well aware, but none that would seriously trouble locomotive designers; and on the other hand, any necessity for a boiler of undue diameter would be removed. I think by embodying such a boiler in the engine you sketch out, we should arrive at something very near the ideal of a powerful express locomotive.

Springfield, Coventry, March 18th. H. W. STANER.

ENGINE POWER IN PADDLE STEAMERS.

SIR,—The old and new Flushing-Queenborough boats have, it is true, been engined at the same works, but there exists a wide difference between the systems of the paddle-wheels which have been adopted for the two. The excellent old boats have, as shown in the following table, compared to the power, large wheels, while the new boats have small wheels.

	Old boats.	New boats.
D, eff. diameter of wheels	20ft.	18ft. 6in.
Number of floats	10	9
Length of floats	12ft.	12ft. 9in.
Breadth of floats	4ft. 2in.	4ft. 10½in.
A, area of one float	50 square feet	62·34 square feet
I.H.P. (actual)	3543	9000
I.H.P. (intended)	—	7000
$\frac{\text{I.H.P.}}{\text{D.A.}}$	0·282	0·165 and 0·128

Small as the relation $\frac{\text{I.H.P.}}{\text{D.A}}$ is in the new boats, it was originally even still smaller. The result was as might have been expected; at her first trial the first new vessel was unable to keep the stipulated speed, although the engines ran away with the small wheels, actually exhausting all the steam which the boilers could supply. Doubt about the boiler capacity arose; fortunately the propeller question was also examined into; at first it was thought that the enormous slip which had been observed was due to the wheels working in a hollow of the deep wave which the hull raised at great speed. But instantaneous photographs of the vessel under way did not confirm this idea.

Enlargement of the wheels, as far as practicable, was then resorted to; by successive additions the floats were increased up to their present size, the largest which the paddle-boxes would allow to pass. This makeshift was so far successful, that the boats were at length accepted, and are in service, giving much satisfaction in a nautical way. With wheels more in accordance than the actual ones, with the practice followed in the older boats, the same good results could, however, have been obtained with much less slip, *i.e.*, much less power and much less consumption of coal. J. M.

March 24th.

PERMANENT WAY.

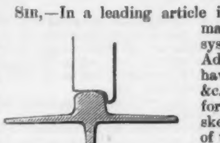
SIR,—In your editorial of 20th inst., the gist of the recent discussion is very properly summed up in the question, "What is the road of least resistance?" and, in effect, you answer it by indicating that the road of least resistance is—*cæteris paribus*—the road with the stiffest rails. That, however, is qualified by saying that "an absolutely rigid road would be intolerable to passengers."

I venture to think that if a road could be constructed absolutely rigid, and also absolutely even and uniform, it would be not only tolerable but perfect. Of course, neither condition is possible in practice. Unevenness causes shocks between the wheel tires and the rails, and the resulting vibrations have to be absorbed by some suitable material as near their origin as possible. The Mansell wheel seems admirably adapted for the purpose as far as rolling stock is concerned, and the evil of these vibrations is incomparably greater to the rolling stock than to the track. As regards the track, evenness and uniformity are of the first importance, and it is a pity that the advantages possessed by the longitudinal system in this way are over-balanced by other considerations. However, with a cross-sleepered road and high speeds, there is scarcely any appreciable shock as the wheels pass successive chairs, providing a sufficiently rigid rail is used, and the line properly ballasted and packed.

Every one who has seriously considered the subject must be of your opinion that too little attention is given to ballast. With bad ballast it is impossible to preserve a good and reliable track, however much labour may be expended upon it. You, Sir, have placed monetary advantages at a lower level than I should have assigned for them, but, in any case, I believe it would pay to lead good ballast long distances rather than employ local rubbish. What is called the "elasticity" of the road, as well as its stability, depends mainly on the ballast; and perhaps I may ask you at some future time to allow me to express in your columns my ideas in this connection.

As you have remarked, the subject is one of permanent interest, and it will remain so until some concerted effort is made by both scientific and practical men to solve it. There have been opportunities for observing and recording the behaviour of permanent way under all sorts of conditions in this country, but, as far as I know, they have not been pursued in any systematic way. Probably your columns afford the best medium for exchanging the data of experience and the deductions of science, and I hope that is this behalf THE ENGINEER may do more in the future than the Board of Trade has done in the past. JAMES WHITESTONE.

113, Queen Victoria-street, E.C., March 24th.

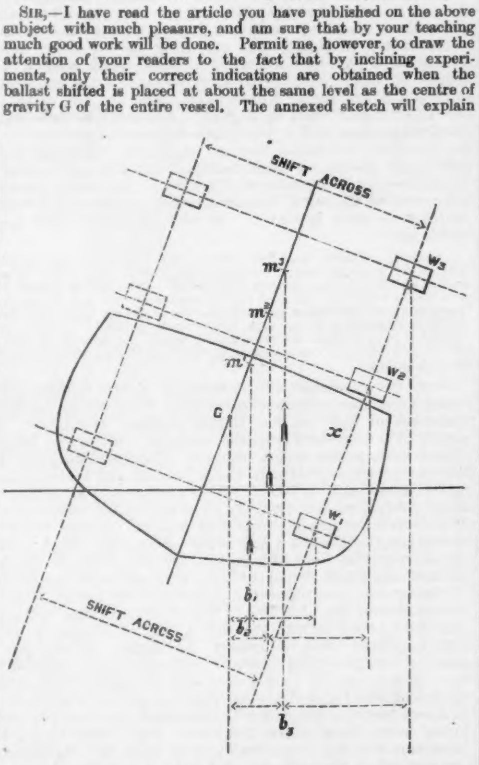


SIR,—In a leading article in to-day's ENGINEER reference is made to W. Bridges Adams and his system of permanent way. Mr. Adams at different times appears to have introduced various types of rails, &c. In 1853 he patented a girder rail for use without sleepers; I enclose a sketch of this rail in section. Width of tread, 2¼in.; total depth from top of rail to bottom of keel, 8in.; horizontal bearing surface on ballast, 14in. It will be interesting to know if a railway were ever laid out with this rail, and if so, the results of the experiment. Perhaps some of your readers can give particulars. G. A. SEKON.

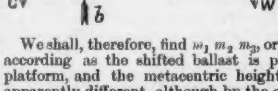
March 20th.

NAVAL ARCHITECTURE—NO. IV., STABILITY (INCLINING).

SIR,—I have read the article you have published on the above subject with much pleasure, and am sure that by your teaching much good work will be done. Permit me, however, to draw the attention of your readers to the fact that by inclining experiments, only their correct indications are obtained when the ballast shifted is placed at about the same level as the centre of gravity G of the entire vessel. The annexed sketch will explain



the point I allude to. W_1 W_2 and W_3 shall be three different positions of the ballast trimmed to one side, in three experiments. The shift across shall be in all three cases alike. G is the centre of gravity of the ship minus the shifted ballast W. b_1 b_2 b_3 will be three different centres of buoyancy, because in each case we have a simple balance, with the weight of ship b at one end and the ballast W_1 at the other.



We shall, therefore, find m_1 m_2 m_3, or three different metacentres, according as the shifted ballast is placed on a higher or lower platform, and the metacentric heights G m_1 G m_2 G m_3 will be apparently different, although by the common formula it ought to be the same, because the level of the ballast is not taken into account. The greater the height of the ballast the greater will be the heel. The correct position for the ballast would be at X. In the case of small craft such as torpedo boats, destroyers, and single-decked vessels generally, the ballast is always placed far too high up in inclining them, and consequently the G m obtained is apparently less than it really is. In large vessels having several decks it would generally be possible to place the ballast at about the level of the centre of gravity G, and thus obtain correct angles of heel. F. W. C.

March 23rd.

RAILWAY AXLE BEARINGS.

SIR,—I regret that I am unable to answer all the queries addressed to you by your correspondent "Headstock," in your issue of the 13th inst., but I will try to do the best I can in that direction. But permit me here to premise by saying that for many years you have known me as a somewhat persistent advocate, from an economic point of view, if nothing else, for working to obtain the maximum amount of efficiency in all bearings of rolling stock, and hence my special interest. Of necessity the inital step to this end belongs to the brass foundry.

In the selection—if selection I may call it—of a vehicle used in forming a passenger train, I am confined to one, namely, a travelling post-office, this being the only vehicle, so far as I know, that runs a specified mileage day by day. This van runs, out and home again, every day from Aberystwith to Shrewsbury, and so covers 163 miles per day. In October, 1894, I supplied this van with a set of brasses—six—which, when fitted on journals, weighed 62 lb. 11 oz., and when returned to works October, 1895, for general repairs, I found the weight to be 57 lb. 8 oz., the total loss being 5 lb. 3 oz.

Miles run in 362 days, at 163 per day .. .. = 59,606
Total loss for 1000 train miles .. .. = 1·40 oz.
" " " 25,000 " " .. .. = 35·16 "
Total single bearing 25,000 train miles .. .. .. = 5·86 "

The above is no special case of results, but is practically that of three successive sets of brasses. The lubricant is not oil, but just the ordinary yellow grease. In oil the wear would have been considerably less. I trust this information may be of interest to your correspondent "Headstock" and others of your readers.

FOUNDRYMAN.

Oswestry, March 20th.

ROCHESTER BRIDGE.

SIR,—Referring to description of above in your current number, I believe I am right in stating that this very interesting example of cast iron bridges was actually designed by Rowland Mason Ordish for Sir W. Cubitt. I have heard the late Mr. Ordish mention that the wrought iron swing portion was never once used since the date of the opening of the bridge for traffic. In being attributed to another than the actual designer, this bridge shares the fate of most of Mr. Ordish's important works, which, by-the-bye, includes St. Pancras Station roof, the Albert Hall roof, the Holborn Viaduct bridge, &c.—all designed by commission from other engineers, whose names are now incorrectly attached to them. J. W. LEIGH.

17, Barton-street, West Kensington, W., March 24th.

[We publish Mr. Leigh's letter, but we must add that Mr. Ordish's position in these matters was quite well understood by himself, and he was not acting in them as principal any more than many others who receive instructions from the engineer-in-chief of an undertaking.—ED. E.]

W. H. HARRISON FUND APPEAL.

SIR,—After thirty years of scientific writing, Mr. W. H. Harrison's health and strength have completely broken down, and he lies stricken with brain paralysis.

The readers of THE ENGINEER are doubtless familiar with his work. New scientific matter of special interest; lectures delivered at the Royal Institution; reports of meetings of the British Association for the Advancement of Science; descriptions and details of engineering works and plant employed in new industries, were his special forte.

He achieved much success as an experimental photographer. To him is the credit due for the discovery of the gelatine emulsion dry plate and the employment of an alkaline pyro developer. This discovery he gave freely to the public in 1868.

Briefly, during thirty years Mr. Harrison has steadily worked on photographic and kindred scientific matters, but never tried to make pecuniary gain out of his work.

A testimonial fund has been started, and it is hoped that a sufficient sum will be obtained to tide him over his illness and be a solatium in recognition of his services in the cause of scientific progress. It is with much confidence that Mr. Andrew Pringle and myself appeal to all his scientific friends to assist in this most deserving case, and I will gladly receive and acknowledge contributions. FREDERICK H. VARLEY.

82, Newington Green-road, Highbury, London, N.

JABEZ CHURCH.

IT is with great regret that we have to announce the death of Mr. Jabez Church, M.I.C.E., which took place at his residence, 17, Holland Park-gardens, Kensington, on the morning of March 20th, 1896. The cause of death was congestion of the lungs and heart disease.

Mr. Church was born at Chelmsford in 1845, and was educated privately. After finishing his education, he was articled to his father, Mr. Jabez Church, of Great George-street, Westminster, who was also the son of a well-known engineer bearing the same name. Upon the completion of his term of pupilage in 1869, the deceased gentleman was admitted into partnership with his father, and practised as a consulting engineer in conjunction with him until the death of the latter in 1875. He then continued the practice on his own account, and during his too short career, was engineer to, or professionally engaged for, a very large number of gas and water undertakings, far larger perhaps than any of his professional brethren practising in the same branches of engineering.

Mr. Church had a very wide practice in Essex. Amongst other works in that county which he had either designed and constructed, or to which he was consulting engineer, were the Braintree gas works, the Barking gas works, the Brentwood gas works, the Chelmsford gas works, the Enfield gas works, the Epping gas works, the Harwich gas works, the Ilford gas works, the Saffron Walden gas works, the Witham water and drainage works, and the Thetford water works. Besides these he was engaged for the Barnet gas and water works, the Colney Hatch gas works, the Cromer gas works, the Dublin Consumers' Gas Company, the Horley gas works, the Woking gas works, and the Godalming water works. Mr. Church was also the consulting engineer for no fewer than twelve water works, all of which he designed and erected. Chief amongst these are the Henley-on-Thames water works, the Great Marlow water works, the Clacton-on-Sea water works, the Barton-on-Humber water works, the Braintree water works, the Halstead water works, the Goring water works, and the Mid-Sussex water works. He also designed the Gainsborough water works, which are now in course of construction.

Mr. Church was elected an Associate of the Institution of Civil Engineers on May 23rd, 1871, and was transferred to the class of Member on November 27th, 1877, at which time he had already designed and carried out many works of importance, and was engineer to no fewer than fifty corporations and companies. The deceased gentleman was a Past-president of the Society of Engineers, having been elected to that office two years in succession, namely, in 1882-3, his father having enjoyed that distinction ten years previously, namely, in 1872-3. He was also a Fellow of the Geological Society, and a Member of the Meteorological Society.

Mr. Church's practice will be carried on by Mr. Percy Griffith, A.M.I.C.E. and M.I.M.E., who has been professionally associated with the deceased gentleman for the last eight years, and has been in partnership with him since 1892.

TRACTION ENGINES ON ROADS.

A select committee of the House of Commons sat for the first time on Monday, the 23rd inst., in Committee-room No. 13, with a view to taking evidence relating to the laws controlling the use of traction engines on common roads. The Committee was made up of the following members:—Mr. H. Hobhouse, Chairman; Captain Bagot, Mr. Bill, Mr. Griffith-Boscawen, Mr. Vaughan Davies, Mr. Seale-Hayne, Mr. Hermon-Hodge, Sir W. Houldsworth, Colonel Kenyon-Slaney, Sir J. Kinloch, Mr. Luttrell, Mr. Tulley, and Colonel Warde.

The first evidence taken was that of Mr. Rotton, the legal adviser to the Local Government Board, who detailed the laws in existence relating to the subject. The witness cited three Acts of Parliament as controlling broadly the working of traction engines or road locomotives. These are as follows:—The Locomotive Act, 1861, which applies to Great Britain; the Locomotives Act of 1865; and the Highways and Locomotives (Amendment) Act of 1878; the two former being construed together as one Act. The portion of the Act of 1861 referring to the tolls levied upon road locomotives and vehicles drawn by them was considered as being out of the bounds of the inquiry, owing to the practical abolition of tolls on turnpike roads. We may, however, briefly recapitulate the salient points of the sections of these Acts which were given in evidence and still hold good in the regulation of the use of locomotives on roads. In Section 4—1861 Act—it is set forth that it shall not be lawful for any wagon, wain, or cart or other carriage drawn or propelled by locomotive or other engine not having cylindrical wheels to carry any greater weight than is permitted in such vehicles by the General Turnpike Act; and it shall not be lawful for such vehicles having cylindrical wheels to carry over or above the weight of the vehicle any greater weight than 1½ tons for each pair of wheels unless the fellies, tires, or shoes are 4in. or more in breadth; nor to carry a greater weight than two tons for each pair of wheels unless the fellies, tires, or shoes are 6in. or more in breadth. To carry three tons the fellies, tires, or wheels have to be not less than 8in. in breadth. The section further specifies that for every single wheel one-half of that allowed for a pair of wheels must not be exceeded, but in no case must a pair of wheels carry more than four tons, nor one wheel more than one-half of this weight. Should springs be provided on each axle the Act permits an additional sixth of the above-mentioned weights upon each pair of wheels.

Section 5 of the 1861 Act relates to the power of the Secretary of State to prohibit the use of locomotives destructive to highways or dangerous to the public, any person using such locomotive contrary to any order published in the *London Gazette* "shall for every such offence, on summary conviction thereof before two justices, forfeit any sum not exceeding ten pounds." Section 6 sets forth that it shall not be lawful to drive a locomotive over any suspension bridge nor over any bridge on which a conspicuous notice has been placed by the authority of the surveyor or persons liable to the repair of the bridge that the bridge is insufficient to carry weights beyond the ordinary traffic of the district, without previously obtaining the consent of such authority. Should this permission be refused, on the application of either party, the question of insufficiency may be referred to one of her Majesty's principal Secretaries of State, whose certificate of sufficiency gives the owner of the locomotive the right to take the same over the bridge. Section 7 implies that any damage done by locomotives or carriages propelled by the same to turnpike or other roads carried over any stream, watercourse, navigable river, canal, or railway, by means of a bridge, shall be made good by the owner or owners of the locomotive, who shall also compensate any person for obstruction, interruption, or delay, caused by the said damage. Section 9 specifies that no "locomotive, wagon, or carriage," shall be used on the turnpike or other roads "except there be at least two persons to drive or conduct such locomotive. and if more than two such wagons or carriages be attached to such locomotive, one person to take charge of such wagons and carriages." Between the hours of one hour after sunset and one hour before sunrise two efficient lights are to be carried on either side of the front of the locomotive.

The Act of 1865 is described as "An Act for further regulating the use of locomotives on turnpike and other roads for agricultural and other purposes," and repeals the sections 5 and 9 of the 1861 Act." It enacts that every locomotive propelled by steam or any other than animal power on any turnpike road or public highway shall be worked according to the following rules and regulations:—

> "Firstly, at least three persons shall be employed to drive or conduct such locomotive, and if more than two wagons or carriages be attached thereto, an additional person shall be employed, who shall take charge of such wagons or carriages.
>
> "Secondly, one of such persons, while any locomotive is in motion, shall precede such locomotive on foot by not less than sixty yards, and shall carry a red flag constantly displayed, and shall warn the riders and drivers of horses of the approach of such locomotives, and shall signal the driver thereof when it shall be necessary to stop, and shall assist horses, and carriages drawn by horses, passing the same.
>
> "Thirdly, the drivers of such locomotives shall give as much space as possible for the passing of other traffic.
>
> "Fourthly, the whistle of such locomotive shall not be sounded for any purpose whatever; nor shall the cylinder taps be opened within sight of any person riding, driving, leading, or in charge of a horse upon the road; nor shall the steam be allowed to attain a pressure such as to exceed the limit fixed by the safety valve, so that no steam shall blow off when the locomotive is upon the road.
>
> "Fifthly, every such locomotive shall be instantly stopped, on the person preceding the same, or any other person with a horse, or carriage drawn by a horse, putting up his hand as a signal to require such locomotive to be stopped.
>
> "Sixthly, any person in charge of any such locomotive shall provide two efficient lights to be affixed conspicuously, one at each side on the front of the same, between the hours of one hour after sunset and one hour before sunrise."

The second of the just-mentioned regulations was afterwards repealed, as will be hereafter mentioned, while the sixth is practically embraced in Section 9 of the 1861 Act. The penalty for the non-compliance with any of the above regulations is not to exceed £10.

The fourth section fixes the maximum limit of speed of locomotives at four miles per hour along any turnpike road or public highway, and at two miles an hour "through any city, town, or village," any person acting contrary to these instructions shall be liable to the forfeiture of a sum not exceeding £10. Two important sections of the Act relating to the size and weight of locomotives, and the power of local authorities to make orders as to hours, &c., during which locomotives may pass through cities, &c., have been repealed by the 1878 Act, particulars of which we are now about to give.

The Highways and Locomotives (Amendment) Act, 1878, is divided into three parts, and does not apply to Scotland and Ireland. Part I. refers to highway law, and contains one section—23—of particular interest to owners of traction engines. This section—devoted to "extraordinary traffic" enacts that:—

> "Where by a certificate of their surveyor it appears to the authority which is liable or has undertaken to repair any highway, whether a main road or not, that, having regard to the average expense of repairing highways in the neighbourhood, extraordinary expenses have been incurred by such authority in repairing such highway by reason of the damage caused by excessive weight passing along the same, or extraordinary traffic thereon, such authority may recover in a summary manner from any person by whose order such weight or traffic has been conducted the amount of such expenses as may be proved to the satisfaction of the court having cognisance of the case to have been incurred by such authority by reason of the damage arising from such weight or traffic as aforesaid."

In connection with this section it should be pointed out that the term "excessive weight" is extremely vague, and, although pressed for its definition, Mr. Rotton, in his evidence, declined to give a legal decision, but thought that no owner of a locomotive used on a road under ordinary conditions would be liable for employing excessive weight. It will, of course, be apparent that "extraordinary traffic" may be attributed to other means of locomotion than traction engines. Mr. Rotton cited several cases of litigation involving these terms, and considered the decisions arrived at as being far from unanimous.

Part II. of the 1878 Act is devoted to the Amendment of the Locomotive Acts of 1861 and 1865, of which Section 3 of 1861, and Section 5 of 1865, are repealed so far as relates to England. According to this amendment it shall not be lawful to use on any turnpike road or highway a locomotive constructed otherwise than in accordance with the following provisions:—

> "1. A locomotive not drawing any carriage, and not exceeding in weight three tons, shall have the tires of the wheels thereof not less than 3in. in width, with an additional inch for every ton or fraction of a ton above the first three tons; and
>
> "2. A locomotive drawing any wagon or carriage shall have the tires of the driving wheels thereof not less than 2in. in width for every ton in weight of the locomotive, unless the diameter of such wheels shall exceed 5ft., when the width of the tires may be reduced in the same proportion as the diameter of the wheels is increased, but in such case the width of such tires shall not be less than 14in.; and
>
> "3. A locomotive shall not exceed 9ft. in width or fourteen tons in weight, except as hereinafter provided; and
>
> "4. The driving wheels of a locomotive shall be cylindrical and smooth soled, or shod with diagonal cross-bars of not less than 3in. in width nor more than ¾in. in thickness, extending the full breadth of the tire, and the space intervening between each such cross-bar shall not exceed 3in."

The paragraph commencing "secondly" of Section 3 of the 1865 Act, above alluded to, is repealed by this Act, and now reads as follows:—"Secondly, one of such persons, while the locomotive is in motion, shall precede by at least 20 yards the locomotive on foot, and shall, in case of need, assist horses, and carriages drawn by horses, passing the same." Section 30 of the 1878 Act provides that all steam locomotives shall be constructed to consume their own smoke under a penalty not exceeding £5 for every day during which such locomotive is used on any road. Section 31 defines the authorities which have power to make bye-laws as to the hours during which locomotives are not to pass over the turnpike roads or highways, the hours being in all cases consecutive, and no more than eight out of the twenty-four, and for regulating the use of locomotives upon any highway or preventing such use upon any and every bridge where it would be attended with danger to the public, a fine, not exceeding £5, being the penalty upon any person acting contrary to such bye-laws. Section 32 of the 1878 Act enacts that—

> "A county authority may from time to time make, alter, and repeal byelaws for granting annual licences to locomotives used within their county, and the fee—not exceeding ten pounds—to be paid in respect of each licence; and the owner of any locomotive for which a licence is required under any byelaw so made who uses or permits the same to be used in contravention of any such byelaw shall be liable to a fine not exceeding forty shillings for every day on which the same is so used, all fees received under this section being carried to and applied as part of the county rate.

Upon the conclusion of the evidence of Mr. Rotton, the chairman of the committee called upon Mr. Chittenden, the chairman of the Traction Engine Owners' Association, a society of one hundred members, including owners and users of road locomotives, to give evidence. This gentleman stated that there were at present in use in England and Wales about 8000 of these engines, 700 of which were employed in Kent alone. As representative of the above-mentioned association, Mr. Chittenden complained that traction engine owners should have to take out a licence for each county; that, with the exception of Kent and Sussex, the authorities of which granted rebates of 50 per cent. on all licences taken out in adjoining counties, other county authorities insisted upon the maximum fee of £10. In the opinion of the witness one fee should suffice for the whole of England. He also suggested that a greater uniformity in the bye-laws of neighbouring counties should exist respecting the close hours—if such hours were necessary—and that the reduction of the restricted hours should only take place in towns having a population of 10,000 and upwards, the said hours being those when the street traffic was heaviest. With regard to the maximum limits of speed, Mr. Chittenden recommends that these should be raised to five or six miles an hour in country districts and three miles in larger towns. Besides advocating the raising of the limit of maximum weight of traction engines from 14 tons to 20 tons and the exemption of steam rollers from licences, the witness considers that the present law, confining the wheels of road locomotives to one pattern, might advantageously be altered to allow local authorities to sanction the use of other approved forms. Speaking generally, Mr. Chittenden desires to see the road locomotive put on the same footing as ordinary road vehicles.

Upon the conclusion of Mr. Chittenden's evidence, the Committee adjourned until yesterday (Thursday).

THE MERSEY ESTUARY.

The report of the acting conservator of the Mersey, Sir G. H. Richards, K.C.B., F.R.S., for 1895 has been published fully a month earlier than last year, and very much earlier than has been the case in former years. This is a decided improvement, and as the effect of the Manchester Ship Canal upon the *regime* of the estuary will be raised before the Committees of both Houses of Parliament during the current session, Admiral Richards' report will be heard of frequently.

The annual reports are more than usually interesting owing to the dredging operations on the bar, and also to the completion of the Manchester Ship Canal, which in some ways modifies the conditions of the estuary to a greater or less extent.

On the bar the work of dredging has been continued. The new 3000-ton sand pump dredger G. B. Crow, similar to the Brancker, was delivered last autumn, and commenced work at the Queen's Channel towards the end of November, from which it removed upwards of 220,000 tons. The Brancker was employed on the bar during a portion of each month o the year, and worked there in all 3127 hours; during this time 2,570,700 tons were removed.

The smaller dredgers have been taken from the neighbourhood of the bar since the first month of the year. The total amount of material removed from the bar is stated to be 2,606,000 tons. In addition to this, the Brancker has removed nearly 2,000,000 tons from the easterly side of Taylor's bank, which lies to the north and west of the Queen's Channel.

The material consists of sand with a large proportion o silt, and the pumps not being so efficient as formerly, when there was less admixture of silt, the Dock Board decided to fit a tender with new apparatus, consisting of pumps and an arrangement of pipes to be lowered to the bed of the channel. By forcing jets of water through these pipes at high pressure the silt is disturbed and carried by the ebb tide into deep water. The average time of working each tide is about four hours, and although it is difficult to estimate the amount of material removed by this means, there is no doubt that the general effect is good. The result of the dredging operations during 1895 is regarded by the conservator as very satisfactory. The minimum depth on the bar at dead low water of spring tides is 22ft., and this occurs only in a few spots on the outside line of the area operated upon. The maximum depth is 29ft., the mean 25ft. In mid-channel and for a width of 500ft. a depth of 24ft. can be carried at low water of spring tides. Since the commencement of operations in September, 1890, 11,742,000 tons have been dredged at the bar, and the plant now in the possession of the Mersey Dock Board appears adequate to maintain and still further improve the navigation.

In addition to the dredging at the mouth of the estuary, 146,000 tons have been removed by the Brancker and 772,000 tons by other dredgers in the neighbourhood of the landing stage, at which Atlantic steamers now arrive and depart, to the great convenience of the passengers. When the work was commenced the depth opposite the stage was in places only 8ft. at low water spring tides; now there is nowhere less than 26ft., and it is intended to persevere until a depth of at least 30ft. is obtained. During the last half of 1895, 172 transatlantic and other large steamers have used the stage. The London and North-Western Railway now run trains through from Euston to the landing stage without stopping in three and a-half hours, and passengers can proceed at once on board ship.

The gales during 1895 were neither so numerous or so intense as in 1894; until December there was an extraordinary absence of very high velocities, but that month was a stormy one. Throughout the year, as in the previous year, the gales were nearly all from the west, two only coming from the south-west, and one from the north-west.

The report shows in an appendix the increased difficulty which is found in the disposal of refuse. Not only are dredgings to the extent of 2,500,000 tons sent to sea, but we find upwards of 700,000 tons of heavy material got rid of in this manner. The dredgings from the estate of the Mersey Dock and Harbour Board amount to upwards of 1,500,000 tons from the Manchester Ship Canal—including the Bridgwater Canal—570,000 tons, Garston Docks contribute 100,000 tons, while the city of Liverpool sent 150,000 tons, and Salford, which lies sixty or seventy miles away from the place of deposit, sent 42,000 tons last year.

Under the head of "Manchester Ship Canal," we observe that dredging operations have been carried on for deepening the approach to the canal entrance at Eastham, but the result of this work is not recorded. It appears also that timber dolphins have been constructed on either side of the channel below Eastham for the convenience of vessels entering the canal. The report also refers to the condition of the Mersey between Runcorn and Warrington, which was especially noticed in the report for 1894, and states that there has been a still further drop in the height of high water at Warrington to the extent of 1ft. 7in., which added to 1ft. 1in. previously noted, shows a deficiency of 2ft. 8in. This is a very remarkable change, and must call for the serious attention of all authorities interested in the navigation of the river; no doubt the question will be threshed out by the Committees on the Ship Canal Bill, and if it is proved that the works of the Ship Canal have caused the deterioration of the estuary, the Canal Company will, it may be supposed, be called upon to make some alterations. It is stated by some engineers that the only real cause of any such damage would probably be undue abstraction of fresh water from the old bed of the river at Warrington, a great portion of which has been allowed to pass into the lower reaches of the Ship Canal through the sluices at Latchford. The report states that a weir on the old river has been removed, that a cutting has been widened, and other works have been done which will allow from 18,000,000 to 20,000,000 cubic yards of water to flow through and along the old river course past Warrington in twenty-four hours; whereas, until recently, since November, 1893, less than one half of this quantity flowed along the course. The channel is still insufficient for dealing with big floods from the uplands. These works are a step in the right direction, but may be found insufficient if the figures quoted above are correct. It is, however, possible to increase the scouring power, as we pointed out last year, by impounding high tides, and allowing the water to escape by means of sluices at the upper end of the estuary.

The Bill promoted by the Ship Canal Company seeks power to close the tidal openings. Nothing is said about raising the normal level of water in the Ship Canal, which now stands at 14ft. 2in. above Old Dock sill at Liverpool, but if the Bill passes in the present form it will enable the Canal Company to do this. We do not know whether they have power to construct large sluices at Walton. If that were done, our recommendations, which now appear to be partially, would then be completely adopted, and we have no doubt that the result to the estuary would be most beneficial.

The traffic in and out of Liverpool was greater than ever, 44,856 vessels passed in and out, a daily average of 123 vessels. There were 1928 more than the previous year, and the Custom House tonnage returns are:—Inwards, 9,061,648 tons; outwards, 9,406,180 tons, a total of 18,467,808 tons, an increase, as compared with 1894, of no less than 752,945 tons.

The Cardiff Exhibition of 1896 promises to be one of the largest, if not the largest, ever held in Wales. All important features of its industries are to be well represented.

OWARD AND TAITE'S RAILWAY CARRIAGE WARMING APPARATUS.

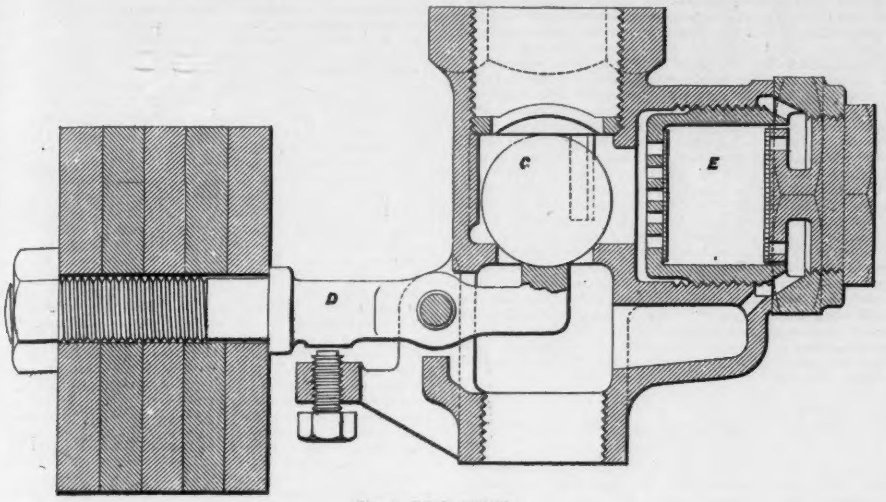


Fig. 1—DRIP VALVE

POSSIBLY the greatest difficulty which engineers have to combat to secure the effective working of railway carriage warming apparatus in which steam is employed as the heat-giving medium, is the accumulation of condensation water in, and the consequent freezing up of the pipes. With the object of obviating this and other defects, Messrs. Taite and Carlton, of Queen Victoria-street, E.C., are introducing a system which in some important details differs from others in use at present. In this apparatus live steam from the locomotive boiler, reduced to a suitable pressure by means of a sensitive reducing valve, is employed. At the reduced pressure of, say, 40 lb., it is conducted throughout the whole length of the train by means of a continuous train pipe, the connection between the vehicles being made by flexible hose and couplings in the usual manner, with the exception that the engine and tender are coupled up by means of flexible metallic couplings having ball-and-socket joints. From the main pipe underneath each coach the steam passes through branch pipes laid in transverse heating chambers in the floor of each compartment, the said branch pipes being connected at their other ends to a drain pipe placed in a lower plane than, but running parallel with, the main supply pipe. Both the supply and the drain pipes are given a certain amount of fall at about the middle of their lengths, and are fitted at their lowest points with drip valves, so that the water of condensation may find a continual outlet from the system without the escape of steam, which would be objectionable to passengers. The hose couplings have also provided in them valves for the same purpose. In the floor of the compartment, and above the heating chambers, which are open to the atmosphere below, gratings are placed. These may be opened or closed at the will of the passengers concerned by operating with the foot a hit-and-miss arrangement, so that the incoming supply of warmed air may be regulated without necessitating the adjustment of any valve. It is claimed by the makers that by bringing in the warm air through the floor in this manner the warmth is distributed more evenly than in other systems, and that the feet of the passengers, where the cold is most acutely felt, derive a corresponding benefit.

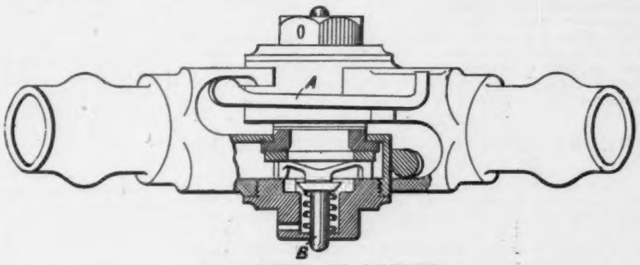


Fig. 2—DETAIL OF COUPLING

The hose pipe couplings between the coaches are very similar in construction to those employed with the Westinghouse brake, but are so designed that they cannot inadvertently be coupled up with the latter. Fig. 2 shows a pair of these couplings in plan, the drip valve for getting rid of the condensation water being shown in section. It will be seen that, instead of the engaging parts A being rigid, as in the case of the brake coupling, they are made of spring steel, and encircle the end of the coupling. This arrangement is rendered necessary owing to the steam-tight joint being made by non-elastic material. The drip valve in the coupling will be readily understood from the illustration. It consists of a conically seated disc with a projecting stem round which is coiled a helical spring, so that when steam pressure is in the pipes the valve is closed against the resistance of the spring, but when the pressure is released the valve opens automatically, and allows the escape of water. It will be noticed that the stem of the valve projects slightly through the coupling. This arrangement enables the removal of any particles of dust or corrosion, which may accumulate on the seating, to be removed by tapping the end of the stem. In order to prevent scalding by the escape of steam when uncoupling vehicles without shutting off the supply of steam to the apparatus throughout the train, cocks having by-passages are affixed on the pipe at the end of each coach. These are normally open to allow of a flow of steam through the apparatus, but when closed the by-pass is opened, enabling the steam accumulated in the hose pipes only to escape.

The principal drip valves, of which a sectional illustration is given in Fig. 1, are applicable to any system in which one line of main steam pipes is employed. The valve consists of a metal ball C—held off its seat by a weighted arm D, when the steam is shut off and the principal condensation is going on—but which the pressure of steam closes automatically. Any leakage which takes place while the apparatus is under steam must be through the device E, consisting of a metal cylinder screwed into the body of the valve and filled with asbestos fibre, which is compressed to the desired extent by means of a nut, and through which the water percolates, finally escaping through the passage shown. It should be stated that an essential feature in this system of steam heating is the provision of a small pet cock at the extreme rear of the train, whereby a jet of steam is continually allowed to escape, thereby ensuring its circulation through the pipes.

The system, we are informed, as a whole, has not so far been adopted in this country, but the drip valves have been applied with satisfaction to other systems at work. The apparatus—so far as can be judged from the inspection of a full-size model under steam—appears to possess the necessary qualifications for successful working.

THE NEW DESTROYERS FOR THE ARGENTINE NAVY.

IN our issue of March 13th, in the column of "Miscellanea," we noted as under construction by Messrs. Yarrow and Co., of Poplar, for the Argentine Government, a number—four—of torpedo boat destroyers of what has come to be known as the Sokol type, which our readers will remember as the name of a vessel of the destroyer class built by Messrs. Yarrow for the Imperial Russian Government.

Although the vessels now in hand at Messrs. Yarrow's shipyard for the Argentine Navy are of the same general type as the Sokol, they differ from her so much in many of her essential features that a somewhat detailed description is necessary to enable those interested in such vessels to form a proper conception of them.

The dimensions of the new destroyers are:—Length over all, 190ft.—the same as the Sokol—and breadth, 19ft. 6in., or 1ft. more than that vessel. The shape of the hull above the water-line is considerably modified, there being no "tumbling home" of the sides, and consequently the deck is the full width of the vessel and very roomy. An important alteration has been made—by special desire of the Argentine Naval Commission—in the shape of the fore parts of these boats. This consists in giving the bows a considerable flare, so as to throw off the seas when going against them, and keeping the decks drier. It is also of importance when firing the 14-pounder gun on the conning tower forward, as spray interferes with taking a correct aim.

The leading feature in the construction of the hull in these vessels is that both the sides and deck for the entire length of the machinery and boiler space are armoured. The first vessel of the "destroyer" type armoured in this manner was built by Messrs. Yarrow for the Japanese Government some seven years ago, and during the late war between Japan and China, this protection was found by experience to be of the greatest value. This vessel—named the Kotaka—led two important torpedo attacks during the recent war, and came out of them comparatively uninjured, while other similar boats which were not armoured in the same way, were in many instances completely destroyed.

Of necessity the armour adds considerably to the weight of the vessel, and reduces its speed, when the same propulsive power is employed as without it; but the Argentine authorities are of opinion that it is worth sacrificing something in speed for the sake of protection. There is, however, other gain accruing from the use of armour, for it not only protects the machinery and vessel, but gives greater confidence and energy to the engine-room staff, owing to the protection afforded them by it. In a head seaway its extra weight is certainly rather an advantage than otherwise. In addition to the protection afforded by the armour-plating, the boilers of the vessel are entirely surrounded by coal bunkers, which are unusually capacious, as they will hold about 80 tons of coal.

The subdivision of the hull by water-tight bulkheads in the new vessel is very complete, and there is a total absence of those dangerous ingenuities—especially in small vessels—called water-tight doors, which are a delusion and a snare.

The whole of the fore part of the hull, under deck in the new vessels, is devoted to the accommodation of the crew, the executive and warrant officers being comfortably berthed abaft the engine-room. Here we must draw attention to the fact that in these vessels the commanding officer's cabin, as well as the officers' mess-room, is next to the engine-room, where the motion of the vessel is least felt. In British torpedo-boat destroyers, the commanding officer is accommodated quite aft in the vessel, where sound sleep when off duty is well-nigh impossible, and where he is most out of the way of those who may have to consult him. It is also noticeable that the galley and kitchen in the Argentine boats are in close proximity to the pantry, a point of some importance for the comfort of officers in bad weather.

The propelling machinery of the new vessels consists of two sets of inverted cylinder triple-expansion engines of Messrs. Yarrow's usual construction, but many of their details have been modified in directions shown to be desirable by the most recent experience. The balancing of machinery has been made the subject of very careful and extensive study by the builders of these vessels, as the question of vibration has become a matter of first consideration in lightly built vessels which have high-speed propelling engines.

The boilers of the new destroyers are six in number, of the Yarrow water-tube type, and capable of easily supplying sufficient steam for about 4000 indicated horse-power. Forced draught is provided for by two fans, which are placed horizontally, and rotated by small engines which are laid upon the floor of the stokeholds.

The armament of the vessels comprises:—One 18in. torpedo tube built into the stem for bow-fire; two 18in. swivel torpedo tubes aft for discharge on either side; one 14-pounder quick-firing gun on the conning tower forward; three 6-pounder quick-firing guns on deck aft, and two Maxim automatic machine guns, one on either side just above the conning tower.

The vessels have the usual steam steering gear, electric light machinery, distilling apparatus, &c. &c. Their guaranteed speed, carrying a load of 35 tons, is 26 knots, but when the extra weight of armour and fuller model is considered, this is undoubtedly a fine result.

THE U.S. RAM KATAHDIN.

THE Katahdin is the latest addition to the United States Navy, and although as regards speed she has failed to come up to the contract requirements, yet her efficiency as a ram is but slightly impaired. She needs no heavy armanent, for she is her own weapon. Her destructive power is indicated by the following figures:—At an ordinary cruising draught of 15ft. and steaming at 16 knots speed she will strike a blow of over 24,700 foot-tons, a force capable of sinking any vessel that now floats. At 15 knots speed the blow would be about 21,700 foot-tons, and at 10 knots 9660 foot-tons.

The Katahdin's greatest *forte* lies in her strength as a body and the excellence of her model for manœuvring and offensive and defensive powers. The stem or ram proper is formed by a 14-ton casting, and massive girders and longitudinals converge to it from deck, keel, and sides, well stiffened by breasthooks and intercostal frames and beams, so as to make all parts of the ship take the effect of the blow and ensure no local weakness. The keel of the vessel is elliptical, and it is remarkable to see how rapidly she can turn and how quickly she answers her rudder, and this feature is absolutely necessary in a vessel intended for efficient harbour service. The bow and stern lines are remarkably full and hard, and there is no deadwood or cutwater whatever. A sharp knuckle formed where the side and deck armour meet, about 8in. under water, runs from the centre of the stem the whole length of the ship, and this will tend to rip out the side of a vessel struck. There are no important projections above deck with the exception of the conning tower, which weighs 45 tons and is 18in. thick, and the smoke pipe and ventilators, which at the base have 6in. inclined armour for about 3ft. high. The deck is convex and completely armoured, and there are two strakes of side armour below water from 3in. to 6in. thick. Four 6-pound rapid-fire guns are carried, two forward and two aft, in small barbettes as a protection against light torpedo craft.

The dimensions of the vessel are well known, but it may be well to state here that she is 251ft. long over all, 43ft. 5in. extreme beam, and 15ft. mean draught; displacement 2183 tons. The engines are twin-screw horizontal triple expansion, with cylinders 25in., 36in., and 56in. diameter by 36in. stroke, designed for 4800 horse-power at 150 revolutions. There are two double-ended and one single-ended Scotch boilers, with 12,160 square feet of heating surface and 354 square feet of grate surface.

On December 10th, 1894, the Katahdin made her first preliminary trial trip over a measured mile course off Southport, Me. The propellers had a diameter of 10ft. 6in., 15ft. 2in. pitch, and 30 square feet blade area. Her bottom was somewhat foul, and the engines not working satisfactorily, a speed of but 14·4 knots was attained with 2440 indicated horse-power, the slip being 27·4 per cent. The vessel was then taken to the Charleston navy yard and docked. New wheels of 10ft. 10in. diameter, 14ft. 4in. pitch, and 38·5 square feet blade area were fitted, and late in March, 1895, the second speed trial was made. A speed of 15·71 knots was attained, with 4124 indicated horse-power, and the slip was reduced to about 22 per cent. During April and May similar full power trials were made, the maximum speed obtained being 16·06 knots, with 5749 indicated horse-power and 27 per cent. slip, the power on this run being no less than 20 per cent. in excess of contract requirement, and yet the speed was one knot less. On May 31st a progressive trial from 8 knots upwards was decided upon, but after reaching a speed of 13 knots the bed plate of the after or starboard engine broke, and the vessel returned to Bath under one engine. It was not until August 17th that the progressive trial could be concluded, the maximum indicated horse-power developed being 5059, which gave a speed of 15·86 knots and 25 per cent. slip. In the meantime a large cofferdam 40ft. long and 50ft. wide had been built by the Bath Ironworks, and when the Katahdin had completed her progressive trials with wheels No. 2, the stern was placed in the cofferdam, and wheels of 12ft. diameter, 14ft. pitch, and 36 square feet blade area were fitted. On August 31st a progressive trial was made with these wheels, and they showed considerable improvement over their predecessors. These screws had an inclined element aft of 15in. in 56in., and were designed by the United States Bureau of Steam Engineering, from data received from the previous trials. The maximum speed was 16·07 knots, with 4900 indicated horse-power and a slip of but 16·7 per cent. The Bath Ironworks, having worked out all the vessel's performances on a theoretical basis, then submitted them to the Navy Department, and the latter officials decided that all that could be done had already been done, and that the only course left was to run the vessel on her official trial, and get all they could out of her.

This the builders decided to do, as they had already spent 40,000 dols. in experimenting with her. She was accordingly taken to the Charleston navy yard and again docked. It was then discovered that one of the wheels had sprung somewhat, and the tips of the blades had been bent very badly by striking against the side of the ship. New wheels were therefore hurriedly cast, similar to the previous ones, but only 11ft. 10in. diameter, and, after having these fitted, she left Boston, and steamed to Long Island Sound for her official speed trial. This trial took place in very unfavourable weather on October 31st, the result being that but 16·11 knots mean speed was attained with about 5300 indicated horse-power, or over 10 per cent. more than the contract specified.

It is undoubtedly the model of the Katahdin that is faulty, but Mr. William A. Fairburn of the Bath Ironworks, who has made all the calculations and curves of the vessel's performances during her speed tests, is confident that the speed could be increased from one-half to three-fourths of a knot per hour by moving the propellers much farther astern. A couple of struts and a new length of shafting would be necessary, but the total cost of the change would not exceed 5000 dols. The fact of having the propellers so far astern would certainly prove a slight detriment to the efficiency of the ship for harbour service, but this could be overcome to a great extent by building propeller guards that would project so far from the sides of the vessel as to completely protect the wheels. This is done on most torpedo craft, and it should be remembered that the propellers as now located on the Katahdin project beyond the side of the ship and are unprotected. It is said that chief engineer Melville of the Bureau of Steam Engineering has proposed to the Secretary of the Navy that the wheels be moved aft, and if this proposition is approved it will be interesting to watch the result of this trial.

The Katahdin has made over fifty runs over the measured mile during her preliminary speed trials. For low speed up to about 13 knots the model is admirably adapted, and at 13 knots the Admiralty displacement coefficient of performance is 260. This good performance at low and medium speed is undoubtedly due to the small wetted surface of the vessel. At 15 knots the performance coefficient has dropped to 165, and at 16 knots it is but 135. All the propellers fitted have brought out about the same final results, and as slip was decreased so were revolutions and to a certain extent indicated horse-power, and as regards the prime object—speed—the first wheels fitted were almost as satisfactory as the last ones. It is also a well-known fact that the change in the wheels made just before the vessel went out on her official trial was not by any means beneficial to her.—*Marine Review.*

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

Steel arch bridge.—Work is now in progress on the foundations for the great steel arch bridge over the Niagara River gorge, just below Niagara Falls, which is to replace the present suspension bridge on the same site. This is the bridge nearest to the Falls, below it being the cantilever bridge of the Michigan Central Railroad and the double-deck suspension bridge for the Grand Trunk Railway and a roadway. The new bridge will have two arched trusses of 840ft. span, with a rise of 150ft., the trusses being 26ft. deep and spaced 30ft. apart at the centre and 68½ft. apart at the abutments. The crown of the arch will be about 170ft. above the water. Deck truss spans of about 200ft. will extend from the bridge proper to the cliffs. The floor will be 46ft. wide. In the middle will be a space 22ft. 9in. wide for a double-track electric railway; on each side will be an 8ft roadway; and outside these again will be sidewalks 3ft. 9in. wide. Work will be carried out from each end, the unfinished portions being sustained by anchorages, as the use of false works is impossible. The present bridge will be kept open for traffic during the construction and until the completion of the new bridge. About 4,000,000 tons of steel will be required. On the New York side the foundations are carried down to solid sandstone rock, but on the Canadian side they rest upon a compact mass of gravel and boulders, and are carried back to the solid vertical rock of the cliffs to receive the horizontal thrust. The foundations consist of four masses of concrete, one for each end of each arch, with a facing of limestone masonry, the pressures being 220 lb. per square inch on the masonry and 101 lb. per square inch on the concrete, or 35 lb. vertical pressure per square inch on the base of the foundation. The largest metal arch bridges now in existence are as follows:—

	Feet span.	Feet rise.
Luis Bridge, Oporto, Portugal	566	146
Gonalit Bridge, France	542	170
Pia Maria Bridge, Portugal	525	121
Eads Bridge, St. Louis, U.S.A.	520	47
Washington Bridge, New York, U.S.A.	510	91¾
Paderno, Italy	492	123
Park Bridge, Rochester, U.S.A.	428	67

Railway water supply.—Owing to the injurious effects of the water supplied to its locomotives, necessitating renewing all the tubes of 200 locomotives every year, the Long Island Railroad has now established a central source of water supply, and pumps the water through a pipe line to its principal terminal, a distance of ten miles. The supply is taken from several wells 24in. diameter, and 38ft. deep, driven into a water-bearing formation which yields a very pure soft water. The wells are lined with perforated vitrified clay pipe, and in each well is a 4in. suction pipe; the upper end is connected to a horizontal suction main, extending to the 16in. suction main at the pumping station. The pumping plant consists of two Worthington horizontal triple-expansion engines, with a total capacity of 4,000,000 gallons per twenty-four hours, and return tubular boilers carrying 125 lb. steam pressure. From the pumping station the supply main is laid along the railway, and consists of 8½ miles of 12in., and one mile of 10in. pipe, all cast iron, except that 10in. wrought iron pipes and bends are used for a submarine crossing of Dutch Kills Creek. Shut-off gate valves are placed at intervals of ¾ mile to admit of inspection and repair. This main supplies a stand-pipe or water tower, 20ft. diameter, and 90ft. high, four railway stations, about ten signal cabins, and the terminal station, freight yards, shops, engine tanks, &c., as well as the boilers of the large ferry boats carrying passengers and wagons across the East River from Long Island City to New York. The engine tenders take water from tanks or water columns in the yards, and not direct from the main. Fire hydrants of 4in., 6in., 8in., and 12in. diameter, are placed at short intervals, and gate-valves and air cocks are also provided. Water is supplied for some large manufacturing plants.

The Nicaragua Canal report.—The board of engineers appointed by the United States Government to report on the feasibility and cost of constructing the proposed Nicaragua Ship Canal has made its report, and estimates the cost at £26,000,000. The most serious problems affecting the design and construction of the canal at the present time are those involved in the heavy rainfall and consequent discharges from the lake and streams, whose variations of surface and volume must be taken into account. The rainfall record at Greytown for a period of three years shows a mean of 267in. A record at Rivas, on the west side, for fourteen years gives a mean of 65in. In addition to these there is reliable information of precipitations of 3in. in an hour, of 9in. in nine hours, and 35in. in eight days. A record of nearly 25ft. of water in a year on the Caribbean coast diminished to 5½ft. between the Lake Nicaragua and the Pacific, needs no comment to indicate the important results that must ensue with reference to matters of local drainage and engineering construction. As to the climate of Nicaragua, it is the continued moderate temperature, in conjunction with the high humidity, that so seriously reduces the value of physical labour in the tropics. There has never been any yellow fever at Greytown, except when imported. The heavy rainfall will increase largely the cost of excavating the deep mud at several embankment sites, in excavations, building embankments, &c. The natives are not likely to prove useful in the severe and steady work of canal construction. Jamaican negroes, such as have been employed on the Panama Railway, are docile, and, from a tropical point of view, industrious and fairly effective. They will undoubtedly form the labour supply for the canal. Wages are only about half as much as in the United States, but the efficiency of the labourers is proportionately much less. As a matter of fact, the Jamaica negro is constitutionally opposed to hard work, wherein lies one reason of his health and longevity. Machinery will be used largely, but will be of little value after the completion of the canal, and little, if any, will be worth removal. Its entire cost would, therefore, be charged to the canal construction, making the plant charge higher than usual. There are now no shops or facilities of any kind on or near the canal line, and they will have to be supplied as adjuncts of the work. Skilled labour will have to be imported. Fuel will cost more than double its cost in the United States. Freight on materials and supplies will increase their cost greatly, particularly if sent to interior points. The entrance to the Atlantic harbour at Greytown, as proposed by the company, is too near the angle of the coast line, and the entrance to the canal should be moved eastward about a mile and a-half. The harbour throughout should be dredged to 30ft. below water, and its depth increased to six fathoms. The Ochoa dam, as proposed by the company, is to be a rock-fill across a powerful river, on a sand foundation. A dam so constructed, the Commission says, has no precedent, and its erection in conflict with the unknown volume of the floods presents grave difficulties. In regard to the western division, from the lake to Brito—the Pacific entrance—the information with reference to the site proposed for the La Flor dam indicates that its construction is impracticable, and the Commission suggests an alternative low-level route, which offers no special difficulties in construction. As to the terminus at Brito, the Commission suggests the desirability of moving it southward from the location proposed by the company. The report, closes with the following general conclusion:—"The official estimate by the company of £13,000,000 is insufficient for the work. In several important cases the quantities must be greatly increased, and in numerous cases the unit prices do not make proper allowance for the difference in cost of work between the United States and Nicaragua. The provisional estimate by the Board is £26,000,000. It should be understood that the existing data are inadequate as a basis for estimating the cost of many of the structures; some portions of the work may cost more, others less, but in the judgment of the Board the entire project can be executed for about the total amount of its estimate. For obtaining the necessary data for the formation of a canal project, eighteen months' time, covering two dry seasons, and an expenditure of 350,000 dols., will be required." The Panama Canal suffered from the total absence of preliminary study and investigation, but the Nicaragua Canal is in no sort of danger of this kind, as the most careful and complete surveys, borings, investigations of conditions, &c., have been made.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, March 16th.

THE New York bankers are trying their best to prevent the beginning of another gold outflow to Europe until after the Presidential nominations. They know a large gold exportation will arouse the people against monometallism. The iron trade has been dull for a week, but active buying may set in at any time. Prices have receded slightly. Pig iron production has also fallen a fraction, and the report is a few more furnaces will blow out this month. Steel makers who usually secure large contracts in March for summer delivery have not yet entered the usual amount of business. Rail manufacturers have not booked half the contemplated business for February and March, but they anticipate compensating activity in April, particularly in girders for electric lines. Billets have weakened close to cost, and large consumers refused this week to place orders. Lake ore miners cannot quite satisfy buyers at large that they can prevent a break in prices. Structural steel makers have run across a large amount of probable business. Bridge iron makers are not very busy, but all railroad companies contemplate more or less bridge building during summer and autumn. Manufacturers then anticipate a busy time. There is less disposition to look far ahead, the excuse being that with such enormous open-hearth capacity, as well as Bessemer capacity, there is no need of taking a thought for the morrow. A further decline in pig iron production is probable, as stocks have increased 250,000 tons in four months.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

GOOD attendance on 'Change. The demand for steam coal remains very moderate, and the shipments for the past week were under the average. House coal shipments are affected by the warmer weather, but prices remain without change. Tin-plates show no improvement in demand, and prices are weaker. The iron and steel works are well employed.

Coal: Best steam, 8s. 3d. to 8s 6d.; seconds, 8s.; house coal, best, 10s. to 10s. 3d.; dock screenings, 5s.; colliery small, 4s. 3d. to 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 46s. 11d.; hematite warrants, 48s. 5d., f.o.b., Cumberland; Middlesbrough, No. 3, 38s. 5d. prompt; Middlesbrough hematite, 45s. 10½d. Iron ore: Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel: Rails, heavy sections, £4 15s.; light ditto, £5 to £5 5s. f.o.b.; Bessemer steel tin-plate bars, £4; Siemens tin-plate bars, best, £4 2s. 6d., all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel, coke, 9s.; Siemens, coke finish, 9s. 3d.; ternes, per double box, 28 by 20 C, 21s. to 22s. Pitwood: 15s. 3d. to 15s. 6d. London Exchange telegram: Copper £4 15s. 7d.; Straits tin, £60 5s. Freights: Outwards, steady; homewards, firmer.

LAUNCH.—Messrs. Fleming and Ferguson, shipbuilders, &c., Paisley, launched, on the 17th inst., the steel screw steamer Sir Evelyn Wood, built to the order of the British Government. The dimensions of the vessel are 160ft. by 24ft. by 14ft. moulded. The Sir Evelyn Wood is intended for the transport of heavy ordnance, and to meet the requirements of this work has been built with specially heavy scantlings. Machinery for the vessel will be supplied and fitted by the builders.

MINING IN NOVA SCOTIA.—The Department of Mines in Nova Scotia issues a yearly report, which for the past year has just reached this country, and which has some details as to colliery working that are of interest. It appears that the output of coal was for the year 2,089,245 tons, and the total number of persons employed in the production was 5793. The collieries are not very numerous, but they vary greatly in the extent of their output. There are tables of both the men and the working days per year, and it may be said that the quantity per day varied from 400 tons to 4190 tons; but the pits worked from 76 days to 285 days in the year; and the largest colliery had a production of about 809,000 tons for the year, or more than a third of the total output of Nova Scotia. There is an interesting table of the air circulation which shows that there are variations of from 6000 cubic feet to 69,000 cubic feet of air circulating per minute through Cape Breton mines in the different months of the year, the variation being probably due to the lessened number of working days in some of the months. There are detailed reports of the different districts, and of the changes in the machinery of the collieries. The introduction of air compressor plants at the Sydney mines, the procuring of new fans such as Walker's in the Drummond colliery, which has a capacity of 200,000 cubic feet per minute, and the making of important new levels and sinkings being detailed in the reports of the sub-inspectors of mines. The Department of Mines seems to be doing good work in Nova Scotia; and it had entered into an elaborate inquiry into the causes of the fires that had occurred in Picton mines, and which interfered so greatly with the production of the district for the year. Details are given in regard to collieries there, such as the quantity and kinds of timber used in Springhill collieries in a year, details that cannot possibly be given for the great masses of mines such as in this country, which are none the less of interest. A table which details the extent of the sales of coals from the Nova Scotia mines for a hundred years traces the output from a thousand tons up to 1835, when it passed 100,000 tons for the year, and thence to 1881, when it reached 1,000,000 tons. Since that time, with an increased demand, and with better machinery at the mines, there has been a more rapid growth of the production, until the total yield from the mines has now reached 40,000,000 tons, apart from the colliery consumption. The figures given are of value, though their totals are far below those of the great coal-producing districts.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

OLD contracts are being finished off, and new ones have scarcely yet been booked, though to-day—Thursday—in Birmingham there were inquiries which presaged a fair amount of business at the ensuing quarterly meetings. Meanwhile operations at the works are being hastened in view of the Easter holidays. Prices are a little less firm on the week. Lincolnshire pigs are 44s. to 45s.; Northampton forge sorts, 41s. to 42s. 6d.; and Derbyshires, 42s. to 43s. Staffordshire cinder pigs are 36s.; part-mines, 42s. 6d.; and all-mines, 55s. to 57s. 6d. Marked bars are £7 to £7 12s. 6d.; merchant sorts, £6; and common, £5 5s. to £5 10s. Prices of sheets are kept down by the great production. Doubles are quoted £6 12s. 6d. to £6 15s., and lattens £8. In the steel trade a good deal of work is under execution, but prices are not by any means what steel masters could wish. Basic steel boiler plates continue £6 5s., and girders and angles £5 10s., while bars are £5 15s. to £6. Most of the engineering establishments are well engaged.

At the present time the advantages of modern machinery are being experienced in a gratifying manner by the Patent Shaft and Axle Tree Co., Wednesbury, to whose position a brief reference was made in my last letter. As indicating the extent of the concern, it may be stated that for the greater part of the last six months they have been giving employment to about 2000 persons, of whom 1700 are engaged in the manufacture of iron and steel wheels and axles, and over 300 at the collieries. The establishment consists of three distinct sections, namely, the Brunswick Iron and Steel and Wheel and Axle Works, the Monway Iron and Steel and Tire and Axle Works, and the Old Park Works, where bridge and girder construction is carried on. These works cover an area of nearly 70 acres, and in addition there are the collieries, which make up an entire estate of 500 acres. The assessment of the property is between £12,000 and £13,000, and last year's payment for rates and taxes exceeded £4000.

In the wheel and axle department the directors have made of late many improvements and alterations, the result of which is to increase the capacity of the works from an output of 500 pairs of wheels and axles per week to 1000 pairs. Every variety of railway wheel is made, and for their production a number of improved appliances have been erected. The new and powerful hydraulic presses which shape the bosses of the wheels out of red-hot metal are in striking contrast to the smaller presses which did service up to a few years ago. The latter possessed a power of from 80 to 100 tons each, but the principal new press is 1200 tons, and the foundations have just been dug out for one of 2000 tons. The turning and finishing shops have also been overhauled, and the fine inspection shed, 200ft. by 50ft., is among the buildings erected since the reconstruction of the company. The company also lays itself out for producing a superior quality of steel suitable for the weldless steel-tube trade, and for which the directors claim favourable comparison with Swedish steel.

An exceptionally fine plate mill is among recent additions to the plant, which will roll steel plates for boilers, bridge work, and tubes up to 7ft. 9in. in width and $\frac{3}{16}$in. to 1½in. in thickness. Some recently turned out were 35ft. in length by 40in. in width. They were trimmed with a very small amount of scrap, and were being sub-divided into lengths for conversion into steel water tubes. The mill is by far the largest plate mill in the district, and has been erected at a cost of about £15,000. Both the plate mill and the cogging mill are driven by a pair of powerful reversing engines of the newest type and of 2500-horse power. The foregoing machinery, and also mills for the production of various sections of merchant steel—girders, angles, &c.—are all under one roof, which is traversed from end to end by a travelling crane for changing the rolls and facilitating repairs. A new hydraulic testing machine of the latest type, by Buckton and Co., of Leeds, has also been recently erected, and is capable of applying a strain up to 50 tons. In the merchant iron department of the Brunswick Works, the directors have provided a new type of Siemens furnace for reheating wrought iron "pile" and billets. The furnace, which is heated by five gas producers, will in twelve hours reheat a shift of 20 tons, and effects a great saving both of fuel and of time.

A matter of considerable importance to the extensive brass foundry interests of Birmingham and district—which is the chief brass seat in the Kingdom—is the issue of the new special rules in the brass trade. A condensation of the official document follows:—Factory and Workshop Acts, 1878 to 1895. Mixing and casting of brass and of certain other alloys; special rules. Under Section 8 of the Factory and Workshop Act, 1891, and Section 28 of the Factory and Workshop Act, 1895, for the processes in the mixing and casting of brass, gun-metal, bell-metal, white-metal, delta-metal, phosphor bronze, and manila mixture. These processes are certified to be dangerous or injurious to health by the Secretary of State, by certificate dated January 1st, 1896, and published in the *London Gazette* of January 10th, 1896. Duties of Occupiers: (1) They shall provide adequate means for facilitating, as far as possible, the emission or escape from the shop of any noxious fumes or dust arising from the above-named processes. Such means shall include the provision of traps or of louvre gratings in the roof or ceiling of any shop in which such processes or either of them is carried on. In any shop, which is situated under any other shop, there shall be provided an adequate flue or shaft to carry away any fumes. (2) They shall cause all such mixing or casting shops, whether defined as factories or as workshops under the Factory and Workshop Act, 1878, to be cleaned down and limewashed once at least within every nine months. (3) They shall provide a metal basin, and a supply of water and of soap, for the use of all persons employed in such mixing or casting shops. (4) They shall not, on and after the 1st day of July, 1896, employ any female in any process whatever, in any such or casting shop, or in any portion thereof which is not entirely separated by a partition extending from the floor to the ceiling. Duties of persons employed: (5) They shall not partake of or cook any food in any such mixing or casting shop within a period of at least ten minutes after the completion of the last pouring of metal in that shop. Note: Women and persons under eighteen years of age are by the 39th Section of the Factory and Workshop Act, 1878, expressly forbidden either to take a meal or to remain during the time stated on the notice affixed in the factory or workshop, as being allowed for meals, in any casting shop; and the obligation of enforcing this section rests with the occupier.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—Business in the iron trade here continues to move on slowly, so far as any new buying coming forward is concerned, and although makers are mostly so well booked that they are under no necessity to force business at anything under their quoted rates, iron held in second hands is here and there being pushed for sale, and the general tendency is for the moment towards lessening firmness. This is much what I anticipated in previous notes, but any giving way in prices is not likely to be more than temporary, and although, until after the Easter holidays, business in all probability will continue quiet, the outlook for the future is satisfactory, and regarded with general confidence. Increasing activity is still the report throughout the engineering industries of the district, most of the leading firms having orders on their books which will carry them well over the year, and it is exceptional where establishments have not sufficient work on hand to keep them fully engaged.

The Manchester iron market on Tuesday scarcely brought together an average attendance, and there was only a slow inquiry stirring for either raw or manufactured material. Pig iron continues only in very limited demand, both consumers and merchants, as reported last week, being fully covered, and in many cases overbought for their present requirements. Makers' quoted rates remain generally steady, and where there is any giving way it is chiefly with iron held in second hands. Local and district brands are without quotable change, except that for Lincolnshire, what were makers' minimum quotations are now the full prices obtainable. Outside brands offering in this market are somewhat irregular in price. Delivered by rail at Manchester, foundry Middlesbrough averages 46s. 6d. to 47s., net cash, according to brand, and delivered Manchester Docks, can be bought readily at 45s. 6d. net cash. In Scotch iron, Eglinton averages about 47s. to 47s. 6d., and Glengarnock 48s. to 48s. 6d., delivered Lancashire ports, and about 49s. 6d. to 50s. for Eglinton, and 50s. to 50s. 6d. for Glengarnock are the quoted rates for delivery dock quays, Manchester.

In manufactured iron makers are booking moderate orders, but there is rather less firmness as regards prices. For Lancashire bars £5 10s. is not in all cases being adhered to, whilst it is exceptional where £5 12s. 6d. is being got; and Staffordshire bars are quoted £5 12s. 6d. to £5 15s., delivered here. Sheets and hoops are without quotable charge.

A fair weight of business comes forward in the nut and bolt trade, but no higher prices are obtainable.

The position in the steel trade is not so strong here as in other markets. Ordinary foundry hematites are obtainable at 57s. to 57s. 6d., less 2½, with 58s. 6d. still quoted for some special qualities, delivered here; ordinary steel billets can be bought at £4 10s., net cash; and although makers of steel boiler plates are not quoting under £6 10s. per ton, this figure is not being got on actual business, there being still sellers at £6 5s. to £6 7s. 6d., delivered in this district.

In the metal market only a moderate weight of new business is reported, but makers whose order books are well filled hold firmly to their prices. Not only is the advance reported last week fully maintained, but on brass and copper tubes ⅛d. per pound above list rates is being asked on any small orders that are being secured, although no official advance upon these descriptions of manufactured goods has yet been announced.

Messrs. T. and R. Lees, of Hollinwood, have designed an improved horizontal steam engine containing one or two special features. This engine is fitted with a patent automatic cut-off, under the control of a high-speed governor very positive in its action, by which the valve is regulated with great precision, and the steam supplied in accordance with the varying load. I may add that the right and left-hand engines of this type can be readily coupled to form a steady-running double-cylinder engine, with the fly-wheel between. The firm has also designed a very compact portable hand-power circular-saw bench, for use where steam-power is not available. The table is 4ft. by 2ft., and has rising and falling spindle for rebating, grooving, and tenoning, with a self-acting drag-motion for feeding the timber, and an adjustable canting fence is fitted to the machine. Variable speeds are provided for light or heavy work, and the machine can be operated by one or two handles, according to the thickness of sawing required; whilst it is sufficiently light to be readily removed to any part of the workshop, or to contract jobs outside. The bench can, if required, be supplied in a form suitable for steam power, with fast and loose pulleys fitted on the end of saw spindle, and without drag motion.

I was shown the other day at the works of Messrs. Henry Wallwork and Co., Roger-street, Manchester, a new boiler tube stopper—Watson's patent—suitable for either marine or locomotive boilers. This stopper consists of a rod, of special construction, with plugs at the ends, which is pushed into the leaking or burst tube from the front end, a box-spanner being fixed and held on a nut at one end of the stopper to drive the latter into position. The front joint is then quickly screwed up without removing the spanner. The plugs are slightly tapered in the body and thread, so as to enable the back plug to be readily screwed out from the front end of the tube. If required, the rods can be made hollow, and used as tubes for heated gases. These tubes have passed through severe tests with very satisfactory results, a hydraulic pressure of 600 lb. having been applied without affecting the safety of the stopper. On board ship in case of accidents, they can be applied without letting down the steam pressure, or putting out the fires, which is necessary under ordinary arrangements when a tube is burst, and I understand they have already been adopted by several large steamship and railway companies.

Messrs. Joseph Adamson and Co. have for some time past been introducing electric driving into their works at Hyde, and Mr. Daniel Adamson, one of the firm, who has visited America and the Continent with the object of making himself acquainted with the best methods adopted abroad, gave a description before the members of the Manchester Association of Engineers at their meeting last week, of the special plant they had recently put down. When, he said, they first began seriously to consider the matter of electric driving about three years ago, they required to increase the number of their travelling cranes, and found that their existing engines were not powerful enough to take the increased load that would be thrown upon them by adding the two or three cranes they required. They found that electric-driven cranes were, in other countries at any rate, considered to be more economical in various respects, than other types of cranes, and they therefore put down a combined engine and dynamo, which they considered would be large enough to drive the cranes they had in view, and leave a sufficient margin for lighting as well, and their intention was to double or treble this "unit" as further developments required. Their first three electric cranes, which was the original number they thought of introducing, worked so satisfactorily that they decided to increase the number, and as in the meantime they had also found it advantageous to increase the application of electric transmission of power in other directions, they had been compelled to change their original ideas, and had now in hand a seventy-five kilowatt dynamo, which would be coupled direct to a 100 B.H.P. Belliss engine, running 400 revolutions. Electric driving had been applied to a drilling machine, which, as originally designed by the makers, required three driving belts, viz., one for advancing the drills rapidly up to their work, one for doing the actual drilling at a slower speed, and the third for withdrawing the drills. By the application of a motor which would run in both directions they were enabled to dispense with the belts, and also the great number of pulleys, so that now, when the machine was not working, there was nothing moving in connection with it, and therefore no wear and tear. Another application of electricity was to a small sensitive drill, and although in this instance they had not dispensed entirely with belting, there was considerably less leather about the machine than about one driven in the ordinary way.

More important, however, was the application of motors to the hoists in their riveting tower, which enabled them to stop entirely about six belts, and 50ft. or 60ft. of shafting, besides giving the men something more under their control for the small adjustment of height required when riveting up shells. It also enabled them to hoist, and lower through greater distances, as when adding another ring, at a higher speed than could be done with a strap-driven hoist that was of course always working at the same speed. The belts, he might add, had been found to last longer and to break down less frequently when driven by an electric motor than when driven by a series of belts from the shop engines. One most important application of electric power had been the driving of their overhead travelling cranes. Since they had electric power at their disposal in the works, they had found it very convenient on special occasions for driving individual machines, that might be required to run night and day, or in special positions for a period. On such occasions they now only required to run during the night the comparatively small generating plant, which provided not only the power to drive the machine, but an abundance of light for the men to work by, and also enabled them to make use of the overhead cranes for moving the work when required. This dispensed with the great waste of coal and oil entailed formerly by running the large engines and all the shafting, belts, &c. Amongst the direct advantages of electric driving, he did not think they ought to look to any immediate saving in fuel although he believed this would ultimately follow its application, but the actual expenditure on fuel for power purposes alone was so small that even a reduction by a large percentage would mean very little compared with the other items of cost of production. Another advantage of electric transmission was the regularity of driving obtained by its means, and although the benefits derived from this were greater in such cases as a spinning mill, for example, than in a workshop, even in the latter the advantages of keeping up to the normal speed under the heaviest loads was sure to make a difference in the output when compared with a system of transmission which was liable to ease off when called upon for full duty, and which was subject to every change in the condition of the atmosphere.

The coal trade shows no improvement, but, if anything, the position becomes still more unsatisfactory, and I may mention as a significant fact as to the outlook for the future, that at some of the collieries stocks, with the close of the winter, are so heavy that any further accumulation of these during the summer is out of the question, with the result that pits will have to go on still shorter time than was the case last year, when the large proportion of them were not running more than three days per week. For the better qualities of round coal there is a slackening off in the demand, and it is exceptional where pits are being kept on more than four days per week, whilst prices here and there are easing down, concessions of 3d. to 6d. being made to effect clearances. Supplies of steam and forge coal continue excessive, notwithstanding the limitation of the output, with prices altogether unprofitable, not averaging above 6s. to 6s. 6d. at the pit, whilst to effect sales of anything like quantities still less has to be taken, especially in some of the commoner descriptions. As regards engine fuel, the better sorts meet with a fair demand, and at some collieries supplies are so scarce as to justify an advance on present rates, but as at other collieries the output is still fairly plentiful, any upward move is checked, and even the attempted advance in prices upon forward contracts has scarcely met with success. Common sorts move off but slowly, with no better prices ruling. At the pit mouth the better qualities of slack still average 4s. 6d., with some special sorts quoted 5s., and common slack averages about 3s. to 3s. 6d. per ton.

In the shipping trade prices continue extremely low, with a further weakening tendency, if anything. Delivered ports on the Mersey, common steam coal used for bunker purposes is readily obtainable at 6s. 9d. to 7s., and delivered Partington tips, Manchester Ship Canal, 7s. to 7s. 3d. per ton.

Barrow.—The hematite pig iron trade is brisk, and the orders booked during the past week have been quite up to recent averages. Makers are so fully sold forward that they cannot quote for prompt deliveries. They have 39 furnaces in blast, compared with 28 in the corresponding week of last year, and these furnaces represent an average output of 800 tons per furnace, all of which is going into consumption. Stocks show no increase. They stand at 303,029 tons, or 13,854 tons more than at the beginning of the year.

Iron ore is brisk at 10s. for ordinary, 12s. 6d. for best, and 14s. 6d. for Hodbarrow qualities. Spanish ore is being largely imported, and is quoted at 13s. per ton net at West Coast ports.

Steel makers are busy on heavy steel rails, on plates, and on billets and hoops. There is also a brisk business in heavy steel castings. Orders are well held in all departments, and the demand is active and likely to be maintained. Prices are steady at £4 15s. for heavy rails, and £5 2s. 6d. for steel plates.

The shipbuilding and marine engineering industry is actively employed. No new orders are noted during the week, but some commercial and Admiralty tenders which are likely to lead to business have been sent in.

Coal and coke are in brisk demand, but while coal is weaker in price, coke is the reverse. On shipping account there is a fairly good demand for coal. The shipping trade shows increased activity. Exports of pig iron from West Coast ports during last week reached 10,489 tons, and of steel 13,329 tons, as compared with 1290 tons of pig iron and 2252 tons of steel in the corresponding week of last year, showing an increase of 9199 tons of pig iron and 11,077 tons of steel. The aggregate shipments to date total up to 74,857 tons of pig iron and 100,792 tons of steel, showing an increase of 16,878 tons of pig iron and 14,662 tons of steel. Freights are still very low and unprofitable.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Interest continues to increase in the forthcoming meeting of the Conciliation Board. There is a pretty general hope that a way will be found to prolong its existence for a further term. Coalowners have held informal meetings here and there, and, so far as can be gathered, the feeling is in favour of continuing the body. Although the miners have not had any gatherings on the subject, the utterances of their leaders may be taken as authoritative. Their attitude is simply this, they will be very glad to agree to a prolongation of the Conciliation Board provided that the present rate of wages, 30 per cent. above the 1888 standard, is accepted as the minimum. That is the difficulty, as the coalowners urge what is perfectly true, that under the existing arrangements the bulk of the collieries are being worked at a loss, while the value of coal itself has fallen from 1s. to 2s. 6d. per ton since terms were made at the close of the coal war.

Throughout the colliery districts of South Yorkshire, Derbyshire, Lincolnshire, and Notts, trade continues as unsatisfactory as ever. The early opening of the Baltic ports, of course, will soon make a difference in steam coal, but so far competition is keen and business depressed all round, with a lower rate of values than is usual at this season of the year. The weight of coal sent by rail to London, as well as to the eastern counties, is exceptionally moderate, and in the struggle for business Barnsley house coal has difficulty in holding its own against sea-borne coal, the tonnage rates by water being so much lower. South Yorkshire is suffering from the loss of certain important gas coal contracts. This drawback will be increased by the fact that the South Metropolitan Gas Company has again contracted for its supply from the Durham coalfield. House coal, through the mild weather, gets duller than ever. Quotations are as follows:—Steam coal fetches in the open market 6s. 6d. to 7s. for the best qualities; inferior sorts being obtainable on easier terms. House coal, best Silkstone, 8s. to 9s. 6d. per ton; ordinary, 6s. 9d. to 7s. 6d. per ton; Barnsley house, 7s. 6d. to 8s. 3d. per ton; thin seam from 6s. per ton upwards. Manufacturing fuel, for which the demand exceeds supply, ranges from 4s. 6d. to 5s. 6d. per ton in small nuts; screened slack making from 3s. 6d. per ton; pit slack from 2s. 6d., while smudge can be had as low as 1s. per ton. A good tonnage of coke is being sent to Derbyshire, North Lincolnshire, and Northamptonshire. Values are firm at 8s. to 10s. in owners' wagons at the works.

In the heavy industries there is no change to report, the various departments employed in military, railway, and marine material being pretty full of work, with no little pressure in one or two of the specialities. The volume of business is gradually swelling all round, but there is complaint that prices do not advance in proportion. Several of the establishments, which have presented their annual reports of late, have exhibited less margin of profit than was anticipated. The railway material business is improving in a gratifying way, although this applies more to tires, axles, springs, buffers, and the general appointments of rolling stock. Carriage, and wagon builders, although better off for work than they were six months ago, have not anything like their plant fully employed, the means of production in this branch of business having been greatly augmented, as well as in the works where military material is manufactured. There is an agreeable absence of disputes in the different Sheffield establishments; and in spite of the briskness in most of the iron and steel trades, there is no evidence of a desire to precipitate wage demands, which would interrupt the present revival. There have been times when a distinct accession of work has led the workmen's leaders to instantly demand more money. But the moral of this folly has been so frequently read in lost orders that a more moderate and sensible course is now almost universal.

A good deal of difference of opinion exists as to the condition of the lighter staple trades. It was stated the other day that the cutlery trade, the most ancient of all our businesses, was distinctly on the downgrade, and that it had within the last few months shown deeper depression than ever. Inquiry scarcely confirms this pessimistic view. It is certainly the case that in many markets, more particularly in India, German competition has cut out a great deal of Sheffield work. But it is equally certain that in the finer grades of cutlery neither the German nor American competition has been able to oust the local firms from their position. No little damage, however, has been done by the unscrupulous attaching of imitations of Sheffield marks to inferior German-made goods. But legislation is gradually overtaking this evil, and trade piracy is becoming increasingly perilous every day. Taking a general view of the situation in the lighter trades, it is impossible to avoid the conclusion that the same remark which applies to the coal, iron, and steel industries is equally applicable to cutlery, silver, and electro-plate. Business is being steadily, yet most certainly, gathered up into the hands of the larger firms, who are able to produce great quantities at low rates, and thus command the market. As the small coalowner is being persistently pressed out of the coal market, so the "little master" is finding his occupation passing to the owners of the larger and more perfectly equipped cutlery establishments. It is the same in the important silver, electro-plating, and Britannia metal departments.

The annual meeting of the shareholders of Messrs. Charles Cammell and Company, Cyclops Steel and Ironworks, Sheffield, was held on the afternoon of Wednesday, the 25th inst., at the works, Savile-street, Sir Henry Watson, J.P., D.L., presiding. The chairman, in moving the adoption of the report and accounts, stated that the profits during the last year were £141,238, being just about double the profits made in the preceding year. A dividend of 10 per cent. was declared. Perhaps, remarked the chairman, that was not quite so much as some of them expected, but with Cammell and Company the principle had always been to have plenty of money in hand. It was proposed to put £25,000 to the reserve fund, and carry forward £31,244. The purchase of the Solway Ironworks at Maryport, had been carried out on the advice of Mr. Barbour, one of the directors, who lived in the neighbourhood, and who was well competent to advise in the matter. During the past year the collieries of the company have made a very slight profit, but nothing worth mentioning. Mr. Alexander Wilson, deputy chairman and managing director, in seconding the adoption of the report, stated that the present year opened much more satisfactorily than the last, and they were all looking forward to a steady time of prosperity which would make amends for the depressed period which had just closed. Referring to the purchase of the Solway Ironworks, Mr. Wilson thought the directors had acted wisely in that transaction. Their steel works at Workington required a large quantity of pig iron, and they had bought the Solway works at a low price, which would make them practically independent in their source of supply. The retiring directors, Messrs. T. Barbour, C. Cammell, and T. W. Jeffcock, were afterwards re-elected.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

In all respects trade in this district is satisfactory, and continues to improve. Prices are fully maintained for all descriptions of iron and steel, except No. 3 Cleveland G.M.B. pig iron, and that has been somewhat easier in second hands, but that has been due to speculative operations in the warrant market, some of the "bulls" having to "unload," as they often have towards the end of a month; but nevertheless, there is not likely this month to be as much forced selling as is usual, there having been comparatively little speculative business during the last few weeks, and the fluctuations in warrants have been within such narrow limits that there has been no inducement for either "bulls" or "bears" to operate largely. Thus business has been mostly confined this month to satisfying actual needs, and the easing of the price of No. 3 is regarded as temporary.

Exports of pig iron from the Cleveland district have never in any March been as good as they are this month; they are exceedingly good, a fact which is due in some respects to the earlier re-opening of continental ports that are closed in the winter. The shipments of pig iron from the Cleveland district this month have reached 82,121 tons, as compared with 59,840 tons in February, and 55,155 tons in January, all to 25th. Under these circumstances, and taking into account also that local consumption and inland deliveries have also been very good, it is calculated that the consumption of pig iron will have exceeded the production by 3000 or 4000 tons, which will be a much better result than has been shown for several months past. Very little Cleveland iron is going into the public warrant stores, and the quantity held by Messrs. Connal and Co. on Wednesday night was 187,225 tons, or 1715 tons increase this month.

Makers of Cleveland pig iron have not quoted less this week for prompt f.o.b. deliveries of No. 3 than 38s. 6d., the figure that has steadily ruled for some time past, but early in the week some of the merchants sold small lots, and for delivery at once, at 38s. 3d. That figure, however, is not taken now, the warrant market having improved. No change has been made in any other pig iron prices, as they are little affected at any time by the fluctuations in the warrant market. No. 1 Cleveland pig iron is at 39s. 6d.; No. 4 foundry, 37s. 6d.; grey forge, 37s.; mottled, 36s. 6d.; and white, 36s., all for early delivery. M. Nos. of Cleveland hematite pig iron are firm with makers at 47s., but from merchants small quantities have been obtained at 46s. 6d. Rubio ore has been generally quoted at 12s. 9d. per ton delivered at wharves on the Tees. There has been some foundation for the rumours about the purchase of the Coatham Ironworks, which have been idle since September, 1886. It is a fact that one of the leading Cleveland ironmasters, the owner of more than one iron-making establishment, has had the question under consideration, but what the outcome will be remains to be seen. It is stated in some quarters that the negotiations are off. A well-known Middlesbrough engineer has recently been at the works in order to report upon their condition, and what will have to be done to put them in proper working order.

A testimonial has this week been presented at Southbank to Mr. Walter S. Hill, late manager of the Clay-lane Ironworks, and now occupying a similar position at the Redcar Ironworks.

The Middlesbrough Chamber of Commerce has made a special inquiry as to how far the iron and steel producers of the district have been injuriously affected by foreign competition. It appears the pig iron makers have no complaint to make. They seem to hold their own very well, and are delivering more iron now than at any previous time, even to Germany, though the production in that empire has increased with such rapid strides. But some of the producers of finished iron and steel, especially of the lighter descriptions, have lost trade, and the success of the foreign competition is in part due to the unfair manner in which British shipping and railway companies treat their own countrymen. Thus the shipping companies carry iron from Antwerp to Indian ports and the East at 2s. 6d. per ton less than they charge from Middlesbrough or London to the same ports, and that lower charge enables the foreigners frequently to secure the orders. Then British railway companies carry foreign produce at lower rates than are charged for iron of British manufacture, so that it is possible to send from

Hamburg, Antwerp, &c., say to Liverpool and Manchester, at lower rates per ton than will be accepted from this district to the same points. Attention was directed at the annual meeting of the Chamber to the fact that the longer hours worked on the Continent enabled the manufacturers to reduce costs. Where British workmen leave at noon on Saturdays the continental works are kept going till 6 a.m. Sunday, and they are only kept idle till 1 a.m. Monday, where British establishments are idle. Thus, where the continental mills are stopped at the week ends only 19 hours, the British works are idle 42, so that the continental firms get 23 hours per week more work out of their machinery.

A fair business is being done in finished iron and steel, and especially in steel rails and plates, which are showing a decided tendency upwards in value. Generally £4 15s. net at works is quoted for heavy steel rails, but in some cases £4 17s. 6d. has been asked. With respect to the report that the Darlington Steel Works were to be re-opened shortly, the assertion is not likely to prove correct, indeed it is officially contradicted. The directors have taken no steps in the matter, except that they have had an engineer to report upon the condition of the works, and his report is said to be unfavourable. It would require a large amount of money to re-start them and equip them with machinery necessary to enable them to compete with similar works more advantageously situated. It might have been expected that with such an active demand for rails, the rates of steel sleepers could also be brisk, but such is not the case—they are in comparatively poor request, as wooden sleepers are again generally used, because where many of the railways are now being constructed, the latter can be procured cheaply from the neighbouring forests, whereas steel sleepers on account of their long carriage are costly. This accounts for some of the steel sleeper plant in the district being only poorly employed. Steel ship plates are firm at £5 2s. 6d., less 2½ per cent., and steel angles £5, less 2½ per cent., f.o.t. The West Stockton Iron Mills, Stockton, have this week been offered for sale by auction by order of the Court of Chancery. They have been idle since December, 1892, but when in operation made 1100 tons of iron plates weekly. They could readily be converted into sheet mills

The engineering industry is disturbed by the general demand that has been made for advances of wages, and this has caused the inquiries to fall off, so that this week the masters have not had as active a time as for some time previously. The demand of the engineers does not err on the score of modesty, for they require no less than 3s. 6d. per week advance. Employers do not find themselves in a position to grant any such advance, as the improvement so far has been in the demand, and very little better prices have been secured. It cannot be denied that the men give them no time to get any benefits themselves from an improvement, for directly business begins to get a little brisker, they are down upon them for advances. The employers have, however, offered 1s. a week advance at once and 6d. more in July, no further change to be made this year. The men are now considering this offer. The patternmakers have claimed a similar advance in this district. The blacksmiths and strikers have sent in a demand for 2s. a week advance on time rates and 5 per cent. on piece work, and the joiners are proposing to apply for a rise. The boilermakers and iron and steel shipbuilders of the North of England claim an advance, but have not stated any specified sum, but 5 per cent. is what they think the trade warrants.

Sir W. G. Armstrong, Mitchell, and Co. are about to enlarge their Elswick works, and have bought land therefor at the foot of Water-street, Newcastle. The directors of this firm have declared an interim dividend of 5 per cent. per annum on the ordinary shares and 4 per cent. per annum on the preference shares.

The coal trade is still dull where steam qualities are concerned, but some very good contracts for gas coals have been secured within the last few days at prices which range from 6s. 3d. to 6s. 6d. per ton, f.o.b. The South Metropolitan Gas Company has ordered 700,000 tons, and an Italian order is for 800,000 tons, the North-East Coast. Coke is in very good request, with prices tending upwards; in fact, a large quantity of coke has been sold at 14s., delivered at the Middlesbrough furnaces, though there are still plenty of sellers of good coke at 13s. 6d.

The Stockton and Middlesbrough Corporations Water Board have accepted the tender of Mr. John Scott, of Cotherstone, for the construction of the Larlington Filter Bed, at £57,041 2s. 9d. The other tenderers were:—Parker and Sharp, York, £53,146 12s. 1½d.; J. Schofield, Sons, and Co., Leeds, £56,240 5s. 10d.; A. Kellett, Ealing, £57,062 14s. 5d.; Henderson and Duncan, Edinburgh, £65,698 0s. 2d.; Whitaker Bros., Horsforth, Leeds, £69,917 11s. 11d.; F. Braithwaite and Co., Leeds, £76,901 13s. 11d.; J. H. Ridley, Middlesbrough, £78,137 10s. 2d.

The coal trade of Durham and the ironstone mining industry of Cleveland have this week presented a testimonial to Mr. Thomas Bell, who for twenty-one years has been H.M. chief Mines Inspector of the district, and has now retired. There were upwards of 200 subscribers to the testimonial, which consisted of a "grandfather's clock," a silver tray, silver candlesticks, a diamond ring for Mrs. Bell, and an illuminated address. The presentation was made by Mr. Lindsay Wood. Mr. Donald Bain is his successor in the district.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE is no abatement of activity in the manufacturing branches of the iron trade, but the warrant market has got into a somewhat irregular state. Reports from the United States and elsewhere as to trade prospects are not quite so good as of late, and the demand for warrants on the part of speculators having fallen off, the market has lacked support. The "bears" are alleged to have taken advantage of this state of matters in order to depress prices, and the business in Scotch warrants in the early part of the week was large in consequence. It frequently happens that operations of this description form the prelude to an unsettled and excited condition of the market, and on one or two occasions this week there has been evidence of an uncertain feeling, which tended to arrest the course of prices. There has been a comparatively large business in Scotch warrants, which have been done between 46s. 11d. and 46s. 8d. cash, and 47s. and 46s. 10½d. one month. The demand for Cleveland warrants is quiet, and the prices are 38s. 2d. and 38s. 3d. cash. Cumberland warrants have been fairly active, with business from 48s. 3½d. to 48s. 1d. cash, and 48s. 6d. and 48s. 5d. one month.

The output of ordinary Scotch pig iron has been increased since last report to the extent of about 600 tons per week. There are now 43 furnaces producing ordinary, 35 hematite, and 3 basic pigs, the total of 81 in blast comparing with 79 in the preceding week, and 74 in the corresponding week of last year.

The demand for makers' pig iron is very active, largely for the home trade. In the past week 1700 tons of pigs were added to the stock in the Glasgow warrant stores, and some additions are also reported as being made to makers' holdings, but the total stocks in Scotland are still in good manageable compass, and their amount is not such as to occasion any anxiety.

The prices of makers' pig-iron are comparatively steady, as follows:—Govan and Monkland, f.o.b. at Glasgow, Nos. 1, 48s.; No. 3, 46s. 6d.; Carnbroe, No. 1, 48s. 6d.; No. 3, 47s.; Clyde, No. 1, 50s. 6d.; No. 3, 47s. 6d.; Gartsherrie, Calder, and Summerlee, Nos. 1, 51s.; No. 3, 48s. 6d.; Coltness, No. 1, 53s. 6d.; No. 3, 49s.; Glengarnock, at Ardrossan, No. 1, 51s.; No. 3, 47s.; Eglinton, No. 1, 48s.; No. 3, 47s.; Dalmellington, at Ayr, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Shotts, at Leith, No. 1, 52s. 6d.; No. 3, 48s. 6d.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 49s.

The export demand for Scotch pigs continues small, and it is the coastwise trade to the West of England and elsewhere that accounts for the larger proportion of shipments. The quantity despatched from Scottish ports in the past week was 6956 tons, compared with 5420 in the same week of last year. Of the total there was despatched to Holland 480 tons, Belgium 45, United States 10, India 255, Australia 75, France 85, Italy 482, Germany 521, other countries 202, the coastwise shipments being 4801, against 3634 in the same week of 1895. The total shipments since the beginning of the year now reach 64,245 tons, as compared with 58,756 in the corresponding period of last year. Less than one-third of the total shipments have been sent abroad, the quantity despatched along our home coasts being 44,000 tons.

A good demand is reported for manufactured iron on the part of consumers, and the works in Lancashire are very well employed. Rather better prices on the whole are obtainable, but makers still regard the current rates as too low. In the steel trade there is much activity, and prices have been gradually advancing. Ship plates are reported to be selling at £5 7s. 6d., and some makers are quoting £5 10s. angles being £5. These prices are subject to the usual 5 per cent. discount for delivery in Glasgow district. Merchants are said to have made considerable purchases below the figures just quoted; but the firms mentioned as having done so are known to be extra large purchasers, both in the West of Scotland and the North of England, so that it is not at all unlikely that they may have been able to obtain special terms. While the quantity of steel being used is very large, the output is also on the increase, and there is the usual competition between English and Scotch makers.

The engineering branches are getting busier, and so also are brass-workers, rivet-makers, and a great variety of branches. The pipe-founders are doing well, at least in the small pipe department, and the tube makers are busy.

There is an improvement in the shipping department of the coal trade so far as the quantity of coals dealt with is concerned, the past week's coal shipments having been 124,164 tons, compared with 104,742 in the proceding week, and 119,190 tons in the same week of last year. Steam coals are in large supply and difficult to get rid of, main are dull and splint is easy. The better qualities of ell coal are in fair request, and there is a brisk demand for small coals and dross. Main coal is quoted f.o.b. at Glasgow, 5s. 9d.; splint, 6s. 3d. to 6s. 6d.; ell, 6s. 6d. to 6s. 9d.; and steam, 7s. 6d. per ton.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

AFTER a duration of seven weeks, and a loss to the district estimated at £25,000, the Plymouth strike has been brought to an end. A test case, regarding allowances, was tried last week before the Lord Chief Justice in the Law Courts, and adjourned until Tuesday, when, in a great measure owing to the active intervention of Sir W. T. Lewis, Bart., an arrangement was brought about by which the matters in dispute will be settled by arbitration. Work was resumed on Wednesday, though it will be some time before the whole of the men can get into their working places.

It must not be forgotten that in the settlement "Mabon," Mr. Abraham, M.P., strove unweariedly for peace. Sir William's advocacy was acknowledged by a hearty vote of thanks from both parties. The arbitrator referred to is Mr. Frank James, solicitor, clerk of the Merthyr Board of Guardians, and esteemed as thoroughly impartial and well versed in colliery law.

The Welsh press is unanimous in its condemnation of the discharge note.

There is no change in the situation at present. A meeting of the miners' representatives is fixed for the 30th inst., when they are to receive a reply from the Coalowners' Association. It is to be hoped that the "note" will be withdrawn, as a general strike would be most disastrous. If, as alleged, the introduction of the "note" is a violation of the sliding scale arrangement, I do not think that there need be any fear of its being persisted in. The government of the Association has been a firm and consistent one, marked with every disposition to concede where the claims of justice have demanded it.

There is a fair demand for coal for prompt shipment, and cargoes to Bombay have again been numerous. The leading ones were as follows:—From Newport, Mon., the Induapura with 4900 tons. From Cardiff, Strathford with 6000 tons; Sheikh, 5600 tons; Ramillies, 3700 tons; Roma, 3600 tons.

The total shipment of coal from Cardiff last week amounted to 325,000 tons; Newport, foreign 45,224 tons, coastwise 21,587 tons; Swansea total 30,417 tons, all indicating a busy week. Prospects of a continuance until the holidays are fairly good for best coals. The latest report on 'Change, Cardiff, is to the effect that for some class of goods inquiry is rather backward. This includes seconds, drys, and Monmouthshire coals. The forecast as regards house coal has been quite fulfilled, and the "green winter of 1896" will figure in future annals as one of the slackest known for this class of coal for many years.

On 'Change mid-week Cardiff prices were as follows:—Best steam coal, 10s. 3d. to 10s. 6d.; seconds, 9s. 3d. to 9s. 9d.; drys, 8s. 9d. to 9s. 3d.; best Monmouthshire, 8s. 6d. to 8s. 9d.; seconds, 8s. to 8s. 3d.; best small, 4s. 6d. to 4s. 10½d.; seconds, 4s. to 4s. 3d.; drys, 3s. 6d. Closing prices, house coal, were:—Best, 10s. 3d. to 10s. 6d.; No. 3 Rhondda, 9s. 6d. to 9s. 7½d.; brush, 7s. 6d. to 7s. 9d.; small, 6s. to 6s. 2d.; No. 2 Rhondda, 7s. 6d.; through, 6s. to 6s. 3d.; small, 4s. to 4s. 6d. Swansea prices: Anthracite best, 11s. to 11s. 6d.; seconds, 10s. to 10s. 6d.; ordinary large, 8s. to 9s. Steam coal, best, 9s. 6d. to 10s. 3d.; seconds, 8s. 9d. to 9s. 3d.; bunkers, 7s. to 9s.; small, 4s. 3d. to 4s. 6d.; house coal, No. 3 Rhondda, 10s. to 10s. 3d.; No. 2 Rhondda, 8s. 9d. to 9s. 6d.; patent fuel, 9s. 9d. to 10s. 3d.

At Cardiff the patent fuel trade is rather brisk, prices, 10s. 3d. to 10s. 6d. For coke the demand steadily improves, price: furnace, 13s. to 15s.; foundry, 15s. to 16s. 6d.; best, 19s. to 19s. 6d. The pitwood market is weaker, and 15s. ex-ship is the utmost that can be obtained, sales occurring at 14s. 9d.

Cardiff prices for iron ore, which is in good steady demand, are as follows:—Best Rubio, 11s. 9d.; Tafna, 11s. 3d.; Garucha, 10s. 9d. to 11s. At Swansea Rubio is quoted at 12s. 3d. Numerous cargoes continue to arrive. The Dowlais Company had five from Bilbao, and one from Elba this week, Pyle and Blaina Co., one from Carthagena. The principal iron and steel works generally have been securing large consignments of late. The iron and steel trades continue buoyant. Cardiff Exchange report this week was to the effect that all the steel works were busy, and the production of steel rails, sleepers, sheets, and small goods had been considerably increased.

Swansea Exchange report is not encouraging. Pig iron has dropped 8d. per ton; Glasgow warrants, Middlesbrough, 6d.; and hematite, 6d. A lull is also noted in the finished iron and steel trade, and the fact has been recorded that Welsh trade has gone into other countries on account of lower prices prevailing.

The last quotations, Swansea, are:—Glasgow warrants, 46s. 9½d., cash; Middlesbrough, No. 3, 38s. 4d., prompt; hematite, 45s. 10½d.; Welsh bars, £5 10s. to £5 15s.; sheet iron, £6 15s. to £6 17s. 6d.; steel, £6 12s. 6d. to £6 15s.; Bessemer steel bars, £3 17s. 6d.; Siemens, best, £3 18s.; steel rails, heavy, £4 10s. to £4 12s. 6d.; light, £4 17s. 6d. to £5 7s. 6d.; Tin-plates: Bessemer steel coke, 9s. to 9s. 1½d.; Siemens, 9s. 1½d. to 9s. 3d.; ternes, per double box, 28 by 20 c., 16s. 6d., 17s. 6d., to 22s. 6d.; best charcoal, 12s. 6d. to 12s. 9d., according to finish of brand-wasters 6d. to 1s. less than prime. It must be noted that these tin-plates are merely nominal, for it is stated on good authority that forced sales are being made at a very low figure. Of course best brands are firmer. The shipments last week were in excess of make, being 38,664 boxes, while make was 33,690 boxes. Stocks are now at 176,417. Several shipments from Llanelly took place this week direct to Liverpool. It is reported from America that the tin-plate trade is carried on there at a loss, so hopes are held that some improvement may probably take place in the Welsh trade. At present the condition of things is unmistakably bad. In several quarters stoppages are rumoured, and announcements made that works are for sale. I do not specify these cases or enter into details, for any day may bring about a change.

Compared with this time last year the falling off is marked, and this, of course, has told on harbour totals. I see that the anthracite trade at Swansea is expanding, and some fine tonnage is due. Good orders for Germany have been booked for this class of coal.

At Briton Ferry nineteen mills were in operation last week—Vernon, four; Baglan Bay, three; Gwalia, three; Villiers, six; Earlswood Tin-plate Works, three.

A second coal seam has been struck at Cadaxton Heath by Messrs. Glasbrook Brothers. This proves to be the 5ft., and the 9ft. seam may now be expected.

The Dowlais strike amongst the fillers continues, and the introduction of new hands has led to disturbances. The company offer rewards for offenders.

The Miner's Provident Society, which commends itself to the consideration of the benevolent public as the best means for distributing relief to sufferers from colliery explosions, received this week on behalf of the Tylorstown sufferers £500 from Messrs. Carlisle, Nuna, Rider, and Canning, and £100 from the National Colliery Company.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

A BRISK demand and further advances in quotations have been the characteristic features of last week's iron business. Makers and manufacturers are well situated, and prospects may be considered very satisfactory.

In Silesia the iron trade is extremely active, orders being plentiful. The blast furnace works are fully occupied, and somewhat better prices have been realised lately. The different sorts of malleable iron are in very good call on foreign as well as on local account, and buyers willingly pay the slight advances that have been agreed upon for some articles.

There is nothing particularly interesting to be told in connection with the Austro-Hungarian iron industry, the situation of the raw and also of the finished iron department being much the same as last week. In the bar and girder trade there has been a good deal of activity recently, and the result has been a decided upward tending of prices. Officially, however, the same rates are quoted as before, but next month is sure to bring an advance in the quotations for structural iron, and, perhaps, for plates and rails also. The railway material trade is exceptionally brisk, home orders being heavy; on foreign account not much has been doing hitherto.

Business on the French iron market shows considerable improvement, large contracts having been secured in the course of the week. Pig iron is getting rather scarce, and fairly good prices have been received in many instances. The manufactured iron branch is also developing satisfactorily, foreign demand having been fairly animated, while that on local account is considered much better than it has been for some time. Quotations, though exceedingly firm in most instances, have as yet not been officially raised, but purchasers show less reserve, and in some special cases are known to have willingly paid a few francs more for bars and girders.

On the Belgian iron market the general upward tendency continues. The demand for both raw and finished iron is so strong that the works have in a number of instances hardly been able to execute the orders within the time stipulated. The advanced prices are paid without questioning. Foundry pig has been rising very rapidly of late, No. 3 Luxemburg sort standing on 53f. p.t., against 48f. p.t. on February 1st. Steel rails are in rather less active inquiry than was anticipated. Comparing the official quotations for March 1st and February 1st of the present year, an upward movement can again be perceived for almost all articles. Luxemburg forge rose from 45f. p.t. on 48f.; basic remained on 54f. p.t. Bars No. 2, free Belgian station, advanced from 125f. on 127·50f. p.t.; No. 3 from 130f. on 132·50f. p.t., for export prices likewise rose 2·50f. p.t. Girders No. 2, free Belgian station, remained on 125f. p.t.; the same, f.o.b. Antwerp, rose from 117.50f. on 120f. p.t.; angles, free Belgian station, rose from 130f. on 137·50f. p.t. Plates, both for home and for foreign demand, remained the same as before, while steel rails rose from 110f. on 112·50f. p.t. On March 1st there were 27 blast furnaces in blow in Belgium, out of 43 existing, 10 producing ordinary pig, 3 foundry, and 14 basic. Output of pig iron in Belgium was, for February and during the first two months of 1895 and 1896, as under:—

	February.		January 1st to March 1st.	
	1896.	1895.	1896.	1895.
	Tons.	Tons.	Tons.	Tons.
Forge pig	22,475	34,160	49,600	71,980
Foundry pig ..	7,685	8,120	14,505	17,110
Basic	33,350	25,520	69,000	56,210
Totals	63,510	67,800	133,105	145,300

A firm tone prevails on the Belgian coal market. For some classes of engine fuel higher prices are paid without questioning; best steam coal is quoted 12f. to 13f. p.t.; best small coal, 11·50f. p.t.; seconds, 9·50f. p.t. Coke continues to be offered at 13·50f. p.t. Import of coal amounted to 136,479 t. for January of present year, against 108,193 t. for the same month the year before; 77,028 t. came from Germany, against 53,159 t. for the same month last year. Import in coke was 17,941 t., against 32,393 t.; import from Germany into Belgium decreasing from 31,995 t. on 16,924 t. Export in coal amounted to 380,809 t., against 373,843 t.; to Germany 10,503 t. were sent, against 21,699 t.; while to France 299,813 t. were exported, against 294,793 t. in the year before. Export in coke amounted to 67,311 t., against 75,734 t.; 7550 were sent to Germany, against 15,890 t., France receiving 44,558 t., against 38,729 t.

Last week was a brisk one all round in the iron and steel trade of Rheinland-Westphalia. There is a very marked activity at the blast furnace works, most of them having secured contracts for the third and even for the fourth quarter. Prices are very firm and exhibit a decided upward tendency. The aspect of the malleable iron trade is very cheerful. In the beginning of the year, after the revival set in, there were still some mills that were only irregularly and even insufficiently occupied, but during the last few weeks the improvement has progressed so quickly and has become so general that, judging from the order books, full employment will be secured to all the mills for several months to come.

Bars sell much better than they did; the convention of the South German rolling mills has raised the price on M. 118 p.t. free Neunkirchen. Girders are very briskly called for, with prices a trifle higher than two weeks ago. The same holds for hoops. Plates of all descriptions are very brisk of sale, but attempts to raise the prices have met with but little success. Numerous orders are being received at the sheet mills. Less favourable accounts must be given of the wire business, which continues dull and depressed in the extreme, in spite of all that has been said to the contrary; foreign demand, which is specially important for the wire trade, has dwindled down to a mere nothing, the present tariffs and high prices for raw material rendering a successful competition on foreign markets almost impossible. In the different departments of the railway and engineering trade a fair amount of work is available, and the position of matters is decidedly more hopeful than it has been for a long time past.

Official reports concerning the Spanish iron industry state that the 300 existing iron ore mines, employing 12,926 men, yield an output of 5,352,253 t. iron ore, worth 19,979,559 pesetas; and 736 t. argentiferous iron ore, worth 4130 pesetas; 473 collieries with 15,174 men, and 67 brown coal works, with 562 men, produced 1,659,274 t. pit coal, worth 11,638,383 pesetas, and 48,460 t. brown coal, worth 316,330 pesetas; 17 blast furnace works, employing 9025 men, produced 123,798 t. forge pig, valued at 8,498,411 pesetas; 54,214 t. foundry pig, worth 11,049,390 pesetas; and 92,851 t. basic, worth 17,921,999 pesetas.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

10th March, 1896.

5423. Art of Producing Combustion, P. J. Schlicht, London.
5424. Construction of Shaking Grates, G. M. Conway, London.
5425. Golf Drivers, W. R. Briggs, London.
5426. Rapid-fire Guns, The Hotchkiss Ordnance Co.—(*L. V. Benet and H. A. Mercié, France.*)
5427. Emery Wheels, H. Smith, London.
5428. Mandolines, G. B. Maldura, London.
5429. Hooks and Eyes for Roller Blinds, J. T. Lawrence, London.
5430. Steering Gear, E. J. Clubbe and A. W. Southey, London.
5431. Evaporating Apparatus, S. M. Lillie, London.
5432. Nitro-cellulose Compounds, O. Nagel, London.
5433. Taps, R. Holbrook, London.
5434. Toy Cannon, J. T. Lawrence, London.

11th March, 1896.

5435. Transmitting Money by Post, A. E. Payne, London.
5436. Machine for Drilling Hubs, J. Clifton, London.
5437. Anchors, E. L. Walker, London.
5438. Infants' Binders, M. A. Cutting, London.
5439. Hooks and Eyes, C. J. S. Spedding.—(*J. W. H. P. Spedding, Italy.*)
5440. Tobacco Pipes, F. J. Whatton, London.
5441. Combination Shank for Cornets, W. Needham, Crewe.
5442. Holding Sheets of Glass, H. W. Braddock, London.
5443. Mechanical Stokers, J. Proctor, Manchester.
5444. Brakes for Railway Wagons, L. W. Williams, Glasgow.
5445. Haulage Clips, J. Harvey, Derby.
5446. Frames of Umbrellas and the like, G. Bowmar, London.
5447. Pendant Frames, J. E. Bryant and W. Dudley, jun., Wolverhampton.
5448. Frames for Cycles, A. W. Sutton, Wolverhampton.
5449. Taps, F. Cave, Nottingham.
5450. Needle for Making Cloth Mats, F. T. Archer, London.
5451. Hem-stitching Machines, J. Mulholland, Armagh.
5452. Carts for Distributing Water, T. Greves, Warwick.
5453. Cycle Lamps, E. Gerard, Liverpool.
5454. Parts of Photographic Cameras, J. B. Brooks, Birmingham.
5455. Departure and Arrival Indicators, J. C. Sellars, Liverpool.
5456. Weighing Packages or Goods, E. Banks, Liverpool.
5457. Brake Mechanism for Road Vehicles, J. W. Cook and C. Scott, London.
5458. Windmills, E. J. Schrock, London.
5459. Drip Cock for Steam Engines, J. A. Wright, London.
5460. Lavatory and Bath Overflows, A. F. Morrison and M. Ingram, Manchester.
5461. Hearth Blocks for Fireplaces, J. H. Goodman, Reading.
5462. Displaying Advertisements, E. G. Butler and T. E. Benson, Birmingham.
5463. Metallic Bedsteads, S. I. Whitfield, Worcester.
5464. Bicycle Holders, T. Lamb, jun., Stirling.
5465. Screens for Hotel Bars, T. Naylor and S. H. Hurst, London.
5466. Disconnecting Power Looms, A. E. Walker, Halifax.
5467. Electric Tramcars and Tramways, E. H. Hackett, Halifax.
5468. Circular Cutters, E. Richardson and G. W. Elliott, Sheffield.
5469. Archimedean Hand-drill, C. W. W. Wilson, Newcastle-on-Tyne.
5470. Apparatus for Heating Water, J. F. Wiles, Jersey.
5471. Digestive Cheese, J. B. Sincock, Bridgwater.
5472. Tobacco Pipes, W. C. Phillips, Bradford.
5473. Attachments for Chairs, O. B. Hatch and J. W. Dougall, Glasgow.
5474. Railway Wagon Brakes, J. E. Alderman and A. H. Barnett, Birmingham.
5475. Locomotive Carriages, E. J. Clubbe and A. W. Southey, London.
5476. Manufacture of Bread, W. S. and W. H. Mitchell, London.
5477. Measures for Lawn-tennis Courts, H. Bawtree, Surrey.
5478. Cleaning Bottle Stoppers, &c., F. C. Garrod, Kent.
5479. Alternating Current Electric Motors, A. S. Frazer, London.
5480. Means for Locating Leakages, W. V. Hunt, London.
5481. Kilns for Malt Drying, R. Hardy, London.
5482. Bricks, G. Power, London.
5483. Rocking Shafts, J. McAndrew, Ashton-under-Lyne.
5484. Baskets, W. J. Lyne, London.
5485. Motor, A. Hodost, London.
5486. Augers, The Sandycroft Foundry and Engine Works Company and J. Jones, London.
5487. Toy Guns, M. David and A. Davies, London.
5488. Manufacture of Boxes, R. C. Wixcey, London.
5489. Portable Household Fire Escape, H. A. Foot, London.
5490. Salicylic Acid, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
5491. Motors, Siemens Bros. and Co.—(*Siemens and Halske, Germany.*)
5492. Head Gear of Pits, C. Sebastian-Smith, London.
5493. Cutting Tool, H. Cohn.—(*D. Schoenfeld, Switzerland.*)
5494. Material for Photographic Printing, H. McClean, Croydon.
5495. Nitrogenous Substances, J. S. Wallace and J. Castell-Evans, London.
5496. Fastening the Wheel Axles of Cycles, A. S. Beyreiss, London.
5497. Automatic Stopcock, S. R. Bottone, Surrey.
5498. Folding Ladders, F. Birch, London.
5499. Sheet Metal Cans or Boxes, F. W. Feaver, London.
5500. Flanging of Tubes, G. F. Redfern.—(*F. Fuhrmann, Germany.*)
5501. Lamp Extinguishers, J. N. Lewis and T. Stubbs, Liverpool.
5502. Neckties, J. H. Clegg, Liverpool.
5503. Seating of Passengers, J. Miess, Manchester.
5504. Fastening for Shoes, &c., A. Yole, Birmingham.
5505. Hermetically Sealing Vessels, J. C. Gittins, Liverpool.
5506. Electric Accumulators, P. F. Ribbe, Liverpool.
5507. Slaughtering Animals, J. Favets, London.
5508. Hand Looms, &c., The Honourable R. Flower, London.
5509. Form of Ratchet Screw Driver, F. Partridge, London.
5510. Flower Tubes, C. C. Mallett, London.
5511. Arc Lamps, W. J. Davy, London.
5512. Cars, E. A. Sperry, London.
5513. Gloves, O. Werfel, London.
5514. Beverages, R. E. Harrison, London.
5515. Sash Fasteners, J. Wood, London.
5516. Car Starters, T. Heather, London.
5517. Advertising Devices, J. T. Bustin, London.
5518. Covers for Biscuit Boxes, E. L. Antrobus, London.
5519. Presses for Production of Coins, W. B. Challen and Taylor and Challen, Ld., London.
5520. Cranks for Velocipedes, &c., T. Shepherd, London.
5521. Providing Pistols with Butts, A. Samut, London.
5522. Preventing Re-filling of Bottles, W. F. Darcy, London.
5523. Utensil for Frying Eggs, T. H. Gaskin, London.
5524. Tires, W. Tatham, London.
5525. Gear and Friction Driving, S. Z. de Ferranti, London.
5526. Dough Kneading Machines, R. Dean, London.
5527. Handle Bars for Cycles, G. Antoine, London.
5528. Economisers for Steam Generators, H. McPhail, London.
5529. Chain Cables for Ships, &c., W. S. Simpson, London.
5530. Fasteners for the Hair, E. M. M. Mackay, London.
5531. Apparatus for Raising Water, G. S. Jones, London.
5532. Loading Silk, C. E. Puller and A. Biermann, London.

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5533. Extraction of Gold from Ores, J. B. Torres, London.
5534. Wheels, H. R. Stockman, Dover.
5535. Burnishers for Bits, W. H. Duly, Sussex.
5536. System of Combined Girders, U. Geneviève, Brussels.
5537. Automatic Telegraph Apparatus, G. Hyvert, Brussels.
5538. Unsinkable Boats, A. and A. Faure, Brussels.
5539. Stay Rod Ends, T. Griffiths, Birmingham.
5540. Section or Delivery Hose, J. L. Jones, Dublin.
5541. Drum Yarn Tester, W. Stock, Oldham.
5542. Heating of Tires, W. Mottram, Polesworth, near Tamworth.
5543. Feeding Bottle, W. F. Wood and E. C. Toller, London.
5544. Pipe, T. W. Vipond, Newcastle-on-Tyne.
5545. Steel Tires for Cycles, T. E. Weaver, Wolverhampton.
5546. Sealing Cans, R., A., W. A. Read, Liverpool.
5547. Wash-house Boilers, E. Handslip and J. Taylor, Newcastle-on-Tyne.
5548. Safety Water Boiler, E. A. Jennings, Huddersfield.
5549. Intercepting Trap for Drains, E. Codling, Manchester.
5550. Footballs, R. Young, Glasgow.
5551. Boiler Tube Stopper, T. Gibbison, Newcastle-on-Tyne.
5552. Pneumatic Tires, W. Macdonald, Glasgow.
5553. Door Knob, J. Jackson, Halifax.
5554. Shedding Motions of Looms for Weaving, W. Morris, J. Morris, J. Walsh, and H. Sharples, Halifax.
5555. Making Bedsteads, A. Lawrence, Birmingham.
5556. Filtering Apparatus, H. S. Young and C. J. Ellis, Glasgow.
5557. Overflow Apparatus for Baths, J. Shanks, Glasgow.
5558. Graters, E. Gilmore, Hamilton, Ontario, Canada.
5559. Surveyors' Tape Measure Box, B. S. Peaker, Bradford.
5560. Universal Projector, J. Haegele, Hastings.
5561. Rope Grip, W. H. A. Everett, Cambridge.
5562. Tobacco Pipe Cover, S. Smith, Norwich.
5563. Compasses for Night Marching, J. H. Steward, London.
5564. Producing Peat-fibre, E. Paté and J. A. Brion, London.
5565. Foot Guard for Railway Rails, J. K. Rile, London.
5566. Heat Radiators, J. B. Fox, London.
5567. Washboard, R. J. Hartwick and H. G. Blanchard, London.
5568. Brazed Joint Cleaning Process, W. H. Kitto, London.
5569. Perambulators, Mail-carts, &c., W. Middleton, London.
5570. Scarifying Machine for Roads, E. G. Harris, London.
5571. Apparatus for Signalling, A. W. Robinson, London.
5572. Mechanical Toy Gun or Cannon, O. Hanks, London.
5573. Fireplace, &c., S. Pollitzer and R. E. Ogilby, London.
5574. Mechanical Musical Instrument, E. Welte, London.
5575. Ships' Signal Lights and Rockets, A. Pain, London.
5576. Producing Figures in Carpets, R. Etherington, London.
5577. Stands for Bonnets and Dresses, W. Arthur, London.
5578. Cycle Chains, F. W. Golby.—(*A. Humbert, France.*)
5579. Puzzle, W. C. Owsman, London.
5580. Liquid Measuring, H. E. Smith and M. Salomon, London.
5581. Window Fastener, A. Richartz, Cologne.
5582. Wood-wool Machines, H. Klippel, Cologne.
5583. Journal for Cycles and Vehicles, C. Truman, London.
5584. Treating Carbon in Electrolytic Processes, A. Coehn, London.
5585. Manufacture of Oxybenzoic Acids, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
5586. Brake Mechanism for Cycles, O. T. Blathy, London.
5587. Vaporiser Injectors, B. Bourdallé and C. Berthemet, London.
5588. Cycle Brakes, A. E. Hench, London.
5589. Animal Feeder, L. P. Selbach, London.
5590. Device for Injecting Powder, E. Hartman, London.
5591. Production of Preserved Grain, S. Hagyi-Ristic, London.
5592. Boxes for Ambulance Bandages, W. P. Thompson.—(*E. Zillibiller, Germany.*)
5593. Water-closet Seats, W. P. Thompson.—(*E. Zillibiller, Germany.*)
5594. Commodes, W. P. Thompson.—(*E. Zillibiller, Germany.*)
5595. Bottle Stoppers, W. P. Thompson.—(*R. Porumbaru, Roumania.*)
5596. Spanners, J. B. Marshall and J. M. Moss, Manchester.
5597. Corliss Valves of Steam Engines, W. Porter, Liverpool.
5598. Braking Oil and Gas Engines, W. Thompson, Liverpool.
5599. Apparatus for Silvering Mirrors, C. L. Erlwein, Liverpool.
5600. Safety Appliances for Lamps, A. W. Brittain, London.
5601. Fittings for Water-closets, J. B. Schnitzler, London.
5602. Walking Stick or Umbrella, B. J. O'Rorke, London.
5603. Manufacture of Buoyant Pulp Ware, H. Thame, London.
5604. Apparatus for Propelling Boats, J. Kirkaldy, London.
5605. Spring Wheels, A. Kotin, London.
5606. Gas Burners, A. J. Boult.—(*E. Rousseau, Belgium.*)
5607. Wrenches, G. F. Johnson, London.
5608. Window Cleaners, W. E. Allen, London.
5609. Starching Machines, A. T. Hagen and D. McC. Cooper, London.
5610. Machines for Making Shells for Sliding Boxes, A. J. Boult.—(*The Stecher Lithographic Company, United States.*)
5611. Draining Surface for Beer Engines, C. Erb, London.
5612. Pads for Boat Seats, D. Champion, London.
5613. Camp Cooking Outfits, J. W. Mackenzie.—(*F. C. Wilson, United States.*)
5614. Field Rations Kits, J. Y. Johnson.—(*G. H. Preston and L. M. Fuller, United States.*)
5615. Treating Rice for Brewing, A. and H. Perry, London.
5616. Electrolytic Apparatus, A. E. Peyrusson, London.
5617. The Automatic Cycle Alarm, H. S. Halford, London.
5618. Increasing the Lever Power of Cranks, W. S. Simpson, London.
5619. Ammunition Hoists, Sir G. S. Clarke and G. H. Banister, London.
5620. Preparation of Coal for Fuel, C. E. O. Betts, London.
5621. Adjustable Mould Blocks of Linotypes, The Linotype Company, C. L. Ireland, and F. J. Wich, London.
5622. Pottery-ware Glaze Firing-kilns, C. Mayer, London.
5623. Balancing Two-wheeled Vehicles, T. A. Simpson, Banff.
5624. Gas Manufacturing Apparatus, E. Farnsworth, London.

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5625. Metallic Fenders, C. Meason, L. E. Wood, T. B. Davis, and A. Mawson, Birmingham.
5626. Extinguisher for Oil Lamps, S. Shaw and N. T. Dutton, Manchester.
5627. Oil Motors, W. H. Casley and A. F. Woodman, Exeter.
5628. Steam Generators, N. Soliani, London.
5629. Shears for Cutting Lawns, J. Ellis, Isle of Wight.
5630. Propelled Vehicles, Cycles, &c., J. Roots, London.
5631. Combination Necktie, A. J. Bradshaw, West Croydon.
5632. Drawing Presses, &c., D. Smith, Wolverhampton.
5633. Police Whistle, A. Robertson and G. H. McKay, Glasgow.
5634. Automatic Flushing Valve, T. Carlaw, Lanark.
5635. Collar Studs, W. Pearce, Birmingham.
5636. Steam Generator for Heating Fluids, J. Schmidlin, Manchester.
5637. Means for Illuminating Objects, Y. Schartz, Birmingham.
5638. Steering Lock for Bicycles, W. H. Bird, Wolverhampton.
5639. Stoppers for Bottles, A. Daw, Birmingham.
5640. Vacuum Dryers, H. F. Talbot.—(*O. Siedentopf, Germany.*)
5641. Obviating Noise from Engines, R. McLeod, jun., Glasgow.
5642. Preservation of Pictures, &c., C. S. Cox, Sheffield.
5643. Cylinders for Lubricators, G. H. Shakespeare, Birmingham.
5644. Treating Hides, J. A. McIntosh, Newcastle-on-Tyne.
5645. Automatic Gas Meters, C. G. Beechey, Liverpool.
5646. Horse Nosebags, G. J. Hues, Liverpool.
5647. Refrigerating Machinery, W. B. Cumming and A. Webster, Liverpool.
5648. Circular Knitting Machines, G. Sowter, Nottingham.
5649. Consuming Furnace Smoke, J. Hay and J. Montgomery, Glasgow.
5650. Seed Drills, J. W. Shore, London.
5651. Machines for Washing, H. W. Wichman, London.
5652. Wheels and Axles for Trolleys, T. Rowbotham, Manchester.
5653. Tightening Bedstead Laths, C. Horner and E. Gothard, Barnsley.
5654. Supporting Artists' Sketch Blocks, N. M. Macdougall, Glasgow.
5655. Treatment of Sewage, J. T. Wood and J. A. Brodie, Liverpool.
5656. Holders for Music, C. H. Tenniers, jun., London.
5657. Pulleys for Hoisting, J. C. W. Kjelgaard, London.
5658. Hook and Eye Fasteners, J. H. Smith, London.
5659. Securing Handles of Cycles, H. J. W. Braine, London.
5660. Cover for Tires of Cycles, W. E. Formby, London.
5661. Labels, W. E. Alexander, London.
5662. Appliance for Use of Writers, J. M. Carter, London.
5663. Churn, H. Palmer and M. Massie, London.
5664. Chairs, W. B. Crees, London.
5665. Utilising Paper Mill Sludge, J. Bradley, London.
5666. Furniture Castor, A. P. Lundberg, London.
5667. Securing Card Clothing, J. H. Kay, Manchester.
5668. Springless Safety Locks, C. P. R. Fiebig, Berlin.
5669. Preventing Illicit Abstraction from Letter-boxes, T. E. Williams, London.
5670. Fire-escapes for Domestic Use, G. Parrott, London.
5671. Wheel Rims, B. G. King, London.
5672. Ozone Compounds for Medicine, E. Langheld, London.
5673. Refining Metals, A. S. Elmore.—(*J. O. S. Elmore, India.*)
5674. Cycle Gearing, H. C. Hall, London.
5675. Oil and Gas Motor Engines, G. S. Hooker, London.
5676. Velocipedes, T. Norton, London.
5677. Bevelling, &c., Glass, A. Griffiths, Birmingham.
5678. Securing Packing Cases, S. G. Umfreville, London.
5679. Pumps, A. and W. Purvis, Glasgow.
5680. Refacing Spinning Rollers, T. Crabb and J. Wishart, Fife.
5681. Reducing the Draught of Ships, J. F. Crease, London.
5682. Jewel Cases, F. Walker, London.
5683. Recoil Machine Guns, C. H. A. F. L. Ross, London.
5684. Musical Instruments, F. E. Malke and F. H. Oberländer, London.
5685. Suspending Ladies' Skirt, L. and B. Brèlaz, London.
5686. Washing Gas, S. Hersey and Kirkham, Hulett, and Chander, Ld., London.
5687. Making Matches, W. P. Thompson.—(*B. T. Steber, United States, and W. E. Cook, Canada.*)
5688. Pace Indicators, W. P. Thompson.—(*A. B. Holson, United States.*)
5689. Sorting Chips, W. P. Thompson.—(*N. M. Jones and R. S. Talbot, United States.*)
5690. Cesspools, W. P. Thompson.—(*E. de Harven, Belgium.*)
5691. Clutches, J. J. Hooker, Manchester.
5692. Appliance for Use with Ferrets, R. B. Kellet, Liverpool.
5693. Incandescent Gas Lamps, G. Himmel, Liverpool.
5694. Cocks and Valves for Bottles, J. Bengué, London.
5695. Mount for Photographic Albums, M. G. Amson, London.
5696. Means for Toasting Bread, &c., W. H. Aish, London.
5697. Stands for Kitchen Utensils, H. A. W. Candler, London.
5698. Carriage Apron and Canopy, G. Volland, London.
5699. Photographic Apparatus, B. Acres, London.
5700. Cage, J. S. Wyndham, London.
5701. Windows, H. Selk, London.
5702. Tubulous Steam Boilers, J. Jardine, London.
5703. Arc Lamps, A. J. Boult.—(*W. B. Jolles and E. H. A. H. Ritter von Nollendorf, Austria.*)
5704. Sharpening Tools, W. Kraus, London.
5705. Insecticide, J. N. Spence, London.
5706. Apparatus for Cisterns, &c., A. J. Blackburn, London.
5707. Jacquard Apparatus, A. J. Boult.—(*M. Kemmerich, Belgium, and O. Weese, Germany.*)

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5708. Gaiter, W. Ward, Birmingham.
5709. Window Sashes, W. Johnson, Shetland.
5710. Bells for Doors, B. Ray and J. W. Harness, Grimsby.
5711. Scouring Material, A. J. Jacobs, Bristol.
5712. Production of Fast Colours, J. Barnes, Accrington.
5713. Boot Trees, A. W. Brewtnall, Manchester.
5714. Stoves, W. T. Crooke and C. J. Saunders, Sheffield.
5715. Pinless Clothes Line, J. H. Wharton, Liverpool.
5716. Affixing Down Pins, A. H. Woodward and F. A. Willmott, Birmingham.
5717. Brackets, H. Tibbins and A. O. Morley, Birmingham.
5718. Shortening Driving Ropes, S. J. Rivett, Manchester.
5719. Heating Apparatus, T. Arnold, Manchester.
5720. Flower Clip or Holder, J. E. Atkinson, London.
5721. Hand Tackers, W. H. Dorman, Stafford.
5722. Toy Bricks or Blocks, F. Green and J. H. Lake, Exeter.
5723. Sealed Gas Reversing Valves, G. A. Daniel, Monmouthshire.
5724. Flyer for Spindles, J. Knox and J. Orr, Belfast.
5725. Indicating Names of Railway Stations, J. C. Buchanan, London.
5726. Steam Engines, W. B. Crichton, Bradford.
5727. Butter Churns, A. E. Frost and The Dairy Outfit Company, Ltd., London.
5728. Cycle Saddles, L. H. Curtois and W. H. B. Brook, Lincoln.
5729. Self-supporting Golf Carrier, D. T. Thring, Bedford.
5730. Stoves for Heating Water, J. Major, Manchester.
5731. Operating Liquid Elevators, T. Leech, Lancashire.
5732. Cisterns and Taps, J. Carpenter and J. S. Pearce, Southampton.
5733. Hanging Pictures on Walls, A. Brier, Manchester.
5734. Hauling Railway Vehicles, H. L. Marlett, London.
5735. Refrigerators, M. J. McNeil, London.
5736. Feeding Thrashing Machines, F. Needley, Lincoln.
5537. Fixing Spirit Glasses, A. W. and S. Butterfield, Oldham.
5738. Gas Regenerative Furnaces, E. Johnson and J. Thompson, Lemington-on-Tyne.
5739. Solutioned Repair Patch, A. Frost and W. J. Cordener, Ireland.
5740. Distributing Artificial Manure, A. Burns, Glasgow.
5741. An Adding Appliance, G. A. Vetch, Glasgow.
5742. Spoke-bending Apparatus, E. Leadbeater and G. Elliot, Sheffield.
5743. Cinder Shifter or Separator, S. Willoughby, London.
5744. Box, E. W. Smith, London.
5745. Message Board or Apparatus, B. M. O'Reilly, Dublin.
5746. Steam Engines, H. Cautherley and T. Birtwistle, London.
5747. Deep Well Pumps, J. Ralphs, London.
5748. Power Propelled Vehicles, F. W. Lanchester, London.
5749. Extracting Albuminous Substances, D. Finkler, London.
5750. Cotton-holder for Sewing Machines, C. Mace, London.
5751. Cycle Supports, W. Webber, London.
5752. Electro-motor, J. Perry, London.
5753. Crosleigh Coal Pedestal or Bunker, F. J. Cross, London.
5754. Argand Gas Burners, W. H. Harvey, London.
5755. Forging of Screws and Bolts, H. P. Boyd and P. Burt, London.
5756. Drying and Cooling Grain, &c., J. Pannevis, London.
5757. Preventing the Overheating of Shafts, J. S. Fitzpatrick, London.
5758. Chronophotographic Apparatus, F. Gossart, London.
5759. Movable Deviced Surface Bodies, W. Symons, London.
5760. Road Vehicles, T. Briggs, London.
5761. Ceramic Products, C. and H. Riessner, E. Stellmacher, and R. Kessel, London.
5762. Handles for Vessels, C. E. Challis, London.
5763. Pneumatic Tires, W. F. Williams, London.
5764. Pneumatic Tires, W. F. Williams, London.
5765. Pneumatic Tires, W. F. Williams, London.
5766. Drying Fabrics, La Société Anonyme dite "Blanchisserie et Teinturerie de Thaon," London.
5767. Seamless Metallic Tubes, E. Pilkington, Birmingham.
5768. Liquid Meters, W. M. Fowler, London.
5769. Colour Printing, J. Martin and V. D. Knowles, London.
5770. Stamp Batteries, W. Foggo, London.
5771. Manufacture of Steel Tubes, W. Starley, London.
5772. Manufacture of Ceramic Stone Objects, L. A. Garchey, London.
5773. Obtaining Motive Power, G. Robinson and C. D. Tustin, London.
5774. Polisher for Silk Hats, W. S. Simpson, London.
5775. Appliance for Hoppling Mares, T. Castle, London
5776. Ferrule Tip for Umbrellas, &c., A. Barnett, London.
5777. Manufacture of Lock Nuts, H. B. Hopewell, London.

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5778. Automatic Fountains, P. C. Jones, Guildford.
5779. Telephone Switchboard, D. McNamara, Dublin.
5780. Skips, J. Crossley, Manchester.
5781. Coating Iron with Zinc, S. O. Cowper-Coles, Manchester.
5782. Flax Hackle, J. Carroll, Belfast.
5783. Pen or Pencil Holder, A. E. Gilbert, Whitley, Northumberland.
5784. Clamps for Lathes, H. Meynell and G. Wade, Wolverhampton.
5785. The Smokers' Pocket Companion, J. Hough, Croydon.
5786. Burning Small Coal in Fire-grates, H. A. Kent, Ringwood.
5787. Steam Engines, W. R. Cummins, Fife.
5788. The "B" Combination, H. C. Backhouse, Dundalk.
5789. Photographic Burnishing Machine, T. S. Hargreaves, Clitheroe.
5790. Manufacture of Fuel, P. R. de F. D'Humy, Liverpool.
5791. Production of Lubricants, P. R. de F. D'Humy, Liverpool.
5792. Manufacture of Soap, P. R. de F. D'Humy, Liverpool.
5793. Disinfectants, &c., P. R. de F. D'Humy, Liverpool.

5794. Insulating Material, P. R. de F. D'Humy, Liverpool.
5795. Fire-lighters, P. R. de F. D'Humy, Liverpool.
5796. Manufacturing Briquettes, P. R. de F. D'Humy, Liverpool.
5797. Metal Polishers, P. R. de F. D'Humy, Liverpool.
5798. Tackle Box, D. R. Clark, Glasgow.
5799. Drilling Tools, G. Harrison and E. Fleming, Halifax.
5800. Cycle Saddles, P. A. Martin, Birmingham.
5801. Enclosure or Case for Cycles, R. H. Hepburn, Birmingham.
5802. Weighing and Mixing Machines, B. H. Uhlig, Berlin.
5803. Sifting Machines, C. A. Israel, Berlin.
5804. Cranes, &c., B. B. Dadley, London.
58 5. Two-wheeled Vehicles, R. E. Baker, Dublin.
5806. Furnace Fronts for Steam Boilers, J. Howden, Glasgow.
5807. Safety Catches for Coal-pit Cages, T. H. Eddleston, Wigan.
5808. Casting Tops on to Cast Iron Fenders, J. Crawford, Dudley.
5809. Women's Sanitary Band, G. Thrailkill, London.
5810. Sewing Machines, W. H. Harrap and W. H. Cottam, London.
5811. Cycle Stand and Home Trainer, V. H. Norman, Great Yarmouth.
5812. Writing Appliances for Reporters, W. Milne, Glasgow.
5813. Production of Acetylene Gas, T. Holliday, London.
5814. Gas and Oil Motors, F. W. Lanchester, London.
5815. Making Nitrate of Ammonium, G. Craig, Glasgow.
5816. Saddles, W. Matthews, Liverpool.
5817. Producing Designs upon Surfaces, E. J. and E. Lee, Leeds.
5818. Knife Sharpener, R. H. and J. F. Shaw, Manchester.
5819. Machinery for Making Tubes, E. Atkinson, London.
5820. Cup Hooks, J. A. Crane, C. E. Thomas, and J. Whitehead, Birmingham.
5821. Attaching Sticks to Umbrellas, J. G. H. Percy, Llanelly.
5822. Filtering Feed-water, D. A. Quiggin, Liverpool.
5823. Ruling Pen, E. Mann and C. Blodig, London.
5824. Bands for Holding Persons, J. J. Wilson, Birmingham.
5825. Playing Golf, E. P. Davis, London.
5826. Nosebags, W. H. Hall and J. Pritchard, London.
5827. Fire-lighters, J. Maynes and C. L. Watchurst, London.
5828. Tires, J. Turns, London.
5829. Flower and Ticket Holder, J. White, London.
5830. Slicer and Grater for Vegetables, T. R. Watson, London.
5831. Game, J. L. Lardner, London.
5832. Automatic Self-locking Tap, A. Postlethwaite, London.
5833. Cotton Cleaning Mechanism, J. D. Morel, London.
5834. Duplicate Games of Cards, W. T. Johnson, London.
5835. Zithers, W. Eschemann, London.
5836. Trimming Vegetable Fibres, M. S. Macdonald, London.
5837. Shafting Pulleys and Fly-wheels, W. Griffiths, London.
5838. Road Skate, W. Griffiths, London.
5839. Cutting and Moulding Presses, L. A. Garchey, London.
5840. Letter-boxes, Alms-boxes, &c., H. Gibbons, London.
5841. Pocket Stoves, Right Hon. D. M. B. H. Cochrane, London.
5842. Picture and similar Frames, A. Guttenberg, London.
5843. Regenerative Petroleum Lamps, F. Ludwigs, London.
5844. Preparing Soluble Starch, J. Kantorowicz, London.
5845. Extracting Gold from Ores, J. B. Torres, London.
5846. Boots, J. S. King, London.
5847. Fenders for Tramway Cars, &c., G. Beit, London.
5848. Cooling Grain, W. Byers, London.
5849. Water Softening Apparatus, F. H. Tyacke and C. E. Gittins, London.
5850. Tee Fitting for Tubes, F. Dye, London.
5851. Connecting Pipes Together, A. T. Harris, Alperton.
5852. Hat Cover or Protector, A. Rattner, London.
5853. Combination Tool, G. Hughes.—(*H. Hunt and H. Hunt, jun., United States.*)
5854. Brakes, W. P. Walker, London.
5855. Grinding Machines, J. Coyne, London.
5856. Steam Boilers, D. Purves, London.
5857. Colouring Matters, H. H. Lake.—(*Farbwerk Mühlheim, Germany.*)
5858. Colouring Matters, H. H. Lake.—(*Farbwerk Mühlheim, Germany.*)
5859. Supplying Disinfectant to Urinals, W. Hanlon, London.
5860. Motors, S. J. Ledin, London.
5861. Advertising Devices, A. Palmer and G. G. O'Brien, London.
5862. Evaporating Liquids, F. Hartmann, London.
5863. Life-saving and Swimming Belt, J. Chisholm, London.
5864. Draught Excluders, C. Bossen and A. Burghardt, London.
5865. Chime Clocks, A. J. Boult.—(*R. E. Gunther, Canada.*)
5866. Sprocket Chains, B. F. Sparr and F. K. Partric, London.
5867. Bearings, B. F. Sparr, London.
5868. Burners, A. Rose, London.
5869. Bottle Stoppers, J. D. Bushell, London.
5870. Expanding Chucks, W. A. Elliston and C. J. Jones, London.

17*th March*, 1896.

5871. Gauge for Steam Boilers, J. McLaren, Dersingham.
5872. Lift, J. McLaren, Dersingham.
5873. Additions to Parts of Umbrellas, C. Alexander, Birmingham.
5874. Carbon Pencils for Arc Lights, T. C. Hepworth, London.
5875. Stopper Labelling Machine, W. Browne, Horley.
5876. Cuff, H. J. Robbins, London.
5877. Chisel, A. Bourne, Croydon.
5878. Showing Calculations of Figures, A. Ganderton, Birmingham.
5879. Valves, C. H. Holgate, Leeds.
5880. Gilling Fibres, F. W. and C. Greenwood, Halifax.
5881. Tramcars, H. F. Christie, Halifax.
5882. Files, W. Junge, London.
5883. Sizing Machines, W. E. Heys.—(*J. Cuquelin, France.*)
5884. Switches, R. Brymer, Manchester.
5885. Cuff Guard and Protector, J. G. Williams, Manchester.
5886. Fastening Covers of Tires, &c., A. E. Hall and J. W. Sadler, Bootham.
5887. Otter Boards for Surface Water Fishing, J. Reid, Glasgow.
5888. Preacher's Aid, W. J. Potter, Essex.
5889. Machines for Embroidering Cloth, A. Gass, Belfast.
5890. Toys, J. B. Howard.—(*Uhlig and Schwerin, Germany.*)
5891. Driving Mechanism for Cycles, L. N. Dyhrberg, W. W. Curties, and A. Crum, London.
5892. Pneumatic Tires, A. L. Smith, Manchester.
5893. Power and Spray Ejector, R. H. Cox, Dundalk.
5894. Pneumatic Wheel-acting Air Pump, S. Hadland, Leamington.
5895. Cycle Friction Wheel Brake, W. J. Smith, Sheffield.
5896. Elastic Wheel Tires, &c., J. T. Southworth, Manchester.
5897. Opening Closed Cans, G. H. Stechman and G. J. Robohm, Manchester.
5898. A New Parlour Game, H. W. Bromfield, Bristol.
5899. Tin Openers, G. W. Elliott and E. Richardson, Sheffield.
5900. Chimney Pots, J. Hargreaves, Manchester.
5901. Printed Designs upon Fabrics, A. A. Kuenemann and F. D. Haddon, Manchester.
5902. Advertising Lamp, B. McDermott, London.
5903. Furnace Firebars, E. Edwards.—(*B. Fröhlich and Co., Germany.*)
5904. Adjustable Sash Balance, R. K. Brown, London.
5905. Gas Generator, G. Webb and J. W. Kelly, London.
5906. Cricket Gloves, T. H. and G. W. L. Short, London.
5907. Crushing Mill, F. A. Huntington, London.
5908. Pencil Sharpening Machines, B. J. B. Mills.—(*The A. B. Dick Company, United States.*)
5909. Golf Cleeks, A. Taylor, London.
5910. Naval Chess, H. W. H. Helby, Chatham.
5911. Typewriting Machines, J. D. Daugherty, London.
5912. Plough Tackling, R. A. Kellaway, London.
5913. Garment Holders, W. Nolan, Birmingham.
5914. Letter-boxes, H. Searle, London.
5915. Cleaning Tramway and like Rails, H. Searle, London.
5916. Treating Coke for Transport, F. A. MacKinnon, London.
5917. Couplings for Shafting, G. A. Bateman, London.
5918. Toilet Preparation, H. Priester, London.
5919. Machines for Cleaning, &c., Grain, G. Twinn, London.
5920. Hooks and Eyes, C. Standish, London.
5921. Delivery of Checks or Tickets at Exhibitions, T. Shepherd and The Simplex Cash Register Syndicate, London.
5922. Lock, C. F. Westoby, London.
5923. Lacing Hooks, E. Kempshall, London.
5924. Plastic Materials, E. Kempshall, London.
5925. Covering Lacing Hooks, E. Kempshall, London.
5926. Apparatus for Covering Eyelets, E. Kempshall, London.
5927. Eyelets, E. Kempshall, London.
5928. Photographic Cameras, H. H. Lake.—(*Automatic Camera Company, United States.*)
5929. Interchangeable Gear for Cycles, J. Tixhon-Laguesse, London.
5930. Mudguards for Cycles, H. Coyle and M. Coyle, London.
5931. Cycle Gearing, O. Badge, London.
5932. Stopping Tramcars, A. J. Higgins and A. J. Barnes, London.
5933. Pistons, J. Pollit and E. Wigzell, London.
5934. Toy, F. C. Haste, London.
5935. Valves or Cocks, W. Davey, London.
5936. Cycle Gear Cases, R. Chaplin, London.
5937. Finger Protector or Cap, J. Dreyer, London.
5938. Regulating Device for Incubators, J. Wright, London.
5939. Steering Mechanism for Cycles, H. Burstow, London.
5940. Labels, G. H. Hallam, London.
5941. Cotton Reels, W. Smith, London.
5942. Chains for Cycles, J. Boes, London.
5943. Engines with Slide Valve Gear, W. Schmidt, London.
5944. Tobacco Pipe Cleaner, A. A. Ashby, London.
5945. Apparatus for Cleaning Gulleys, F. L. Decairie, London.
5946. Devices for Drawing Spikes, H. N. Lewis, London.
5947. Scale Measures for Cloth, &c., J. I. Wagner, London.
5948 Joints, G. J. Carson, London.
5949. Machine for Abrading Covers, W. H. Staynes, London.
5950. Boxes and Canisters, W. R. Comings, London.
5951. Suspension of Motors, J. Devonshire.—(*N. C. Bassett, United States.*)
5952. Furnace Fronts and Doors, A. C. Whittome, London.
5953. Purifying Molasses, &c., C. F. Kastengren, London.
5954. Cycles, L. C. Papenfus and L. Loewenthal, London.
5955. Utilisation of Waste Products from Iron and Steel Industries, W. E. Adeney and W. K. Parry, London.
5956. Washboards, J. T. Sargent, London.
5957. Washboards, J. T. Sargent, London.
5958. Machine for Sharpening Razors, D. Thomson, London.
5959. Vehicle Wheel Bearing, J. Pettinger, London.
5960. Appliance for Saving Beer Workings, A. B. White, London.
5961. Combined Milk Jug and Sugar Basin, C. S. Pearson, London.
5962. Tea-pots, &c., E. C. Stimson, London.
5963. Lowering, &c., Ships' Boats, J. Lee, London.
5964. Flower-pots, H. Iken, London.
5965. Steam Generators, J. A. I. Claudon, London.
5966. Horseshoes, G. H. Jantzen, London.
5967. Bicycles, W. A. Osborn, London.
5968. Bottles, M. A. F. Young, London.
5969. Embroidery, M. H. Le François, London.
5970. Self-acting Steering Apparatus for Boats, J. Macé, London.
5971. Bicycles, &c., W. P. Thompson.—(*C. S. Travis, United States.*)
5972. Steam Valves, W. P. Thompsom.—(*J. L. Judge, United States.*)
5973. Compressing Wood, &c., A. and S. de Pont, Manchester.
5974. Air Ventilating Apparatus, J. Backhouse, jun., Liverpool.
5975. Mincing Machines, F. W. Follows, Manchester.
5976. Storing Acetylene, E. Appleby and H. F. Harris, London.
5977. Clocks, L. J. Smith, London.
5978. Washing Boards, G. C. Marks and F. W. Thomas, London.
5979. Axle Arms, F. R. R. Day, London.
5980. Switches, A. J. Bonnella, London.
5981. Combination Gardening Tools, E. A. S. MacMunn, London.
5982. Preservation of Food, &c., H. Higgins, London.
5983. Locking Devices for Boxes, A. J. Boult.—(*L. G. Bierling, Germany.*)
5984. Manufacture of Artificial Fuel, W. W. Holmes, London.
5985. Water-tube Marine Boilers, H. Göhrig, London.
5986. Glove, J. H. Loewenstine, London.
5987. Treatment of Cellulose Compounds, S. W. Wilkinson and The Grove Company, London.
5988. Grain-cleaning Machines, F. Seereiner and A. Misky, London.
5989. Mantles for Incandescent Gas Lighting, T. M. Ash and H. N. Weldon, London.
5990. Bird-houses, &c., G. Walker.—(*N. L. Chrestensen, Germany.*)
5991. Fencing, &c., C. Horton, Birmingham.
5992. Photographic Emulsions, H. Wandrowsky, Cologne.
5993. Castors, H. Kinsey, Swansea.
5994. Joints of Pipes for Sewers, &c., E. Codling, Manchester.

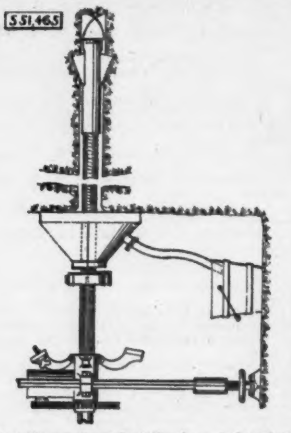
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

551,465. Dust Arrester for Mining Drills and Reamers, *R. H. Elliott, Birmingham, Ala.—Filed July 31st*, 1895.

Claim.—A dust arrester for use in drilling or reaming bore holes, which comprises a hollow truncated cone loosely mounted on the drill spindle, and provided with a fringe on the face of the base thereof, adapted to fit snugly against the face of the mineral about the bore hole, means for holding the said cone in position against the said mineral, and an orifice for the escape of the dust from the lower portion of said cone, substantially as described.

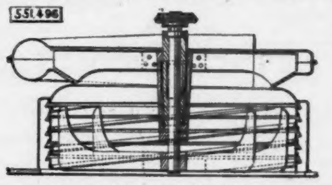
551,465



551,496. Centrifugal Grain Separator, *F. F. Landis, Waynesborough, Pa.—Filed August 19th*, 1895.

Claim.—(1) The combination, with a cylindrical grain separating chamber having an inlet opening for straw at its bottom and formed of a series of superposed rings having passages between them and lips arranged below the said passages, of means for whirling around the straw in the chamber, and guiding devices for causing the straw to pass upwardly through the chamber, substantially as set forth. (2) The combination, with a cylindrical grain separating chamber having an inlet opening for straw at its bottom and formed of a series of superposed rings having passages between them and lips arranged below the said passages, of a discharger arranged on top of the said chamber and operating to draw a current of air through it and through its passages, and means for whirling around the straw in the chamber, substantially as set forth.

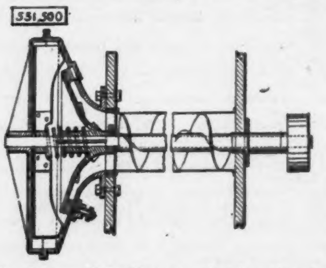
551,496



551,500. Rethrasher and Elevator for Tailings, *F. F. Landis, Waynesborough, Pa.—Filed August 28th*, 1895.

Claim.—(1) The combination, with a conveyor spout, and a casing secured over one end thereof, and provided with a conical portion and a delivery passage at its periphery; of a shaft passing through the said spout and casing and provided with means for revolving it, a spiral conveyor secured on the shaft inside the spout, a pneumatic discharger secured on the shaft inside the said casing, and a spring-pressed rethrashing disc splined on the shaft between the said conveyor and discharger, substantially as set forth. (2) In a rethrasher for tailings, the combination, with a chamber provided with an annular channel, a ring provided with teeth and let into the said channel, adjusting plugs screwed through the side of the chamber behind the ring, and studs provided with nuts and operatively connecting the said ring with the plugs; of a revoluble rethrashing disc having teeth at its periphery opposite the aforesaid teeth on the ring, substantially as set forth. (3) The combination, with a discharger casing having a rethrashing chamber at one side, of a shaft provided with a stop, a discharger secured on the said shaft, a rethrashing disc splined on the said shaft, and a spring interposed between the said discharger and disc and operating to press the disc against the said stop, substantially as set forth.

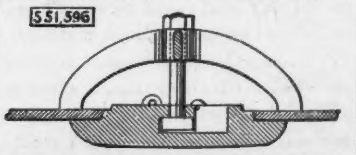
551,500



551,596. Hand Hole Plate for Steam Boilers, *E. C. Myrick and G. C. Doeg, Providence, R.I.—Filed June 26th*, 1895.

Claim.—(1) A hand hole plate provided with a mortise *a*, overhanging flanges a^1, and perforated ears *f*, substantially as described. (2) A hand hole plate provided with a mortise *a*, overhanging flange a^1, perforated ears *f*, and lug *h*, substantially as described. (3) The combination with a hand hole plate provided with a mortise having overhanging flanges of perforated lugs adjacent to the ends of said flanges, a bolt having a head engaging said flanges, and a pin passing through said lugs, substantially as described.

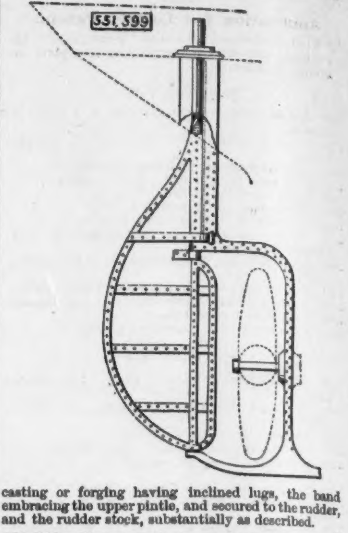
551,596



551,599. Stern Frame and Rudder for Vessels, *J. R. Oldham, Cleveland, Ohio.—Filed March 23rd*, 1895.

Claim.—The combination with a vessel, of the stern frame comprising the lower forward portion and the upper rear portion, the horizontal connection formed with a gudgeon, of the rudder having a forward extension, the pintles, the rudder stock, the stop casting or forging having inclined lugs, the band embracing the upper pintle, and secured to the rudder, and the rudder stock, substantially as described.

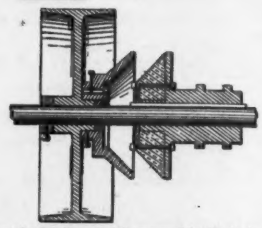
551,599



551,760. Clutch, *G. H. Gere, Grand Rapids, Mich.—Filed December 12th*, 1894.

Claim.—(1) A clutch comprising frictionally operated clutch members and centrifugally operated positive clutch members, substantially as described. (2) In a clutch, in combination with the driving and driven members of a friction clutch, a centrifugally operated pawl pivoted to one member of said friction clutch, and projections on the opposite member of said friction clutch to engage said pawl, substantially as described. (3) In combination, a shaft, a pulley loosely mounted upon said shaft, collars secured to said shaft at opposite sides of said pulley, the driven member of a friction clutch secured to the hub of said pulley, a centrifugal pawl pivoted to said friction member, a spring engaging said pawl, an adjusting screw engaging said spring, a longitudinally movable sleeve splined upon said shaft, the driving member of said friction clutch mounted upon said sleeve, and bolts securing said driving member to said sleeve, said bolt heads being adapted to be engaged by said pawl, substantially as described.

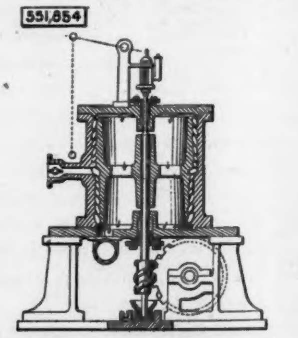
551,760



551,854. Engine, *A. Desgoffe, Odessa, Russia.—Filed November 10th*, 1891.

Claim.—(1) In an engine, the combination of a plurality of bodies provided with opposing surfaces, each provided with continuous threads, the threads on the opposing surfaces being inclined to cross each other, and increasing in capacity from the inlet to the outlet. (2) In an engine, the combination of a plurality of bodies provided with opposing surfaces, each provided with continuous threads, the threads on the opposing surfaces being inclined so as to cross each other, and increasing in inclination from the inlet toward the outlet passage, the average or medium inclination of said threads forming, preferably, an angle of seventeen degrees forty minutes.

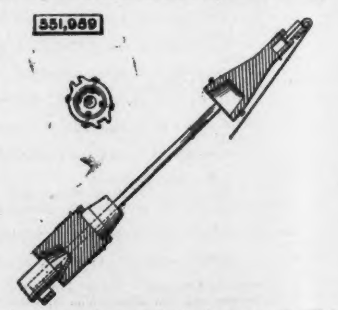
551,854



551,989. Pile Driver Hammer, *J. Munro, Astoria, Oreg.—Filed August 3rd*, 1895.

Claim.—In a pile driver, the combination of a hammer having in its lower portion a vertical frusto-conical socket, of a follower having seated in its upper end a removable non-metallic block formed with a frusto-conical portion adapted to enter the said socket, and with a lower cylindrical portion of too great a diameter to enter said socket, said follower having also apertures through which a suitable implement may be introduced to remove the said block, substantially as specified.

551,989



WAGES IN THE ENGINEERING TRADE.

By J. STAFFORD RANSOME.

I.—THE GREAT INEQUALITY IN RATES.

CERTAIN recent events, notably the strikes on the Clyde and at Belfast, the Report of the Committee of the British Iron Trades Association on Foreign Competition, various questions raised on Government contracts in the Houses of Parliament, and the correspondence in the *Times* about shipbuilding contracts, have brought into prominence the question of the wages paid in this country to the operatives employed in engineering works.

The interesting feature in this question does not lie so much in the comparison between British and foreign wages, as between the different rates paid in different parts of Great Britain for more or less similar work to a more or less similar class of men. This variation is very great, and there is no sign of any alteration in prospect. The so-called "levelling-up" tendency of Trades Unionism, of which one hears so much, on the one hand, and the levelling-down policy with which the masters are credited, on the other, appear to be equally powerless to bring about an equalisation of rates in engineers' shops in anything like the degree which is noticeable in all other countries.

It is generally assumed that this state of things is to be deplored on account of masters where wages are high being handicapped by it. But I do not think that this necessarily follows, for although individual masters may be hit hard in endeavouring to compete with firms better situated than themselves, the theoretical remedy is that such masters should put up their factories in localities where labour is cheaper. No doubt it is often extremely difficult for firms who are already established in one locality to remove their works to another; but the economist's obvious reply to this will be, that if they cannot maintain a demand for their products at profitable prices, they must finish by going to the wall, and so they undoubtedly do. It does not, however, follow from this that firms situated where labour is high cannot make their manufacturing pay, as many of the best known firms in the country are successfully working under such conditions.

In endeavouring to get at the real reasons for the absence of equalisation of wages, the questioning of men who ought to know something of the matter is usually attended by no results beyond the widest of generalities. The favourite stock methods of accounting for the present state of things are:—First, that the trades unions have forced up the wages in localities where they are strong; and secondly, that living in the big towns is much more expensive than in the small ones, and so wages are proportionately higher in the former. Unfortunately, however, neither of the above apparently plausible theories will account for the actual state of things. The first is negatived by the fact that in many of the localities where the trades unions are strong, wages are much lower than in others where their influence is weak. The second suggestion, while true enough in a general sense, is not sufficient in itself to account for anything like the difference which exists, and often it is found that the rates of wages are not at all proportionate to the size of the town.

Before going into any comparison of wages, however, it is well to run through the various trades which are followed by the hands employed by manufacturing engineers and iron shipbuilders. In all, these two industries, which are so mixed up as to be almost considered as one, comprise some fifty trades and sections of trades, and among them may be noted: angle iron smiths, angle iron strikers, boat builders, boiler men, brass finishers, brass moulders, cabinet makers, caulkers, chippers, coppersmiths, cranemen, enginemen, dressers, erectors, felters, fettlers, firemen, fitters, flangers, grinders, hammermen, hand drillers, holders-up, iron loam moulders, iron sand moulders, joiners, light and heavy platers, machine borers, machine drillers, machine screwers, millwrights, outworks men, packers, painters, pattern-makers, planers, plumbers, polishers, punchers, red leaders, riggers, riveters, sail makers, saw mill men, spar makers, smiths, strappers, strikers, tool fettlers, turners, and a host of labourers, helpers, boys, and apprentices attached to the various sections.

Among the trades enumerated above there are, no doubt, several which, dealt with in the abstract, might be said to have nothing whatever to do with engineering work, but large numbers of such men are employed by engineering and shipbuilding firms, and their work being so interwoven with that of the mechanic proper, it is difficult to ignore them when treating the subject. To schedule their various rates of wages on anything like a comprehensive scale, however, would merely be complicating the general question, and the mass of figures entailed thereby would only serve to confuse those who do not intend to study the question in an exhaustive manner. For this reason, although I have the figures before me, I do not propose to attempt it.

Another complication of the question lies in the fact that the line between skilled and unskilled labour is so incoherently and unfairly drawn at the present day, that classification is difficult; for, on the one hand, while many of the so-called labourers who work in conjunction with fitters and boiler-makers, attain to a certain special skill which fits them for their own class of work, so, on the other, many of the machine hands who are habitually classed as skilled are really nothing more than glorified labourers. Then some of the skilled unions in the trade do not, at the present day, hesitate to enrol unskilled hands and even apprentices among their members, as long as they can get subscriptions from them, and such men, by the mere fact of joining, become skilled to all intents and purposes, as far as statistics are concerned. Again, with regard to some of the trades, the men employed in them work under such widely different conditions, and with so great a disparity in the way of skill, that their wages, if given, would be more misleading than otherwise. For instance, smiths doing a certain very high class of work obtain wages amounting to three or four times as much as that paid to other men described under the same heading, while turners on special and complicated work are often paid wages which would in a schedule appear entirely out of proportion to that of others in the same line.

For the purpose of explaining in a simple manner how slightly the size of a town or trade union influence really affect the wages question, I give two schedules below. Both these schedules deal with thirteen localities, all of which may be said to be important engineering centres, with the exception perhaps of Dundee, which is merely put in for the purpose of showing the minimum of wages. That town claims the distinction of paying its men at the lowest rate in the kingdom, some of the fitters in that district receiving about the same wages as first-class fitters' labourers in London.

The first schedule is drawn up in a form which shows at a glance the relative positions of the various districts with regard (1) to their size—from the point of view of population; (2) their rates of wages; and (3) the trade union influence to which they are subjected.

The population column requires no explanation, being merely taken from the ordinary statistics. The rates of wages are gathered from various sources, and are based on the averages paid in the various trades of each district. The trade union influence, as referred to in the schedules, is based on membership rolls issued by the unions, as compared with the total number of men in the locality who might be unionists if they wished to be. Unskilled labour is not taken into account.

It is true that trade unionism is in the habit of bringing to bear all its influence on one or a few localities at certain times, and that its indirect influence on a given locality is not always in direct proportion to its membership, but this I propose to deal with in a forthcoming article.

Table showing the Various Towns in their Order of Size, Wages, and Trade Union Influence.

Population.	Rate of wages.	Trade Union influence.
1 London	London	Belfast
2 Liverpool (with Birkenhead)	Sheffield	Sunderland
3 Glasgow	Manchester	Bolton
4 Manchester	Birmingham	Newcastle-on-Tyne
5 Birmingham	Liverpool (with Birkenhead)	Leeds
6 Leeds	Bolton	Glasgow
7 Sheffield	Belfast	Dundee
8 Belfast	Bradford	Bradford
9 Bradford	Newcastle-on-Tyne	Manchester
10 Newcastle-on-Tyne	Sunderland	Liverpool (with Birkenhead)
11 Dundee	Glasgow	Sheffield
12 Bolton	Leeds	Birmingham
13 Sunderland	Dundee	London

The second schedule deals with the same districts, but gives the actual proportion of the population, wages, and trade union influence to which they are subject, and for purposes of comparison the figure 1000 is taken as representing the maximum in each column, all other figures being proportionate:—

Comparative Table with 1000 as Maximum.

	Population.	Rate of wages.	Trade Union influence.
London	1000	1000	120
Liverpool (with Birkenhead)	112	870	220
Glasgow	103	810	330
Manchester	92	890	250
Birmingham	78	890	180
Leeds	67	790	400
Sheffield	52	950	200
Belfast	46	840	1000
Bradford	39	830	300
Newcastle-on-Tyne	31	830	500
Dundee	27	680	310
Bolton	20	840	900
Sunderland	18	830	950

From the above tables it will be seen that London is the only centre where the wages are in proportion to its size. Whereas, as far as trade union influence is concerned, the five districts where the highest wages are paid are the very five where direct trade union influence is at its lowest ebb. The really union-ridden districts, Belfast, Sunderland, Bolton, Newcastle, Leeds, and Glasgow, rank low as far as wages are concerned, and most of them are among the lowest, viz., 7th, 10th, 6th, 9th, 12th, and 11th respectively.

I rank Belfast as the most union-ridden town of all, because, while during the recent strike there, when the trade societies were boasting that every man in the place belonged to the union, and that every unionist was out on strike, and the total number actually on strike hardly reached 1000, the Amalgamated Society of Engineers alone claim to have over 1800 members on its books in that locality. Again, the general secretary of that union recently stated that Belfast was the strongest union district they possessed. I put London at the bottom of the list in the trade unionist influence column, because out of about 64,000 men in the trade—Booth's "Life and Labour of the People of London," vol. v., is my authority—some 8000 only belong to the Amalgamated Society of Engineers—*vide* their report. Out of these, about one-fifth are compulsory members in Government workshops, and many of the other branches in the metropolis are kept going by large sums sent to them from country branches and from Woolwich, which means that the union very often cannot get its money from the London men.

Of all provincial centres, Sheffield, while being only the seventh town in the schedule as regards population, pays the highest wages. The trade union quoted above has but three branches in this district, and two out of the three are so unsound financially, according to the union's last report, that in order to keep their heads above water they had to receive grants from other localities amounting to over £3 per member for the one year alone. However, there are two other unions in the town, the members of which have to be taken into consideration, otherwise Sheffield would be at the bottom of the list with regard to trade union influence. It is true that the details of the third column of the second schedule may be open to criticism, owing to the untrustworthiness of trade union statistics, and the absence of authorised statistics with regard to the total number of men in the trade in certain of the towns, but no pains have been spared to get at the correct figures, and in a general way they may be looked on as approximately accurate.

Enough, however, has been said to show that in localities where the trade unions are strong it does not follow that wages are higher or even so high as in other localities; and that the size of the town, with the exception of London, is no criterion to the scale of pay. In future articles I shall deal with the various influences which go to produce the great inequality in the rates which at present exists.

THE INSTITUTION OF NAVAL ARCHITECTS.

OUR report last week gave the proceedings for Wednesday; we have only to add that a paper was read in abstract, on "Some Geometry in connection with the Stability of Ships," by Mr. J. Brahn. This was an extremely mathematical paper, and we do not believe that its reproduction in our columns would serve any useful purpose, seeing that our own series of articles are intended to supply all the information our readers are likely to desire on the subject in a very much more simple form. There was no discussion. On Thursday morning papers were read on "Salvage Appliances," by Mr. J. G. Kinghorn, published in our last impression, and on "A Method of Estimating Feed-Water," by Mr. Stromeyer. There was no discussion on either of the papers worth reprinting. A paper by Mr. Seaton on "Microscopical Investigations into Steel," received a good deal of notice. It would be of little service to publish the discussion until we give the paper, and we pass on therefore to the proceedings on Thursday night, when three papers on water-tube boilers were down for reading. The first of these was by Colonel Soliani, on a compound boiler. It is not necessary to give this paper. It will suffice to say that Colonel Soliani proposes to place a number of water tubes in the combustion chamber of a marine boiler. The idea is not new. The Kingstown and Holyhead mail boats had at one time double-ended boilers, and the combustion chambers which were common to both sets of furnaces, and without a dividing wall of fire-brick, were fitted with a couple of vertical tubes of considerable diameter to promote circulation and add to heating surface. Colonel Soliani would, however, use a number of small tubes, with the object of protecting the tube plate. It was pointed out in the discussion, however, that there were considerable difficulties in the way of adopting the plan, one being the interference with the ends of the ordinary fire tubes. It was held generally by those who took part in the discussion that the proposed boiler would have all the faults of both the Scotch and the water-tube boiler, and few of the advantages of either. Colonel Soliani was followed by Mr. Watt, whose paper appeared in our last impression, and he was followed by Professor W. H. Watkinson, of Glasgow University, whose paper we give in full elsewhere.

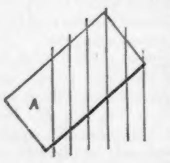
The interest of the meeting centred on this paper, and the hall was crowded to overflowing. Professor Watkinson, however, commenced by saying that instead of reading his paper through seriatim, he would use it as the foundation for a kind of lecture, explanatory of a number of models which he showed in action. These models were all of considerable size. Unfortunately the draughts set up in the hall disturbed the gas flames, and several glass tubes were burst. It was noted, however, that no tubes burst in the model of a Yarrow boiler. On the whole, however, the lecturer's demonstrations were quite successful. It may be said here with advantage that Professor Watkinson has made the action in water-tube boilers a special subject of study, observation, and investigation for the last two years or so, and he has no doubt acquired a great deal of information, much of it very interesting, and we call attention to the fact that his explanation of the cause of circulation in water-tube boilers is identical in every respect with that which we have always and consistently put forward. As we have dealt with the question on another page, however, we shall say nothing further about it here. Two or three facts of considerable interest and novelty were stated by Professor Watkinson. For example, he finds that the size of steam bubbles is almost independent of the pressure, that is to say, they are about as big when the pressure is 100 lb. as at atmospheric pressure. This is contrary to received opinions, but seeing that next to nothing is known as to how a bubble is formed, what determines its size, the surface tension of the fluid surrounding it, and so on, we see no theoretical grounds for thinking that Professor Watkinson's observations in practice are erroneous. The statement, again, that in the Belleville boiler there is no circulation whatever in the commonly accepted sense of the word, evoked no contradiction from anyone present, and appears to be borne out by the behaviour of the large model shown at work, in which the bubbles of steam coursed regularly through the tubes, albeit no circulation of water took place.

The discussions were taken on all three papers together, and, as is usual, was not in any sense adequate. The time at the disposal of the meeting was quite too short, and the speakers hurried over what they had to say, and left the greater part of their notes untouched. Mr. Alfred Durston, Chief Engineer of the Navy, began. He held that Mr. Watt's experiments were not generally applicable, and that the results he obtained only applied to the model boiler he used. After a few remarks on Colonel Soliani's paper, he proceeded to deal with Professor Watkinson's statements. It had been argued that the tubes in the Belleville boiler ought to be arranged athwartships, because rolling would interfere with the circulation. In the French steamers of the Messageries Company, however, no trouble had been experienced, and the boilers were all fired athwartships. In one case a vessel had steamed 300,000 miles without any injury to the boilers, and the engineer reported that they were still in good condition. However, as a matter of fact, in the Powerful and Terrible all the boilers except about one-third in the forward boiler-room were fired fore and aft. The water-hammer action which took place when steam was being got up was of very small importance. As regards the temperature of the tubes, he had had experiments carried out to test the expansion, and thence deduce the temperature of a tube in the middle of a nest in an ordinary marine boiler and of a stay rod beside it in the water, and the experiment was tried in H.M.S. Vulcan. They were ·7in. apart. The tube was found to be 180 deg. Fah. hotter than the water. Similar experiments made with a Belleville boiler showed that the tubes were from 60 deg. to 210 deg. hotter than the water; as to straight and bent tubes, he found that in use all tubes if straight at first bent and became distorted. He preferred the bent tube, as it was less likely to come to grief if the boiler got a little short of water. In certain small Government craft, which he might almost call river police boats for foreign service, he used water-tube boilers with large tubes, because they ought to last about nine years, whereas boilers with tubes of small diameter only lasted three to five years.

Mr. Yarrow stated that he had proposed to give some information as to the methods of making his boiler, but he found that he would be out of order, and so would content himself with saying that his experience with the straight tube had been most satisfactory, and he had had ample experience, inasmuch as about 200,000 tubes are now at work in his boilers. He had recently invented a method of expanding tubes by steam, and he concluded with a graceful invitation to the members of the Institution, particularly the foreign members, to go to the Isle of Dogs to his works, where they should be shown everything.

M. Normand said that in dealing with experiments it was most important to consider their scale. In small model boilers the "steam loop" might exist. There was no doubt a very great difference between the temperature of the tubes and the water, and copper was not a suitable material. The only trustworthy material was steel or the best soft ingot iron. He found by experiment that submerging the upper end of the tubes did not reduce the circulation. Mr. Thornycroft criticised Colonel Soliani's boiler very briefly, and said that Mr. Watt's model proved too much. He then spoke at some length concerning the action of downcomers, but he added very little, if anything, to what is already well known on the subject. Mr. Durston's remarks about tubes were very interesting. He might be pardoned if he said that he preferred the bent to the straight tube. It was most important that the water in a boiler should move in an orderly manner down one set of tubes and up another set. It was most objectionable to have the water unable to make up its mind which tube it would ascend and which tube descend.

After a few words from Captain Sankey and a caution from Mr. Leslie Robinson as to the difference in the value of heating surfaces in different places in a boiler, Mr. Thom went on to describe some experiments he had carried out with a Niclausse boiler in a 47ft. steam launch. The boiler worked very well, and gave no trouble. He thought he would try what effect the internal circulating tubes had, and to this end he ran the boat on a measured course first with the internal tubes, then these were removed, and he ran again, and found to his surprise that the boiler worked just as well without them as with them. As to the use or non-use of downcomers, he pointed out that if we have a U tube heated highly and use one leg of it as a hot downcomer, we may get the other leg crowded with steam; but that if we couple a cool downcomer on at the bottom of the U tube, that we can have two delivering mouths instead of one, and much greater efficiency and less chance of priming.



Mr. Blechynden said that Mr. Watts' results were quite fallacious, because when the tubes in his model were inclined, as the heat of the lamp went straight up the length of tube to be heated was reduced. Thus A is the boiler, and the vertical lines show the hot products of combustion rising. As to metals, copper is a worse conductor than iron while clean; and when dirty, copper and iron give precisely the same result, as will be found by trying the experiment with two ordinary domestic kettles, one of copper the other of iron.

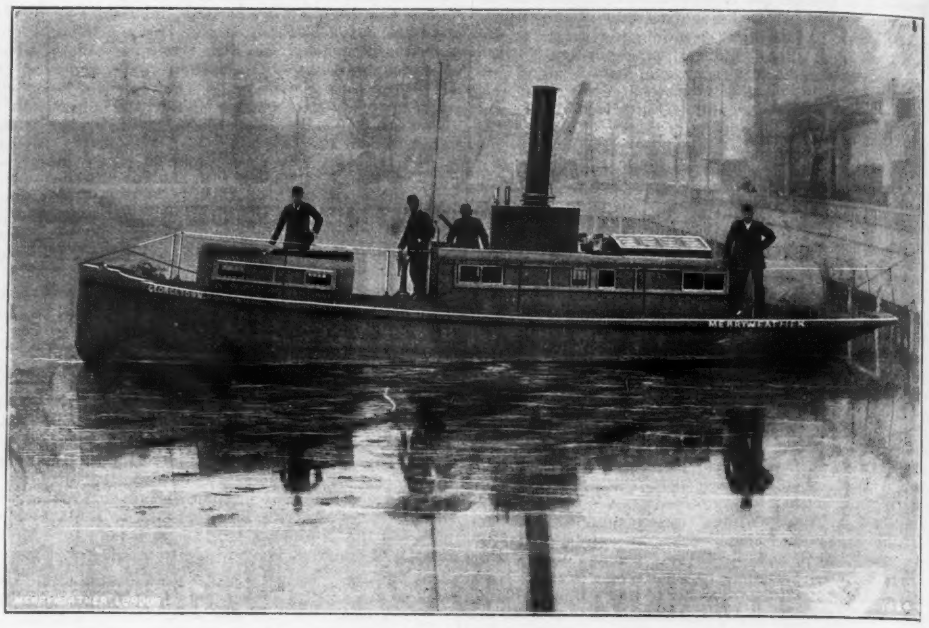
Professor Lambert criticised Professor Watkinson's theory of circulation, and maintained that circulation was caused by difference of density in the water in the two legs of a U tube. If a hot downcomer were used, he thought there was danger that the rising tube would make steam so fast that not enough water would remain in it to prevent overheating. Mr. Wingfield, of Messrs. Thornycroft, held with Professor Lambert that circulation was due to difference of weight in the two legs of the tubes. Copper, according to a somewhat new theory, was spoilt in the brazing, not because it was "burned" or got too much oxygen, but because it was deoxidised.

As the hour was late, Lord Hopetoun closed the discussion, brief replies by Col. Soliani, Mr. Watts, and Professor Watkinson bringing the proceedings to an end. As most of the members rose to go as soon as Mr. Wingfield sat down, it was not easy to catch the somewhat hurried remarks of the last speakers.

On Friday morning the papers read were of extremely small general interest. The first was "The Non-uniform Rolling of Ships," by Mr. R. E. Froude, F.R.S., Associate Member of the Council. The second was on "A New Theory of the Pitching Motion of Ships on Waves, and of the Stresses produced by this Motion," by Captain A. Kriloff, Professor at the Naval Academy of St. Petersburg. A third paper of more general application was "Notes on the Carriage of Grain Cargoes," by Mr. George Herbert Little, which concluded the meeting.

A NEW FLOATING STEAM FIRE-ENGINE

MESSRS. MERRYWEATHER AND SONS, GREENWICH, ENGINEERS



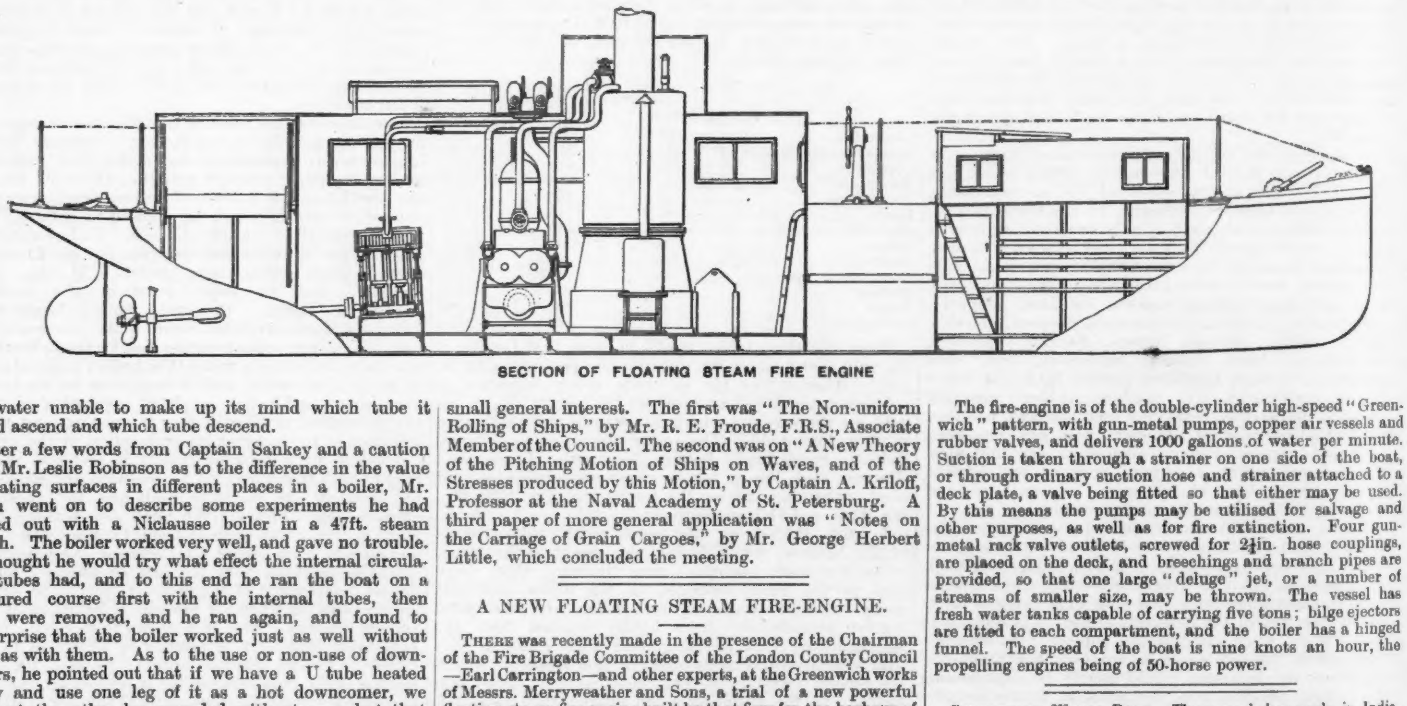
A NEW FLOATING STEAM FIRE-ENGINE.

There was recently made in the presence of the Chairman of the Fire Brigade Committee of the London County Council—Earl Carrington—and other experts, at the Greenwich works of Messrs. Merryweather and Sons, a trial of a new powerful floating steam fire-engine built by that firm for the harbour of Georgetown, Demerara. Supt. E. F. Wright, of the Georgetown Fire Brigade, directed the testing of the apparatus, and the results were very successful. Steam was raised in ten minutes from the time of lighting the fire. A 1¾in. jet of water was thrown with ease 200ft. high, while good results were attained with two 1¼in. jets, three 1in. jets, and as many as eight smaller jets, thrown simultaneously. Having when afloat an unlimited supply of water, the boat can thus attack a fire on shore or amongst shipping from all sides at once. For raising sunken vessels by pumping them out, or for rapidly filling ships' water tanks, this fire float will also form a useful acquisition to the harbour of Georgetown.

The boat, of which we give a sectional elevation in Fig. 2, and an outside view in Fig. 1, is 40ft. long, 10ft. beam, and draws 2ft. 6in. of water aft. It is built of Siemens-Martin steel, and has water-tight compartments fore and aft. There is a cabin forward, with sleeping berths for the crew, a large engine and boiler-room amidships, and a well aft with water-tight doors, containing an iron hose-reel capable of carrying 3000ft. of 3½in. canvas hose. The machinery space is covered with an iron housing, and is fitted with sky and side lights, a hatchway, and ladder. The steering wheel is placed forward of the engine-room, as will be seen on inspection of the engraving below, and a windlass, mooring bitts, anchor, &c., are provided.

The boat-propelling machinery consists of a pair of double-cylinder engines of the inverted vertical type, driving twin screws. The engines have double link motion reversing gear, and enable the vessel to be easily turned, the swift current of the Demerara River rendering this arrangement necessary.

The boiler is of Merryweather's patent vertical water-tube type, capable of raising steam from cold water to 120 lb. pressure per square inch in about ten minutes from the time of lighting the fire. In actual working this time will be considerably reduced, as a novel petroleum-fired feed-heater is carried, which will enable the water in the boiler to be kept constantly above boiling point. The boiler tubes are of copper, and the shell of steel. The boiler feeding arrangements are very complete, including two feed pumps on the fire-engine, a self-starting injector, and a separate donkey pump.



SECTION OF FLOATING STEAM FIRE ENGINE

The fire-engine is of the double-cylinder high-speed "Greenwich" pattern, with gun-metal pumps, copper air vessels and rubber valves, and delivers 1000 gallons of water per minute. Suction is taken through a strainer on one side of the boat, or through ordinary suction hose and strainer attached to a deck plate, a valve being fitted so that either may be used. By this means the pumps may be utilised for salvage and other purposes, as well as for fire extinction. Four gun-metal rack valve outlets, screwed for 2½in. hose couplings, are placed on the deck, and breechings and branch pipes are provided, so that one large "deluge" jet, or a number of streams of smaller size, may be thrown. The vessel has fresh water tanks capable of carrying five tons; bilge ejectors are fitted to each compartment, and the boiler has a hinged funnel. The speed of the boat is nine knots an hour, the propelling engines being of 50-horse power.

Corrugated Water Pipes.—These are being made in India. Corrugated iron culverts from 12in. diameter to over 24in. in diameter have been largely used there for some time, and an Indian paper says there is a great demand for corrugated iron culverts of a smaller diameter, but it has been hitherto almost impossible to make them so small as 18in. diameter, owing to the great difficulty in bending the sheets without injuring the material. Spirally corrugated culverts can, it is said, be made any diameter without cracking or damaging the material. Considering the small delivery through frictional and eddy losses which such pipes would have, it is curious that the form should have acquired any favour.

The Civil and Mechanical Engineers' Society. — At the meeting held on Thursday, March 26th, Mr. A. Myall, A.M.I.C.E. read a paper on "Wire Netting Machinery." The author reviewed the history of his subject, drawing special attention to the patent of 1854 of J. Whitehead, in which was embodied the essential principle upon which the majority of subsequent machines have been constructed for manufacturing wire netting. He entered into the details of many machines, and pointed out their main features and the reasons for their adoption or rejection, and concluded his observations by drawing attention to the various defects of the machines at present in use; and indicated where, notwithstanding all that had been done and the thousands of miles of wire netting that had been made, there was still plenty of room for improvement in the machines now in operation. A discussion ensued, and the following gentlemen took part therein:—C. T. Walrond, Hal Williams, E. H. G. Brewster, J. N. Cooper W. Cooper Penn, and Chester Dawson.

THE SAFETY OF COMPRESSED GAS CYLINDERS.

In May of last year a Committee of Inquiry was appointed to consider the causes of explosion of cylinders containing compressed gases, and the measures which might be taken to increase the safety of such vessels. With Professor Unwin as chairman, and with an adequate array of experts, including a distinguished chemist in the person of Dr. Dupré, as members, the Committee may be considered representative and likely to be efficient. The report of the deliberations of this body, which has lately been issued, bears out this supposition. It is clear, judicial, and tolerably exhaustive. The conclusions are reasonable, if not incontrovertible, and with certain of the recommendations all interested in the subject will agree. A detailed account of the evidence, or even of the report based thereon, would be out of place here. The whole document is procurable for a trifling sum, and will be doubtless in the hands of all technically or commercially concerned in the manufacture and testing of the cylinders and their contents; such will find it excellent reading. A few of the more important matters touched upon may be briefly dealt with.

In a disclaimer as to the jurisdiction of the Committee over cylinders used for military purposes which appears in the preamble, occurs a statement not to be let slip. It is said with truth that compressed gas cylinders used in our own and continental armies are of lighter construction than those employed in ordinary trade. It would be distinctly interesting to know by the use of what material or of what methods of manufacture such cylinders are prepared so as to cause no excessive risk of accident, and yet to fulfil the onerous conditions of weight necessitated by the requirements of military service. It would then be possible to judge whether the use of similar material and methods might be adapted to commercial requirements, or whether there are in military cylinders inherent causes of danger which would make their employment, even in a modified form, wholly inapplicable to civil purposes.

Weighty words, which will be found wholesome if bitter by the scaremongers who clamoured for drastic legislative action on the strength of a few explosions attended by loss of life, are embodied in the section of the report dealing with the advisability of recommending some control of the trade in compressed gas cylinders. It is said with much cogency that "the risk in the generation of steam is probably greater"—than that in the use of cylinders of compressed gases—"and yet, in this country, it has not been found desirable to interfere with the responsibility of steam users by official regulations." The report goes on to point out that accidents to cylinders of compressed gas are more likely to occur in public and crowded places than are those which occasionally determine the existence of boilers, and in succeeding paragraphs leans to the exercise of a certain amount of control. The discussion of this question may be left until the conclusions and recommendations of the Committee are considered in a later part of this article, but the broad fact remains that, having regard to the magnitude of the present trade in compressed gases, the number and gravity of the explosions which have occurred are altogether insignificant.

The possible causes of explosion fall under three heads. The first is the ignition of an explosive mixture in the cylinder. Mixed hydrogen—or coal gas—and oxygen, constitute an explosive of a formidable kind if their proportions fall within well-known limits; no cylinder extant can be expected to withstand the bursting action of such a charge should it by chance be fired. Seeing that cylinders of mixed gases are not an article of commerce, the occurrence of a mixture in a cylinder is generally due to carelessness, and is most readily avoided by the use of fittings with left-hand threads for the less common, *i.e.*, the hydrogen cylinders. The spontaneous ignition of mixed gases in a cylinder is possible, but rare, and its causes have not been satisfactorily elucidated. With the precaution indicated above, viz., the employment of non-interchangeable fittings, this risk of explosion becomes infinitesimal. The second cause of explosion is the mechanical weakness of the cylinder. This weakness may arise from undue thinness—general or local—of the walls of the cylinder, unsuspected flaws—as in a badly closed weld—and from defect in the quality of the metal of which the cylinder is made. With regard to this last, the metal may be softer and of lower yielding point than a material should be to carry the working pressure; cases of failure from this cause are, however, but little likely to happen if the cylinder has been subjected to an hydraulic test considerably above the working pressure. Conversely, the metal may be unduly hard and brittle, either from faulty composition—of which more anon—or from bad annealing after manufacture. The third possible cause of explosion is the exposure of a sound cylinder containing a liquefied gas to excessive pressure generated by accidental heating; adequate spare space in the cylinder ensures that the liquefied gas shall only exert upon the cylinder the pressure of its saturated vapour at the temperature prevailing, but should the cylinder be nearly or quite full of liquefied gas at the temperature of filling, and be afterwards exposed to a higher temperature, the pressure exerted by the expansion of the liquid *qua* liquid may be destructive in its effects. A knowledge of the capacity of the cylinder and of the weight of liquid placed therein evidently suffices to prevent accidents from this source. The chief possible causes of failure of cylinders of compressed gas having thus been sketched, it is clear that, given the most ordinary care and skill in manufacture of the cylinders and of their contents, no serious risk is to be apprehended from any cause other than some defect in the quality of the metal of which the cylinders are constructed. Wrought iron may be dismissed as being used in small and decreasing quantity, and attention may be concentrated on ingot iron—"mild steel"—as the most usual material for making cylinders. The chemical composition of the ingot iron used is of primary importance, and much controversy has arisen concerning what, if any, limits may be fairly laid down. It is generally recognised that the quality of ingot iron is governed by the nature and amount of the impurities which it contains; speaking broadly, of these carbon, and in smaller degree manganese, are legitimate hardening and strengthening constituents, while silicon, sulphur and phosphorus are most esteemed when absent.

It is, therefore, surprising that in the rules for the transport of cylinders which the railway companies endeavour to enforce, the percentage of carbon alone is specified, 0·2 per cent. being adopted as the maximum, while no direct restriction is placed on the proportion of other constituents. Such a regulation is best passed over in charitable silence. Returning to the region of right reason, it may be said that high class ingot iron, containing little but Fe and C, is likely to prove a safer material even when its content of carbon appreciably exceeds the limit suggested above, than a metal containing as much and as many impurities as an indifferent steel maker may venture to leave in, "corrected" by a copious dose of manganese. Should it prove requisite to fix limits of composition, systematic experiments on cylinders of metal, the analysis of which is accurately known, will be requisite. With the data thus collected it may be possible to construct a sliding scale for the permissible percentage of carbon, according to the nature and amount of the other elements present.

One section of the report of the Committee treats of the danger which may arise from the explosion of pressure gauges—which is sometimes traceable to the presence of oil in the Bourdon tube. The whole matter was threshed out some years ago, and as the Committee remarks, such care is now taken by makers that no accidents have lately occurred. A question of greater novelty and interest is the protection of cylinders from corrosion, and consequent weakening. At present it appears that no precautions against internal rusting are in use. Seeing that, owing to the necessity for subjecting the cylinders to an hydraulic test, water is left adhering to the inside of the cylinder, the probability of internal corrosion proceeding unperceived is not trifling. Some limit to this injurious effect is set by the fact that carbon dioxide, which is a potent if not indispensable adjunct to water and oxygen as rusting agents, is usually absent from oxygen made by modern processes, and thus a wet cylinder filled with compressed oxygen would not necessarily suffer severe corrosion. It is not advisable, however, to rely on a fortuitous safeguard which may disappear with an alteration of manufacturing methods, and some protective coating for the interior of cylinders — duly chosen with regard to what they are intended to contain —should be devised and adopted. In the summary of recommendations made by the Committee, appearing at the end of the report, the following points may be touched on. Cylinders made of ingot iron for oxygen, hydrogen and coal gas should consist of metal containing not more than 0·25 per cent. of carbon—0·05 per cent. higher than that desired by the railway companies—and not less than 99 per cent. of pure iron. The greatest working pressure should be 120 atmospheres, and the stress due to working pressure should not exceed 8 tons per square inch for seamless cylinders, and 7½ tons per square inch for lap-welded cylinders. The tensile strength of the metal should be between 26 tons and 33 tons per square inch, and the extension should be not less than 1·2in. in 8in. An hydraulic test of the cylinder of 224 atmospheres should be adopted, and the permanent stretch of the cylinder thus tested should not exceed 10 per cent. of the elastic stretch. It is recommended that cylinders complying with these conditions should be allowed to be sent by road or rail without packing. It is further recommended that "there should be a general inspection of all factories manufacturing compressed or liquefied gases under the direction of the Factory Department of the Home-office, or, possibly, a department of the Board of Trade," and that the inspectors thus brought into official existence should be entrusted with considerable powers.

It will be seen that certain of these recommendations, if ultimately adopted, will have wide-reaching effects. The maker will be tied down to a particular quality of steel—not necessarily the best—and to a particular minimum thickness of the cylinder walls, and will be liable to the supervision of a Government official at all stages of his work. The prospect is scarcely alluring to a manufacturer accustomed to carry out his own processes in his own way; and it will hardly be surprising if opposition be offered to the translation of the recommendations of the Committee into statute form. We are disposed to consider that the Committee has taken too fearful a view of dangers that may never come. That the risk which is sought to be averted is somewhat remote appears from a phrase in the report. After alluding to the few accidents which have hitherto occurred, largely because of manufacturers' voluntary precautions, the Committee goes on to say that there is "a possibility that, in the course of time, with increase of competition in the trade, the care and attention on which safety has depended may be sensibly relaxed." So moderate and sensible a forecast as this scarcely warrants the recommendation of drastic restrictive measures for meeting a doubtful contingency. That the Committee has acted in good faith, and is free from the influence of mere panic, none who study its composition can doubt for a moment. It is, therefore, reasonable to suppose that the recommendations are to be taken as a warning rather than as a draft scheme for legislation. Having regard to the fact that official interference is now tolerated with edifying meekness by all classes and interests, manufacturers cannot usefully attempt to repudiate supervision in any other way than by showing that they already exercise as much care and skill in a somewhat difficult industry as can fairly be demanded of them. Failing this, and given another explosion or two, they will find themselves securely swathed in highly inelastic ligatures, fiery in hue and official in design.

H.M.S. MARS.

From the *Globe* of the 25th April, 1894, we observe that the name was won from the French just one hundred and fifty years ago, in one of the smartest single-ship actions ever fought. The taking of the Mars by the gallant Captain "Phil" Saumarez, of the Nottingham, off Cape Clear, was the talk of the year 1746. Our captured Mars—a sixty-four —did nine years' service under the British flag, and then was wrecked when with the first expedition against Louisburg. The second Mars—a seventy-four—launched within two years of her predecessor's loss, saw service at Quiberon Bay in Hawke's heroic victory on "la journée de Monsieur Conflans" in November of "the wonderful year." After serving on the active list for some thirty years, she eventually became a hospital ship at Portsmouth. Our third Mars—another seventy-four—was launched in 1794. In the first year of her career, the Mars won high distinction for the gallant part she took as rear ship in Cornwallis' brilliant fighting retreat before the French Brest fleet—five British line-of-battle ships and two frigates against twelve French line-of-battle ships and thirteen frigates. Three years later—in 1798—the Mars chased, brought to action, and took single-handed, well within sight of Brest Roads and the French fleet there, the French seventy-four Hercule, after one of the most desperately contested single-ship duels on record. The Mars lost her gallant commander, Captain Alexander Hood, in the battle, as well as sixty men. At Trafalgar the Mars was the third ship of Collingwood's line to get into action, and she acquitted herself with distinguished gallantry throughout the battle. Her commander, Captain George Duff, was killed by a cannon shot on his own quarter-deck. From 1805 to 1813 the Mars was constantly on war service in the Channel, in the Bay of Biscay, and in the Baltic, including the bombardment of Copenhagen in 1807. She was broken up in 1816. The fourth Mars, an eighty-one gun ship—now training ship to a local association at Dundee—was built at Chatham in 1843. The new Mars is the fifth of her line.

The Mars, built by Messrs. Laird Brothers, of Birkenhead, is one of the largest battleships constructed for the British Navy. She is of the Majestic type or class, and was designed by Sir William H. White, K.C.B., Director of Naval Construction. Her dimensions are:—Length, 390ft.; breadth, 75ft.; mean draught, 27ft. 6in.; displacement, 14,900 tons; freeboard, forward, 25ft.; aft, 18ft. 6in.; power of engines, with forced draught, 12,000 indicated horse-power; with natural draught, 10,000; speed, natural draught, 16½ knots; forced draught, 17½ knots; coal, carried at the designed load draught, 900 tons, with a reserve of 500 tons a side, making a total stowage for 1900 tons, with which she will steam at 10 knots for about a month, or 8000 knots. The reserve bunkers form additional protection, with an armoured deck behind side armour. The barbette guns are above the water-line 27ft. The citadel or side armour is 220ft. long, with a vertical height of 15ft. of Harveyed steel, 9in. thick, and barbette's 14in. thick. The protective deck from the lower edge of the armour, covering machinery, magazines, and other vital parts, is 4in. thick on the slopes and 2½in. thick on the flat, and extends to the extreme ends.

The ship is exceptionally strong, and built entirely of mild steel, the stem and stern post, rudder and shaft brackets being formed of steel castings. There is a double bottom, and numerous subdivisions by athwartship and longitudinal bulkheads to minimise to the fullest possible extent the danger arising from damage to the outer plating. These bulkheads are so arranged as to form passages for easy communication below the water-line from end to end. In order to procure a safe passage for the ammunition from the several magazines to the guns of the secondary armament, armoured tubes have been specially fitted. It is also to be noted that, with a view to preventing water from finding its way below the protective deck, means are provided for closing the several openings by water-tight covers, while in the case of those which must necessarily remain open, coffer-dams have been fitted with the same object. She is lighted throughout with an installation of about 900 electric lights, and equipped with six search-lights of 30,000-candle power, each of which is capable of being worked by dynamos under protection. There are two conning towers, the forward tower armoured with 14in. and the after one 3in., and to these towers are led all voice pipes and telegraphs to be used by the officers in charge of navigating the ship when in action. The port and starboard engines and boilers are separated by middle-line longitudinal bulkheads, and, therefore, can be worked independently. There are also longitudinal bulkheads, also water-tight, at the sides, extending throughout the machinery space, forming coal bunkers and wing spaces. On the platform *débris* and lower decks is placed the auxiliary machinery for the working of the ship, including steering engines in duplicate, electric engines—the electric wiring being done by Messrs. Laird—and hydraulic pumping engines, as well as a fully-equipped engineers' workshop, and numerous store-rooms. The officers and crew are accommodated on the main and belt decks. The officers' accommodation consists of very completely fitted cabins situated aft, the superior officers being located on the main deck. The Admiral's suite of rooms, which are especially handsomely fitted, are at the extreme aft end of the main deck, and communicate with a handsome stern walk. The upper deck extends from stem to stern without a break, and above it is a continuous bridge deck, extending the whole length between the barbettes, and on this deck are the conning towers, surmounted by the navigating bridge, which will be about 40ft. above water, and the chart-house.

The boats, of which there are eighteen, including two torpedo boats, are stowed amidships. A strong steel derrick is fitted to the mainmast for lifting them, and wood derricks are also fitted in the side of the casings for working those of a lighter description. The masts, which are built of steel, are fitted with military and signalling tops, and there are two funnels on the same athwartship lines.

The armament of the Mars will comprise four 12in. 46-ton breech-loading, new type, wire-coiled guns, mounted *en barbette* in pairs, and firing a projectile weighing 850 lb., with a powder charge of 148 lb. There are fifty quick-firing guns in all—twelve 6in. on the main and upper decks, mounted in casemates protected by 6in. armour, eighteen 12-pounder, twelve 3-pounder quick-firers, eight small machine guns, and five field guns. The auxiliary armament of the lighter guns is distributed all over the ship, a considerable number disposed upon the bridge and in the mast tops. The main armament is worked by hydraulic machinery, supplied by Sir W. G. Armstrong and Co. The other guns are all worked by hand. There are five torpedo tubes, four submerged, while one discharges above water at the after end.

The main propelling machinery consists of two sets of engines of the triple expansion inverted type of Messrs.

Laird Brothers' most advanced design. Each set is placed in a separate engine-room. The cylinders are—high-pressure 40in., intermediate-pressure 59in., and low-pressure 88in. in diameter respectively, with a stroke of 51in., and are separate castings bolted together by brackets. The slide valves for the high-pressure are of the piston type, for the intermediate and low-pressure cylinders flat double-ported valves. The main condensers, which are of brass, have a collective cooling surface of 13,500 square feet, and there are four centrifugal pumps, each driven by an independent engine. The shafts and all the principal moving parts are of steel, as usual. The screw propellers are four-bladed, the blades and bosses being of manganese bronze. The boilers are eight in number, single-ended, of the cylindrical return tube type. Following out the search for safety on the principle of subdivision, each pair of boilers is in a separate water-tight compartment, with independent coal supply, separate access to and from main deck, &c. The exhaust steam from the whole of the auxiliary machinery in the ship is delivered to an exhaust pipe connecting with the two auxiliary condensers, one in either engine-room, each of these condensers having its own air and circulating pump worked by an independent engine.

Two distillers with circulating and distributing pumps, four Admiralty type main feed and four auxiliary feed pumps, of ample size to supply the whole of the boilers at full power, and four double-cylinder double-acting bilge and fire-pumps, and a pump for pumping out the drain tank, are provided. The several pumps are connected to the large drain pipe and double bottom. General ventilation is secured by two large fans 72in. in diameter; and eight fans 72in. in diameter supply the forced draught for the boilers and engines. The weight of the anchors and chain cables is 112 tons, and if the cables were laid out in a single line they would extend about one mile. The total weight of metal work treated in the construction is upwards of 10,000 tons, and the wages expenditure in Birkenhead alone was upwards of a quarter of a million.

The Mars illustrates the advantage of building these large battleships in dock in preference to building them on a slip and launching them, as she carries with her all her citadel armour and most of the barbette armour and four casemate fronts; indeed, all the armour-plating would have been completed had it not been for the press of work in Sheffield rendering it impossible for the armour-plate manufacturers to make delivery as early as required. The main boilers are on board, with all mountings and connections complete ready for steam save the funnels. The whole of the auxiliary machinery is also in place, and pipes and connections fitted, and the main engines are fully two-thirds erected on board, so that the vessel as floated out from the building dock is in a far more advanced state than would have been the case had she been launched in the ordinary way.

The order for the Mars was given exactly two years ago on the 26th March, and steel and other material got, and her keel was laid on the 2nd June, 1894, practically twenty-two months to date, and when ready for the pennant in six or eight months she will have a complement of 750 men.

The service appointed to be used at the launching of ships of her Majesty's Navy was read by the Rev. Canon Linton, M.A., Vicar of St. Mary's, Birkenhead, and the vessel was named by Mrs. Laird, wife of the senior member of the builders' firm. A large concourse of spectators witnessed the proceedings, and among the guests were many distinguished individuals.

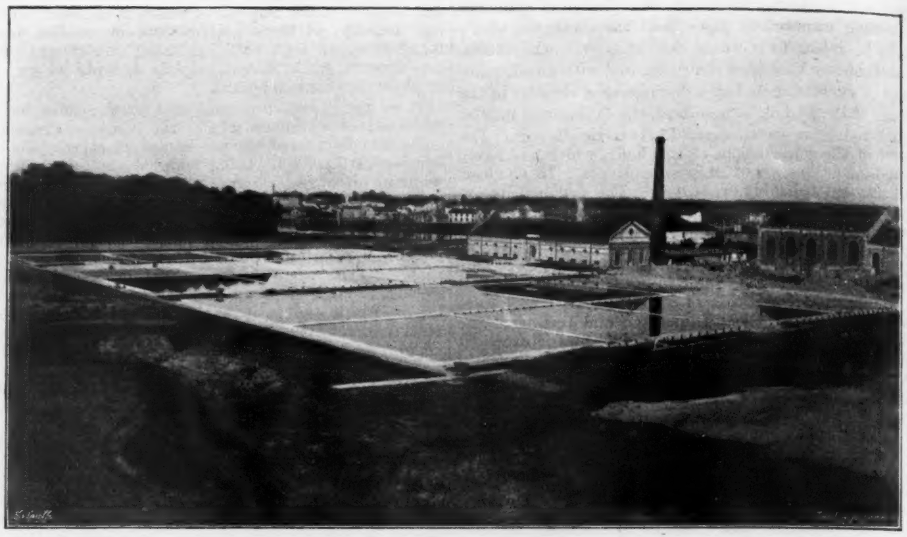
THE PROPOSED CRINAN SHIP CANAL.

As briefly intimated in our issue for the 6th ult., a proposal has been under the consideration of shipping and commercial circles in Glasgow and the West of Scotland for some years past to form a canal extending from Loch Gilp to Loch Crinan. The direct object of this, of course, is to cut off the 85 miles or so of impediment interposed by the long peninsula of Kintyre between the commerce of the Clyde and the West and North Highlands, and the Baltic and North German ports. The proposal is now assuming a more practical shape, and influential shippers and commercial gentlemen in Glasgow and the West Highlands are interesting themselves in promoting a definite scheme. Messrs. Crouch and Hogg, Glasgow, have prepared plans, and opinions have been taken and calculations made which show that the proposal is not only practicable, but that such a canal would prove of immense benefit, and in all likelihood an undertaking which would be immediately successful financially. It is anticipated that in addition to the smaller vessels which use the present Crinan Canal, most of the West Highland steamers yachts of all sizes, and vessels trading between Glasgow and the north-west of Europe would take advantage of the waterway as being the shortest and safest. The present Crinan Canal, constructed about the end of last century, is, of course, inadequate to the requirements of modern shipping, being narrow and shallow, and having a large number of locks throughout its length of nine miles, all of which are of the small size common at the time of construction.

According to the plans which have been prepared the canal will be 20ft. in depth and of 80ft. width on bottom, sufficient to allow vessels of at least 1500 tons to pass through. It will extend from the head of Loch Gilp in as straight a line as possible to Bainakill, from whence it will wind to Old Crinan, its western end, the distance altogether being about six miles. There will only be two locks, one near each end, and the summit level will only be from 6ft. to 8ft. above high-water level. The engineers, in fact, have selected the lowest ground available throughout the entire route, and they believe the work, as a whole, will be very easy of execution. They propose to accomplish the greater part of the work by dredgers cutting their own flotation, and using suction dredgers where the material is suitable. There is only one stiff piece of rock-cutting throughout the whole route, situated between Cairnbrom and Dunardry, the summit of the present canal.

Thence the new ship canal would proceed through Crinan Moss, a tract of waste which Rennie, the engineer, in laying out the present canal, purposely avoided. The engineers of the present scheme boldly propose to carry the ship canal through the moss for a distance of about a mile and a-half. To accomplish this they would form an embankment across the mouth of the river Add, at Crinan, by this means forming a large reservoir on Crinan Moss, the surface level of which would be that of the new canal—6ft. or 8ft. This would obviate the need for any artificial banks at this part of the route, the canal simply being a dredged channel defined by buoys. The estimated cost of the whole scheme, which also includes the reclamation of the extensive ebb at Lochgilphead, is about half a million sterling.

WATERWORKS AT CHOISY-LE-ROI

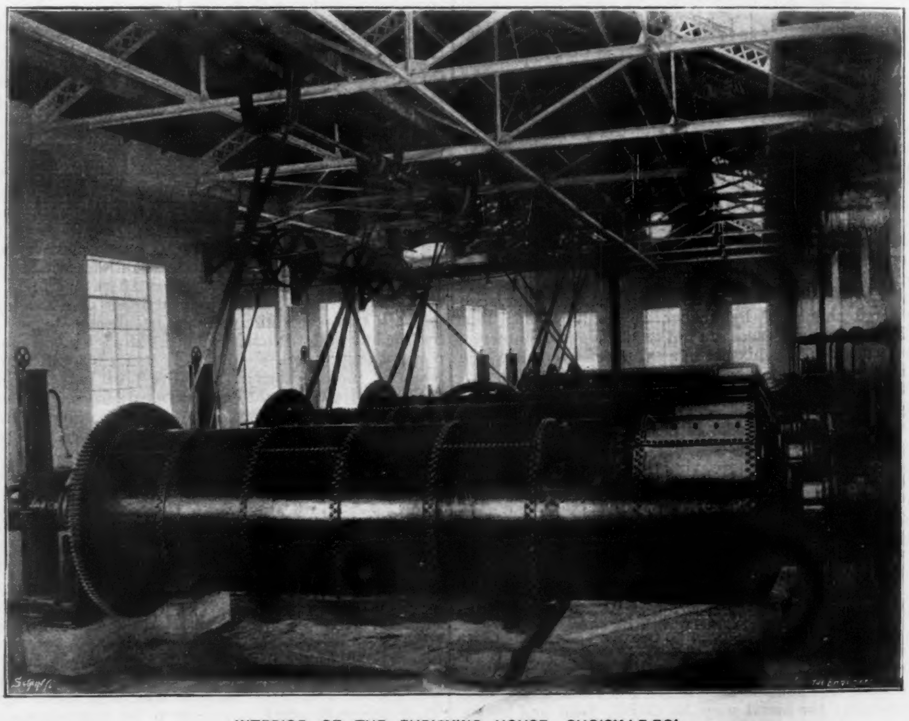


THE WATER SUPPLY OF THE PARIS SUBURBS.

On the 21st of February the Prefect of the Seine, accompanied by a large number of representatives of the various Communes of the Department, visited the waterworks of the Compagnie Générale des Eaux at Choisy-le-Roi, in order to inaugurate the new supply to the suburban Communes of the Department.

By a contract made early in 1894 between the Compagnie Générale des Eaux and the Department of the Seine, the Compagnie des Eaux undertook to erect at various pumping stations complete plants for purifying the waters of the rivers Marne and Seine, capable of dealing with 70,000 cubic metres of water daily, or over 15 million gallons. These plants were to be in complete going order by January 1st, 1896.

The method of purification adopted is the now well-known "Anderson" process, in which the water is agitated with scrap iron, in horizontal revolving cylinders, and afterwards filtered rapidly through sand. This process was employed by the Compagnie des Eaux at their Boulogne-sur-Seine pumping station four years ago, and by its aid the Seine water taken below the city was converted into a supply which rivalled the spring water of the Vanne in purity. The Compagnie des Eaux has guaranteed that by the employment of this process it will remove 99·6 per cent. of the microbes present in the raw river water at the intakes of the new works.



INTERIOR OF THE PURIFYING HOUSE, CHOISY-LE-ROI

These installations, which were all in operation by the appointed day, are situated at three points: at Choisy-le-Roi, on the Seine, and at Nogent-sur-Marne and Neuilly-sur-Marne. From the three pumping stations extends a network of mains which embraces the city, and supplies the whole of the extra-mural Communes of the Department of the Seine, except a few supplied by another company. The population supplied at present is about 600,000.

The purifying plant at Choisy-le-Roi pumping station comprises six revolving purifiers with 14in. inlet pipes, delivering into a settling channel of special design, and fifteen filters each of 625 square metres area, or in the aggregate 100,000 square feet. The daily capacity is 30,000 cubic metres, or nearly 6½ million gallons. The works at Neuilly-sur-Marne are a duplicate of this, dealing with the same quantity, and at Nogent-sur-Marne are three 14in. machines with corresponding filters treating 10,000 cubic metres, or 2¼ million gallons daily.

The results are already excellent, and fulfil the guarantees of the Compagnie des Eaux. In his speech at the inauguration the Prefect of the Seine drew special attention to the clearness and limpidity of the water, being able to read letters on the wall of a house at a distance through a thickness of five metres of the water.

Our illustrations comprise a general view of the works at Choisy-le-Roi, showing engine house, purifier house, settling arrangement and filters, and a view of the interior of the purifier house, showing the six 14in. revolving purifiers with the overhead shafting for driving them.

With regard to the few Communes alluded to above as not being included in the supply from the pumping stations of the Compagnie des Eaux, it may be stated that they are those occupying the loop of the Seine to the north-west of the city. The concession for supplying water to these Communes is in the hands of the Compagnie des Eaux de la Banlieue, which has concluded with the Department of the Seine a contract precisely similar to that under which the plants just inaugurated have been erected. Its supply will be taken below the city at Suresnes, and purified by Dr. Anderson's process, as it has been proved by the four years, working at Boulogne-sur-Seine that the Seine water taken below the city and treated on this system furnishes a perfectly pure and wholesome supply.

The process is also almost certain to be applied to another important river-derived supply in the same locality.

It may be added that the satisfaction given by the new supply is so great that it has already been decided that in the course of the present year the quantity of purified water pumped from the three works of the Compagnie des Eaux shall be increased from 70,000 cubic metres to 110,000 cubic metres daily, or over 24 million gallons daily.

All trade disputes on the Clyde have now been arranged, and vessels aggregating 300,000 tons are in hand. During March the number of vessels launched was double that of January and February combined. Twenty-nine steamers of fully 40,000 tons aggregate were launched, against nineteen of 20,000 tons. Twenty-two steamers were for British and seven for foreign owners.

THE JAPANESE WARSHIP FUJI.

THE Japanese war vessel launched on Tuesday from the Thames Ironworks and Shipbuilding Company is named the Fuji, or "Unequalled," and the following are a few of the principle features of her design:—

	ft.	in.
Length between perpendiculars	374	0
Breadth..	73	0
Draught of water	26	6
Displacement	12,450 tons	
Coals at this draught	700 tons	
Total capacity	1300 tons	

The original inquiry in 1883, through Admiral Ito, was for an improved Collingwood, but the displacement tonnage was to be limited to 8000 or 8500 tons, and seeing it was difficult to improve on a Collingwood with 1500 tons less weight, the necessity of a larger tonnage soon became evident, and a limit was then given of 10,500 tons, or a Centurion type; but as it was required to carry a heavier armament than that vessel, a still larger tonnage became necessary, resulting in a vessel of 12,450 tons, of the Royal Sovereign type, as above. The Fuji has an armour belt 226ft. long, 18in. thick through machinery and boiler spaces, and 16in. at ends; two barbettes, armour plated with 14in. armour, and standing upon the armour deck. A screen of 6in. armour runs across on the main deck, as well as on the lower deck to protect the broadside 6in. quick-firing guns from a raking fire; also a belt of 4in. armour on 2in. teak backing between main and lower decks of about the same length as the main belt.

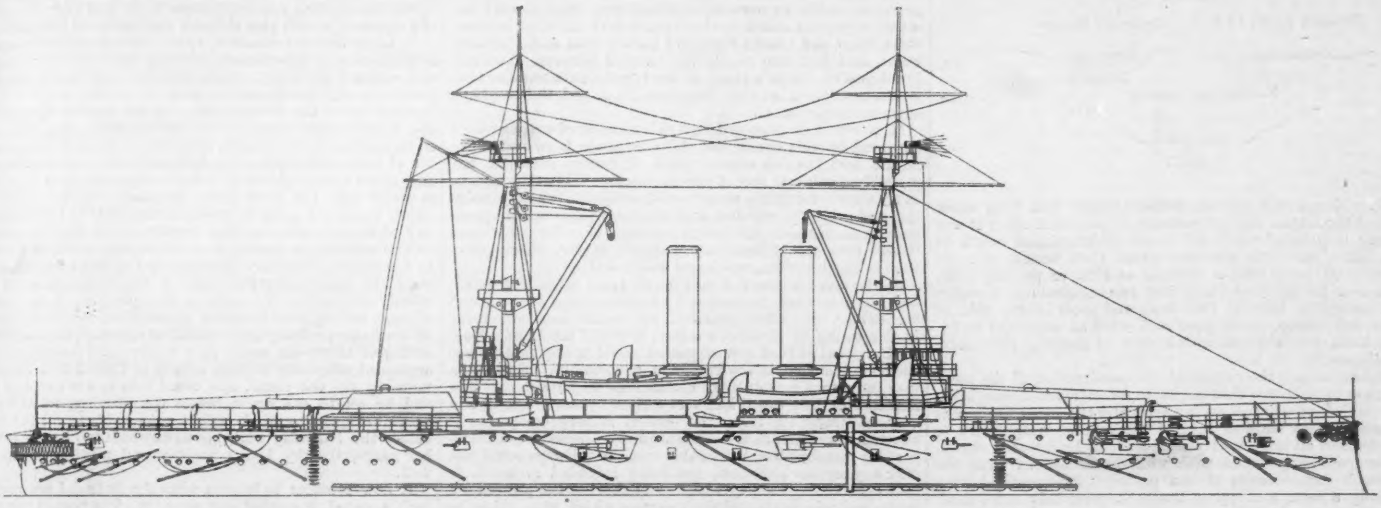
The barbettes carry two 12in. breech-loading guns in each, with armoured shields 6in. thick, also ten 6in. quick-firing guns, four of which are in casemates and the other six on the upper deck, and protected by heavy shields; twenty 3-pounder Hotchkiss quick-firing guns, four 2½-pounder Hotchkiss quick-firing guns, and five 18in. torpedo ejectors, one above water and four below.

The armour deck extending from stem to stern is 2½in. thick, and terminates in a powerful ram at the fore end. The decks are of teak. There are two military masts with double tops, with derricks for lifting the boats in and out from off the skid beams. Thirteen boats in all are to be carried, including two 56ft. vedette boats, navy pattern. Five search lights, and the whole of the vessel to be lighted internally by electricity. The conning tower is 14in. thick, and the director tower aft 3in. thick.

In view of the disastrous effects of the shell fire from the machine guns, as witnessed in the late war with China, all woodwork is substituted by steel and other metal wherever possible. The seamen's mess shelves, and also other fittings, as the bulkheads of the saloons and cabins, are all of steel and brass. The engines, which are triple expansion, of 14,000-horse power, are constructed by Messrs. Humphrys, Tennant, and Co., of Deptford, the boilers being of the usual cylindrical type. Speed, 18¾ knots. The vessel has been designed by Mr. George C. Mackrow, naval architect of the Thames Ironworks and Shipbuilding Company.

Good progress is now being made with her construction, as upon the cessation of hostilities with China it was suggested by the Japanese Government that the time of completion should be shortened, and the past few months have made a very material change in her general appearance on the slip, otherwise the delivery was not required for five or six years, so that twelve months' time has been lost. Some 7300 tons of material are in her, including 1600 tons of Harveyed armour, some of which plates weigh 28 tons, and cost £2870 each. The armour for the hull has been made by Messrs. Vickers and Son, of Sheffield, and the nickel casemate armour by Messrs. William Beardmore and Co.

The construction of the vessel is under the superintendence of Captain Takayama, that of the engines under Captain Miyabara, that of the armament under Lieutenant Kitakoga, while Captain Yendo, who is also Naval Attaché to the Imperial Japanese Embassy, is the chief of the Commission. The Thames Ironworks find, however, that they are entering upon a new experience in fitting out this large vessel and adapting and fitting all the multitudinous departments to the requirements of their clients in the Far East. In Europe methods of feeding and systems of carrying provision for crew and officers are fairly uniform, barrels and cases being of pretty general proportions, but the Japanese provisions are stowed in barrels, conical shape, something like our harness casks, and most inconvenient for stowing, as the larger diameter is at the top, and not at the bottom, as with us, so that each barrel or cask has to have its allotted place, and consequently there is a great loss in stowage.



THE JAPANESE WARSHIP FUJI

ENGINEERING SOCIETY, KING'S COLLEGE, W.C.—At the terminal business meeting of this Society held on Friday last—27th—the following gentlemen were elected officers for the ensuing term:—President, Mr. M. Mowatt; vice-president, Mr. D. J. Strutt; re-elected; hon. treasurer, Mr. R. Robinson; hon secretary, Mr. R. W. Bailey.

DUNOON BURGH PIER.

FOR some time past the existing pier at Dunoon has been found too small for the growing traffic of this favourite Clyde watering-place, whilst the shallowness of the water around it has been a constant source of inconvenience at certain states of the tides to steamers coming alongside. Last year it was decided by the Burgh Commissioners to construct a new and more commodious pier in deeper water, and parliamentary powers were accordingly sought and obtained to effect this. Eventually, as the result of negotiations with the Hafton Trustees, owners of the existing pier, that structure was acquired, *inter alia*, by the Dunoon Burgh Commissioners, for a sum of about £27,000, which included sundry rights and property on shore; and it was decided to incorporate the old pier in the new one, and to utilise the existing gangway for goods and luggage traffic, leaving the new gangway free for passengers. This arrangement, moreover, gives a good berth on the north side, and generally results in a particularly commodious and serviceable pier.

The new pierhead is 440ft. long by 60ft. wide, whilst the gangway is 170ft. in length, with a width of 40ft., the new works including the formation of a sea-wall from the Castle rocks to the band-stand in front of the Argyll Hotel, a length of about 1000ft.; various waiting-rooms, foot pavements, and other contingent works being included in the undertaking. The pierhead and gangway will be built of timber throughout, the whole of the bearing, fender, and mooring piles of both being of greenheart timber 12in. square. The front, back, and end piles of the pierhead will have a batter of 1 in 16, the remainder of the piles being plumb. The lower and intermediate wales and runners, the lower joists, the diagonals, struts, dwangs, and cleats, will be of greenheart, whilst American rock elm will be employed in the fenders and coping; with the exception of the handrail, all other timber in both pierhead and gangway will be pitch pine creosoted with 8 lb. of oil per cubic foot.

The dimensions of the struts will be 12in. by 8in., those of the cleats for carrying dwangs 12in. by 4in., and the remainder of the greenheart timber 12in. by 6in. The top and bottom horizontal fenders and all vertical fenders will be 12in. by 6in., whilst the intermediate horizontal fender is 8in. by 6in. The coping on the face and ends of the pierhead is 18in. by 9in., and the creosoted pitch pine, upper wales, runners, and joists are 12in. by 6in. The flooring for the gangway will consist of 4½in. thick creosoted pitch pine, that for the pierhead being of the same material ½in. thicker; spikes, 10in. and 11in. long, will secure the planks to the joists of the gangway and pierhead respectively. The spike heads will be driven 1in. below the surface of the planks, the hole thus formed being subsequently run up flush with pitch.

The wales and runners are designed with butt joints on the centre of a pile, all wales, runners, joists, diagonals, and ties being fixed to piles with two bolts at each end of every length of timber, and with one bolt to intermediate piles. The bolts used throughout are 1⅛in. diameter, and of iron. Those fixing top and bottom horizontal elm fenders on the pierhead have square necks and flat heads, the heads being sunk flush with the face of the timber; all other bolts have square heads. The nuts throughout are square, the circular plate washers being 3in. diameter and ¼in. thick. Each vertical elm fender is secured in position by four rag-spikes and four turned oak treenails, the spikes being placed two near the upper and two near the lower end of each fender. Two rag-spikes, one near each end, and two treenails, secure each intermediate horizontal fender in position. The rag-spikes and treenails are each 14in. long, and ¾in. and 1¼in. diameter respectively, both will be driven flush, the latter receiving a coat of white-lead immediately before being driven. A space of ½in. will be left between each plank on the gangway and pierhead flooring.

The connection between the existing and the new pier will be made in a particularly substantial manner, as many of the upper and lower joists as possible being carried right across and connected to the old piles. A pair of horizontal iron straps, 5in. by ¾in., will be carried round and bolted to the corner piles and fenders, the edges of the straps being bevelled, and the ends returned and bolted to the sides of the piles. The pierhead cope is sheathed with plate iron, 2ft. broad and $\frac{3}{16}$in. thick, solidly bedded on the timber, and protected from rust by a coat of archangel tar. The mooring pile heads have cast iron covers, with 1in. metal, the space between the iron and timber being run up solid with pure Portland cement. The gangway and pierhead handrail is designed to be 3ft. 6in. high, the uprights being 4in. by 4in., the top and bottom runners and diagonals 4in. by 2½in., and the rounded cope 5in. by 2in., the uprights being secured by a pair of ½in. bolts to the runners and joists. As will be noted from the accompanying drawings, the pierhead is formed of six rows of piles, varying in length from 50ft. long at the front to 40ft. long at the back.

The sea-wall, where not founded on rock, will be carried on concrete foundations, 12in. in thickness, and will be built of concrete rubble masonry, surmounted by a 16in. by 9in. ashlar coping, carrying a substantial and ornamental railing, which is to receive one coat of anti-corrosive paint before erection, and two coats of oil paint after erection. The pavement inside the sea-wall will have a bottoming of broken stone 4in. deep, the metal being required to pass through a 3in. ring, whilst the pavement surface will have a fall of 4in. from the kerb to the sea-wall. For the granolithic paving, a 3in. layer of ordinary concrete will be formed on top of the broken stones, covered by a finishing coat 1½in. in depth of concrete, composed of one part by measure of Portland cement to two parts of crushed granite passed through a ⅜in. sieve.

The New Pier entrance carriage-way will also be of granolithic paving, the bed of ordinary concrete being 5in. in depth and the granolithic 3in. in depth, the surface of the footpaths being dabbed, and that of the carriage-way being grooved on the track of the horses' feet. The run channel is 20in. broad, formed of square dressed whinstone causeway 3½in. to 4in. broad and 7in. deep, set on a 2in. bed of sharp sand, grouted with lime mortar. The whinstone kerb is designed 12in. by 6in., and is ridged on top face and back edge, the cast iron road gullies being connected with the sea-beach by 6in. diameter fireclay pipes jointed with cement.

Turning now to a brief *résumé* of the materials for the contract, the Portland cement is required to weigh at least 112 lb. per imperial bushel, and when made into briquettes to withstand a tensile strain of 360 lb. per square inch after seven days in water. The concrete employed in the sea-wall will consist of one part by measure of Portland cement, two parts of sand, and two parts of gravel, whilst the cement mortar for setting the coping and for painting coping and walls will be composed of equal parts of Portland cement and sand. The lime mortar used for building the fence walls, grouting causeway, &c., will consist of one part by measure of good lime shells, thoroughly slaked, to 2½ parts of sharp sand, whilst the Arden lime mortar will be formed of one part by measure of freshly ground Arden lime to two parts of sand and one-half part mine dust. The cast iron in the undertaking is required to have a tensile strength of seven tons per square inch, whilst all wrought iron is specified with a breaking strain of 20 tons per square inch. The work, now vigorously in hand, is to be completed within fourteen months at a cost of £15,000, such sum, however, excluding the outlay on waiting-rooms, &c., which is estimated at about £2000. The engineer of the undertaking is Mr. William Robertson Copeland, M.I.C.E., of Glasgow; the contract having been secured by Mr. James Watson, of Bath-street, Glasgow.

NIGHT CHANNEL SERVICES.—We learn that the new and commodious passenger steamer Dover, of the London, Chatham, and Dover Railway Company, will perform the Channel crossing in connection with the night mail service leaving Victoria at 8.15 p.m., and Paris and Brussels at 9.0 p.m. daily from April 1st. This vessel has made many passages during her trial trips in 65 and 70 minutes. The sister ship Calais will be shortly ready to be placed in this service, and it is quite probable that the smaller boats will then be entirely discarded. This company is now running its large boats Calais-Douvres and Victoria in both the 9.0 a.m. and 11.0 a.m services from London daily.

THE INSTITUTE OF JUNIOR ENGINEERS.—This thriving young society, which now has a membership of upwards of 500, held a highly successful conversazione on Saturday last at the Westminster Palace Hotel. A capital programme was arranged, by means of which the members and friends were kept interested for about four hours. Mr. H. L. Tyson-Wolff gave an interesting description of Professor Röntgen's recent discovery, with special reference to the results obtained by Mr. A. A. C. Swinton, who kindly lent lantern slides and photographs for the purpose. Mr. R. W. Paul gave an exhibition of the highly ingenious device known as the "Theatrograph," and Mr. James Rennie contributed a short paper on "Illustrated Newspaper Production." A large number and variety of exhibits were on view, and altogether the institution is to be congratulated upon the success achieved by its first conversazione.

TECHNICAL COLLEGE FOR PAISLEY.—The governors of Paisley Educational Trust having some little time ago resolved to erect a technical college at an outlay of some £17,000, exclusive of site, and having invited competitive plans from a number of architects have now selected the successful design, having been assisted in coming to a decision by Dr. Rowand Anderson, the well-known architect of Edinburgh. Nine separate designs were submitted, the author's identity being under separate cover, and the accepted design was found to be by T. Graham Abercrombie, Gilmour-street, Paisley, who is also the architect of the new infirmary and the Barbour Academy and Grammar School, both in course of erection in Paisley. The plans show a building three stories in height with a frontage to George-street of 120ft., the style of architecture being a simple treatment of Italian classic. The main entrance leads to a spacious vestibule, from which are the principal rooms and offices for janitors. Running east and west of the ground floor is the main corridor, 10ft. wide, and off this are the art masters' rooms, library, and designing room. In the centre of the building is the art lecture hall, in which accommodation will be provided for 300 persons. Grouped round this hall are the art class-rooms, which will be lit from the roof as well as by side windows. Above the ground floor the building becomes L-shaped. On the first floor are the science department rooms with lecture hall, and on the second the chemistry and physical departments, &c.

PROPOSED SHIP CANAL FOR CONNECTING THE BRISTOL AND ENGLISH CHANNELS.

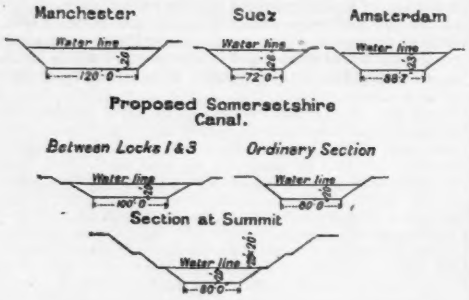
By W. O. E. Meade-King, M. Inst. C.E.

(*Concluded from page 274.*)

The present course of the river Axe from near Axminster is the one best suited for the line of the canal, and as the canal is to be so much lower than the river, it is proposed, by straightening and dredging, to convert the latter into a navigable channel, with locks at Seaton, by which vessels could make use of the canal at all states of the tide. The London and South-Western Railway has to be crossed near Axminster, and for this reason the canal has been kept as low as possible, the formation level being Ordnance Datum; this will only necessitate the railway being raised about 40ft. to give a headway of 75ft., as allowed at the crossing of the Great Western Railway, near Taunton, and the remarks concerning the embankments and gradients of the Great Western Railway apply in every respect to this line.

In these days, when so much is being said about agricultural depression, such a canal would be of immense advantage to what is purely an agricultural County, as a cheap means of despatching its produce to the capital and other large centres of industry, and also for obtaining necessaries for farm labour, for the transport of all of which it is now dependent on the railways, excellent no doubt where time is of vital importance, but the rates of which, being so heavy when compared with water carriage, must necessarily make a large hole in the profits.

It may be interesting to compare the proposed Somersetshire Canal with some already in existence, and the following sketches show three of the best known canals:—



The Manchester and Amsterdam Canals will both allow two of the largest class of steamers to pass each other at any point; in point of width the Somersetshire Canal would do the same, but it is not anticipated that vessels of more than 3000 tons, with a draught of 16ft. or possibly 17ft., will ever be likely to use it, the average steamers probably not exceeding 1500 or 2000 tons, and these having 30ft. or even 35ft. beam, could pass each other at any point easily. The locks are laid out with a view of meeting any future contingencies.

Before leaving the subject of the construction of the canal there are two things that ought to be mentioned, one being the subject of wharves or lay-byes, and the other the means of access from bank to bank of the canal. With regard to the former, all important places, such as Bridgwater, would, of course, be provided with wharves consistent with the probable requirements of the position; Bridgwater having already a certain shipping trade, as previously mentioned, would want something more than wharves, that is, docks, and Taunton has already been mentioned as being provided with docks.

As to the latter, that is means of access from bank to bank, the estimate allows for two swing bridges, one at Bridgwater and one near Taunton, being the two most important places, and both in the lowest part of the canal, and eighteen high level bridges, approaches to which would, of course, be formed by excavated material from the canal. This makes twenty bridges suitable for vehicular as well as pedestrian traffic, in addition to the two high-level railway bridges. The estimate also allows for twenty ferries suitable for foot passengers who would also be able to cross at each set of locks, making sixty-six means of crossing for pedestrians and twenty for vehicles, so that in the forty-three miles of canal no vehicle could be more than a mile at the outside from a point where it could cross, and no pedestrian would be more than about a quarter of a mile from a crossing place. Both entrances to the canal would have to be protected by breakwaters, as much to keep them clear of shifting sand, &c., as to protect vessels entering and leaving from storms; for this purpose a sum of about half a million has been included in the estimate.

Enough has been said concerning the actual construction of the canal; it now remains to show the utility of such an undertaking if carried out. Inland navigation is a subject that has been very much neglected, especially so since the introduction of railways, for one by one the canals or most of them got into the hands of the railway companies, to whose interest it was to let them die a natural death as speedily as possible. It has been already shown the variety of ways in which such a canal would benefit the County of Somerset. First of all, the northern portion of it acting as a waste-water course to take the superfluous drainage in times of flood; the remainder of the canal also would act in a measure in this manner, owing to its being so much below the natural level of the ground, though being through comparatively high land, the surface drainage would find its way into its own ordinary courses much quicker.

And another very important item of saving to the County would be in the rates charged for the carriage of agricultural produce; for instance, at the present time, grain, packed manure, potatoes, and such like things are charged 14s. a ton between Taunton and London, and fresh meat as much as 49s. 6d.; and in order to show what might be saved, let it be supposed that 1000 tons of grain has to be sent from Taunton to London, at the present rate this would come to £700; supposing the canal to be made and the same cargo sent by water, the rates being 1s. 6d. a ton for the canal and 4s. 6d. per ton for the remainder of the voyage, the rate would then come to £300, showing a saving on this cargo alone of £400. As another instance, 100 tons of fresh meat by rail would come to £247 10s.; by the canal, allowing 1s. 6d. a ton for the canal and 7s. a ton for the remainder of the voyage, it would cost £42 10s., showing a saving of £205. According to this estimate, the saving in carriage amounts to nearly 58 per cent. in the case of grain, and rather more than 80 per cent. in the case of fresh meat. It is shown later on, in estimating the financial prospects of the canal, that a charge of 1s. 6d. per ton for the County through which the canal flows is plenty to enable it to pay good dividends, and the charge of 4s. 6d. per ton is about the rate charged now for coal from Cardiff to London; 7s. has been allowed in the case of fresh meat, being more difficult, and therefore more expensive to handle.

But it is not only to the county or counties through which the canal is to pass that its chief benefits are expected to be felt. The shipping trade of the Bristol Channel is said to be one-fifth of the total shipping trade of the whole of England and Wales put together, and a large percentage of this must necessarily now have to round the Land's End, the Cornish coast, as the official returns of wrecks show, being a most dangerous one to all classes of vessels. According to the official register compiled in the Board of Trade, the following wrecks and casualties are approximately the number that took place between the places named during the year ending 30th June, 1891:—

	Strandings.		Collisions.		Other causes		Total.
	Sailing.	Steam.	Sailing.	Steam.	Sailing.	Steam	
Between southern entrance to Somersetshire Canal and Start Point ..	14	5	7	6	12	12	56
Between Start Point and Land's End	21	9	26	11	46	29	142
Between Land's End and Hartland Point	12	6	8	15	43	23	107
Between Hartland Point and northern entrance to Somersetshire Canal..	25	34	27	37	29	27	179
Totals	72	54	68	69	130	91	484

In order to arrive at those numbers, half the registered number of wrecks between St. Catherine's Point and Start Point has been taken as the number between the southern entrance to the Somersetshire Canal and Start Point; the actual registered return has been taken as the number between Start Point and Land's End, and Land's End and Hartland Point, and half the registered number between Hartland Point and St. David's Head as the approximate number that would be effected between Hartland Point and the northern entrance to the canal.

It is not to be supposed that this number of wrecks would be saved by this canal; the shipping trade from and to the Devon and Cornish coasts would of course continue, but probably a safe estimate of wrecks saved would be 50 per cent., as all vessels using the canal would avoid the risk of stranding, and probably collision, and the less the number of vessels passing these coasts, the less the chances of collision for those vessels that would have to use the sea passage in any case, that is whether there was any canal or not.

At the present time not only do all these casualties occur, but boats between the east and west coasts and boats bound for Belfast are often detained for weeks together, being unable, owing to stress of weather, to round the Land's End. Such a canal as that now suggested would at any rate reduce the time occupied in the voyage to a certainty, naturally a very important matter in all commercial undertakings. The Manchester Ship Canal had very serious opposition to it, and very naturally so, from the various railway companies it affected, inasmuch as it formed a competitive source of transport for merchandise, but in this case the railways could not offer any serious objection, not being intended so much to take the existing railway traffic as to shorten the present sea route, and take boats and their cargoes which were going by sea in any case.

A great number of instances might be quoted showing the extent to which distances would be reduced by the canal, but as the following table of comparative distances has been prepared, it is thought that one or two instances will suffice, and these will also explain the table.

Table of Comparative Distances between Points in the Bristol and English Channels.

From.	To a common point in English Channel.			To Falmouth.			To Plymouth.			To Guernsey.			To La Hague.			To Havre.			To Dieppe.		
	By Land's End.	By canal.	Saved by canal.	By Land's End.	By canal.	Saved by canal.	By Land's End.	By canal.	Saved by canal.	By Land's End.	By canal.	Saved by canal.	By Land's End.	By canal.	Saved by canal.	By Land's End.	By canal.	Saved by canal.	By Land's End.	By canal.	Saved by canal.
Point off St. David's Head ..	295	216	79	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Swansea	307	134	173	201	206	—	242	171	71	295	180	115	323	176	147	419	248	171	457	289	168
Barry	321	99	222	214	172	42	256	135	121	310	144	166	337	141	196	433	213	220	471	253	218
Cardiff	331	103	228	224	176	48	266	139	127	320	148	172	347	145	202	443	217	226	481	257	224
Newport	342	111	231	235	184	51	277	147	130	331	155	176	358	153	205	454	225	229	492	265	227
Bristol	348	108	240	241	181	60	283	144	139	337	154	183	364	150	214	460	222	238	497	263	234
Sharpness	363	130	233	256	203	53	298	166	132	352	175	177	379	172	207	475	244	231	513	284	229

If 69·5 miles are saved by means of canal, the time occupied in reaching that point is the same either by Land's End or canal.

Note.—All distances are in English statute miles. From Cardiff to point off Ushant by Land's End, 332 miles; from Cardiff to point off Ushant by canal, 320 miles; showing saving by canal of 12 miles, together with increased safety of voyage.

Cardiff being about the most central of the South Wales ports, is a good instance to take first, and it is to be supposed a vessel is trading between that port and London, or any other port on the East Coast. To do so the boat would, of course, have to go through the English Channel, having rounded the Land's End, and having travelled about 331 miles—land miles — would reach a point in the English Channel off Portland which she would reach by means of this proposed canal in 103 miles, which shows a saving in distance of 228 miles, to say nothing of what she might save if there was rough weather in the Atlantic. This point in the English Channel, in the table attached, has been called a common point, and is meant to apply to all boats bound to pass through the Straits of Dover. Swansea, the worst situated of all the Bristol Channel ports, so far as this canal is concerned, being the nearest one to the open sea, and farthest from the entrance to the canal, would nevertheless save 173 miles in reaching this common point by use of the canal; while Bristol would reap the greatest benefit, effecting an actual saving of 240 miles. These distances hold good for all vessels trading between the Bristol Channel and Northern Russia, Sweden, Norway, Denmark, Germany, Holland, and Belgium, while the trade with the Channel Islands and France would also be affected, much to the credit of the canal; for instance, take Cardiff and Guernsey, at the present time 320 miles apart, but by the canal only 148, saving by that means 172, and to the Hague from Cardiff a boat by the canal would save 202 miles, to the Havre 226, and to Dieppe 224, each amount saved being as a rule rather more than a half of the distance it has at present to travel.

But while on the subject of distances there is another point well worthy of careful consideration. Within the last few months a new line of steamers has been started to run between Manchester and London, the traffic per week already amounting to about 1500 tons each way, and showing unmistakeable signs of increasing; the continental traffic also amounts to at least 2500 tons a week. The whole of this might be estimate to make use of the canal, inasmuch as the distance from a point off St. David's Head to the common point in the English Channel, *viâ* the Land's End, is about 295 miles, and if by the Bristol Channel and Somersetshire Canal, 216 miles, thereby saving 79 miles in distance, with an estimated saving of time, as will be explained hereafter, of two hours, also saving certain light dues, and with the advantage of avoiding the Devon and Cornish Coasts. And if it can be satisfactorily proved that vessels trading between Manchester and London would find it to their advantage to make use of this canal, there is really no limit to the trade that might pass through it, so far as the West Coast of England, the Irish ports, and the South Coast of England east of Seaton, the North of France, and everything east of the Straits of Dover, were concerned. There is yet one other instance coming under the headings of distance saved by the canal; it is very slight, but nevertheless a saving. From Cardiff to a point off Ushant by the Land's End is about 332 miles, and by the canal 320, a difference of 12 miles in favour of the canal in point of distance, but the canal route would enable a vessel to travel between 50 and 60 miles of her voyage quite protected by the canal and coasts of Devonshire from the furies of an Atlantic storm, and if the canal was adopted in this case, it opens another and still larger field for trade, taking as it would the Spanish and Portuguese trade, and everything that of a necessity would pass through the Straits of Gibraltar.

So far as time is concerned, which, according to shipowners, is of the utmost importance, allowing that the average rate of a collier is eight and a-half miles per hour, in the case of a boat between Cardiff and London, it would take her 38·94 hours to reach the common point in the English Channel by the Land's End route, and by the canal allowing only four miles per hour for forty miles of the canal, ten minutes for each set of locks and eight and a-half miles per hour for the portion of sea route—about 57 miles—she would have to travel, it would take her 21·03 hours to reach the same common point, showing a point in favour of the canal of 17·91 hours—say eighteen hours—on that portion of her journey, and all this in addition to the fact that her voyage would be reduced to a certainty, humanly speaking, and without incurring the risks she would otherwise run off the dangerous coast previously alluded to. To continue the question of the saving of time, the eighteen hours, of course, is on one journey only; on her homeward voyage it would be repeated, thus making a saving of thirty-six hours on her trip; and to continue the argument, supposing a collier arrives at Cardiff on a Saturday morning *viâ* the canal, she could take in her cargo of coal and be off to sea again before the Sunday, when by the present existing route she might not be able to get to Cardiff before the Saturday night, or at any rate too late to take in her cargo, thereby losing Sunday and possibly Monday as well.

It now remains to be seen what the financial prospects of such a canal, if carried out, are like. The port of Swansea, having supplied the most complete returns of any of the South Wales ports, is taken as an example, details being given of it, and the other South Wales ports are worked out having Swansea to go upon as a basis. The shipping of these ports has increased enormously; for instance, in Swansea the exports of coal and coke in 1862 amounted to 700,866 tons, and in 1893 they amounted to 1,459,475 tons, showing an increase of 758,609 tons. The exports of patent fuel in 1862 came to 92,134 tons, and in 1893 360,960 tons, showing an increase of 268,826 tons. In tin-plates the exports in 1878 came to 12,425 tons, and in 1893 275,030 tons, showing an increase of 262,605 tons. These are only three instances of the trade done. The total tonnage—dead weight—of imports and exports are as follows:—

	Imports. Tons.		Exports. Tons.		Total. Tons.
In 1862	369,700	..	914,000	..	1,283,700
In 1893	589,791	..	2,216,418	..	2,806,209
Showing an increase.. ..	220,091	..	1,302,418	..	1,522,509

It has now to be calculated how much of this tonnage could be fairly expected to make use of the canal, and the following shows in a concise form the countries traded with and the amounts, from which table can be taken the exact tonnage that would have had to pass through the Straits of Dover.

The figures given are the official returns for the port of Swansea for the year 1893.

	Imports.	Exports.	Total.
Russia (North, say)	5,550	32,927	39,477
Sweden, Norway, and Denmark	16,780	61,051	77,831
Germany, Holland, Belgium	5,371	83,210	88,581
Channel Islands	1,011	16,006	17,017
France	41,397	655,848	697,245
Total	70,109	851,042	921,151
Portugal, Gibraltar, Malta, Madeira, Spain, Italy, Austria, Greece, Roumania, Algeria, Turkey, Egypt, Morocco, Cape of Good Hope, East and West Africa, Java, Ceylon, and Japan	154,547	455,125	609,672
South Russia, say	5,550	32,927	39,477
North America, West Indies, and South America	60,601	421,342	481,943
Total foreign trade	290,807	1,759,436	2,050,243
Coastwise	298,984	456,982	755,966
Total	589,791	2,216,418	2,806,209

The total Russian trade amounted to 11,100 tons of imports and 67,854 tons of exports, and for the sake of this paper, half the imports have been taken as coming from North Russia, and therefore through the Straits of Dover, and the same has been done with the exports. This makes the foreign trade which may be counted upon as using the canal amount to—

	Imports.	Exports.	Total.
	70,109	851,042	921,151
In addition to which the coasting trade has to be taken into account, and to be on the safe side, only half the total imports and exports have been taken as likely to go south, making	149,492	228,491	377,983
Total	219.601	1,079,533	1,299,134

	Tons per annum.
Therefore out of the total amount of shipping of 2,806,209 tons, 1,299,134 tons—or rather more than 46 per cent.—may be calculated upon to pass through the canal, but in order not to raise false hopes or appear too sanguine, 45 per cent. only will be allowed for, which makes the shipping to and from the port of Swansea likely to use the canal equal to	1,262,749
It is now necessary to consider what may be reckoned on from Barry, Penarth, Cardiff, and Newport, these being the other most important South Wales ports, taken in their order travelling east from Swansea. At Barry the *average* shipping trade per week done for four weeks in April and May, 1894, amounted to 105,008 tons—45 per cent. of which amounts to 47,253 tons. To allow for holidays, the year is taken as 50 weeks. Therefore Barry trade through the canal per annum ought to be	2,362,650
Average at Penarth, in same way, 37,327 tons per week—$\frac{37,327}{45 \text{ per cent.}} = 16,797 \times 50$ weeks	839,850
Average at Cardiff, in same way, 300,000 tons per week—$\frac{300,000}{45 \text{ per cent.}} = 135,000 \times 50$ weeks	6,750,000
Average at Newport, in same way—five weeks taken, coasting trade only—19,675 tons per week—$\frac{19,675}{45 \text{ per cent.}} = 8853 \times 50$ weeks	442,650
Trade between Manchester and London, 3000 tons per week × 50 weeks	150,000
Between Manchester and Continent, 2500 tons per week × 50 weeks	125,000
Shipping trade from Bristol, Avonmouth, and Portishead for year 1893-4 = 779,483 tons, 45 per cent. of which =	350,767
Total through traffic	12,283,666

Inland Traffic.

	Tons.	Tons.	Tons per annum.
Bridgwater—			
Imports—Coasting	149,396		
Foreign	14,249		
		163,645	
Exports—Coasting	49,207		
Foreign	1,987		
		51,194	
Total			214,849
Taunton—			
Anticipated			30,000
			244,849

Of course, if it was considered advantageous for vessels bound for Gibraltar to make use of the canal, the numbers given would be very largely increased; but in order to be on the safe side none of this shipping has been taken into account; and as Sharpness, Gloucester, Worcester, and many other places, all of whom transmit their share of shipping to the English Channel, have not been taken into account, though they rightly might be, nothing has been deducted from the figures given for contingencies.

The estimate for the canal is as follows:—

Approximate Estimate.

Description.	£	£
Purchase of land—		
For canal	688,000	
For railway deviations	20,400	
For reservoirs	50,000	
Total for land		758 400
Earthwork—		
Including excavation of canal and river diversions, dredging, railway and canal embankments, and puddle walls, &c. &c.		3,143,231
Pitching, slopes of canal, &c.		404,000
Fencing		19,800
Locks		1,990,000
Bridges—		
Swing	54,000	
High level	324,000	
		378,000
Ferries		2,000
Railway deviations, including bridges		250,000
Dock walls		132,000
River weirs		15,000
Reservoirs and pipe tracks		500,000
		7,592,431
Add for contingences, 10 per cent.		759,243
Total for works and land		8,351,674
Parliamentary expenses		200,000
Engineering expenses		275,000
Legal expenses		30,000
Total approximate estimate		8,856,674

But in order to simplify matters, as well as to be on the safe side, the capital for present purposes may be called £9,000,000, and this may be divided as follows:—4 per cent. debentures, £1,000,000; 6 per cent. preference, £4,000,000; ordinary shares, £4,000,000; total, £9,000,000. The question of rates is one that would have to be determined in time to come, but as the lowest rate at present for canal traffic is about 1d. a ton per mile, it will be on the safe side to estimate traffic in this case at about ½d. a ton per mile, or, say, 2s. a ton for the whole canal.

	£	s.	d.
Through traffic, amounting to 12,283,666 tons per annum, carried at this rate would yield	1,228,366	12	0
Inland traffic of 244,849 tons at 1s. 6d. would yield	18,363	13	6
Giving a gross revenue of	1,246,730	5	6
Deduct working expenses 40 per cent.	498,692	5	6
Leaving net revenue	748,038	0	0

	£
4 per cent. on £1,000,000 debentures absorbs	40,000
6 per cent. on £4,000,000 preference absorbs	240,000
8½ per cent. on £4,000,000 ordinary absorbs	340,000
Leaving amount to be carried forward	128,038
	748,038

The only figure not taken from actual returns in the whole of the above estimate is the anticipated amount of trade done at Taunton, and as docks are intended to be there, owing to its being the most important town *en route*, 30,000 tons per annum cannot be said to be an excessive amount to anticipate, and so far from estimating a profit from dock dues, the whole of the inland traffic—that is, Bridgwater, Taunton, &c.—has been put in at only 1s. 6d., which is to pay for the portion of the canal they must necessarily use.

Attention ought also to be called to the amount deducted from the gross profits for working expenses. No canal or dock working expenses ought to come to more than 35 per cent. of the gross profits, but in this case 40 per cent. has been deducted, a figure which may safely be said to be in excess of that required.

All the points mentioned at the commencement of this paper have now been dealt with; the scheme has been described, and that it is perfectly feasible or practicable there can, I think, be no doubt. It is believed that the arguments in favour of the scheme, as stated in this paper, will considerably outweigh any arguments its enemies may bring against it, and it only remains for shipowners and others to make use of the canal to the extent estimated to prove its financial success.

TRACTION ENGINES ON ROADS.

THE Select Committee of the House of Commons appointed to investigate the working of the laws affecting the use of traction engines on roads sat for the second time on Thursday, the 26th ult., in Committee Room No. 13, when the first witness called was Lord Ancaster, a large employer of steam traction in Lincolnshire for agricultural purposes. The substance of the evidence given by the witness was to prove that traction engines had been employed by him since the year 1878 for hauling purposes, with a considerable saving of money. In 1879 he was involved in litigation with the local authorities for "extraordinary" traffic, the said traffic consisting in the use of locomotives for hauling wagons containing bricks to and from some farm buildings which he was erecting for the convenience of the farmers on his estate. The result of the litigation was that he had to take over the road said to be injured, and also pay certain costs. He had on several occasions since had to compensate for wear and tear of roads.

Mr. Edison, a director of Messrs John Fowler and Co., Leeds, was the next witness called. In answer to the chairman, Mr. Hobhouse, Mr. Edison informed the Committee that his firm had an annual output of more than one hundred road locomotives for use in England alone. He stated that the style of engines had altered very materially during the last thirty years, and that the wheel base had been much shortened, the motion and gearing all covered in, the tanks for carrying the feed-water enlarged, the steerage better arranged, and that by means of the differential gearing employed these engines were much more easily driven round corners than formerly. Roughly speaking, the weights of their engines are—6-horse power engines, 8 to 9 tons; 8-horse power engines, 10 tons; 10-horse power engines, 12 tons; and steam ploughing engines about 16 tons.

Questioned as to the hauling of trains of wagons on the roads, witness stated that there had not, so far as he knew, been any difficulty in this matter, and did not think that it was necessary to limit the number of wagons by statute. With regard to the clause in the statute relating to the type of wheels employed on engines, he suggested that this might with advantage be made more elastic, so that wheels suitable for the particular districts in which they were used might be employed. As an instance illustrating the necessity for this modification of the law, he mentioned that in Lancashire the present wheel with transverse bars had been found very unsuitable owing to the damage done to the hard pavements general in the streets. A model wheel was exhibited to the Committee having wood blocks round the rim, and this had been found to answer the requirements on such pavements admirably. With regard to wagon wheels, it is usual to arrange these so that the back wheels break gauge with the front ones, and that the gauge be narrower than that of the engine wheels, so that the effect of an engine and wagon passing over a road was to roll and solidify it. Mr. Edison considers that an inclusive licence fee of £10 should be sufficient to cover the whole of the country. He thinks that a differentiated fee upon engines above and below 10 tons would be a suitable arrangement, and that traction engines might with advantage be permitted to travel through towns at the same speed as ordinary traffic. The use of steam traction in agricultural districts would be greatly extended if the close hours were more uniform in adjoining counties, and other restrictions removed, while by raising the quality of all roads these would be improved rather than injured by road locomotives. As an instance proving the veracity of this statement, Mr. Edison pointed out to the Committee a certain road in Leeds upon which steam traction engines were constantly plying.

Mr. Allen, manager of the Oxfordshire Steam Ploughing Company, owning forty agricultural engines, in his evidence stated that a great increase had taken place during recent years in the number of engines employed for thrashing purposes. The witness informed the Committee that there were no close hours in the district where their engines were chiefly employed, and no complaints had been made respecting the movement of engines during the night. A great inconvenience was felt by owners of road locomotives in not being able to pass through the City of Oxford during the daytime, between the hours of 10 a.m. and 6 p.m. With regard to the licence fees, the three adjoining counties—Oxfordshire, Berks, and Bucks—each imposed the maximum duty of £10 if a licence is taken out for one of these only, whereas by taking out a licence in each of the three this sum was sufficient to cover the whole owing to the system of rebates. The following are the charges made by his company for agricultural purposes:—Ploughing, 7s. to 12s. per acre; thrashing, 30s. per day.

Mr. Fearnley, the manager of the Barnsley and District British Co-operative Society, next detailed the use this society made of traction engines, and complained chiefly of the restrictions of hours and types of wheels. The former in Barnsley are from 5 p.m to midnight.

On Monday, the 30th ult., four witnesses were called, the first being Mr. R. Bomford, a farmer of 4000 acres of arable land in Worcestershire and Warwickshire. Mr. Bomford stated that he owned six sets of steam ploughing plant, two road locomotives, and four road rollers, and considered that for haulage purposes the traction engines effected a saving of 30 per cent. over horse haulage. Referring to the nature of the roads in his district, the witness stated that those of Gloucestershire were mainly good, but in Warwick and Worcester chiefly poor. Nevertheless, he had not found that his engines did any damage, but rather improved the surfaces. Speaking of licence fees, these were as follows:—Gloucester, £10 for 10-ton engines, and £8 for 8-ton engines, subject to no rebate; but Warwick and Worcester each allowed a rebate of £5, if a licence had already been granted in a neighbouring county. The common complaint of want of uniformity in the close hours was made by this witness, who also considers that two men to each engine are ample to secure the public safety. Respecting the hauling of loads, the Warwick County Council prohibited the haulage of a greater weight than 12 tons net, a limit which ought to be increased to 25 tons. This weight the witness has repeatedly dealt with without damage to the surfaces of roads. He estimated the saving effected by steam traction over horse traction as 50 per cent. on heavy roads over eight miles, and 25 per cent. for short journeys. The following figures are given by Mr. Bomford as illustrating the relative cost of steam and horse haulage:—Horses, 8·2d. per ton mile; steam, 5·25d. per ton mile.

Mr. Cripps, solicitor, and town clerk of Tunbridge Wells, in his evidence stated that he had considerable experience of the working of the laws relating to traction engines, and strongly urged that the power to make bye-laws should be taken away from the county authorities and placed in the hands of a central authority. As bearing upon this he produced a new code of bye-laws recently proposed by the Kent County Council, some of which he considered vexatious and liable to hamper the steam hauling industry. As these have not yet come into effect, it will not be necessary to give them *in extenso*. Mr. Cripps considers that the words "on foot" in Section 29 of the 1878 Statute should be struck out, and cited a case of litigation in which the man preceding the engine had been provided with a cycle, was held to be contrary to the wording of the Act; although it was held that it would be legal for the man to lead a horse and cart. Respecting close hours, the witness holds that these are necessary, but should be universal. In Tunbridge Wells traction engines were prohibited between the hours of 10 p.m. and 6 a.m. which he considers as being the most suitable hours. On the subject of licence fees, Mr. Cripps advises that a levy be made on traction engines, and the same be distributed to the local authorities in which the engines are licensed. Questioned by the Chairman respecting Section 23 of the Highways and Locomotives (Amendment) Act, 1878, the witness maintained that the term extraordinary traffic applied to all kinds of traffic, but considers that, according to the wording of the Act, if a locomotive be used on any road on which such form of traction had not been employed previous to the said Act, such use is liable to be considered extraordinary traffic. An injustice in the administration of the law was pointed out in the case of certain owners of a traction engine who had been allowed the use of a road for seven years before the authorities came down upon them for damages over the whole of that period for extraordinary traffic. Mr. Cripps suggests the altering of the law so that such claims should be made within a specified time—say, twelve months.

Mr. Walter Carter, the well-known carrier of Manchester, was the next witness to give evidence, in the course of which he complained of the annoyance and expense he was put to owing to the arbitrary arrangements made by the different authorities with regard to the close hours. Mr. Carter is the owner of seven traction engines, each weighing 20 tons, which are chiefly employed in the transport of heavy boilers. Notwithstanding the express wording of the 1878 Act relating to the type of wheels used on engines, he informed the Committee that his engines were licensed with wheels on which the Bolton blocks are employed instead of bars, and caused considerable amusement by stating that one of the bye-laws made by the authorities of Ashton-under-Lyne required a toll of five shillings for each engine passing through the town unless the wheels are shod with the above-mentioned illegal blocks. Another bye-law made by the town of Bury necessitated that an owner of a traction engine going through this town should deposit a sum of £100, presumably to cover the cost of repairing the damage done to roads. The prohibited hours which affected the working of his plant are as follows:—Manchester, 9 a.m. to 5 p.m.; Salford, 9 a.m. to 5 p.m.; Bolton, 9 a.m. to 5 p.m.; while other places prohibited during the hours between 5 p.m. or sunset and midnight. The licence fees are:—Lancashire, £5; Cheshire, £10; and West Riding of Yorkshire (if the engine be licensed elsewhere), 1s. per annum.

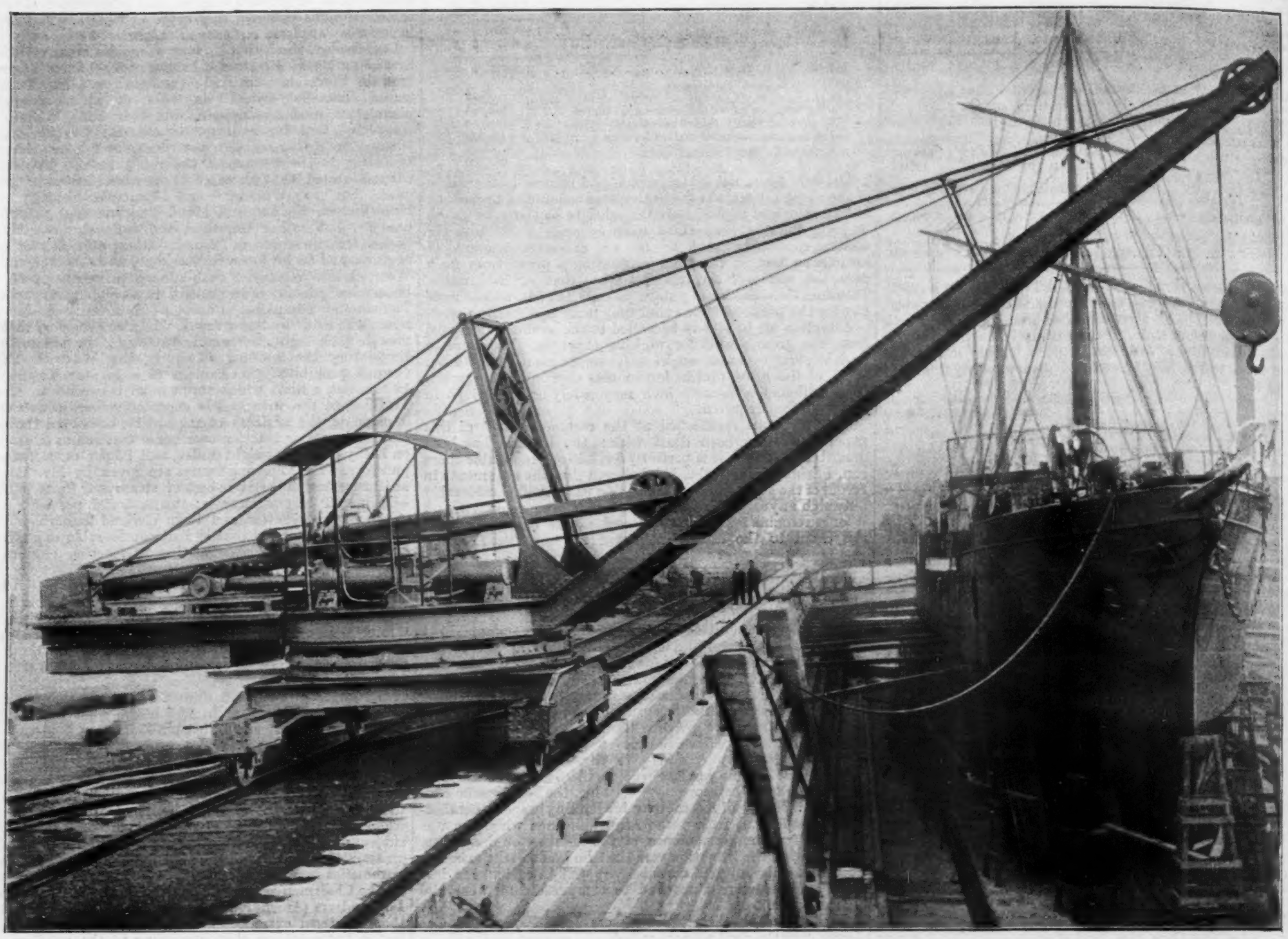
Mr. Mornement, a farmer residing at Thetford, was the last witness called, and generally confirmed the earlier witness respecting the economy of steam haulage, but suggested that the maximum limit of speed should be increased to at least six miles per hour outside of towns and three miles inside. He stated that in the counties of Norfolk, Suffolk, and Cambridge no licence fees were charged.

The Committee then adjourned till the 16th inst.

CHESTERFIELD AND MIDLAND COUNTIES INSTITUTION OF ENGINEERS.—A general meeting of the members of the Institution will be held in the Municipal Science College, Green-lane, Derby, on Saturday, 4th April proximo, at 3 p.m. The following papers will be read or taken as read:—"How a Mine may be Dry, but not Dusty," by Mr. George Fowler; "The Yorks and Notts Coalfield. Geological Suggestions Relative to its Eastern Extension," by Mr. W. S. Gresley. The following papers will be open for discussion:—July, 1895.—"Photometric Value of, and Notes upon, various Illuminants used in Mines," by Mr. A. H. Stokes. Fed. Inst. "Trans.," vol. x., pages 135 and 438. December, 1895.—"Fencing Gates for Winding Shafts," by Mr. William Hay. December, 1895.—"A Boring below the Blackshale Coal at Apperknowle, near Sheffield," by Mr. G. E. Coke. February, 1896.—"The Vibromotor as applied to the Screening of Small Coal," by Mr. Emerson Bainbridge, M.P. February, 1896.—"Lead and Lap of Winding and other Engines," by Mr. Hargrave Walters. February, 1896.—"The Eastern Limits of the Midland Coalfield," by Professor Ed. Hull, F.R.S

TEN-TON HYDRAULIC CRANE

MESSRS. FIELDING AND PLATT, GLOUCESTER, ENGINEERS



TEN TON HYDRAULIC CRANE.

The 10-ton hydraulic dock crane illustrated by the above engraving has been at work for some time past at the new graving dock of the Wallsend Slipway Company. The adoption of a crane of this type for putting the machinery on board new steamers is due to the initiative of Mr. Wm. Boyd, managing director of the Company, and the crane was designed jointly by the late Mr. R. H. Tweddell and Messrs. Fielding and Platt, who have built it. The crane is capable of lifting the load mentioned through a height of 50ft., and it is fitted with a treble ram arrangement, by means of which it can be used to lift 3⅓ tons and 6⅔ tons also, with a corresponding reduction in the consumption of power.

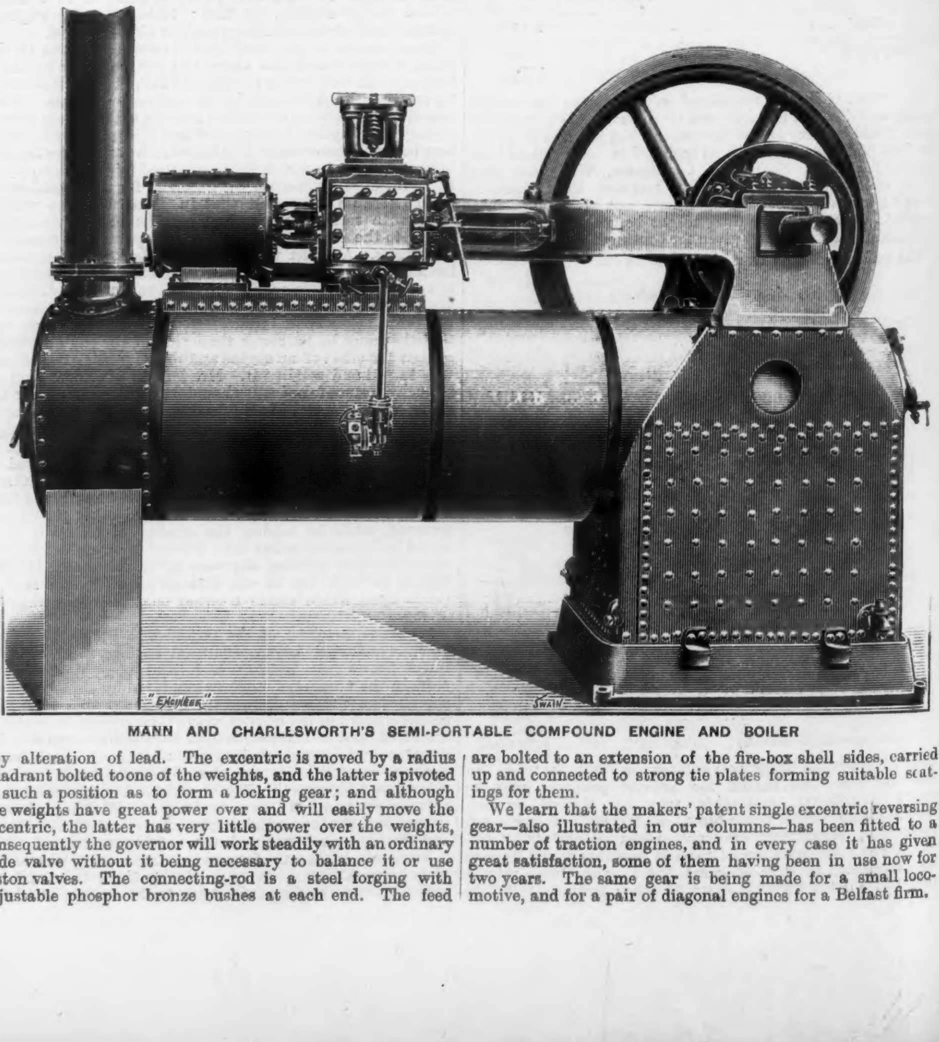
The crane is slewed by hydraulic pressure also, through rather more than a complete circle. The crane can be worked at any point around the sides of the graving dock, suitable pressure hydrants being provided at intervals. The whole arrangement of the crane on the turntable is well balanced, rendering the use of holding down clips unnecessary. A platform is provided for the man working the crane, who has complete control of the valves whilst he faces the load being lifted.

SEMI-PORTABLE TANDEM COMPOUND ENGINE AND BOILER.

We illustrate by the accompanying engraving a new type of engine made by Messrs. Mann and Charlesworth, of Leeds. It is a self-contained tandem compound, which, although quite independent, is shown mounted upon a boiler of locomotive type, forming a compact and substantial semi-portable engine, or, if desired, the engine may be bolted upon a stone or concrete foundation as a separate horizontal engine.

Side-by-side cylinders or double-crank compound semi-portables are frequently met with, but this is the first we have seen of the tandem type, with the engine self-contained and quite independent of the boiler. It has few working parts, and to secure simplicity it is fitted with the makers' automatic expansion gear, which we illustrated in The Engineer of July 5th last. It is also, we are informed, very economical in the consumption of steam.

The following is from a specification of the engine and boiler :—The cylinders are—high-pressure, 7in. diameter ; low-pressure, 11in. diameter ; stroke, 12in. The high-pressure cylinder is steam jacketed, and both are covered with non-conducting material cased with steel sheeting. They are connected and firmly tied together by the firm's improved double cover, which is made so that it may be drawn out of the other end of the low-pressure cylinder, in order to examine or take out the high-pressure piston. These covers being cast together, and having turned projections on them accurately fitting into the end of each cylinder, ensure the latter being concentric and perfectly true with each other. The bed-plate is of the double girder type, and is self-contained, relieving the boiler from all the working strain of engine, and requires no outside bearing. The crank shaft brasses, adjustable by wedges, are of gun-metal, with large wearing surfaces. The barrel part is bored out to form guides for the cross-head, and the flange forms the front cover of the high-pressure cylinder, into which it is recessed in order to get them perfectly true with each other. The crank shaft is 4in. diameter, bent out of a round steel bar, and is of sufficient length for the fly-wheel to be put on either side. The speed of the engine is controlled by the patent variable expansion governor, acting direct upon the slide valve of the high-pressure cylinder. The excentric is carried in a very similar manner to single excentric reversing gear, and automatically cuts off steam from nil to five-eighths of the stroke without any alteration of lead. The excentric is moved by a radius quadrant bolted to one of the weights, and the latter is pivoted in such a position as to form a locking gear; and although the weights have great power over and will easily move the excentric, the latter has very little power over the weights, consequently the governor will work steadily with an ordinary slide valve without it being necessary to balance it or use piston valves. The connecting-rod is a steel forging with adjustable phosphor bronze bushes at each end. The feed pump is fitted with gun-metal valve boxes, and phosphor bronze valves, and pumps the water through a feed-heater which is raised in temperature by the exhaust steam, the water thus entering the boiler a few degrees under boiling point. The boiler is constructed of steel plates, and strongly stayed for a working pressure of 140 lb. It contains 164ft. of heating surface and 7·5ft. grate area. The cylinders are fastened to a wrought iron fixing so that no studs or bolts enter the steam space, and the feet of the crank shaft bearings are bolted to an extension of the fire-box shell sides, carried up and connected to strong tie plates forming suitable seatings for them.

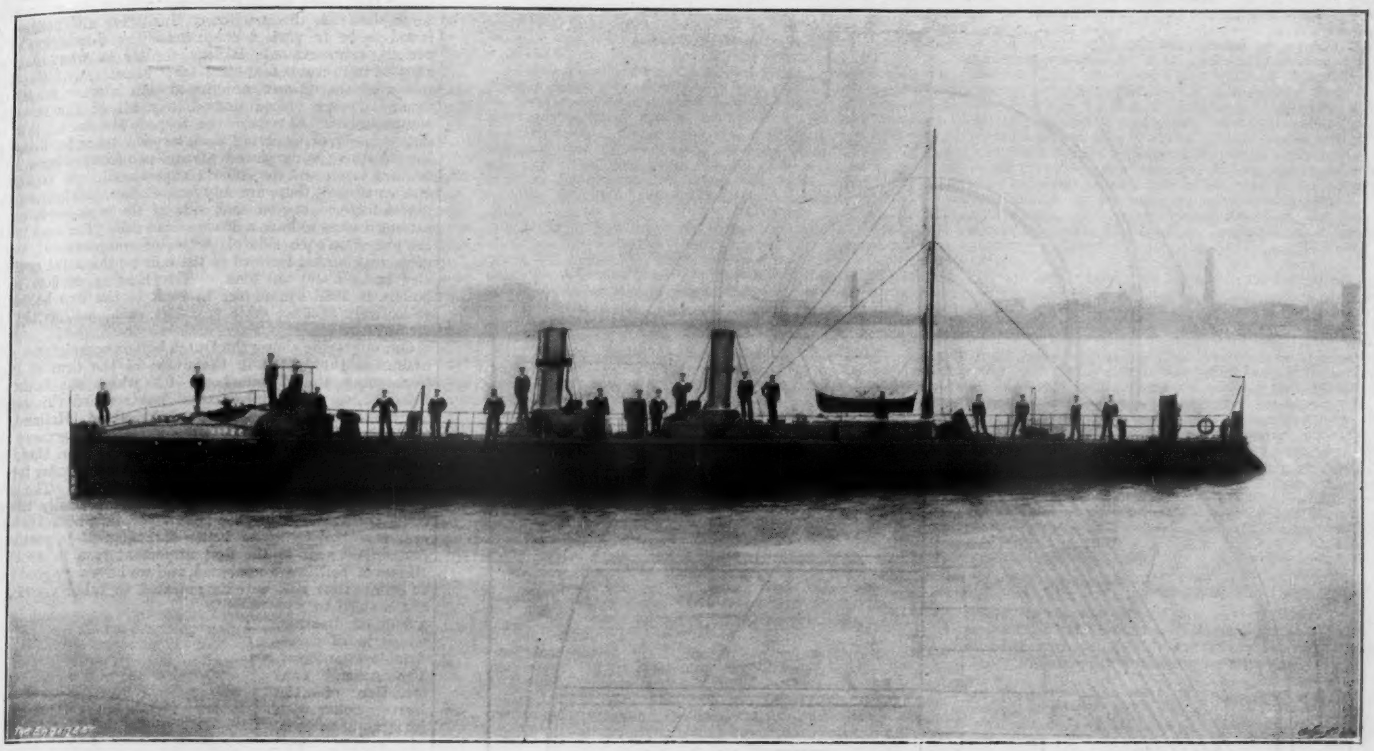


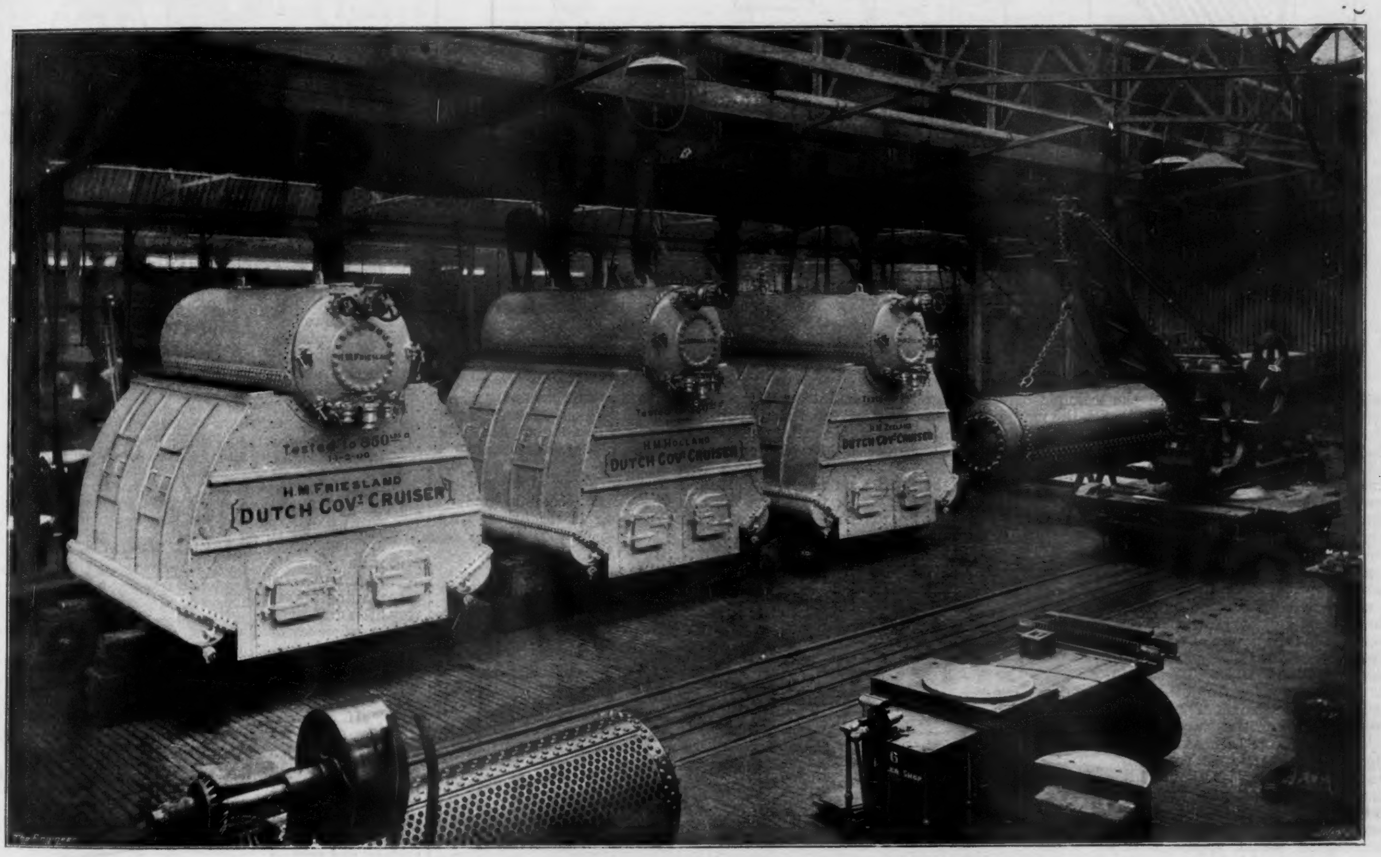
MANN AND CHARLESWORTH'S SEMI-PORTABLE COMFOUND ENGINE AND BOILER

We learn that the makers' patent single excentric reversing gear—also illustrated in our columns—has been fitted to a number of traction engines, and in every case it has given great satisfaction, some of them having been in use now for two years. The same gear is being made for a small locomotive, and for a pair of diagonal engines for a Belfast firm.

THE AUSTRIAN TORPEDO BOAT VIPER

MESSRS. YARROW AND CO, POPLAR, BUILDERS AND ENGINEERS





YARROW WATER-TUBE BOILERS FOR DUTCH CRUISERS

THE AUSTRIAN TORPEDO BOAT VIPER.

THROUGH the courtesy of Messrs. Yarrow and Co., we are enabled this week to illustrate the Viper, a large torpedo boat recently built by that firm for the Austrian Government, and a set of boilers constructed for the Dutch Government, which are similar to those in the Viper. The trials of this craft took place on the 5th of February last, in the presence of Chevalier Leopold von Jedina, Naval Attaché; M. Krainer, Engineer-in-chief to the Austrian Navy; Captain Padevit; M. Thiel, naval architect; and Lieutenant Schwarz and Mr. Nitsch, the future commander and engineer respectively of the vessel. The Viper is 147ft. 6in. long and 14ft. 9in. beam, and was guaranteed to attain a speed of 24 knots when fully equipped and in the loaded condition. With 26 tons deadweight on board to represent her armament, &c., the vessel left Poplar at 10 a.m., and on arriving at Thames Haven about noon commenced a three hours' continuous trial, during which six consecutive runs were made on the measured mile. A speed was attained on these runs of 26·633 knots. The boilers of the Viper are of the Yarrow water-tube type. The scheduled particulars of the run are given in the following table:—

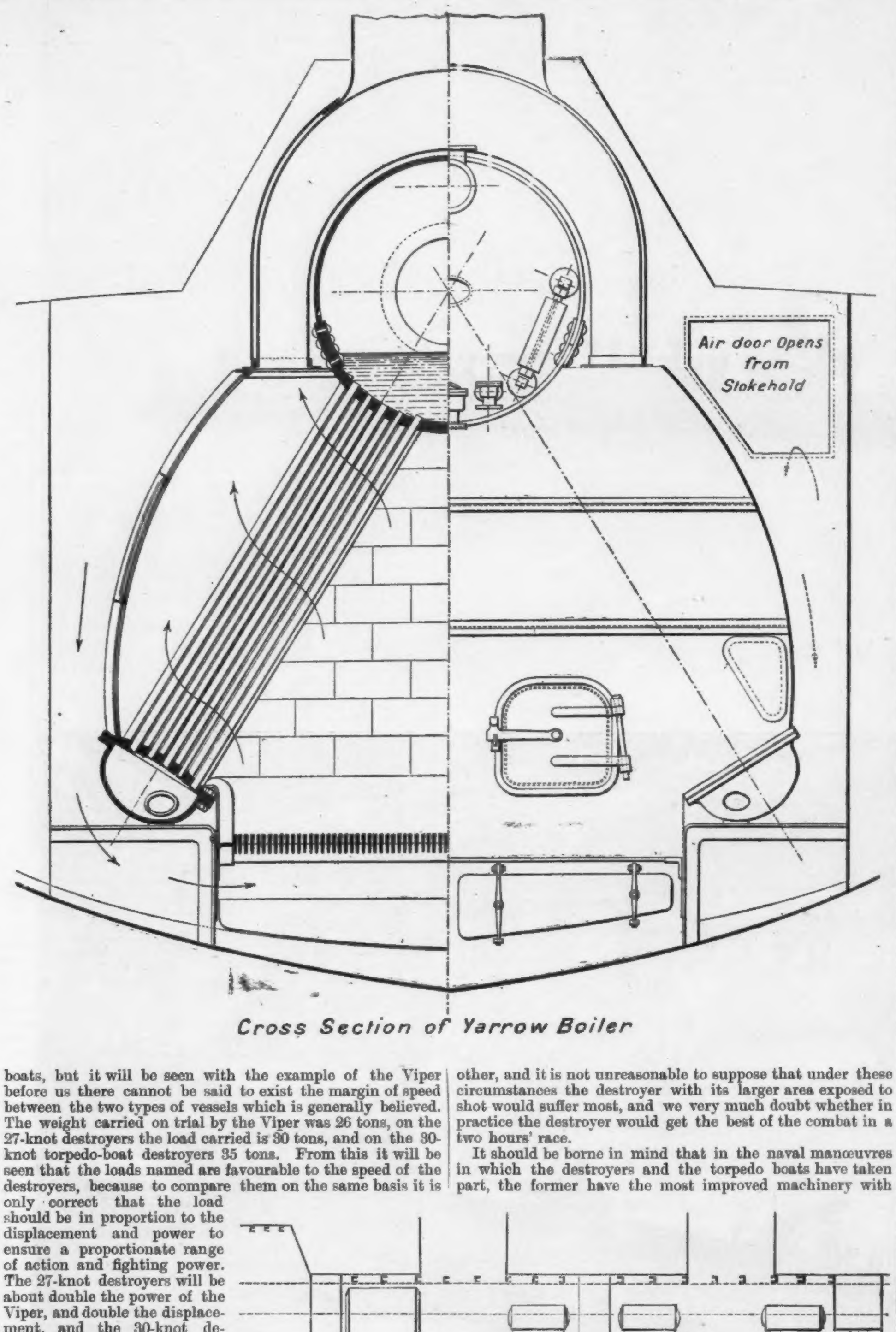
Hour.	Steam in boilers.	1st R.	2nd R.	Vac.	Air P.	Revs. per min.	Time.	Speed.	Mean.	2nd means.	Notes.
							m. s.				
1·36	175	69	11	25	·875	379·84	2 10	27·692	26·703		Lower Hope.
1·43	175	69	16	25	·875	378·00	2 20	25·714	26·597	26·650	
1·51	173	68	10	25	·875	382·86	2 11	27·480	26·975	26·786	26·633 Slip 11·3 p.c.
1·57	173	68	10	25	·75	386·46	2 16	26·470	26·373	26·674	I.H.P. 1940
2·3	173	68	10	25	·75	362·19	2 17	26·277	26·471	26·422	
2·10	175	70	11	25	1·	390·00	2 15	26·606			
Means	174	69	10·5	25	·875	379·89	—	26·716	—		

After these runs, went down to the Maplins and back. Accepted mean revolutions for the three hours 379·888 per minute. Accepted mean speed 26·638 knots.

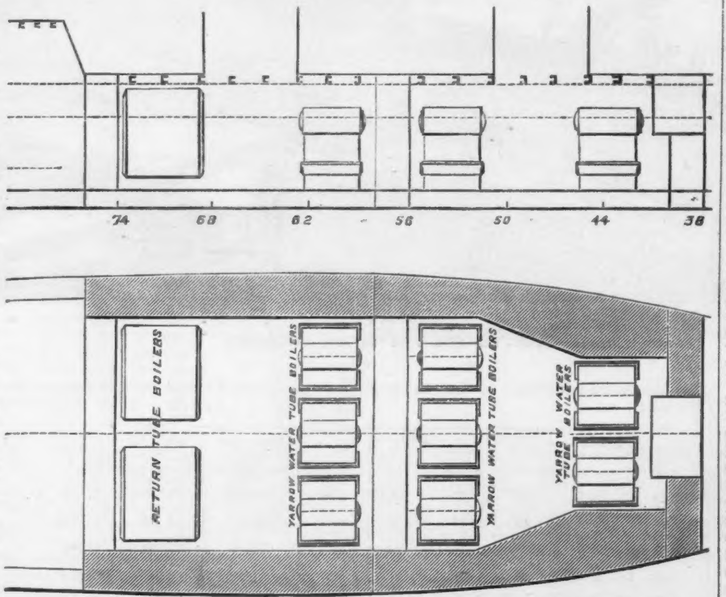
The Viper has since safely made her passage from the Thames to Pola. Her sea-going qualities were thoroughly tested on the passage out, as she experienced excessively rough weather in the Bay of Biscay. As a general rule in her Majesty's service first-class torpedo boats are convoyed by vessels of large size, but in the present instance the Viper made the passage from England to Austria unattended. This vessel attained on her trial on the Thames a speed, as shown above, of 26·6 knots with only ⅞in. air pressure in the stokehold, and it is instructive to draw some comparison between this result and those obtained with the destroyers, about which we have heard so much of late.

The object of the destroyers was to overhaul the torpedo boats, but it will be seen with the example of the Viper before us there cannot be said to exist the margin of speed between the two types of vessels which is generally believed. The weight carried on trial by the Viper was 26 tons, on the 27-knot destroyers the load carried is 30 tons, and on the 30-knot torpedo-boat destroyers 35 tons. From this it will be seen that the loads named are favourable to the speed of the destroyers, because to compare them on the same basis it is only correct that the load should be in proportion to the displacement and power to ensure a proportionate range of action and fighting power. The 27-knot destroyers will be about double the power of the Viper, and double the displacement, and the 30-knot destroyers about three times the power and displacement. Therefore to compare the various types on the same basis as the Viper which carried 26 tons, the 27-knot destroyers should carry 52 tons, and the 30 knots 78 tons; and if this load were carried on board the destroyers their speed would approach very near to that of the Viper.

No doubt the destroyers will have the advantage in rough weather owing to their better sea-going qualities, thanks to their size, but we greatly doubt whether the increased length of from 150ft. in the torpedo boat to 200ft. in the destroyers, will be sufficient materially to modify the comparative merits of the two types of vessels as regards speed in rough weather. Moreover, it must be borne in mind that in vessels of this type, which are quite unprotected, the destroyers expose a much larger area to the enemy's fire than the torpedo boats, and for this reason the larger vessels are the more vulnerable and more likely to be disabled in action. If the 27-knot destroyers were loaded with their proportionate load, there would probably be very little difference in speed between them and the first-class torpedo boats, and if the 30-knot destroyers were also proportionately loaded the probable difference in speed would not amount to more than 2 knots.



Cross Section of Yarrow Boiler


74
68
62
56
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44
38
RETURN TUBE BOILERS
YARROW WATER TUBE BOILERS
YARROW WATER TUBE BOILERS
YARROW WATER TUBE BOILERS

ARRANGEMENT OF SCOTCH AND YARROW BOILERS IN DUTCH CRUISERS

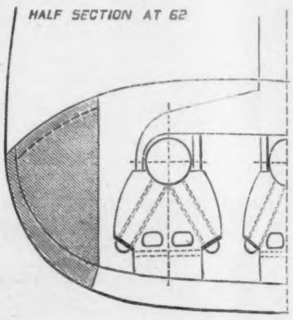
Now, assuming that a 30-knot destroyer were chasing a first-class torpedo boat, and the latter had the start of the former to the extent of ten minutes, which would give the torpedo boat a start of 4 knots, it would take about two hours for the one to overtake the other, during which time we may presume that both vessels would be firing at each other, and it is not unreasonable to suppose that under these circumstances the destroyer with its larger area exposed to shot would suffer most, and we very much doubt whether in practice the destroyer would get the best of the combat in a two hours' race.

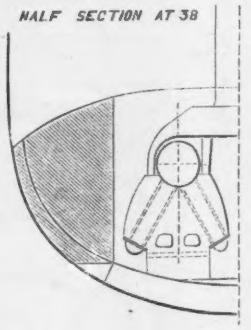
It should be borne in mind that in the naval manœuvres in which the destroyers and the torpedo boats have taken part, the former have the most improved machinery with water-tube boilers, and the latter are more or less boats of an obsolete type built years ago. The comparison would be very different if made between vessels in which modern improvements were introduced. Consequently, it becomes with the present light a question for Governments to consider how far they are justified in building vessels of the destroyer type, when the same expenditure of money would enable them to get two or three times the number of first-class torpedo boats. This is a matter rather for the naval officer than the engineer to decide.

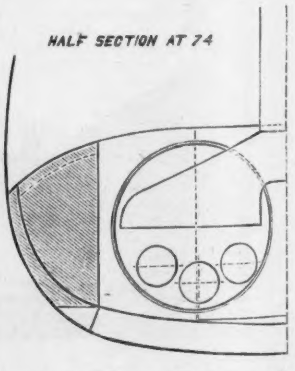
Returning now to the Viper, we may say that she has a single screw, and the engines indicated from 1900-horse power to 2000-horse power. The very low air pressure required to obtain this speed bears testimony to the great boiler power. After the run, the machinery, including the boilers, was found to be in perfect condition. The disposition of the various compartments is very similar to what has been adopted in previous first-class torpedo boats, with the exception that the officers' accommodation is more ample than usual, it being placed immediately aft of the machinery compartment. As regards the torpedo armament, that consists entirely of revolving deck torpedo tubes for firing over the sides, one being placed aft and two forward between the conning tower and the boiler compartment. As regards the gun armament, there are only two 47 mm. quick-firing guns, placed forward, one on each side of the conning tower, and arranged so as to have a direct-ahead fire. The coal bunkers are placed on each side of the boiler compartment, and one cross coal bunker forward of the boilers, the total coal capacity being about 30 tons. The heating surface in the boilers is 1868 square feet in each of the two boilers, *i.e.*, collectively 3736ft.; grate area 35ft. each, collectively 70ft.; air pressure ⅞in.

Our engraving shows the Dutch boilers complete with their casings as they stood in the works of the firm at Poplar. Concerning the Dutch boats for which the boilers are intended, very little information has reached this country. They are three cruisers, named Friesland, Holland, and Zeeland. The diagrams show the general arrangement of the boiler compartment, from which it will be seen there is an installation of two boilers of the old return tubular type and eight of the Yarrow water-tube boiler type. The Dutch boilers are, with very minor exceptions, practically the same as in the Austrian torpedo boat Viper, in which boat there are two boilers. The boiler arrangement is particularly interesting, as it is the first important case in which two classes of boilers are combined, and we have very good reason to believe that this will be repeated in other vessels. We are enabled to add a detailed drawing, which is of considerable interest. The general construction of the Yarrow boiler with its straight tubes is, of course, well known, but our engraving shows the thickened tube plates and the arrangement of the grate and air casing. It is a noteworthy fact that thick as the tube plates are, they can be distorted in expanding the tubes, and that skill and experience are required on the part of those setting the tubes, who work first at one side, then at another, as the indications demand; subsequently there is no trouble.

As it is a matter of very great interest to the profession generally as to the manner in which tubes can be renewed in a straight tube boiler like this, we append the following remarks—As a rule, if a few tubes burst they are plugged up. This is a very simple operation, and a few tubes failing makes very little difference to the efficiency of the boilers, considering the large number of tubes which each boiler contains. If, however, it is desired to replace the tubes, this can be done with very much greater rapidity than is generally believed. Messrs. Yarrow can replace and expand a complete transverse row in from three to four hours. The manner in which this is done is as follows:—The tubes in front of the burst one are removed, which may be done in the reverse manner to the way in which new ones are replaced. The tube is first inserted into the first hole in the drum and passed upwards into it; it is then lowered into the first hole in the water chamber below; after this is done it is then passed up again into the next hole in the steam drum, then brought down again into the next hole in the lower tube-plate, the tube being zigzagged as it were, into the position required. There is not the slightest difficulty in carrying this out, and it can be done rapidly. The upper end of the tube is expanded in the usual way from the inside of the steam drum. The lower end can be expanded in the same manner if the water pocket is sufficiently large to admit of a boy working in its interior, but if the water pocket is too small for this to be carried out, the expander is placed opposite the tube and the mandril of the expander is driven round by means of a jointed bar inserted from the steam drum.







One feature in the boiler arrangement is that the air passes to the fire through openings fitted with light non-return valves which are attached to a diaphragm plate, which is fixed to the front of the boiler. Immediately there is pressure in the stokeholds the air passes through these valves round the entire casing of the boiler, and then underneath the bars to the furnace. By this means the coal bunkers, which generally surround the boiler, are kept comparatively cool; and what is a much greater advantage, the hinged doors, from their position, are not likely to be distorted, while if these hinged doors are placed in front below the bars as previously done, they are very apt to get out of shape by the heat they are subjected to, and also by the accumulation of cinders preventing the doors from closing properly.

The advantage of straight tubes is self-evident, as they can be readily cleaned out and examined internally. It is a cheap form of construction, and the number of spare tubes required to be carried, as they are all straight, is much less than if they are curved to various forms. Boilers having straight tubes have now been in actual service for many years without any disadvantage being found through their adoption. The fact is the tubes are for all practical purposes, at the same temperature as the water, and are consequently of the same temperature as one another, therefore the difference through expansion—if there be any—is of such a trifling character as not to be beyond the limits of the elasticity of the material. This was clearly confirmed by Professor Watkinson's paper on water-tube boilers recently delivered at the Institution of Naval Architects.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

LIGHT RAILWAYS *v.* LIGHT ROAD LOCOMOTIVES.

Sir,—The following is written having particular regard to the probable effects upon the light road locomotive system of transport, consequent upon recent and future improvements in the construction and maintenance of country roads, and the possibilities incident upon repeals of the Road Locomotive Acts. It may be advisable at the outset to explain that my views are favourable to the use of light road locomotives in preference to light railways; but it is as well advisable to state that it is not intended to seek to claim general superiority of the former over the latter, but rather to advocate an extension of transport by light road engines under conditions favourable to their employment.

It is perhaps unfortunate for the pioneers of the "light railways panacea for the relief of distressed agriculture," that in many quarters too much by far is expected of it, and it may be taken for granted that the direct pecuniary relief to be gained by the distressed agriculturists from the laying down of light railways will be found—should the experiment be tried—in many cases rather theoretical than practical. Exponents of light railways should remember that at the present time, after over half a century's railway experience, one of the agriculturist's great grievances is that he is handicapped by high railway charges. To many it appears strange that a further commitment to railway enterprise, and that specially for agricultural produce purposes, should be so strongly advocated as a method of relief.

Now it is an admitted fact that road locomotive engines, in spite of the ridiculous restrictions imposed upon their use, have proved of very considerable service to the farming community in the matter of haulage of produce, manure, timber, &c.; and in considering this, special attention must be drawn to the fact that Acts of Parliament have not only restricted the employment of these engines, but have as a consequence restricted the manufacturers of them in the developement of design and construction, fitting them for up-to-date requirements. Added to these restrictions has been a not inconsiderable public prejudice, and, perhaps more important still, the undoubtedly bad condition of roads in rural districts.

It is in reference to this latter restriction that particular attention is drawn; it being almost unrecognised that in consequence of the results of the County Council and Parish Council Acts in the matter of an increased attention to road construction and maintenance, a condition of affairs is being produced that is certain to have a great influence on this question of the transport of agricultural produce from place to place.

The revolution effected in the construction and repair of macadam roads in towns and congested districts by the steam road roller is notorious; but it is little known that during the past two years in particular a most important innovation has taken place in rural districts—and is still developing—in this matter of improved roads; so much so, in fact, that the time is not far distant when our country roads will be in such a sound condition as would, a few years since have been thought not only improbable, but impossible. The value of steam road rollers was proved and settled a quarter of a century ago; but, owing to the peculiarities of our old system of rural district government, their use in country districts to any extent was hampered, and in fact almost impossible.

The new Acts have, however, by consolidating and grouping districts, and insisting upon a general system of public management, opened the way for improvements in road making, and these upon permanent and practical lines, with the result that during the past two to three years several hundreds of County and Rural District Councils have acquired steam road rollers of their own; very many more are hiring of other Councils or of contractors, and of the remainder it may be assumed that ere long they will have followed suit, rendering it more than probable that within a comparatively few years the whole of the main and ordinary traffic roads of this country will be in such an improved condition as will justify the opinion of interested observers that a great development of the road locomotive system of haulage on common roads is certain.

Another factor is at work hastening the consummation of this assumption, viz., the cordiality of the reception of the autocar, the commercial advent of which must mean such an alteration in the present Road Locomotive Acts as shall open up a very big field for the light, quick-running road engine, whether actuated by steam or any other motive power. In its present state the petroleum or electric motor-car does not seem to offer much scope for heavy traffic purposes, although it may be taken for granted that in this respect the future has many developments in store, and for practical purposes, as concerns the material subject in hand, steam engine makers of the standard type of road locomotive will probably very quickly take advantage of the licence a repeal of the Acts will allow, and produce engines which in such important points as speed, lightness, power, and economy, will mark an important departure from present practice, fulfilling the conditions required, viz., cheap and speedy transport.

In spite of the fact that Acts of Parliament make liable to a heavy fine the running of a steam engine upon the high road at a greater rate of speed than four miles per hour, there are at present working in this country a number of traction engines specially constructed for running at speeds up to seven miles per hour, and it may be assumed that, opportunities presenting themselves, these engines are frequently running at unlawful speeds.

In the early days of road locomotives there existed reasons for some of the restrictions imposed, the engines constructed thirty to forty years ago being at best cumbersome, noisy, and in many ways objectionable; but during the intervening period a number of improvements have been introduced, until the present day the traction engine is anything than the offensive object the early engine was regarded as. The principle of compounding has been adopted, economy in fuel consumption of 30 to 35 per cent. resulting; improvements in boiler construction have been continuous, with the same results; the spring difficulty has been practically solved, traction engines now being as well off in this respect as railway locomotives; noise in travelling has been much reduced; by the use of compound cylinders the objectionable beat of the exhaust steam is much reduced in intensity, and from being exhausted at a little above atmospheric temperature, is not nearly so perceptible as with single-cylinder high-pressure engines. Weight for weight, traction engines are much more powerful now than formerly. They are *recognised* "necessary evils," and as a proof of their success in the face of opposition, the fact of there being between 6000 and 7000 working in the British Isles is strong evidence.

An argument in their favour—and it is a strong one—is that traction engine development has been effected not only without the assistance of legislation, but in the direct face of its opposition, proving that these engines have been successfully meeting a practical demand, and meeting it to the advantage of both owners and employers. The question then arises, given fair play by law, and that official and public recognition their success warrants, in addition the advantage of better roads for travelling on, is it not probable that an important development is possible for road haulage by steam?

Judging by what has been so far accomplished in the face of obstacles, this deduction seems assured, and the question then arises, Is it certain that the present transition period is an opportune one, and would it seem prudent at such a time for the sinking of large sums of money, public or otherwise, in the laying down and equipping of light railways, whose future success or failure would in the majority of cases be quite problematical?

Belgium is quoted as an instance of successful light railways. But Belgium is practically destitute of traction engines; Belgium is not an agricultural country in the strict sense of the term. Distances between centres of population and industry are small; and Belgium has had no education in the subject of steam haulage on common roads. Ireland is quoted as possessing instances of non-success in light railways; and for comparison with the requirements and possibilities of Great Britain I would prefer to take Irish experience, case for case, than that of Belgium. Consider the difference in capital expenditure between the cost of opening up a district with a light railway and that with road engines. The former means purchase of ground in many instances, and in all instances the laying down and equipping of permanent ways, the building of stations, wharves and sidings, the permanent employment of officials, and the sundry incidentals necessary to the conduct of a railway; and in addition the heavy expense attached to the purchase of rolling stock. The latter means absolutely no expense whatever in the matter of permanent way, land, buildings, &c., nor a penny's expense in the matter of officials. A striking difference, surely?

But then consider the difference as regards security for capital expenditure. In the event of the failure, from a commercial point of view, of a length or system of light railway—and it is certain that such could not continue to be conducted at a loss—what becomes of capital sunk? To a large extent it would be lost, and the second state of those wont to depend upon the line for the transport of their produce and material would be worse than the first. With road engines a fiasco would be impossible; and, more important still for the users or customers, the competition that would be certain to result would ensure low rates of carriage. In the event of business on a particular route not proving remunerative to a road engine contractor, he would simply remove his plant to a more satisfactory locality; and should the user be the owner—which would be found in the majority of cases—he would in all respects be better off in keeping his engine at work, it being, in the first place, a fact that steam haulage on roads can be accomplished at half the expense of horse and with nothing like the trouble, and, in the second place, he would escape the inconvenience resulting from the abandonment of an unsuccessful light railway.

The point arises: Would it be possible for road engine haulage to be accomplished at as low rates as light railways? It is impossible to answer this satisfactorily in detail, circumstances being so varied. Where a light railway could command sufficient traffic to enable it to convey at low rates, the railway rates would in all probability be lower than those of the road engine, particularly if the distances traversed were considerable, and in such cases light railways would be of undoubted utility and pecuniary assistance to users. But it is unlikely that these instances would prove more than the exceptions; and bearing in mind the opinion generally expressed and nearly as generally accepted, that much reasonable doubt is allowable as to the success of much of the light railway that might be laid down, it would seem, in view of the promising prospects of road traction due to the several causes enumerated, that the time present is not to be considered propitious for a wholesale embarking in light railway schemes. There are doubtless many localities and districts in which light railways may prudently be constructed, and that as quickly as possible, but in many of such cases it is more than likely that distressed agriculture will not be found in a chronic state, lessening correspondingly the need prompting the railway's construction from the "distressful" point of view. The greater probability is that in districts where agricultural distress is chronic or intense, the very conditions accounting for such distress will militate against the success of light railways, and the responsibility attached to the sinking of capital under such circumstances would be more than sufficient for the man of ordinary conscience. It is to be hoped that public money will not be hazarded without the most careful consideration of not only the claims for and requirements of particular localities, but of the practical principles of the schemes, having in view the possible development of other methods of transport more likely to command success.

It remains a fact, however, that in spite of what may be done in the matter of light railways, the road engine has "come to stay," and is on the eve of a further important development. As a feeder for railways it is unequalled by any other system of motive power extant. It can be used nearly anywhere where it is possible to use a horse, and can accomplish under many difficult conditions work where horse traction is impossible. Its two chief drawbacks so far have been:—(1) That owing to law restrictions as regards speed, heavy slow-running engines for heavy loads have resulted. (2) That owing to the bad state of the majority of country roads, these heavy engines and their heavy loads have been in many instances held responsible for road damage, bringing upon the shoulders of their owners liability for heavy penalties. The latter of these drawbacks is being rapidly removed, and of the former it may be assumed that we have almost reached the end.

The position will then be that with better roads and fewer restrictions of the law, what is now being accomplished by road engines is as little compared with what will be possible under these altered conditions; it being recognised that the cost of transporting one load of, say, twenty tons, twelve miles in four hours, could be effected in two journeys, with half the weight, at double the speed, for at least no extra cost. But then an advantage would be that, whereas it does not pay to run heavy engines with light loads, thereby restricting their use, the light, quick-speed engine will be equally economical with light loads as the present engine is with heavy ones. That is to say, the light, fast engines will step in and deal with the light traffic heavy engines could not be profitably employed in; whilst, at the same time, by reason of their increased speed, they will be able to transport, when required, the same weight in the same time as the heavy engine, except in cases where bulk could not be divided, when the more powerful engine will still be employed.

There is another point worth notice in connection with this comparison of traction engines with light railways. It is impossible for the latter to reach the door of every customer; and except in the few cases where lines might pass or run through farms, produce and material will have to be transported to and from the line, incurring the expense of an additional loading and unloading when gauges might be different. With the traction engine the material can be loaded directly from the field, barn, or railway station, and conveyed to its destination without further handling; and it would be found in practice that, except in long distances, it would often cost as much to convey to the light railway as to the main line.

There is, of course, the question of capital, and it would be asked, Is there in rural districts the capital with which to develope this traction engine haulage system? From my own experience it can be assumed that to a very considerable extent private capital would be forthcoming for a further development upon paying lines, as indicated; but it can nevertheless be advocated that there would be good reasons for financial assistance in some public form, and that, too, with infinitesimal risk, should it be publicly and officially recognised that there is that sterling merit in the business by which the distinct probability of pecuniary advantage to agriculture could be anticipated. One advantage of immense importance possessed by the road haulage system is that to test its value for a locality no large initial outlay is necessary, as would be the case with a light railway. In fact, past experience has been that opportunities and demand have led to the development of road haulage, the one being automatic with the other. It has been a practical, profit-bearing business all through, and it is this that should make it worth the serious consideration of legislators and public men interested in this question of practical relief for agriculture.

It will be gathered from remarks in the foregoing that I do not put forward this road engine haulage system in direct antagonism to light railways. I have remarked that in many favoured localities the latter could well be laid down and profitably worked; and whilst my personal convictions on the subject are stronger than I have in this article given expression to, I admit and recognise that it would be almost as foolish to claim general suitability for road engine haulage as it is to advance the same claim for light railways. But from over twenty years' experience with business closely allied to that of agricultural haulage, and from having for a number of years made almost daily use of the oldest piece of open road light railway in the country, I have acquired the conviction that for the purpose in question the light, quick-speed road engine is capable of more general utility and benefit to agriculture than a wholesale system of light railways, having in view that the results attending unremunerative or lost capital, public or private, sunk in light railways, must in the end be felt by the public.

Slow Speed.

Maidstone, March 24th.

PERMANENT WAY.

Sir,—I pretend to something more than a mere practical knowledge of the above-mentioned matters, acquired during a series of years' service with the late Thomas Brassey, as "agent" entrusted with the construction of railways; and it is just possible, especially at the present moment, that a few words upon this very important matter may not be taken amiss by your readers—may possibly even be of use.

Whilst the locomotive has ever been the subject of consideration, to the last nut and rivet employed in its construction, or the endeavour to get the last unit of heat out of the fuel used, and every other department of railway manipulation—with one exception—has gone with the times, and has been subject to close practical and scientific investigation, that of the permanent way and platelaying—repairing—exist to-day just as when the department was handed over to the tender mercies of the navvy fifty years ago, a matter of "rule of thumb."

The great margin of safety which undoubtedly once existed between a tolerably well-bedded road, and the load rolling over it, does not exist to-day. Engines of four times earlier weights, and speeds of running at least double, constitute a coefficient of danger eight times, if not sixty-four times, what had once to be provided for. This is not accomplished now, with sleepers poised in the air upon not much more than 2ft.—certainly not 3ft.—super of surface of "packed" ballast, with all the rest of the sleeper in mid-air—"shovel packing" to the contrary notwithstanding—exactly as obtained fifty years ago, and under precisely the same kind of intelligences.

A body representing 90 tons, rolling down an incline of 1 in 200 at something like a speed of sixty to seventy miles an hour, would easily shift or "slew" a new road dangerously out of line, especially if it were not fully ballasted, and it had been subject to a soaking downpour of rain just before.

To be on the safe side in such an important work, something more should be required than the tap which the navvy gives with his beater on the sleeper when he moves away to "beat up" the next one; for dangerous forces have, with the time, come into play, far beyond what such a man or his ganger can appreciate, and which need all the intelligence of the professional man as well.

A new era of platelaying and maintenance will be inaugurated the day that a sufficient number of accidents have occurred to demonstrate the danger attending the present unconsidered and old-fashioned system, and, with all humility, I forward you these few lines in the hope that they may arouse the attention of the most interested in the business, and lead them to attempt the removal of one serious danger in railway travelling.

J. W. Wilkins.

15, Lilford-road, Coldharbour-lane, S.E.

(*For continuation of Letters see page* 354.)

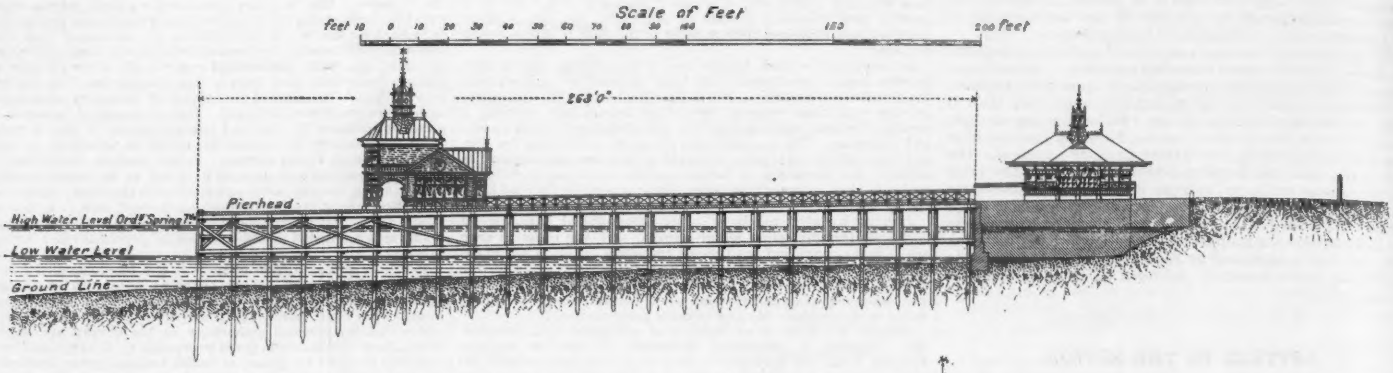
King's College Engineering Society.—At a meeting of this Society, held on Friday last, a paper was read by S. L. Fletcher, entitled, "The Planets: Are they Worlds like Ours?" Reference was made to the doctrine of Copernicus that the earth was itself a planet, revolving around the sun, and turning upon its axis in the same direction as the other planets. In fact, the earth was so truly a planet, from the astronomer's point of view, that it was natural to inquire whether the planets were worlds, and whether life was likely to exist upon them. The planets naturally fell into two groups—the four small planets, including the earth, whose orbits lay within the ring of asteroids, and the four great planets, all situated further from the sun. The small planets were solid bodies, as shown by their densities, and revolved on their axes in about the same time as the earth; the large ones had low densities, and appeared to be in a heated and vaporous condition. The large planets were all attended by satellites varying from one to eight in number, and on these, warmed and lighted to some extent by the neighbouring bodies of their primaries, life might exist; though it could hardly exist at the present time on the giant planets themselves.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—Fleet-Engineers: John T. H. Denny, to the Trafalgar, additional, and for recommission; and Henry J. J. G. Moon, to the Thunderer; and Elijah Tucker, to the Colossus. Staff-Engineer: Henry J. Walker, to the Victory, additional, for the Boadicea. Chief Engineers: Edward R. Odam, to the Fox; and John G. Stevens, to the Nelson; and William F. Turner, to the Victory, additional, for the Mercury; Robert S. G. Norgate, to the Victory, for the Nymphe; Stephen Hockey, to the Sphinx. Engineers: Victor de Paris, to the Victory, additional, and afterwards to the Fox; Edward Chisman, to the Empress of India; and Herbert J. Little, to the Trafalgar, additional, for the Nelson; Ernest C. Thornhill, to the Redbreast; and Henry R. Teed, to the Pembroke, additional, for the Jaseur. Assistant Engineers: John L. Kimber to the Victory, additional, and afterwards to the Fox; Arthur Oliver, to the Resolution; Llewellyn Howell, to the Magnificent; and Gordon Robertson, to the Majestic; Thomas T. Brown, to the Trafalgar, additional, for the Nelson; and William Rattey, to the Nelson; and Edgar C. Smith, Henry R. S. Hughes, and Hugh L. M. Ford, to the Trafalgar, when recommissioned.

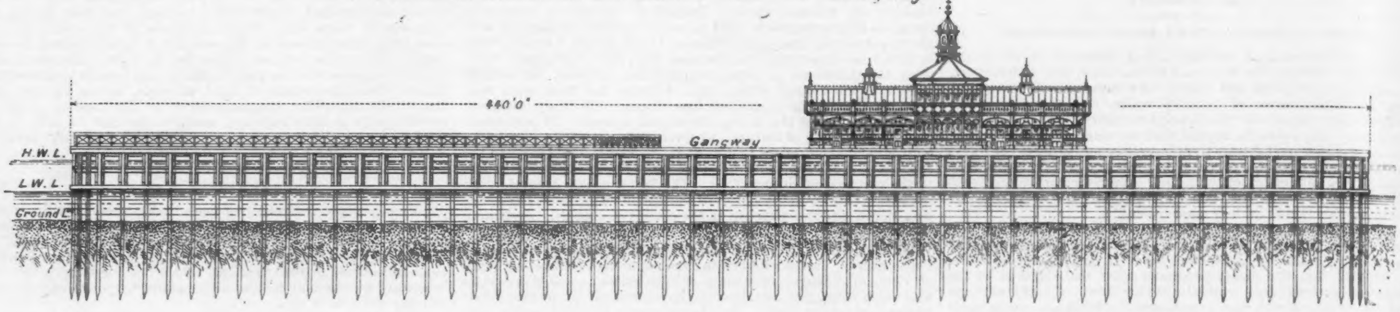
THE DUNOON BURGH PIER

MR. W. R. COPLAND, M. INST. C.E., GLASGOW, ENGINEER

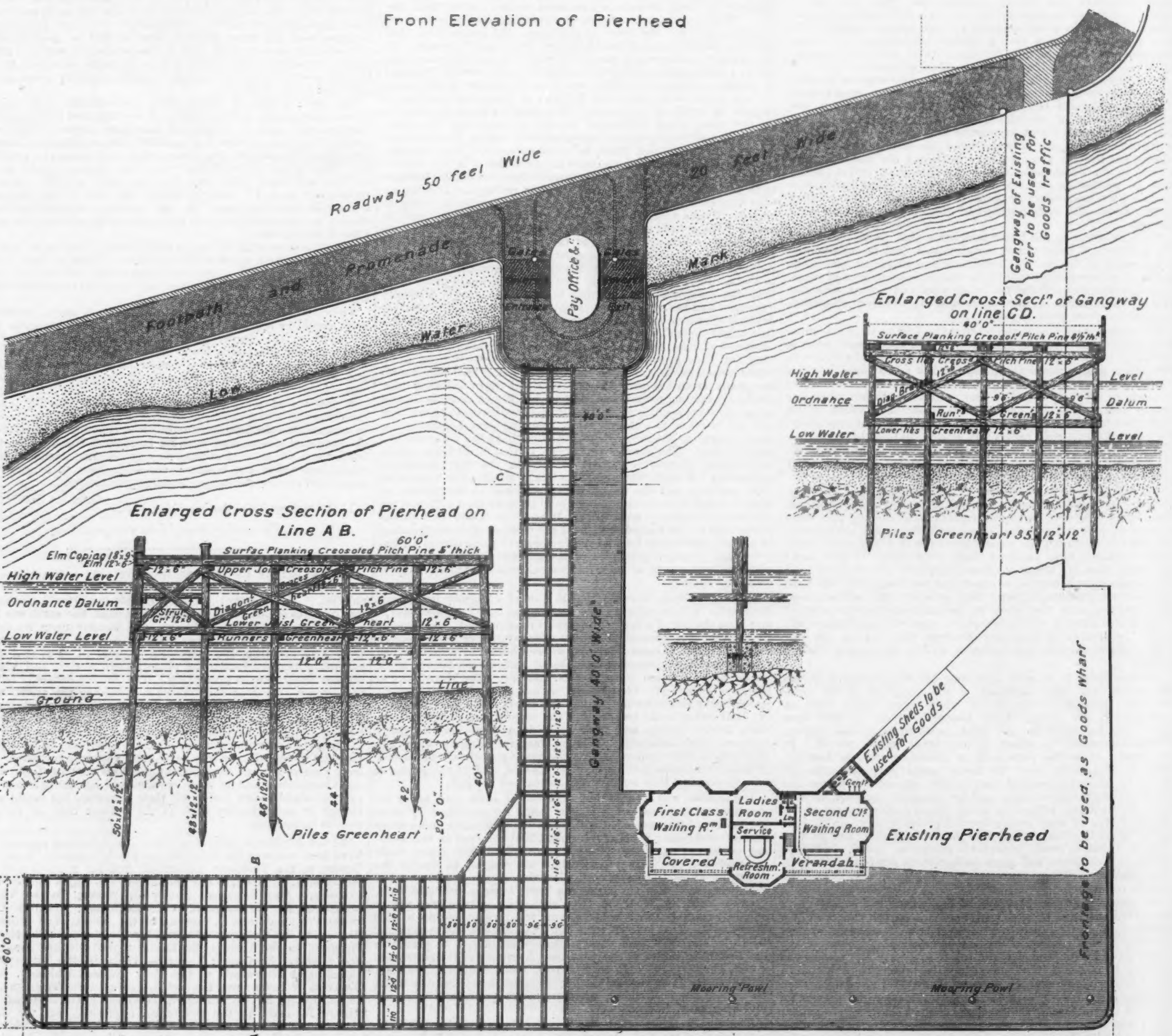
(For description see page 339)


Scale of Feet
feet 10 0 10 20 30 40 50 60 70 80 90 100 150 200 feet
263'0"
Pierhead
High Water Level Ord^y Spring T^s
Low Water Level
Ground Line

Sectional Elevation on Centre line of Gangway


440'0"
Gangway
H.W.L.
L.W.L.
Ground L

Front Elevation of Pierhead


Roadway 50 feet Wide
20 Feet Wide
Footpath and Promenade
Pay Office &c.
Gates
Entrance
Exit
Low Water Mark
40'0"
C
Gangway of Existing Pier to be used for Goods traffic
Enlarged Cross Sectⁿ of Gangway on line C D.
40'0"
Surface Planking Creosot^d Pitch Pine 4½" th^k
Cross ties Creosot^d Pitch Pine 12" x 6"
12" x 6"
High Water Level
Ordnance Datum
Low Water Level
Diag^l Br^s
9'6"
9'6"
Run^{rs} Green^t 12" x 6"
Lower ties Greenheart 12" x 6"
Piles Greenheart 35' 12" x 12"
Enlarged Cross Section of Pierhead on Line A B.
60'0"
Elm Coping 18" x 9"
Elm 12" x 6"
Surfac Planking Creosoted Pitch Pine 5" thick
12" x 6"
Upper Joist Creosot^d Pitch Pine
12" x 6"
High Water Level
Ordnance Datum
Diagon^l Braces Green heart 12" x 6"
12" x 6"
Strut Gr^t 12 x 8
Lower Joist Greenheart
12" x 6"
Low Water Level
12" x 6"
Runners Greenheart
12" x 6"
12" x 6"
12'0"
12'0"
Ground Line
50' x 12" x 12"
48' x 12" x 12"
46' x 12" x 12"
44'
42'
40'
Piles Greenheart
203'0"
Gangway 40'0" Wide
Existing Sheds to be used for Goods
Gents
First Class Waiting R^m
Ladies Room
Service
Second Cl^s Waiting Room
Covered
Refresh^{mt} Room
Verandah
Existing Pierhead
Frontage to be used as Goods wharf
Mooring Pawl
Mooring Pawl
60'0"
A
B
440'0"
With Surface Planking Removed
On top of Planking

Plan of Pierhead and Gangway

Scale of Feet

10 0 10 20 30 40 50 60 70 80 90 100 150 200

"The Engineer"

Swain Eng.

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Wednesday, April 8th, at 2.30 p.m. To inspect the works of the Waterloo and City Railway.

GEOLOGISTS' ASSOCIATION.—Friday, April 10th, at 8 p.m. Demonstration, illustrated by the lantern, of Photographs taken on recent excursions of the Association, by Messrs. W. F. Gwinnell, F.G.S., and H Preston, F.G.S.

THE ENGINEER.

APRIL 3, 1896.

CIRCULATION IN WATER-TUBE BOILERS.

PROFESSOR WATKINSON'S paper, which will be found in another place, is a valuable contribution to the literature of an obscure subject, every point of which has been made matter of debate and controversy. How and why circulation is brought about, not only in water-tube, but in all other forms of boiler, is in no way obvious to those who are satisfied to think for themselves. At every step we take to an explanation of the phenomena we encounter difficulties and perplexities, contradictions and objections. It is not worth while to deal particularly with ordinary boilers, although on the circulation or want of circulation within them depends their success or failure when forced. We shall confine ourselves just now to the water-tube boiler. Professor Watkinson gave a very lucid statement of his theory of circulation. With that explanation we cordially agree. It would be remarkable if we did not, seeing that it is almost word for word the explanation that we have more than once advanced. To this explanation Professor Lambert takes exception. He says it is not true, and puts forward another. Professor Lambert's theory is that of many engineers. It is none the less unsound. Let us see what it is.

Taking the familiar illustration of a U tube, down one leg of which water descends, while up the other, heated by a suitable flame, steam and water rise, Professor Lambert asserts that the descent of the "solid" water results from the fact that the contents of the rising leg of the tube are less dense—in a word, lighter than the contents of the descending leg, or downcomer. There is a want of scientific precision about this statement, but we are not responsible for that. We must endeavour to find out what the statement means. The contents of the rising leg are water and bubbles of steam. Now Professor Lambert cannot possibly mean that the water in the riser is less dense than the water in the downcomer. What he does mean is, that the column of water containing bubbles of steam weighs less than the column of water without the bubbles, and is overbalanced by the downcomer, and so circulation is set up. But this bald statement will not suffice, for the simple reason that the weight of steam and water together in the rising leg may greatly exceed the weight of solid water in the descending leg, and yet rapid circulation will take place. In the Yarrow and Thornycroft boilers, for example, the weight of water and steam in the numerous risers very greatly exceeds the weight of solid water in the downcomers; yet circulation goes on, and this, too, although steam is actually made in the downcomers and bubbles are present in them. It is clear, therefore, that inasmuch as 5 lb. or 6 lb. of water in a downcomer can cause circulation, although opposed to 50 or 60 lb. of water in the risers, it is not mere relative weight that can bring it about. Let us suppose, indeed, that the water and steam are intimately mixed, and still the weight of the mixture in a number of tubes may be greater than that in a single downcomer. It is clear, therefore, that Professor Lambert, who doubtless knows all this, has something else in his mind. The moment, however, that the notion that mere difference of weight in the contents of the two tubes is the cause of circulation is abandoned, then the explanation which we have advanced, and which is accepted by Professor Watkinson, becomes the only explanation that is satisfactory. At the lowest point in the U tube we may conceive of the existence of a plane of demarcation dividing the water in the right leg from that in the left leg; we may imagine a diaphragm placed here across the tube. It is obvious that no movement of the water can take place down the right leg, let us say, so long as the *pressure* against the diaphragm due to the left leg is equal per square inch to the pressure of the water trying to descend. Now, so long as there is a column of water, no matter how thin or how light, extending from the top of the riser to the diaphragm, no movement can take place; the hydrostatic pressure being the same at both sides of the diaphragm. Of course it will be seen that the diaphragm is not in any way necessary. We suppose its existence merely to make our meaning clear. The contents of the riser may be broken up and ragged to any extent. There may not be half or a quarter of a tube full. So long as a column of water extends from top to bottom, so long will the water in the downcomer remain there. If it descends, it is not because of the fact that it weighs more than the contents of the riser, but for other reasons altogether. Neither Professor Lambert, nor any one else, has, so far as we are aware, attempted to prove that this argument is unsound. He will willingly admit, no doubt, that if a glass rod were put down the rising leg it would not cause the descent of the water in the downcomer, and he will not dispute that one riser, an inch in diameter, would balance the contents of a thousand downcomers of the same diameter. Thus, then, the controversy between himself and Professor Watkinson reduces itself to the assertion that such a column of unbroken water does not exist in a riser. On this point it is necessary to read carefully what Professor Watkinson has said. We assert that such columns always exist in the riser, unless the bubbles are sufficiently large to plug the tube; that is to say, to fill its whole diameter, as shown in Fig. 4 of Professor Watkinson's paper. But it is obvious that this plug action simply means cutting so much out of the hydrostatic column, and conditions may exist when a boiler is forced, under which an accumulation of foam takes place in the upper portion of the tube. The vertical length of the column producing hydrostatic pressure is correspondingly diminished, and a very violent circulation may result. But all this has nothing to do with Professor Lambert's views. He and many others with him hold that, under any and all circumstances, the presence of even a few bubbles in a tube is sufficient to produce circulation, because the water with bubbles weighs less than the water without them. It may be worth while to add one word here on the subject of entraining. Professor Lambert will have none of it. There is no such thing. Engineers would be only too happy if this were true, for then there would be no priming.

We may now proceed to inquire why bubbles of steam rise. The rising is often confounded with circulation; but, as a matter of fact, there is no very close connection between the two, and a water-tube boiler may get on very well without any circulation of water within the tubes. Thus, one speaker during the discussion at the Institution of Naval Architects, told the meeting that he had found the Niclausse boiler in a steam launch do just as well without as with the internal circulating tubes. We ourselves know of a large Field vertical boiler which worked successfully for more than twenty years without any internal or "Field" circulators whatever. The reason why a bubble rises is that it is pushed up. The pressure below it is greater than the pressure above it, and so it goes to to the top; and it will go to the top in a single tube so long as it does not fill the tube, and it will rise because water descends past it, between the sides of the bubble and the sides of the tube, and so circulation takes place under conditions which are certainly not those set forth by Professor Lambert. If the bubble quite fills the tube then there can be no movement. This can easily be proved by a very simple experiment with air bubbles in a small glass pipe. Now we may have conditions in which the bubble very nearly fills one leg of a U tube, but not quite. In that case it is pushed up from below, and it would rise, the water descending down the side of the tube. But water will take the line of least resistance, and inasmuch as it is easier to come down the open downcomer than it is to pass down round the sides of the bubble, it will take the downcomer as well as the sides of the riser, and the quantity descending in each tube will be as the areas open for the passage of the water, and so circulation will be produced. The downcomer and the riser may be regarded as one vessel for the time being. When the number of bubbles is so great that they quite fill the top of the riser with foam, the hydrostatic column is shortened by so much, and the circulation is correspondingly violent; and this is no doubt what occurs in nearly, if not all, water-tube boilers when pressed. It would be superfluous to reproduce here what Professor Watkinson has said on this point elsewhere.

We believe that we have now put this interesting subject into such a form that the issues are narrowed to the simple question—Does or does not a hydrostatic head exist at the base of the riser of a water-tube boiler? If not, what has become of it? We have shown that when the boiler is so pressed that the upper portions of the tube contain only foam, the hydrostatic head is reduced by the length of the foam column, and that in no possible case can the mere weight of water in the riser or downcomer have anything to do with the matter. The agent causing the flow or circulation of water is just the same as that causing the flow of water through any other system of pipes, and the laws of hydraulics operate without consideration for the circumstance that in one case the water may be hot, in another it may be cold. It is now for Professor Lambert, and those who hold his opinions, to find and point out the flaws in our reasoning and the inaccuracies of our statements.

INCANDESCENT GAS LIGHTING.

FOR many years attempts have been made, not without partial success, to convert a larger proportion of the total energy represented by the combustion of coal gas into light than is the case with ordinary burners, however good. The theory now generally received concerning the conversion of energy of combustion into vibrations of a wave length sufficiently short to be appreciable to the human eye as light, is to the effect that particles of carbon both solid and refractory are raised to incandescence at the high temperature engendered by the combination of the chief constituents of coal gas with the oxygen of the air. The nature and mode of translation of the bodies immediately concerned in the production of these solid refractory particles, and in their conversion into centres of radiant energy of short wave length, are still a matter of much controversy, pursued indeed by some of the combatants with a vigour bordering upon animosity. When the trifling percentage of the total energy of the combustion of coal gas which appears as light is considered, it is not surprising that means for increasing the output should have been earnestly sought, and that refractory particles less transient than those evolved by the action of combustion should have been tried as a medium for this conversion. The old Bude light, which exists to this day in the form of the lime light—still preferred for theatrical purposes over the light given by an arc lamp—is an instance of the kind, inasmuch as in that case the luminosity to be obtained by the consumption of gas with a normal quantity and pressure of air is sacrificed voluntarily, in order to attain a temperature high enough to raise a typically refractory substance, viz., lime, to incandescence. The obstacle to the general adoption of some such material thus heated arises from the fact that for the consumption of the gas in a manner capable of producing the requisitely high temperature a blast of air is indispensable. The prospect of supplying public and private burners with air under pressure is enough to make all but the boldest shrink. It could be done, of course—but the price? Consciously or unconsciously, inventors have gone at once to the root of the matter, and have sought a better refractory material—one which should be capable of yielding a fair output of light without needing special precautions for the raising of its temperature greatly above that attainable by a non-blast burner. Magnesia was tried in a variety of forms, one of the most efficient of which was probably that used in the Fahnehjelm burner, an apparatus consisting of a comb of magnesia rods suspended over a Bunsen burner and heated by the flame issuing therefrom. Similarly, some ten years ago, zirconia—the oxide of the rare metal zirconium—had a considerable vogue among magic-lantern exhibitors as a substitute for lime. From these facts it is clear that the instinct of the inventor led him to the exploitation of the matter to be heated rather than to the improvement of means of heating it, and events have shown that his instinct was sound.

The light now familiar to us as the incandescent gas light *par excellence*, more properly known as the Welsbach, may be truly regarded as the heir of previous devices, in that the refractory substance chosen is greatly better than that used in earlier attempts, while the burner embodies no new principle. Without being tedious, we may perhaps be permitted to touch shortly on the essential points of the modern Welsbach light. The burner is of the Bunsen type, *i.e.*, air is mixed with the gas before combustion in such a manner and in such quantity that the flame is non-luminous. Further, this Bunsen burner is of the "solid flame" class, its characteristic being that the supply of air is so ample that the inner cone visible in an ordinary Bunsen flame is diminished in size and sharpened in outline, and the flame as a whole would be on the brink of "catching back" but for the provision of a gauze cap over the mouth of the burner. This form of burner is capable of giving the highest temperature which is attainable without the use of a blast, and depends somewhat for its efficiency on the pressure at which the gas is delivered, about 1in. of water being a minimum below which the pressure should not fall. The jet from which the gas issues in the Welsbach burner is central, but the upper end of the burner is annular, the flame thus issuing so as to heat the mantle—of which more anon—in an efficient manner. From the centre of the ring-shaped mouth of the burner rises a rod of steatite, having a forked upper end adapted to carry a refractory mantle by a cross thread at the top of the latter. The mantle is thus hung in the flame from a single point of support. A chimney is used both to protect the mantle, from disintegration by chance draughts, and to ensure that the flame shall be caused to heat it uniformly. This chimney is generally provided with a choke, which, however, has no discernible influence on the efficiency of the burner, and may be conveniently reversed in position by turning the chimney upside down. Continuing a discussion of the mechanical arrangements, it may be said that most burners are provided with a bye-pass, so that they may be lighted without the use of a match, and with the avoidance of any slight explosion such as generally follows the lighting of a gas lamp having a chimney. Shock to the mantle on lighting is thereby mitigated. The bye-pass is a thing of dread; it has two adjusting screws, and conduces to profanity on the part of the regulator. One cardinal rule in the use of the burner should be observed: the cock proper to the burner should be turned full on, so as to shut off the bye-pass while the burner is alight, and regulation of the amount of gas supplied to the burner should be made by the cock on the common gas fitting, to which the burner is usually attached as a substitute for a plain jet. These matters are, however, not the kernel of the subject. Interest centres in the nature and properties of the refractory mantle. It must be premised that much which is known is not published, and many things published are much better unknown. The following description will nevertheless elucidate the principles concerned. There is a group of bodies of the same chemical class as aluminium, which includes the metals of what are termed "the rare earths." For the purpose of the present exposition they may be distinguished as substances forming oxides, viz., the rare earths themselves, which are exceptionally refractory and infusible. Their chief sources are certain minerals, formerly supposed to be extremely rare, and now found in fair abundance in Norway, Carolina, and other unconnected spots, known as thorite, orangite, monazite, æschynite, euxinite, and by similar esoteric terms. It is the oxides, fairly pure as regards common forms of matter, *e.g.*, silica, but judiciously blended among themselves, which constitute the material of which the mantles are composed. Thoria—the oxide of the metal thorium—is the chief constituent, its quantity amounting to 60 to 70 per cent.; the balance may consist of such bodies as terbia, yttria, and ceria. In the manufacture of the mantles the pure earths are first laboriously isolated from the cacophonously-named minerals containing them, and are then converted into nitrates by solution in nitric acid. The nitrates are chosen in preference to other salts, because they are freely soluble, and readily break up on heating, with the regeneration of the oxides. The substratum of the mantle is the best procurable cotton fabric, as nearly free as may be from ash; the reason for this freedom will be apparent later. The fabric is dipped in a solution or paste of the nitrates of the earths mentioned above, dried and ignited in a muffle until the organic matter of the fabric is burnt off, and the nitrates are decomposed, leaving a skeleton of the pure earths. This is much too fragile for transport, and is accordingly strengthened by treatment with a stiffening agent, the rationale of the operation being not dissimilar to that of domestic starching. The stiffening substance is of organic matter and free from ash, so that on first using the mantle it is burnt off, and the fragile skeleton of pure oxides is left once more. The operose character of the whole process is shown by the fact that whereas the cost of the raw material for one mantle—in the ore—may be taken as less than 1d., the manufacturing cost of the finished mantle is 8d. to 10d. The mantle thus made remains efficient until finally relegated to the dustbin. A passing word of pity for the fate of these rare earths, naturally shy and segregated, may possibly be permitted. The fate of these exclusive molecules, jostled by vulgar silica, and crowded by their poor relation alumina, is truly deplorable; moreover, it is not without practical inconvenience, for should failure of the present supply occur and the demand continue, the ruthless dissemination now taking place will indeed be regretted, but it cannot be repaired. A good mantle made in this manner gives a duty from gas much higher than can be attained by any other known means. Thus, a good governor burner, automatically lowering the gas pressure at the exit slit and burning 5 cubic feet per hour, will give about 15-candle power; 3¼ cubic feet of gas if burned in a Welsbach light will give 50 to 60-candle power when the mantle is new, and 40-candle power after 1000 hours' use. It must be remembered that but few mantles in use, even for domestic lighting, have a life of 1000 hours; the average is perhaps about half that period of time. The conditions which are essential for long life are, that the burner should not be on a swinging bracket, that it should be adjusted so that its axis is vertical—not often the case if a common gas fitting is used without correction—and that it should be protected from draughts and vibration.

The reason for the great light-emitting power of a mantle of those rare earths has been much debated. There are those who believe that the material has some specific property whereby it is capable of converting vibrations of large wave length—heat vibrations—into those of short wave length — light vibrations — and certainly the astonishing brilliancy of the rare earths compared with substances considered equally refractory, *e.g.*, alumina, gives some support to this view. The tendency of the results of such experiments as have lately been made is, nevertheless, in a contrary direction. It does not appear that thoria and its congeners differ from other relatively infusible substances in their power of emitting light. It is with them as with better known bodies, a function of the temperature to which they are raised. Logically it follows that a thoria, or similar mantle must be raised to a higher temperature than would be one of alumina when heated by the same burner. Now, the mean temperature of a Bunsen flame is approximately known, and is not inordinately high; very fine platinum wire will just fuse in it—as it will in a common luminous flame—a fact which gives the temperature as a little above 1775 deg. Cent. = 3227 deg. Fah.—always supposing that the fusion is not due to the formation of a carbide. However this may be, the temperature is not so high as to lead to the expectation that vibrations of very short wave length would be emitted by a refractory solid body immersed in the flame. But although the *mean* temperature of the flame may be moderate, *locally* the temperature may be exceedingly high. Hence an extremely fine fibre of refractory material may be raised to a temperature at which it emits white light. Such fibres would, of course, be vastly finer than the coarse strands composing the mantle, and, compared with them, the hair-like platinum wire mentioned above as fusible in a Bunsen flame, would be thick and coarse. The probable reason for the superiority of the rare earths over other refractory materials is at once apparent; it may well be that their infusibility is such that their most tenuous particles scarcely sinter or agglomerate even at the high temperature reached by them, whereas corresponding particles of alumina may tend to aggregate, and form fibres or masses comparatively gross. When once aggregation has occurred, the light emitted is no longer that proper to the local temperature of particular groups of molecules in the flame, but depends on the mean temperature of the flame, which is moderate enough. The necessity for the exclusion from the material of the mantle of all impurities capable of acting as fluxes, and favouring the sintering together of the fine fibres on which the efficiency of the mantle appears to depend, becomes evident from these considerations.

A final word must be said as to the products of combustion of the incandescent gas burner. Statements made for trade purposes are commonly allowed a little latitude, and in this case that axiom may be borne in mind when considering advertisements. There is no reason to suppose that an incandescent gas burner, working normally with an adequate air supply, does not consume the gas used as nearly completely as does a good Bunsen burner or a good flat flame luminous burner. The difference in the amount of products of combustion is, therefore, simply that due to a smaller consumption of gas for a given candle-power. There is no ground for believing that the products are less objectionable in kind than with a common burner; that most noxious impurity, sulphur, duly appears as its ordinary product of combustion, sulphur dioxide, and is only less harmful because its total quantity is diminished *pari passu* with that of the gas. The same is true generally. But this is a very different thing from basing the statement of the improvement in light on an equal consumption of gas, and in the same breath giving the diminution in quantity of products in terms of an equal output of light. One cannot eat one's cake and have it.

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WAGES IN THE CLYDE SHIPBUILDING TRADE.

As might have been anticipated, the settlement of the protracted and deplorable wages dispute in the Clyde and Belfast engineering trade, and the granting of a rise without the necessity of a strike to the iron shipbuilders, were the signals for demands by other sections of artisans—blacksmiths, carpenters, joiners, &c. All these branches have happily now been satisfied by an amended offer of the employers, and there is at last peace, or as near an approximation to it as possible, in the entire circle of trades connected with the shipbuilding industry. As the result of a ballot of the Clyde and Belfast districts of the Associated and Amalgamated Societies of Carpenters and Joiners, these bodies, on the 27th ult., agreed, by a majority of 858, to accept ¼d. per hour advance, dating from March 20th, and a further advance of ¼d. per hour on July 17th next. The men originally asked an immediate advance of ½d. per hour, and were offered ¼d., which they refused. Their acceptance of the amended offer means that their wages are increased as at the 20th ult., from 7½d. to 7¾d., and on July 17th they will rise to 8d. per hour. As to the duration of this agreement, the employers insist on a period of six months from the date of the second increase. This being agreed to means that there will be no change in wages either way before February 17th, 1897, as after the expiry of agreement either side would have to give one month's notice of proposed change. The work on hand, and already booked, in many cases will occupy builders during the larger part of the intervening period, so that actual work and further contracts will now be proceeded with cheerfully. There is cause for satisfaction also in the arrangement which has just been come to—as the result of conference in Glasgow—between the engineering employers of the Clyde and the Amalgamated Society of Workmen, on the subject of sectional or single-shop disputes. It has been agreed to form a Standing Committee composed of an equal number of employers and employed to deal with disputes prior to any stoppage of work. Many minor difficulties in individual shops have cropped up since the settlement of the larger dispute, and these having become so serious a trouble, a conference, having the above happy outcome, was arranged. In future no sectional dispute can reach a critical stage without first coming before the Standing Committee—a fact which in itself should go far to obviate strikes in individual shops, if not to prevent the disaffection which culminates sometimes in a general crisis.

THE COKE GAS POSSIBILITIES OF THE STATES.

The Dominion Coal Company of Nova Scotia, which produces and sells in Canada about 1,000,000 tons of coal a year, has applied to the Massachusetts Legislature for power to produce coke-oven gas at Boston, and to pump it through pipes to various parts of that State. The idea is to bring the raw coal from Cape Breton to Boston, erect a large central range of coke-ovens there, and then sell the resulting coke and tar and gas and ammonia. An Act is necessary, and the Committee on Manufactures has just heard evidence, the details of which have reached England since our last issue. The matter is more important than a mere commercial undertaking, because it virtually proposes to pipe coke-oven gas in the same way as natural gas, the supplies of which last illuminant and power producer are, as is well known, becoming short in the United States. The wholesale supply of coke-gas as a means of power and light would work an industrial revolution in the States if it were generally adopted; hence this first experiment in this direction is of great interest. The object of the promoters was explained by Mr. Henry M. Whitney, chairman of the Dominion Coal Company, who dwelt upon the desirability of locating the bye-product ovens near Boston, in the centre of a group of towns of over 500,000 people, where gas had a high commercial value. The inhabitants would, it is proposed, go to the expense of 1,500,000 dollars, or about £300,000, in laying down gas-holders and mains for the supply. The present consumption of gas in that group is 581,000,000 cubic feet, or 3,000,000,000 cubic feet short of a year's supply to Manchester in England—a city of 20,000 less people. The company aims at supplying this 3,000,000,000 cubic feet of coke oven gas. Either the inhabitants of the district or the promoters of the scheme would also have to put down plant for enriching the gas so as to give it adequate illuminating power. Mr. Joseph D. Weeks, of Pittsburgh, who has just completed his term as President of the American Institute of Mining Engineers, and who is a Government coke and gas expert, gave evidence in support of the scheme. He points out that natural gas is pumped 116 miles in some parts of the States, and coke oven gas could be treated in the same way. The highest coke production of the United States so far was in 1882, when it was 12,010,820 net tons, in the production of which 8,813,337 tons of coal were used. The official figures for 1895 are not yet issued, but they will be greater than these. Not one ounce of the valuable bye-products from these 18,000,000 tons of coal was saved. If we assume that 1 per cent. of sulphate of ammonia and 3 per cent. of tar are produced from each ton of coal coked, then it is clear—contended Mr. Weeks—that there were lost in the United States in that year 180,000 tons of sulphate of ammonia, which the land was crying for; 540,000 tons of tar—full of all the valuable coal-tar products, such as creosote oil, light oils, anthracene, and pitch—and in addition 10,000 times 18,000,000 cubic feet of gas, or in other words, 180,000,000,000 cubic feet of gas.

A QUARTER'S CLYDE SHIPBUILDING.

Clyde shipbuilding for the first quarter of the year—owing probably to the extra activity prevailing since the termination of the engineers' strike, and the retarding effect it had upon shipbuilding operations—has attained to record figures as regards tonnage output. Altogether, some 53 vessels of 98,700 tons have been sent off the stocks, this being the heaviest first quarter's tonnage ever put off the stocks of Clyde shipyards. The figures for March alone amount to 29 vessels of 40,700 tons. With the exception of March, 1891, and 1892, when 41,270 and 57,600 tons represented respectively the outputs, the present is the largest March output in the annals of the industry. As many as 11 of the vessels turned out during the period were over 3500 tons, and five were over 5000 tons. With the exception of the second-class cruiser Dido, of 5600 tons, all the work was for the mercantile marine. The total was made up of tonnage of the usual variety, large mail and passenger steamers, heavy deadweight carriers, swift river and channel passenger steamers, hopper dredges and barges, sailing vessels, and steam trawlers. As regards work on hand, this is estimated at somewhat over 300,000 gross tons. The total contracts booked since the year began aggregate about 100,000 tons, thus more than balancing the output, large as it has been. The bookings for March alone amount to over 45,000 tons, and several good contracts are known to be in the market, apart from the Government work still to be given out, in which the Clyde will probably share as usual.

LITERATURE.

A New View of the Origin of Dalton's Atomic Theory. A Contribution to Chemical History, together with Letters and Documents concerning the Life and Labours of John Dalton, now for the first time published from Manuscript in the possession of the Literary and Philosophical Society in Manchester. By HENRY E. ROSCOE and ARTHUR HARDEN. London: Macmillan and Co. 1896. Demy 8vo, pp. 191. 6s. net.

JUDGING from the fact that Sir Henry Roscoe has appended his name to two books on John Dalton within the last few months, it would seem that the chemical world is much perturbed concerning the origin of the atomic theory, and the object of the present volume is to set the matter all right, and incidentally to throw some light on the early days of present-day chemistry. The main point at issue is that it has hitherto been supposed that the atomic theory was the outcome of the experimental discovery of the law of combination in multiple proportions, whereas certain manuscripts and note-books of Dalton and others are taken to indicate that Dalton approached the atomic theory from a physical standpoint, and that this at once led him to conceive of chemical combinations as taking place between varying numbers of atoms of definite weight. The authors support the latter view, and ingeniously mould scarcely reconcilable data to bring conviction to the mind of the reader. The amount of success achieved in this directions will depend on the temperament and good nature of the latter, and whether he or she is sufficiently enthusiastic to weigh the conflicting statements with the perseverance displayed by the authors. One thing is very certain, that Dalton was endowed with a most fertile imagination, that was constantly at work suggesting consolatory explanations of tiresome problems arising from his investigations, that he thus propounded hypotheses, promulgated them, and frequently subsequently confirmed them, or even altered them, as his new knowledge dictated, and the atomic theory appears to have been one of these. Anyway, as the authors say at the end of the first chapter, to Dalton must be ascribed the rare merit of having, by the application of a single felicitous idea to a whole class of facts of chemistry, so completely comprehended the prevailing relations, that his generalisations have sustained without alteration the labours and changes of almost an entire century. The second chapter contains excerpts from Dalton's diaries—1802-1808—chronologically arranged. During the first four years his work was mainly physical, although there was some chemical work. In 1806 *et seq.* he did more chemical work, speculated about heat, &c. In the third chapter the various numbers suggested for atomic weights are set forth, with the considerations concerning them; whilst the fourth chapter is devoted to specimens of Dalton's lecture notes for lectures at the Royal Institution and elsewhere, the subjects being "On Heat," "Chemical Elements," "On Natural Philosophy, &c.," and "On Mechanics," and they form an interesting epitome of the views entertained on these matters eighty-five years ago. "Letters Written and Received by Dalton" is the title of the fifth chapter, and an insight is obtained into the reception of Dalton's views by chemists at home and abroad; into the work that was being done in those days, and the flounderings of the workers; and into the relations that existed between contemporary men of science. Here is an interesting example. Thomas C. Hope in 1811 writes to Dalton:—"I need not conceal from you that I am by no means a convert to your doctrine, and do not approve of putting the result of speculative reasoning as experiment. Still, however, I admire the ingenuity of your speculations, and the happy adjustment of its subordinate parts. It must be gratifying to you to see your doctrines adopted by the first names in the chemical world." In another letter Brewster refers to a proposed great meeting of scientific individuals in Great Britain, to be held at York on the 18th—25th July, 1831. This was the first meeting of the British Association. In conclusion, we may add that the work will provide instructive reading, more particularly for those interested in the rapid but gradual development of the science of chemistry; but to all who appreciate the progress of erudite thought and speculation its perusal can also be recommended.

Cinematica della Biella Piana. Per L'Ing. Lorenzo Allievi
Napoli. 1895.

ALL movements of articulated links in mechanism are reducible, as described in Kennedy's "Mechanics of Machinery," to what is technically called the three-bar motion; for instance, the beam, connecting-rod, and crank of a beam engine. The most complicated curves described by the different points of the parallel or valve motion of a steam engine are three bar motion curves. These curves are analytically of the sixth degree, and a most important discovery in their theory was made by Mr. Samuel Roberts, who showed that any such three-bar motion curve can be generated by three distinct arrangements of the mechanism. A very concise demonstration of this theory was given by Clifford in his "Kinematic." In Watt's parallel motion the head of the piston-rod is guided along one of these curves in the neighbourhood of a point of inflexion where the curve is straightest. For a long time it was supposed that an exact parallel motion, which should guide the head of the piston-rod in an exact straight line, was a mechanical impossibility; but the appearance of Peaucellier's parallel motion disproved this idea. Unfortunately, Peaucellier's motion did not make its appearance until parallel motion in steam engines was just going out of fashion, and the only place where it can be seen in active work is in the ventilating machinery of the House of Commons. Mr. Penrose, the architect of St. Paul's, has found that a modification of the Peaucellier cell will serve as a useful instrument for drawing the arcs and cutting the stones to circles of large radius, 200ft. or 300ft. Theoretically speaking, the Peaucellier cell and its modifications are the only mechanical means at our disposal for drawing an exact straight line; usually in geometry we copy a so-called straight edge when we carry out Euclid's instructions to draw a straight line; and however tight we may stretch a thread, we cannot pull it absolutely straight. Mr. Kempe's interesting little lecture, "How to Draw a Straight Line," will be found to be full of valuable criticisms and ideas on this subject.

The author of this book, L'Ing. Lorenzo Allievi, has made a collection of interesting and accurate drawings of all the most important cases that can arise in three bar motion. He starts with the well-known theorem that the relative motion of two planes in contact can be produced by rolling one curve fixed in one plane on another curve fixed in the other plane; these two curves are called the *centrodes*, by Clifford. At the point of contact of the two centrodes two equal circles are drawn, having the same tangent, and a diameter the reciprocal of which is the sum of the reciprocals of the radii of curvature of the centrodes; these circles afford simple geometrical methods of determining the curvature of any curve described by a point or swept out by a line which is carried round by the rolling centrode, the other centrode being taken as fixed. Carried points which lie on one of these circles—the circle of inflexions, *circolo dei flessi*—are passing through a point of inflexion on their paths; while carried lines envelope curves having cusps on the other circle——the circle of cusps, *circolo delle cuspidi.* In designing Watt's parallel motion, we draw the circle of inflexions of the centrode and place the carried point, the head of the piston-rod, on this circle. The amateur of mechanical movements, as well as the designer of working machinery, will find great pleasure and profit from a study of Signor Allievi's collection of diagrams; more especially if he will construct working models in accordance with the instructions given in Mr. Kempe's "How to Draw a Straight Line." Sheets of cardboard, or of zinc, will serve for the framework and moving parts; while the joints can be made rapidly and efficiently with the brass eyelet holes used by shoemakers, closed up by the bootmakers' pliers.

Sugar Machinery: A Descriptive Treatise devoted to the Machinery and Apparatus used in the Manufacture of Cane and Beet Sugar. By A. J. WALLIS TAYLOR, C.E. London: W. Rider and Son. 1896.

THERE is room for a comprehensive book on the subject which forms the title of this one. Mr. Wallis Taylor's book has made little difference. In his preface he speaks of the circumscribed limits permitted to a volume of moderate cost, and of his endeavour within those limits to provide as complete a compendium on the subject as possible. While, however, apparently sensible of the limitation as to space, he has filled a large number of his pages with matter which is not necessarily more appropriate in a book on sugar machinery than it would be in a book on brewing or brickmaking, or on steam engines, or boilers or pumps. For instance, there is no necessity for the author to go into a description on very inadequate grounds on what he considers the most suitable steam engine for sugar works; neither is it necessary that he should give a specification of a steam boiler which is neither complete nor brief; nor does the reason for occupying a lot of space with one kind of direct-acting pump when space necessary for relevant matter is absent, appear obvious. The same may be said of the room given to light railways and trucks, and to a large view of a centrifugal pump, or to much of the matter which is given in the appendix. There is, it must be admitted, a good deal in the book that is really relevant to sugar machinery or apparatus, but a great deal of the description is written in an involved style difficult to understand and incomplete in illustration. Examples of this are found on page 128 and many others. A description is given of the very elegant device of Mr. J. G. Hudson for an automatic pressure regulator for sugar mills, as made by the Mirrlees, Watson and Yaryan Company, and the description is more complete than that given of other apparatus, but the credit of the invention of the device is not given to Mr. Hudson. By revision and re-editing the book might be made much more useful than it is in the present edition.

SHORT NOTICES.

Physical Units, by Magnus Maclean, M.A., D. Sc., F.R.S.E. London: Biggs and Co. Price 2s. 6d.—This is in many respects a very useful book, more particularly to those who have to deal with facts, figures, and forces recorded and measured in C.G.S. units. The first chapters are on fundamental, geometrical, kinematic, dynamic, electric, magnetic, electrostatic, and electromagnetic systems of units, and these are followed by twenty-two tables relating to the physical properties of solids and gases, including modula of elasticity, moments of inertia, densities, molecular data for gases, specific conductivities and resistances, specific heats, boiling points, and so on. Amongst the tables there is one on indices of refraction of solids, liquids, and gases, in which several of the figures given are incorrect, and in the tables of specific heats of liquids and boiling points of latent heats of evaporation, the petroleums of which we so frequently want in these days to know, these values are not given. Useful as the book may be to those who are teaching physics, the use of metric and C.G.S. units limits its value to this field.

Griffin's Electrical Engineers' Price Book, for the use of Electrical, Civil, Marine, and Borough Engineers, Architects, Railway Contractors, Local Authorities, &c. &c. Edited by H. J. Dowsing. New edition, revised throughout and enlarged. London: Charles Griffin and Co., Ltd. 1896. Price 8s. 6d.—A price book like this provides with little trouble much of that information which can otherwise only be obtained from large numbers of catalogues. It provides, moreover, an index to the names of the makers of various machines and fittings, a selection of whose prices are given. A difficulty in preparing a price book lies in the necessity for selection among makers. The difficulty is in this case very well surmounted, but in the case of gas and oil engines the omissions are rather striking. The electrical apparatus, of which particulars, hints, and prices are given, are so numerous that every maker seems to be well represented. Beside the prices, the book contains a great deal of handbook information relating to statutory powers, and to each of the subjects of the thirteen chapters. These introductions to the chapters, and the hints with respect to the use and working of the materials, apparatus, and machinery dealt with, add considerable value to the book.

BOOKS RECEIVED.

The Journal of the Royal Agricultural Society of England. Third Series. Vol. VII. Part I. No. 25, 31st March, 1896. To be continued quarterly. London: John Murray. Price 3s. 6d.

Life and Labour of the People in London. Edited by Charles Booth. Vols. VI. and VII. Population classified by trades (continued). London: Macmillan and Co. 1896. Price 7s. 6d. each vol. net.

A Laboratory Notebook of Elementary Practical Physics. Part I., Mechanics and Hydrostatics. By L. R. Wilberforce, M.A., and T. C. Fitzpatrick, M.A. Cambridge: At the University Press. London: C. J. Clay and Sons. 1896. Price 1s.

The Mechanism of Men-of-War. Being a Description of the Machinery to be found in Modern Fighting Ships. By Reginald C. Oldknow, Fleet Engineer, R.N., retired. With numerous illustrations. London: George Bell and Sons. 1896. Price 5s.

Domestic Sanitary Drainage and Plumbing. Lectures on Practical Sanitation delivered to Plumbers, Engineers, and Others in the Central Technical Institution, South Kensington, London, under the auspices of the City and Guilds of London Institute for the Advancement of Technical Education. By William R. Maguire. Second Edition. London: Kegan Paul, Trench, Trübner and Co., Ld. 1896. Price 12s.

The Ocean Liners of the World. A Collection of High-class Illustrations specially prepared from Photographs of the Principal Ocean Steamships of our Time, embracing the latest additions to the Merchant Navies of Great Britain, France, Germany, and the United States, and accompanied with Explanatory Information. By W. Bellows. London: Kegan Paul, Trench, Trübner and Co., Ld. 1896. Price 1s.

Light Railways for the United Kingdom, India, and the Colonies. A practical hand-book setting forth the principles on which light railways should be constructed, worked, and financed, and detailing the cost of construction, equipment, revenue, and working expenses of local railways already established in the above-mentioned countries, and in Belgium, France, Switzerland, &c. By John Chas. Mackay, F.G.S., A.M.I.C.E. Illustrated with photographic plates and other diagrams. London: Crosby Lockwood and Son, 1896. Price 15s.

YORKSHIRE COLLEGE ENGINEERING SOCIETY.

GAS ENGINES.

AT the meeting of this Society in the Yorkshire College on the 16th ult., Mr. Wm. Norris, M.I. Mech. E., gave a paper on "Gas Engines."

At the outset the author dwelt upon the early pioneering work of Messrs. Crossley Brothers in taking up the manufacture of the 1866 free piston type, which now appears so crude when compared with the celebrated 1876 pattern. In speaking of the further developments of the gas engine, Mr. Norris strongly deprecated the tendency to construct engines having a large bore and short strokes, which from a mechanical, and even a scientific, point of view is wrong. With regard to "self-starters," Mr. Norris thought their introduction was due to Messrs. Hamilton and Rollaston, who brought out the first hand pump starter, whereby a charge of gas and air is pumped into the cylinder. Illustrations were shown of Lanchester's low-pressure starter, and Clerk-Lanchester's high-pressure starter. The author then described the methods of governing gas engines adopted by Messrs. Robey and Co. on most engines. The application of Mr. J. Richardson's electric governor to a gas engine was described and illustrated. This consists, briefly, of a solenoid wound as a shunt from the main current, into which an iron core is drawn by the magnetic force. This movement actuates the pecker of the gas valve, and cuts out the supply as the speed rises. The "Scavenging Method" was well described and illustrated; results of tests with and without the scavenging method were given. Mr. Norris said there was little or nothing to be gained by using more than 95 lb. compression; in fact, very good results have been obtained by using a much less compression.

Dealing with the question of impulse every revolution, Mr. Norris said that in his opinion this cycle would ultimately take the place of the now almost universal Otto. The early Clerk and Robson engines were described, and though it was considered by some that the Clerk engine was obsolete, the author thought very good results might be obtained by modyifying the construction of the engine. The author then described his own "impulse-every-revolution" engine, which has been very favourably received. In this engine the exhaust products are discharged at the extreme end of the combustion chamber by a charge of pure air; the piston to be taken out at the front end without breaking any joints; the gas injected into the combustion chamber on the return or compression stroke, and the whole operation performed in one cylinder, with an ordinary crank and connecting-rod. The front end of the cylinder—unlike the Clerk and Otto engines—is closed, the motor piston having a rod and gas pump combined. There is a compression space as in other engines containing the exhaust valve and gas inlet from pump. The action is as follows:—During the return stroke air is drawn into the front end of the cylinder at atmospheric pressure through an automatic valve, and gas is also drawn into the small pump cylinder. The next outstroke compresses the air into an intermediate chamber—at about 4½ lb. per square inch above atmosphere—until the piston has travelled nine-tenths of the outward stroke. A port in the piston then opens communication with the air-port passage from an intermediate chamber, and remains open until the piston has travelled one-tenth of the inward stroke. The exhaust valve having already been opened before the piston has travelled nine-tenths of its outward stroke, and the exhaust column having been put in motion, the air in the receiver accelerates the products. In the meantime, the compressed charge of air has been transferred from the front end to the combustion chamber, and immediately the air and exhaust ports are closed the gas is tripped at a high pressure. The remaining nine-tenths of the inward stroke is available for compressing the gaseous mixture, which is fired by the ordinary incandescent tube when the piston has reached the end of its inward stroke.

Owing to free passages the power absorbed by gas and air pumps is, it is said, only about 1¾ indicated horse-power with an 8in. cylinder.

The governor is arranged so that when a cut-out is effected the gas is allowed to pass back to a small reservoir which is shut off from the gas main by means of an automatic valve. There is, therefore, no gas stored up at a high pressure. This engine is also made with a differential piston, having the same cycle of operations, though fitted with a double-acting air pump. The advantage gained by using a differential piston is, that when working up full power with large engines, a greater quantity of air is allowed to pass through the combustion chamber. Should, however, this engine be required at half-load, only one side of the differential piston need be used. The air inlet may be spragged; and the governor may be arranged to act on the suction valve at the back end of the differential piston with great advantage. The maximum pressure from explosion is said not to exceed 200 lb.

A RICHMOND paper announces that Mr. Arthur Peirce, son of Mr. Peirce, the borough waterworks engineer, has been appointed to the post of assistant engineer to the Calcutta Corporation out of seventy-seven candidates. Mr. A. Peirce, who will leave England shortly to take up his new post, has held an appointment in South Africa, and is at present engineering assistant to Mr. Gaskin, the chief engineer to the Nottingham Corporation.

SOME MORE HORSELESS CARRIAGES.

THE engravings on this page illustrate, and the following is a description of an experimental horseless carriage, constructed conjointly by Mr. G. B. Petter, engineer, and Messrs. Hill and Boll, carriage builders, Yeovil. It is driven by an oil motor, the cylinder of which is of cast iron, 3·5in. diameter and 6in. stroke, with light steel water jacket. It is bolted to two parallel steel bars, which carry the main bearings. The crank shaft is balanced, and has a bored recess for oil, of which it carries sufficient for a day's run. The first motion chain E E^1, Fig. 2, conveys power to the intermediate shaft H by means of a friction gear operated by a lever at G, Fig. 2, and A, Fig. 3. This lever, pressing by means of frictionless steel centres against the bell crank W, slightly moves the shaft, and grips the chain wheel E between the wood blocks F F F F. The same lever, pulled instead of pushed, puts on the brake V V, and thus forms in one, starting, stopping and brake lever. M, Fig. 2, and B, Fig. 3, is the lever for changing speed, and the slow speed wheel L has a ratchet box at R, which enables the axle to overrun when the high speed is in operation. T T, &c., are the carriage springs, and X X the axle bearings. The steering gear requires no explanation.

The water and oil tanks are at the rear immediately under the back seat. The total weight of the carriage, with oil and water complete, is 9 cwt., of which the engine proper, including fly-wheel and side bars, weighs 120 lb. Mr. Petter thinks considerable reduction can be made in the total weight without decreasing the strength of the engine. The carriage is intended for two persons, with which a speed of ten miles an hour is obtained on level road. It will mount the hills of the neighbourhood with two persons, but larger power would be used for four persons. The vehicle shown will carry four persons on level roads and small gradients as in the engraving, which shows Mr. James B. Petter, of the Nautilus Grate Works, steering; Mr. H. W. Southcombe, magistrate, of Yeovil; and Mr. G. B. and Mr. E. W. Petter.

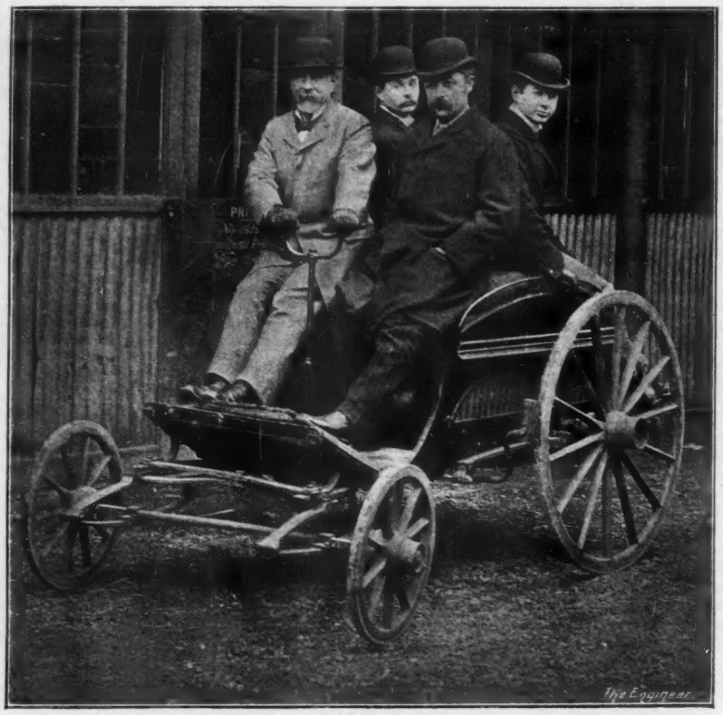

The Engineer.

Fig. 1—PETTER AND HILL AND BOLL'S OIL-MOTOR CARRIAGE

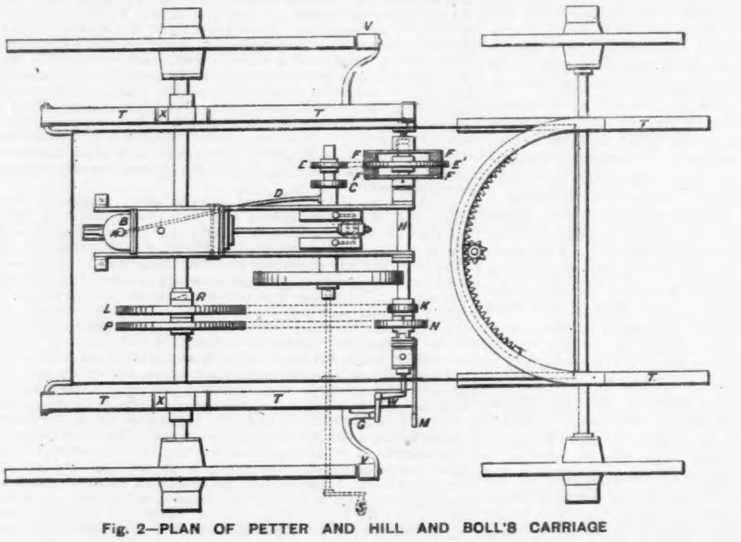
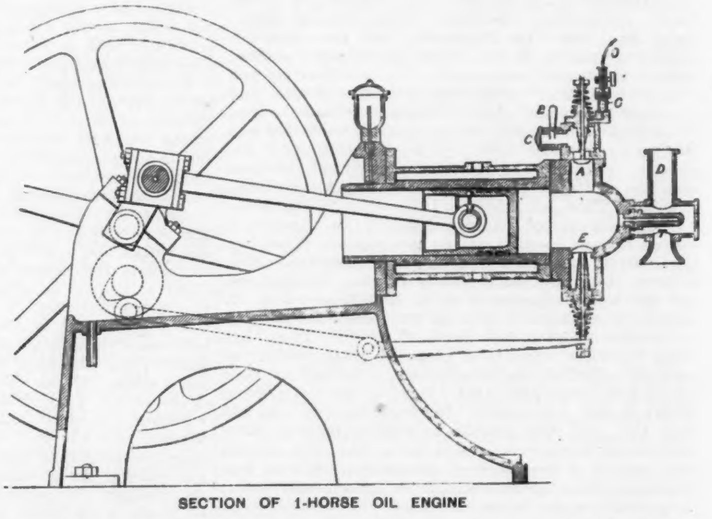


Fig. 2—PLAN OF PETTER AND HILL AND BOLL'S CARRIAGE



SECTION OF 1-HORSE OIL ENGINE

The exhaust is, we are informed, quite invisible, and the engine almost noiseless. The whole of the machinery is enclosed and completely out of sight, but can be easily reached for oiling, &c., by raising the back and seat covers. The levers are conveniently placed for the right-hand driver. A removable handle S is used for starting the engine in the first place, and an arrangement — not shown on plan — is made so that this handle when put in position automatically opens the exhaust valve, which closes instantly, when a good impulse having been given, the handle is withdrawn and the engine starts. The main road wheels are 42in. diameter.

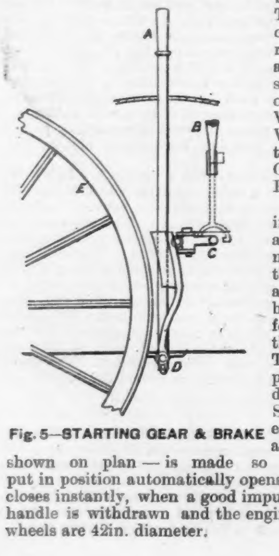
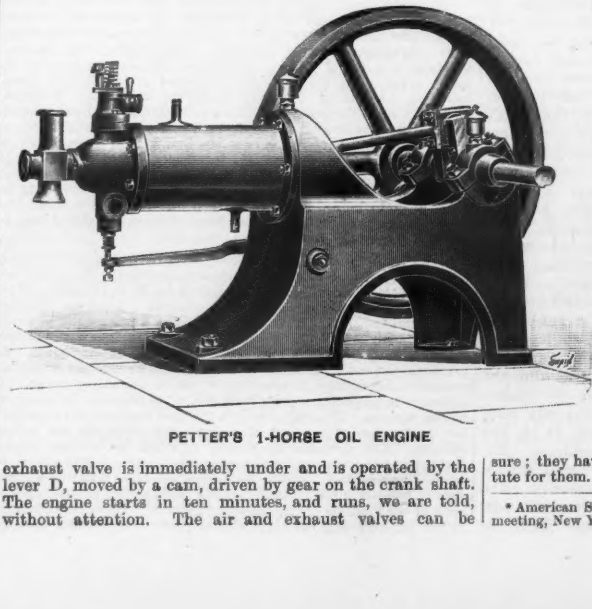


Fig. 5—STARTING GEAR & BRAKE

The 1-horse power oil engine used in the carriage is shown, as made in the form of a horizontal stationary oil engine, by the accompanying engravings, the principle of both engines being the same. As illustrated, however, it is mounted on a cast iron bed and has a heavier fly-wheel for stationary purposes. The oil gravitates to the combustion chamber, into which it enters through the air valve. The exhaust valve is opened by a lever operated by a cam driven by spur wheels from the crank shaft. Tube ignition is adopted, and a small heating lamp is used. The air valve A opens by the suction of the piston, and forms also the oil inlet to the combustion chamber B. The oil drops from an oil receiver through a glass tube to the top of the valve, where it spreads and is drawn in and broken up into spray by the entering air. The exhaust valve is immediately under and is operated by the lever D, moved by a cam, driven by gear on the crank shaft. The engine starts in ten minutes, and runs, we are told, without attention. The air and exhaust valves can be removed for cleaning when necessary, and replaced in two or three minutes without breaking any joints. The cylinder, vaporiser, and valves are shown by the sectional engraving.



PETTER'S 1-HORSE OIL ENGINE

SCREWED FITTINGS FOR HIGH PRESSURE.*

By HUGH J. BARRON.

ONE of the most remarkable things in the development of the use of iron pipe has been the standard fitting and standard thread, both of them depending primarily on the standardising of wrought iron pipe. When we come to think what the pipe industry would be without these standard articles, we begin to think it marvellous that they have been devised, and that an agreement in regard to standardising was reached so early in the development of the industry. Standard articles of every character tend tremendously to the cheapening of their production, and thus fill an economic necessity, but this very advantage has its drawbacks. With standard fittings the great difficulty to-day is that the refining process of cheapening production has gone so far as to call for a reaction in favour of special fittings for special work, and the purpose of this paper is to advocate the manufacture of wrought iron or wrought or cast steel or malleable iron fittings for screwed work for heavy pressures and for all large pipe work except that used for very low pressures. Forged fittings are so much more reliable, so much surer in every way, that it is strange efforts have not been made to displace the cast iron fittings. When the fittings that are now in use were designed, low pressures and small sizes of pipe were the rule. Within a few years the conditions have changed; high pressures are now the rule, and large sizes of pipe in connection with large power plants are no longer the exception. The changes that are required by modern conditions are confined to ells and tees and to sizes larger than 3in.; all other fittings, I believe, are safe and satisfactory, and the smaller sizes of tees and ells are not seriously objectionable, even at high pressures, but the ordinary 3in. ell or tee at 100 lb. pressure is decidedly dangerous, and the engineer who does not feel nervous when he is close to one of these fittings when there is water hammer and heavy pressure combined, must be very courageous or very reckless. When the various strains that such fittings are subjected to are considered, instead of the usual factor of safety of six being present, there is absolutely no factor of safety at all, or the factor is so slight as not to be worth considering; first there is the pressure, then there is the pressure or tension set up by the taper thread when it is jammed in by the fitter and the chain tongs—this is a constant strain tending to burst the fitting—then there is the shrinkage strain of the casting, slight of course, but must be considered as increasing the complexity of the tension on the fitting. To these add the strains due to the expansion of the pipes and the tremendous strains due to the blow a fitting receives when water jumps into a partial vacuum, and is it any wonder that fittings burst? Blow holes and imperfect castings add to the danger and unreliability of cast fittings; the marvellous thing is that there is not more trouble from this cause, but as pressures continue to go up this trouble will increase. None of the ordinary ells and tees above 4in. in size should be used for pressure above 50 lb.

These remarks do not apply to flanged cast fittings, and many get over the difficulty of the screwed cast fittings for power work by specifying and using flanged cast fittings and flanged cast pipe or wrought iron or steel pipe with cast flanges, but I am inclined to think that there is a better way of overcoming the difficulty; that is, either make cast screwed fittings for power work twice as heavy as they are made to-day, or substitute forged fittings or cast steel or malleable fittings. I am one of those who do not like flanged joints if they can be avoided, and I believe that, with the proper fittings, screwed joints are far more satisfactory. The question of pipe and fittings for high-pressure steam is outside the scope of this paper, but that there is room for improvement in ordinary power piping is evident by even a slight examination of any large plant. Engine builders some years ago, in order to get the initial pressure in their cylinders as close as possible to boiler pressure, advocated long sweep fittings, similar to hydraulic or hot water fittings. Some engine builders make patterns for these fittings that were extra heavy, and I think with a sufficient factor of safety, but I am inclined to believe that a forged wrought iron fitting would be the best, and to have the pipe work almost entirely wrought iron; that is, the fittings and even the valve bodies forged, would be the safest for high pressures. A possible solution of this problem may be in the gradual introduction of malleable steam fittings of heavy pattern for steam work. I have used such fittings for many years and have always found them satisfactory, but the larger sizes are entirely too light for present day pressures. If, in addition to the standard flanges which have been adopted by the trade, we had a standard ell and tee, it might possibly be a step in advance. I am averse to advocating special measures of this kind, as I am afraid they interfere with the natural development of the best device, or have a tendency to do so, but I do not believe any harm can be done by condemning the present cast fitting for high pressure; they have outlived their usefulness, and we need a substitute for them.

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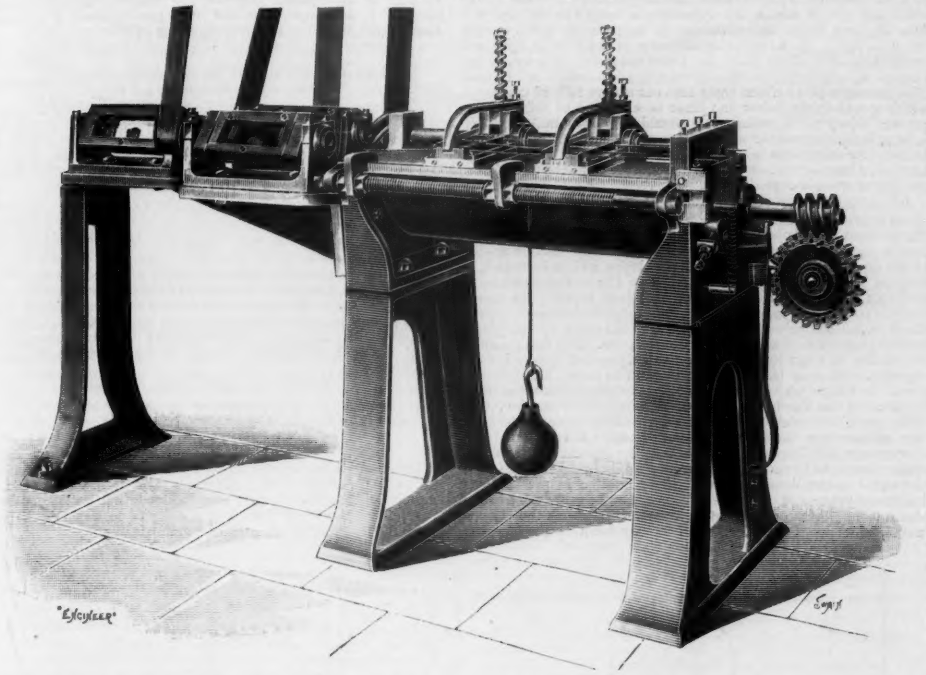
* American Society of Heating and Ventilating Engineers. Annual meeting, New York, January, 1896.

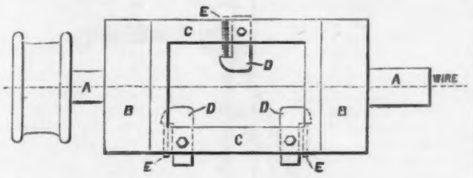
THREE-WIRE CUTTING AND STRAIGHTENING MACHINE

MESSRS. TAYLOR AND HATTERSLEY, BRIGHOUSE, ENGINEERS



THREE-WIRE CUTTING AND STRAIGHTENING MACHINE.

By the accompanying engravings we illustrate a three-wire cutting and straightening machine, designed to keep pace with the demand for cut wire of various lengths, more particularly as used in the cycle trades. The machine under notice will take a range of sizes from No. 7 S.W.G. to No. 14. The carriages with the nipping device are of new form and design. They are shown separately, and are so arranged that each wire receives exactly the same pressure, so that no slip can possibly take place when the tension is once adjusted. The carriages are moved forward by a cam, and drawn back by the weights shown hanging down. The cutting-off device is operated by a worm and wheel motion, into which are inserted pegs, thus avoiding the trouble and delay when change wheels are employed. The three revolving spinners, into which the brass or hard steel dies are inserted for straightening the wire, are arranged to be driven by one belt. This device, along with the cut-off motion and nipping arrangement, is the subject of a patent. The weight of the machine is about 14 cwt. Its output is equal to three single-wire machines, but we understand its price is little more than that of a first-class machine of the old sort. The revolving spinners are separately shown by the above diagram, in which A are the bearings; B is the body of casting; C is the loose piece bolted on to B; and D are the brass or hard steel dies set up by screws E. If the wire is stiff more tension is put on it by advancing the dies towards each other. These dies revolving round the wire at a speed of 2000 revolutions per minute, make it perfectly straight. The two carriages carrying the nipping dies working alternately, carry the wire forward to the cut-off dies, the motion of which is regulated by the worm and wheel device shown in illustration.



CIRCULATION IN WATER-TUBE BOILERS.*

By Professor W. H. Watkinson, Glasgow.

The main object of this paper is to draw attention to a series of models, which will be shown in action at the meeting, and which I have had constructed in order to show the nature of the circulation in the various types of water-tube boilers. The tubes in these models are of glass, ranging in internal diameter from $\frac{3}{8}$in. to $1\frac{1}{4}$in., and the drums are provided with glass ends, so that the whole of the action in the boilers can be observed. As there has been a great deal of discussion, and as inaccurate views are still prevalent regarding the causes of circulation in water-tube boilers, it will be well, before describing the action in the various models, to summarise the author's conclusions regarding this matter.

Causes of circulation.—"The causes of circulation in water-tube boilers are:—(1) The difference in density of the water due to difference in temperature when the fires are first lighted. This circulation is very sluggish. (2) When the water is all at approximately the same temperature, and steam is being generated, but not with sufficient rapidity to cause a break in the continuity of the water, a much more vigorous, but mainly local, circulation is set up by the entraining action of the bubbles of steam rising through the water. (3) When steam is generated with such rapidity, that in some part of the circuit there is steam or foam only present, a very rapid circulation takes place, due to the difference in density between this steam or foam and the continuous water in the downcomers, internal or external."† These conditions are illustrated by the annexed diagrams. In Fig. 1 steam is not being generated rapidly enough to completely fill any portion of the tube A with either steam or foam, and the continuity of the water in A being unbroken, the only cause of circulation, assuming the water to be all at the same temperature, is the entraining action of the bubbles rising through the water. By many the circulation, in this case, is said to be due to the difference between the density of the column of water in B, and the average density of the steam and water in A. That this is not so is shown by the experiment illustrated in Fig. 2, in which air is sent into the inner tube from a horizontal nozzle at C. When the top of the inner tube is above the water level the rise of level in the inner tube is very small, and when the conditions are as shown the circulation is comparatively sluggish. If the nozzle C, however, be turned upwards a much better circulation is induced, but the action in this case is not analogous to that in a boiler. Another way of regarding the matter is indicated in Fig. 3, where a series of beads are shown attached to a fine wire. When the beads are moved either upwards or downwards a circulation is set up due to their entraining action, exactly as in Fig. 1. The circulation, therefore, under the conditions shown in Fig. 1 is due solely to entraining action, and not to difference in density of the substance in the two legs. It is due really to the difference in density between the steam and water in the same leg, which sets up a relative flow of the two, and the entraining action of the rising bubbles causes the circulation round the circuit, as well as the local currents which are at the same time induced. In Fig. 4 steam is being generated more rapidly, and portions of the tube are filled with steam to the complete exclusion of water from these portions. In this case a rapid circulation takes place on account of the average density of the substance in A being less than that in B. This kind of circulation is by far the most thorough, as none of it is merely local. When working at atmospheric pressure, at rates exceeding about 2 lb. of steam per square foot of heating surface per hour, and with tubes $1\frac{1}{4}$in. in diameter, the bubbles do not fill up the whole diameter of the tube, as shown in Fig. 4, but the upper part of the tube becomes filled with foam to the complete exclusion of continuous water, as shown in Figs. 7, 8, and 10. The circulation in this case is, of course, due to the difference in density between the foam in tube A, and the corresponding column of water in tube B, Fig. 10. The circulation in this case is also vigorous, but, as a considerable amount of water falls down from the foam, it is more local, and not as thorough as in the last case.

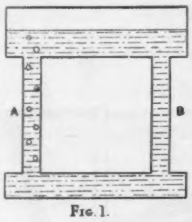


Fig. 1.

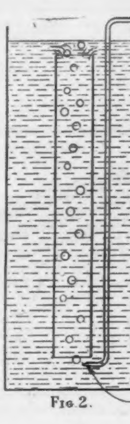


Fig. 2.

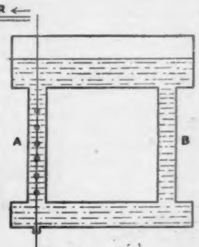


Fig. 3.

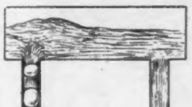


Fig. 4.

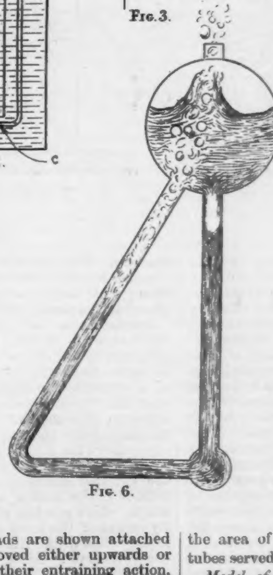


Fig. 6.

Description of Models.

Model of Belleville boiler (Fig. 5).—This consists of two elements, each containing twelve tubes of $\frac{11}{16}$in. internal diameter, joined in series. The distance between the centres of the end boxes is 2ft. 3in., and the inclination of the tubes is 4 per cent., as in actual boilers of this type. The action of the automatic non-return valve at A is very clearly shown. The normal level of the water is about that of the middle tube, but in starting, in order to prevent overheating of the upper tubes, it is necessary to have water in all the tubes. The action in the Belleville boiler is so different from that in any other boiler that it may be well to explain it somewhat fully. As is well known, this boiler consists of a number of elements connected in parallel between the feed distributing box—as I prefer to call it—and the steam drum. The total length of tube in each element is, roughly, 150ft., and, as the inclination is only 4 per cent., the upper end of this 150ft. of tubing is only 6ft. above that of the lower end, and the discharge into the drum takes place at about $1\frac{1}{2}$ft. above this. If each element consisted of one straight tube 150ft. long, instead of twenty tubes connected by end boxes, as in the actual boiler, the circulation would be of the same nature as that in other water-tube boilers, and a circulating force of, say, 1 lb. per square inch—assuming the head effective for circulation to be 2ft.—might be great enough to push the water through the tubes, in spite of their great length. Owing, however, to the abrupt changes in the direction of flow of the water which take place at each junction box, the total resistance to the flow is too great to allow sufficient circulation with this circulating force. To get over this difficulty the orifices through which the water flows from the feed distributing box to the elements are very contracted, and at the bottom of each of the two downcomers is an automatic non-return valve. With these arrangements the action of the boiler is similar to that in the old-fashioned Savery steam pump; the water is forced into the elements intermittently by the available head of about 2ft. instead of by the atmosphere, as in Savery's pump, the non-return valve and the contracted orifices serve as the suction valve, the steam is generated in the tubes themselves instead of in a separate boiler, and the necessity of a delivery valve is got rid of by discharging into the steam drum above the water-level. The action, therefore, is intermittent, and some water is driven backwards through the contracted orifices during the time plugs of water and steam are being pushed forward into the steam drum. The non-return valves prevent water being driven back through the downcomers into the steam drum. When warming up the action is intermittent, as in all cases where the discharge takes place above the water-level, but in this case there is a violent water-hammer action, owing to the form of the end boxes, and to steam being generated in several of the tubes at once. Steam generated in the lowest tube pushes the water up into the upper tubes; the steam formed in the upper tubes tries to push this water back again at the same time that it pushes the water in front of it forward into the upper drum; and on this account when first raising steam the shocks are often very violent. When properly in action the circulation is very vigorous and thorough, the alternating plugs of water and steam racing each other through the tubes of the element at a very high speed. The amount of water in the tubes is, however, very small, excepting in the lowest tube of each element, which contains much more than any of the others. The circulation in the lowest tube of the element is least thorough and is partly alternating.

Model of the Yarrow boiler (Fig. 6).—It will be observed that one half of this boiler is arranged with the tubes discharging below the water-level, as in actual boilers of this type, and the other half with tubes discharging above the water-level. An external downcomer is provided for each half, and a plug is provided so that the downcomer for the drowned tubes may be closed. Either half of the boiler may be used separately. (1) Action with the submerged tubes and with the downcomer shut off. As soon as the fires are lighted circulation commences, and when boiling first begins, plugs of steam and water are periodically projected into the upper drum, causing a considerable disturbance of the water level there. When the boiler is working at a high rate of evaporation the discharge from most of the tubes is practically continuous, and the disturbance of the water-level not so violent. Some of the tubes, which are not as highly heated as the rest, act as downcomers, while in some others the flow is alternating in direction. When the external downcomer is used an improvement is observable in the general circulation; there is less alternating flow, but some of the tubes still act as downcomers. When the other half of the boiler is used, in which the tubes discharge above the water-level, there is, of course, no circulation until boiling begins, but on this account steam begins to be formed in the tubes nearest the fire almost immediately after the heat is applied. This steam projects the water in the upper part of the tubes into the steam drum, cool water flowing from the drum through the downcomer to take the place of the water thus discharged. The action during warming up, then, is of an intermittent character but, as the average temperature of the water in the whole boiler is increased, the intervals between the discharges become less and less, and when the boiler is working at a high rate of evaporation the action is quite continuous. Each half of this model consists of sixteen tubes, in four rows, each tube being $\frac{7}{16}$in. internal diameter, and the tubes in the different rows are opposite the spaces in the other rows. The internal diameter of the down-comers is $\frac{11}{16}$in., therefore the area of each downcomer is equal to $\frac{1}{5\cdot4}$ of the area of all the tubes served by it.

Model of Thornycroft boiler (Fig. 7).—This consists of twelve tubes, $\frac{7}{16}$in. internal diameter, with a downcomer $1\frac{3}{8}$in. diameter. The area of the downcomer is therefore approximately equal to the area of the tubes served by it. When heat is applied to this boiler, an intermittent discharge of plugs of water is almost immediately set up, due to formation of steam in the tubes, although the water in the upper and lower drums is practically cold. This action is obviously of great service in preventing overheating of the upper portions of the tubes which, before this action commences, do not contain water. In actual boilers of the Daring type, with internal heated downcomers, circulation of water between the drums will be started through the downcomers as soon as the fires are lighted. As before remarked, at high rates of evaporation, even with tubes below $\frac{1}{2}$in. in diameter, the water and steam do not follow each other in plugs; the upper halves of the tubes are more or less filled with coarse foam, to the complete exclusion of continuous water. Under these conditions the circulation is wonderfully active, and the water part of the foam is projected in a continuous stream right across the steam drum, as

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[*] Read at the Thirty-seventh Session of the Institution of Naval Architects, March 26th, 1896

[†] From a paper by the author, Inst. Engineers and Shipbuilders in Scotland, January, 1895.

shown, the steam being given off freely, and the water level is only very slightly disturbed.

Model of Babcock boiler (Fig. 8).—This model consists of three tubes, each $1\frac{7}{16}$in. internal diameter, and the distance between the centres of the headers is 33in. The tubes are inclined at 15 deg. to the horizontal. The circulation in this case is due partly to the entraining action of the bubbles moving through the inclined tubes, partly to the foam filling the upper ends of these tubes, but mainly to the column of foam in the front header. When the level of the water before starting is below that of the bottom of the steam drum, a much smaller drum may be used, without priming taking place, than when the water-level is above. When the water-level before starting is below the bottom of the steam drum—see Fig. 8, line A B—as soon as the boiler has got into full action a large amount of water is carried up into the drum along with the steam, and there is a continuous and very rapid flow of water along the bottom of the drum, as shown.

Model of Niclausse boiler (Fig. 9).—In this model there are five tubes, each 1in. internal diameter and 18in. long. The internal tube is $\frac{3}{8}$in. internal diameter, and the inclination is 15 deg. The action is practically the same as in the Babcock boiler.

Effect of inclination of tube on velocity of circulation.—When each tube draws its supply of water directly from the water drum, and discharges it directly into a steam drum, the greater the inclination of the tubes to the horizontal the better the circulation. If the tubes draw their supply from, and discharge their steam into, headers, the inclination of the tubes does not greatly affect the circulation, providing it does not fall below about 15 deg., and providing the currents from the different tubes do not interfere with each other. This is because the circulation in boilers of this type is mainly due to the low density of the foam in the upper part of the front headers. When the inclination is much below 15 deg., no matter whether the supply of water to the tubes is from a back header or is by means of internal tubes, the circulation is largely local, and the amount of water in the tubes is very small. When the tubes are only slightly inclined to the horizontal, the only safe way of preventing the water being driven out of them is to use a non-return valve, or a very contracted orifice at the lower end of each tube; with a non-return valve the tubes may be quite horizontal.

Relative advantages of above and below water delivery of steam.—When the discharge takes place just at the water-level, it seems evident that the velocity of circulation must be a maximum, because the head of water effective for circulation is the same, whether the discharge takes place at or below the water-level. In the latter case, however, part of the energy due to this head is expended in giving motion to a considerable body of water in the drum, and the velocity of circulation through the tubes must necessarily be less than when the discharge takes place at the water-level. If tubes are carried much above the water-level the circulation is, of course, reduced in these tubes. When the discharge takes place above the water-level the area of the downcomer is constant under all conditions, but when the discharge is below, this area varies even when external downcomers are used, because the number of tubes acting as downcomers varies with the rate at which steam is being generated. When the discharge takes place above the water-level a much smaller drum may be used for a boiler of a given power, and priming is less likely to take place, because the water level in the drum is only very slightly disturbed, whereas when the discharge takes place below the water-level the disturbance is considerable. Should straight or curved tubes be used? From what has been said in connection with the action of the boilers when the fires are first lighted, it will be evident that when the discharge is above the water level, some parts of the boiler may be at a very much higher temperature than other parts. From this it seems to follow that, when the discharge is above the water level, provision must be made for free expansion of the tubes, either by bending them or by leaving the ends free, as in the boilers of Belleville and Niclausse. When the discharge is below the water-level, the temperature throughout will never differ much from that of the water, providing the circulation is good, and in this case straight tubes may be used without difficulty. The author has found, by calculation, that when evaporating at the rate of 20 lb. of steam per square foot of heating surface, the difference in temperature between the inside and outside of the tube is only 2·6 deg. Fah. for each $\frac{1}{16}$th of an inch in thickness of the tube in the case of steel. The temperature of the metal will, of course, be a few degrees above that of the water, but the more rapid the circulation the less the difference in temperature between the water and the tube. When working at the above rate, if the water be entirely driven from the heating surface for one second, and the thickness of the tube is $\frac{1}{8}$th of an inch, the rise in temperature in that time will be less than 10 deg. Fah. Assuming a difference of even 100 deg. Fah. between the temperature of some of the tubes and that of others, the difference in length in the case of a tube 5ft. long due to this difference in temperature would be only ·04 of an inch. If the external diameter of the tube be $1\frac{1}{8}$in. and its thickness $\frac{1}{8}$th of an inch, the force necessary to prevent any increase in length due to this increase in temperature is 3·15 tons. This corresponds to about eight tons per square inch of the metal, which is sufficiently below the limit of elasticity of mild steel to prevent injury to the boiler, even should the above unlikely difference of temperature ever exist between the different tubes of the boiler. By using bent tubes it is possible to obtain a much larger amount of heating surface for a given number of joints, and a given amount of space occupied by the boiler.

Relative advantages of heated and non-heated downcomers.—With a given rate of evaporation from a given amount of heating surface, the greatest velocity of circulation will be obtained when all the heat is supplied to the upcomers; but if additional heat be applied to the downcomers, the velocity of circulation will be increased, so long as the amount of heat supplied to the downcomers is insufficient to generate steam with sufficient rapidity to nearly exclude continuous water at some part of the downcomers. In all these models the velocity of circulation is increased by applying a moderate amount of heat to the downcomers. For this reason it is probable that the circulation in the Thornycroft boilers is more vigorous in those of the Daring type than in those of the Speedy type. In boilers where the discharge takes place below the water level, as in the Yarrow, Normand, Babcock, D'Allest, &c., even when special external downcomers are provided, some of the tubes most remote from the fire act as downcomers. In connection with downcomers it is important to note that the entrance to the downcomers ought to be removed as far as possible below the surface of the water in the drum, otherwise the reduction in pressure just inside the upper end of the downcomer may be sufficient to cause steam to be generated in it at that part. The steam thus formed would, of course, be condensed on its way down by the increased pressure. This action is indicated in Fig. 11. In connection with internal heated downcomers, insufficient attention has, I believe, been paid to the advantages of a few tubes of larger diameter being placed in the midst of tubes of smaller diameter.

Determination of weight of circulating water ÷ weight of feed water. — When considering the best method to be adopted in order to determine this ratio, the author first thought that the best arrangement would be by means of a circular thin-lipped orifice, of known dimensions, placed near the top of the downcomers, but it soon became evident that although this method might be adopted for cases where the discharge takes place above the water-level it could not be used in cases where the discharge is below the water-level, because in these cases some of the tubes act as downcomers, no matter how large the external downcomer may be. In order to get over this difficulty the author used the model illustrated in Fig. 10, above, which consists of only one upcomer and one downcomer. By means of the loose glass tube shown attached to the brass rod in the steam drum, the discharge may be made to take place above the water-level. After trying various methods for measuring the circulation it was found that the simple water column pressure gauge was the most convenient, and of sufficient accuracy for present purposes. In Fig. 10 this is shown attached to the top of the lower drum, another column being attached to the bottom of the steam drum as shown. The head available for circulation is the difference in the heights of these two columns, and the velocity of the water in the downcomers is proportional to the square root of this difference of levels. In connection with this, it is important to remember that this difference of level may be increased, either by an increase in the velocity of circulation, or by an increase in the resistance to the flow of the water from the upper to the lower drum. By means of the glass-tube extension to the upcomer, it was possible to take the readings of the columns when discharging above, and when discharging below the water-level, immediately after one another. To determine the weight of circulating water in each case, separate tests were made for each size of downcomer with the upcomer disconnected, and the outlet from the bottom drum contracted to give a suitable difference of level between the columns. Water at about 200 deg. Fah. was then syphoned into the upper drum, and the weight of water flowing down the downcomer per minute, and the difference of level of the column being obtained, it was possible to determine, with considerable accuracy, the weight of circulating water under the actual conditions of working as given in the above table.

The following results were obtained with this apparatus when working at atmospheric pressure and evaporating 13 lb. of water per hour; the evaporation per hour per square foot of heating surface actually subjected to flame being 10·8 lb.

Area of Down-comer.	Depression of Water Column.		$\frac{\text{Weight of Circulating Water}}{\text{Weight of Feed Water}}$		Remarks.
	Discharge above.	Discharge below.	Discharge above.	Discharge below.	
sq. in.	in.	in.	lbs.	lbs.	* The difference between these two readings was so small that it could not be read.
·087	21	18	40	37	
·359	$8\frac{1}{4}$	$7\frac{1}{4}$	147	138	
·994	$8\frac{1}{4}$	$8\frac{1}{4}$	242*	242*	

When I commenced to write this paper my intention was merely to describe the action in the various models shown, but as practically the whole of the problems connected with the design of water-tube boilers depend on the nature and amount of the circulation under various conditions, I was gradually led into a discussion of some of the most important problems which are affected by the circulation.

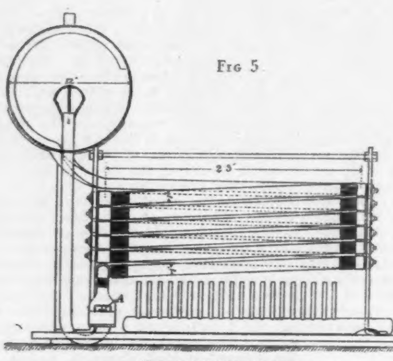


FIG 5

MODEL OF BELLEVILLE BOILER.

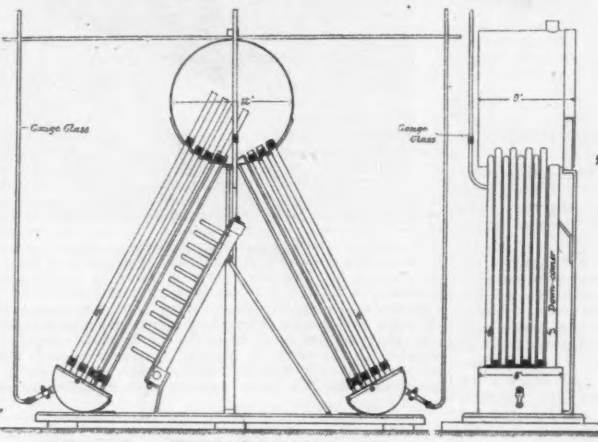


FIG. 6

MODEL OF YARROW BOILER

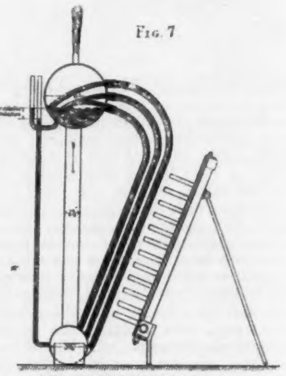


FIG. 7

MODEL OF THORNEYCROFT BOILER

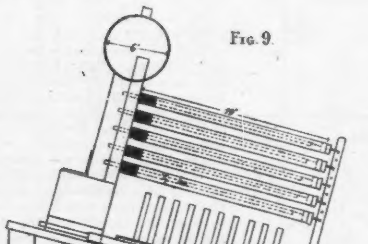


FIG. 9.

MODEL OF NICLAUSSE BOILER.

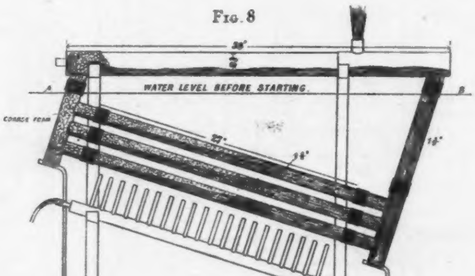


FIG. 8

MODEL OF BABCOCK AND WILLCOX BOILER.

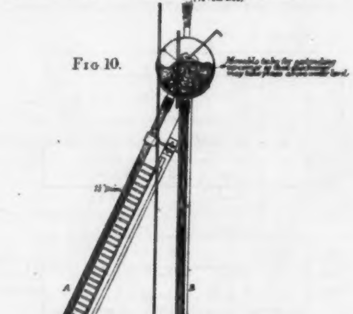


FIG 10.

EXPERIMENTAL BOILER.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, March 26th.

The trade situation throughout the United States is not altogether satisfactory. Manufacturers are not working to full capacity. The banks are not accommodating customers freely. Throughout the West there is a scarcity of money that serves to intensify hostility to the present administration.

Conditions are improving slowly in most lines, but in several, raw material, such as cotton, wool, ore, and coal are too high. There is a reviving demand for reciprocity arrangements, and steps will be taken next month under the new republican silver president the people will elect, to return to the discarded reciprocity policy.

The Brazilian and Argentine Governments have extended an invitation to the Chambers of Commerce of our leading American cities to visit those countries this summer to arrange for the establishment of banks and steamship lines, and save us and them the circuitous methods of business, *viâ* Liverpool and London. The iron trade don't know whether to cry or not. Business is not up to expectations.

Pig iron accumulates. Billet mills have too many furnaces idle. Rolling mills are reducing output. Summer orders are not coming in, though promised. There is a general holding-off policy among large buyers. Railroad companies are still economising. Locomotive builders are hopeful of catching good home and foreign orders next month. Recent estimates of cost of pig iron show cost at Southern furnace to be 7·50 dols., at Eastern Pennsylvania furnace 9·60 dols. High freight rates work against the long hauls of southern pig into northern markets. The best posted in the American iron trade have the least to say these days. Political questions are calculated to restrain activity. The consumers demand cheaper Lake ore and cheaper coke, but the dozen men who control these products are hard of hearing.

Trade and Business Announcement.—Mr. W. Schroller, of Old Elvet, Durham, announces that he has changed his address to 38, Claypath, Durham.

A Local Government Board Inquiry was held, on the 19th inst., by Mr. Rienzi Walton, C.E., into an application of the Todmorden Urban District Council to borrow £40,000 for sewerage and sewage purification purposes. Evidence in support of the application was given by Mr. Shaw, surveyor, Dr. Thorp, the medical officer, and Mr. A. Crossley, chairman of the Sewerage Committee. Mr. Sutcliffe, the clerk to the Council, stated that the sewage would be treated by the International system, precipitation by ferozone, and filtration through polarite.

RAILWAY MATTERS.

The text of the edict of the Emperor of China relating to railway construction shows that the Emperor now, without doubt, recognises the importance of railways in peace as well as in war.

Mr. William Pollitt, of Fornlea, Bowdon, the general manager of the Manchester, Sheffield, and Lincolnshire Railway Company, has been put upon the Commission of Peace for the County of Chester.

In the German Empire 1087 miles of new railways were opened during the year 1895, as compared with 500 miles in 1894. About 435 miles opened last year were built under the provisions of a Prussian law of 1893, providing for light railways and private lines making junctions with established lines. The longest single line opened had a length of less than 45 miles.

A German resident at Mombassa writes, says the Berlin correspondent of the *Standard*, that the staff of sixty Europeans and about eleven hundred labourers, who have been sent from British India to assist in the construction of the Uganda Railway, have been quartered near Mombassa since the middle of last month. The scarcity of water for the first hundred miles or so will be met by the use of sea water condensing apparatus.

A good deal of public interest attaches to the Ahmedabad-Parantij railway line from the fact of its being the first railway constructed by private enterprise in India with rupee capital. Lord Sandhurst, Governor of Bombay, recently performed the ceremony of cutting the first sod of the line. The necessary funds have or had to be desposited with the Bombay-Baroda and Central India Railway Company, which is to construct and work this feeder line to its system.

Under instructions from the Secretary of State, the Government of India has issued orders to the agents and managers of the metre-gauge State Railways in India, through their respective Governments, to afford every facility to Mr. T. H. Trevithick, Superintendent of Locomotives and Rolling Stock of the Egyptian Railway Administration, who is to make a tour in India with a view to acquaint himself with the metre gauge rolling stock used in this country for the purpose of adopting the same for use on the Egyptian line now under construction from Kineb to Assouan.

On Saturday last an inaugural trip upon the North Wales and Liverpool Railway was made, Mr. and Mrs. Gladstone being of the party. The line is only fifteen miles in length, but it is one that cuts through a portion of Cheshire hitherto untraversed by a railway, joins the existing Mersey Railway under the river, and gives to Liverpool a direct access to North Wales. Mr. Pollit, chairman of the new railway, and general manager of the Manchester, Sheffield, and Lincolnshire Railway, presided, and gave the health of Mr. and Mrs. Gladstone, who were present, which was cordially received.

The Directors of the South-Eastern Railway Company received on Monday, at the Charing Cross Hotel, a Sub-Committee representing the agriculturists of the whole district served by the line, in order to consider the proposed reduction of rates on agricultural produce. The discussion was of the most friendly character, and a number of important reductions were agreed to, subject to confirmation by the London, Chatham, and Dover Company. An arrangement to lower the rates for the carriage of milk by 15 per cent., and for small parcels up to 56 lb. by 30 per cent., will take effect on and after Saturday next.

The experimental car of the New York and Brooklyn Bridge Railroad, equipped with four 50-horse power electric motors, has been subjected to tests in shunting trains at the Brooklyn terminus, and is reported to have saved about half the time required to shunt trains by the steam locomotives. At a meeting of the Bridge Trustees, February 10th, Chief Engineer Martin submitted a report on the successful trial of electricity on the railway, and recommended that a contract be made with the General Electric Company for equipping sixteen cars with the necessary electric apparatus. The report was adopted.

An influential syndicate in London has put forward a proposal to connect the East Indian with the East Coast Railway by a line between Raniganj on the former and and Midnapur on the latter. The importance of this proposed connecting line can hardly be over-estimated, for it will not only afford the much-needed direct route to Juggernath—Puri—for the north-western pilgrim traffic, but, better still, says the *Indian Engineer*, from an industrial point of view, bring the coalfields of Jherria and Raniganj into immediate touch with the Southern Presidency. In addition to these desiderata, a large and new area for produce will be effectually tapped in the interests of mercantile Calcutta.

Official returns regarding the rail and river-borne trade of Bengal during the quarter ending the 30th September, 1895, show a decrease of 9,59,868 maunds, or 11·94 per cent. in the total external trade of the Lower Provinces, in comparison with the corresponding period of the year before. The falling off occurred entirely under imports, which decreased by 17,24,518 maunds, or 41·49 per cent. This was due to an absence of demand for export to Europe. The decrease was especially conspicuous in the consignments for Calcutta and Behar from the North-Western Provinces and Oudah and Punjab. As regards exports, there was an increase of 7,64,650 maunds, or 19·17 per cent. The largest increase was in the import of rape and mustard seed, which amounted to no less than 1,71,654 maunds, and was due to a good demand in Calcutta for local consumption.

It is reported that successful arrangements for preventing damage to merchandise through excessive cold have been experimented with on a German railway. The winter 1894-5, which was particularly severe throughout Central Europe, caused great losses of perishable freight in transit during the winter months. It was, therefore, proposed to heat freight cars carrying such goods. A stove in the centre part of the car, which is fed from without, supplies the necessary warmth, and a thermometer, which is visible from the outside, reveals to the inspector, whose duty it is to ascertain the temperature of each car at every station, whether he has to open the ventilators on top to reduce the heat, or whether new fuel ought to be introduced to keep up the fire and increase the temperature. A slight additional freight is charged, and as the shippers prefer this increase to the uncertainty of the weather, the *Railroad Gazette* says, the entire system is said to have been pronounced a success on all sides.

A company is likely to be formed for the purpose of acquiring the tramways in Middlesbrough, Thornaby, and Stockton, and working the same by the overhead electric system. The tramways at Middlesbrough are owned by the Imperial Tramway Company, and are worked by horses, while those at Stockton and Thornaby are owned by the Stockton and Darlington Tramways Company, and are worked by steam power. Mr. Emile Garcke, the engineer of the British Electric Traction—Pioneer—Company, has just inspected the Stockton Company's lines, and also those of the Imperial Company's at Middlesbrough, and as a result a scheme has been formulated to acquire the entire properties of both companies if the local authorities would assent to the construction of the requisite overhead electric plant. The Stockton authorities have refused permission. It is, therefore, now intended to obtain the assent of the Town Councils of Middlesbrough and Thornaby, and if it is granted, the Stockton and Darlington Tramway Company and the Imperial Tramway Company will be amalgamated, so far as Middlesbrough and Thornaby are concerned. New lines will be laid down of a uniform gauge, and a connecting line constructed between Thornaby and Newport.

NOTES AND MEMORANDA.

Aluminium is now being used instead of magnesium for "flash-light" photography. The light is said to be equally actinic, while *Aluminium* say the metal keeps better and burns away more completely.

It is stated that after an aluminium cooking utensil has been in use for some time, a brown enamel or coating is formed on the inside, which is perfectly harmless, and Messrs. Bowen, of the Phœnix Foundry, Clerkenwell, say this acts as a protection to the surface of the metal.

An American contemporary makes the statement that the greatest corporation on earth is the London and North-Western Railway Company. It has a capital of 595,000,000 dols. and a revenue of 6500 dols. an hour; has 2300 engines, and employs 60,000 men. Everything is made by the company—bridges, engines, rails, carriages, wagons, and an innumerable lot of other things; even the coal scuttles and wooden limbs of the injured of its staff.

The Philadelphia Natural Gas Company, of Pittsburg, have a larger supply of gas for their private customers than at any time within the past three years. The prices charged are:—For the first 500,000 cubic feet or part thereof consumed per month, 15 cents per 1000; for the second 500,000 cubic feet or part thereof consumed per month, 10 cents per 1000; for all over 1,000,000 cubic feet consumed per month, 8 cents per 1000, subject to the conditions and provisions of the regular form of contract.

The decomposition by shock of endothermic compounds, discovered by M. Berthelot, and the explosion of carbon bisulphide vapour described by Dr. Thorpe, led Messrs. H. B. Dixon and J. A. Harker to determine whether a true explosion-wave was transmitted through these compounds. The results of their experiments are given in the Chemical Society's *Journal*. It was found, however, that when a charge of fulminate was fired in a steel bomb attached to a long tube filled with cyanogen or acetylene, the detonation was not transmitted through the gas in the tube except for a short distance. With carbon bisulphide the flame extended for some distance, but gradually died out. M. Maquenne has recently obtained similar results. It would appear from the experiments that a true explosion-wave is propagated through chlorine peroxide.

In view of the enormously increased consumption of platinum in electrical work it is agreeable, says the *Engineering and Mining Journal*, to note the well accredited statement that large deposits of this valuable mineral have been discovered at Fitfield, New South Wales. It has been known for several years that platiniferous lead existed in this locality, and the deposits have been worked, though only on a small scale. It is now found, however, that the platiniferous lead is over a mile long, varying in width from 60ft. to 150ft., and covered with from 60ft. to 70ft. of loam. The precious metals are practically confined to the bed-rock and the drift for 3in. above the bottom. Nuggets which weighed from a few grains up to 5 dwt. have been occasionally found. The crude metal contains about 75 per cent. of platinum, and realises at the present time upon the field 24s. per ounce.

In a recent paper read before the Chemical Society "On the Mode of Formation of Carbon Dioxide in the Burning of Carbon Compounds," Mr. H. B. Dixon, F.R.S., says:—"Assuming that in the combustion of carbon compounds the carbon burns first to carbonic oxide, the author discusses the views that have been advanced concerning the function of steam in promoting the union of carbonic oxide and oxygen. Professor Armstrong considers that the moisture acts as an electrolyte, and that chemical change only takes place when carbonic oxide, steam, and oxygen are in contact. The chief difficulty in this theory is to account for the great velocity with which the explosion wave is propagated through a damp mixture of carbonic oxide and oxygen. In gaseous mixtures the rate of explosion approximates to the rate of the forward movement of the reacting molecules, *i.e.*, the wave is transmitted like sound from molecule to molecule. According to the electrolytic theory, the chemical change could only occur on the simultaneous collision of at least three molecules; yet the explosion wave is propagated in carbonic oxide, steam, and oxygen at a rate of 1738 metres per second. In the explosion of cyanogen, carbon dioxide is formed without the intervention of steam. This theory, which has the advantage of including a number of cognate phenomena, seems better suited to explain reactions at ordinary temperatures than those occurring in the explosion wave."

In a recent paper before the Geological Society on "Observations on the Geology of the Nile Valley, and on the Evidence of the Greater Volume of that River at a former Period," Professor E. Hull, F.R.S., drew attention to the two great periods of erosion of the Nile Valley, the first during the Miocene period, after the elevation of the Libyan region at the close of Eocene times, and the second during a "pluvial" period extending from late Pliocene times into and including the Pleistocene. He notes the course of the river through escarpments of the granitic and schistose rocks of Assuad, the Nubian sandstone, the cretaceous limestone, and the Eocene limestone, and observes that in places the line of erosion of the primæval Nile was directed by dislocations of the strata. In a second part of the paper he dwelt on the terraces of the Nile Valley, and the characters of a second terrace, at a height varying from 50ft. to 100ft. above the lower one, which is flooded at the present day. The second terrace is devoid of vegetation, and its deposits have frequently furnished river-shells. The second terrace is traceable at intervals for a distance of between 600 and 700 miles above Cairo. Two old river channels are also described, one at Koru Ombo, and the other at Assuan itself. The author discussed the mode of origin of the second terrace and the old river valleys, and believes them to be due to the former greater volume of the river, and not to subsequent erosion of the valley. He gave evidence of the existence of meteorological conditions sufficient to give rise to a "pluvial" period, and points out that other authors have also considered that the volume of the Nile had been greater in former times.

Some very interesting tests which have been applied to standard Clark cells have recently been described in the *Electrician* by Mr. Fisher. The cell used is Muirhead's, in which the positive pole consists of a spiral of platinum wire amalgamated and filled with mercury. It is very generally believed that if by any chance a Clark cell becomes short-circuited, then the cell is either totally ruined or only recovers after a very long time. Mr. Fisher has shown that the Clark cell will stand very much rougher usage than one would think, and still recover even in a very short time. In one set of experiments a Muirhead pattern cell had for one minute a potential applied to the terminals of $\frac{1}{100}$ volt in excess of the electromotive force of the cell. As a result, the electromotive force rose about three parts in 14,000, but regained its normal value after ten minutes. After short-circuiting for one minute through 500 ohms the electromotive force fell from 1·4323 volts to 1·431, but recovered its normal value after thirty minutes. Short-circuiting the cell through 2in. of No. 18 copper wire for thirty seconds caused a drop from 1·4319 volts to below 1·431, but after thirty minutes it had almost recovered. A cell having been short-circuited through a few inches of copper wire—No. 20—for twenty hours, its electromotive force fell to 0·17 volt. The recovery was at first very slow, and continued so till it reached 0·5 volt, the average rate of recovery being 0·03 volt per hour. After this the recovery was much more rapid, and in twenty-four hours the cell had almost completely recovered. The effect of applying a constant potential of 1·4 volts to a cell which had been "dead" short-circuited for twenty hours, was to very much hasten the recovery, so that after two and a-half hours it had regained its former value.

MISCELLANEA.

Richmond residents in the neighbourhood of Petersham-road and the main streets of the town were during last week somewhat troubled by a series of concussions underground, which they attributed to various alarming causes. They were, however, only the effect of the heavy gelignite shots fired in the Richmond well adits, in the hope of increasing the water supply.

In accordance with a recent amendment to Section 63 of the Baltimore City Code, the City Commissioners hereafter are to be civil engineers. The Code says:—"There shall be appointed biennially in the month of March, by a joint convention of the City Council, a City Commissioner, who shall attend daily at his office, and there shall be also appointed three Assistant Commissioners, who shall be under the direction of the said City Commissioner; said City Commissioner and Assistant City Commissioners to be practical civil engineers of not less than five years' actual experience, and the entire time of both commissioner and assistants shall be devoted personally to the interests of the Corporation; and should it be ascertained that any of the aforesaid officers is engaged in or connected with any business or pursuit other than that appertaining to his official duties, it shall be deemed good and sufficient cause for his removal."

After experiments extending over a period of two years, the Admiralty have now decided to generally adopt the "Temperley Transporter" for use in battleships and first-class cruisers. It is probable that the apparatus would have been adopted before had it not been for its awkward length and the difficulty of stowing it clear of the working parts of the ship. The trials, however, says the *Naval and Military Record*, have resulted in most favourable reports, and the commanding officers of the vessels in which the transporter has been tried are unanimously of opinion that the time and labour saved when coaling ship far outweigh the inconvenience occasioned by stowing the gear away. Apart from this, it has been found that the transporter will enable a torpedo boat or destroyer to fill up with coal from her parent ship when both vessels are steaming at a fair rate of speed, pro viding, of course, the sea is moderately calm.

The fate of Bruxelles, port-de-mer, hangs once more in the balance. It may be remembered that the contract for the conversion of the capital of Belgium into a seaport was signed on October 21st last, the cost of the undertaking, estimated at £1,400,000, being divided between the State, the city of Brussels, the suburbs, and the provinces. Latterly, however, a modification of the original plan has been proposed by the Minister of Finance, following which the waterway would be carried through the plain of Monplaisir, instead of that of Tour and Taxis. The *Times* Brussels correspondent says this scheme, while connecting the docks with the line of the Metropolitan Railway now under consideration, would have the effect of removing them further from the capital. The town of Brussels resents the Minister's interference, and at a meeting of the Communal Council M. Buls, the burgomaster, has moved that Brussels should withdraw the promised subsidy, and refuse all participation in the enterprise in its altered form. The vote upon the motion was adjourned.

The building up of industrial towns in the natural gas regions of Ohio and Indiana during the past few years has been marvellous. In the glass trade particularly these new conditions have been felt, and the centres of business have shifted westward. It has since been demonstrated that the supply is limited. Now the manufacturing concerns, built on practically free fuel, are wondering what is to be done when the gas becomes exhausted. A recent dispatch to a leading Chicago journal states that the Chamber of Commerce of Brazil, Ind., is in receipt of many letters from manufacturers in the actual gas belt, stating that they realise that the life of the gas is not more than four or five years, and that they are taking time by the forelock in arranging for a suitable location in the coal fields when the blow comes. Some, the *American Manufacturer* says, are securing all new gas territory they can. If the next few years do not develope some great changes in the production and application of fuel, there will be some very cheap factories in the western gas belt.

The Renown, battleship, was taken on the 27th ult. into the Channel by Captain H. Rose for the first of her series of official speed trials. The trial was of eight hours' duration, with natural draught, and throughout the engines and boilers worked satisfactorily. The *Times* says the mean results were:—Steam, 143 lb.; vacuum, starboard 26·9in., port 26·9in.; revolutions, starboard 97·5, port 98·2; indicated horse-power, starboard 5233, port 5475—total, 10,708; speed, 17·9 knots. Messrs. Maudslay, Sons, and Field, the makers of the machinery, were responsible for an indicated horse-power of 10,000 only on the natural draught trial, but more than once on Friday's steaming the engines easily attained 11,000 indicated horse-power, while the mean was 708 in excess of the stipulated power. The mean speed was exactly one knot more than her designers anticipated that the vessel could attain on her natural-draught trial, and two-tenths of a knot more than it was estimated she would steam under forced draught with 12,000 indicated horse-power. The Renown returned to the Hamoaze in the afternoon to be prepared for a four hours' forced-draught trial on the 6th inst. Before she passes into the Reserve she is to carry out a thirty hours' full-power trial in the Channel.

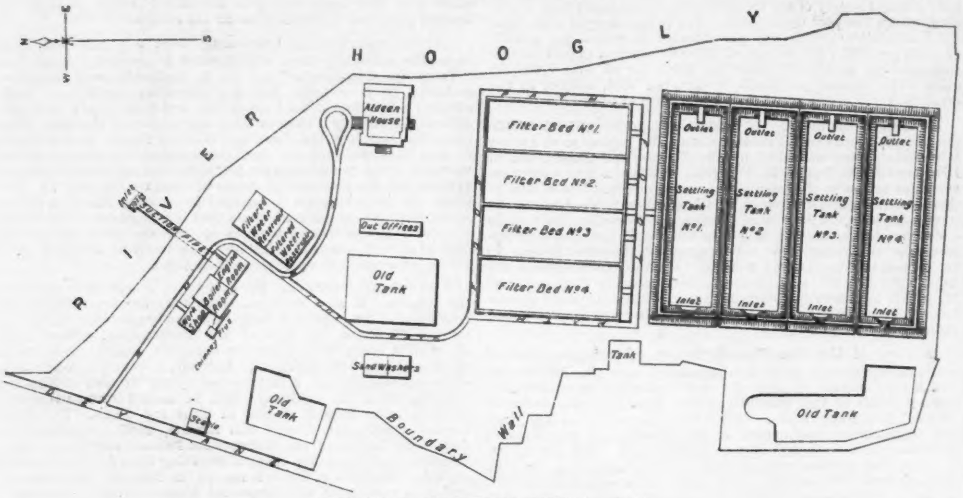
The following resolution has been passed by the Grand Jury of County Waterford:—"That having learned that there is a probability of torpedo boat stations being established at several ports upon the Irish coast, we wish to point out the strong claims that Waterford possesses for selection. The harbour is spacious, safe, and easily entered at all times; it is the only harbour between Queenstown and Kingstown, being 60 miles from the former, and 110 miles from the latter, while it is 80 miles from Pembroke Dock. From its geographical position it commands the approaches to St. George's Channel and the Bristol Channel. It has two piers, one at Duncannon and one at Dunmore, and at both places the Government possesses ample accommodation for coal stores. Dunmore is practically upon the sea, and in addition to affording a safe berthage, has a good anchorage off its entrance, making it suitable for occupation by torpedo boats; so having regard to these considerations, and to the fact that since Duncannon has been abandoned as a fortress, leaving no defence of any kind for the harbour, we are strongly of opinion that, both on imperial grounds and the grounds of its local utility, the claims of Waterford to be made a torpedo boat station are greater than any port in Ireland."

The screw steamer Algoa, which has recently left the hands of her builders—Messrs. Doxford and Sons, Sunderland—in addition to being the largest cargo boat ever built on the Wear and the third largest deadweight carrier afloat—being in that respect beaten by the Georgic and her sister ship the Civic of the White Star Line, built by Messrs. Harland and Wolff—possesses several other points for which she is noteworthy. She is plated on the Bell-Rocliffe system, whereby packing is dispensed with, and on this account is some 68 tons lighter than if plated on the old system, and has a very large number of steam derricks on board—eighteen—and is further equipped with a new design of steering gear, the invention of Messrs. Fawcet, Preston and Co. This gear is worked on the hydraulic principle, having attached to it a duplex steam pump. For the hydraulic cylinders oil is used instead of water to obviate the chance of the fluid being affected by frost. The advantages of gear on the hydraulic principle over the ordinary steam steering gear are numerous. It is noiseless and safer, inasmuch that it has not connected with it chain and toothed gearing, and there is less likelihood of a breakdown if a sea strikes the rudder. The hydraulic cylinder applying the power also acts as an elastic brake, and allows the rudder to give way before the sea. By an automatic readjustment arrangement the rudder is afterwards replaced in position. The Algoa is owned by Messrs. Crow, Rudolph, and Co., Liverpool.

HOWRAH WATER SUPPLY.

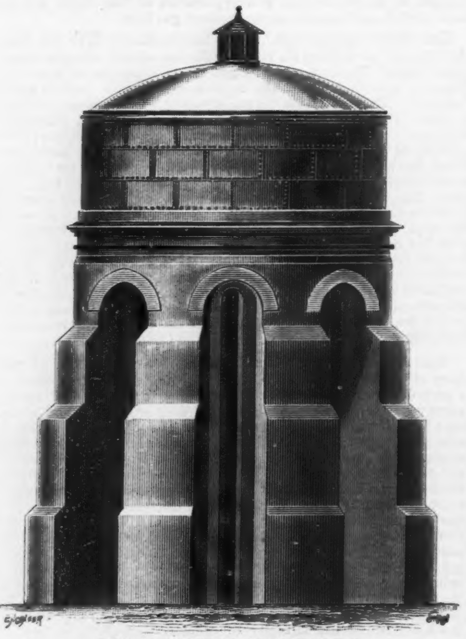
The waterworks are designed to provide a domestic water supply of 1,250,000 gallons a day, or 10 gallons per head, for a population of 125,000 persons in the Howrah Municipality. The water is pumped against a total head of 42ft. from the river Hooghly at Serampore through a 22in. steel hydraulic riveted suction pipe, carried out into the river on a wrought iron screw pile jetty, 130ft. in length. The mouth of the suction pipe, which is protected by a rose, is 12ft. above bed of river, and will be always covered with water at the lowest known river level.

The river water is delivered into four settling tanks, a distance of about 1500ft. from the engine house, by duplex compound condensing steam pumping engines, of which there are two sets, each capable of pumping 1,300,000 gallons in ten hours, or a little more than a day's maximum demand. The settling tanks are 250ft. long by 100ft. wide at bed level, each capable of holding a day's supply. They are constructed with earth banks, the slopes being 2 to 1 outside and 1½ to 1 inside. The width at crest is 8ft. The water is delivered into masonry inlet chambers forming a trough and tumbling weir about 40ft. in length. After the water has been allowed to settle for about three days, it passes by gravitation through iron pipes to the filters, the take-off being always surface water. This is accomplished by means of floating pipes supported by small jetties.



HOWRAH WATERWORKS—GENERAL PLAN

The filters are four in number, 181ft. long by 81ft. wide, each having an area of 14,661 square feet, and the process is mechanical through filtering media consisting of fine sand, coarse Mugra sand, pebbles, and close-jointed bricks, the whole being supported on brick channels laid on a masonry floor. The water, after filtration, passes along a masonry channel, formed in the centre of the filter, to the filtered well, where the results of filtration can be observed. From this well the water is delivered, also by gravitation, through iron pipes to the underground filtered water reservoir, a distance of about 500ft. from the filters. The reservoir is divided into two compartments each holding 183,000 gallons of water, and each formed by a series of five masonry-arched passages, supported by masonry walls, with an opening at one end for the passage of the water. These are so arranged as to ensure circulation of the water during filling and emptying, thus advoiding any chance of stagnant water at any point in the reservoir.



TOWER—HOWRAH WATERWORKS

From the filtered water reservoir the water is pumped against a total head of 215ft. by duplex compound condensing pumping engines, of which there are two sets, to the three raised reservoirs in Howrah, and, practically speaking, the water does not see the light after leaving the filters, until it is taken from the standposts in Howrah. These three reservoirs, which supply three sections of Howrah with water, are circular in shape, and constructed of masonry piers arched across to form the flooring for the iron tank. No. 1 reservoir is 60ft. in diameter and holds 176,714 gallons of water. No. 2 is 65ft. in diameter and holds 207,394 gallons of water. No. 3 is 36ft. in diameter, and holds 63,619 gallons of water. The height of the three reservoirs to full supply level averages 51ft. above ground level. From the three raised reservoirs the water is distributed through 37 miles of iron pipes, varying in size from 16in. bore to 2in. bore, to the different roads and lanes of the town.

Along the pipe lines are placed 120 sluice valves, by means of which any line of pipes can be shut off from supply. For the use of the public there are placed 240 taps on standposts, the design being such that water can only be obtained so long as the tap is held open by the hand, thus preventing waste. In addition to the 37 miles of distribution pipes, there are 15 miles of main piping, principally 15in. bore, between Serampore and Howrah, and to provide against the discharge of the water backwards, through the main, eight reflux valves are placed with sluice valves and scours. In the event of a fracture occurring between the head works and the reservoirs, the water can be at once shut off, and only a small portion of the pipes requires to be emptied. The mains are also provided with air valves. The supply pipes to the raised reservoirs in Howrah are so arranged that, in case of anything happening to the reservoir, the water can be supplied through a by-pass direct to the town distribution.

The engines are of a very high class, both in design and finish, and embody all latest improvements. A remarkable feature in their design is that for the high and low-pressure cylinder only one casting is used, this being double the length of the stroke, and the high-pressure cylinder is formed by means of a trunk connecting the two pistons. The valve gear has Evans' improved valve motion, and the cut-off valves, which are most perfect in their action, are of the circular type, driven direct from the crossheads, so that the point of cut-off, and thereby the number of expansions, can be regulated while the engines are in motion. The unfiltered engines have each two high-pressure cylinders of 8in. and two low-pressure of 14in. diameter by 18in. stroke, and the filtered engines have each two high-pressure cylinders of 11in. and two low-pressure of 20in. diameter by 12in. stroke. Steam is supplied by three Lancashire boilers, each 28ft. long by 7ft. diameter, any two of which are capable of doing the work required. An economiser is fixed in the flue, between the boilers and the chimney; the waste gases passing around the pipes are thus utilised in heating the feed-water, which is pumped through them by donkey engines—in duplicate.

The contract was commenced on November 1st, 1894, and completed on January 15th, 1896, or a period of fourteen and a-half months, and the cost has been:—

	Rs.
Pipes, valves, standposts, reservoirs, tanks, buildings, and jetty, &c.	11,34,500
Engines and boilers..	1,30,000
Land, preliminary expenses, establishment	1,30,000
Or a total of	13,94,500
Against the estimated cost of	14,86,980
Showing a saving of..	92,480

The works, which in Bengal are next in extent to those of Calcutta, have been carried out under the supervision of Mr. W. Parry, M. Inst. C.E., as resident engineer for the municipality, and Messrs. Burn and Co., of Calcutta and Howrah, have been the contractors for the whole, including the engines, which were supplied by Messrs. Joseph Evans and Sons, of Wolverhampton. The works were opened on February 8th last by Sir Alexander Mackenzie, K.C.S.I., the Lieutenant-Governor of Bengal.

THE INSTITUTION OF CIVIL ENGINEERS.

THE THERMAL EFFICIENCY OF STEAM ENGINES.

At the ordinary meeting on Tuesday, March 24th, Sir Benjamin Baker, K.C.M.G., the president, in the chair, the paper read was entitled "The Thermal Efficiency of Steam Engines," by Captain H. Riall Sankey, R.E. (ret.), M. Inst. C.E. The question of the standard with which the results of steam engine trials should be compared had occupied considerable attention in several papers on steam engine economy which had during the past fourteen years been read and discussed at the Institution. The matter was nevertheless in an undecided condition, and the author expressed the hope that discussion on this paper might prepare the way for the adoption of some definite standard. He urged that in order to obtain full information of the thermal performance of an engine, two efficiencies had to be stated, namely, the absolute thermal efficiency, and the "standard" thermal efficiency, the latter denoting the comparison of the actual engine with an ideal steam engine working within the same temperature limits. In other words, the "standard" thermal efficiency was the absolute thermal efficiency of the actual engine divided by the absolute thermal efficiency of the ideal steam engine chosen as the standard. It was the choice of this standard which had caused so much discussion. Many views were held as to what should constitute the ideal engine required for this standard of comparison; but the author considered that the true object of such a standard was to provide ready indication as to how far the particular engine under consideration fell short of what was physically possible within the limits of temperature by which the engine was bound, having regard also to the varying temperature at which the heat was supplied to the feed-water. It was shown that this requirement was met by the Clausius "perfect" steam engine, slightly modified, however, as regards the point to which the expansion was carried, for practical reasons which were universal and permanent.

To assist in a decision as to the standard to be adopted, other ideal engines which had been proposed or used as standards were considered; for instance, the Carnot cycle, the engine whose expansion line was the saturated steam line, and the engine the expansion line of which followed the law $p\,v = \text{constant}$; and in each case it was pointed out in what respects the requirements of the standard were not fulfilled. This comparison was also made by means of the $\theta\,\phi$ chart.

After considering certain points in connection with the various lines of the indicator diagram of the standard in greater detail, the author proposed the following as the standard of comparison:—(1) Admission line at the temperature of the steam at the stop valve of the engine; (2) expansion line adiabatic, and carried to within 0·15 atmosphere of the back pressure; (3) back pressure, that in the exhaust immediately outside the engine; (4) compression nil, and clearance nil.

The object of limiting the expansion, as suggested, by carrying it down to within 0·15 atmosphere of the actual back-pressure was to obtain a compromise between the two following conditions:—If the expansion were carried to the back-pressure, the standard would lead to the use of engines too large for their work; if, however, the expansion in the standard were only carried to a pressure equal to the back-pressure plus the mean pressure—referred to the low pressure—corresponding with the friction of the actual engine, a premium was, so to speak, awarded to a stiff engine, and the standard would be made to vary with the stiffness of the actual engine. To avoid the lengthy calculation of the absolute thermal efficiency of the proposed standard, curves had been prepared enabling the required result to be obtained by inspection, and numerical examples were given to show the method of application.

The author pointed out that in many cases a comparison of the actual engine with what he proposed to call the "type" standard was useful. The type standard was an ideal engine which took into account the clearance, compression, back-pressure, &c., necessary with the particular type of engine under consideration. For instance, the ideal engine with an expansion line following the saturation line was the type standard for a jacketed engine. The difference in the amount of heat utilised by the standard and the type standard showed the unavoidable loss normal to the particular type of engine, whereas the difference in the heat utilised by the type standard and the actual engine gave the more or less avoidable loss.

The proposed standard was applied to the case in which superheated instead of saturated steam was used, and the $\theta\,\phi$ diagram of this standard was given, and two numerical examples were worked out. It was pointed out that the actual commercial criterion of a steam engine's economical performances, namely, the number of pounds of water per indicated horse-power, led to errors of about 1 per cent. as a maximum when using saturated steam; but that the error might be as much as 13 per cent. when superheated steam was used. This difficulty would be met by stating the amount of heat required per indicated horse-power, as proposed by Mr. Mair-Rumley in 1882.

The paper was accompanied by appendixes demonstrating the use of the $\theta\,\phi$ chart for finding the absolute thermal efficiency of the proposed standard engine, and an investigation of the efficiency of the fluid in heat engines in general.

LETTERS TO THE EDITOR.

(*Continued from page 345.*)

THE FIRST STEAM HAMMER.

Sir,—In your issue of the 20th inst., while referring to the works of the late Mr. Crawshay, you state:—"The first Nasmyth hammer ever erected in England was put up at these works." Permit us to say that the first order given Nasmyth for a steam hammer was for our works—see Nasmyth's "Autobiography" (Smiles), Chap. XIII., where he states:—"The first order came from Rushton and Eckersley, of Bolton, who, by the way, had seen the first copy of my original design a few years before. The steam hammer I made for them was more powerful than my own. The hammer block was of five tons weight, and had a clear fall of five feet. It gave every satisfaction, and the fame of its performances went abroad among the ironworkers. The Lowmoor Ironworks Company followed suit with an order for one of the same size and power, and another came from Hawkes and Co., of Newcastle-upon-Tyne;" and in Chap. XV. he mentions the working of this hammer in the presence of the Admiralty representatives.

It may be of interest to your readers to know that this hammer is still in use. Charles Harrison.

Bolton, March 25th.

NAVAL ARCHITECTURE—NO. IV., STABILITY.

Sir,—In my letter to you on the above subject, which you kindly inserted in the last number of your valuable paper, it should read, "b_1 b_2 b_3 will be the three vertical centre lines of three different centres of buoyancy, because in each case we have a simple balance with the weight of the ship G at one end and the ballast W at the other." F. W. C.

March 28th.

Sir,—Your correspondent "F. W. C.," whose communication appears in the last issue of The Engineer, has fallen into a not uncommon error in supposing that the vertical height of the shifting weight used in inclining experiments for determining the centre of gravity of a ship has any more influence upon the result than is due to the centre of gravity of the ship, inclusive of the shifting weight, being raised or lowered, according as the shifting weight is put on board at a level above or below the centre of gravity of the ship itself. If the weight to be shifted is put on the uppermost deck it will, of course, slightly raise the centre of gravity of the whole mass; and if it is put on a deck below the centre of gravity of the ship, it will lower the centre of gravity of the whole mass. But as the shifting weight bears but a very small proportion to the total weight of the vessel, and as the available vertical range in the vessel is not many feet, the vertical change in the centre of gravity is scarcely appreciable. Such as it is, an allowance is always made for it at the completion of the experiment.

But your correspondent does not refer to this small matter at all. He seems to think that the higher the shifting weight is placed in the vessel, the greater will be its effect in inclining her from the upright; and by his diagram it is clear that, in his opinion, the highest position of the weight possesses double the heeling moment of the lowest position. Herein lies the fallacy of his reasoning. The effects of the weights in the three positions are practically the same. What little differences there are consist in the fact that, when the shifting weight is put in at the highest level, the centre of gravity of the vessel is very slightly raised, and she therefore inclines a little more readily than if the weight had been put on board at the lowest level. But with the small ratio which the shifting weight bears to the displacement of the vessel, the differences are immaterial. The Writer of the Articles.

March 30th.

HORSELESS CARRIAGES.

Sir,—In your last week's issue the full text of the proposed alteration of the law contains in the first clause the words, "shall not apply to any vehicle propelled by mechanical power if it is under two tons in weight unladen, and is not used for the purpose of drawing any other vehicle, and is so constructed that no smoke or visible vapour is emitted therefrom."

These words seem to shut out from the benefit of the Act a light carriage—carrying a motor—which could be attached to all existing carriages without alteration. Probably this will deter many people from having such a tractor, which could easily be attached to either summer or winter carriages suitable for invalids.

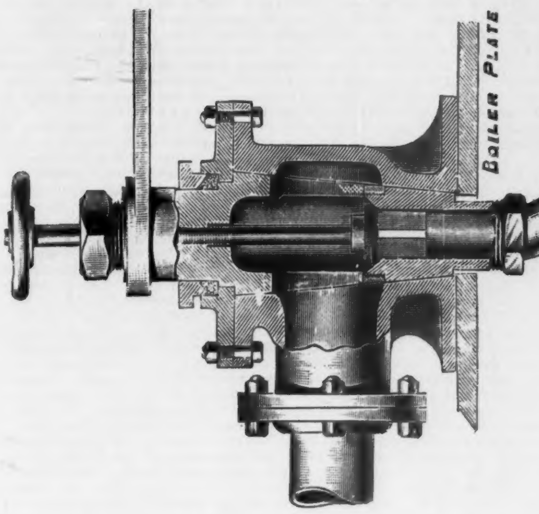
Messrs. Lister and Co., of Keighley, have been for some time engaged in perfecting a tractor which can be fitted to all vehicles without alteration, and probably other firms have it also under consideration. One advantage of the tractor is that, being a separate carriage, no vibration would be felt in any carriage to which it is attached.

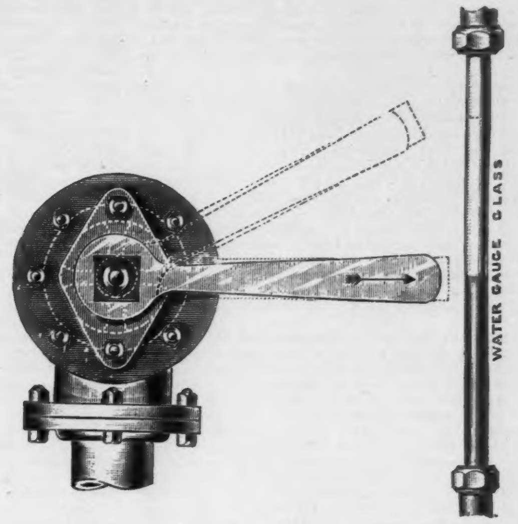
To me it seems that this should be brought to the notice of the Parliamentary Committee now inquiring into the subject.

March 30th. John Todd.

MARKS AND MORDEY'S SURFACE SCUM COCK AND VALVE

MESSRS. HUNT AND MITTON, BIRMINGHAM, ENGINEERS





MARKS AND MORDEY'S SURFACE SCUM COCK AND VALVE.

The accompanying sketches illustrate a novel invention, the object of which is to take the scum off the surface only of the water in a boiler without drawing off and wasting any body of water. The invention also fulfils the double purpose of not disturbing the scum on the top of the water by sudden withdrawal of water. By this arrangement it is possible to take the scum off the water at any height without disturbance of water or distributing the scum. The arrangement is as follows:—

The combination consists of a plug cock and a valve inside the plug, to which plug the movable pipe is connected on the tail end, and is moved into position by setting the handle to the level of the water. The handle of the plug cock is parallel to the line of the revolving arm pipe in the boiler, and when at work is set to the water level by the indication in the gauge glass, and when not at work is put into the steam space, which prevents any leakage of water through the valve. When the plug is set to the surface level of the water, the valve is opened, which releases the scum from the surface only, and does not disturb the body of the water. The scum is directed through valve to the waste pipe.

The advantages claimed are—(1) Economy of water in any position of scumming; (2) perfect scumming of the surface of the water at any level; and (3) security from leakage when not at work. The mounting is made entirely of gunmetal in small sizes, and the scum pipe is bell mouthed. The sole manufacturers are Messrs. Hunt and Mitton, Oozells-street, Birmingham.

LOCAL ANNEALING OF HARD FACED ARMOUR PLATES.*

By Herman N. Lemp, Jun.

Every one is now more or less familiar with the Thomson electric welding process, which in past years has been introduced in almost every metal industry in one shape or another. This process created a new field in the technical application of currents of large volume and small electro-motive force, a field which, while it was primarily intended for welding, naturally suggested a number of other applications to so fertile an inventor as Prof. Thomson; and so it happened that early in its fundamental inception the use of large currents was contemplated to be utilised for heating plain metal bars or parts of sheet billets, &c., for forging purposes, to rivet, upset, to temper or withdraw the temper, or to be worked upon in any well-known manner while being kept heated by current. It has been the good fortune of the writer to lately work out one of these novel applications, and since the literature concerning this branch of electro-technics is somewhat limited, he has thought it advisable to bring an account of the same before the Institute.

One of the latest advances in the making of protective armour for battleships, or even forts, has been the introduction of what is known as the Harvey process. For those not conversant with the latter, I will briefly state that it consists in taking an ordinary low carbon steel plate and introducing an additional percentage of carbon into the surface metal, thus changing the crust to the depth of about an inch into a steel resembling tool steel. A plate thus treated is lastly water-hardened, similarly to an ordinary tool, and by experience has shown to offer, under equal conditions, more resistance to the impact of a projectile than any other armour known. And, therefore, we will take this as an illustration of hard faced armour. The extreme hardness of the surface of a Harvey plate, while exceedingly valuable in preventing projectiles from piercing it, has a disadvantage when it is required to be pierced by a drill and tap. Such holes may be required either for fastening ladders, swivels, or other appliances to the hull of the vessel, or to fasten T flanges supporting the deck to barbettes or turrets.

The methods heretofore used to produce these holes were principally two:—(1) To protect the surface of the plate in patches or strips, to prevent carburation, wherever holes were expected to be drilled; (2) to make accurate drawings and patterns of each plate beforehand, to which all holes are drilled before plate is hardened. Plan No. 1 was practised in the United States until it had to be abandoned. In practice it was found that numerous alterations in construction, errors in either draughting-room or mills, made it necessary to pierce holes where no provisions for annealing were made. It also happened quite frequently that the method for prevention of carburation did not always work satisfactorily, and while white paint indicated well enough where soft metal was expected, very often hard metal was actually found. Hence it was patent from the first that some process was needed to rectify errors of this kind. Experiments were then made with oxyhydrogen blowpipe, or the electric arc, to anneal such spots as were required to be drilled, and numerous mechanical devices for drilling, with drills of every design and method of tempering, were tried, until it seemed that the case was without a remedy. It was at this stage that the problem was referred to the Thomson Electric Welding Company, of Lynn, and experiments were immediately undertaken to solve it. The process and apparatus necessary to carry it out, all resulting from the experiments undertaken, will be described presently.

The second method, which is used in England, has the advantage over the first that there is no difficulty in carrying it out, provided there are no alterations made and no errors committed. The present method of construction seems to be to make beforehand a complete model of the vessel to be built; then make accurate drawings and full-size patterns of every plate, giving the exact location of every hole. These are then bored, tapped and countersunk to a depth of approximately ⅝in., and of a much larger diameter, filled with clay, and then the plate as a whole is heated and hardened with water—see Fig. 1. This method works apparently all right, although in spite of drawings and models errors are made. There is no doubt, however, that it is a slow and very costly method of working, and would hardly ever be resorted to in the United States. From the above it seems clear that there has existed a need for a process by mean of which isolated spots, regardless of location, might be annealed so as to permit drilling and tapping. If, by sending a current of large volume through any spot thus to be treated, the spot is brought to a temperature of, approximately, 1000 deg. Fah., there can be no doubt that the temper has been withdrawn. Experiments carried out to that effect at once showed, however, that upon taking off the heating current the heat was so rapidly conducted away by the surrounding metal masses as to cause the heated spot to become chilled just as effectually as if it had been plunged into cold water. No method of outside protection of the heated spot would prevent this, and the gradual cooling of the spot had to be attained by different means—namely, a gradual and slow withdrawing of the heating current. The method of introducing the annealing current is best shown in Fig. 2. C C are two copper contacts cooled by water circulating inside. The current enters the plate by one end, and leaves it by the other. Right under the contact the metal comes to a bright cherry heat—shown in black—while the portion intervening and partly surrounding the contacts acquires a temperature of just a visible red. Line H H indicates where the influence of the Harvey treatment stops.

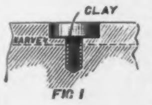


FIG. 1

The shaded portion in Figs. 2 and 3 shows the zone softened and ready to be machined, while the dotted line shows how far the heat radiation would cause the metal to turn blue. When cooled, the annealed portion shows a chocolate colour, while the place where the contacts have been resting is scaled and hard, and cannot be touched by a tool to a depth of about ¼in. These places can again be annealed later on, if required. The apparatus necessary to carry out this process consists of the generator, the annealer proper—transformer—and the regulating apparatus. The generator is commonly a separately excited alternator of variable potential, of a maximum of 300 volts and 100 ampères. The frequency, preferably, should be low, 50 cycles per second being used. When more than one annealer is to be run simultaneously from one generator, constant electro-motive force of the latter should be used, and each annealer regulated separately by a reactive coil. The annealer proper is a transformer similar to the well-known welding transformers. As the apparatus is to be operated outdoors, on board of vessels during construction, it is important that the same may be handled with immunity from electric shocks, even when operated in mist and rain. To meet these conditions a copper-clad type of transformer is used, one in which the secondary is composed of two copper castings, each having a rectangular groove, which two halves, when bolted together, form a closed rectangular frame in which the primary is held enclosed. The hollow space intervening between primary and secondary is, moreover, filled with a heavy oil, which acts both as the insulator and conductor of heat from primary to secondary. The secondary, by completely surrounding the primary, affords an excellent mechanical protection, and prevents electric as well as magnetic leakage. The primary is a copper ribbon insulated with asbestos, and the ratio of conversion is 100 to 1. The transformer has two trunnions fastened to its sides, in a line a little above the centre of gravity, which trunnions swing in bearings, part of a yoke which straddles the whole. The yoke in its turn has a hook which may be secured to the latter at any place of the arch, thus allowing the transformer to be suspended, like a compass in gimbals, in any position desired.

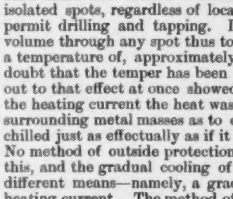


FIG. 2

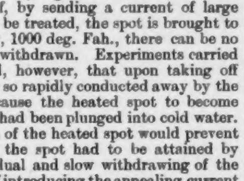


FIG. 3

It goes without saying that the copper castings which compose the secondary are cut through at one place in the circuit. On either side of the cut, two short platforms form the base for copper contacts of various shapes and sizes, by means of which the currents are made to enter and leave the plate to be annealed. These copper contacts are of forged copper, hollowed out to receive water circulation for cooling purposes, and terminate in narrow tips rounded at the end. The weight of the whole annealer, being approximately 1000 lb., is sufficient to give proper contact pressure for all work on a horizontal plate. When inclined surfaces, vertical or otherwise, are to be worked upon, the transformer is suspended so that its weight shall not interfere with the contact pressure, which is obtained for work by bracing the contacts directly with wooden wedges against any object near by. On the outside of a hull it is proposed to use a pair of electro-magnets, which are made to hold themselves against the iron hull, and form a support for the annealer.

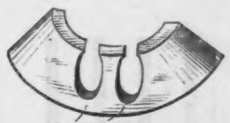


FIG. 4

The remarkable thing is the great amount of current that is being carried by the copper contacts into the plate. The contact surface is seldom more than about ½in. square, and yet 10,000 ampères are made to flow through it continually. This is equivalent to 40,000 ampères per square inch, a density which is only possible on account of the thorough cooling by the water circulation.

The regulating apparatus is in most cases simply a rheostat in series with the field of the generator. When more annealers than one are run simultaneously from one generator, as mentioned before, a reactive coil is interposed between the two, and this latter has been made automatic; that is to say, provided with a dashpot, which permits the current to be reduced uniformly and at any given rate it is set for. This reactive coil is composed of a solenoid coil of cable, well insulated, having a movable laminated iron core which is raised out of the coil by means of a leather strap and winch. The core is composed of thin iron strips placed side by side around a circle, and projecting radially from the same, and being held on top and bottom by a slate disc, in a manner similar to the securing of the copper segments of a commutator. No insulation of the core is necessary, and good ventilation is obtained. The core once raised out of the coil tends to return by gravity and the attraction of the solenoid, but is checked in its descent by a pair of dashpots, one on each side of the coil. These latter communicate with each other, top and bottom, and have one of the pistons provided with a valve which opens when the core is raised, and closes when the core descends. The dashpot cylinders are filled with a light mineral oil, which does not freeze nor clog under any ordinary conditions of temperature. An adjustable by-pass valve allows the oil to flow from the tube to the top side opposite. By opening or closing this valve more or less, any rate of descent, and, consequently, diminution of current, can be uniformly obtained, without requiring any skill on the part of the operator.

The annealing operation is carried out as follows:—The transformer is placed in position, the contacts touching the plate either side of the place marked to be annealed, and the primary current brought up by means of a rheostat to from 75 ampères to 90 ampères for about two minutes, according to the size of spot to be annealed, which will bring the metal to a dull red heat, a temperature at which a pine stick catches fire when held in contact with the plate. If no reactive coil is used, the current is now diminished by turning the rheostat one point every minute. If the reactive coil is used the core is now raised by winch, the coil put in circuit by opening a short-circuiting switch, and then is allowed to descend on its own account. The operation generally takes seven minutes, all told. No difficulty has been experienced from the beginning. The annealing of individual spots was, however, only the stepping-stone to a more important work of a similar nature: work which was about to be given up, owing to what was considered insurmountable difficulties.

In the construction of a modern man-of-war there are many armour plates which act as shields to the guns, and have to be perforated to allow the gun muzzle to pass through and to be either raised or lowered. Some of these shields are circular or oval, with narrow edges around the ports, in the case of Harveyed plate. To perforate these shields after carburation, and before being water-hardened, was the only possible way, since previous experiments had shown that prevention of carburation could not be relied on, and no process was known to anneal the plate locally after hardening. The hardening of a plate once perforated showed itself to be, however, almost impossible; in fact, a matter of chance. In most cases the plate cracked in two—as shown in Fig. 4—or the whole plate became distorted in such a way that it could not be used. As individual spots for holes could be annealed, there could be no doubt that a series of annealed spots could be likewise obtained by the electric process, following a line along which a cutting tool was expected to be run. The first attempt, therefore, and made in England, was to anneal a number of spots in proximity to each other in such a way that the annealed zones should overlap each other.

As described above, it is very important that the temperature of any individual part should be gradually and slowly withdrawn; and while for individual spots the only possible way was to do this by gradually diminishing the current, it was obvious that when a line was to be annealed, instead of annealing a number of spots side by side, the same effect of withdrawing the heat gradually from one portion could be obtained by moving the apparatus itself relatively to the plate to be treated. The rate of this movement, of course, depended upon the rate at which the temperature should be allowed to fall in any particular spot to prevent chilling. The apparatus was therefore arranged to be moved along a line to be annealed, the motion being obtained by an ordinary screw and nut held in a bracket, the nut being turned at a predetermined rate controlled by a watch. It was found that a speed of about ¼in. per minute was sufficiently slow to ensure thorough annealing.

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The copper contacts were of the simplest kind, as described above, bedding themselves partially in the surface, and when being dragged along by the screw and nut, raised in front of themselves a burr or chip similar to a planing tool. After a whole day's continuous use the copper contacts were found intact, while a number of chips from the steel surface were lying about. We thus had the peculiar phenomenon of a hard steel chip cut with a copper tool.

Upon the completion of the work, it was found that a strip about 2¼in. wide throughout the length over which the machine had been moved could be operated upon by drills or a shaper in a manner as easily as if it had never been hardened before.

In the work just described, the apparatus was moved about, but in regular practice it would be better to construct a machine consisting of a large bed, on which the plate to be treated may be fastened and moved in any direction automatically at a predetermined speed, while the annealer proper is suspended in a given position above plate. The annealing operation occupies but a small percentage of the time required for the cutting.

It is unnecessary to state that when the apparatus is used for continuous annealing, the primary current is kept at a nearly constant value, the diminishing of heat at any individual spot being obtained solely by the moving of the apparatus from it.

As mentioned before, the places where the contacts are passing over the plate, being brought to a higher temperature than any other, remain hard. Experience has demonstrated, however, that they may be re-annealed later on, by treating the spots in the same way as any other hard spot on the plate. By this means we are therefore able to anneal any shaped portions, not merely lines. This is best seen in Fig. 5, in which a series of strips are annealed side by side—shown in shaded lines A. The soft faced surface is then removed on such places by a planer and drill; the machine is then run a second time over the annealed strips, resting it this time on the bottom of the groove and on the softer metal, thus annealing the ridges C left between the annealed strips, on which ridges the contacts were running previously. When all these strips are annealed they may be removed by machine tools without any further difficulty. In a similar manner a large round place may be annealed, as shown by Fig. 6. The transformer is set on the plate, one contact resting on C′, the other at any other place in circle C; the apparatus is then slowly revolved around contact C′ as a centre, until the second contact has completed the circle C. The shaded portion A represents now the annealed surface, which is removed by a cutting tool. The contacts are then made to rest on either side of the centre C′, and the latter is annealed and removed in its turn.

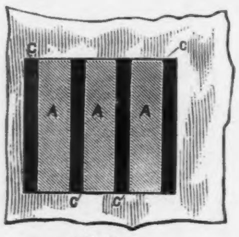

FIG. 5

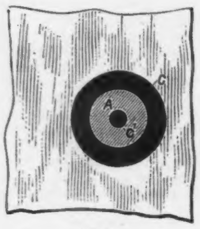

FIG. 6

The apparatus may also be used for the reversal of the annealing process; that is to say, for creating isolated hard spots in soft tool steel by sending a current through the spot to be hardened until it reaches a bright cherry heat, and then suddenly removing the current or machine.

Various other applications will suggest themselves in the operation of this process, already adopted by the United States Government. It may be used in the construction of burglar proof safes, for dies and punches, for projectiles, and other articles of a similar nature.

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

Large freight cars.—Most modern freight cars have a weight-carrying capacity of 30 tons, while some cars for coal and ore traffic can carry 40 tons, exclusive of the weight of the car. In a recent discussion on the capacity of cars for general interchange traffic—that is, of traffic hauled over various connecting roads—at a meeting of the New York Railroad Club, a resolution was adopted that cars of over 30 tons capacity should not be built for this class of traffic, but should be confined to local traffic on such roads as desire to use them. This was largely in view of the fact that in ordinary freight service cars are rarely given a full load in each direction, but are often hauled empty in one direction. As to the relative damage to permanent way by engines and cars, Mr. E. E. Russell Tratman pointed out that the intensity and concentration of wheel loads had more to do with such damage than the distributed load of the train, the engine wheels, with three or four driving-wheel loads of 6 to 10 tons on a wheel-base of 12ft. to 20ft., while the car-wheel loads of 4 to 7 tons per wheel are on a total wheel-base of 20ft. to 35ft. Cars of less than 20 tons capacity are not to be accepted for interchange service, as being unfair to the roads owning larger cars. Some large grain cars built by the Northern Pacific Railroad have six sills 5in. by 9in., four 1½in. truss rods below the underframe, riveted steel body bolsters, Fox steel framed bogies, automatic couplers, and air brakes. The dimensions and particulars of these cars are as follows:—

	ft.	in.
Length over end sills	42	0
,, inside	41	0
Width over side sills	9	1
,, inside	8	6
,, over roof	9	11½
Height from sill to roof-plate	7	7
,, rail to side of roof	11	9
,, ,, to top of roof	12	5¼
,, ,, to bottom of sill	2	7¾
,, ,, to c. of coupler	2	10¾
Wheel-base, truck	5	2
,, total	37	0
Body, cross-section	77 sq. ft.	
,, cubic capacity	3157 cu. ft.	
Weight of body	20,000 lb.	
,, of two trucks	12,000 lb.	
,, total	32,000 lb.	
Freight capacity	70,000 lb.	

The Detroit River bridge.—The channel or so-called river which forms the connection between lakes Huron and Erie is a bar to railway traffic, for the elimination of which many plans have been proposed. At the upper end the Grand Trunk Railway on the Canadian side, and the Chicago and Grand Trunk Railway on the American side, are connected by a single track tunnel from Port Huron to Sarnia, but at the lower end the Michigan Central Railroad, the Grand Trunk Railway, and the Canadian Pacific Railway have to carry their trains across on large steam ferry boats, between Windsor on the Canadian side and the important city of Detroit on the American side, a distance of about 2500ft. This ferry system is the source of considerable delay, on account of the lake navigation and of the ice in winter. The largest of these boats is 280ft. long, 45ft. beam, 74½ft. wide over the deck, and 17¼ft. deep. With twenty-one loaded cars on board the draught is 11ft. to 12ft. There are paddles—each worked by an independent engine—and a screw propeller. The bow is formed for breaking the ice. A tunnel was commenced some years ago, but abandoned on account of the peculiarly difficult material, involving great expense. The navigation interests strongly oppose a bridge, but the latest project is for a cantilever bridge with a central span of 1130ft., carried by masonry towers, the shore arms being of 527ft. span, connecting with approach viaducts having lattice deck spans. The headway under the channel span would be 140ft., and the foundation would reach bed rock at about 100ft. below the water, passing through 50ft. to 60ft. of mud, sand, clay, &c. The height from water-line to top of cantilevers over the piers would be about 317ft. The rest piers for the shore arms are on the bulkhead lines. The main channel for the navigation of the larger lake steamers is 35ft. to 50ft. deep. The preliminary plans have been approved by the Chief-of-Engineers, United States Army, and by the Secretary of War.

Sewage pumping plant.—The city of Ithaca is about to put in a duplicate plant for pumping sewage, consisting of two engines, two boilers, and two air compressors, each half of the plant being of the full capacity for the estimated requirements. The pumps, however, are to be arranged so that they can be worked together if required by exceptional circumstances. Each pump is to be of a capacity sufficient to lift the sewage from the screening chamber at the pumping station, raise it to the 14in. discharge main, which is 10,700ft. long, and discharge it into the lake at a rate of at least 1500 gallons per minute. While tenders will be received for any suitable kind of pump, the station is arranged to be equipped with centrifugal pumps, and special excellence in design and guaranted duty will have to be obtained in other designs to ensure favourable consideration. They must deliver the stipulated discharge when running at the most economical speed, and with the sewage 12in. above the suction pipes in the pump well. Steam will be supplied by two boilers. The air compressors will be of a capacity to deliver each 200 cubic feet of free air per minute under a working head of 12 lb. per square inch. Proper means must be provided for priming the pumps and for draining the pump well. The two suction pipes will connect with 12in. pipes at the bottom of the well, and the two discharge pipes must unite before connecting with the 14in. outfall main. The engines are to be fitted with variable cut-off mechanism. The foundations will be of concrete, capped by stone masonry. The duty test will consist of a run of each engine with each boiler for twenty-four hours, or four runs in all, being conducted by one representative of the city, one for the contractor, and a third appointed by these two. For these tests Cumberland bituminous coal at 10s. per ton will be used. Any part found to be defective or overstrained by excessive wear, strain, bad material, or faulty design within the first year of operating must be replaced by the contractor.

Gasoline tramcar.—A self-contained tramcar, operated by a gasoline engine, is now in use at Dayton. It is an ordinary four-wheel car, with vestibuled or enclosed platforms. There are two cylinders, side by side, driving a shaft having a 40in. fly-wheel at each end, these fly-wheels giving a steady motion. Both cranks are in the same plane. On the middle of this shaft is a 12in. friction wheel, 8in. wide. On each axle of the car is hung a frame carrying a friction wheel running on another friction wheel keyed to the axle. For the reverse or backward motion the swinging wheel is brought into direct contact with the friction wheels on the shaft and rear axle, but for the forward motion another small wheel is interposed between the swinging pulley on the front axle and the wheel on the shaft. The swinging frames are operated by screws, the nuts of which are turned by bevel gear on a longitudinal horizontal shaft, the gearing being such that as the forward motion is brought into action the backward motion is thrown out of action. A vertical shaft through the platform, with a crank handle or hand wheel, is used by the driver to regulate the speed and direction of the car. The engine runs continually at unvarying speed. The gasoline is stored in a cylinder tested to 2000 lb. pressure, from which it is admitted to the engine cylinders and exploded by an electric spark from a four-cell battery. The exhaust is discharged through pipes, which in winter pass through the car for heating purposes. A tank is also provided to carry water to cool the cylinder. All the machinery is mounted on the truck frame, thus preventing vibration of the car body.

AUSTRALIAN NOTES.

The drought and hot weather which have been experienced in New South Wales for several months past culminated during the past few weeks in heat waves of an intensity never before experienced throughout the Colony. In the interior the thermometer has stood at over 110 deg. for a fortnight, scorching all vegetation and killing live stock to an extent that will take another season to recover; in fact, in several of the country towns business was at a complete standstill.

The wool season has been successful so far as quality of clip and prices realised are concerned; but, owing to the drought, the clip has fallen short to the extent of about 150,000 bales. The settlement of the tariff in New South Wales has opened up capital, and business shows a better tone than any time during the past year.

A new line of railway has been sanctioned by the Public Works Committee, from Jerildine to Berrigan, the successful tenderers being Smith, Finlayson, and Jones, the price being £19,879.

Walkers, Limited, engineers, Maryborough, Queensland, have secured the contract for the supply of thirty locomotives for the Queensland railways. The contract price is £2390 each. An order for ten more has been placed with the Yorkshire Engineering Company, at, it is stated, £1620 each.

The increase in business in West Australia continues in a marked degree—the revenue returns showing a substantial increase in every branch. For the month of December the principal items were as follows:—

	1895.	1894.
	£	£
Customs	66,423	41,548
Land revenue	19,887	1,670
Mining	7,044	682
Railways	40,815	26,151

The revenue for the year ending December, 1895, being £449,878, showing an increase of £202,814 over the previous year.

The report of the Railway Commissioners of New South Wales for the quarter ending 31st December, state that the earnings show a decrease of £72,263, arising entirely from the effects of the drought. The working expenses for the quarter were reduced to the extent of £22,676, and the percentage of working expenses to revenue stands at the low figure of 47·52 per cent. The figures for the quarter are as follows:—

	£
Gross revenue	870,838
Working expenses	413,865
Net revenue	456,973

A mining conference has been opened by the Minister for Mines in Sydney, and attended by about 300 delegates, who have not yet completed their labours. It is expected that a more complete development of the mineral resources of the Colony will be the outcome of their investigations.

REDUCING JOURNAL-BOX FRICTION.

The resistance of trains to being hauled constitutes the work that locomotives in overcoming it must perform. Any increase in this resistance is a tax upon locomotives, and any decrease in such resistance enables locomotives to perform more useful work—haul more cars or make better time—with the same expenditure of power. It is, therefore, evident that efforts to decrease train resistance are in the line of economy and greater efficiency. Train resistance is really made up of several "resistances," or it has several elements, such as the resistance of the air, the rolling friction of the wheels on the rails, journal-box friction, and the inertia of the load. Probably the most susceptible to reduction of all these is journal-box friction. In cold weather this friction is greatly increased because of the viscosity of the congealed oil. We treated this matter at some length in the last—December, 1895—issue of the *National Car and Locomotive Builder*, and will not go into it again here further than to say that carefully conducted railroad laboratory tests have demonstrated that with a fall of temperature of 70 deg. the friction was doubled with the same oil. Dilution, preferably with kerosene, to a fluid consistency in actual service is the best remedy for this evil.

Our present purpose is to call attention to another possible means of reducing journal-box friction, and this is by giving to new axle-journals a smoother finish than is generally done before they are put in service. Persons familiar with the usual condition of new axle-journals know that they are much less smooth than journals that have seen some service. Actual service gives a smooth, high polish, the equal of which is not even attempted in most shops building new equipment or putting in "new wheels" beneath old equipment. In fact, it is commonly expected that new equipment will have hot axle-journals, and that "new wheels" in old equipment will "run hot." This is principally because of the commonly too rough surface of new journals. There are few more potent causes of train delays than "hot boxes," and in this connection the experience of the Missouri Pacific Railway should be valuable to every person interested in the most efficient operation of rolling equipment. As we announced a year ago, it is the practice of the mechanical department of this road to give a high polish to the journals of all axles and crank pins before they are put in service, and we then illustrated—*National Car and Locomotive Builder*, January, 1895—and described a tempered steel roller of cheap and simple construction used for burnishing the journals. This roller burnisher takes no metal from the journal, but compresses the surface about ·002in., and imparts a harder and smoother finish, and higher gloss than we ever saw imparted by the longest and most successful service. On the road named this method has been found to give the *sine quâ non* for avoiding hot boxes.

Used at
Car Work
Swindon

It may be assumed as true that the harder and smoother any two surfaces are, the less will be the amount of friction between them. Watchmakers know that fine steel pivots, running in highly polished holes cut in the hardest jewels, give rise to the least amount of friction, and consequently such surfaces are always chosen for fine watches, as the disturbance of the motion is thus reduced to a minimum. An apparent exception to this is found in the case of Babbitt metal, which is comparatively soft. We do not attempt to offer any explanation of this apparent exception to the general rule—for an exception it certainly is. In selecting the material for axle and crank-pin journals it is important that the material be hard and close-grained. Open-grained surfaces will begin to cut sooner or later, and when once this action fairly sets in it is almost impossible to stop it. Where wrought iron is used, it is important that the fibres of the bar of which the axle is made be thoroughly welded together. If they be left in a loose and fibrous condition, and the direction of the motion be at right angles to the direction in which the fibres run, it will be impossible to produce a smooth-running journal.

One of the greatest benefits conferred upon mechanics by the modern improvements in the manufacture of steel and iron is the introduction of a hard, non-fibrous material for journals. Common steel, good enough for all purposes except the making of fine edge tools, can now be had at a very moderate price, and wherever a journal is required to give the best satisfaction, it should be made of steel. In finishing the surfaces of journals, great care ought to be taken to avoid the use of emery. It is wonderful how readily the hard-cutting grains of emery and similar polishing substances become imbedded in iron, brass, and other materials, and then act just like diamond drills. Every watchmaker knows that a copper wheel or disc smeared with diamond dust will rapidly cut the hardest steel, and the action is the same in regard to all metal surfaces to which emery has been applied with considerable force, as in the ordinary process of polishing. Smoothness is an essential requisite in all surfaces that slide or roll one upon the other, but this smoothness ought in all cases to be attained by burnishing in the manner described, or by cutting with sharp steel tools, and not by polishing with grinding substances.—*The American Engineer.*

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

A meeting of the sub-committee of the Midland Iron and Steel Wages Board was held at Dudley on Tuesday. The certificate of the accountants showed that the average selling price of finished iron for January and February was £5 16s. 8·02d. per ton. In accordance with the sliding scale puddlers' wages will continue at 7s. 3d. per ton, and millmen's wages in proportion, from April 6th to June 6th.

The quarterly meetings will be held next week, and a fair amount of new business is looked for. The works have been finishing old contracts before the Easter Holidays, and business is now practically suspended until these are over. Prices of pig and finished iron are therefore at the moment nominal, but they are slightly weaker than hitherto; though steel is well maintained.

The will of the late Mr. John Lysaght, of Hengrove Hall, Suffolk, and Springfort, Clifton, founder of the firm of John Lysaght—Limited—of the Patent Galvanised Iron Works, of Bristol and Wolverhampton, and head of the firm of Lysaght Brothers and Co., of Sydney, has been proved. It shows personalty to the amount of £424,000, making with other property upwards of half a million. The duty paid on personalty alone reached £32,000. His shares and interest in the business are left to his sons. There are legacies of £250 to several Bristol institutions.

The heavy ironfounders have lately been keeping their men steadily employed, and the producers of all classes of machinery have been fully employed, while the bridge and girder makers have been engaged on some valuable contracts. A considerable amount of work has been turned out by the electrical engineers, who have a great deal of business on their books, and have had recently to keep their men engaged night and day.

A meeting of the General Committee of the Unmarked Bar Association has been held, under the presidency of Mr. S. Hingley. A conversation took place on the present position of trade, and it was reported that all works were well employed, the demand for every description of finished iron was greater, and it was expected that prices would advance in a short time. The chairman said the Association had proved of great service to the trade by assisting in the maintenance of prices, which were relatively higher than formerly.

At the annual meeting of Muntz's Metal Company, at Birmingham, the chairman of the company, Mr. A. Keen, presided; and there were also present Sir H. Wiggin, Bart., deputy chairman; Mr. P. A. Muntz, M.P., Mr. G. Heaton, and Mr. A. W. Marriott, directors; with Mr. R. L. Thompson, general manager; and Mr. W. T. Balcombe, secretary. In moving the adoption of the report and accounts, the chairman said that the shareholders would have observed that the profit for the year amounted to £6767 15s., and, as their reserve fund was created for the purpose of equalising dividends, they proposed to take £4000 from that fund to enable them to pay the same dividend as they paid for 1894, namely, 7½ per cent. The motion was carried unanimously, and a dividend of 7½ per cent. for the half-year on the ordinary shares, making, with the 5 per cent. interim dividend for the first half-year, a 10 per cent. dividend for the year, was declared. Sir H. Wiggin said they had £16,000 left in the bank for equalising dividends, and £55,000 besides. At the time of the great boom in copper the company had large stocks in hand, and this was sold out. The £20,000 extra profits they made that year was invested outside the business, and had remained intact until the present year.

An event of the week is the revolt of a section of the metal trade against the combination for lifting prices and wages, which has been formed in that branch. The dissentients resist a movement which they believe would deprive them of freedom of contract and give a new impulse to foreign competition, and they complain of the form of pressure which is brought to bear on them through their workpeople. With some of the leading and second-class firms in opposition, it will be difficult for the newly founded association to enforce its programme. The German and French competition in sheets, tubes, and wire, has for some time past been very keen. It is now extending to cased tubes, and the German makers of metallic bedsteads, taking advantage of the recent advance in English makers' prices, are reported now to be invading this country. It is understood that a large London house has recently placed an order for 30,000 bedsteads, which will be "made in Germany," with the help, presumably, of Birmingham closed tubes and brass bedstead mounts.

A midland counties district meeting of the Incorporated Association of Municipal and County Engineers was held at King's Heath Institute, on Saturday, there being upwards of a hundred members of the Association present. Mr. T. R. Bayliss—Chairman of the King's Norton Rural District Council—presided at the outset, and welcomed the Association. The president, Mr. E. R. C. Escott, Halifax, thanked Mr. Bayliss, who then vacated the chair. Mr. Robert Godfrey—Kings Heath—read a paper descriptive of fourteen years' work in Kings Norton.

An interesting discussion on motor cars has taken place at a meeting of the Walsall Chamber of Commerce. The president—Mr. E. J. Rhan—said the committee had considered the Locomotives on Roads Bill, and had decided to recommend the chamber to ask that the placing of a light on all vehicles passing along roads be made compulsory, the motor cars to carry a distinguishing light—by preference, red and white; that a speed indicator be attached to every such car, the speed in towns being limited to six miles an hour, and in the country to twelve miles; that bells, or some other similar appliances be placed upon the cars, and that provision be made for the car to be stopped on the appeal of a person riding or driving until he had passed the car. Mr. J. Scott proposed the adoption of these recommendations, arguing in favour of the chamber doing all it could to safeguard riders and drivers, and to protect the interests of Walsall, which were so largely bound up in the continuance of the use of carriages and horses. Mr. Hill seconded the motion. It was useless to attempt to prevent motor cars coming, but they ought to do all they could to make them as safe as possible. Mr. Rathbone thought it would be impossible to stop the motor car, and it was unfair to compare it to the steam car. Mr. Leckie thought the chief objection to the motor car was that it was to be used for the conveyance of heavy traffic. Mr. Hulton proposed as an amendment that the speed suggested should be eight miles for towns and fifteen miles for the country. He thought the benefit that would accrue to the trade of the country at large from the introduction of the motor car would more than counterbalance any harm to the trade of Walsall. Mr. Blyth seconded the amendment, which was agreed to by seven to six.

The remainder of the collieries, machinery, and plant belonging to the New British Iron Company, which is in liquidation, were offered for sale by auction recently at the Queen's Hotel, Birmingham, by Messrs. T. J. Barnett and Son, by order of the Court of Chancery. Mr. W. N. Fisher was present as the receiver and manager of the estate, but there was only a small attendance. The auctioneer—Mr. T. J. Barnett—said that a very large portion of the estate had been realised, and the collieries were practically the remainder of the mineral properties belonging to the estate. The parties interested in the sale were anxious to dispose of the whole of the property as speedily as possible, and the collieries would be sold if there were any reasonable offers for them. The first lot was the Fly and Black Wagon Collieries, in the parish of Rowley, comprising a freehold mineral area of over 66 acres, and a freehold surface area of over 18 acres, with plant, machinery, tramways, and buildings. There was no bidding, and the property was withdrawn. Lot 2 consisted of the Codsall and Bearmore Collieries, embracing a mineral area of 93 acres, and a surface area of 40 acres. The first bid was £1000, and then £1250 was offered. After some persuasion there was a bid of £1500, but beyond that figure nobody was inclined to go, and consequently the property was withdrawn.

The seventh annual dinner in connection with the Birmingham Municipal Technical School Engineering Society has been held recently at the Colonnade Hotel, Councillor Martineau, chairman of the Technical School Committee, presiding. Among those president were Mr. F. C. R. Marks, president of the society; Councillors Howard Lane and Jephcott; Dr. Sumpner, principal of the Technical School; Mr. Mellor, secretary to the Technical School, &c. The chief feature of the after-dinner proceedings was the delivery of a presidential address by Mr. Marks, who said the society had had a very successful session, and was now in a very flourishing condition. Proceeding to deal with various sources of mechanical power, the president predicted that superheating would be again resorted to for the purpose of increasing the efficiency of the steam engine. Numerous forms of energy applicable to practical uses, including gas, water, tidal motion, the wind, electricity, &c., were touched upon by Mr. Marks, who said in conclusion, that whilst heat was the great source of mechanical energy, they had to recognise that our coalfields would not last for ever; there was plenty of energy bottled up in the earth, however, and was it too much to expect that the day would come when means would be found of drawing from that enormous reservoir of heat beneath the comparatively thin crust constituting the earth's surface.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—Just for the present there is very little to really test the actual position of the market, as not only are merchants and consumers for the most part more than fully covered for present requirements, but the holidays act as a further check upon buying, where orders might otherwise be given out. There is consequently a general absence of inquiry, and this tends to give a weakness to prices, as although makers are mostly in a position to hold with tolerable firmness to their full quoted rates, merchants, in many cases, have iron bought which they are compelled to put upon the market, and this is being pushed for sale at very low figures. The position, however, taking it all through, as I have previously reported, continues satisfactory, and temporary fluctuations in prices, or underselling by merchants, have no appreciable effect upon the strong confident tone prevailing with regard to the future.

The Manchester Iron Market on Tuesday was not more than moderately attended, and there was only a slow sort of business doing generally. In pig iron very little business was stirring, and although makers held to late rates, prices in the open market were very irregular. Local and district brands were firm at recent quotations, so far as makers are concerned, but in Lincolnshire iron there were second-hand parcels to be bought at about 6d. under makers' quotations. In outside brands offering here there is some very keen cutting to get hold of business, and for immediate delivery small parcels could be bought at excessively low figures, both in Middlesbrough and Scotch iron. Delivered by rail, Manchester, 46s. 6d. to 47s. are about the average figures for No. 3 foundry, Middlesbrough, and delivered Manchester Docks, orders could be placed at 45s. 3d. to 45s. 6d., net cash; whilst for Eglinton the average quotations, delivered Lancashire ports, are about 47s. 3d. to 47s. 9d., and, delivered Dock Quays, Manchester, 49s. 3d. to 49s. 6d., net prompt cash.

Finished iron meets with a moderate demand, but as regards bars, it is only in exceptional cases where the full quoted list rates are being secured. Delivered Manchester district, £5 10s. represents about the average figure for Lancashire bars, in most cases, with Staffordshire qualities, £5 12s. 6d. to £5 15s.; sheets remain at £7 10s. to £7 12s. 6d., and hoops at £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths, delivered Manchester district, with 2s. 6d. less for shipment.

In the steel trade, makers of hematites are very firm at their full rates, but merchants would sell at lower figures, ordinary foundry hematites being obtainable through second hands at about 56s. 9d. to 57s., less 2½, with ordinary steel billets about £4 7s. 6d. to £4 10s. net cash, and boiler plates to be bought at £6 5s. to £6 7s. 6d. delivered in this district, although makers nominally hold to £6 10s. per ton.

An active business is reported in the metal market, all descriptions of manufactured goods being in brisk request, and prices well maintained at full late rates, with makers securing on small orders an advance of ⅛d. per pound upon the official list rates for brazed brass and copper tubes.

Throughout the engineering trades of the district new work continues to come forward freely, and generally all the leading establishments are not only fully engaged, but amongst stationary engine builders, machine tool makers, and machinists, there is generally work in hand to keep them going for some time forward. Boilermakers and locomotive builders are now in most cases fully employed, and activity is also reported amongst all the general engineering industries of Lancashire.

I have recently referred in my notes to the activity which has come over the machine tool making trade, and to the very varied class of work that has been given out. As an illustration of what is now going on in some of the principal establishments, a few particulars of a visit I paid to the works of Messrs. Hulse and Co., Salford, will be interesting. I found this firm exceptionally busy with work in progress, principally in connection with special machine tools for dockyard and gun-making operations. Amongst work of the above class were complete plants for the construction of Belleville boilers, and other special tools for Government dockyard and private firms both in this country and abroad, these including special screwing, cutting off, tapping, and facing machines for tubes and junction boxes, and hydraulic presses for staving the tubes. They had also in hand several massive armour plate slotting machines, with universal adjustments for cutting at any required angle, without disturbing the work, and several radial drilling, and boring machines arranged for tapping and studding work, with reversing gear carried on the spindle slide close to the hand of the workman, and with the usual releasing motion to free the spindle and counter-weight to bring it rapidly from the work. Some of these radials are of the box type, with arms to raise and lower upon a sleeve encircling the column, while others have swivelling spindle slides for drilling at an angle. The firm is also engaged in the construction of machines specially designed to deal with stern frames and other large irregular shaped marine castings, these including a horizontal and vertical side planing machine, to plane a height of 6ft. and upwards of 6ft. in length, and a horizontal side planing and shaping machine with 7ft. overhang, which I understand is not only the largest of its class that has so far been made, but possesses a universality of action that has not hitherto been attained. Amongst tools suitable for gunwork were a number of patent vertical milling and profiling machines, whilst the firm had also just finished a large rifling machine, with several new and special features for dealing with guns up to 12in. calibre, and two complete plants for Hotchkiss and Nordenfelt quick-firing guns and ammunition. Messrs. Hulse were also making a horizontal milling machine for locomotive connecting-rods, and universal machines for cutter making and other similar work. The progress of electric driving, I may add, has led the firm to devote special attention to the arrangement of various kinds of machine tools, as well as overhead travelling cranes, with the view of applying motors either direct or otherwise, and they had in hand a number of machine tools specially designed for the above requirements, including large lathes with electric motors, self-contained, with the fast headstock.

Amongst recently designed special tools which Messrs. Hulse and Co. had in hand, there were a couple possessing features of which a rather more detailed description will be interesting. One of these is a universal boring, drilling, tapping, studding, and milling machine, by means of which holes may be drilled, tapped, and fitted with studs over the surface occupied by the largest cylinders, the space commanded being 16ft. long and 10ft. high. The machine has a powerful drilling and boring headstock, made to carry a spindle of from 2½in., which is driven quickly for small work, with double and treble-gear intermediate variations being provided for the different speeds required, whilst it is made to rise and fall on a massive vertical pillar, and to do its work at heights up to 10ft. above the base-plate, or even more if required. The speeds of feed can be varied by means of change wheels, the rising and falling motions being operated by power, with specially arranged slow speeds for use when milling vertically. The vertical pillar itself has the same varied motions by power along a strong side bed, so that its position may be changed rapidly, or it may be traversed to suit the feed required when milling horizontally. When the machine is required for tapping or studding, rebasing and reversing gear is applied to the spindle, and a large grooved base-plate to suit the work in hand, and of any required dimensions, is attached to the machine. The other new tool is an improved band sawing machine, specially designed for dealing with heavy marine work, such as cutting the webs out of large double cranks, or the runner heads off large steel castings, and any other operations of a similar character. This machine, which is throughout of exceptional strength and massiveness, consists of a large baseplate in tee form, the upright of the T carrying the frame which supports the top pulley over which the band saw passes, and the transverse part carrying the beds on which the articles to be cut are traversed. The lower pulley over which the saw passes is secured beneath the baseplate, the pulleys in this machine being 40in. diameter. To keep the saw in tension a balance weight is provided, which acts on the under side of a vertical sliding block carrying the top pulley over which the saw passes. There are two beds on the transverse parts of the baseplate, each of which carries a traversing saddle, actuated together by twin screws, and so arranged that the saw may pass between them. The twin screws are driven through change wheels adjustable on a swing framework, so that any desired traverse may be obtained, and the feed motions give a perfectly steady movement to the traversing saddles. The machine is driven by cone pulleys and the usual driving apparatus, giving several speeds to suit the work under operation.

In the coal trade, except some extra buying to cover requirements during the holiday stoppages of the pits, which will extend over three or four days, there is no material change to notice. All descriptions of round coal continue plentiful, and low in price, especially in the inferior qualities, suitable for steam and forge requirements. With regard to engine fuel, a slight advance has in some few cases been obtained on the better qualities, for forward contracts, but generally prices, although firm at recent quotations, are unaltered. The average quoted rates, with the commencement of the month, are without change, best Wigan Arley remaining at about 10s. to 10s. 6d.; Pemberton, four feet and seconds Arley, 8s. 6d. to 9s.; common house coal, 7s. to 7s. 6d.; steam and forge coals, 6s.; and the better qualities of engine fuel, 4s. 6d. up to 5s.; and common slack, 2s. 9d. to 3s. 3d. per ton, at the pit mouth.

In the shipping trade business shows an improvement, and prices continue extremely low, 7s. to 7s. 3d. being about the average figures for ordinary steam coals, delivered Mersey ports, with as low as 6s. 9d. per ton taken in many cases to move away quantities

Barrow.—The hematite iron trade is still very busy, and makers are sanguine of the continuance of the active market, and are accordingly preparing further to increase the production of iron. At present thirty-nine furnaces are in blast, as compared with twenty-eight in the corresponding week of last year. Stocks are steady at slightly over 303,000 tons. Prices are firm at 50s. for mixed Bessemer numbers, net f.o.b.; while warrant iron is selling at 48s. 4d. net cash, buyers offering 48s. 3½d. In forge and foundry iron business is quiet, but Bessemer is active.

Iron ore is firm in tone, and ordinary sorts are steady at 10s. net at mines, with best descriptions as high as 14s. 6d. Spanish ores, on the other hand, are quoted at 12s. 9d., delivered at West Coast ports. The trade in the latter is growing, and now Spanish ores are largely used for mixing purposes at most of the works in the district.

Steel makers report a very busy state of things in almost every department. Rails are specially brisk, and makers are well sold forward. Ship and boiler plates are also in good demand, and there is much life in the steel casting, billet, and hoop trades, while merchant steel is in growing demand.

Shipbuilders and engineers are very busy, and are expecting some new contracts.

The coal and coke trades are active, and the demand seems to be on the increase. Coal, however, is easy in price, while coke is dearer.

The shipping trade shows increased exports of pig iron and steel, and still further activity is expected in this direction.

The statement is made on the basis of good authority that a new and independent company is about to be formed to erect works at Barrow for the production of heavy armour plates and other classes of shipbuilding material required in Admiralty and commercial tonnage. Attention has been given for some time past to the fact that Barrow is in every sense admirably situated for the successful working of this branch of the steel trade. There is an abundance of rich ores from which the best class of steel can be made, the docks at Barrow will enable makers to deliver cheaply to the dockyards and to the big shipbuilders on the West Coast, and there is also the fact that a large amount of Admiralty work is done at Barrow, assuming at least one good local customer. There are only four works engaged in this trade in the country, and they are exceedingly busy and making big profits. The new company, which is backed with plenty of capital, proposes to draw its supply of metal in a molten state from the furnaces of the Barrow Steel Company. The importance of this new development in Barrow's trade cannot be over-estimated.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THOUGH business is quiet this week, it is not slacker than is usually expected when holiday times intervene; and after the heavy buying that has recently been recorded, a lull is not unwelcome, so as to enable producers to get something like even with their engagements. There is no yielding in prices; in fact, in the lower qualities of Cleveland pig iron, the scarcity of these qualities has led makers to advance them 3d. per ton this week, and now pretty nearly the normal differences between the values of the higher and lower qualities has been re-established. Prices were firmer at the close of March than is usual towards the end of a month, because the makers did not put pressure upon second hands to take deliveries, as they had plenty of orders to deliver without these, and the wharves were quite blocked with steamers awaiting cargoes. A large quantity of iron has recently been sold for delivery to the Continent, and the exports for April are likely to be as satisfactory as those of March have been.

The Cleveland ironmasters' statistics for March are expected to show a decrease of between 2000 or 3000 tons in the stocks of Cleveland pig iron, as compared with an increase of 19,657 tons in February. In Connal's stores at March 31st there were lodged 187,474 tons of Cleveland pig iron, an increase of only 1964 tons during the month, as compared with 4717 tons in February. The hematite trade is evidently not so good as that in ordinary Cleveland iron, for Connal's stock of hematite pig increased 5383 tons during the month, against 3814 tons in February, the quantity being 150,779 tons, and it seems that there is difficulty of getting rid of the hematite iron when once it goes into the stores, as consumers are shy about buying it, seeing that they cannot be sure of the brand they will get

The price of No. 3 Cleveland G.M.B. pig iron in makers' hands has been maintained at 38s. 6d. for prompt f.o.b. delivery, but merchants have been selling at 38s. 4½d., and some odd lots were sold in the last two days of March at 38s. 3d. Practically 38s. 6d. is the figure for April delivery. No. 4 foundry has been advanced to 37s. 9d.; grey forge to 37s. 3d.; mottled to 36s. 9d.; and white to 36s. 3d. Messrs. William Whitwell and Co. have blown out a furnace producing hematite iron, as it needs relining. For mixed numbers hematite pig iron, 46s. 6d. per ton f.o.b. is taken, but several firms hold out for 47s. Rubio ore is 12s. 9d. per ton delivered Tees wharves. There will be no iron market at Middlesbrough next Tuesday.

The sale of the Coatham Ironworks by the National Provincial Bank to a syndicate of local capitalists has been concluded, and the new proprietors will at once proceed to repair them. As the two furnaces, which have been idle for close upon ten years, need relining, it will be several months before they can produce any pig iron. It is stated that the Lord of the Manor has reduced the ground-rent from £400 to £200 per annum, and that the new firm will have better facilities for shipping their iron than the old proprietors had. The furnaces, it is calculated, will require £20,000 spent upon them before they can set to work. Originally the cost was between £60,000 and £70,000, as they were built in 1872, when everything was extremely dear.

On Monday the shareholders of the Teesside Iron and Engineworks Company met at Middlesbrough, and finally confirmed the transfer of the company's property to Sir Christopher Furness, of West Hartlepool

The slag from furnaces producing basic pig iron has long been utilised for manurial purposes, and with excellent results, but the Normanby Ironworks Company has been successful in introducing for similar purposes the slag from its blast furnaces, which are making hematite pig iron. It was first tried last year, and has proved valuable, especially for potatoes, roots, and grass. It contains a large proportion of lime, alumina, and silica, together with sodium chloride. It assists germination to a very great extent.

The finished iron and steel industries show improvement, and prospects are encouraging. It was feared that there might be some interruption to work at the plate and angle mills in this district owing to the dispute in the engineering and shipbuilding industries, where the men claimed advances of wages. Happily the difficulty has been settled in some quarters, and there is every reason to believe that there will be a general settlement on the same lines as have already been agreed to. The engineers originally asked for an immediate advance of 2s. per week on time and 10 per cent. on piecework, and the masters offered 1s. at once and 6d. more in July, but that failing to satisfy the men, the offer was amended and 1s. offered at once, with 1s. more in September, no further change in wages to be made till March next year. To these latter terms the men on Teesside have agreed, and wages have been settled for practically a year to come, which is a great advantage for masters, as well as for the district generally. The West Stockton Ironworks, at Stockton, which made, when in full operation, 1100 tons of plates weekly, and which could readily be converted into sheet mills, were offered for sale by auction a few days ago, but not a single bid was elicited, which is rather strange taking into account the report that one of the leading shipbuilders in the district was reported to be in negotiation for them. Of the twenty workmen's cottages not one was sold.

Platemakers are well supplied with orders, and the price of steel ship plates is maintained at £5 2s. 6d. per ton, less 2½ per cent. f.o.t., while boiler plates are 20s. more, and girder plates 5s. more; there being a very fair demand for the latter, as there is a large amount of bridge building going on, chiefly on export account. Steel ship angles are at £5, iron ship angles at £4 15s., iron ship plates at £5, and common iron bars £5, all less 2½ per cent. and f.o.t. Heavy steel rails are firm at £4 12s. 6d. net at works, and manufacturers have plenty of work on hand; but there seems to be no probability of an early re-opening of the Darlington Steel Works, for on account of their inland situation they—the Darlington Works—cannot compete with the establishments nearer the seaboard. The demand is now mainly for rails for export, and comparatively small quantity being needed by our home railways and in inland works, has very little chance of being successful against the manufacturers having mills near the coast, as they have railway rates to pay on the carriage of their pig iron, or upon the hematite ore if they make their own pig, and then they have to pay railway rates back to the coast of the rails they manufacture. Steel sleepers are in poor request.

The January-February official statistics presented by Mr. Edwin Waterhouse to the Board of Conciliation and Arbitration for the North of England Manufactured Iron Trade, and showing the tonnage of finished iron delivered, and the average net prices realised therefor by the firms in the district, cannot but be regarded as disappointing, seeing that a different state of affairs was expected. It was thought that with the improvement in trade and quotations there would have been a larger production, and a substantial advance in prices, but such has not been the case. The average net realised price of manufactured iron was only 4·2d. per ton better than in the previous two months, and this does not entitle the men to any advance in wages under the sliding scale, as it only brings up the average price to £4 16s. 7·89d., whereas it has to be £4 17s. 6d. before any advance can be given. No change of wages has been made since the end of 1894, when a reduction of 2½ per cent. took place.

It is rather surprising to learn that any description of finished iron realised lower prices than in the previous return; nevertheless, both angles and bars had a lower average, angles by 11·83d. per ton, and bars by 0·79d., but plates went up 9·24d. It is evident that, while manufacturers were quoting higher prices, they have not been in many cases getting them, or they must have had a good many cheap contracts to execute. Iron rails went up 2s. 7·81d., but as out of 20,755 tons made only 491 tons were rails, the advance had little influence in determining the general average price of manufactured. The advance in iron rails is very small compared with that in steel rails. The increase in deliveries is poor—only 448 tons—as compared with November-December. The following is the official record of the deliveries and average net realised prices during the two months ended February 29th:—

Description.	Weight invoiced.				Percentage of total.	Average net selling price per ton.		
	Tons	cwt.	qr.	lb.		£	s.	d.
Rails	491	5	3	19	2·37	4	9	3·93
Plates	7916	3	0	25	38·14	4	13	6·99
Bars	9424	6	0	25	45·40	5	0	5·39
Angles.. ..	2924	1	0	15	14·09	4	14	0·27
	20,755	16	2	0	100·00	4	16	7·89

A special meeting of the shareholders of the Tees-side Iron and Engine Works Co. was held at Middlesbrough on Monday, when the transfer of the company's property to Sir Christopher Furness, of Middlesbrough, was finally confirmed.

The North-Eastern Railway Company has now almost completed the extensive alterations that have been in progress between Gateshead East Station and Pelaw Junction. The railway has practically been doubled—there being four sets of rails over the greater part of the distance, and every bridge from Gateshead to Pelaw has had to be rebuilt. At Pelaw Junction three lines converge, the old Leamside south route, the Sunderland line, and the Jarrow and South Shields line, the first and last approaching by sharp curves. Considerable improvement is being made in the approaches, and a new station is being erected at Pelaw much further to the west than the present structure. Felling station is approaching completion. The company has refrained from demolishing the little stone station-house—the original station of the old Brandling Junction Railway, the earliest line in the district—and is thus a landmark of early railway history. The improvements at Gateshead East Station have had to be curtailed, owing to the opposition of the Corporation, chiefly in regard to the stone bridge crossing High-street. The company desired to carry the proposed extra double line of rails across High-street by means of an iron bridge built alongside the existing stone bridge, but the Corporation insisted upon the demolition of this stone bridge, and the building of a new one, with a single span instead of three—one for the roadway and two for the footways. The company could not come to terms with the Corporation, and so this part of the scheme was abandoned.

The coal trade is beginning to show more satisfactory features; shipments are increasing, as the open weather is allowing of the earlier re-opening of the Baltic ports. Tenders are to be invited shortly for steam coal to be supplied to the Cronstadt Naval Works. The St. Petersburg Gas Company has ordered between 40,000 and 50,000 tons of gas coal, delivery over the season, and the price is 10s. 2d. per ton, c.i.f. Cronstadt. Of the 75,000 tons of gas coal for the Rotterdam Gas Company, two-thirds will be supplied this year from the North of England at 10s. 3d., delivered Rotterdam. Last year only one-third came to this district, the other two-thirds going to German collieries. Coke is very firm at 13s. 6d. to 14s. per ton, delivered at Middlesbrough furnaces.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has been very little animation in the Glasgow pig iron warrant market this week. This is due to some extent to the holidays, but, apart from these, the speculative interest in the business has become small. Business was done in Scotch warrants from 46s. 9d. to 46s. 7d. cash, and from 46s. 11d. to 46s. 9½d. one month. The demand for Cleveland warrants was extremely poor, scarcely any business at all being reported at some meetings of the market. The few transactions quoted were at 38s. 6d. to 38s. 3d., one month. Although the current consumption of hematite pig iron is very large, the market for warrants is very dull. A small business was done this week in these at 48s. 3d., cash, and 48s. 6d. to 48s. 5½d. one month. In Scotch-made hematite large deliveries are taking place direct to the works.

The output of ordinary Scotch pig iron has been increased by 300 tons per week. At present the stock in Glasgow warrant stores is increasing about 1000 tons weekly; but the stocks are low, and the prices obtained for sending iron into the store and selling it as warrants are, at current costs of output, quite satisfactory. There are now 43 furnaces producing ordinary, 35 hematite, and three basic pigs, the total number of furnaces in operation being 81, compared with 74 at this time last year.

Prices of makers' special brands of pig iron are fairly steady, as follows:—Govan and Monkland, f.o.b. at Glasgow, Nos. 1, 48s.; No. 3, 46s. 6d.; Carnbroe, No. 1, 48s. 6d.; No. 3, 47s.; Clyde, No. 1, 50s. 6d.; No. 3, 47s. 6d.; Gartsherrie, Calder, and Summerlee, Nos. 1, 51s.; No. 3, 48s. 6d.; Coltness, No. 1, 53s. 6d.; No. 3, 49s.; Glengarnock, at Ardrossan, No. 1, 51s.; No. 3, 47s.; Eglinton, No. 1, 48s.; No. 3, 46s.; Dalmellington, at Ayr, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Shotts, at Leith, No. 1, 52s. 6d.; No. 3, 49s.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 49s.

The shipment of pig iron from Scottish ports in the past week amounted to 7438 tons, compared with 7398 in the corresponding week of last year. Of the total there was sent to the United States 70 tons, South America 200, India 294, Australia 20, France 30, Germany 290, Holland 535, Belgium 30, other countries 197, the coastwise shipments being 5552, compared with 5495 in the same week of 1895.

In the malleable iron and steel departments there is continued activity. For finished iron the inquiry is well maintained, but it is scarcely possible to obtain any increase in prices. The steel industry is very busy, the staple work in hand being for the shipbuilding trade. The question of wages in the steel trade has been causing a good deal of anxiety, but it has at length been practically settled, at least for the present, by the Board of Arbitration agreeing that the men shall have an advance of 5 per cent., to begin at once.

There is no real improvement in the condition of the coal trade. The total shipments, taking the clearances at all the ports, are some 4000 tons better than in the preceding week, but this has had no appreciable influence on the state of the market, which as a whole is very dull. Wages are now reduced all over the mining districts, the colliers of Fifeshire having been the last to submit to a reduction of 6d. per day. Inquiries are rather better for shipping coals, and it is now expected that the demand for the Baltic ports will now begin to assert itself. Fair cargoes are being despatched from the West Coast abroad, but the business in the Firth of Forth has been rather restricted. The total coal shipments during the week reached 128,730 tons, compared with 124,164 in the preceding week, and 123,516 in the corresponding week of last year. The prices f.o.b. at Glasgow are:—Main coal, 5s. 9d.; splint, 6s. 3d. to 6s. 6d.; ell, 6s. 6d. to 6s. 9d.; and steam, 7s. 6d. per ton. These rates are in some cases quite nominal.

During March there was launched from the Clyde shipyards 25 new vessels with a total tonnage of 41,086, compared with 22 vessels and 24,755 tons in the same month of last year. The output of the three months comprised 49 vessels of 94,299 tons, against 48 vessels of 61,249 tons in the first quarter of 1895. It is estimated that the new orders placed in the course of the month amount to 44,000 tons, compared with 30,000 in March last year.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

IT has been strongly enforced in this column of late with respect to the discharge note, that, as a prudential measure, it would be wise to suspend the operation of the note and thus give time for reconsideration and, if imperative, for the formulation of a substitute. I am glad to state that the suggestion, which has been reiterated several times, for the urgency was so palpable, was adopted on Saturday last by the Coalowners' Association, and ratified by the Sliding Scale Committee. The threatened strike has now been averted, and only just in time. On Saturday the men's representative, who met the Sliding Scale Committee in Cardiff, would hear of nothing until the note, difficulty was settled one way or the other, and had the coalowners been as decided, the order would have gone forth, I am informed, for a general strike. It would be well now for the belligerents to cool down a little, and then will be the time to see how far the contention is true, that the introduction of the note was a violation of the sliding scale, and also to arrange, by the collective wisdom of the joint representatives, a sufficient distinction between the industrious and the irregular workmen. One of the contentions of even loyal colliers is that, granting the note to be sound in principle, it was abused, and it gave power into undeserving hands to oppress colliers with whom they were in disagreement.

The Plymouth colliers are now making up for their long holiday, and are busily working, though it will be a long time before all the working places are filled. It is a tribute to the management that no disaster has happened so far, showing that every care was taken in looking after ventilation, &c. These collieries are better equipped with electric appliances than any other I know in Wales, and this, though costly, must pay in the end. The coal audit, Saturday, declared no change in wages.

The coal trade last week was quieter than expected. Probably the rush for clearances will be this week. Since my last there have been some noticeable shipments, Port Said taking the chief in tonnage of 5200 tons, 3000, 3800, and 3500 tons. Several important ones have been sent to Cape Town, Buenos Ayres, and Genoa, and one fine one of 4601 tons to Kurrachee. Coalowners are quite aware that the war feeling has not all blown away, and coaling stations will be well looked after for some time to come. Swansea and Newport, Mon., coal shipments have been slightly below the average. As regards Monmouthshire coal for Cardiff shipments, it was remarked on 'Change, Saturday, that the market was in a drooping condition. Best Western Valleys were quoted at 8s. 3d. to 8s. 6d., and Eastern Valley coal 7s. 3d. to 8s. This week, 'Change, Cardiff, has been well attended, and much more animation shown. Inquiries for best and seconds have increased. Dry coals remain flat. Best small is improving. Latest prices were: Best steam, 10s. 3d. to 10s. 6d.; best seconds, 9s. 9d. to 10s.; ordinary seconds, 9s. 3d. to 9s. 6d.; drys, 8s. 9d. to 9s. 3d.; best Monmouthshire, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s.; best small steam, 4s. 9d. to 5s.; seconds, best, 4s. 3d. to 4s. 6d.; drys and other inferior sorts, 3s. 6d. to 3s. 9d.

There is no change for the better in the house coal trade, and it was currently reported on 'Change, Cardiff, this week, that the supply of No. 2 Rhondda was so much in excess of requirement, that some owners are considering the advisability of limiting output. Prices, maintained with difficulty, are:—Best, 10s. 3d. to 10s. 6d.; No. 3 Rhondda, 9s. 6d. to 9s. 7½d.; brush, 7s. 6d. to 7s. 9d.; small, 6s. to 6s. 3d., No. 2, Rhondda, 7s. 3d. to 7s. 6d.; through, 6s. to 6s. 3d.; small, 4s. to 4s. 3d., Cardiff. Coke continues in a vigorous condition; furnace, 13s. to 15s.; foundry, 15s. 6d. to 16s. 6d.; special foundry, 19s. to 20s.

Pitwood is in better demand, and stocks are moving more quickly, but being heavy, prices remain 14s. 9d. to 15s., Cardiff.

Patent fuel is moderately active, Swansea and Cardiff. Disposition of buyers is not to give full quoted prices. Swansea unchanged, Cardiff ranging from 10s. to 10s. 3d. inferior, and 10s. 4½d. to 10s. 6d. best. Swansea export last week 3259 tons, Italy taking 2434 tons.

Pig iron warrants are declining slightly, and a revival is not expected for a few weeks. Generally, quotations iron and steel and tin-plate remain as last week. Iron ore prices are also the same, Rubio, 11s. 6d. to 11s. 9d.; Garucha, 10s. 9d. to 11s.; Tafna, 11s. 3d., c.i.f., Cardiff. Only a few cargoes have come in this week, principally to Cyfarthfa, Dowlais, and Société Commerciale.

The tin bar trade is deplorably bad, and as prospects ahead are anything but encouraging, at all events for some time, I am not surprised to note certain changes going on in leading steel works for improved plant, &c., for steel rails. Works which for a long period, especially during the prosperous days of tin bars, had ignored steel rails altogether, and others only made colliery sections, are now preparing to pay more attention to the rail branch, and there is just a possibility that they may reap the reward of their foresight. Swansea Exchange report is that the demand for tin bars has fallen off appreciably, and fewer inquiries are reported for other local makes. Steel rails are in good demand, although this branch of the steel trade is keenly competed for by foreign producers.

The shipments of tin-plate from Swansea last week amounted to 43,797 boxes, receipt from works 29,375 boxes, thus reducing stock a little more than usual, though not enough to improve the condition of things. Stocks now amount to 161,995 boxes, as compared with 176,417 boxes this time last week, and 182,424 boxes contrasted with the corresponding period of 1895.

In the Briton Ferry district, which, through good and ill report, has maintained a hopeful condition, I am assured that the outlook for the immediate future is bad. This week notices were posted at the Vernon Tin-plate Works to terminate all contracts with the workmen. The mills at the Baglan and Earlswood Tin-plate Works have been fully occupied. At the former the 1874 list is rigidly adhered to. An average make of pig iron at the Briton Ferry works, and of ingots and steel bar at the steel works, is reported.

Liverpool reports that some tin-plate business has been done in Wales at 8s. 10½d. to 9s. 3d., and Siemens from 9s. to 9s. 9d.

A serious colliery explosion occurred on Saturday at Meiros, near Llantrissaint, one man being killed on the spot, and ten others more or less severely burnt. It appears that the pit is considered so safe as to be worked in part with naked lights. The down cast is only 80 yards, output 500 tons per day, and average number of men employed 250. The explosion is attributed to a sudden discharge of gas from a "blower."

I am glad to see that the Cambrian Railway is the first in the field with a reduction of first-class fares. The Cambrian and the Brecon have a fine season ahead of them in connection with North Wales, the installation at Aberystwith, and the Eisteddford at Llandudno.

The Workmen's Tin-plate Union is to meet shortly. Fairwood men, Gowerton, have conceded 15 per cent. and resumed work.

Sir W. T. Lewis, Bart., has left for the Continent. The testimonial movement at Aberdare is well advanced and another in the Rhondda is progressing, but the chief recognition of his baronetcy is at Merthyr, the proposal being to erect a statue, and to this I hear subscribers are sending in from all parts of the country.

Mr. H. W. Lewis, J.P., C.C., C.E., identified with the mechanical engineering progress of the mining district, has left for Madeira on account of ill health. It should not be forgotten that Mr. Lewis was one of the rescuers at Tynewydd, and obtained the medal for valour.

3500 colliers are in disagreement at Tredegar, on account of refusing to use boxes for slag; only a temporary stop is apprehended, though the colliers have shown a strong reluctance to give in to the request of the management. It should be admitted at once by them that coal despatched with a quantity of slag tells badly in the market. At some collieries I have seen the utmost care shown in clearing off slag, and men employed on the wagon for a final clearance before the coal train is despatched.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

REPORTS from the different iron-producing districts testify to a very lively trade. The steady rise in quotations that has been going on ever since the beginning of the present year has led to the belief that purchasers will not derive any advantage by waiting, but, on the contrary, are likely to have to pay more; a disposition to buy without delay is, therefore, noticeable, the more so as an active spring trade is promised. In the building line considerable animation is already to be perceived, owing to the singularly mild weather which we have had this month.

The Silesian iron market is steady, and there is a good demand experienced in all departments. Pig iron sells briskly at fairly remunerative prices. The finished iron and steel works are also well employed, the number of contracts increasing from week to week. From the coal district of Silesia pretty favourable accounts are being received, and summer quotations, which have recently been fixed, will be 2 pf. to 4 pf. p.t. higher than those of last year.

The week commenced favourably on the Austro-Hungarian iron market. Bars, which have been in extremely good request, were raised 25 to 50 cr. per 100 kilos., and a further advance is likely to take place next month. The blast furnace works are in fairly regular employment, though, on the whole, but few large orders have been placed recently. The strike of the colliers in Moravia is ending as usual, the majority of the men returning to their work. Only from some parts of Austrian Silesia unfavourable reports are being received, no less than 8000 colliers having put down work. Up to the present the loss in wages amounts to about 300,000 fl., while for coal, which on account of the strike had to be imported from abroad, nearly 1,000,000 fl. were paid.

The tone of the French iron trade has, of late, been extremely firm. There is an upward movement noticeable in all departments. The demand that is coming in on home account is sufficient to secure regular employment to the works for some time, and there are also some fair export orders holding out. The convention of the plate mills has been prolonged till end of 1901. Axles recently met with an advance of 2f. per 100 kilos. In the Ardennes there is a decided upward tendency to be noticed; steel was advanced 10f. p.t.

In Belgium the demand for nearly all sorts of iron and steel is strong, and the raised quotations are willingly paid. Foundry pig is in particularly good call. Among the different articles of manufactured iron, bars and plates are, perhaps, those that meet with the most active request; for the last named article an advance of 0·25f. p.t. has been agreed upon, iron plates, No. 2, now standing on 137·50f. p.t. Steel plates fetch 147·50f. p.t. The Belgian coal market has been showing a slightly weakening tendency of late, but there is still a fair number of orders coming in. Until now the colliers' strikes have, fortunately, had but little influence on the Belgian coal trade in general. On March 31st tenderings for the supply of 520,000 t. coal for the State railways will be received at Liège and Charleroi.

During the week now past the business in iron and steel has been exceptionally brisk on the Rhenish-Westphalian iron market, spring demand being strong. Stocks are decreasing rapidly. Prices continue to improve, and consumers are really anxious to purchase largely, as there is every cause to expect a further rise in next quarter. With regard to iron ore, quite favourable accounts have been received upon the week. Siegerland sorts are very brisk of sale, and the Nassau ore mines have likewise secured some rather heavy contracts lately, in spite of the keen competition from Spain, Sweden, and Luxemburg. The prices quoted last week were for spathose iron ore, M. 9·10 to 9·60 p.t.; roasted do., M. 12·70 to 13·40 p.t.; calcined iron ore, M. 12 to 14 p.t.; inferior sorts fetching M. 10 to 11 p.t. For Nassau red iron ore, 50 p.c. contents, M. 9·30 p.t. is given. The trade in Luxemburg-Lorraine minette is a fairly good one, prices for the different sorts ranging between M. 2·40, 2·60, and 3·20 p.t., according to quality.

Inland as well as foreign demand for pig iron has been exceedingly brisk of late, and the number of orders that are booked increases from week to week. This has naturally had a good effect on prices, and list rates are on an average 2 to 4 marks per ton higher than a fortnight ago. Spiegeleisen, 10 to 12 p.c. grade, is sold at M. 58 to 59 p.t. Forge pig, No. 1, M. 53 to 55 p.t.; No. 2, M. 42 p.t.; hematite, M. 65 p.t. Foundry pig, No. 1, M. 65; No. 3, M. 57 p.t., free at works. Basic, M. 54 to 56 p.t.; German Bessemer, M. 60 p.t.; Luxemburg forge pig, 56f. p.t., free Luxemburg. The malleable iron trade is very busy. Bars are experiencing a good demand, and prices continue to improve. For the present, however, makers are gaining but little.

A very active inquiry is coming in for girders; hoops also show some improvement. The plate mills are reported to be steadily occupied; sheets also continue in very good call. A somewhat improving report is generally given of the activity in the wire and rivet business, but prices remain poor. Machine and construction shops are, as a rule, in satisfactory employment; the same can be told of the foundries.

Present list rates, per ton at works, are as under:—Good merchant bars, M. 116 to 118; rivet iron, M. 135; angles, M. 125; girders, M. 92 to 95; hoops, M. 123 to 125; billets in basic and Bessemer, M. 84 to 85; heavy plates for boiler-making purposes, M. 160; tank ditto, M. 135 to 140; steel plates, M. 130 to 135; tank ditto, M. 120; sheets, M. 145 to 155; iron wire rods, common quality, M. 125; drawn wire in iron or steel, M. 120 to 135; wire nails, M. 127 to 130; rivets, M. 170; complete sets of wheels and axles, M. 270 to 280; axles, M. 220; steel tires, M. 200; steel rails, M. 108 to 110; steel sleepers, M. 106; fish-plates, M. 112 to 120; light section rails, M. 98.

LAUNCHES AND TRIAL TRIPS.

On the 30th ult. Messrs. Ropner and Son, of Stockton-on-Tees, launched a steel screw steamer of the following dimensions, viz:—Length between perpendiculars, 290ft.; breadth, extreme, 43ft.; moulded depth, 19ft. 9in., which they have built for Mr. Christian Klaveness, of Christiania. The vessel is built on the part awning decked rule, with poop and raised quarter deck, her deadweight carrying capacity being 3500 tons on 18¼ft. The saloon and cabins for captain and officers are fitted in the poop, the engineers' accommodation being amidships. She is built on the web frame principle, leaving the holds entirely clear for cargo, and carries her water ballast in a cellular bottom and in the after peak. All labour-saving appliances are fitted for the economical working of the steamer, and also for the expeditious loading and unloading of cargoes. She has steam steering gear amidship and screw gear aft, four powerful steam winches, a large multitubular donkey boiler, direct steam windlass, stockless anchors, &c. The engines will work up to about 900 effective horse-power, and are by Messrs. Blair and Co., having cylinders 21½in., 35½in., and 58½in. by 39in. stroke, steam being supplied by two large steel boilers working at 160 lb. pressure. The name of Laurelwood was given to her as she left the ways.

On Thursday, March 26th, the new steel screw steamer Lorle, recently launched by Messrs. Irvine and Co., of West Hartlepool, proceeded on her trial trip. She is the fourth vessel built by this firm for Messrs. Trechmann Brothers, of West Hartlepool. A large party were on board, amongst whom were Messrs. Otto Trechmann and Albert Trechmann, who represented the owners; Captain Ben Murrell and Mr. Maddison, who superintended the building of hull and machinery; Messrs. R. Coulson and E. F. Irvine, representing the builders; and Mr. Corking, the engine builders. Her dimensions are 314ft. by 44ft. by 23ft. 3in., with a gross tonnage of 2685 tons, and has been built to Lloyd's highest class. Her deck erections consist of poop, bridge, and topgallant forecastle. The saloon and cabins for captain and officers are fitted up in poop, engineers being berthed under bridge deck at sides of engine-room, and crew in topgallant forecastle. A cellular double bottom extends fore and aft for water ballast. In order to provide for rapid loading and discharging, four powerful steam winches by Irvine and Co. have been placed at hatchways, with double derricks to suit. Steam steering gear amidships, screw gear aft; two large donkey boilers and direct steam windlass. Boats are placed on beams overhead. Triple-expansion engines by Messrs. Blair and Co., Stockton-on-Tees, have been fitted; cylinders, 23in., 37½in., and 61½in. by 39in. stroke. After cruising about for some time for adjusting compasses, the vessel's speed was tested, when an average of 12 knots was obtained. The vessel then proceeded to Cardiff, under the command of Captain Grahl, to load for her maiden voyage.

On Saturday, March 28th, Messrs. Wigham Richardson and Co. launched from their Neptune Shipyard a steel screw steamer which they are constructing for the well-known Rickmers Company, of Bremen, built of steel on the web frame principle, 427ft. in length, 50½ft. beam, and 30ft. in depth, and carrying about 7200 tons deadweight of cargo on a moderate draught of water, and, being intended for the Eastern trades, she is fitted with every accommodation for a limited number of passengers in the citadel amidships. The arrangements for loading and for discharging cargo are very extensive, and with other appliances include eight steam winches as well as various other steam deck gear, &c. Unlike other vessels of her class, the Elizabeth Rickmers is built with a clipper bow and a female figure by Allan, which it is hoped will satisfy the artistic feelings of her owners, who are well known in Germany as patrons of art, and whose residence at Vahr contains Fitger's frescoes of the "Midsummer Night's Dream." She will be rigged as a two-masted schooner, and her lower masts will be of such a length that she can go up the Manchester Ship Canal in ballast. The propelling machinery is of the quadruple expansion type, working at 215 lb. pressure, and self-balanced according to the Yarrow, Schlick, and Tweedy system, and is also being constructed by Messrs. Wigham Richardson and Co. Quadruple engines balanced according to this system are now becoming well known and extensively used, not only because of the saving in fuel, but also on account of the entire absence of vibration at whatever speed the engines may be running. It has been found that the consumption of fuel is from 10 to 15 per cent. less with this type of engine than with ordinary triple engines working at 160 lb. pressure. The builders have several more sets of balanced engines in course of construction for steamers for various purposes, though this is the only steamer hitherto acquired by the Rickmers Company which is fitted with them. The launch was witnessed by a goodly number of visitors, including Mrs. R. Spence Watson and the Misses Spence Watson, Mr. Charles J. and Miss Spence, Mr. and Mrs. F. W. Dendy, Mr. and Mrs. Christie, Mr. Wigham Richardson, Mr. J. Tweedy, Miss Dupré, Miss Roberts, Miss Moffatt, Mr. Frank Richardson, Mr. Burland, Mr. and Mrs. Frank Christie, Mr. R. H. Winstanley, Mr. E. P. Sturge, Mr. G. Glover, and Mr. A. Heine, of Bremen, under whose superintendence the steamer is being constructed. The vessel was named by Miss Mary Spence Watson, daughter of Mr. R. Spence Watson, of Bensham Grove.

The s.s. Algoa, which has been built and engined by Messrs. William Doxford and Sons, Pallion, left the Wear on the 26th ult. for her official trial trip, after which she proceeded direct to Cardiff. She has been built to the order of Messrs. Crow, Rudolf, and Co., Liverpool, and at this date is the largest cargo vessel yet built in Great Britain, her deadweight capacity being 11,375 tons. The dimensions over all are 465ft. by 58ft. by 35ft., and load draught 26ft. She has tri-compound engines of 29in., 50in., and 80in., by 51in., with two single-ended boilers fitted with Brown's induced draught and Serve tubes, enabling the vessel to steam fully 10½ knots when loaded. She is exceptionally well provided with discharging gear, being fitted with eighteen cargo derricks, all of which are carried on side posts so as to shorten the radius of the derricks necessary to put the cargo clear over the side. This is an arrangement which was originally adopted by Messrs. Doxford in the large steamer built by them for the British-India Steam Navigation Company in 1890. These posts are fitted vertical with the keel-line, enabling the derricks to be easily moved either in or out, saving a large amount of labour which is usual in the ordinary arrangement of derricks on raked masts. There are nine horizontal steam winches by Messrs. Clarke, Chapman, and Co., fitted so that each winch works two of the derricks. The steering arrangement adopted is that of Messrs. Fawcett, Preston, and Co., of Liverpool, in which hydraulic power is used, and from experience already gained has been found particularly economical in steam consumption, as the motive power—that is, the hydraulic pumps—are fitted in the engine-room, in close proximity to the boilers; the controlling wheel for these pumps being fitted on the bridge amidships. In addition to this the vessel is fitted with Harfield's compensating hand gear. The anchor gear is also of an exceptional nature, consisting of two independent steam windlasses, by Messrs. Clarke, Chapman, and Co., with vertical engines, each operating independently one of the cables, and also one steel wire mooring rope, each having its own independent brake and clutch gear. The vessel is also fitted throughout with electric light on Messrs. Clarke Chapman's system, with four large deck clusters for cargo working, and the usual arrangement of lighting throughout engine and boiler spaces, cabins, holds, &c. On the trial trip, after the adjustment of compasses, the vessel was run at full speed, when a record of about 11½ knots was shown. This vessel has been built throughout under the superintendence of Mr. F. J. Pilcher, of Liverpool, representing the owners.

Last week the new steamer Balmoral, built by C. S. Swan and Hunter, Wallsend-on-Tyne, for Messrs. Raeburn and Verel, of Glasgow, was taken to sea for her trial trip. The Balmoral is a finely modelled high powered spar deck steamer 380ft. long over all, by 46ft. beam, by 30ft. 3in. moulded depth, and has been constructed with a long poop, long bridge amidships, and topgallant forecastle, giving her a large cubic capacity for Eastern trades. She has been fitted on all the latest ideas for the rapid handling of cargo; and for the convenience of trading in different ports, is sub-divided, not only with the usual bulkheads, but also with extra high 'tween decks. The machinery has been constructed by Mr. Geo. Clark, of Sunderland, and consists of a set of engines 26in., 42in. and 69in. diameter by 48in. stroke, supplied with steam by two large single-ended boilers fitted with Howden's system of forced draught; and in order to meet the requirements of various ports, the hull and engines and boilers have been constructed, not only to pass Lloyd's survey, but also those of the British Corporation, Board of Trade, and the German law. The weather being somewhat stormy and thick, it was impossible to run the measured mile. The steamer therefore headed direct for Middlesbrough, and steamed to her destination at a mean rate of about 12½ knots, and was moored safely at the Redcar wharf, where she took in part of her cargo of pig iron, proceeding afterwards to Middlesbrough docks for bunkers, after which she steamed over to Antwerp to complete her loading for Japan, the vessel having been chartered by the owners to the Nippon Yusen Kabushiki Kwaish, Tokio, Japan, for their line of steamers between Europe and Japan. At the trial trip the managing owners were represented by Mr. William Raeburn, and Mr. William Thomson, the superintendent; the builders by Mr. Rowland Hodge, and the engine builders by Mr. John Clark. In the course of a few remarks which were made after luncheon, Mr. Raeburn took the opportunity of observing that he had in recent years been carefully considering the question relating to the model and power of what are usually known as "Tramp steamers," and he had come to the conclusion that in order to compete successfully with other firms it was necessary to have vessels which should not be too full, and should not be too slow, and with this object in view, all their recent steamers, such as the Osborne and Linlithgow, and in the present case the Balmoral, had been built on fine lines and with good power, so that, if necessary, the steamers could be propelled economically at a fair rate of speed, and thus be in a position to obtain the top freights which were available.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

18th March, 1896.

5995. Pneumatic Tires for Cycles, &c., J. Watt, Glasgow.
5996. Spraying Machines, G. F. Strawson, London.
5997. Apparatus for Collection of Card, &c., J. Partington, London.
5998. Thread Bobbin Holder, A. Brown Glasgow.
5999. Roller Letter Copiers, E. E. Young, London.
6000. Advertising, A. J. Pheazey, London.
6001. New Form of Vacuum Tube, H. C. Newton, London.
6002. Chain Wheel, J. Hollis, Ilkeston.
6003. Brakework for Cycles, J. Hollis, Ilkeston.
6004. Detachable Pneumatic Tire, J. Hollis, Ilkeston.
6005. Making Pipe Joints, J. Wood and W. Clark, London.
6006. Strong's Patent, E. G. Strong, Cardiff.
6007. Printing, J. E. Thornton, Altrincham.
6008. Apparatus for Evaporating Liquids, F. S. Cripps, Surrey.
6009. Composition of Furnace Bottoms, J. Hill, Stockton-on-Tees.
6010. Pocket to Fit in Tubes of Cycles, A. E. Hall and J. W. Sadler, York.
6011. Automatically Closing Water-tight Doors, W. O'Brien, Glasgow.
6012. Diminishing the Risk of Kitchen Boiler Explosions, G. Pinnington, Chester.
6013. Door Curtain-rods, T. Pursey, Edinburgh.
6014. Beating Engines for Paper Pulp, J. Shaw, Halifax.
6015. Waste Water-closets, J. J. Green and W. Oates, Halifax.
6016. Grooved Collars for Ships' Lamps, J. and W. Hayes, South Wales.
6017. Combination Furniture, J. Mather, jun., Glasgow.
6018. Lubricator Expeditor, J. T. Thornton, Huddersfield.
6019. Food Preparations, D. Horn, London.
6020. Combination Spools for Cotton, &c., H. and A. White, Derbyshire.
6021. Fire-grates, T. Hill, Hull.
6022. Brake for Road Vehicles, W. Hawley, Sheffield.
6023. Heating Feed-water for Engines, F. Wilson, Sheffield.
6024. Cylinder Friction Clutch or Grip, W. L. Preece, Derby.
6025. Penholders, J. Bader, London.
6026. Basins, W. C. Ramshaw, Bradford.
6027. Brakes for Velocipedes, W. Bratby, jun., Manchester.
6028. Kiers for Bleaching Fabrics, E. Deakin, Manchester.
6029. Valve Gear of Fluid-pressure Engines, J. W. Melling, Manchester.
6030. Applying Wheels for Skating, H. and J. Thomson, Huntingdonshire.
6031. Shelf Tidy for Libraries, A. Lewis, Leominster.
6032. Umbrellas, W. S. S. Fleming, Glasgow.
6033. Aluminium Alloys, W. Pearson and J. A. Bott, Birmingham.
6034. Appliances for Buckles, &c., G. Brazenor, Worcestershire.
6035. Hinges for Oven Doors, &c., A. Chatwin, Birmingham.
6036. Elevators, J. F. Fitchett and F. Fitchett, Birmingham.
6037. Stocking-knitting Machines, F. B. Salzer, London.
6038. Securing Tarpaulins to Hatches of Ships, J. R. Watson, London.
6039. Lamp for Cycles, J. Jelinek, London.
6040. Oil Cooking Stoves, F. S. Rippingille, London.
6041. Water Filters, F. H. Eydman, London.
6042. Combined Weighing Machine, &c., H. Davies, Cardiff.
6043. Stands for Exhibition of Eggs, &c., W. Fowler, London.
6044. Buckles for Harness, T. E. Williams, London.
6045. Bolts, W. Keen, London.
6046. Gear for Cycles, E. Schebesta and E. S. E. von Linderstamm, London.
6047. Extension Crank, R. Wilcox and D. V. Eskell, London.
6048. Controllers, J. Devonshire.-(*W. B. Potter, United States.*)
6049. Machines for Cleaning Knives, J. G. Pike, Norwich.
6050. Weighing Instruments, &c., A. Finney, Glasgow.
6051. Stitched Leather Belting, &c., G. Hurn, London.
6052. Igniting Compound for Matches, G. Schwiening, London.
6053. Primers for Firing Guns, The Morris Tube Ammunition and Safety Range Co., C. Cuthbertson and W. H. Stentiford, London.
6054. Diminishing Visible Smoke, E. E. Dulier, London.
6055. Regenerative Gas Lamps, G. Bower, London.
6056. Handle Bars for Velocipedes, J. F. O'Brien, London.
6057. Billiard and other Cues and Tips, H. Misener, London.
6058. Electric Incandescent Lamps, G. Bamberg, London.
6059. Gear Cases, H. Fearncombe and Co., and A. Evans, London.
6060. Lubricators, W. P. Thompson.—(*S. Bernstein, Germany.*)
6061. Pen, E. Herrmann, London.
6062. Cycle Driving Gear, W. Reilly and C. Haigh, Manchester.
6063. Appliance for Govening Horses, J. N. Beevor, Birmingham.
6064. Apparatus for Washing Bottles, W. Smith, Liverpool.
6065. Bedsteads, F. Wood, Liverpool.
6066. Washing and Cleansing Sand, J. Arnold, Birmingham.
6067. Gas and Oil Engines, &c., F. H. Briggs, Liverpool.
6068. Spindles and Knobs for Locks, J. Masters, London.
6069. Electrically Coating Wire, W. S. Rawson, London.
6070. Cocks and Valves, J. Ascough and H. C. Fowler, London.
6071. Primary Electric Batteries, W. Rowbotham, London.
6072. Pneumatic Tires for Cycles, F. E. V. Taylor, London.
6073. Production of Motive Power, D. Cook, London.
6074. Improved Sewing Machine, H. Manning, London.
6075. Photographic Apparatus, B. J. B. Mills.—(*C. Chorretier, France.*)
6076. Water-closets, J. Jones and S. H. Rowley, London.
6077. Manufacture of Armour Plates, J. H. Dickenson and E. M. Fox, London.
6078. Cycles, K. Klose, London.
6079. Envelope for Use with Letters, H. Southey, London.
6080. Compound Steam Engines, T. G. Clayton, London.
6081. Fastening Tobacco Pouches, W. W. Reed, London.
6082. Tin Plate and Spike Lock, A. S. Hardman, London.
6083. Mucilage Bottles, W. T. Williams, London.
6084. Yachts, D. McLean, London.
6085. Swings, S. W. White, London.
6086. Attachment for Stoves, W. Laubersheimer, London.
6087. Car Fenders, N. Leccese, London.
6088. Hat Pins, M. H. Coltharp and W. L. Dorram, London.
6089. Game Devices, R. W. Tunstall, London.
6090. Cycle Bells, C. V. Zinn, London.
6091. Fish Traps or Hooks, A. W. Phillips, London.
6092. Manufacturing Cardboard, A. J. Boult.—(*C. David and Sohn, Austria.*)
6093. Manufacture of Boots, &c., J. E. Leavesley, London.
6094. Tongs for Suspending Articles, A. J. Boult.—(*D. J. Aubert*, ——.)
6095. Water-tube Boilers, W. H. Wilson, London.
6096. Aluminate of Barium, &c., D. A. Péniakoff, London.
6097. Stop Valves, F. N. Mackay, London.
6098. Cycles, B. Lefebure, London.
6099. Manufacturing Hollow-ware, W. L. Wise.—(*La Società Italiana per la Fabbricazione di Bossoli e Scatole Metalliche, G. Franchi and Co., Italy.*)
6100. Appliance for Tubes, W. E. Carmont, London.
6100. Valve, W. E. Carmont, London.

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6101. Mottie String, J. W. Cuffling and J. Unwin, Ridgeway.
6102. Saucepan Lid, E. A. Barnes, Pembroke Dock.
6103. Gas Engines, J. Enright, London.
6104. Making Decorations on Paper, A. Lipscombe, Surrey.
6105. Syphon Flushing Cisterns, F. C. Lynde, Manchester.
6106. Tool for Re-cutting Grooves, G. E. Cornioley.—(*G. Rabe, Germany.*)
6107. Door Knob with Spindle, H. Askew, Rotherham.
6108. Purifying Saccharine, F. Sykes.—(*R. Hirsch, Germany.*)
6109. Bowl Balls, W. Brocklebank, Nottingham.
6110. Match Box made from Mussel Shell, G. F. Blower, Ramsgate.
6111. Extinguishing for Burners, W. Redman, Wolverhampton.
6112. Driving Gear for Brake, J. T. Bustin, New Brunswick.
6113. Adapting Telephone Line Wires, A. G. Burrell, Sheffield.
6114. Wheels, F. Cook, Glasgow.
6115. Forceps, F. Wagner, Berlin.
6116. Rollers, E. Sykes, E. Heppenstall, and E. Sykes, Halifax.
6117. Bottle Screw Stopper, &c., L. Vallett, Liverpool.
6118. Metallic Bedstead Pillar Mounts, E. Lawson, Birmingham.
6119. Boot-blacking Machines, R. L. Tapscott, Liverpool.
6120. Patent Opener for Letters, A. H. Lowe, Glasgow.
6121. Producing Vapour for Inhalation, T. W. Rees, Cardiff.
6122. Sure and Safe, D. McPhun, Argyleshire.
6123. Ruling Machine, E. Graber and L. Hepworth, London.
6124. Ruling Machines, E. Graber and L. Hepworth, London.
6125. Flushing Water-closets, T. W. Twyford, Birmingham.
6126. Machines for Spinning Rope Yarns, J. McClure, Glasgow.
6127. Movable Seat for Polo Carts, H. McMullan, Glasgow.
6128. Ovens for Baking Porcelain, &c., W. Dall, Glasgow.
6129. Milking Apparatus, W. H. Lawrence and R. Kennedy, Glasgow.
6130. A Microscope, R. B. Brown, York.
6131. Fastening Arms to Flanged Rings, J. W. Lea and J. H. Perrins, Birmingham.
6132. Treatment of Impure Waters, H. B. Sharp, Manchester.
6133. Manufacture of Covered Whalebone, J. Hall, Manchester.
6134. Polishing Granite Balls, R. Lawrence, Glasgow.
6135. Furnaces of Steam Boilers, R. H. Williamson, Manchester.
6136. Extinguishing Lamps, G. Stork and T. H. Lee, London.
6137. Holding the Cords of Pictures, J. J. James, Birmingham.
6138. Attaching Postage Stamps, E. S. Fardell and C. E. Smith, London.
6139. Rims of Wheels for Cycles, &c., R. Corsham, London.
6140. Looms for Weaving, G. H. Sargent, R. H. Coupe, and B. Walker, Bradford.
6141. Fastening Means for Boots, J. C. Rhodes, London.
6142. Machines for Drilling, E. F. Moy and T. J. Digby, London.
6143. Billiard Tables, J. Turns and the Pneumatic Billiard Cushion Syndicate, London.
6144. Water Taps or Faucets, C. Flick, Barmen, Germany.
6145. Photographic Mountings, J. F. Hoyne and D. B. Athol, Dublin.
6146. Ornamental Edgings, C. Draeger and W. Gunn, Manchester.
6147. Treating Brewers' Grains, &c., F. B. Pike, London.
6148. Fittings for Electric Lighting, H. Lea, Birmingham.
6149. Releasing Tubes from the Mandrel, W. and A Pilkington, Birmingham.
6150. Oil Lamps for Lighting Purposes, R. Dorsett, London.
6151. Closing of Canisters, Boxes, &c., H. Mardon, London.
6152. Wickless Oil Lamps, J. F. Duke, London.
6153. Roller Bearings, W. H. Woodcock, London.
6154. Holders for Umbrellas, J. A. Gregory, Liverpool.
6155. Fastener for Boxes, &c., H. Fregberger, Manchester.
6156. Heel Tips for Boots and Shoes, V. A. P. Louis, London.
6157. Separation of Silicic Acid, &c., F. Brünjes, London.
6158. Lathes, R. G. Brooke, London.
6159. Shirts, W. Hayter, London.
6160. Eyelets, E. Kempshall, London.
6161. Water-tube Steam Boilers, A. F. Yarrow, London.
6162. Water-tube Steam Boilers, &c., A. F. Yarrow, London.
6163. Water-tube Steam Boilers, A. F. Yarrow, London.
6164. Separating Dust from Air, H. Simon, London.
6165. Flexible Tubing, &c., W. H. K. Bowley, London.
6166. Horse Collars, S. H. Brambley, London.
6167. Marine Boilers, N. Soliani, London.
6168. Saddles for Cycles, N. R. Roskell, London.
6169. Chimneys, M. T. Lander, London.
6170. Linotype Machines, The Linotype Company, C. L. Ireland, and F. J. Wich, London.
6171. Locking Devices for Nuts, &c., J. W. Cooper, London.
6172. Cooking of Food Materials, H. Higgins, London.
6173. Boots, B. Toon, J. W. Black, and A. Adcock, London.
6174. Fluid-pressure Motors, G. Sellers, London.
6175. Keyboard for Pianofortes, &c., T. Norton, London.
6176. Working Theatrical Scenery, R. Affleck, London.
6177. Self-moving Carriages, F. H. Wenham, London.

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6178. Keeping Bouquets Fresh, J. Hall, Dundee.
6179. Back-pressure Valve Cocks &c., T. Sabine, Derby.
6180. Tea-pots, C. H. Dent, Tamworth.
6181. Apparatus for Feeding Steam Boilers, J. Weir, Glasgow.
6182. Disinfecting Apparatus, P. S. Hyslop, Glasgow.
6183. Propellers, J. Paris, Glasgow.
6184. Boilers for Gas Cooking Stoves, L. Redmayne, Sheffield.
6185. Improved Shower and Spray Bath, C. Darrah, Manchester.
6186. Garment Cutting and Making, J. Walsh, London.
6187. Bedstead Pillar Mounts, J. W. Hoyland and R. W. Littleboy, Birmingham.
6188. Spectacles and Eye-glasses, T. J. Phipps, Herts.
6189. Re-bounding Twine Box, H. Auton, Crewe.
6190. Condenser, G. Love, Durham.
6191. Safety Tower Bolt, M. P. Galloway Leith.
6192. Hooks and Eyes, E. Mackenzie and C. Mackenzie, Dundee.
6193. Adjustable Cycle Seats, G. E. P. Gaskell, London.
6194. Musical Instrument for Singers, A. Walhorn, Glasgow.
6195. Squeegee, M. P. Galloway, Leith.
6196. Tube Spinning, &c., Machinery, W. Firth, Bradford.
6197. Electric Traction, T. E. Doyle and J. McKenny Dublin.
6198. Cycle Brake, A. A. J. Hall, Glasgow.
6199. Oil Lamps and Stoves, E. F. Hulse, Manchester.
6200. Receptacle or Box for Matches, H. Dawson, Keighley.
6201. Vehicle Wheels, F. Warwick and E. Warwick, Birmingham.
6202. Pneumatic Wheel, J. B. Small, P. Maclellan, and J. W. O. Walker, Glasgow.

6203. Fire Screen, W. Grosvenor-Bradley, Manchester.
6224. Fire Screen, W. Grosvenor-Bradley, Manchester.
6205. Brake Apparatus for Vehicles, L. R. Thomas, Wiltshire.
6206. Bicycles D. du Boulay, Salisbury.
6207. Apparatus for Cooling Air, C. D. Barker, London.
6208. Electric Switches, A. Ballance and E. H. Hewson, London.
6209. Chalk Glue, P. H. Riemer, London.
6210. Charging Furnaces, S. T. and C. H. Wellman, London.
6211. Steering Handle Bar for Cycles, B. Naumann, London.
6212. Gas Generators, P. C. Frewin, London.
6213. Pen-holders, M. Klemisch, London.
6214. Game, V. Maillard and F. Haus, London.
6215. Belts or Straps, J. H. Wolff and J. Schimmel, London.
6216. Treatment of Sodium, C. H. Parker and J. Pullman, London.
6217. Flushing Cisterns, J. Jones and H. E. Price, London.
6218. Steering Mechanism of Cycles, C. C. Fontaine, London.
6219. Golf Clubs, J. A. Davison, London.
6220. Lavender Bags, L. Uwins and E. N. Uwins, London.
6221. Cycle Clip or Holder, F. H. Bluemel, London.
6222. Weighing Tea, E. A. Schacht, London.
6223. Cycle Clip, H. Hodges, London.
6224. Drain Pipe, L. A. Wilson and W. A. Brunning, London.
6225. Compasses and Trammels, W. T. Davies, Swansea.
6226. Felt Hat Forming Machines, J. B. Macqueen and R. Robinson, Manchester.
6227. Recording Votes, E. T. Hughes.—(*G. J. Sweeney, United States.*)
6228. Preventing Collision between Trains, H. Rakow and J. Stocker, London.
6229. Collapsible Bracket Device, A. Bramhall, Liverpool.
6230. Securing Horseshoes, M. Schwertführer, London.
6231. Treating Metallic Bars, T. S. Kendrick, Birmingham.
6232. Imitation of Wood, F. L. Schauermann and J. S. Cowper, London.
6233. Indicating Statements of Account, G. Doré, London.
6234. Painting Letters upon Glass, J. H. Parish, London.
6235. Controlling Engines for Raising Loads, G. Donkin, London.
6236. Connecting Parts of Furniture, J. Cassagne, London.
6237. Dial for Clocks, J. C. Hart, London.
6238. Bicycle Handles, T. G. Russell, London.
6239. Combined Driving and Riding Coat, A. B. Giles, London.
6240. Apparatus for Starching Articles, R. Oliver, London.
6241. Diaphragm System for Lenses, A. W. Penrose and W. Gambie, London.
6242. Separating and Saving Gold, J. Mait, London.
6243. Corking Machines, J. W. Flower and R. J. Cousins, London.
6244. Edging for Ladies' Dresses, S. Lemberger, London.
6245. Taking Photographic Pictures, M. Freudenberg, London.
6246. Vacuum Tubes, A. W. Isenthal, London.
6247. Punching Holes in Letters to be Filed, F. Müller, London.
6248. Stiffening Material for Corsets, &c., H. W. Reynolds, London.
6249. Boots, W. Howard, London.
6250. Bottles, M. M. J. O. O'Conor and A. L. Gruggen, London.
6251. Apparatus for Corking Bottles, C. Malmendier, London.
6252. Pulleys and Bands, G. F. Gautier, London.
6253. Making and Baking Rusks, W. Kutschke, London.
6254. Cooling Coke, W. Parley, London.
6255. Steam Turbines, P. J. C. Carron, London.

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6256. Toy for Advertising Purposes, E. J. Hayball and A. H. Deakin, London.
6257. Tips of Billiard Cues, E. W. Lancaster, Birmingham.
6258. Syphon Water-waste Preventer, W. H. Webster, York.
6259. Smoke Consumer, R. H. and W. H. Shiers, W. Gillespie, and C. H. Bottoms, Oldham.
6260. Railway Signal Apparatus, R. Coats and J. Landells, North Shields.
6261. Music Stands, W. F. Chapman, Leeds.
6262. Handles for Cricket Bats, &c., G. E. Haworth, Accrington.
6263. Apparatus for Laying on Paint, A. W. Thatcher, Birmingham.
6264. Bottling Machines, J. W. Crichton, Glasgow.
6265. Hand Stamps, J. Gardner, Manchester.
6266. Wheels, A. J. Lehmann, J. Hillyard, and G. T. Haigh, Liverpool.
6267. Oil Cans, J. Frail, Glasgow.
6268. Auxiliary Fittings to Fire-arms, J. Wolffe, Glasgow.
6269. Wooden Casings, C. J. Wightman and A. Hudson, Bradford.
6270. Treatment of Earths, J. S. Pattinson and Fawcett, Preston, and Co., Liverpool.
6271. New Tool, J. Forsythe and W. O. Stanley, Dublin.
6272. Combined Air-lock and Bulkhead Door, W. S. C. Greene, London.
6273. Applying Adhesive Stamps, C. Brewster, London.
6274. Pneumatic Tires, A. Nicholson, Dublin.
6275. Preventing Unsymmetrical Coins Entering Slots, A. Pollard, Burnley.
6276. Locks, W. E. Copping, London.
6277. Exposure of Photographic Plates, E. Mosely, London.
6278. Self-sealing Ink Wells, A. Thomson, Manchester.
6279. "In and Out" Indicators, J. P. Milbourne, Manchester.
6280. Working the Points on Tramway Lines, J. P. Milbourne, Manchester.
6281. Brake, C. H. Richardson, Bristol.
6282. Securing Sackings to Bedsteads, F. Hoskins, Birmingham.
6283. Watch Protectors, W. Smith and T. W. Baker, Leicester.
6284. Securing the Ends of Cornice Poles, J. G. Hall, Birmingham.
6285. Device for Fastening Boots, C. J. Crapper, London.
6286. Burners for Lamps, I. Schwarz, Manchester.
6287. Cycles, W. B. Bromley, London.
6288. Sliding Pivoted Window Sashes, W. Johnson, Shetland.
6289. Chemical Manure Mixer, E. Paternotte, Brussels.
6290. Double Aluminium Sulphides, D. Péniakoff, London.
6291. Churn, G. C. Oeters, London.
6292. Bungs for Barrels, G. Busby, Birmingham.
6293. Die for Manufacture of Tiles, J. Sherwin, Manchester.
6294. Kinographic Apparatus, W. Hunt and J. Trotter, Lanark.
6295. Spacing Pieces for Type-setting, E. Wentscher, London.
6296. Cycle Bracket Holder, L. Fisher, Wolverhampton.
6297. Honeycomb Foundation Manufacture, J. H. Howard.—(*E. B. Weed, United States.*)
6298. Bicycles, F. L. Emanuel, London.
6299. Selvedge Motion for Looms, A. Walton, London.
6300. Locking Velocipedes, J. H. Hughes and G. Capewell, Birmingham.
6301. Spiral Track Pleasure Towers, T. W. Heath, London.
6302. Seam-rubbers for Boot-closing, T. Parris, London.
6303. Hoes, A. Foste-Melliar, London.
6304. Shirt Sleeves, W. F. Williams, London.
6305. Surface Trolleys for Electric Railways, W. S. Hull, London.
6306. Electric Motors, A. Greenwood, London.
6307. Knitting Machinery, S. Lowe, London.
6308. Locking Devices for Boxes, A. J. Boult.—(*J. E. Deconinck, France.*)
6309. Staple for Carriage-door Locks, H. Defries, London.
6310. Internally Stoppered Bottles, A. F. Spencer, London.
6311. Advertising, M. J. Allen, London.
6312. Lubricating Chain Gear of Cycles, T. Price, London.
6313. Buckles, I. Parkinson, Liverpool.
6314. Curtain Rings, I. Parkinson, Liverpool.
6315. Purses, I. Parkinson, Liverpool.
6316. Steam Boilers, G. Rollo and M. M. Rollo, Liverpool.
6317. Haulage Clips, L. Worthington and J. Soar, London.
6318. Treating Vegetable, &c., Fibre, J. F. Lester, London.
6319. Holder for Blind-cords, &c., G. R. Downer, London.
6320. Fastener for Collars of Uniforms, C. Schmidt, London.
6321. Cutting Leather, F. Squire and F. Squire, jun., London.
6322. Construction of Poles for Punts, &c., T. Myers, London.
6323. Tanning Skins without Acids, C. Marter and M. J. Myers, London.
6324. Engines Worked by Compressed Air, J. Molas, London.
6325. Supporting Objects in Varied Positions, C. Nube, London.
6326. Charging Pneumatic Tires, H. H. Johnson, London.
6327. Money-box, C. J. Berridge, London.
6328. Holder for Curling Tongs, A. Mosely, London.
6329. Applying Electricity, E. J. Preston and A. B. Gill, London.
6330. Scaffolds, P. Jensen.—(*Kaufmann and Heiland, Germany.*)
6331. Engines Operated by Steam, W. H. Scott, London.
6332. Combined Adjustable Calendar, J. B. Thomas, London.
6333. Pencils, S. W. Pedley, London.
6334. Cranks, L. P. Crace, London.
6335. Steam Generators, H. Matheson, London.
6336. Paper Making Machines, H. H. Lake.—(*C. Christophersen and O. Wahlberg, Norway.*)
6337. Ore Concentrators, F. J. Woods, London.
6338. Churns, T. Bradford, London.
6339. Saddle for Velocipedes, L. Périssé, London.

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6340. Scythes and Reaping-hooks, F. Parkes, Birmingham.
6341. Ploughs, F. H. Keane, Waterford.
6342. Tilting Automatic Sand-box, J. F. Chapman, Stonehouse.
6343. Flexible Needle, A. A. Roberts, Waterloo, near Liverpool.
6344. Flax, &c., Spinning Machinery, T. Watson, Belfast.
6345. Nailless Horseshoe, J. Tobin, Cork.
6346. Tubular Lanterns, W. Redman, Wolverhampton.
6347. Cut Outline Maps, &c., B. Hoyland, Barley Royston.
6348. Corrugated Wire Netting, S. M. Wilmot, Bristol.
6349. Illuminating Apparatus, H. Hart, London.
6350. Valve-gear of Engines, M. Watson and J. G. Joicey, Newcastle-on-Tyne.
6351. Loading Coal into Ships, E. W. Crone and R. Wight, Newcastle-on-Tyne.
6352. Horticultural Seed Hand-drill, J. Elsley, Alcester.
6353. Construction of Kitchen Fenders, W. P. Eglin, Halifax.
6354. Steam Boiler Furnaces, T. York, Birmingham.
6355. Mouth-piece for Cigar Holder, W. P. Thompson.—(*H. Heisler, Austria.*)
6356. Pendulum Escapement, W. P. Thompson.—(*J. C. Bauer, Germany.*)
6357. Coal Tongs, J. A. Crane and C. E. Thomas, Birmingham.
6358. Trawl Gangways, A. Jeffs, Grimsby.
6359. Supporting Post for Bicycles, R. F. W. Beardsley, Glasgow.
6360. Brackets for Curtain Rods, J. Jones, Liverpool.
6361. Pneumatic Tire for Bicycles, W. W. Gibson, Kidderminster.
6362. Enema Apparatus, &c., W. T. Whitmore, London.
6363. Brake for Tramcars and Vehicles, J. Willis, Belfast.
6364. Distributing Tapes into Fabrics, H. Longbottom, Bradford.
6365. Rope Grip for Lifts, M. Robinson, Newcastle-on-Tyne.
6366. Rat Trap, J. B. Pohl, London.
6367. Lubricating Crank-pins of Engines, B. Robinson, Bolton.
6368. Display of Advertisements on Metal Plates, W. Walters and The Birmingham Advertising Tablet Company, London.
6369. Road Vehicles, B. G. King, London.
6370. Fish-trawling Apparatus, J. H. Maclure and W. A. Massey, London.
6371. System of Propelling Boats, M. Chenivesse, London.
6372. Unrolling and Measuring Cloths, H. James, London.
6373. Bath Thermometer, W. F. Hussey, sen., London.
6374. Electric Traction, D. Korda and A. G. New, London.
6375. Method of Opening Tins or Cases, J. W. Brooke, Lowestoft.
6376. Axles of Railway Carriages, H. Biermann, London.
6377. Producing Highly Overheated Steam, D. Adorján, London.
6378. Valve Motion and Engine, D. Adorján, London.
6379. Combing Machinery, W. Johns and R. Hancock, London.
6380. Fuel Economisers, E. Green, London.
6381. Penholders, W. C. Stevenson, London.
6382. Jacquard Machines, G. and F. Priestley, Bradford.
6383. Safety Folding Fire-guard, &c., R. Abrey, London.
6384. Pneumatic Tires, W. and I. Darby and J. H. Punchard, London.
6385. Draw Gear for Road Vehicles, H. Stanbridge, London.
6386. Time and Date Changing Stamp, D. G. Cavé, London.
6387. Portable Closed-in Stove, W. and I. Darby and J. H. Punchard, London.
6388. Driving Gear of Bicycles, A. J. Boult.—(*R. S. Dixon and J. J. Marshall, Australia.*)
6389. Manufacture of Celluloid, M. E. Asselot, London.
6390. Dyeing Materials, H. A. Brownsword and L. O. Lindley, London.
6391. Hose Pipes, H. W. Brüning, London.
6392. Combined Bicycle Rest and Pump, J. Emery, London.
6393. Natural and Artificial Ambers, F. Spiller, London.
6394. Machinery for Cycle Wheels, G. Skinner, London.
6395. Gearing, W. P. Thompson.—(*P. Langat, J. Jacque, and Société H. Dalifol et Cie., France.*)
6396. Blacking for Leather and the like, K. Thon, London.
6397. Conduits Applicable for Wires, J. J. Bate, Liverpool.
6398. Preparing Diagrams of Music, &c., G. Baty, Manchester.
6399. Driving and Controlling Animals, J. Welsh, Birmingham.
6400. Elastic Supports or Pads, &c., G. Uhlmann, London.
6401. Corset Stiffeners, E. Joseph, London.
6402. Foundations for Wigs, &c., E. de la Salle, London.
6403. Ink Guard or Finger Support, H. Lombard, London.
6404. Device for Stopping Horses, &c., B. Benny, London.
6405. Manure, N. F. B. De Mercey, London.
6406. Dress Fasteners, L. McCreary, London.
6407. Coating Articles with Zinc, W. S. Rawson, London.
6408. Oxygen Gas, A. Sweetser, London.
6409. Traces for Draught Harness, J. B. Chevillard, London.
6410. Albumen Tannin, W. L. Wise.—(*Knoll and Co., Germany.*)
6411. Regulating Bunsen Burners, &c., E. Savor, London.
6412. Woven Fabrics, H. H. Lake.—(*The Firm of D. Billwiller, Italy.*)
6413. Riding Habits, P. Nillson, London.
6414. Bags for Packing Food, &c., W. H. Feltham, London.
6415. Pneumatic Hat Lining, F. Hughes.—(*J. M. T. Mare, Australia.*)
6416. Sanitary Flushing Cistern, A. T. Handley, London.
6417. Driving Gear, H. J. Dowsing and F. Bremer, London.
6418. Tacking or Nailing Machines, F. Cutlan, London.
6419. Self-propelled Carriages, H. C. Capel and T. Clarkson, London.
6420. Detonating Fog Signals, &c., L. Waydelin, London.
6421. Golf Clubs, F. W. Brewster, London.
6422. Golf Clubs, F. W. Brewster, London.
6423. Switches, W. H. Dingle and J. M. Urquhart, London.
6424. Ventilating and Purifying Air, J. A. Hart, London.
6425. Pneumatic Tires for Cycles, C. F. A. H. Bagot, London.
6426. Lamp-carrying Bracket, J. Woldthausen, London.
6427. Transmitting Power, Keats Bros., Ld.—(*J. and S. Keats, France.*)
6428. Finishing Boots, Keats Bros., Ld.—(*J. and S. Keats, France.*)
6429. Ball Bearings, Keats Bros., Ld.—(*S. Keats, France.*)
6430. Inserting Rivets in Boot Soles, R. Poore, London.
6431. Explosive Compounds, A. V. Newton.—(*A. Nobel, France.*)
6432. Adjustable Fastening for Gloves, &c., R. H. Bishop and W. Down, London.
6433. Holding Window Sashes, E. R. Calthrop and J. C. Taite, London.
6434. Polishing Cloths, A. A. Attree and M. Robinson, London.
6435. Mats for Lamps, A. A. Attree and M. Robinson, London.
6436. Shelling Small Seeds, H. H. Lake.—(*G. Strafurini, Italy.*)
6437. Current Collectors, H. H. Lake.—(*Union Electricitates Gesellschaft, Germany.*)
6438. Bearings for Vehicles, P. F. Turner, C. McBride, and E. Klahn, London.

24th March, 1896.

6439. Handle Clip, G. K. Letts, Northampton.
6440. Cushioned Cotton Reel, E. Enock, London.
6441. Buffer Guides, W. Austin, London.
6442. Golf Club Head, W. Frier, Edinburgh.
6443. Metallic Bedstead Mounts, J. W. Hoyland and R. W. Littleboy, Birmingham.
6444. Pneumatic Tires, F. S. Cocks and W. H. Goodman, Peterborough.
6445. Runners for Umbrellas, &c., D. Bergmann, London.
6446. Alarm-bell for Cycles, &c., H. Brockas, Coventry.
6447. Brush, S. Draper, Dublin.
6448. Message or Letter Holder, R. H. Baker, Liverpool.
6449. Whetting Stone, J. I. Booker and R. Robson, Leeds.
6450. Match Box, K. M. Davies, Liverpool.
6451. Flanges for Jointing Tubes, R. Baird, Glasgow.
6452. Motors, H. Gee, Manchester.
6453. Resinous Solutions and Mixtures, H. Wendler, Manchester.
6454. Gas Burners, M. Clare, A. Niel, and Fletcher, Russell, and Co., Manchester.
6455. Vapour Lamps, H. B. Moran and J. B. de Lery, Manchester.
6456. Ruling Machines, D. E. Hipwell, London.
6457. Coffin Furniture, W. A. Bruff, Birmingham.
6458. Change-box Motions, G. Leek, H. S. and G. E. Walker, Lancashire.
6459. Ploughs, G. P. le Cappelain, Jersey.
6460. Taper-bend Pipe for Drains, J. W. Mearns, Sunderland.
6461. Fasteners for Windows, H. Redgate, Nottingham.
6462. Mandrels, H. and R. Speakman, London.
6463. Powder for Toilet Purposes, F. T. Gordon, Birkenhead.
6464. Cleansing Clothes, W. H. and H. Sugden, and S. Woodrup, Keighley.
6465. Sheet Metal Roofing, T. von Karlowski, Glasgow.
6466. Clips for Ball Programmes, L. Emanuel, Birmingham.
6467. Roller and Ball Bearings, R. Brenner, Crayford.
6468. Pneumatic Tires for Cycles, J. W. Smallman, Nuneaton.
6469. Wearing Apparel, C. Sunderland, Liverpool.
6470. Blotters, J. Temler, London.
6471. Pumps, J. Allan, C. B. Crowe, and T. A. Reed, Blyth.
6472. Securing Door Mats, J. J. James, Birmingham.
6473. Treatment of Refractory Ores, H. R. Angel, London.
6474. Dropping Bottles, A. B. Calder, London.
6475. Artificial Horizons, G. W. Heath, London.
6476. Advertising Machines, S. S. Bromhead.—(*S. Silberberg, United States.*)
6477. Electric Light Fittings, &c., G. O. Donovan, London.
6478. Cases for Manuscripts, &c., F. Friedrishs, London.
6479. Alarm Clocks, E. Benest, London.
6480. Rail Bond and Connection, E. A. Turner, London.
6481. Supplying Electricity, A. Mégros, London.
6482. Spanner, G. C. Downing.—(*F. Piron and P. Rouselle, France.*)
6483. Apparatus for Packing Tea, N. W. H. Sharpe, London.
6484. Writing Cases, Portfolios, &c., F. Wich, London.
6485. Motor, G. J. J. Legrand, London.
6486. Corsets, H. H. Lake.—(*N. F. T. Hunt, United States.*)
6487. Electric Motors, J. Devonshire.—(*E. D. Priest, United States.*)
6488. Riding Cycle Machines, M. Fabbrucci, London.
6489. Photographic Cameras, C. Beck, and W. Beck, jun., and J. T. Clarke, Harrow.
6490. Sewing Machines, L. E. Blackwell, London.
6491. Pocket Flasks, G. Nathan and R. Hayes, Birmingham.
6492. Pincers, J. A. Brown, London.
6493. Steam Boilers, S. Pitt.—(*La Compagnie Internationale des Procédés Adolphe Seigle, France.*)

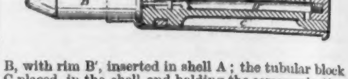
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

552,090. Miniature Ammunition, *H. Andrews, London, England.—Filed December 31st*, 1892.

Claim.—(1) A tubular piece, adapted to hold a cartridge composed of a shell A, provided with an internal tubular block C, carrying the communicating pin or striker D, and having a split ring G, surrounding said block C, at its front end, substantially as and for the purpose set forth. (2) A tubular piece adapted to hold a cartridge composed of the shell A, made of metal of the shape shown; the miniature cartridge B, with rim B′, inserted in shell A; the tubular block C placed in the shell and holding the communicating pin or striker D, the head F placed in cavity C^2 of the block C as described; and the split ring G, surrounding the block C at the front end as described, and all arranged as described and for the purpose set forth.

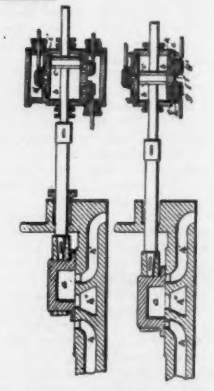
552,090



552,156. Valve Gear, *G. A. J. Telge, Oldenburg, Germany.—Filed February 21st*, 1895.

Claim.—In a valve motion for steam engines, the combination of the main slide *a*, of the main steam cylinder, the valve cylinder *b*, the valve piston *c* working in cylinder *b* and connected with slide *a* through a suitable rod, channels *i*, *i′* and *i″* on one side of cylinder *b*, slide valve *d* controlling said channels, the channels *e*, *e′*, *f*, *f′*, *k*, and *k′* on the other side of said cylinder *b*, slide valves *g*, *g′* controlling said channels, and suitable operating mechanism, substantially as and for the purpose set forth.

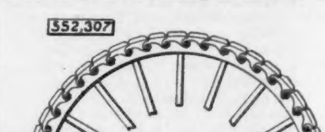
552,156



552,307. Elastic Tire for Wheels, *J. Tonks, Birmingham, England.—Filed June 20th*, 1895.

Claim.—(1) A sectional elastic tire for the wheels of common road vehicles formed of a series of metallic sections shaped so as to embrace the ordinary metallic tire and wooden fellies, and hook together at the sides of the same and each provided with one or more india-rubber blocks which together form the wheel tread and fit in corresponding perforations in the metallic sections and extend between the insides of the metallic sections and the periphery of the ordinary metal tire of the wheel, all substantially as described. (2) A sectional elastic tire comprising the metallic sections having the depending sides with hooks at the front ends thereof, and studs at the rear of said sides to receive the hooks of the adjacent sections, said sections having the opening a^4 in the upper part with inwardly turned flanges a' and the grooved rubber blocks held by said flanges, substantially as described.

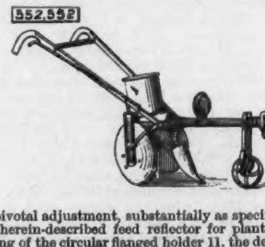
552,307



552,552. Sight-feed for Planters, *J. D. Schofield, Dallas, Tex.—Filed July 25th*, 1895.

Claim.—(1) The combination with a planter, of a feed reflector pivotally supported thereon in front of the feed mechanism for back and forth adjustment, and means for securing the reflector at any point of its pivotal adjustment, substantially as specified. (2) The herein-described feed reflector for planters, consisting of the circular flanged holder 11, the depending perforated beam embracing ears 13 cast in a single piece, the adjusting bolt 16, and the mirror 15, substantially as specified.

552,552



NOTES ON LIGHT RAILWAYS ABROAD: THEIR PERMANENT WAY AND ROLLING STOCK.

THE construction and working of light railways being now so much under consideration, a description will be of interest of the narrow-gauge lines which have been already established and worked many years in other countries. In the course of this description it will be shown how the difficulties of fixing the gauge and the transhipment of goods have, in accordance with the local circumstances, been practically overcome by the different arrangements adopted. The country most advanced in the development and beneficial working of narrow-gauge lines is at the present moment Belgium, where the most powerful and best organised society to this end has been established. It is financially assisted by all the districts through which the lines pass, by the Government, and by public subscription. It depends on and is controlled by the Board of Public Works, Railways, Posts and Telegraphs. This is the "Société Nationale des Chemins de Fer Vicinaux," and is the only authorised governmental concessionaire of the kingdom. The provinces or districts desiring lines to be established apply through their local authorities, to the Société Nationale, who after thoroughly examining the probable prospects of the line paying its way, or at least covering the cost of construction, working, and maintenance, applies to the Government for the concession. If authorised, the Government pays a subvention of from quarter to half of the capital, and guarantees an interest, while the rest is subscribed for by the corresponding provinces or districts and the public. The Government reserves, however, the right of either directing the Société Nationale to build the lines they will require, or to construct the lines themselves, paying compensation to the society, if the concession has been granted to them before. The Société Nationale des Chemins de Fer Vicinaux is at present concessionaire of 66 lines, comprising 1342 kiloms. (832 miles) with 84 new lines, inclusive of extensions extending to 1424 kiloms. (883 miles) in construction and working.

Gauge.—After long and careful investigations and long practical experience, the society adopted the metre (3ft. $3\frac{3}{8}$in.) as the standard gauge, and has now:—

53 lines, comprising 1056 kiloms. (655 miles) of 1 m. gauge.
8 " " 239 " 148 " " 1·067 "
5 " " 64·5 " 40 " " 1·435 "

The gauge of 1·067 m. (3ft. 6in.) was adopted to suit the Dutch lines they join, while for the other few lines of 1·435 (4ft. $8\frac{1}{2}$in.) gauge, the particular reason was that for those special cases it became important to avoid any transhipment of goods.

System of traction.—Out of 62 lines 60 lines, comprising about 1232 kiloms. (764 miles) are worked by steam, one of 5·1 kiloms. (about 3 miles) by horses, and one by electricity. Besides the above-mentioned 66 lines, there are six other steam tramways at work of a total length of 57·6 kiloms. (36 miles) which the Government had constructed and worked, for special reasons, by some private companies. Adding these lines, the number of light or narrow gauge lines worked in Belgium reaches the respectable figure of 72, comprising 1399 kiloms. (867 miles).

Working of the lines: The staff.—There are about 185 permanent officials for the whole service of all the lines. They are either paid by the day or month. The Société Nationale is anxiously considering the questions of fixing a scale of minimum wages, insurance against accidents, and old age pension.

Capital.—The working capital of all the lines is, in round figures, 57,024,000f. (£2,281,000).

Rolling-stock.—It consisted, up to the end of last year, of 258 locomotives, 716 carriages, 1780 vehicles, comprising the luggage vans, goods wagons, and trucks, representing a capitalised value of 12,196,856f. (£487,874).

Expenses.—The average cost for rolling stock and transport material per kilometre—or 0·62 of a mile—is 9813f. (£392·52) corresponding to about £633·09 per mile.

The average number of rolling stock in use is—

1 Locomotive for 4·912 kiloms. (or about 3·04 miles) of main line.
1 Passenger carriage for 1·734 kiloms. (or about 1·07 miles) of main line.
1 Luggage van for 8·878 kiloms. (or about 5·5 miles) of main line.
1 Goods wagon for 0·758 kilom. (or about 0·47 mile) of main line.

The 258 locomotives in service are subdivided as follows:—There are at work—

				Weight in full working order.
13	Locomotives for 1 m. gauge (3ft. $3\frac{3}{8}$in.) of			15 tons.
4	ditto	ditto	ditto	17 tons.
158	ditto	ditto	ditto	18 tons.
6	ditto	ditto	ditto	22 tons.
17	ditto	ditto	ditto	24 tons.
5	ditto	ditto	ditto	$27\frac{1}{2}$ tons.
3	ditto	ditto	ditto	30 tons.
6	Locomotives for 1·067 m. gauge (3ft. 6in.) of			11 tons.
1	ditto	ditto	ditto	17 tons.
31	ditto	ditto	ditto	18 tons.
9	Locomotives for 1·435 m. gauge (4ft. $8\frac{1}{2}$in.) of			28 tons.

The 716 vehicles in service are subdivided in the following manner:—20 carriages for horse traction, of which 10 are closed and 10 open; 116 carriages of first-class compartments; 387 carriages of second-class compartments; 12 carriages of second-class, and provided with De Rechter's suspension system; 98 mixed carriages, that is, of first and second-class compartments; 30 ditto, and provided with De Rechter's suspension system; 21 mixed carriages with luggage and goods compartments; 14 mixed carriages of first and second-class and goods compartment, and on bogies; 8 mixed carriages of first and second class, on bogies; 10 carriages of second class, on bogies.

The 1780 vehicles are subdivided as follows:—140 luggage vans; 76 closed goods wagons of 5 tons; 188 ditto of 10 tons; 128 wagons with raised frames of 5 tons; 1018 ditto of 10 tons; 70 flat wagons of 5 tons; 151 ditto of 10 tons; 2 trucks to carry normal gauge line material; 1 truck of 20 tons for the transport of stones; besides three cranes and three cisterns.

Permanent way.—The narrow-gauge lines can be divided in three types: (1) Lines laid on the road sides; (2) lines laid across country roads, having, therefore, independent platform; (3) paved lines across towns. (1) Lines on road sides: The Société Nationale has adopted the Vignoles steel rail, weighing 21·5 kilos. (47·30 lb.) per lineal metre (3ft. $3\frac{3}{8}$in.), corresponding to about 43·25 lb. per yard. The sleepers are of oak, are creosoted, and of the following dimensions:—1·80 m. (5ft. $10\frac{7}{8}$in.) long, and 20 cm. ($7\frac{7}{8}$in.) wide, and 10 cm. ($3\frac{15}{16}$in.) deep, or 24 cm. ($9\frac{7}{16}$in.) wide, and 12 cm. ($4\frac{23}{32}$in.) deep, according to their being of rectangular or half-round shape. The rails are 9 m. (29ft. $6\frac{5}{16}$in.) long, and are supported on a straight line by ten sleepers, placed as represented in Fig. 1. Each sleeper is provided with an iron bearing or sole-plate to support the rail—as shown in Figs. 1 to 4—weighing 1 kilo. (2·2 lb.) each. Those sole or bearing plates were at the beginning only used at the rail joints; experience, however, had shown that it was preferable to use them on all sleepers. In curves, one sleeper more is used per rail-length. On the straight line, and in curves of more than 100 m. (328ft. 1in.) radius, the rail joints are unsupported. The short rail used on the inside of curves of 100 m. and more is of such a length that the number of 9 m. (29ft. $6\frac{5}{16}$ in.) rails used is exactly the same as the number of 9 m. rails used for the outside of the curve. For curves of smaller radius ordinary rails are used inside, the beginning and the end of the curve being filled up with odd pieces of rails, called stopping, filling up, or packing-piece rails; great care is taken, however, to break joint. The rails are connected by means of strong fish-plates shaped like angle irons; each pair, exclusive of bolts, weighing 10 kilos. (22 lb.), as represented in Fig. 2 to 4. The smallest radius adopted by the Société Nationale is 30 m. (98ft. $5\frac{1}{16}$in.), which is only used in very exceptional cases, when, through local conditions, it cannot be prevented. Circumstances compelling the Société Nationale to adopt such small curves occur mostly in passing through towns or agglomerations of industrial establishments. In the country or on open roads, where the lines are laid on independent platforms, the radius of the curves is never less than 75 m. (246ft. $0\frac{3}{4}$in.). On account of the great number of curves of small radius the Société Nationale has been particularly engaged with the study of laying out curves, and has issued a special circular on the subject, giving the necessary formulæ, designs, and methods by which to proceed. In general, the instruction contained in the circular is, that the elevation of the outer rail is to be obtained according to circumstances, either by raising the outer rail or by lowering the inner rail, or by following a mixed combination of raising the outer rail half of the elevation required and lowering the inner rail the other half, so that the centre line of the permanent way conserves exactly the necessary longitudinal elevation of the line. This last method is recommended as the best. The whole development of a curve of the same radius must have the same rise throughout. This elevation must be gained without any sharp or abrupt transition of gradients or inclines, and must be effected by gradual levelling. To obtain the rise gradually it is necessary to insert an adjusting curve between the straight line and the curve of the permanent way, which starts and finishes the rise, and of which the radius of curvature in each point corresponds to the elevation at this point. This adjusting curve is a parabolic curve, half of which is distributed on each side of the tangential point. The amount of rise to be given in the curves depends on the maximum speed of the trains. This is fixed at 30 kiloms. (18·6 miles) per hour in the country, and 10 kiloms. (6·2 miles) per hour in town, and can only be altered by special authorisation. In the country the curves will generally have a radius of at least 100 m. (328ft. 1in.) If for special reasons the radius of these curves is less than 100 m., a special signal post, painted a green or blue colour, is placed on the right-hand side of the line at 30 m. (98ft. 5in.) in advance of the starting point of the curve, to indicate to the driver that the speed when crossing the curve has to be reduced to 20 kiloms. (12·40 miles) per hour. Curves of less than 75 m. (246ft.) radius are not allowed for lines of a normal gauge of 1·435 m. (4ft. $8\frac{1}{2}$in.). For lines of 1·067 m. (3ft. 6in.) gauge, or of 1 m. (3ft. $3\frac{3}{8}$in.) gauge, curves of less than 50 m. (164ft. $0\frac{1}{4}$in.) radius are not allowed, except in towns and in special cases, as at the approach of a station or of a swing bridge, or at dangerous points, which compel either the slackening of speed or the stopping of the train. In towns or centres of industrial establishments, factories, &c., the smallest radius of curves for permanent way of reduced sections is not to be less than 30 m. (98ft. 5in.).

To determine the elevation of the outer rail, in the curves the Société Nationale has adopted the formulæ

$$S = \frac{l\,V^2}{g\,R}, \text{ in which}$$

l = gauge; V = maximum train speed per second.
g = force of gravity per second = 9·8088 m. (about 32ft. $2\frac{1}{8}$in.)
R = radius of curve.

The parabolic curve is the curve adopted as the line forming the union between the straight and the bend of the outer rail. The formulæ used for setting out this parabolic curve are as follows:—The length of the parabolic curve $p = \frac{P}{R}$, where

P = varying parameter,
R = radius of circle,

from which follows, that the positions of the tangential point T_0 of the straight line with the parabola

$$T = \tfrac{1}{2} P.$$

The tangential points T are exposed to a lateral displacement $T\,T^1$, given by the formulæ

$$T\,T^1 = \frac{P^2}{24\,R}$$

whereby the calculation proves that the centre of $T\,T^1$ is a third point of the parabola, while other points of the parabolic curve are obtained by the formulæ

$$y = \frac{1}{6\,P}\,x^3, \text{ whereby}$$

x = abscissa, reckoned from the new tangential point;
y = ordinate; while the radius of curvature p^1 of each point of the parabola is given by the formulæ

$$p^1 = \frac{P}{x}.$$

However, to facilitate the operations of setting out, standard tables are given to that effect, indicating the parabolic unions for all the radii generally in use.

In determining the elevation of the outer rail by means of the above formulæ, $S = \frac{l\,v^2}{g\,R}$, it is necessary, by adopting a value for v, to take into consideration the slow speed which is fixed for sharp curves of small radius, as otherwise the rise of the outer rail would be of such an exaggerated height, which no public authority would allow, especially in traversing towns or manufacturing centres. The Société Nationale has further decided not to allow any increase of gauge or widening of the permanent way in curves which are *not* below 50 m. (164ft. $\frac{1}{4}$in.) radius.

For the type of locomotives used on the society's lines the following clearance or excess in gauge is only allowed:—

In curves of	30 m. (98ft. 5in.) radius ...	0·01 cm. ($\frac{3}{8}$in.)
Ditto	35 m. (114f. 10in.) radius ...	0·007 mm. ($\frac{1}{4}$in.)
Ditto	40 m. (131ft. $2\frac{13}{16}$in.) radius	0·005 mm. ($\frac{3}{16}$in.)
Ditto	45m. (147ft. $7\frac{5}{8}$in.) radius ...	0·003 mm. ($\frac{1}{8}$in.)

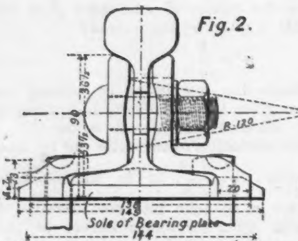
The cross section of the permanent way varies according to the width of the roadside at disposal, as shown in Figs. 5 and 6. The line is bordered, dividing it off the road by a range of raised kerbstones, each of which is about 40 to 50 cm. ($15\frac{3}{4}$in. to 20in.) long, 30 to 40 cm. ($11\frac{3}{4}$in. to 15in.) high, and 13 cm. ($5\frac{1}{8}$in.) thick. This border permits the raised line to be kept dry and in a good state of preservation, preventing carts or other vehicles running it, to damage the permanent way, and to come in contact with the trains. As far as practically possible, these border stones are set against the road pavement, so that they touch each other, as seen in Figs. 5 and 6; but this method has sometimes to be abandoned, as either the roads do not go exactly parallel to the axis of the line or the roadside becomes too wide to be completely occupied by the platform or paved part of the line. In the case where the contact between the two borders cannot be maintained, some inconvenience will be experienced through the cart-wheels getting in the free and soft space left between the two borders, namely, the kerbstones of the line and the paving stones of the road. If the border stones do not run rigorously parallel the soft space left between them is then generally not very wide, and it can be filled up with small stones, gravel, &c. If, however, the cross section of the line is limited to a certain size, and a certain zone or part of the roadside has to be kept free, say, for example, of 50 cm. ($19\frac{3}{4}$in.) width, then the above-mentioned defect can only be remedied by paving the full width of the free space left between the two borders. The paving of such a width as given above would cause an additional expense of about 3000f. per kilometre (or about £193 10s. per mile).

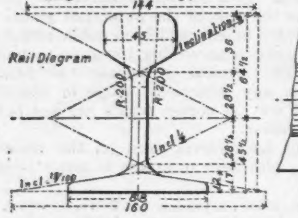
To prevent the raised border or kerbstones from causing the water to collect on the road, a free space of 10 cm. (about 4in.) is left between two border stones wherever required, corresponding to a similar open channel dug out across the line, thus allowing all the water to flow freely into the road channel. Different other systems, but all very expensive, were brought forward and highly recommended as efficient means of preventing the kerbstone being the cause of the paving which is inclined towards the line not drying. None of these methods have given more effective results than the system used by the Société Nationale. It is simple, practical, and efficient, and requires only that the drains of the line shall be properly maintained and cleaned. This system of open transverse drains has been criticised. It is reproached with not giving the same facility to pedestrians to walk along the roadside of the line. The objection is not altogether unfounded, but considering the result obtained by this system, it is recommended. Besides, it is better, and in the interest of public safety, to keep pedestrians off the roadside occupied by a railway line. The use of raised borders or kerbstones influences sensibly the cost price of the narrow gauge lines laid along road sides; its cost varies from 1500f. to 3500f. (from £60 to £140) per kilometre, equivalent to £96·77 to £225·8 per mile, according to the distance of the quarries from the place where the stones are to be used, and the quality of the stones. The high value adopted as bending moment of the rails has permitted to modify the distance formerly adopted, between the sleepers of the $21\frac{1}{2}$ kilos. (47·3 lb.) rail. They are eight for a bay of 9 m. (29ft. $6\frac{5}{16}$in.). The method of laying the rails is shown in Figs. 1 and 7. The great depth of the 30 kilos. (66 lb.) rail requires the permanent way to be connected by metal cross stays or ties, represented in Figs. 7 to 10. The only modification in the cross section of the permanent way with 30 kilos. rail consists in laying somewhat more ballast on the line, on account of the great difference in height of the two types of rails. By joining the permanent way of $21\frac{1}{2}$ kilos. rail with one of 30 kilos. rail, the joint is made by means of a special fish-plate composed of one-half of each type welded together, called a compound fish-plate, fixed to each side of the rail, as shown in Figs. 11 to 13. The use of the $21\frac{1}{2}$ kilos. rail in combination with the 30 kilos. rail is caused by the former lighter rail being used on the country road, while the latter heavier rail is used in town, where pavement occurs. The consequence is, where both rails meet a joint had to be provided, which led to the above combination of a compound fish-plate. Figs. 20 and 21 also show how the use of both kinds of rails occurs. For lines established in centres of metallurgical industries, the Société Nationale have brought

THE PERMANENT WAY OF BELGIAN LIGHT RAILWAYS

(For description see page 361)

Fig. 2.


Sole of Bearing plate
90
144
R. 120


Rail Diagram
45
Inclination
R 200
R 300
Incl. 1/20
88
160

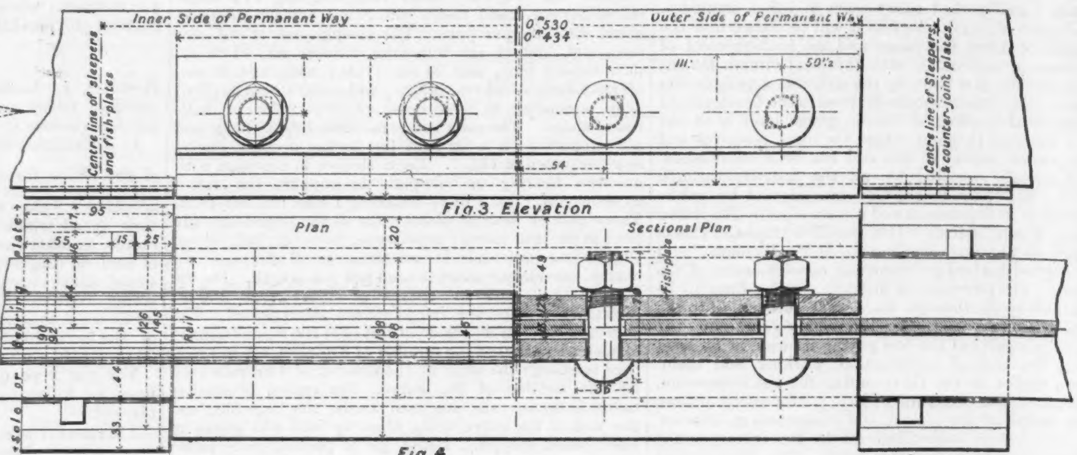

Inner Side of Permanent Way
0m 530
0m 434
Outer Side of Permanent Way
Centre line of sleepers and fish-plates
Centre line of Sleepers & counter-joint plates
111
50½
54
95
55
15
25
Sole or Bearing plate
Plan
Sectional Plan
Rail
Fish-plate
120
138
90
45
36

Fig. 3. Elevation

Fig. 1.

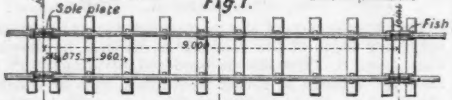

Line on road side
Sole plate
1 Meter Gauge
Line on pavement
Fish plate
Joint
.875
.960
9.000

Fig. 4.

Fig. 5.

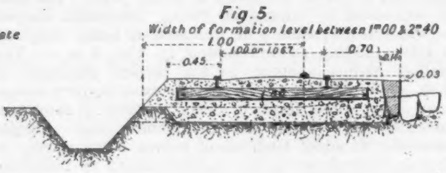

Width of formation level between 1m 00 & 2m 40
1.00
1.00 or 1.067
0.45
0.70
0.03

Fig. 6.

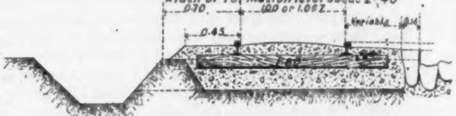

Width of formation level about 2m 40
0.70
1.00 or 1.067
0.45
Variable

Fig. 7

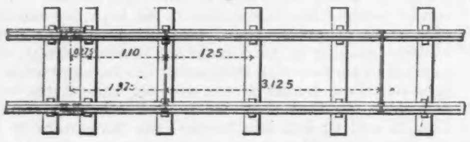

.875
1.10
1.25
1.375
3.125

Fig. 8.

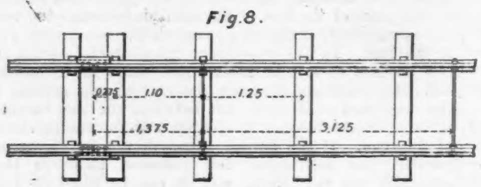

.875
1.10
1.25
1.375
3.125

Fig. 9.

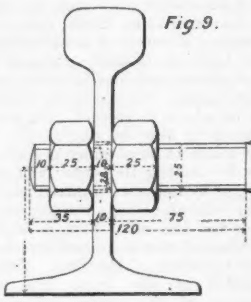

10
25
18
25
35
10
75
120

Fig. 11.

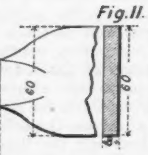


Fig. 16.

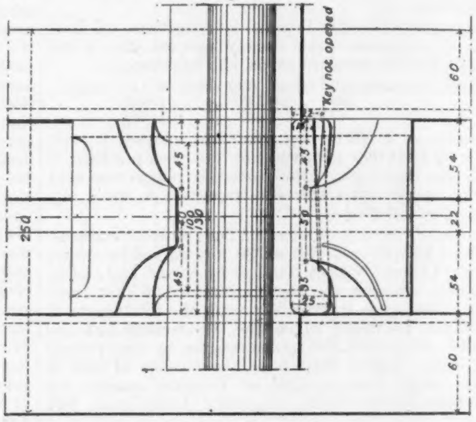

Key not opened
60
54
22
54
60
250
45
100
130
45

Fig. 14.

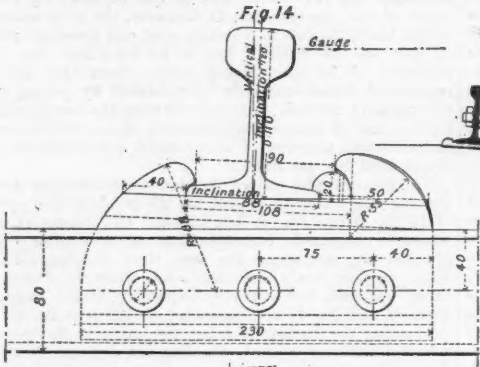

Gauge
Vertical
Inclination 1/20
0.110
Inclination
90
40
108
50
75
40
40
80
230

Fig. 10.

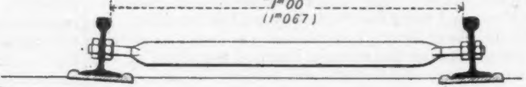


Fig. 15.

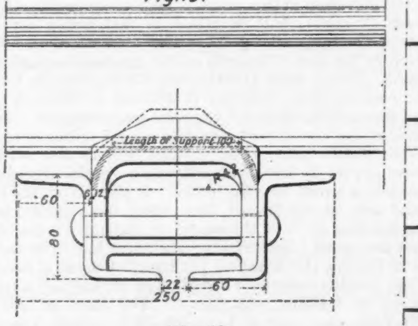

Length of support 100
60
80
22
60
250

Fig. 19.

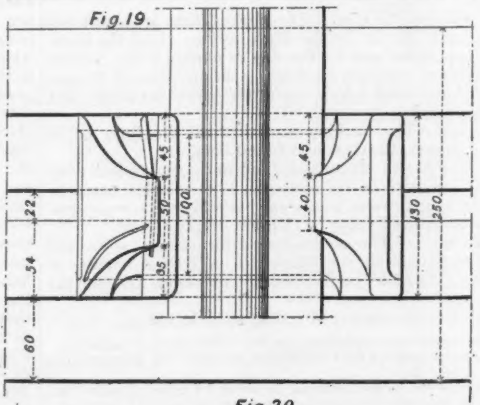

45
100
30
22
54
60
130
250

Fig. 17.

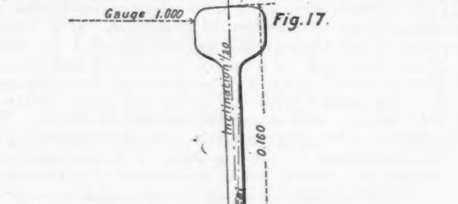

Gauge 1.000
Inclination 1/20
0.160
Vertical
Inclination 1/20
45
32
40
130
110
40
230
75
40
80

Fig. 18.

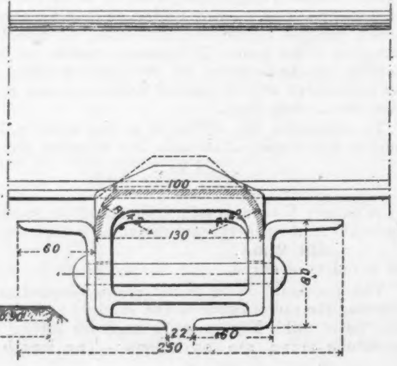

100
130
60
80
22
60
250

Fig. 20.

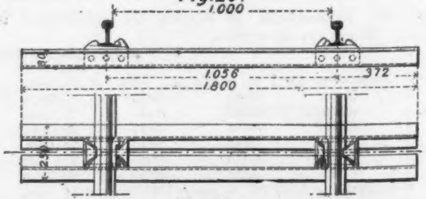

1.000
1.056
1.800
372

Fig. 21.

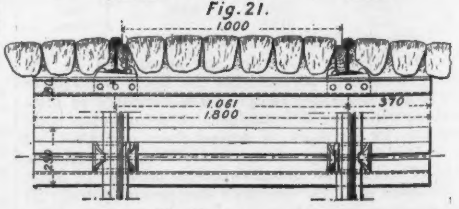
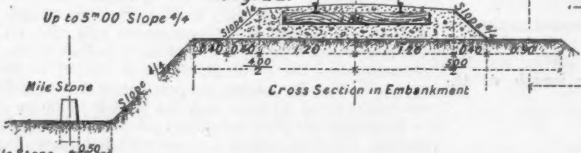

1.000
1.061
1.800
370

Fig. 22.


Up to 5m 00 Slope 4/4
1.00 or 1.067
Slope 4/4
Slope 1/1
0.40
0.40
1.20
1.20
0.40
0.90
2.00
4.00
Mile Stone

Cross Section in Embankment

Fig. 23.

Cross Section in Cutting

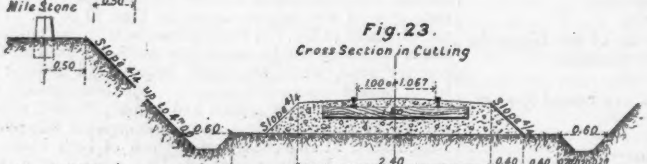

Mile Stone
0.50
0.50
Slope 4/4 up to 4m 00
1.00 or 1.067
Slope 4/4
0.60
2.40
4.00
0.40
0.60

Fig. 12.

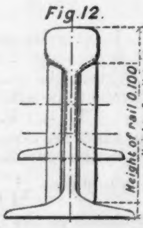
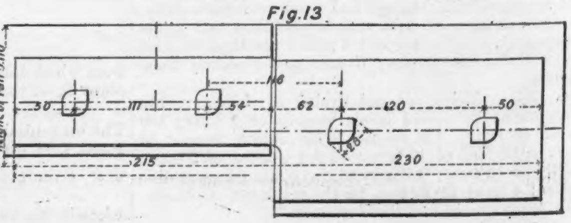

Height of rail 0.100
Height of rail 0.110

Fig. 13


30
111
54
116
62
120
50
215
230

"THE ENGINEER"

SWAIN ENG.

out and use very largely metallic sleepers of the Z form, as represented in Figs. 14 to 21. These sleepers have proved after long experience to be very good, and it is only their comparatively high price, in comparison to the present price of wooden sleepers, which prevents their general adoption. Some experiments, but not of a very extensive character, were also made with other systems of metallic sleepers, and of other special arrangements as to fixing the rail to the sleeper with no better, but rather inferior results. Figs. 14 to 16 represent the type A of the metallic Z sleepers—shown in Fig. 20—which is used up-country along road sides where there is no pavement, while Figs. 17 to 19 and Fig. 21 represent the type of metallic Z sleepers for paved roads. Fig. 16 and Fig. 19 show also in plan for both types the arrangement of the split pin, or rather split key, for fixing the rail. As will be seen from plan—Fig. 16—the closed key is driven in first and opened out afterwards, to grip the rail and have firm hold of it.

Ballast.—Some of the narrow-gauge or vicinal lines are ballasted with gravel or small broken stones, but these are exceptions, as the greater part of them, on economical grounds, are ballasted with cinders from large factories. There is under the sleeper at least a thickness of 20 cm. (7⅞in.) of ballast, which for permanent way laid along the roadside is raised flush to the top level of the rail, while for lines laid on independent platforms it is raised to the top level of the rail, along the centre line of the railway only.

(2) *Permanent way on independent tracks.*—The permanent way is laid on independent tracks in the following cases:—For lines in hilly countries leading to a main line of railways, or when the roads, which the narrow-gauge line has to follow, are—as seen in plan—of so many sharp curves and pronounced bends that they could not be properly adapted for a small railway line, or if they present steeper gradients than the limit allows. The independent formation becomes also necessary when the roads are too small. In this case, however, a wider area or zone of the roadway is taken for the establishment of the line. Gradients: The limit of steepness admitted by the Société Nationale is 3 cm. per metre—or about 1 in 33. This very steep gradient extends on some lines without interruption over several kilometres. Under exceptional circumstances still steeper gradients, but for very short distances only, were admitted reaching 6 cm. per metre—or about 1 in 17; but these special cases only occur in crossing towns or industrial centres. In Figs. 22 to 24 are represented the types of transverse sections followed for lines established on independent formation. There is no special arrangement which would distinguish them from the formation of ordinary railway lines, except that they are of smaller size. Fig. 22, however, shows the line established on embankment; while Fig. 23 shows the type of cross section of the line on cutting. The reduction in size does, of course, not apply to the formation of the slopes or to the cuttings or embankments.

(3) *Paved lines.*—The line is principally paved in traversing towns or industrial centres; while along the line pavements are laid at level crossings, communal passages leading to main roads and passages of private properties, or along industrial establishments situated in front of the road. As to the paving of any passages leading to private property, the Société Nationale was guided by the principle that a narrow gauge railway, making use of the roadside of a public highway, should offer them the same facilities of access to the public road as they had before the establishment of the railway. But, on the other hand, the Société Nationale considers that it is not obliged to put down pavements at their expense across the line or along industrial establishments, when such necessities arise, after the line has been established. In such cases the necessary work to gain access to the road should be carried out at the expense of the proprietor interested to get the passage, and only after he has received the necessary permission from the proper authorities to establish such level crossing. The raised border or kerbstone is broken off at all paved level crossings, but so that it is on both sides slanting down to the level of the passage. More often when the line is paved there is no kerbstone used. The repairs and maintenance of the pavement of the permanent way is a very serious item in the cost of the line. The principal cause of these nearly permanent repairs is the use of such big paving stones as those used by all public authorities in Belgium. The sample mostly used measures 14 to 16 cm. (5½in. to 6¼in.) at the head and at least 14 cm. (5½in.) at the bottom. It will easily be seen that it is impossible to raise the rail so much above the sleeper as to prevent the seat of the paving stone from receiving the effects of the vibrations produced by the passing train. (See Figs. 25, 26, 29, and 30.) These vibrations produce, especially at the beginning of the working of the line, the loosening of the paving stones laid above the sleepers, especially if there is no great and heavy traffic passing over the road. To minimise this injurious effect it is well to select shorter paving stones, or even if such cannot be obtained, to shorten the longer ones. For permanent way laid in pavement the 21·5 kilos. (47·3 lb.) rail is used, seated on cast iron shoes, which are fixed to the sleeper, as represented in Figs. 25 to 28.

Fig. 27

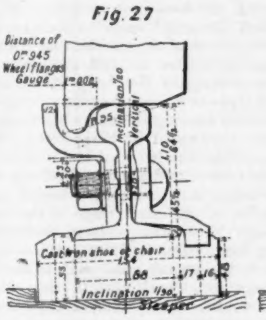


Fig. 28.

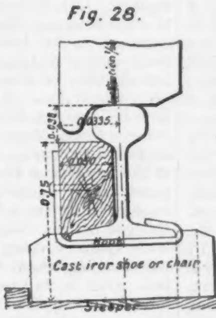


Fig. 29.

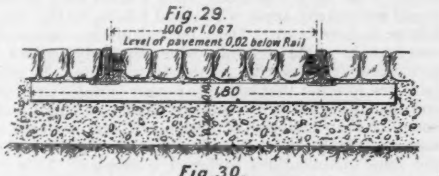


Fig. 30.

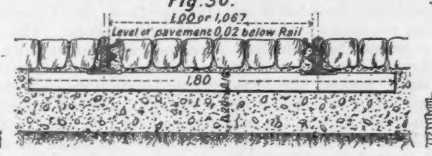


Fig. 31.

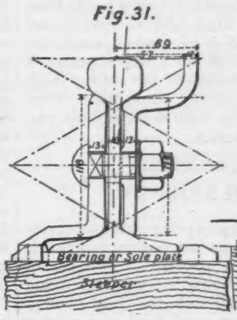
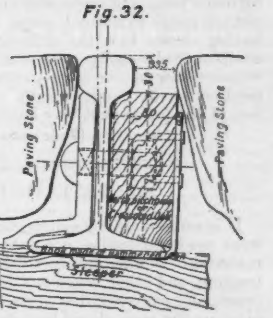


Fig. 32.



More generally, and especially in traversing towns or manufacturing or other industrial centres, the 30 kilos. (66 lb.) rail is used, which is directly placed on the sleeper by means of the usual intermediate sole or bearing plate, as shown in Figs. 30 and 31. To prevent the head of the rail coming in contact with the paving stones where the ordinary traffic runs, and to form a groove for the reception of the wheel flanges of the railway vehicles, two methods have been adopted. The one consists in placing against the rail a wooden distance piece or wooden curb, which is firmly held against the rail by means of an iron plate, one end of which is bent over the foot or bottom member of the rail, thus forming a hook, while its other end is screwed on to the wooden curb—as shown in Figs. 25, 28, 29, and 32. The wooden curb is thus fastened to the rail without drilling the latter. The other method consists in riveting or bolting to the rail a counter or guard rail, bent into angle iron shape, of which one end is fixed to the web of the rail, while the other end leaning against the pavement is bent into a curved shape, forming the groove to receive the flange of the wheel—as shown in Figs. 26, 27, 30, and 31. This shape is called the bayonet-rail, The part fixed to the rail is so arranged to be able to serve as fish-plate also; whereby, however, care is taken that its projection beyond the rail is equal to half the size of an ordinary fish-plate, and to use it at the other end only of the same length of a half fish-plate. In curves of less than 50 m. (164ft. ½in.) radius for the outside rail the guard or bayonet-rail is replaced by using the wood key for the formation of the groove, in which case, however, a stronger wood key is used, as on the ordinary line. This precaution is taken to prevent the wheel-flange getting wedged in the groove.

For the inner rail the grooved bayonet or counter rail is used throughout, serving as a guard rail at the same time. As the groove is, however, only 35 mm. (1⅜in.) wide, for curves of minimum radius, the bayonet rail is substituted, and the groove formed by means of an ordinary rail, which is bolted to the main rail of the line; while, on the other hand, cast iron distance pieces are inserted between them, thus maintaining the width of the groove. The paving between the rails is made of sets transversal to the direction of the line, and the paving stones in contact with the rails are alternately headers and ordinary paving stones, so as to form cross-joints without using half paving stones. On the outer side of the line the paving stones in contact with the rails are also alternately headers and ordinary paving stones. As will be seen hereafter when dealing with the cost price of the different kind of permanent way, the cost price of paved lines provided with guard rails forming a metallic groove is far higher than the one formed with wooden curbs; the former, however, looks better, stands better, gives a better pavement, and should preferably be used, especially in important towns and industrial centres. Metallic grooves naturally last longer, while those formed of wooden curbs, lasting only a very limited time, would oftener cause the lifting of the rails for repairs and maintenance, and thus increase the cost.

Fig. 24.

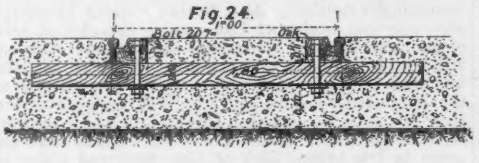


Fig. 25.

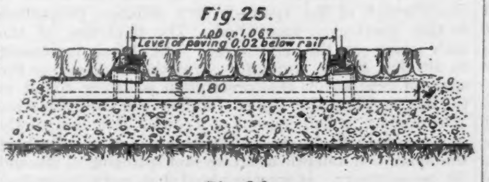
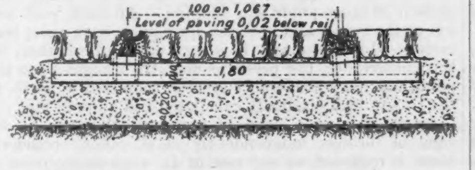


Fig. 26.



The cost price of the different kinds of permanent ways laid since 1888 summarises as follows:—

(*a*) Line laid on independent formation with 21½ kilos. (47·3 lb.) rail, 12,286f. per kilometre, or about £792 13s. per mile, as represented in Figs. 22 and 23.

(*b*) Line laid on road side, with same rail and raised border or kerbstone, 15,136f. per kilometre, or about £976 10s. per mile, as represented in Figs. 5 and 6.

(*c*) Line laid with old pavement, same rail of 21½ kilos., with groove formed by wood key, 17,173f. per kilometre, or about £1108 per mile.

(*d*) Line laid with old pavement and with 30 kilos. (66 lb.) rail, with groove formed by wood key, 18,478f. per kilometre, or about £1192 per mile.

(*e*) Line laid with old pavement and with 21½ kilos. rail, with groove formed of bent guard rail, 21,643f. per kilometre, or about £1396 6s. per mile.

(*f*) Line laid with old pavement, with 30 kilos. rail, with groove formed of bent guard rail, 23,124f. per kilometre, or about £1492 per mile.

(*g*) Line laid with new paving, with 21½ kilos. rail, with groove formed by wooden key, as represented in Fig. 25, 29,173f. per kilometre, or about £1882 per mile.

(*h*) Line laid with new paving, with 30 kilos. rail, with groove formed of wooden key, as represented in Fig. 29, 30,478f. per kilometre, or about £1966 per mile.

(*i*) Line laid with new paving, with 21½ kilos. rail, with groove formed of bent guard rail, as represented in Fig. 26, 33,643f. per kilometre, or about £2170 per mile.

(*j*) Line laid with new paving, with 30 kilos. rail, with groove formed of bent guard rail, as represented in Fig. 30, 35,124f. per kilometre, or about £2266 per mile.

Some apprehension has been felt in this country, in reference to the use of the narrow gauge permanent way, on account of the junction with the normal gauge of the main lines and the transhipment of goods, especially so in case of large farming districts, where farmers could on their farms only profitably use portable railways, with the corresponding rolling stock. This, again, would require some arrangement at the junction of the portable railway with the narrow gauge line for the transhipment and transport of market produce. This difficulty would, however, not occur in traversing manufacturing or other industrial centres. Other countries besides Belgium have dealt with this point and solved it in the best practical way, as the local conditions permitted. In France, the late M. Banderali, engineer-in-chief of the traction material of the Northern of France Railway, with whom the writer had some intercourse concerning steam tram service, and in connection with M. Sartiaux, also engineer of the Great Northern of France, have thoroughly considered the subject, and practically experimented with reference to some narrow gauge feeders of their main lines. These engineers considered the transhipment of goods for the time as the most practical and cheapest method. They reserved for this purpose special lines for loading and unloading in the goods-station yard. All the loaded wagons of the normal gauge line which were to be emptied into those of the narrow gauge were placed on a special line reserved for them, and reciprocally so the wagons of the narrow gauge line. These lines were specially reserved for the transhipment service alone, and were provided with all the necessary implements and material which the transhipment required, according to the nature of the goods. With proper disposition and a well organised service the cost of transhipment, according to the nature of the goods, varied from 2d. to 3d. per ton, and in exceptional cases only reached about 4d. For light goods requiring careful handling the narrow gauge line was raised so that the platforms of both goods wagons were level, and thus the goods were easily carried or shifted from one platform of the goods wagon to the other.

For goods of great bulk, as timber, stones, &c., movable cranes across the normal gauge were used for their transhipment either way. For lighter goods and of smaller size the unloading is effected by having the narrow gauge line on a lower level than the normal gauge, and unloading the heavier wagons of the normal line into those of the narrow gauge by means of iron plates laid from the floor of the high level normal gauge wagons down on the floor of the low level narrow gauge wagons, and over which the goods are made to slide. In the reverse case of loading from the low level narrow gauge into the high level normal gauge wagon, the narrow gauge line leads by means of a gradient to the level of the normal gauge, so that the floors of both wagons are on the same level. The loading is done from end to end of wagon, whereby corresponding sidings are so arranged that the loaded wagons of the normal gauge and the empty wagons of the narrow gauge are respectively shunted in the corresponding sidings, until the transhipment is done. The empties are sent back as empty train on the narrow gauge line, while the loaded goods wagons of the normal gauge are sent as loaded train to destination. It is only a matter of careful selection of sidings placed on different levels according to requirements, to effect the transhipment. These are principally the methods used in France. Some different methods besides these are used in Germany. The transhipment is not only effected by the unloading of the goods, but also by lifting the fully-loaded body of the goods wagon off the axle and wheel frame, by means of overhead travelling cranes. These are erected in the goods yard over the lines, spanning both lines at the same time. The traveller crosses from one line to the other, lifting and lowering the full-loaded body on to the wheel frame of one line to the other. This method is considered the most practical for breakable goods.

Another method is the following:—The narrow gauge line is laid between and in the centre of the normal gauge for such length as the loading operations require; and about 1ft. higher than the level of the normal gauge. A short-wheeled truck or cradle of the normal gauge is run into position under each of the axles of the narrow gauge wagon; both are then moved forward together to a short incline of, say, 1 : 10, where the rails of the normal gauge drop somewhere about 1in. or 2in.; this causes the axles of the narrow gauge wagon to get seated on the normal gauge cradles to which they are then firmly fixed. The wheel base of the cradles is about 3ft. The cradles carry a cross-beam, which is pivoted and bent downwards to get hold of the wheel flanges of the narrow gauge wagon, which supports them and prevents any damage to the wheels. A similar arrangement is made by reversing the system, to carry normal gauge goods wagons on narrow gauge lines. For large agricultural districts especially a somewhat similar arrangement is introduced by Oernstein and Koppel, contractors, of Berlin, by transporting farm carts used on ordinary roads, loaded or unloaded, on the portable railways used on farms, doing at one and the same time, as stated, the work of eight farm carts. They also use cradles, which are, however, provided with blocks, in which the carts get seated—as shown in Figs. 33 to 35. The cradles are made strong enough to run also on corresponding narrow gauge lines, from where the loaded carts could also be directly transhipped to wheeled frames of the normal gauge. It would thus be a continuous uninterrupted transport of the wagons up to destination without any previous unloading of goods, which would thus be preserved from any damage, and the whole transport would be effected at very moderate cost.

Having herewith recorded the different methods used in those countries where light railways are fully developed for many years and successfully used to forward goods from narrow gauge to normal gauge lines, and *vice versâ*, and having shown how the difficulties of transhipment are comparatively easily overcome at no great expense, it remains now to give some particulars of the rolling stock used on narrow gauge or light railway lines, the particulars of the permanent way having been described above.

(*To be continued.*)

CONCRETE ARCH BRIDGES.

It is some years since energetic and persevering attempts were made to utilise concrete as an ordinary building material. Numerous methods, processes, systems of framing, and other ingenious devices, were patented and practically experimented upon, all with the view of supplanting the ancient and time-honoured brick-and-mortar mode of construction. These laudable endeavours were, it is true, made more in the interest of the architect and builder than of the engineer, for the promoters of the new *régime* directed their attention chiefly to the employment of concrete as a suitable material for building ordinary dwelling-houses, warehouses, and similar structures. They left the great part, and for which it is pre-eminently suited, to be developed by the skill and care of the engineer, to whom it may be said to be now, especially in the matter of foundations, his sheet anchor. Although some habitable dwellings were erected of concrete, it is only necessary to give a glance at any building operations of the present day to demonstrate that, as a rule, the attempts to which we have referred were a failure. It is not far to seek for the causes of their want of success. Some are of a theoretical, others of a practical, character. In the first place, it was a troublesome and comparatively expensive job to put a good surface both inside and outside on the walls themselves. The frames, whether of timber or iron—for both descriptions of material were used—left deep scores, small furrows, and rough excrescences of all kinds, which demanded a liberal use of cement, trowel, and labour to eradicate. But the fundamental error in these attempts was in endeavouring to employ the material in positions and under conditions for which it was not adapted. Concrete, however perfect its mixing, consistency, and the incorporation of its ingredients may be, does not possess the bond of brickwork. Hence it is not to be wondered at, that the attempt to assimilate, as nearly as might be, the thickness of lofty walls of houses built of concrete to those of brickwork, should eventuate a failure. Concrete planks do not constitute an advantageous form in which to use that material either vertically or horizontally.

The value of concrete, in fact its very *raison d'être*, consists in its mass, in its weight. It is thus an excellent material for the construction of large and heavy massive works of all descriptions, such as retaining walls, docks, harbours, and breakwaters, where polish or beauty of surface is not an indispensable requirement. As an example of its unrivalled utility on a scale of magnitude, witness the mammoth blocks, over three hundred and fifty tons in weight, forming the north wall of the harbour of Dublin. It must be admitted that large blocks have been displaced by the action of storms, as at Madras, but it was simply because they were not large and heavy enough. Instances are not wanting, although they are by no means frequent, in which concrete has become cracked, fissured and disintegrated even when placed under the most favourable conditions, that is when deposited *en bloc*. A notable example was afforded shortly after the completion of the works of the Alexandra graving dock, Belfast, about six years ago. An investigation of the cause of the failure partially exonerated the material itself from blame. The concrete could not, or at any rate did not stand the continual flux and reflux of salt water heavily charged with magnesia. It was alleged that the magnesia, by a very ordinary chemical reaction, abstracted the lime out of the Portland cement, and so brought about the misfortune. At the same time there are an abundance of dock walls which have stood uninjured this action for years.

A high resistance to stresses of a compressive character, a cheap and expeditious process of manufacture, combined with an opportunity of using it under the most favourable circumstances, seems to indicate concrete as exceedingly well adapted to the construction of arches. It has been so utilised for the smaller specimens of arches, such as culverts, sewers and pipes, for many years, but it is only recently that it has been so applied to works of that class having any pretensions to magnitude. The delay may have been occasioned by the absence of experimental or empirical data respecting the absolute strength of the material when exposed to the action of a strong thrust. This, however, was not altogether owing to the entire absence of all such data, but to the fact that the experiments had been conducted on such a very limited scale as to furnish but very imperfect information respecting what the results might be when it became a question of building an arch of large span. Many of the early experiments were conducted with concrete arched ribs of a span of only 3ft., and a depth and width at the crown of 2in. respectively, thus giving a gross sectional area of four square inches, which was slightly increased towards the springings. Subsequently the span was increased to 10ft., but this dimension would be but a poor specimen upon which to base data for the strength of a similar structure over 100ft. in span. This was the fault of nearly all the earlier experimentalists, although they can hardly be blamed for it, considering the very rude and inefficient apparatus and machinery they had at their disposal, compared with the splendid and highly-finished instruments now in common use. The fault to which we allude was not so much the limited scale upon which the experiments were conducted, as the erroneous conclusions deduced from them. It was a serious error to suppose that a constant derived from an experiment, however carefully conducted, upon a small arch or beam, would necessarily apply with equal fidelity to the case of a large arch or beam. Data for calculation obtained in this manner would certainly, when similarly applied, not give correct results with respect to concrete. It should be borne in mind that concrete is very variable in quality; and that though it is not difficult to make a small arch or beam of that material of fairly good and uniform consistency, yet there is considerable difficulty in ensuring the same qualifications in larger examples. As a rule, constants deduced from experiments on small specimens are too high for those of greater dimensions. The early experiments made upon pine and other woods fully confirm this statement. Again, in the experiments with the small arches, the testing to destruction was effected by weighting the arch at the crown only, and the tendency of the haunches to lift was counteracted by loading them. These conditions do not fairly represent those occurring in actual practice, and the coefficients deduced from them require modification.

A step, although a small one, was made in the application of concrete to the building of arch bridges, by the erection of the first of that type in the United States. It was a road bridge over a creek in Philadelphia, and consisted of two spans of 25ft. 6in. each, and a rise of about one-fourth of the span, which is an unusually large ratio in such structures. The depth, 2ft. 6in., of the voussoirs at the crown was also large, as will be seen on comparison with other existing examples. It is possible that as the bridge was the first of its kind in the country, extra precautions were taken to ensure its strength and stability. As a further element of safety, wire nets with meshes of 1¼in., and a diameter of wire of ¼in., were inserted throughout the concrete at every 2ft., both horizontally and vertically. A further advance was made in the same direction by the construction of the compound concrete and iron arch bridge over the river Neutra at Neuhäusel in Hungary, in which thirteen skeleton girders or frames were used. There were six spans in this bridge, each of 55ft. 6in., and a rise of one-fifteenth of the span—a very different proportion to that previously mentioned. The thickness of the arch rings at the crown was but 12in., increasing to 1ft. 6in. at the springings. Another increase in the span of bridges of this description is to be found in the one crossing the Upper Danube near Rechtenstein, Wurtemburg, which consists of a couple of arches wholly of concrete, 75ft. 6in. in span, with a rise of one-ninth of the span, and a depth at crown and springing of 2ft. and 3ft. respectively. It may be noted that, notwithstanding the somewhat insignificant dimensions of this bridge, the system of hinge joints was adopted. An open joint was left at the crown and near the springings, with sheet lead interposed in the joint. It is very doubtful whether, by this contrivance, the pressure actually brought upon the joints was not considerably greater than that of 86 lb. to the square inch originally calculated and allowed for.

As the maximum span of any particular type or design of bridge, independently of all other considerations, is regarded, at any rate in an engineering point of view, as the best "record" until it is surpassed by some other, so the progress of concrete arch bridges advances in proportion to the spans successively achieved. A road bridge at Erbach in Wurtemburg raised the standard or criterion of dimension to 105ft., with the small rise of barely one-eighth and a thickness at the crown of 1ft. 8in. and at the abutments of 2ft. 3in. It should be borne in mind that with a material like concrete, the striking of the arch—always an anxious moment with the engineer and architect—whatever may be the material of which the arch may be built, is attended with more than ordinary risk. The flatter the arch the greater the liability to deformation, which means serious cracks in the material. As a precaution against the occurrence of these cracks in the Erbach bridge, flat asphalte joints were introduced at the crown and springings. A very similar structure in the neighbourhood of Dresden has a still greater span of 114ft., and another over the adjacent river Weisseritz of 142ft. Both these latter are skew bridges, the former with an angle of skew of 18¼ deg., which is one of the sharpest we can call to mind, and increases the span on the square from 56ft. to the dimension already given.

The greatest achievement in the construction of concrete arch bridges appear to have been reached in the erection of the new road bridge over the Danube at Munderkingen, the building of which was commenced just three years ago. The span is 164ft., with a rise of one-tenth of the span, a very safe and judicious proportion, and a depth at the crown of 3¼ft., increasing to 3½ft. at the abutments, which is less than the same ratio of the thicknesses of the arch in the examples previously given. An elaborate system of a dozen iron joints is distributed both at the crown and springings throughout the entire cross section of the arch, which practically divide the arch into two separate and distinct segments so far as the abutments are concerned. It may be stated, in connection with the subject of our article, that some very interesting and valuable experiments have been recently undertaken by the Austrian Association of Engineers and Architects. The researches of the members embrace the question of arches of masonry, of brick, and of concrete. Omitting smaller specimens, their testing and fracture, a concrete arch rib was built with a span of 75ft., a width of 7ft., a rise of one-sixth the span, and a depth at the crown of 1ft. and of 2ft. at the springings. At the end of a couple of months the centres were struck, although, as is usual with arches of stone and brick, they had been previously eased. The arch was then loaded to the breaking point, which was reached with a load of 3½ tons per running foot. So far as the span, rise, and some of the other dimensions of the arch rib thus experimented upon might be relied upon to furnish trustworthy data for calculations for the strength of similar larger structures, there is no objection to be taken; but there is, nevertheless, a great difference between an arch rib and an arch of some ten times its width. A thin rib has little or no lateral rigidity. In a word, it does not possess, or only to a small extent, that element "mass" which has been assumed to be indispensable to enable this valuable constructive material to utilise its full strength. The introduction of wire netting in the body of a concrete arch, which does not appear to be necessary unless the arch be very flat, thereby causing the haunches to spread, belongs to the Monier method of building arches. It is supposed to counteract the tendency of the arch to split at the intrados at the crown, and at the extrados at some point of the haunching, thus bringing a tensile stress upon or near the soffit of the arch rings at the crown. Bridges of this design have been built in Switzerland, with spans varying from 62ft. to 122ft. Whether the wire netting, which is somewhat analogous to the hoop iron used in ordinary brickwork, fulfils the purpose intended, is open to doubt. The principal objections to all compound structures are that, in the first place, it is impossible to be certain that the two distinct materials act together as one, and even if they did, what portions of the total stresses do they each undergo? Secondly, that the bond between the wire and concrete would be worth very little; and thirdly, that chemical action, and consequently corrosion, would be set up between the two materials. There is no evidence from actual experiment, or from bridges which have been built now for some years, that any of these objections possess any validity worth consideration. It has been alleged by some who are haunted by that engineering *bête noire*—contraction and expansion—that the difference in the coefficients of the two substances might lead to cracks and dislocations in the concrete; but having regard to the fact that the two coefficients are exactly equal to six decimal places, we think the remaining difference may be neglected with perfect safety. From the examples we have adduced—and there are many others as well—it may be fairly anticipated that concrete arch bridges have a future before them. Portland cement or its equivalent is now manufactured largely on the Continent and in still more distant localities, and the other ingredients of this useful compound constructive material can be procured almost anywhere.

Royal Institution.—On Tuesday next, April 14th, Professor James Sully will begin a course of three lectures on "Child Study and Education." On Thursday, April 16th, Professor Dewar will begin a course of three lectures on "Recent Chemical Progress;" and on Saturday, April 18th, Professor W. B. Richmond, R.A., will begin a course of three lectures on "The Vault of the Sixtine Chapel." The Friday evening meetings will be resumed on April 17th, when Professor G. Lippmann will deliver a discourse on "Colour Photography."

Society of Arts.—The next course of Cantor Lectures will be delivered by Professor Henry A. Miers, M.A., on Monday evenings, April 13th and 20th, the subject being "Precious Stones." The lecturer will deal with (1) The properties which make precious stones esteemed among minerals; (2) the properties by which precious stones are recognised; (3) the distinction of stones which may be confused, as garnet and ruby, jacynth and cinnamon-stone, zircon and lux sapphire, garnet and olivine, tourmaline and diopside, &c. The lecture will close with some remarks on artificial stones. Mr. James Swinburne will deliver a course of Cantor Lectures on "Applied Electro-Chemistry," on Monday evenings, April 27th, May 4th, 11th, and 18th. The papers arranged for meetings after Easter are:—April 15th, "Early English Organ Writers," by Mr. Burnham Horner; April 22nd, "The Perfected Photochromoscope and its Colour Photographs," by Mr. F. E. Ives; April 29th, "Fruit Drying or Evaporation," by Mr. E. W. Badger. Papers at subsequent meetings will be read by Captain Abney on "Orthochromatic Photography"; by Mr. Hudson Maxim, on "High Explosives and Smokeless Powders"; and by Mr. E. W. Moir, on "Tunnelling by Compressed Air."

THE INSTITUTION OF NAVAL ARCHITECTS.

WE give this week the principal portion of Mr. Stromeyer's paper, read on Thursday week. The original contains a large number of tables, but we do not think their reproduction is necessary; they refer to individual experiments. All those portions of the paper dealing with the principles involved we have reproduced. The discussion which followed was brief, and of little interest. Mr. Schonheyder held that the system proposed was not as good as the method of measuring by a meter or weir. Mr. Milton said that whatever might be thought in other respects, Mr. Stromeyer was at all events the first to suggest a possible method of measuring the great quantity of condensing water used at sea. Mr. Thom held that Mr. Schonheyder had overlooked the circumstance that meters could not be used at sea, and that Mr. Stronmeyer's methods were, as he had proved by personal experience, very accurate.

Mr. Seaton's paper we give in full in another place. It deservedly attracted a good deal of attention, but in many ways the discussion carried those who heard it and are no longer young back to the past—to the old days when steel shafts were first used at sea, and Mr. David Kirkaldy cut more than one broken shaft up and tested and reported upon it. Mr. Milton was quite right when he said that there had been papers written and read on the subject before. He held that this was the first that showed that the cause of so-called mysterious fractures could be révealed by the microscope. He then referred to the work done by Professor Arnold, of the technical school at Sheffield, and by Dr. Sorby. The shaft—the subject of Mr. Seaton's inquiry—appeared to be of very indifferent quality, and yet, curious to say, it had passed severe mechanical tests. Mr. Milton could not agree with the author that boring out a shaft made it stronger by taking away that part of the metal likely to have been badly worked because it was in the centre of the ingot. In some cases the best part of the shaft was inside and the worst outside. Mr. Hall, of Sheffield, did not think this shaft had given exceptionally good results considering its quality. He knew that ingots would pipe, but the piping was of no consequence, because the piped part was cut off the ingot. The sulphur and carbon collected in the pipe, because that part remained fluid longest. As to annealing, good steel could not be spoiled by it, and forgings needed annealing just as much as castings did. As to impurities and their effect, he could assure his hearers that large quantities of sulphur might be in a casting without injuring it. But if the steel casting were put in an annealing furnace it would be ruined, becoming extremely brittle, a fact which bore out Mr. Seaton's statement that it did not do to rely too much on chemical analysis. Mr. Seaton had expressed doubts as to the soundness of the theory of fatigue of metals, but he—Mr. Hall—had read a paper some years ago on "Fractures in Steel Shafts." He referred to cases in which shafts had worked well for years and then broken, and he could only think that fatigue was the cause of failure. He thought that the microscope had a great future before it for investigating steel.

Mr. Thornycroft, after a few complimentary remarks, asked if the microscope had been employed on gun metal, and if so with what results?

Mr. Ellis, of Sir J. Brown and Co., said his company had been using the microscope for the examination of steel for years, and he could bear out what Professor Arnold had said in his report as to its value. Mr. Ellis did not think that Mr. Seaton's pictures need alarm any user of steel, because it must be remembered that, although the pictures were tolerably large, the section of steel which they illustrated was very minute. They were like drops of water in the oxyhydrogen microscope on a screen which showed hideous monsters. There was usually shown at the same time a drop of pure water that comparisons might be drawn; and he suggested that Mr. Seaton should add a section of pure steel such as that shown on a photograph, which he begged those present to examine as a good and fair specimen.

Mr. Manuel, of the P. and O. Steamship Company, said that as it happened that during the last fourteen years they had been using steel shafts and had never broken one, nor found a flaw, he did not propose to begin using a microscope now. However, he had used the microscope himself years ago. In twin-screw shafts the stresses are different from those occurring in single shafts. He had in all put in 110 steel shafts; one of them had run nearly 1,000,000 miles, and was still good. He did not believe in boring out shafts, because they did not break from the inside but from the outside. The microscope only dealt with very small quantities of metal, and he thought it was hardly fair to judge of the quality of a whole shaft from an infinitesimal portion of it.

Mr. Archibald Denny said that Mr. Manuel's shafts did not break because he made them very strong—stronger than Lloyd's or the Board of Trade asked for. He fully believed in boring out shafts. He would like to see all shafts bored out.

Mr. Matthews, of Sheffield, after denouncing the quality of the shaft tested by Mr. Seaton, said that the proper way to make a steel shaft was under the hydraulic press. The hammer might leave a shaft hollow and unsound in the middle, but the squeezer stood no nonsense. The metal had to go together solid. It was the practice of his firm—Messrs. Whitworth and Co.—to anneal a straight forging, turn it in the lathe, and then anneal it again. They produced the collars at the end by upsetting the metal so as to get the fibres running round into the flange from the shaft. He believed in the doctrine of fatigue. Mr. Manuel's shafts did not break because they were all made with the best Swedish iron.

Professor Arnold described at some length the process of getting up specimens for the microscope. He said it reminded him of the washing away of a macadamised road by heavy rain, when the dirt was washed oft and the small stones stood up like nodules. He then endeavoured to give his hearers a notion of what a molecule was like. He thought that intercrystallisation might explain the effects of annealing. As to fatigue of metals he would like to know what the word meant. His notion was that it meant the loosening of the crystals among themselves. Mr. Matthews had spoken of homogeneous metal, but was there such a thing? Certainly steel shafts were not homogeneous, but composed of an intimate mixture of steel and iron particles. The only approach to homogeneous steel had far too much carbon in it to permit its use in a screw shaft.

Mr. Seaton replied on the whole paper; but he had of course very little to add. As a rule, the writer of a paper keeps back nothing; he puts all he knows on the subject into it, and as Mr. Seaton had practically no criticisms to answer, his reply was all the shorter. As to tests, both Lloyd's and the Board of Trade had tested specimens prepared by the steel makers, and not bits cut out of the shaft itself; he would utilise drillings from holes bored in the shaft for testing. In reply to Mr. Thornycroft, he said that he took little interest in testing gun-metal but much in high strength bronze or alloys, by which it was possible to get very light and strong machinery. Mr. Matthews' remarks about the press and the hammer reminded him of the story of the fox who had lost his tail. Everyone knew why Whitworth's used a press. He could assure Mr. Matthews that very excellent shafts were made under the hammer. As for Mr. Manuel's shafts, they were so big and they ran at such slow speeds, that they would probably have stood just as well if they had been made of good cast iron.

Mr. Seaton's paper was followed by that of Mr. Stromeyer, and then came Mr. Kinghorn's paper, given in our last impression. With the evening proceedings we dealt fully last week. It will be remembered that the interest centred in Professor Watkinson's lecture on water-tube boilers.

THE INSTITUTION OF CIVIL ENGINEERS.

THE TAMPICO HARBOUR WORKS MEXICO.

AT the ordinary meeting on Tuesday, the 31st March, Sir Benjamin Baker, K.C.M.G., the president, in the chair, the paper read was on "The Tampico Harbour Works, Mexico," by Dr. E. L. Corthell, M.A., M. Inst. C.E.

The port of Tampico was situated near the mouth of the river Pánuco, which flowed into the Gulf of Mexico at a point about midway between the port of Vera Cruz and the mouth of the Rio Grande. The volume of discharge at high water in the Pánuco was about 150,000 cubic feet per second, and the cross-sectional area of the river between the mouth and Tampico, a distance of seven miles, was about 25,000 square feet. At very high water the slope was 7in. per mile, and the average width about a quarter of a mile; the channel was about 30ft. deep, the 20ft. channel being about 700ft. wide.

The diurnal tides in the Gulf of Mexico, as shown by a diagram giving one year's continuous tidal record, had an average range of about 15in., but at times ranges of between 2ft. and 2½ft. had been observed. The river water was generally clear, but during floods it became fully charged with sediment, about 18 per cent. of which was siliceous material and the remainder clay. The river entered the gulf in a single channel, there being no delta formation; and the bar in the sea had not altered its position for many years. During floods the river by its sedimentary deposits had caused the bar to encroach upon the gulf, but at low water the waves and currents pushed the bar back to its former position. The direction of the currents in the gulf was northerly under the influence of the Gulf Stream, but the prevailing winds formed much more powerful southerly currents, which were effective in removing the bar. The general condition of the bar for seven years previous to the construction of the works was described, the average depth of water on the bar during this period being 9·06ft. Borings into the bar showed generally fine sand to a depth of 20ft. or 22ft., and then clay.

It had been decided to deepen the bar by means of two parallel jetties, placed 1000ft. apart from centre to centre, and extending from the shore into a depth of about 24ft., or a distance of about 6700ft. The Mexican Central Railway Company, by which the works had been constructed, had extended its line from Tampico to the mouth of the river; and a trestle or pile bridge had been built to carry two lines of railway in connection with the railway on shore, and had been extended, by means of an overhead swinging pile-driver, in advance of the work. It was at the shore 8ft., and at the sea end of the jetties 12ft. in the clear above mean high tide; and from it the mattresses had been suspended during construction and were dropped into the sea. The brushwood for the mattresses had been brought to the site by rail or by barges, as was also the stone for sinking the mattresses. The brushwood was inferior to willow, and after sinking the compression amounted to nearly 50 per cent. Heavy limestone, weighing about 170lb. per cubic foot, had been used, the quarry being about 78 miles from the work, on the line of the Mexican Central Railway. The piles were brought from the Gulf ports of the United States, and were of southern pine; those used under the stringers of the trestle were generally creosoted with 12 lb. of oil per cubic foot.

The amount of stone required to sink and hold down the mattresses was much greater than that used for the same purpose at the mouth of the Mississippi on account of the much larger amount of sediment at the latter place. The north jetty particularly was much more exposed to wave forces. At the Mississippi it required only 0·075 cubic yard of stone to one cubic yard of mattress, while on the north jetty at Tampico it required 0·440 cubic yard. Communication between the south and north jetties was maintained by a barge on which rails were laid, and a steam tug. A locomotive was placed on the south side to work the wagons, which were 36ft. long over all, with a capacity of 15 tons each. The total amount of rock used, up to December 31st, 1892, was 373,048 cubic yards, of brush 390,532 cubic yards, and of pine piling 253,347 lineal feet, of which 57,260ft. were creosoted. The total amount of pine timber was 2,018,950ft., board measure.

The severity of the waves rendered it necessary to consolidate the north jetty and the sea end of the south jetty, with an abundance of rock having easy slopes. The rock was entirely of rubble, of a size not exceeding three cubic yards. No dimension stone and no concrete had been used. The crown of the work was laid up with rough stone, and was rounded, and had easy slopes, like that of the jetties used at the mouth of the Maas, in Holland.

The total cost of construction and maintenance up to December 31st, 1894, but including the real estate purchased, the extension of the railway to Tampico, the construction of commercial wharves and docks, interest on bonds and other expenses, was £617,543 6s. 5d.

The development of the channel had been very satisfactory; and was shown by comparative longitudinal profiles and cross-sections. The effects of the work upon the river channel above the jetties were also discussed. The channel had shoaled for a considerable distance, but when the channel through the bar had developed the river channel had deepened. A peculiar condition had been found in the bar; the development of the channel had been delayed by a formation caused by numerous wrecks of vessels lost upon and sunken in the bar.

The results were given of a flood in 1893, together with diagrams indicating the forces at work to improve the channel; these observations also showed the discharge of sediment and the amount of material excavated in the channel during the flood; the former being 203,000,000 cubic feet, and the latter about 32,500,000 cubic feet. At this flood the inner bar, where the wrecks had been found, had been entirely removed, and a deep and wide channel produced with a least depth of 21½ft. at the sea end of the jetties, but with a depth everywhere else in the jetty channel of between 24ft. and 30ft. The hydrographic conditions before the works were begun, and after they were completed, were shown on two charts, one of May, 1890, and the other of January, 1895. On the latter the channel had a least depth of 24ft., and an average width at that depth of 680ft.

The navigational conditions before the works were begun, and after they were completed, were dealt with, and a table was given showing the increase in tonnage and the value of freights between 1885 and 1894. The tonnage in 1890 was 30,000, and in 1894, 192,000.

The important commercial advantages of the port were briefly stated; it had a deep and safe entrance channel and a land-locked harbour. Communication with the entire railway system of the country had been already established by two routes, and a third line, direct to the City of Mexico, was projected by the Mexican Central Railway Company.

THE INSTITUTION OF JUNIOR ENGINEERS.

COAL HANDLING PLANTS FOR STEAM GENERATION.

AT the meeting of this Institution held at the Westminster Palace Hotel on March 6th, Mr. H. J. Young in the chair, the paper read was on "Coal Handling Plants for Steam Generation," by Mr. Charles H. Fletcher, Member.

The subject, the author stated, had received but little attention at the hands of English engineers, but, owing mainly to the exertions of Mr. C. W. Hunt, of New York, its importance had been fully recognised in the United States, where many applications of special plants had been installed. Descriptions were given of appliances used for hoisting, carrying, and delivering the coal consumed in the generation of steam at various large power and locomotive coaling stations, a number of lantern slides being used in illustration.

In the past the expense of handling coal and ashes had been regarded as a minor one, but, through the more exact knowledge of thermo-dynamics and the perfection of modern steam raising appliances, the saving it had become possible to make in this direction had become relatively more prominent, so much so that in some cases the buildings, boilers, and coal storage had been specially arranged to decrease the daily operating expenses to the smallest possible amount.

The first installation referred to was that at the third district station of the Edison Electric Illuminating Co., of Brooklyn, where the work to be done was to take the coal from wagons, carry it to storage bins above the boilers, weigh it, deliver it to the furnaces, and to remove and dispose of the ashes. The coal is dumped into a hopper under the side walk, from whence it passes through a filler into a conveyor consisting of a series of buckets pivoted in a double chain, the whole system being carried on self-lubricating wheels running on a track, changes of direction being made by running around curves; this, together with the driving, being effected by pawls rolling on pins in the chain, entirely doing away with sprocket wheels and the wear and noise inherent to them. The driver was operated by an electric motor, but other methods, such as a rope drive, leather belting, and directly connected engines, were illustrated and described as suitable. The ashes were removed by the coal conveyor, a separate rotary filler delivering a measured quantity of ashes to each bucket.

At the Ridgewood pumping station of the Brooklyn Waterworks, with a total pumping capacity of 110 million gallons per twenty-four hours, the coal is delivered in railway cars, dumped into a hopper below the track, and then carried by a conveyor to a storage building holding 4000 tons. For carrying from the storage to the boilers, a system of tracks and cars are used, the former being arranged at a convenient distance from the boilers, and the latter designed to make the labour of filling them with coal and firing from them the least possible.

The Brooklyn Heights Railroad Company was next referred to. Here there were, at the Kent-avenue Station, thirty-six Babcock-Wilcox boilers, on two floors. The coal was taken from vessels by a steam shovel, holding about a ton, and lifted by a conveyor over 100ft. vertically, carried horizontally in two directions at right angles, and stored in a pocket holding 6000 tons, and situated directly over the boilers, so arranged that the coal could be weighed and spouted to either boiler-room floor, at the proper place.

The 12,000-horse power for operating the street railways in the southern part of Brooklyn was supplied from a station at the foot of Fifty-second street. The coal was received from vessels lying at the end of a pier 800ft. long, and hoisted by a steam shovel, movable on a trestle, the hoisting engine taking steam from the main boilers 800ft. distant. From the elevator the coal was taken by cars along a cable railway, built on trestles, to a storage building of a capacity of 8000 tons, and situated near the boiler-room, but separated from it by a water tank 90ft. wide. The lower line of a conveyor passes under the storage, then up over a single-span steel bridge above the tank, and carries the coal to the boiler-room. Four men only are required for operating this plant. By its introduction the cost of handling, including all expenses and interest, was reduced from 1s. 1½d. to 2d. per ton. Motive power was supplied by a steam engine specially designed to obviate damage by frost; the taking-up of the wear in the brasses was effected by a set screw in communication with a chamber filled with steel balls of varying diameters.

Various other power stations, and a number of locomotive coaling plants were illustrated. As an example of the latter, in the Philadelphia and Reading Terminal Railway, the problem was to store 500 tons of coal in a building in such a manner that it could be easily drawn into locomotives, and also at the same time to supply them with sand and water, and dump ashes.

The necessity of careful design and good workmanship was dwelt upon. In spite of the character of the use of such machinery, it was found to be a positive economy to pay due regard to these points, durability and freedom from breakdown fully justifying care and expense entailed in the first instance.

THE DOVER UNDERCLIFF.—On Wednesday last, Sir Edward Leader Williams, M. Inst. C.E., opened on behalf of the Board of Trade, an inquiry concerning the effect which the proposed Dover Undercliff Reclamation Scheme is likely to have upon the interests of navigation and the coast and foreshore east of Dover. The scheme has no opponents. It is admitted on all hands that as far as navigation and the preservation of the foreshore is concerned, the reclamation will have a most beneficial effect; and seeing that the great National Harbour will in the course of years monopolise the present sea front, it is most desirable that a new sea front should be provided beyond, so that Dover should not lose its attractiveness as a seaside resort. The promoters have arranged with the War-office and the Admiralty, and all points where the Undercliff scheme could possibly clash with the national harbour have been settled. The inquiry is therefore confined to the probable effect of the scheme on the coast line beyond Cornhill Coastguard station. The sea has at different times made great havoc there. Within the memory of people living there was a road under the cliff to St. Margaret's, with gardens and cottages. They have gone. At the present time the sea at high water washes up to the newly exposed chalk, from which all the footing has been washed away, and the Cornhill Coastguard station and the South Foreland lighthouses are distinctly threatened.

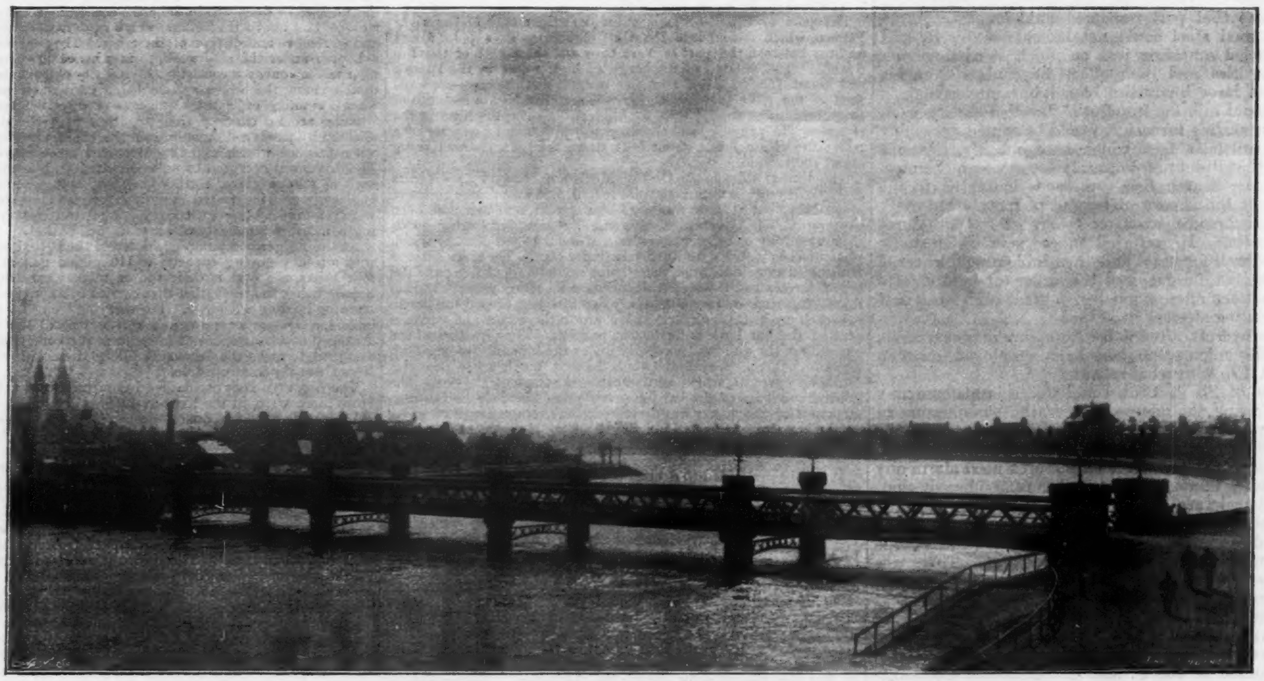
THE NEW WATERLOO BRIDGE OVER THE RIVER NESS AT INVERNESS.

The recently opened steel lattice-girder bridge over the river Ness at Inverness replaces and occupies the site of the old wooden structure known as the "Black Bridge." Built some ninety years ago, the Black Bridge successfully weathered many storms and gales, and came unharmed out of the great flood of 1849, which proved fatal to the grand old stone bridge at Inverness, whose site is now occupied by the great suspension bridge. Tradition has always maintained that the fall of the Black Bridge would be occasioned by a white horse; but the old structure has now disappeared bit by bit under the hands of the workmen pulling it down, and neither the prophesied collapse nor its connection with the white horse has proved its end, as believers in Coinneach Odhar—the Brahan seer—always held.

For some time past the Black Bridge has given signs of decay, whilst its width was found too narrow for the growing traffic of the thriving capital of the Highlands of Scotland, and in 1894 the Town Council of Inverness decided to pull it down and erect on the site a more commodious structure in accordance with the latest and most approved engineering practice. In December of the same year, plans having been prepared, tenders were sought with the following results:—

	£	s.	d.
The Rose-street Foundry Company, Inverness	6,985	10	0
Stockton Forge Company, Stockton-on-Tees	7,098	6	0
Inverness Foundry Company	7,131	0	0
Messrs. Crossley, Tilburn, and Company, Glasgow	7,400	6	8
Messrs. Somervail and Company, Dalmuir	7,541	16	6
Cleveland Bridge and Engineering Company, Darlington	7,725	0	0
Sir William Arrol and Company, Glasgow	7,731	16	3
Messrs. Findlay and Company, Motherwell	7,875	0	0
Workington Boiler and Bridge Company	7,940	3	0
Messrs. P. and W. McLellan, Glasgow	7,957	15	7
Messrs. George Lawson and Sons, Edinburgh	8,207	18	6
Messrs. Head, Wrightson, and Company, Thornaby-on-Tees	8,685	7	10
Arrol's Bridge and Roof Company, Glasgow	8,771	16	8
Teeside Iron and Engine Works Company, Middlesbrough	8,927	12	5
Messrs. Murdock and Cameron, Glasgow	8,952	0	0
Messrs. Hanna, Donald, and Wilson, Paisley	9,333	0	0
Messrs. Charles Brand and Son, Glasgow	10,081	3	3
Messrs. Handyside and Company, Derby	10,916	6	1

The offer of the Rose-street Foundry Company, of Inverness, was accepted, and that concern has now carried the work to successful completion.


THE NEW WATERLOO BRIDGE OVER THE RIVER NESS AT INVERNESS

The site of the bridge is between Grant-street and Waterloo-place, the total length of the structure being 350ft., made up of five spans of 71ft. 3in. each from centre to centre of piers. Massive stone abutments at either end form connection with the banks, while four piers, each consisting of a pair of cast iron cylinders, filled with concrete and stoutly braced together, are founded in the river. Each cylinder is surmounted by a cast iron pilaster of ornamental design, carrying a well-proportioned lamp-post, the style adopted being of the castellated Highland order, well in keeping with the surroundings of the structure, and presenting a very pleasing and imposing appearance. The pilasters on the abutments are of stone, also surmounted by lamp-posts. The main girders, which are two in number, are spaced 29ft. 6in. from centre to centre, permitting an 18ft. roadway, flanked on either side by a footpath 5ft. in breadth.

Turning now to examine the structure in greater detail, the foundations were effected by means of cast iron cylinders 7ft. diameter at and below the bed of the stream, and 6ft. diameter at the level of the roadway. They were cast in 4ft. lengths of 1¼in. metal throughout, being bolted together by internal flanges stoutly stiffened by feathers between each bolt hole. The obstruction to the waterway caused by the piers of the new bridge is almost exactly that of the numerous massive piles of the old bridge, so that the same waterway was secured without increasing the distance between the abutments. The cross bracing connecting the cylinders was 3ft. 8in. and 2ft. 4in. deep at the ends and centre respectively, and was composed of a straight upper member of 8in. by 6in. by ½in. tee bar; and a curved lower member of the same scantling braced together by a double system of 3in. by 3in. by ⅜in. angles, placed back to back, secured to each other by one rivet at the junction and by two rivets at each end, where connection is made with the upper and lower flanges respectively. Connection is formed with each cylinder just beneath the cap by a pair of 4in. by 4in. by ⅜in. angles, and a plate 3ft. 8in. by 1ft. 7in. by ⅜in.

The sinking of the cylinders calls for no special remark, save that some trouble was experienced owing to the nature of the bottom; eventually, however, after sinking through water-logged gravel, a bed of fine sand was entered, in which a satisfactory foundation was made. The excavation inside the cylinder was performed by means of steam grabs, and, as soon as the cylinders were sunk to the required depth, divers descended and levelled the bottom, laying a flooring of neat cement in bags. Before ascending the divers slit the bags open. Four feet of concrete was then deposited in the water by a shoot, and four days later the cylinders were pumped out, and filling continued, as specified. On completion of sinking the cylinders were filled with 5 to 1 concrete, composed of three parts of washed shingle, two parts of sand, and one part of Portland cement, care being taken that "whenever work was suspended for a time the surface of the concrete must be left covered with 6in. of water, which must be removed before any more concrete is put in." The iron employed in the cylinders was specified to be best grey metal, a bar of which, 2in. by 1in. on 3ft. bearings, should be capable of sustaining a load of 27 cwt. at the centre, and bear a deflection of at least ¼in. without fracture.

Turning now to the steel work and the superstructure, the main girders are 7ft. 6in. in depth from back to back of channels of the upper and lower booms respectively. Each boom is composed of a pair of 12in. by 3½in. by 3½in. by $\frac{7}{16}$in. channels, spaced 12in. apart from back to back, with 20in. by ⅜in. plates. The cross girders are spaced 7ft. apart from centre to centre, have a depth of 2ft. and 1ft. at the centre and ends respectively—measured from back to back of angles—and are built with a pair of 4in. by 4in. by $\frac{9}{16}$in. angles, connected by a ⅜in. web, forming both top and bottom booms, both being curved. The lower flange is made up with a 10in. by ⅜in. plate, whilst the web is stiffened by 3in. by 3in. by ⅜in. angles, running its entire depth and made up in the middle with ⅜in. packing to save joggling over the 4in. by 4in. by $\frac{9}{16}$in. angles of the upper and lower booms. The longitudinal girders or stringers, which are spaced 4ft. 6in. apart from centre to centre, and have a total length of 6ft. 10½in., have a uniform depth throughout of 1ft., and are formed of a pair of 3in. by 3in. by ⅜in. angles, both for top and bottom booms, connected by a $\frac{5}{16}$in. web plate, junction being made to the cross girders at either end by means of 3in. by 3in. by ⅜in. angles, packed by ⅜in. packing, to avoid joggling.

The floor plates are buckled, being 7ft. by 4ft. 6in. by ⅜in., and are secured to the cross girders and longitudinals by ¾in. diameter rivets, with a pitch of about 4in. to suit the spacing. Over the cross girders cover strips 17ft. 11¼in. by 8in. by $\frac{5}{16}$in. run on the upper surface of the buckled plate joints. The footpaths are carried on similar buckled plates, supported at each end by a longitudinal 2½in. by 2½in. by ⅜in. angle, and jointed transversely by means of a 5in. by 2½in. by ⅜in. tee bar. The edge of the curb is formed by carrying up A ¼in. plate 1ft. 3in. deep from the end longitudinal girder, and stiffening it at its upper extremity by a 3in. by 3in. by ⅜in. angle, the upper leg of which is turned in towards the main girder. At the inner side of the footpath a 7½in. by ¼in. plate connects the 2½in. by 2½in. by ⅜in. angle, carrying the buckle plate with a 2in. by 2½in. by $\frac{5}{16}$in. angle at the surface of the footpath, which carries the fencing.

Turning now to the bracing of the main girders, which is a double system of triangular bracing, strut No. 1 is formed of a pair of tee bars 6in. by 3in. by ⅜in., connected at each end by an 8in. by $\frac{5}{16}$in. plate, and braced together throughout their length by a single system of 2½in. by ⅜in. flat bars placed on alternate sides. Struts No. 2, 3, and 4 are similar in all respects, save that the tee bars are 5in. by 3in. by ⅜in.; while in strut No. 5, 3in. by 3in. by ⅜in. angles are employed in place of the tee bars. The ties—with the exception of that numbered 5, which is formed like strut No. 5, of 3in. by 3in. by ⅜in. angles braced together by 2½in. by ⅜in. flat bars, and with $\frac{5}{16}$in. plates at each end—are formed of flat bars with the following scantlings for ties Nos. 1, 2, 3, and 4 respectively, viz., 7in. by ½in., 6in. by ½in., 5in. by ½in., and 4in. by ½in. The junctions of the main bracing are made in all cases inside the booms of the main girders, and call for no special remark. The end plates of the main girders are 7ft. 6in. by 1ft. 8in. by ⅜in., the end posts being made up with and stiffened by 3in. by 3in. by ⅜in. angles and an internal ⅜in. plate. The main girders are carried throughout on cast iron bed-plates, those for the fixed ends at the abutments being 1½in. thick in the body, with a 2in. projection 2in. wide at the bottom, and secured to the masonry by a pair of 1¼in. Lewis bolts, the connection between the girders and the bed-plates being formed by four 1in. bolts passing through the lower horizontal leg of the channel bar. Over the piers double bed-plates 3ft. 9in. by 2ft. 8in. are employed, with a 2in. by 2in. projection running across the centre at the bottom; the fixed end is held down by four 1in. bolts, while the free end of the next girder has no attachment to the bed-plate, but simply rests upon it. The bodies of these bed-plates are 2½in. thick, and all bearing surfaces are planed. The expansion joint in the floor-plate for the roadway is formed by a 9in. by ⅜in. plate riveted to the last cross girder of the free girder, and sliding over the prolongation of the end buckle plate of the fixed end. A similar arrangement holds in the expansion joint in the floor plate for the footpath, except that the sliding plate is 1ft. 3in. by ⅜in., the 2½in. by 2½in. by ⅜in. angles of the free end having elliptical holes to allow for movement.

All steel used throughout the structure is Siemens-Martin open-hearth material, having an ultimate tensile strength of 29 tons to 32 tons per square inch, with an elongation of at least 20 per cent. on an 8in. length. The customary bend test requirements being exacted, by which strips 1½in. wide should bend to a curve whose inner radius was 1½ times the thickness of the sample under manipulation, either when cold or after tempering in water at 82 deg. Fah. The rivets employed in the work had an ultimate strength of 26 tons to 32 tons per square inch, with an elongation of at least 25 per cent. on an 8in. length, the same bend tests being required. The specification specially requires that no material should be worked when at a temperature of from 600 deg. to 400 deg. Fah., the dangerous limits known as "blue heat." The highest class of girder work was exacted throughout the contract; all edges being planed and every hole being drilled. Hydraulic riveting was, whenever practicable, employed.

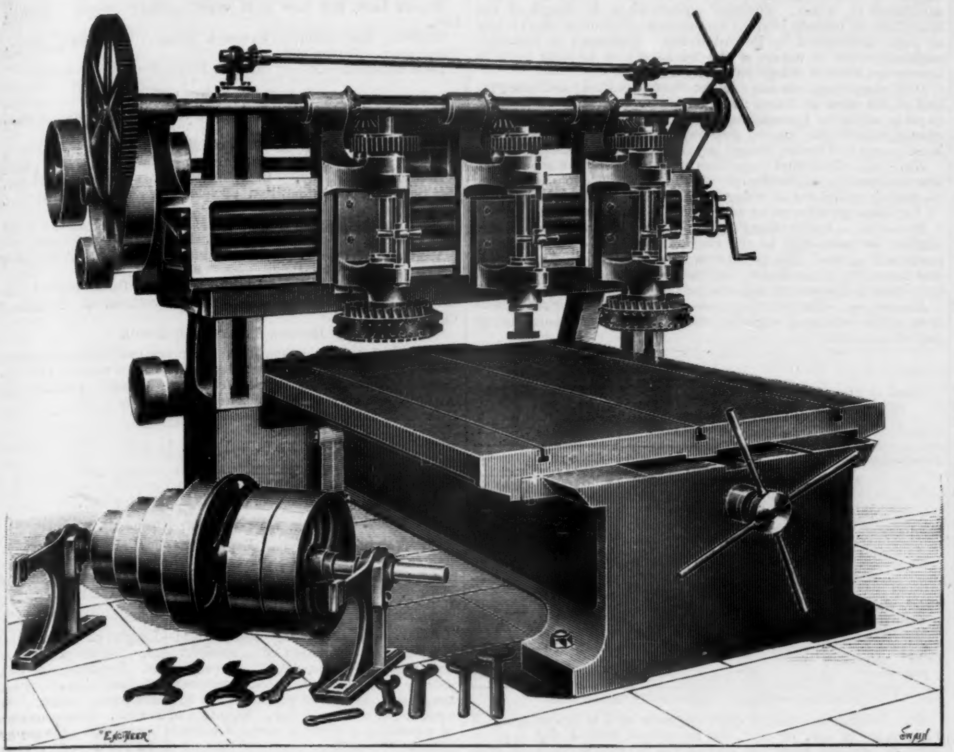
The stone used in the structure is, with the exception of the girder blocks, freestone from Mason Haugh, a peculiarly hard specimen of the Morayshire freestone, the girder blocks of the abutments being of granite 4ft. by 3ft. by 1ft. 9in., dressed smooth on the top to receive the girders. The girder blocks on the piers are also of granite, 4ft. 1in. by 3ft. by 13in., dressed smooth on the top and nidged on all other sides, being bored to receive the four holding-down bolts and embedded in concrete. The cement used is Portland cement, of such fineness that the residue on a sieve having 2500 meshes per square inch does not exceed 5 per cent. by weight. A breaking stress of the cement gauged neat and after seven days was required to be not less 400 lb. per square inch, whilst mixed in briquettes with three times its weight of sand, a strength of not less than 170 lb. per square inch was specified after twenty-eight days. The cement used throughout the undertaking was composed of three parts of washed shingle under 2in. diameter, two parts of clean sand, and one part of Portland cement; the whole being turned over five times. The stone pilasters over the abutments were dressed and dabbed ashlar, with droved margins 2in. wide on each face.

The whole surface of the carriage-way and footways was covered with a mixture consisting of one-third part of bitumen to one part of Portland cement, laid on 1in. thick at the joints of the plates and completely filling the depressions. This was applied hot, and floated to the proper convexity in the carriage-way and to the proper slope on the footpaths, the whole surface, both of roadway and footways, being finally paved with Baltic redwood, thoroughly creosoted, in blocks 3in. across the grain by 4½in. deep, overlying a bed 1in. in thickness made up of thirteen parts of bitumen to one part of sand, combined whilst hot. The redwood blocks were set with strips of creosoted redwood, ¼in. thick and 3in. deep, between each two courses. All steel work received one coat of boiled linseed oil and two coats of oxide paint, the cast iron bed-plates and foundation cylinders being coated with Dr. Angus Smith's solution. The cylinder joints were securely rusted together before the concrete was put in. The total weight of mild steel and cast iron in the structure was 300 tons and 160 tons respectively.

The engineer of the bridge is Mr. John Allan Mackenzie, C.E., Burgh Surveyor, Inverness; with Mr. Murdoch Pater-

THREE-HEAD SURFACE MILLING MACHINE

MESSRS. G. WILKINSON AND SONS, KEIGHLEY, ENGINEERS



son, M.I.C.E., of the Highland Railway Company, as consulting engineer and arbiter.

The illustration we reproduce is from a photograph by Mr. Adam Cooper, Inverness, to whom we are indebted for its use. Further illustrations of the bridge in detail will be published in our next impression.

LARGE THREE-HEAD SURFACE MILLING MACHINE.

The machine illustrated above has been designed for milling the surfaces of cotton spinning frame ends and various other descriptions of work of a more or less simliar kind. The machine has three tool heads, and will mill longitudinally and transversely any article up 8ft. 6in. in length and 5ft. 4in. between the standards. The cross-slide will rise and fall 18in., similar to a planing tool, and it has an independent vertical adjustment to each tool of 2in. The bed is 10ft. long, by 3ft. 7in. across face, by 1ft. 5in. deep, with table 5ft. wide by 7ft. long, having a variable self-acting feed motion given it by a screw down the centre of the bed. It is operated by a double clutch motion at one end of the bed, and a lever is placed at the front side of the machine, where it is easily accessible for putting into gear. By pulling the clutch out of gear with the feed motion, and putting it into gear with the opposite clutch, it gives a quick return motion to the table 150 times the speed of the feed-traverse. The table is stationary when the clutch is in its middle position. An adjustment as to traverse can also be made by a star wheel at the opposite end of the machine. The cross-slide is tilted slightly so that the tools only cut in front, those behind just clearing the work. The outside tool-head will move far enough out of the way to allow a self-acting cross traverse of 3ft. 6in. to the middle tool-head, which has a cutter 5in. diameter and 1in. wide for flat surface and edge cutting, so that an L seating could be milled. The cutter-head discs are made with slots cut in at a proper angle, similar to a worm-wheel, and carrying straight pieces of $\frac{5}{16}$in. square tool steel which require no forging. The angle gives the clearance in front of the tool, and the end of the tool is ground slightly at an angle for clearing the back. The cutter-head discs are 12in. diameter from centre to centre of tools, and 3in. thick, the tools being each held by two nipping screws. The tool discs can be readily screwed on and off to admit a different cutter if desired. The driving cone has four speeds, 18½in., 15½in., 12½in., 9½in. diameter for a 4in. belt, the overhead driving gear being of corresponding dimensions. The machine was made by Messrs. G. Wilkinson and Sons, Keighley, and its weight is seven tons.

NEW SHIPPING—BRITISH AND FOREIGN.

The Peninsular and Oriental Company has in the recent order given out for new shipping, allotted a share of the work to other builders than Messrs. Caird and Company, of Greenock, who, up till lately, built all the company's new vessels. That this circumstance has no significance as bearing on the relationship between this great mail company and its well-tried builders at Greenock is shown by the announcement that Messrs. Caird and Company have just received an order from the Peninsular and Oriental Company for the construction of two first-class mail steamers, each of 8000 tons, and 11,000 indicated horse-power. The engines will be of the triple-expansion type, and both hull and engines will be similar to the India, now on the stocks, and which Messrs. Caird purpose launching on the 15th inst. The India is the largest vessel, as regards tonnage, ever built at Greenock. Though driven by single screw engines on the triple-expansion type, the distribution of power and smoothness of working is insured by the arrangement employed of having four cylinders fitted tandem fashion. With the order for the two new vessels, and one recently received for a twin-screw steamer of 8500 tons, Messrs. Caird and Company have now 32,500 tons on hand for the Peninsular and Oriental Company. Vessels for the same company are being built in other yards—one a twin-screw of 8500 tons, in the yard of the Palmer Company, of Jarrow; and another, the China, similar to the India, in the yard of Messrs. Harland and Wolff, Belfast. The India and China, and the two similar vessels just ordered, are each 500ft. long, of proportionate beam, and will carry 500 first and second-class saloon passengers. They are similar in type, but larger than the Caledonia, Australia, and Himalaya, now running on the Eastern services. The India and China will be ready for service during the coming autumn, and the two vessels now ordered will be delivered in time to commence running previous to the termination of the present mail contracts which expire in January, 1898. To the work already in hand in Clyde shipyards for German owners—notably in the yard of Messrs. C. Connel and Co., where three steamers of approaching 15,000 aggregate tonnage are underway for Hamburg owners — there falls to be added another steamer of 5000 tons, just contracted for by Messrs. Alexander Stephen and Sons, of Linthouse, to German account; three large steamers, each of 7500 deadweight capacity, are at present nearing completion in English yards for the Rickmer's line of Bremen. These facts, looked at in connection with the other fact that the shipyards in Germany are as busy as they can be with local orders, show that German owners are determined not only to keep a firm hold where they have already got a footing as rivals to Britain in the carrying trade of the world, but to secure a share in new trades as well.

The United Steamship Company, of Copenhagen, has placed an order with Messrs. Lobnitz and Co., of Renfrew—who have already built very extensively for the same owners—for two steamers, each of 2000 tons dead-weight capacity. Two steamers of the same dead-weight capacity and 15 knots speed have recently been contracted for with Clyde builders by a firm engaged in the West Indian and Central American trade. The new Continental Express Company, promoted by the Southampton Traders' Company, Limited, is understood to have negotiated with Clyde builders for the construction of three screw steamers of a novel form to be employed in the projected passenger and cargo service between Tilbury-on-Thames and Ostend. The vessels are to be built with three keels, on the principle devised by Mr. T. F. Hodgetts, formerly of the Indian Navy, and late Professor in the Royal Naval College, Prussia. From the central or ordinary keel the vessel's bottom springs away on each side in a concave curve towards the extra side keels, in the region of what, in ordinary ships, would be the lower turn of the bilge. This style of bottom, it is claimed, secures immunity from rolling, and combines with steadiness not only greater ease in steering and handling, but also, it is said, increased speed.

Trade and Business Announcements.—Messrs J. Kershaw and Co., of 38a, King William-street, London Bridge have, we understand, purchased the British and foreign patent rights in Moore's universal carving machine, and are now offering it to engineers for pattern-making.—Mr. Wm. H. Booth has resigned his appointment as managing engineer for Messrs. Le Grand and Sutcliff, artesian engineers, and has taken offices at 17, Shaftesbury-avenue. W. — Piccadilly-circus — where he will carry on business. — Messrs. John Shaw and Co., Maryhill Ironworks, Glasgow, have re-opened their office at 6, Lombard-court, London, E.C., and in future will be represented, both for the export and home trade, by the junior partner, Mr. Hugh Girvan.—Among new companies we find Henry Pooley and Son, Limited, registered with a capital of £100,000 in £1 shares, to acquire the business carried on by Henry Pooley and Son, at Albion Foundry, Liverpool, and elsewhere, to enter into a certain agreement, and to carry on the business of engineers, ironfounders, weighbridge, weighing machine, and scale makers, and repairers, &c. The subscribers are Messrs. H. Pooley, jun., Caithness-road, Liscard; J. S. Pooley, 7, Grafton-road, New Brighton; J. Chater, 223, Peckham Rye, S.E.; J. Hines, Lenzie, Dumbarton, N.B.; L. Jacob, 29, Braithwaite-road, Birmingham; J. Harris, 44, Braithwaite-road, Birmingham; and J. W. North, 33, Weld-road, Birkdale. The number of directors is not to be less than three nor more than five. The first are the first five subscribers. Qualification, 100 shares. Remuneration, as the company may decide.—W. Jessop and Son, Sheffield, inform us that from this date their London address will be No. 54, Cannon-street, E.C., and communications should now be sent there to them or to their agents, Messrs. Calvert, Harris, and Co., who continue to represent the firm as heretofore.

ASSISTANT-ENGINEERS IN THE ROYAL NAVY.

We have received so large a number of letters asking for information as to the nature of the examinations that candidates for the post of assistant-engineer in the Royal Navy will have to pass, that we publish the regulations as issued by the Admiralty in full. The examination papers are never published, but the syllabus indicates their characteristics very closely.

The following are the regulations for the guidance of candidates for direct appointments as probationary assistant-engineers in the Royal Navy:—

General Paragraphs applicable to all Candidates.

1. Candidates for direct appointment as probationary assistant-engineer in the Royal Navy must not be under twenty, nor over twenty-three*, years of age at the date of examination. They must produce a certificate of the date of their birth; or, in default, a declaration made before a magistrate by one of their parents or other near relative, stating the date of birth.

2. They must have attended the regular day engineering course—either civil, mechanical, or electrical—at a recognised college for technical education for not less than one year.

3. They must have been not less than three years under training in approved engineering establishments, and must produce satisfactory certificates of practical ability.

4. They must be British subjects, and must produce certificates of good conduct for a period of not less than five years previous to the date of application, signed by the heads of the schools and colleges at which they were educated, and of the engineering establishments at which they were pupils; if educated in part at home, certificates from a magistrate or clergyman to whom they were personally known must be produced for such period.

5. No candidate can be allowed to present himself for examination unless the certificates mentioned in the preceding paragraphs are considered satisfactory by the Admiralty.

6. Candidates who receive permission to present themselves for examination must attend, where required, for medical examination by Naval Medical Officers, and must be found physically fit to render them eligible for entry.

7. The number of appointments to be made in each year will be fixed by the Lords Commissioners of the Admiralty, and the list of candidates will be kept at the Admiralty.

8. Candidates for entry must send to the Secretary of the Admiralty certificates of ability to swim.

9. Probationary assistant-engineers will be confirmed at the end of twelve months' probationary time, if their conduct and qualifications are satisfactory.

10. In the event of the conduct and qualifications of any probationary assistant-engineer not being satisfactory during his twelve months' probation, or of his failing to pass satisfactorily at the final examination at the Royal Naval College—see par. 15—his commission will be withheld for six months, or for such period as may be determined by their Lordships.

A.—Paragraphs applicable to Candidates who take the Complete Admiralty Examination.

11. All applications for the forms to be filled up by candidates must be sent to the Secretary of the Admiralty, London, S.W., on or after the 1st of February in each year, and care must be taken that the forms, when filled up, are returned with the certificates of birth, training, and moral character, so as to reach the Admiralty on or before the 15th of May following.

12. The examination will be held at the Royal Naval College, Greenwich, in the month of May or June of each year. The exact date may be ascertained on application to the Secretary of the Admiralty, on or after the 1st of February.

13. The following will be the subjects of the examination, and the maximum number of marks for each subject—to be modified at any time, if considered desirable:—

I.—*Compulsory Subjects.*

	Marks.
General paper in elementary mathematics and mensuration	400
Statics, hydrostatics, and graphical statics	500
Hydraulics, pneumatics, and dynamics	500
Elementary theory of mechanism and machinery	500
Physics I.—Heat and light	500
Physics II.—Electricity and magnetism	500
Chemistry	500
Heat and combustion	700
Steam and the steam engine..	700
Practical engineering	700
Workshop appliances and practice	600
Mechanical drawing..	500
Total	6600

II.—*Optional Subjects.*

Advanced algebra and trigonometry..	500
Conics and differential and integral calculus	600
Applied mechanics and strength of materials	600
Practical physics	300
Metallurgy	400
Design of machinery details	500
Engineering	500
Total	3400
Grand total	10,000

14. Candidates who obtain less than 30 per cent. of the marks for compulsory subjects will be considered ineligible for appointment. The eligible candidates will be divided into three classes:—First class: Those who obtain at least 60 per cent. in the compulsory and optional subjects combined. Second class: Those who obtain at least 50 per cent. in the compulsory subjects only, but fail to reach the standard of the first class. Third class: Those who obtain at least 30 per cent. in the compulsory subjects only, but fail to reach the standard for a higher class.

15. Successful candidates, up to the number of vacancies requiring to be filled, will be entered in the Royal Navy as probationary assistant-engineers on the 1st of July succeeding the examination, and will join the reserves at such dockyard ports as may be decided. Officers appointed from the first class will, if they so desire, have the privilege of proceeding to the Royal Naval College on the 1st October succeeding the examination, where they will pass through a course of higher instruction along with those who enter from the Training College at Keyham. Officers appointed from the second and third classes will remain in the reserves, to be appointed to H.M. ships as their services are required.

16. Officers who obtain first and second-class certificates will be allowed to count twelve months and six months of their probationary time respectively towards increase of pay from 6s. to 7s. 6d. a day, and towards promotion to engineer.

17. Two assistant-engineers, who take the highest places at the examination of the whole of the assistant engineers at the Royal Naval College, on the completion of their first course at Greenwich, are selected annually to pass through a further course of scientific instruction if they desire it. These two are allowed to study at the college for a second and third session. They receive 7s. 6d. a day, and 1s. 6d. a day towards the mess. On the completion of the third session at the college, they will be sent to sea as assistant-engineers, and, after one year's service at sea—or such other period as may hereafter be fixed—they will be considered eligible to fill

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* The case of candidates whose age is slightly outside these limits will receive special consideration.

vacancies occurring in the civil appointments at the dockyards and at the Admiralty.

B.—PARAGRAPHS APPLICABLE TO CANDIDATES POSSESSING COLLEGE CERTIFICATES, WHO ARE ENTERED WITHOUT UNDERGOING THE COMPLETE ADMIRALTY EXAMINATION.

18. As regards educational attainments, every candidate must produce the regular college certificate given after attending the day engineering course—either civil, mechanical, or electrical—for not less than one year, or, in the absence of this, must produce a certificate from responsible officers of the college that he has attended one of the above day courses for not less than one year, and passed the examination with credit at the end of that time in the subjects taught. Only such certificates as can be considered by the Admiralty, as regards educational attainments, as equivalent to a third-class Admiralty educational certificate will be accepted.

19. The only examination candidates under these regulations will be required to undergo will be in engineering subjects as described in paragraphs 21 and 22.

20. All applications for the forms to be filled up by candidates must be sent to the Secretary of the Admiralty, London, S.W., and care must be taken that the forms, when filled up, are returned with the certificates of birth, training, and moral character.

21. The engineering examinations will be held at the Admiralty at intervals of about four months. The date of the next examination will be furnished to accepted candidates.

22. The examination will consist of two written papers in practical engineering and workshop appliances and practice, and a *vivâ voce* examination in the same subjects.

23. Successful candidates, up to the number of vacancies requiring to be filled, will be entered in the Royal Navy as probationary assistant-engineers, and will join the reserves at such dockyard ports as may be decided. Officers appointed under these regulations will not proceed to the Royal Naval College for further study, unless they subsequently undergo the examination and attain the standard referred to in paragraphs 12 to 14. They will remain in the reserves, to be appointed to H.M. ships as their services are required.

24. Every officer entered in the Navy under these conditions will be treated as regards pay and promotion in the same manner as officers who have obtained a third-class Admiralty educational certificate, but will be allowed to present himself on one occasion before attaining the rank of engineer—should the exigencies of the service permit—at the complete Admiralty examination—referred to in paragraphs 12 to 14—for the purpose of obtaining a certificate of a higher class.

25. The foregoing regulations will be generally followed, but their Lordships may modify them from time to time as considered desirable.

MEDICAL EXAMINATION.

26. With a view to prevent the inconvenience and expense being incurred of preparing candidates for entry as probationary assistant-engineers in her Majesty's Navy who may be physically unfit for her Majesty's Service, it is suggested that the candidates be examined by the medical adviser of the family, or any other registered medical practitioner, to whom the following points may be submitted as those upon which they will be physically examined by naval medical officers. It is to be understood that this private examination is merely suggested as a guide to candidates, and to lessen the chances of disappointment, and that it is by no means intended to take the place of, or to influence in any way, the regular official physical examination:—A weak constitution, arising from imperfect development or weakness of the physical powers of the body, either hereditary or from chronic disease, wounds, or injuries. Chronic eruptions on the skin or scalp. Malformation of the head, with a dry, harsh, divergent state of the hair of the scalp, fracture or depression of the bones of the skull, disordered intellect, imbecility, epilepsy, paralysis, or impediment of speech. Blindness or defective vision, as tested by Snellen's test types, in one or both eyes, fistula lachrymalis, and ptosis. Impaired hearing, or discharge from one or both ears, disease or thickening of the lining membrane of the external ear. Diseases of the bones of the nose or of its cartilages, or polypus. Disease of the throat, palate, or tonsils; unsound teeth, offensive breath from constitutional causes, unhealthy gums, scrofulous diseases of the glands of the throat or neck, external cicatrices from scrofulous sores. Functional or organic diseases of the heart or blood vessels, deformity or contraction of the chest, flattening of the sub-clavicular regions, phthisis, hæmoptysis, bronchitis, dyspnœa, aphonia, chronic cough, or other symptoms of tubercular exudation into the pulmonary tissues. Swelling or distention of the abdomen, undue obesity, disease or enlargement of the liver, spleen, or kidneys. Rupture, weakness, or distention of the abdominal rings; vesical weakness, or incontinence. The existence of any congenital defect, or of varicocele. Any disease of or pertaining to the alimentary canal. Paralysis, weakness, impaired motion, or contraction of the upper or lower extremities, from whatever cause; aneurism, a varicose state of the veins, especially of the leg. Bunions, distortion, malformation of the feet, or malposition of the finger or toes. Distortion of the spine, of the bones of the chest, or pelvis, from injury or constitutional defect.

By Command of their Lordships,
Admiralty, January 4th, 1896. EVAN MACGREGOR.

NOTE.—Appended to these regulations is a memorandum of the several grades of engineer officers of the Royal Navy, together with the scales of full and half-pay, and other information.

Memorandum as to the Pay, &c., of Engineer Officers of the Royal Navy.

	Full pay.		Half pay.	
	Year of 365 days.	One day.	Year of 365 days.	One day.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Probationary assistant-engineers on entry..	109 10 0	0 6 0	—	—
Assistant-engineers with 1st class certificates—on confirmation in the rank ..	136 17 6	0 7 6	—	—
Assistant-engineers with 2nd class certificates—on completion of six months' service from date of confirmation				
Assistant-engineers with 3rd class certificates—on completion of twelve months' service from date of confirmation				
Assistant-engineers—				
Under 3 years' service	—	—	73 0 0	0 4 0
After " "	—	—	82 2 6	0 4 6
Engineers—				
On promotion	164 5 0	0 9 0	100 7 6	0 5 6
After 3 years' service in rank	182 10 0	0 10 0	109 10 0	0 6 0
" 6 " " "	200 15 0	0 11 0	No increase	
" 9 " " "	219 0 0	0 12 0	—	—
Fleet, staff, and chief engineers—				
Under 2 years' senior service (including junior service allowed as at †)	255 10 0	0 14 0	127 15 0	0 7 0
After 2 years' ditto..	273 15 0	0 15 0	146 0 0	0 8 0
" 4 " "	292 0 0	0 16 0	164 5 0	0 9 0
" 6 " "	328 10 0	0 18 0	182 10 0	0 10 0
" 8 " "	365 0 0	1 0 0	219 0 0	0 12 0
" 10 " "	401 10 0	1 2 0	255 10 0	0 14 0
" 12 " "	438 0 0	1 4 0	292 0 0	0 16 0
" 14 " "	474 10 0	1 6 0	328 10 0	0 18 0
Inspectors of machinery	638 15 0	1 15 0	401 10 0	1 2 0
Chief inspectors of machinery	730 0 0	2 0 0	438 0 0	1 4 0

† Junior service allowed to reckon on the following scale:—Under twelve years' service in junior rank, nil; above twelve years' service in junior rank, one-third of the period in excess of twelve years. Junior service is all confirmed time served as assistant-engineer and engineer from the age of twenty. Officers passed over for unsatisfactory conduct or failure to qualify for promotion to the senior grade, but who may subsequently be promoted, are not allowed to count their junior service, between the dates of their being passed over and the dates of their promotion.

Charge pay.—Engineer officers when in charge of the machinery of ships in commission are allowed charge pay varying from 1s. to 9s. a day, the rate for each ship being determined by the Admiralty. Senior engineers of ships in commission, having engines of 3000 indicated horse-power and upwards, are allowed an additional 1s. a day. Engineer officers when in charge of the machinery of torpedo boats in commission are allowed charge pay at rates determined by the Admiralty. Engineers or assistant-engineers when in charge of the machinery of torpedo boats in reserve are allowed charge pay at 1s. a day.

Half charge pay.—In ships in the Fleet and Dockyard Reserves, half of the rates of charge pay, and senior engineers' allowances, payable whilst in commission, are to be paid to their engineer officers, but in the case of ships with engines of 2000 indicated horse-power and under, charge pay at 1s. a day is to be paid.

Extra pay.—The chief inspectors and inspectors of machinery in the reserves, in consideration of their responsible duties, are allowed an additional 3s. a day. Fleet, staff, and chief engineers of flag ships are allowed an additional 2s. 6d. to 5s. per day.

Promotion.—Assistant-engineers, qualified for advancement, are eligible for promotion to the rank of engineer after five years' confirmed service. The promotion of engineers, chief engineers, and inspectors of machinery, depends on the number of vacancies that occur in the several superior ranks

Retired pay.—The following table shows the age for retirement from active service of engineer officers, and the maximum retired pay of each rank:—

Rank at time of retirement.	Age.		Maximum retired pay.
	Optional retirement may be allowed at.	Compulsory retirement.	
Assistant-engineers ..	—	40	£50 a year
Engineers	—	45	£150 a year (qualified for promotion) £130 a year (not qualified for promotion)
		(May be retained to the age of 50)	£187 10s. (qualified for promotion) £162 10s. (not qualified for promotion)
Chief, staff, and fleet engineers	50‡	55	£450 a year
Inspectors of machinery	55	60	£500 a year
Chief inspectors of machinery	55	60	£500 a year

‡ Optional retirement suspended for the present.

On attaining the rank of chief engineer and afterwards, and if forty years of age, or over, the amount of retired pay depends both on age and length of service, the maximum for each rank being as above, and the minimum rate the amount of half pay of the officer as per scale previously given. Retirement would take place between the ages given in the above table except in the following cases:—(1) Five years' half-pay time in either of the ranks of assistant-engineer, engineer, chief, staff, or fleet-engineer, or seven years' half-pay time in the ranks of inspector, or chief inspector of machinery. (2) Physical unfitness for service. (3) Misconduct. Pensions or gratuities for wounds or injuries can be granted by the Admiralty in addition to the ordinary retiring allowances. Retired pay and half-pay are subject to deductions in case of misconduct.

Naval and Greenwich Hospital pensions.—These pensions are established for affording some relief to retired officers, and are awarded to such retired officers as may be, in the opinion of the Admiralty, most deserving, under the conditions published in the Queen's Regulations and Admiralty Instructions.

Pensions to widows.—The widows and children of engineer officers who had completed ten years' commissioned service are eligible, under stipulated conditions, to pensions and compassionate allowances. The rates payable and the regulations governing their award are published in the Queen's Regulations and the Quarterly Navy List.

Relative rank.—Assistant-engineers rank with sub-lieutenants according to date of commission. Engineers of less than six years' seniority rank with but after lieutenants under eight years' seniority. Engineers of six years' seniority rank with lieutenants of less than eight years' seniority according to date of commission. Chief engineers rank with but after lieutenants of eight years' seniority. Staff engineers rank with lieutenants above eight years' seniority. Fleet engineers rank with commanders according to date of commission. Inspectors of machinery, under eight years' service on full pay as such, rank with captains under three years. Inspectors of machinery, of eight years' service on full pay as such, rank with captains of three years. The captain to reckon his seniority from the date of completing three years in that rank. The inspector of machinery to reckon his seniority from the date of completing eight years' service as such. Chief inspectors of machinery rank with captains of three years' seniority according to date of commission.

SYLLABUS OF INSTRUCTION IN PURE AND APPLIED MATHEMATICS, PHYSICS, AND CHEMISTRY.

STATICS.

Definition and specification of a force:—Its measurement by straight lines. Composition of two forces. Analytical expressions for the resultant and the angles it makes with each of its components. Parallel forces. Couples. Equilibrium of a body—(1) under two forces; (2) under three forces. Principle of the lever. Pressure on the fulcrum of the lever. Moment of a force about a point. Resultant of moments of two forces. Conditions of equilibrium of a body acted on by any number of forces in one plane.

Centre of gravity:—Way to find it.—(1) experimentally; (2) by calculation. Centre of gravity of any number of particles. Centres of gravity of (1) a uniform triangle; (2) a circular arc and sector; (3) hemispherical surface and solid; (4) pyramid and cone; (5) of a body with a part removed from it or another body added to it.

Friction:—Laws of friction and the determination of limiting friction between two bodies.

Machines:—(1) Lever. (2) Wheel and axle. (3) Pulley. (4) Systems of pulleys. (5) Inclined plane. (6) Wedge. (7) Screw. The same machines with friction.

Stable, unstable, and neutral equilibrium:—Condition that a body may stand when placed on a table. Conditions for toppling over and for slipping.

Text book recommended:—"Elementary Statics," by J. B. Lock.

HYDROSTATICS.

Definitions of fluid, liquid, gas:—Definition of fluid pressure. Expression for pressure at any point of a heavy liquid. Resultant pressure. Resultant horizontal pressure on any surface immersed in liquid. Vertical resultant pressure on same. Expression for resultant pressure on a plane surface immersed in liquid. Centre of pressure for (1) a parallelogram with one side in surface; (2) a triangle with one side in surface.

Resultant pressure on any body either wholly or partially immersed in liquid.

Conditions of floating:—Stability and metacentre illustrated by simple cases.

Specific gravity:—The hydrostatic balance. Hydrometers. Bramah's press.

Book recommended:—"Besant's Elementary Hydrostatics."

PNEUMATICS.

Boyle's Law, and how it is experimentally tested. Charles's Law.

Syphon. Air pumps. Common pump. Condensing pumps. Barometers. Diving bell.

Book recommended:—"Besant's Elementary Hydrostatics."

ELEMENTARY DYNAMICS.

Motion in a straight line. Uniform velocity. Velocity uniformly accelerated.

Mass. Momentum. Rate of change of momentum. Laws of motion. Weight. Atwood's machine. Motion on inclined plane.

Impact. Elasticity. Oblique impact. Units of measure. C.G.S. system. Composition of velocities and of accelerations. Projectiles.

Uniform motion in a circle. Motion in a circle when not uniform. Simple pendulum. Conical pendulum. Governors.

Work. Energy. Potential and kinetic energies. Principle of the conservation of energy.

Books recommended:—"Lock's Elementary Dynamics." "Garnett's Dynamics." "Worthington's Dynamics of Rotation," Chaps. I.—IV.

HIGHER ALGEBRA (Optional).

Theory of quadratic equations. Permutations and combinations. Binomial theorem. Exponential and logarithmic series. Intermediate coefficients and partial fractions. Simple conditions of convergency. Summation of series of the types.

(1) $\Sigma\, n^2$.
(2) $\Sigma\, n^3$.
(3) $\Sigma\, n\,(n+1)\,.\,.\,.\,(n+r)$
(4) $\Sigma\, \dfrac{1}{n\,(n+1)\,.\,.\,.\,(n+r)}$

Book recommended;—"C. Smith's Higher Algebra."

HIGHER TRIGONOMETRY (Optional).

De Moivre's Theorem. Expansions for sin θ and cos θ. Exponential forms for the same. Hyperbolic functions. Summation of trigonometric series. Factors of binomial expressions, such as $1 + x^n$. Book recommended:—"Lock's Higher Trigonometry."

ANALYTICAL CONICS (Optional).

Rectangular and polar co-ordinates:—Length of a line. Area of a triangle. Equation of a straight line. Condition that two lines may be (1) parallel, (2) perpendicular. Conditions of collinearity of three points. Angle between two lines where equations are given. Length of perpendicular to a line from a point. Polar equation of a straight line. Equation of a circle. Representation of a point on a circle in terms of a single parameter. Equation of tangent to a circle. Chord of contact of tangents from external point. Polar equation of a circle. Geometrical definition of a conic section by means of focus and directrix. Equation of a parabola. Representation of a point on a parabola by means of a single parameter. Equation of the chord joining two points and thence of the tangent. Equation of the normal. Simple focal properties. Form of the curve as plotted out from the equation. Diameters. Equation of an ellipse. Centre of the curve. Representation of a point on an ellipse by a single parameter. Excentric angle. Ellipse regarded as orthogonal projection of a circle. Equation of a chord joining two points on an ellipse and thence the equation of a tangent. Equation of a normal. Simple focal properties. Conjugate diameters. Equation of a hyperbola. Representation of a point on hyperbola in terms of a single parameter. Equations of chord, tangent and normal. Focal properties. Asymptotes. Conjugate hyperbola. Conjugate diameters. Polar equation of conic referred to focus, with polar equation to tangent and chord. Book recommended:—"C. Smith's Elementary Treatise on Conic Sections.'

DIFFERENTIAL AND INTEGRAL CALCULUS (Optional.)

Differentiation of functions of a single variable. Integration of rational algebraical and trigonometrical functions. Simple geometrical applications of differentiation. Tangents and normals in rectangular and polar co-ordinates. Evaluation of areas of plane curves in simple cases. Successive differentiation. Curvature of plane curves. Questions in maxima and minima of functions of one variable. Taylor's and Maclaurin's expansions of functions of a single variable, the convergency of the expansions being assumed. Indeterminate forms. Book recommended:—"Greenhill's Differential and Integral Calculus," Chapters I., II., III., IV., except §§ 29, 30, 63-65, 67, to end of chapter, 80-87, 93-96, 100, 107, 108, 111.

CHEMISTRY.

Classification of the elements:—Hydrogen; its preparation and properties. Oxygen; its preparation and properties. Mechanical mixtures and chemical compounds. Water; physical and chemical properties. Impurities in water. Hardness in water. Rain, spring, and sea water. Nitrogen; its preparation and properties. Nitrous and nitric oxides. Ammonia. Hydric nitrate. Acids, bases, and salts. Composition and impurities of the atmosphere. Chlorine; its preparation and properties. Hydro-chloric acid gas. Bromine. Iodine. Carbon. Carbonic oxide. Carbonic acid; its properties and preparation. Marsh gas and olefiant gas. Coal gas; its manufacture and bye-products. Silicon. Silica. Sulphur; its occurrence in nature and purification. Sulphuretted hydrogen. Sulphurous acid. Sulphuric acid. Book recommended:—"Roscoe's Lessons in Chemistry."

HEAT.

Temperature:—Measurement of temperature. Filling, marking, and graduating thermometers. Different thermometric scales. Maximum and minimum thermometers. Expansion of solids. Linear and cubical expansions. Compensation of pendulums and balance wheels. Expansion of liquids. Peculiarity in the expansion of water. Expansion of gases. Perfect gases. The air thermometer. Absolute zero of temperature. Quantity of heat. Thermal unit. Calorimeters. Specific heat and methods of determining it for solids and liquids. Latent heat. Laws of fusion and solidification. Freezing mixtures. Cold produced by evaporation. Boiling point of liquids. Latent heat of vaporisation. Pressure of vapours. Saturated and superheated vapours. Determination of pressure of saturated steam at different temperatures. The dew point. Hygrometers. Convection of heat in liquids and gases. Heating by water pipes. Draught of chimneys, &c. Conduction of heat. Safety lamp. The radiation, absorption, and reflection of heat. Theory of exchanges. Laws of cooling. The mechanical equivalent of heat. Joule's experiments. Specific heats of a gas at constant pressure and at constant volume. Books recommended:—"Deschanel's Natural Philosophy —Heat." "Larden's Heat" (latest edition).

LIGHT.

The emission of light:—Luminous gas flame. Bunsen-burner. Lime light. Electric light. Shadows. Umbra and Penumbra. Laws of intensity of light. Photometers. Velocity of light as determined by the motions of Jupiter's Satellites. Reflection of light. Formation of images by plane and concave mirrors. Focal properties of concave parabolic and spherical mirrors. Refraction of light. Law of sines. Determination of coefficient of refraction. Refraction through a prism. Lenses. Formation of images by a convex lens. Chromatic dispersion of light. The solar spectrum. Book recommended:—"Deschanel's Natural Philosophy."

MAGNETISM.

The elementary properties of a magnet:—Magnetic induction. Lines of force. Law of force between two poles. Methods of magnetising iron and steel. Definitions of Pole strength, magnetic moment, intensity of magnetisation susceptibility, permeability, saturation. Use of iron pole-pieces and masses of iron in controlling the distribution of lines of force. Comparison of magnetic forces by the method of oscillations.

Terrestrial magnetism:—Dip. Declination. Magnetic charts. Magnetism of iron ships. Different kinds of errors in the compasses of iron ships, and their corrections.

Book recommended:—"Electricity and Magnetism," by Sylvanus Thompson.

Frictional Electricity.

Production of electricity by friction:—Electricity of two kinds. Laws of attraction and repulsion between electrical charges. Coulomb's balance. Lines of force and equipotential surfaces. The electroscope. Conduction of electricity. Inductive effects. The electrophorus. Frictional machines. Pointed conductors. Lightning conductors. Electric condensers. Capacity. Specific inductive capacity. Leyden jars. Inductive machines. Book recommended: — "Electricity and Magnetism," by Sylvanus Thompson.

Voltaic Electricity.

Chemical mode of producing currents:—Electromotive series. Polarisation. Voltaic cells in common use. Standard cells.

Chemical effects of currents:—Voltameters. Storage cells. Electro-plating.

Oersted's experiments:—Electro-magnetic measure of a current. Electro-magnets. Tangent galvanometers. Galvanometer constant. Astatic and reflecting galvanometers. Voltmeter. Ammeter. Ohm's law. Resistance of wires and columns of liquids. Internal and external resistances. Meaning of "series" and "parallel" arrangements. Method of comparing resistances. Rheostat. Wheatstone's bridge. Post-office bridge. Telegraph. Heating effects of a current. Joule's law. Incandescent and arc lamps. Forces between wires carrying electric currents. Solenoids. Electrodynamometers. Laws of induced currents. Ruhmkorff's coil. Telephones. Production of current by rotation of a coil in a magnetic field. The C.G.S. system of units. Practical units. Thermo-electricity. The thermo-pile.

Books recommended:—"Electricity and Magnetism," by Sylvanus Thompson; and Ayrton's "Practical Electricity."

Practical Physics (Optional).

In the case of engineer students, a voluntary course will be arranged by the head master according to the circumstances and progress of each student. Marks will be given on the work done during the year. Candidates for direct entry will be examined at the Royal Naval College, Greenwich, on the work they have previously performed in the laboratory, of the character of which they should give notice to the Director of Studies on the first day of their examination.

SYLLABUS OF INSTRUCTION IN APPLIED MECHANICS AND MECHANISM.

Elementary Descriptive Mechanism:—Toothed wheels. Belts and pulleys. Crank and connecting rod. Excentrics. Escapements. Cams. Quick return motions. Linkwork mechanisms. Parallel motions. Ratchets. Feed motions. Trains of wheels. Book recommended:—"Goodeve's Mechanism," Chaps. 1—4, 6.

Mechanism and Machines.

Motion:—Sliding, turning and screw pairs. Relative motion of pairs. Units of velocity. Screw-cutting.

Efforts and resistances:—Sources of efforts and resistances. Elastic fluids. Springs. Gravitation. Graphical representation of efforts and resistances.

Friction:—Coefficients of friction. Ordinary laws of friction. Morin's experiments.

Work and energy:—Unit of work. Principle of work. Conservation of energy. Work in turning. Graphical representation of work. Power.

Oblique and variable forces:—Curve of resistance. Indicator diagrams.

Simple machines:—Definition of a machine. Inclined plane. Wheel and axle. Screw.

Pulleys. Belts and wheel gears.

Simple machines with friction:—Waste work. Efficiency. Inclined planes. Windlass. Screw. Pulleys.

The direct acting engine:—Curve of piston velocity. Effect of obliquity of connecting rod. Motion of slide valve. Angular velocity of connecting rod. Application of the principle of work. Polar and linear curves of crank effort.

Unbalanced forces:—Kinetic energy. Radius of gyration. Storage of energy. Case of an unconstrained body. Potential energy.

Dynamometers:

Strength of Materials: Stress. Strain. Elasticity. Thin cylindrical shells.

Hydraulics.

Head. Velocity due to a given head. Discharge from an orifice.

Hydraulic resistances. Surface friction. Virtual slope of pipes. Discharge through pipes.

Hydraulic machines.

Pneumatics:—Flow of gases under a small difference of pressure.

Statics of Structures (To be included in the examination under Statics.)

Struts and ties. Pin joints. Simple triangular frames loaded at the joints. Triangular trusses. Cranes. Diagrams of forces. Straining actions at any point of a loaded beam. Beams under a single load, or a uniformly distributed load. Diagrams of shearing force, and bending moment in elementary cases.

Book recommended:—Cotterill and Slade's "Lessons in Applied Mechanics," omitting Chapters XVI. to XXI. inclusive.

Graphical Statics (Optional).

Graphical construction of the resultant of any system of forces in one plane. Funicular polygon. Suspension chains. Centres of gravity. Graphical construction of moments. Loaded beams. Book recommended.—"Gray and Lowson's," Chaps V. to X., and XV.

Applied Mechanics and Strength of Materials (Optional).

More advanced questions on the subjects mentioned under "Statics of Structures," "Hydraulics," and "Mechanism and Machines." In addition to these the following subjects:—Epicyclic trains of wheels.

Machines:—Periodic motion. Fluctuation of energy. Fluctuation of speed. Fly wheels. Friction of bearings and screws. Efficiency of mechanism. Two crank engine. Necessary correction of indicator diagrams, due to the inertia of the reciprocating parts of an engine. Brakes. Governors.

Framework girders of the Warren and N-types.

Bending of beams:—Bending of a beam of I-section. Bending in a circular arc. Distribution of stress on the transverse section. Neutral axis. Equations of bending. Moments of inertia. Beams of I-section, approximate methods.

Shearing and torsion:—Rivets. Pin joints. Efficiency of a joint. Normal and tangential stresses. Distortion. Torsion of tubes. Solid and hollow shafts. Power transmitted by a shaft.

Experimental results:—Elastic state. Proof stress. Testing machines. Curves of stress and strain. Plastic state of solids. Effect of impact. Crushing of struts. Gordon's formula. Rigid materials. Fibrous materials. Factors of safety.

Hydraulics as above.

Pneumatics.

Books recommended: — Cotterill and Slade's "Lessons in Applied Mechanics," pp. 127, 128; 220-237; 246-254; 259-329; 347-512. Gray and Lowson's, Chap. V. to X., XV. "Goodeve's Mechanism." Chaps. I. and II., omitting Arts. 53-57 inclusive. and Art. 90. Chap. III., omitting Arts. 94-104 inclusive, Art. 111, Arts. 118-123 inclusive. Chap. IV., omitting Arts. 136, 137, 138. Chap. VI., omitting Arts. 169, 170, 175, 176. All the examples are to be worked.

SYLLABUS OF ENGINEERING SUBJECTS, COMPRISED IN THE EXAMINATIONS FOR APPOINTMENTS AS ENGINEER OFFICERS IN THE ROYAL NAVY.

This syllabus is intended to be a guide to candidates in preparing for the above examinations; but, although it practically covers all the subjects on which questions will be set, it must be clearly understood that questions may be set on points not specifically mentioned.

Heat and Combustion.

The paper on these subjects will include questions on:—(1) Elementary notions on the dynamical theory of heat, elementary relations between heat and mechanical energy, with special reference to the steam engine. (2) Fuels, and the combustion of fuel in marine boiler and other furnaces.

The chief points included are:—

Heat.—Nature of heat. General effects. Scales of temperature. Absolute temperature. Laws of thermodynamics. Conversion of heat into work and *vice versâ.*

Conditions and value of maximum efficiency in perfect heat engines.

Communication of heat:—Radiation: Laws, clothing of boilers, &c. Conduction: Internal and external. Rate of conduction through plates. Convection: Circulation of water in boilers.

Application of heat to water:—Sensible heat. Latent heat. Boiling point. Influence of pressure and density on boiling point. Connection between temperature pressure and volume of steam. Formulæ for latent heat and total heat of evaporation.

Density of steam:—Specific volume. Relative volume. Rules for determining the specific volume of steam, wet or dry.

Properties of saturated, moist, and superheated steam.

External and internal work during evaporation.

Action of steam in non-expansive engines, and in expansive engines—assuming the expansion hyperbolic. Heat expended. Work done. Heat rejected, &c. Mean pressure. Graphic representations.

Elementary notions of the general effect of clearance, wire drawing, compression, and the action of the cylinder walls on the efficiency of the steam.

Expansion of steam in stages. Effect on economy.

Real and apparent ratios of expansion.

Superheating.

Steam jackets.

Elementary problems.

Books recommended:—Cotterill's "Steam Engine," pp. 1-70; Sennett's "Marine Steam Engine," Chaps. II.-IV.; IX.-XI.

Combustion.—Properties, approximate composition and uses of the different kinds of fuel.

Nature of combustion. Changes during combustion of coal and other fuels in ordinary furnaces. Amount of air chemically and practically necessary for combustion. Rate of combustion in furnaces of marine boilers. Use of combustion chambers.

Calorific values. Heat of combustion. Temperature of combustion. Evaporative power of fuels. Formulæ.

Causes of loss of evaporative power. Methods of dealing with these losses.

Prevention of smoke. Stoking.

Draught:—Natural draught. Draught of a funnel in inches of water.

Steam blast and other methods of forcing draught. Advantages and disadvantages.

Forced draught with closed stokeholds.

Heating surface:—Efficiency of heating surfaces.

Causes and prevention of spontaneous combustion.

Elementary problems.

Books recommended:— Sennett's "Marine Steam Engine," Chaps. V. and VI.; Rankine's "Steam Engine," pp. 267-297—6th edition.

Steam and the Steam Engine.

Under this heading will be included:—A brief history of the development of the steam engine, with special reference to the chief types of engines and boilers that have been in use for purposes of marine propulsion.

Action of the steam in the steam engine.

Practical application of the principles involved in the subjects mentioned under "Heat and Combustion."

Indicators, construction and use. Theoretical and actual indicator diagrams from the different types of engines. Calculation of indicated horse-power from the indicator diagram. Effects of faults in the engines on indicator diagrams. How to remedy these faults. Method of combining indicator diagrams.

Estimation of the consumption of steam from the indicator diagrams.

Condensation of steam.—Amount of condensation water required.

Expansion by linking up. Independent linking up of two or more cylinders. Variation of power from cylinders by linking up. Throttling. Action of expansion valves.

Stage expansion engines: practical advantages and disadvantages.

Gauges and other measuring instruments:—Pressure and vacuum gauges, counters, anemometers, dynamometers, &c.

Ventilation of boiler and engine-rooms. Increase of power by using forced draught.

Consumption of fuel. Economical speeds.

Rudimentary principles of propulsion. Simple problems.

Tests of machinery and boilers, &c., to ascertain their fitness for service. Methods of conducting trials of machinery and boilers.

Experiments on steam engines, boilers, &c.

Book recommended:—Sennett's "Marine Steam Engine."

[Note.—Detail of construction in the descriptive part of this paper will not be required, except on a few points, such as measuring instruments, &c. It is intended rather to form an examination in the general methods of applying theoretical principles and matters of experience to ordinary practice.]

Practical Engineering.

These papers will be set as an examination in the construction and management of the different types of steam machinery and boilers used for marine purposes, both propelling and auxiliary.

The auxiliary machinery will include steering engines and gear, distilling machinery, circulating, starting, turning, fan, feed, &c., engines, with pipes and valves in connection.

Some knowledge of the machinery for special purposes will also be required, such as torpedo boat machinery, electric light and air-compressing machinery, capstan and hydraulic pumping engines, &c.

Questions may also be set on the chief types of machinery for certain shore purposes, such as cranes and other lifting and hauling apparatus, pumps, &c.

The other points that will be included in these papers are, principally:—Corrosion and preservation of boilers, &c.

Priming: causes, effects, and means of prevention.

Hydrometers: density of water in boilers. Problems.

Distilling apparatus: double distillers. Evaporators.

Fittings and arrangements for forced draught. Experience with forced draught.

Pumping, water-tight, fire, and communicating—telegraph and voice pipes, &c.—arrangements on board ship.

Lubricants and lubricating arrangements.

Elementary knowledge of practical iron and steel shipbuilding.

Procedure in fitting engines on board a vessel.

Necessary examination of machinery and boilers, &c., after being at work some time.

Wear and adjustment of various parts of the engines.

Repairs that can be undertaken afloat.

Objects of fitting separate feed pumps.

Expansion joints: use of, attention they require.

Cause, effect, and prevention of galvanic action due to use of various metals in the hull and machinery of ships, &c.

Raising steam, starting and stopping, precautions to be observed.

Points to be attended to in watch keeping. Hot bearings. Causes of low vacuum.

Racing. Objects and disadvantages of governors.

Details of screw propellers and paddle-wheels, &c. &c.

Illustrative sketches, where necessary, should accompany th answers.

Book recommended:—Sennett's "Marine Steam Engine."

Workshop Appliances and Practice.

The examination in this subject is intended to cover the following:—Descriptions, sketches and modes of working the various machines and machine and hand tools used in the construction of steam machinery and boilers, including the wear and the adjustments required.

Speeds for cutting various materials.

Nature of steel for and method of tempering and hardening tools.

Manufacture of certain special tools and appliances, *e.g.*, surface plates, &c.

The principal processes employed in turning, fitting and erecting machinery, in smiths' and coppersmiths' work, in boiler making, pattern making, and in the iron and brass foundries, with descriptions and sketches of the principal apparatus used.

Processes of galvanising, tinning, soldering, and brazing.

Temporary and permanent repairs in the workshop.

Book recommended:—Shelley's "Workshop Appliances."

Mechanical Drawing.

A paper will be set in this subject comprising:—The construction and use of scales.

Delineation of plane curves, such as the ellipse, parabola, hyperbola, spirals, &c.—Principles and practice of projection.—Conventional shading and colouring.

Construction of simple loci, both from geometrical and mechanical data, such as the practical setting out of curves described by particular parts of machines or linkwork.

Construction of curves from observed or tabular data involving the geometrical use of abscissa and ordinate.

Construction of a curve of areas.

Forms of teeth of ordinary spur and bevel wheels. Meaning of the terms—Pitch, pitch line, root, point, addenda, face, flank, &c.

Sketches of wheel and other gearing.

Sketches and working drawings of details of boilers, machinery, machine tools, &c.

At the examination, candidates will be supplied with rough dimensioned incomplete sketches of machinery details, and they will be expected to produce a complete drawing—two or more views projected one from the other—in pencil to a given scale, with separate drawings of details, if necessary.

Each candidate must also send in for examination rough sketches of some piece of machinery with a finished scale drawing made from them.

In the case of an engineer student at the training school, it must be certified by the chief engineer of the dockyard that, to the best of his belief, these are the work of the student unassisted.

In the case of a candidate for direct appointment, a certificate to this effect must be given by the professor of his college, or by a member of the firm at which he received his practical training.

In every case the candidate must sign a declaration that he has made the drawings and sketches himself without any assistance.

It is necessary that the rough sketches should accompany the finished drawings, as no marks can be given for drawings that are simply copies of others.

Candidates for direct appointments must give in their specimen drawings and certificates to the officer conducting the written examination in "Mechanical Drawing" at the time of that examination.

Engineering (Optional).

In this paper more advanced questions will be set on the subjects of all the preceding subjects.

Design of Machinery Details (Optional).

In this subject, although a general knowledge of the principles of design is expected, difficult mathematical investigations will not be required.

The chief points on which the examination will be based are—Experimental strength of materials used in machine construction; physical and mechanical properties; the straining actions to which the different parts of machinery are subject, and the influence of these actions in determining their dimensions; stress; strain; ultimate strength, limit of elasticity; factor of safety, &c.; simple problems.

Other considerations affecting design. Choice of materials.

Amount of steam space, and grate and heating surfaces allowed in boilers, and cooling surface in condensers.

The ordinary kinds of screw fastenings, proportions of bolts and nuts.

Design of the following:—Single, double, and treble lap and butt riveted joints for various uses—socket joints, knuckle joints, keys.

Detail design of piston-rod, propeller shaft, and flange coupling.

Dimensions of cylinder and slide valve ports.—Zeuner's diagram.

Thickness of boiler shells and furnaces. Diameter and pitch of stays.

Diameter of safety valves. Compression of safety valve springs, &c.

Tests of materials usually made to ensure their fitness for constructive purposes. Effects of heat on strength, &c., of steel, iron, copper, and gun-metal.

Metallurgy (Optional).

Characteristic physical properties of the useful metals:—Tenacity. Ductility. Elasticity. Plasticity. Conductive power, &c.

Iron.—Occurrence in nature. Principal methods of extracting iron from its ores.

Extraction as cast iron:—Calcination. Smelting. Blast furnace and fittings. Hot and cold blast. Fluxes, &c. Chemical action in blast furnaces.

Cast iron. -Manner in which carbon is associated. Varieties of cast iron. Chill casting. Remelting of cast iron. Foundry cupola.

Wrought iron.—Chemical and other distinctions from cast iron.

Manufacture from cast iron:—Refining. Puddling. Reverberatory furnace. Removal of slag. Rolling mills. Piling, &c.

Steel.—Mechanical and physical properties. Chemical and other features distinguishing it from cast iron and wrought iron. Conversion of wrought iron into steel. Cementation. Blister steel. Conversion of blister steel into shear steel and into cast steel. Properties and uses of shear and cast steel. Production of Bessemer steel. Description of converter and process. Siemens-Martin steel. Open hearth process. Steel castings. Annealing. Hardening and tempering steel. Blue heat. Precautions to be observed in working steel plates. Case hardening. Malleable cast iron. Properties, strength, and uses of iron and steel. Fractures of various qualities of iron and steel. Inferences. Cold shortness. Red shortness. Burnt iron.

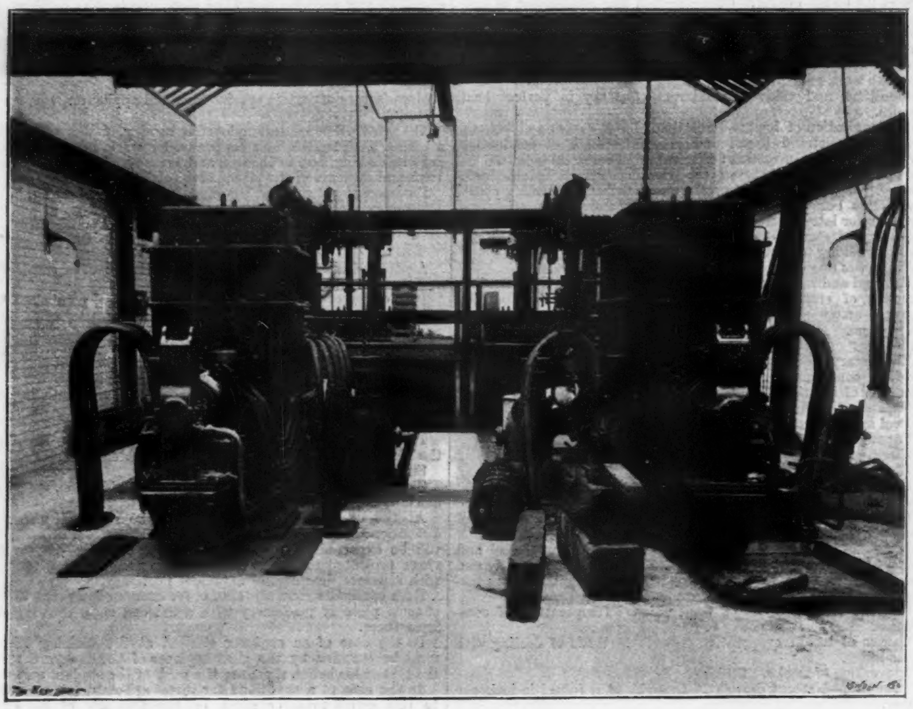
Copper.—Occurrence in nature. Extraction from its ores by Welsh process. Removing iron, and other foreign substances. Blister copper. Refining, &c. Effects of foreign substances on the quality of copper. Strength of copper. Properties and uses of copper.—Properties and uses of tin, zinc, and lead.

Composition and uses of the following alloys:—Gun-metal and brass for various purposes. Naval brass. Muntz metal. Delta metal. Phosphor bronze. Solder and spelter. White metal for bearings. Experimental testing of metals.

It must be borne in mind that some of these subjects are closely related to each other, so that questions may be set in any paper partly bearing on the subjects mentioned under another heading.

THE ELECTRO-CHEMICAL COMPANY'S WORKS AT ST. HELENS.

IT had been known for several years that by the agency of an electric current common salt could be resolved into caustic soda and chlorine gas. Until recently, however, experiments in this direction had been mainly confined to the laboratory, and had failed to obtain commercial results. It was not until the processes patented by Colonel Holland and Mr. James Richardson were invented that endeavour was successfully made to utilise this knowledge commercially. Works on a small scale were established by a syndicate at Snodland, Kent, where during two years the systems were practically tested. The results there obtained justified an extension of the undertaking, and the Electro-Chemical Company was formed.

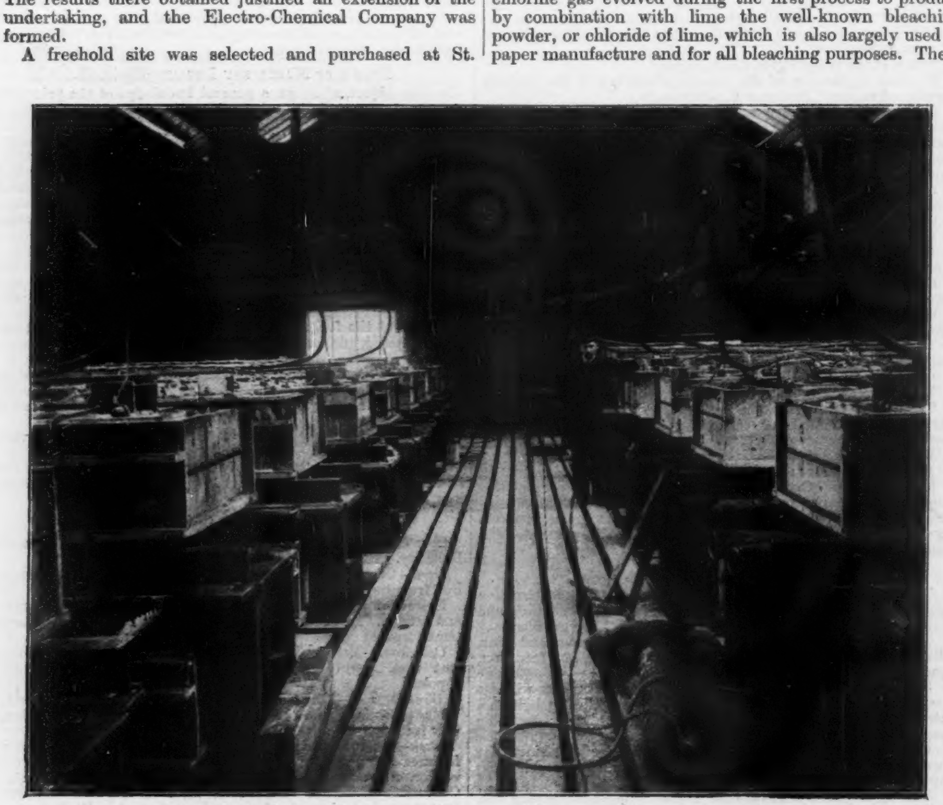


THE DYNAMO ROOM

A freehold site was selected and purchased at St. Helens, Lancashire, the centre of the chemical manufacturing industry. The area of this site is fifteen acres. It has a frontage of about 300 yards closely abutting on the mineral line of the London and North-Western Railway, from which two sidings afford ingress and egress to and from the company's works, throughout which rails are laid for locomotive use. A branch of the same railway bounds the site on one side, while on the other flows the St. Helens and Mersey Canal. On this the company has a wharf provided with a steam crane. Upon this site there have already been erected extensive buildings, large additions to these being now in progress.

The selection of the locality for the works was greatly determined by the proximity to coal pits. Dr. John Hopkinson, F.R.S., Past-president of the Institution of Electrical Engineers, when reporting to the syndicate, had based his calculation as to the commercial efficiency of the process upon a coal supply being obtained at eight shillings per ton, but all the fuel used at the works is now delivered at four shillings per ton.

Before describing the system of manufacture followed, it may be stated that its objects are by electrolysis to obtain with unprecedented economy, first, from common salt—chloride of sodium—the caustic soda of commerce. This is very extensively used in paper, soap, oil refining, bleaching, and numerous other manufactures and processes. A second object is the utilisation of the chlorine gas evolved during the first process to produce by combination with lime the well-known bleaching powder, or chloride of lime, which is also largely used in paper manufacture and for all bleaching purposes. There is, further, a third use to which the process can be applied, though as yet it has only been experimentally tried, this being the production of the chlorate of potash so largely used in the manufacture of explosives generally.



THE TANK HOUSE

The basis of the whole system is rock salt, which is obtained by railway direct from Cheshire at a rate for carriage of 2s. 6d. per ton; this low rate being common to all raw materials for chemical manufactures in and around the St. Helens district. The raw salt is treated in an agitator, being dissolved therein into brine of full saturation. After remaining for a time in settling tanks this brine is pumped up to the tank house.

The arrangement of the tanks in this building is a special feature. The present installation of these numbers two hundred, each tank being 20ft. long and 3ft. wide. The material used for them is slate, and they will contain in all 72,000 gallons of brine, a quantity which will yield under the process 100 tons of bleach and 60 tons of 70 per cent. caustic soda weekly. The tanks are grouped in ten sets of twenty tanks each carried upon iron girders. To these three intersecting platforms at different levels give ready access. Each tank is divided into thirty-two cells, these being provided in alternation with suspended anodes and suspended cathodes.

It may here be remarked that difficulties experienced as to the rapid wasting of the charcoal electrode points used as anodes in the earlier stages of trial, threatened to render nugatory the efforts made at Snodland to obtain commercial success. At length the alternative of using pieces of gas-rètort carbon was hit upon, and proved to be very efficient. A description of these novel anodes will be found later on; but it may be stated here that their life is found to be as extended as eight months. The cathodes are mainly cast iron grids, but other forms for these are now undergoing trial with satisfactory results.

The electric current is conducted to the tanks by copper cables laid along and above the centre of each. A strand is unwound from the cable at each cell, the diameter of it thus progressively diminishing. It is understood that this novel and very simple yet effective arrangement is a special patent owned by the Electro-Chemical Company. Each tank requires from four to five volts to send the 700 ampères through it necessary to the process. When the brine in the cells is subjected to the action of a current of the above strength decomposition immediately commences. From the anodes—which are suspended in cells closed at the top but open towards the bottom to permit the inflow of the brine—is given off the chlorine gas. This is drawn off as it forms through lead pipes, which convey it to an earthenware main, the flow being induced by an exhaust fan driven by a separate engine. The liquid caustic soda, which is attracted to the cathodes, passes through iron pipes on its way towards the evaporating room, the hydrogen gas given off at the cathodes escaping innocuously into the air. By an ingenious method which forms part of the patent, the strength of the brine as it weakens under these withdrawals is maintained by feeding common salt into the cathode cells, for doing which suitable so-called "pockets" are provided to each such cell. The strong caustic solution, being heavy, has a tendency to stratify at the bottom of the cathode cells. When this is deemed to be of sufficient strength it is drawn off, and any salt remaining undecomposed in it is separated before being treated finally by evaporation.

We may now follow distinctively the ultimate dealing with the two products thus obtained. The liquid caustic soda has been above described as having been started on its way to the evaporating room. This is provided with large cast iron evaporating pans, there being twelve of these in present use. In them the caustic liquor is evaporated until eight tons of it yield a residuum of one ton of crystal caustic soda, this part of the process occupying from four to five days. The product is then packed into iron drums containing 6 cwt. each, the selling rate of this quantity being 45s. at the present time.

The chlorine gas produced at the anodes has been named as having been exhausted into an earthenware main. Through this it passes into four absorbing chambers, each of about 12,000 cubic feet capacity. Lime of the best quality—obtained from Buxton by rail at a freight rate of 2s. 9d. per ton—is treated adjacent to these chambers and reduced to the finest powder. In this condition it is spread upon the floors of the chambers to a depth of from 5in. to 6in., the deposit being furrowed by coarsely toothed wooden rakes. The gas, being heavy, falls upon the lime and is rapidly absorbed, the admixture producing chloride of lime or bleaching powder of full commercial strength. This is removed through hoppers in the floors of the chambers, and is packed in wooden casks of a capacity of from 6 cwt. to 7 cwt. The present selling price of the bleaching powder is about £7 5s. the ton.

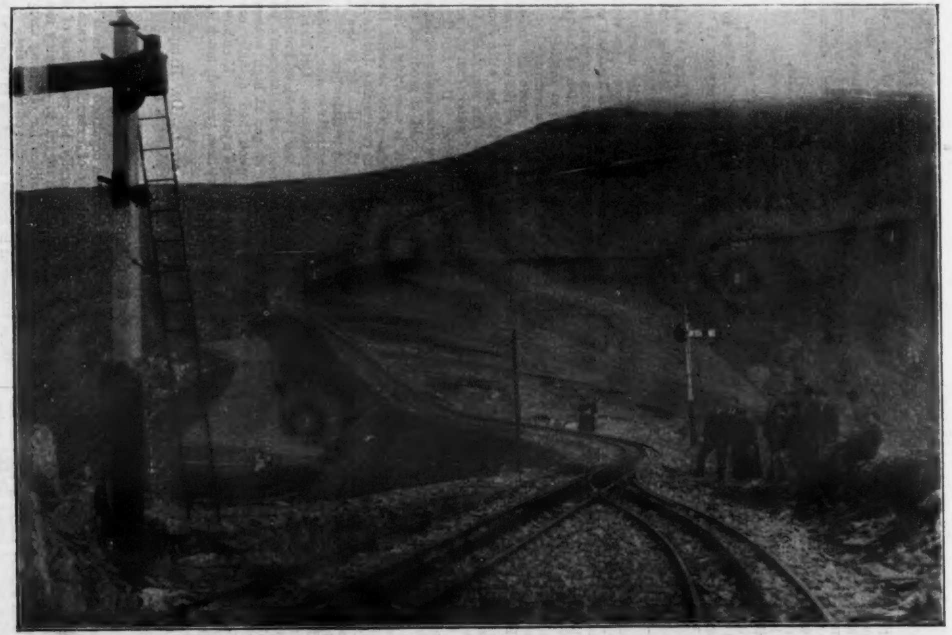
Having thus briefly described the character of the processes, attention may be turned to the machinery producing the electric current, the sole active agent employed in their operation. This is at present generated by two shunt-wound dynamos by Messrs. C. A. Parsons and Co., of Newcastle-upon-Tyne. These are driven direct upon the shafts of two of the same firm's steam turbines, the combination being technically known as Parson's parallel-flow steam turbo-dynamos. Separate condensers are worked by two of Messrs. Robey and Co.'s compound inverted engines, an excellent vacuum being steadily maintained. The revolutions of the turbines and dynamos number 3200 per minute. With a working pressure of 160 lb., each turbine developes 700-horse power. Steam at that pressure is supplied by a battery of five steel Lancashire boilers, each 30ft. long by 8ft. diameter, by Messrs. Beeley, of Hyde, one of the five being held as a reserve. The feed-water for these is from the town supply, and is stated to be very hard; that for condensing is freely obtained through a 16in. cast iron pipe from the adjacent canal, to which it is returned after use. The stack is situated about 200ft. from the boilers; it has a height of 180ft., with an average internal diameter of 15ft. A Green's economiser is fixed at the rear of the boiler battery.

Each of the two dynamos yields a working current of 3500 ampères, a total of 7000 ampères, which is subdivided into ten currents of 700 ampères each. A switchboard, by Messrs. C. A. Parsons and Co., provides for the distribution of these currents; upon it are two Weston ammeters for 4000 ampères each, and a Weston voltmeter, the ten currents being each provided with separate ammeters. From each side of the switchboard five cables lead to the decomposing tanks before described.

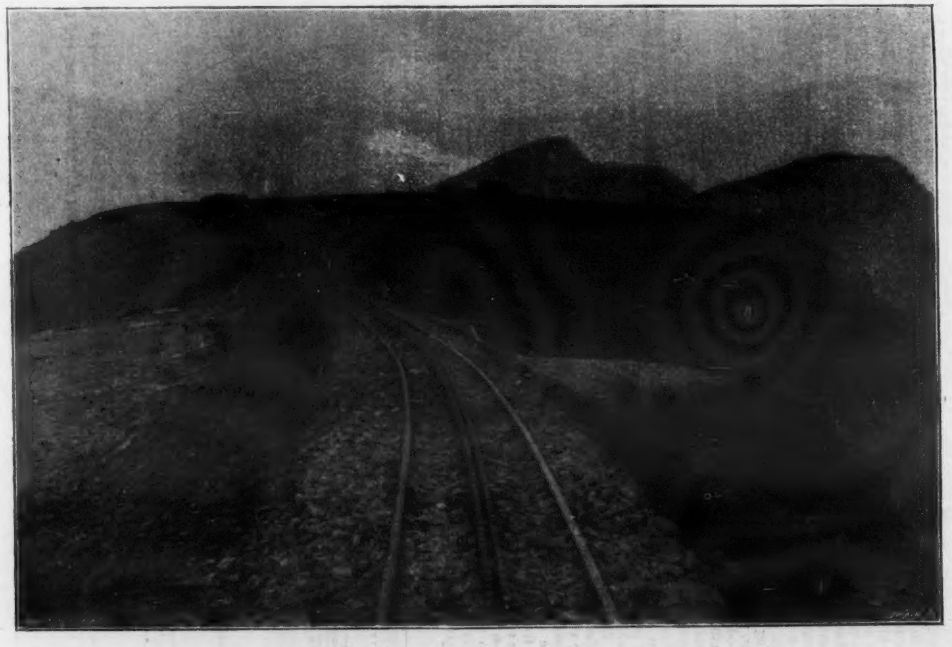
The advantages claimed for this electrolytic process are manifold. That of the first importance is cheapness.

THE ACCIDENT ON THE SNOWDON RACK RAILWAY

(*For description see page 375*)

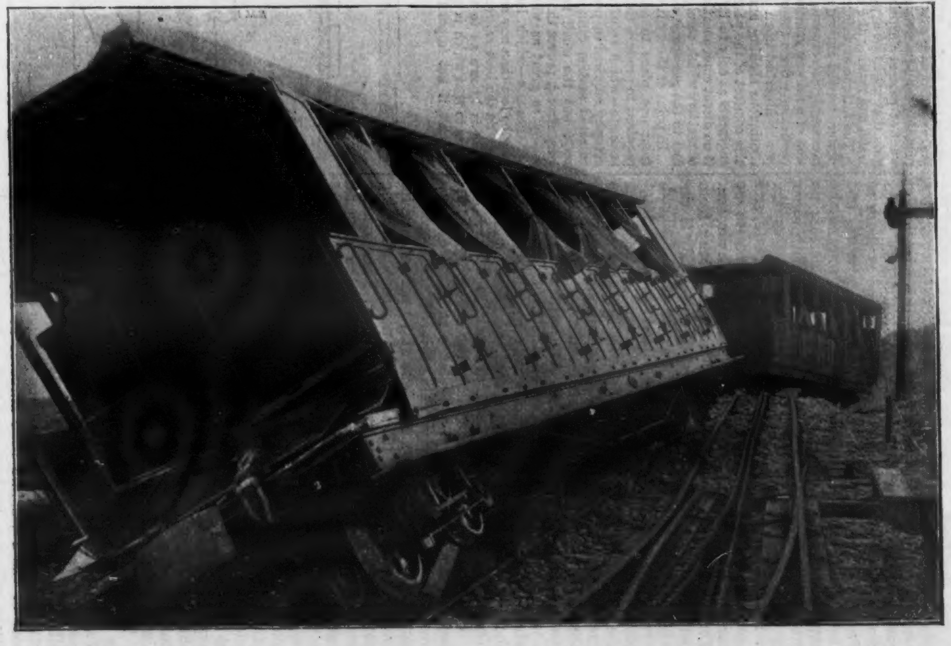


No. 1—VIEW FROM FINAL POSITION OF DERAILED CARRIAGES



No. 2—VIEW FROM POINT WHERE ENGINE LEFT RAILS

No. 3—VIEW FROM FRONT OF DERAILED CARRIAGES SHOWING SECOND TRAIN



No. 4—THE DERAILED CARRIAGES

The chairman of the company recently stated that by it both the caustic soda and the bleaching powder could be produced at about half the cost of that by any other system practised. Under the patents before named the use of diaphragms, which offer great resistance to the electric current, is dispensed with, while the adoption of gas-retort carbon for the anodes has completely solved the economic difficulty of the costly wastage of these at first experienced. The use of sulphur, pyrites, and manganese, being also dispensed with, not only is the expense of these costly agents saved, but there is no production of the noxious alkali "waste." With other processes, to produce one ton of caustic soda involves the production of from three to four tons of that waste, and streams adjacent to the works where such processes are carried on become poisoned with sulphuretted hydrogen. The working of the new system we can testify from personal observation to be wholly inodorous. By it the whole of the chlorine in the decomposed salt is utilised, whereas it is said that in the Le Blanc process at least 50 per cent. of this is lost. It is further claimed that the caustic soda produced is purer, as being wholly free from the sulphides or other sulphur compounds used in the older processes. As to this claim for quality, we may quote a report by Messrs. A. Norman Tate and Co., analytical and consulting chemists, of Liverpool, which certifies that the caustic soda manufactured by the company contains 70 per cent. of alkali, and the bleaching powder 37·4 per cent. of available chlorine.

It cannot create surprise that, the foregoing advantages being established, a very large measure of commercial success has already been achieved. The present capacity of output is about 60 tons of 70 per cent. white caustic soda, and about 100 tons of 35 per cent. bleaching powder, from 60 tons of common salt weekly. This capacity has been found quite insufficient to meet the demand upon the works. The chairman of the company informed a meeting of the shareholders held November 5th of last year, that all that could be produced with the present plant during 1896 had been sold in advance at "top" prices. It became necessary, therefore, to erect plant adequate to a great increase in production. Orders were at once placed for the required new machinery, and it is expected that this will be working within the course of the next three months, the required extension of the buildings to receive it being already well advanced at the time of our visit to the works.

The machines at present under construction will vary in types from that we have above described. Messrs. Yates and Thom, of Blackburn, have in hand four compound inverted cylinder engines, which will indicate in all 3600-horse power. They will be worked at eighty revolutions, and will drive by rope gearing eight dynamos, each of these yielding 1500 ampères at 180 volts. The works will then be furnished with a total of 5000 indicated horse-power, or approaching four times their present capacity of 1400 indicated horse-power.

We alluded in the course of our description of the processes to the success attained by the use of the new forms of anodes constructed of gas-retort carbon. It will be of interest to refer more particularly to these. The deposit which lines the retorts in gas manufacture has until quite recently been regarded almost as a waste product, it having little or no marketable value. On our late visit to the Electro-Chemical Company's works we were shown many tons of this carbon. We were struck by the difference in the grain and weight between such of this as had been obtained from London gasworks and that purchased from those in districts beyond that area. Anodes constructed with the London-produced carbon are found to have a materially longer life than those made of the country product. For the formation of these anodes the carbon is broken into rough pieces about the size of the hand, a lug being sawn upon each piece. Seven or eight of these are arranged in a frame which holds them inverted in the brine.

It is not within our province to express opinion as to the commercial value of particular systems, and we content ourselves with putting before our readers the statements made by the company. In conclusion, we would express our thanks to the courteous manager of the works, Mr. J. Leith, to whose perseverance and chemical and other experiences much of the practical success attained has undoubtedly been due, for the assistance and ready explanations afforded to us on the occasion of our visit.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

PERMANENT WAY.

Sir,—There is, as a rule, no more certain indication of power being wasted than when noise is made in connection with machinery. A train moving at high speed makes a great deal of noise. Probably many hundreds of men striking with sledge hammers on sleepers and rails would not make as much noise, or cause as much vibration as a passing train. Indeed the motion of a train at high speed produces an effect not unlike hammering, and, reasoning by analogy, the power of the engine must be largely consumed, not only in producing jolting, or visible vibration, but in setting up microscopic, or even molecular tremors in the ground and in the train. If a train could be made to move along the rails as sweetly and smoothly as the crosshead of the piston-rod glides along its guide bars it would be an ideal state of matters. This perfection of motion is, of course, impossible of accomplishment, but a consideration of what is theoretically perfect often points the way to practical improvement.

When one watches the wheels of a train passing slowly along the rails, the latter are seen to sink under the weight. When the motion of the train is very rapid the depression must be made as with a blow. It would therefore appear, that in order to avoid this shock, and consequent waste of energy, the weight should be brought to bear as gradually as possible. If this reasoning is correct, an engine having its leading wheels coupled—a type somewhat rare brings great weight to bear on the track instantaneously, and must therefore be more wasteful of energy than the type having a bogie in front, where more lightly loaded wheels depress the rails gradually. It has been noticed that the front of a train is, as it were, always running uphill. This is true, but it is not nearly the whole truth. The distance between successive wheels is usually so great that the rails spring up after each wheel has passed, so that the whole train may be said to be running up hill. Of course, when the speed is slow, this is a fallacious view, as the wheels may be said with equal truth to be running down hill. At highest velocities this downward slope behind the wheels gives probably no advantage, owing to the inertia of the track and its want of perfect elasticity. The accompanying diagram shows the gain that might be expected to arise from grouping the wheels in a train, and making the carriages of the long American type.

The fatigue experienced by a passenger is one result of engine power wasted through vibration or jolting. Vibration is not necessarily accompanied by great waste of power, but the vibration of a railway vehicle is accompanied with much waste of power, particularly when the load is not composed of rigid material. The power absorbed when hundreds of passengers are subjected to a continuous shaking and swaying is probably not inconsiderable. The comfort of the passengers is, perhaps, looked upon by railway engineers as only to be enhanced by expenditure for which there is no direct compensation. It will, no doubt, be found that a state of matters which results in smooth motion, and consequent comfort to the passenger, is a real practical economy.

In point of theory it does not require any power to move matter from one place to another on the same level beyond what is required to produce the rate of motion at which the transference is made—which is, of course trifling in comparison with the force actually required in practice. The resistance of the atmosphere to rapid motion cannot be materially diminished in any practical way, but the small retarding effect of head winds, even when very strong, proves that the resistance from this cause cannot be nearly so great as was at one time believed. Resistance from other causes—which, looked at from the theoretical point of view, may be less than any assignable amount—is in practice very great, even on the best railroads, when the speed is high. Apparently little is known as to the ratio which this great waste of power bears to that which is practically remediable; indeed, it would be difficult, if not impossible, to give even an approximation to the relative amount of power absorbed by the train and the track—that is, the amount of energy destroyed above, as compared with that destroyed below the surface of the rails. Certainly no small amount of force is necessary to produce the earthquake that always accompanies a train.

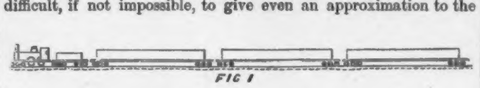


FIG 1

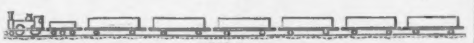


FIG 2

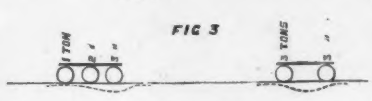


FIG 3

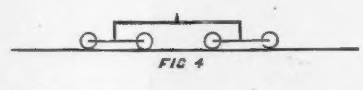


FIG 4

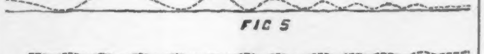


FIG 5

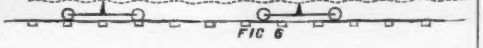


FIG 6

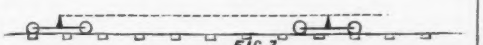


FIG 7

Fig. 1 is a train of long carriages supported on bogies, wheels all in groups, and as close as possible to each other; centre wheels without flanges. Fig. 2 is a train of ordinary carriages, wheels at nearly equal spaces apart. A comparison of the dotted lines showing rail deflection indicates the advantage of the former arrangement, which produces three deflections from the carriages as compared with twelve, and with slighter gradients. Fig. 3 shows the wheels of a bogie, weighted with successively higher amounts, compared with a case where the weight is equal on all wheels. Fig. 4 is a compound lever work to neutralise vibration. Practical value very doubtful. Fig. 5 indicates the path of a ball thrown along the ground, showing the effect of slight inequalities or obstacles in raising the ball when its motion is swift. Fig. 6 gives the wheel spaces agreeing with sleeper spaces, producing vertical vibration. Fig. 7 the wheel spaces regulated to prevent such vibration.
J. C.

Edinburgh, April 4th.

Sir,—It is with great surprise I read in The Engineer of 27th a letter headed Permanent Way, in which the writer states that in his opinion a road constructed absolutely rigid and uniform would be not only tolerable but perfect.

Past experience goes to show otherwise, for in the book, "Safe Railway Working," by Stretton, page 23, we see an attempt to obtain a firm permanent way was made upon the Manchester and Leeds Railway in 1839. One part of the line passed for some distance through a rock cutting, and instead of using sleepers the solid rock was dressed to a surface, and the chairs spiked directly to it. The company's officials concluded, and expected that this portion of the line would stand firm for ever. However, the road was so rigid that if a train passed over it at more than a walking pace, rails and springs were broken, and in less than three weeks from the opening of the railway orders were given for the rails to be taken up and placed upon sleepers in the ordinary way.

The lesson taught us here is that a certain amount of elasticity or give-and-take is required between the rails and the train. We all know, more or less, what a carriage without springs would be, and a rigid road would be like the carriage without springs. Again, the large amount of vibration caused to the locomotive alone would be very detrimental, to say the least. It is a well-known thing that iron, by constant vibration, becomes quite brittle. The parts of a locomotive now become very brittle quite quick enough. Therefore, no system of permanent way is required which will increase this difficulty. Whilst serving my time in the locomotive shops I have seen parts of locomotives taken down quite brittle and crystallised. Should in the future the permanent way be made rigid, as your correspondent advocates, there will be a very prosperous future for the manufacturers of springs.

April 7th. F. J. P.

CIRCULATION IN WATER-TUBE BOILERS.

Sir,—The following easy experiment may throw light on the difficulty which you discuss in your leading article of the 3rd, regarding the cause of circulation in boiler pipes, so far as it depends on the presence of bubbles of steam: Take two pieces of glass tube ½in. internal, connected by india-rubber tube, glass about 15in. long. Also a bottle with a good pouring lip, containing—only half-full—equal quantities, say, of sweet oil and water. Suck up some plain water from a jug to fill both tubes, and turn them up as a U. Suck up one till the water sinks in the other to the rubber tube, and hold it there by pressing the thumb tight on the top of the full limb, and then raise the empty limb till its top stands a couple of inches higher than that of the full limb. With the other hand shake up the bottle till oil and water are well mixed, and quickly fill the empty limb by its open mouth with the mixture to the level of the water in the thumb-stopped limb.

The apparatus is now ready for demonstration, the thumb being still tight pressed over the limb which has pure water in it; the liquids in the two limbs stand at the same level, but the limb containing water with loose drops of a lighter substance—oil—scattered about in it is a few inches longer than the other. Now remove the thumb, and let the liquid find its own level. What will happen? Circulation will instantly set in towards the limb which has the lighter drops of liquid scattered about in the water. The two columns are of the same height, and the same sectional area. One sinks down and the other rises up immediately to a certain point, and there they rest.

Is it not a good and sufficient explanation to say that the former is heavier than the latter?

Is it true to say that the reason why the oil mixture rises up is that the little drops of oil are all floating upwards, and entrain the water?
Senex.

April 6th.

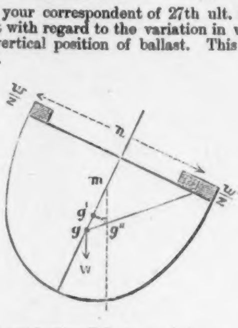
Sir,—I venture to point out a mistake in your last issue. On page 335 you have the following:—"The statement again, that in the Belleville boiler there is no circulation whatever in the commonly accepted sense of the word, evoked no contradiction from anyone present, and appears to be borne out by the behaviour of the large model shown at work, in which the bubbles of steam coursed regularly through the tubes, albeit no circulation of the water took place."

This is not in accordance with the following extract from my paper—see page 351 of same issue:—"When properly in action, the circulation is very vigorous and thorough, the alternate plugs of water and steam racing each other through the tubes of the element at a very high speed."
W. H. Watkinson.

Glasgow, April 8th.

NAVAL ARCHITECTURE—NO. IV., STABILITY.

Sir,—I think your correspondent of 27th ult. is hardly correct in his statement with regard to the variation in value of G M due to variation in vertical position of ballast. This seems to be not obvious *a priori*.



In the figure let G be the C G of vessel alone, and $\frac{w}{2}$ the weight of ballast placed on either side of middle line, and G′ the common C G of vessel and ballast; when $\frac{w}{2}$ is shifted across we have—

$$G' M = G' G'' \cot \theta = \frac{w x}{2 (W + w)} \cot \theta \text{ when } W = \text{weight or}$$

displacement of vessel.

Suppose x to remain constant for any vertical position of the ballast; now θ must be kept within the limits of inclination, for which the metacentric method holds true—*i.e.*, θ must be not > about 10 deg. Now for greater distances above G at which the ballast is placed, so θ will increase, since for same weight of ballast greater leverage of the latter results when vessel is inclined. Hence w must be reduced for higher positions of ballast if θ is to be kept within the limits, and hence $\frac{w x}{2 (W + w)} \cot \theta = G' M$ will be correspondingly reduced. Now G G′ will depend both on w and its vertical position, and it will be found that this vertical position will have greater effect on the value of G G′ than the diminution of w explained above, so that G G′ will increase; and since G′ M was diminished, there will be a tendency to compensation, so that G M (= G G′ + G′ M) will remain practically the same.
B. C. Laws.

Royal College of Science, S.W., April 2nd.

THE LIQUEFACTION OF GASES.

Sir,—The theory put forward by "Zero" as to the action of Dr. Hampson's machine for liquefying oxygen is very interesting but not quite convincing.

He says, "there is no loss of energy or heat at all from the apparatus as a whole." But energy or heat is being steadily expended on the apparatus by a steam engine; what becomes of it? If it cannot get out and is being stored up in the machine, why does not the latter burst, or get red hot, or do something violent? If cold is localised at one point, heat must be localised at another, and with the accumulation of oxygen from which heat has been abstracted there must be an accumulation of heat in some part of the apparatus. On "Zero's" theory, in the felted cylinder there ought to be a hot place which gets increasingly hot the longer the apparatus works. Does experiment prove this to be the case?

Experiment, too, would easily settle the correctness or otherwise of "Zero's" contention that what he calls Joule's effect has nothing to do with the working of the machine. Let compressed hydrogen, at the temperature of water from the main, be passed through Dr. Hampson's machine. If "Zero" is right, the hydrogen will behave as oxygen does under similar circumstances and produce cold. But if no cold is produced there will be a presumption that Joule's effect is operative in the matter, and that "Zero's" theory is wrong. The issue of the experiment would probably lead "Zero" to re-examine Joule's and Thomson's results, and he might find in them the key to the explanation of the thermo-dynamic puzzle that troubles him.

He is filled with pity for "dogmatic science," and for the thermo-dynamic blindness of learned professors. But he might remember that "dogmatic science," in the person of Professor Dewar, did originate an apparatus, in which, as in Hampson's, intense cold was produced by the expansion of gas at high pressure through a minute orifice before Hampson had actually constructed his machine, and before he received a patent. Even now, I believe, Dr. Hampson's patent has not yet been granted, much less published.

April 6th. Cryos.

[Our correspondent is in error. Dr. Hampson obtained his patent on the 23rd of May, 1895.—Ed. E.]

CANAL AND LIGHT RAILWAY LEGISLATION.

Sir,—A movement has been organised in Ireland to press on the Government the desirability of extending to canal construction, and to river navigation generally, the provisions of the forthcoming Light Railways Bill with regard to obtaining money on loans from the Treasury, and facilities for obtaining inexpensively the necessary Acts for the construction of the works.

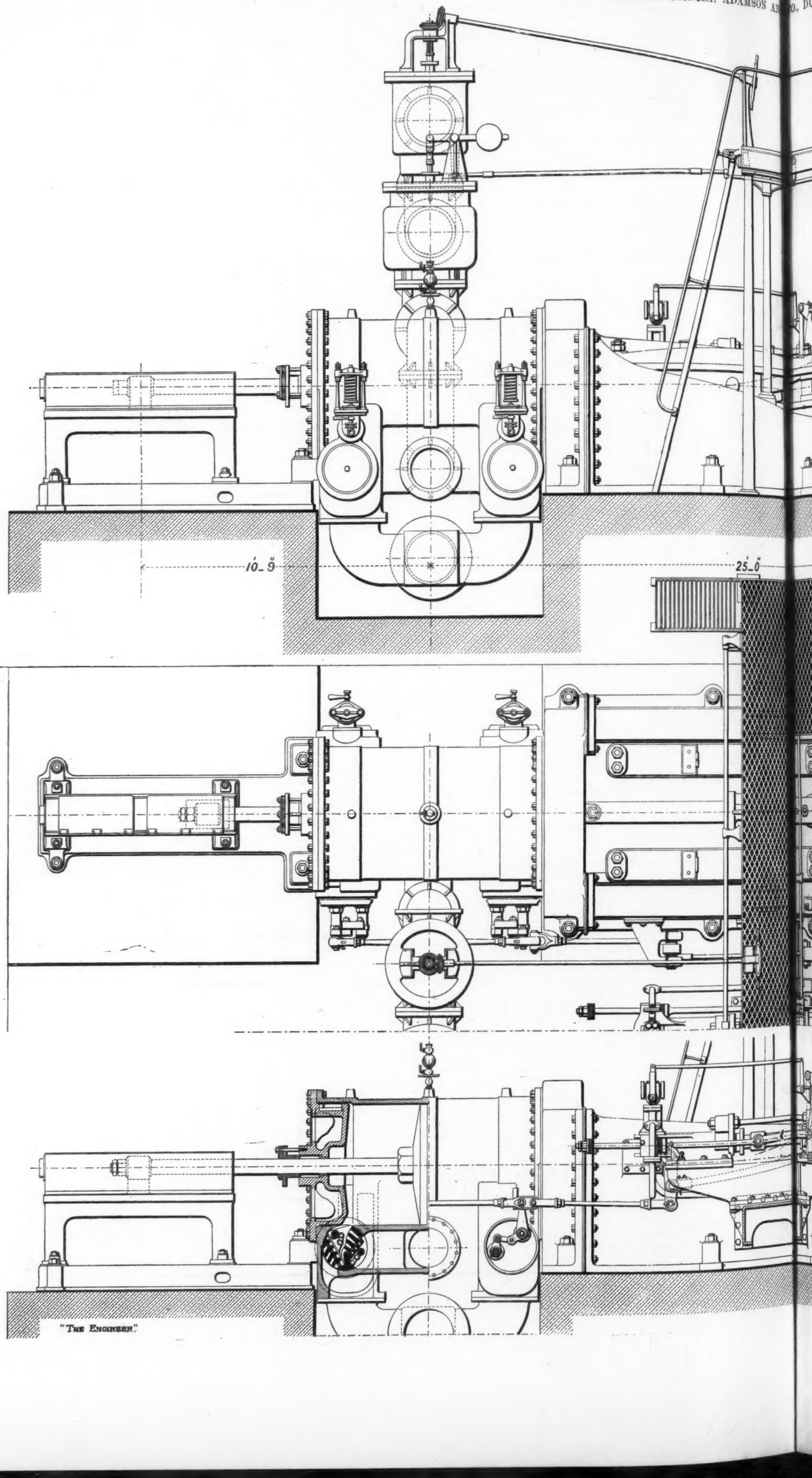
Those interested in inland navigation in England would do well to avail themselves of the present opportunity by supporting the movement made on this side.
E. A. Hackett,
M. Inst. C.E.

County Surveyor's Office, Clonmel,
Co. Tipperary, April 1st.

(For continuation of Letters see page 377.)

ROLLING MILL ENGINES,

MESSRS. DANIEL ADAMSON AN O., DU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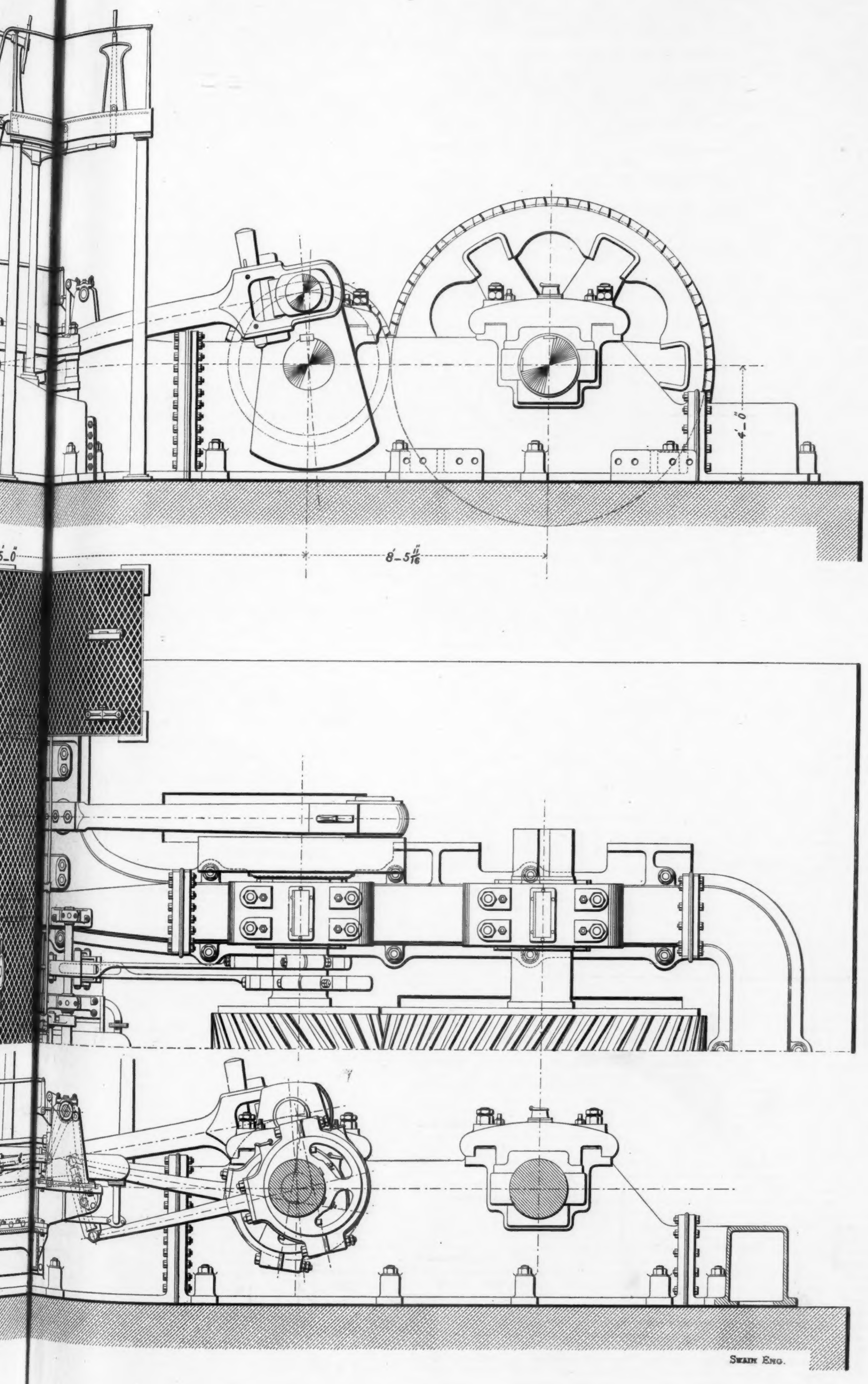
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TO CORRESPONDENTS.

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**** We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

E. BEADLE.—*It is generally believed that the use of a tube for ignition, as in the case you mention, is free to all.*

A. E. E.—"*A Treatise on Marine Surveying,*" *by Rev. J. L. Robinson, M.A. London: Macmillan and Co.*

A.D.—*The centrifugal pump does not know whether its axis is horizontal or vertical, and its efficiency will be the same in either case, other things being equal. The height to which the water would be lifted if the pump had an efficiency of 100 per cent., would be that due to the velocity of the circumference of the revolving wheel in feet per second, or* $\frac{v^2}{2g}$, *which means the square of the velocity, divided by 64·2. But the efficiency will be less than 100 per cent., and the lift will be less in proportion. A good wheel has been found, with a circumferential velocity of 37ft. per second, to carry a head of 18·21ft., instead of about 21·5ft., the theoretical column. Very good pumps will carry a 90 per cent. column. It is understood that there is no discharge. Your pump would carry a theoretical column of about 8ft. If it carries 7ft. in practice its efficiency is very high, about 87·5 per cent*

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, April 16th, at 8 p.m. Paper: "Telephone Exchanges and their Working," by Dane Sinclair, member. Discussion.

ROYAL INSTITUTION OF GREAT BRITAIN.—Thursday, April 16th. Afternoon Lecture: "Recent Chemical Progress," by Professor Dewar, M.A., LL.D., F.R.S., M.R.I. Friday, April 17th, at 9 p.m. Paper: "Colour Photography," by M. G. Lippmann.

THE INSTITUTION OF MINING AND METALLURGY, LONDON.—Wednesday, April 15th, at 8 p.m. Paper: "Transmission of Power by Compressed Air at the North Star Mine, Grass Valley, California," by Mr. P. R. Robert, member.

CLEVELAND INSTITUTION OF ENGINEERS.—Monday, April 13th, at 7.30 p.m. Papers: "The Economical Utilisation of Waste Gases from the Blast Furnaces," by Mr. Archibald S. Keith. "Electric Tramways," by Mr. Phillip Dawson, C.E.

SOCIETY OF ARTS.—Monday, April 13th, at 8 p.m. Cantor Lectures: "Precious Stones," by Professor Henry A. Miers, M.A.—Lecture I. Wednesday, April 15th, at 8 p.m. Paper: "Early English Organ Writers," by Burnham Horner. Dr. E. H. Turpin will preside.

THE SOUTH STAFFORDSHIRE INSTITUTE OF IRON AND STEEL WORKS' MANAGERS.—Saturday, April 11th, at 7 p.m. Paper: "Suggestions on the Report of the Delegation, organised by the British Iron Trade Association, on the Iron and Steel Industries of Belgium and Germany," by Mr. H. M. Punnett.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, April 14th, at 8 p.m. Papers: "The Thirlmere Works for the Water Supply of Manchester," by Mr. G. H. Hill, M. Inst. C.E. "The Vyrnwy Works for the Water Supply of Liverpool," by Mr. G. F. Deacon, M. Inst. C.E. Friday, April 17th, at 8 p.m. Paper: "Recent Developments in Lighthouse Engineering," by Mr. Nicholas G. Gedye, Stud. Inst. C.E. Mr. W. T. Douglass, M. Inst. C.E., will preside.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, April 15th, at 7.30 p.m. Papers: "Mean Amount of Cloud on each day of the year at the Royal Observatory, Greenwich, on the average of the fifty years 1841 to 1890," by William Ellis, F.R.S. "Atmospheric Dust Observations from various parts of the World," by E. D. Fridlander, B.Sc. "Analysis of the Greenwich Rainfall Records from 1879 to 1890, with special reference to the Declination of the Sun and Moon," by Major H. E. Rawson, R.E., F.R. Met. Soc.

THE INSTITUTION OF JUNIOR ENGINEERS.—Friday, April 17th, at 8 p.m. Paper: "Dredgers," by Mr. Walter J. Hunter, member. Synopsis: I.—General considerations in designing dredgers. II.—A short description of the various classes of dredgers. *a.* Bucket ladder dredgers. *b.* Hopper dredgers. *c.* Other classes of dredgers: (1) sand pump, (2) grab, (3) pneumatic, (4) land, (5) spoon barges, (6) other dredgers, (7) unloading apparatus. III.—*a.* Description of a dredger built for the Peruvian Corporation. (1) Vessel, (2) machinery—boiler, engines, driving gear, bucket ladder, top and bottom tumblers, buckets, shoots, ladder hoist gear, crabs, &c.; (3) cost of dredging. *b.* Description of a dredger built for the Leeds and Liverpool Canal Co.: (1) considerations in designing the hull, (2) vessel, (3) machinery—boiler, engine, driving gear, stern delivery, &c.; (4) cost of dredging. The paper will be illustrated by diagrams.

SOCIETY OF ENGINEERS.—Monday, April 13th, at the Royal United Service Institution, Whitehall. Paper: "The Water Supply of Small Towns and Rural Districts," by Mr. Percy Griffith. Synopsis: Scarcity of published matter relating to—Points of difference between large and small works—Ownership by local authorities—Facilities for purchase—Advantages and disadvantages of municipalisation—Supply by meter *v.* supply by rate—Application of meter system at Abingdon and Malvern—Reasons for success—Borehole pumps *v.* well pumps—Improvements in pumping machinery—Matthews' system of running small pumps at high speeds—Riggs' high-speed pump—Pearns' outside packed ram—Halstead Waterworks Extensions:—Description of well-sinking, pumping machinery, reservoir, &c.—Godalming Waterworks:—impounding reservoir—Cost of pumping by means of gas engine—Oil engines for pumping purposes—Description of works at Blandford, Fenny-Stratford, Swanland and Sonning—Results of tests showing costs of pumping—Appendix statistics of thirty small waterworks.

THE ENGINEER.

APRIL 10, 1896.

THE LAST MEETING OF THE INSTITUTION OF NAVAL ARCHITECTS.

WE have been told that the last meeting of the Institution of Naval Architects was a great success. We have been assured that it was a remarkable failure. Both statements contain some truth. Both represent a misapprehension of the facts. All depends on the sense in which the words failure and success are used, and this again turns on the conception which is formed by the individual expressing an opinion as to the object, scope, and functions of the meetings of this or any other society. If the purpose of the council is to get together a number of papers to be read, and overflowing audiences to hear them, then the last meeting was, like most of its predecessors, an unqualified success. If, on the other hand, the object had in view is the advancement of naval architecture and things cognate, then we fear it will have to be admitted that the meeting was a failure. It was a failure not so much because the papers were not good in themselves, as because they were not suited to the situation; it was a failure because those present did not utilise the papers. It will be instructive, we think, to elucidate this proposition a little in detail.

The papers read may be divided into two classes—the practical and theoretical. In the first we shall place two already reproduced in our columns on water-tight doors in bulkheads. Both were excellent of their kind, but the audience quite failed to take any advantage of that excellence. The naval officers—the admirals—had it all to themselves. Colonel Soliani's paper was scarcely mentioned. Lord Charles Beresford's paper was used as a text not for a discussion on bulkhead doors and their construction, but for an attack on the Admiralty by one party and its defence by another party. The two sides would hear of no compromise. The one cried, "away with water-tight doors altogether;" the other said "we cannot do without them." Positively not one word was said or heard about bad and good methods of constructing such doors. No engineers or shipbuilders had a word to say on the point. A couple of inventors managed, indeed, to squeeze a word in edgeway, but they might just as well have been silent. There can be no doubt but that the reading of these two papers was a waste of time. Everything that was said could equally well have been said if the president had tossed to the meeting as a subject for discussion, "Have we too many water-tight doors or not in the bulkheads of her Majesty's ships?" A couple of hours were expended in discussing this point. But the impartial observer will ask, What possible effect will all this have on the construction of our men-of-war? And the answer must be simply that it will have no effect at all. Now it seems to us that Colonel Soliani's paper deserved a better fate. It is certain that we must have such doors. Surely an expression of opinion as to bad and good methods of construction is before all things about them desirable. There are at least half-a-dozen different systems of working such doors in use. Which is best? It was a remarkable fact that some 300 gentlemen—engineers and shipbuilders and shipowners and naval men—could sit quietly and express no opinion nor supply the least scrap of useful information on this subject. If it is true that there was nothing to be said, then why select such a subject for discussion? If, as we believe is the fact, a great deal remains to be said, and said with advantage, why was the discussion permitted to take the turn it did, leaving the important issues entirely unnoticed. The speakers being all far more anxious to win a dialectical success than to advance knowledge, the proceedings were appropriate to a debating club rather than to a representative scientific assemblage.

It may be said that naval officers talked about the points that most interested them, and that not being engineers, they left constructive details untouched. This is true so far as it goes. But the naval officers left Mr. Kinghorn's excellent paper on salvage appliances severely alone, and so did everyone else. The discussion simply collapsed; no one seemed to be disposed to say anything about it. Are we to assume that the subject was not sufficiently important? Perhaps not. It remains, then, to say that it was not suitable to the audience; but it would be very difficult, we think, to prove this. There must have been many persons present who knew a great deal about the subject, and yet preferred to keep silence. Thus, then, we find that the discussion on two very practical papers broke down. As regards the first, as we have said, the speakers ignored the paper and ventilated their opinions on a single point. As regards the latter, no one took the trouble to speak at all. But we may go through the whole list and find that, without any exception, the discussions were poor and inadequate. Take, for example, Mr. Seaton's paper, which we give in full this week. It bristles with points for debate. Such a paper read before the Iron and Steel Institute, for example, would most probably have been followed by an exhaustive discussion, in which eminent metallurgists and steel makers would have taken part. We have gone carefully over the report of the discussion. We give in another place its gist. We have done our best to pick out all that was worth reproducing in our pages, and we ask our readers what it all amounts to? Pages will be occupied by it in the "Transactions." Will the utterances of the speakers modify in the slightest degree future practice? Will, for instance, the fact that Mr. Manuel uses shafts so large that, according to Mr. Seaton, they might just as well be of cast iron as of forged steel, induce Mr. Seaton or anyone else to reconsider his practice and put in bigger shafts? Is it at all likely that Mr. Manuel thinks that cast iron would do just as well as wrought steel? Was any human being the wiser after the discussion than he was before?

The waste of time was appalling, and we confess we do not see how waste can be avoided in future. According to the rules of the Institution, no one should speak for more than ten minutes without the express permission of the meeting. But according to its practice, every one who stands up to speak spends a large portion of the ten minutes in a more or less personal laudation of the writer of the paper; and this, although as often as not he occupies the rest of the time in tearing the writer's arguments into shreds, and in telling the meeting that the paper is a mistake from first to last. It should be a rule of the Institution that laudation should be taken as understood; much valuable time would be saved in this way. But nothing causes such waste of time as the so-called reading of mathematical papers; every one knows that these things cannot be read aloud with any advantage. It is equally well known that they cannot be discussed with any benefit except by those who have read them carefully, and then even if such persons are present and speak, the bulk of the audience entirely fail to comprehend what is going on. All such papers should be taken as read, and printed in the "Transactions," with such written communications in the way of discussion as may be approved by the council or secretary. We have more than once said that we think three-day meetings once a year in London are a mistake; but the greatest mistake of all is to attempt to crowd into these three days work for six. Take Professor Watkinson's paper, or lecture rather, on water-tube boilers. A whole morning sitting might have been devoted to that lecture alone with advantage, instead of the fag end of one evening. There is no due sense of proportion about regulations which permit of such arrangements being made. There is reason to believe that either the Council do not attach much value to discussions, or that they are unable to find adequate speakers. But surely an improvement could be effected. We can call to mind papers and discussions which were in all respects everything that could be desired; but the papers were specially intended to be discussed. In effect it seems to us, and to many others as well, that the Institution attempts too much, and that a smaller number of better papers—better from the point of view of the conditions under which they are used—would give more satisfactory results. The discussing power of the Institute requires cultivation and development. The Institution of Naval Architects has done such excellent work in the past that its performances are judged by a very high standard; it has a considerable, if not great, reputation to live up to. We have criticised the Council, but the Council cannot accomplish impossibilities, and unless the general body of members exert themselves to make the proceedings of the Institution valuable, failure must be the result. Improvement is needed in many respects, in none more than in the proportions and conduct of discussion.

"IF THE COLLIER KEEPS THE PEACE."

This phrase was recently used by the director of one of the largest steel concerns in Sheffield, and repeated by two others this week. It expresses picturesquely the unrest at present disturbing industry in view of an anticipated renewal of difficulties in the coal trade. It is proverbially a foolish policy to meet troubles half-way, but this kind of trouble has got to be met more than half-way. It has got to be faced. The meetings already held of the Conciliation Board show an acute cleavage between coalowners and coalgetters, as represented on the one hand by the masters' executive, and on the other by the miners' leaders. The position of the coalowners may not appear to superficial observers to differ from that of the colliers. Both express a desire for the continuance of the Conciliation Board for another couple of years, but each wants it in a different way. The position taken up by the Miners' Federation is simplicity itself. "We want," in effect, says Mr. Benjamin Pickard, M.P., "recognition once for all of the principle of a minimum and a maximum wage." These are not his exact words, but they appear to be the practical outcome of them. Nor does he insist so strenuously upon a maximum wage as upon a minimum. Mr. Pickard's contention all along has been that wages should never go below what he calls a "living wage." What the "living wage" precisely is, and how it is always to be secured, has not been explained. But Mr. Pickard leaves nobody in any doubt as to what he sets down as the minimum wage. He desires the rate of miners' remuneration to be fixed on the present standard—that is, retaining the 30 per cent. advances on 1888. It is here that the coalowners come into issue with him. They point out that since the arrangement which terminated the coal war of 1893 the value of coal has gone down very considerably, and that the wages now being paid are not only in excess of what that value admits of, but are actually in excess of the rate paid in other and competing districts. For example, the seaborne coal, which comes from Northumberland and Durham, has the advantage of cheap water carriage to the metropolis. This enables the northern colliery proprietors practically to command the bulk of the London market. They have the further advantage that their miners are receiving from 10 to 15 per cent. less in wages. Outsiders may ask why it is the northern miners consent to take so much less than their brothers in the Midlands. The answer is easy enough. The northern coalfield is not bound by the decisions of the Miners' Federation, and the miner being free to follow the bent of his own inclination, he regards wages as the amount of money taken home at the week end, and not the amount per ton he receives for his labour. The Yorkshire, Derbyshire, Notts, Lincolnshire, Leicestershire, Warwickshire, Cheshire, and Lancashire miners are content to take an extra amount per ton for their output and work less in the week. It thus comes about that the coalfields of England present the singular spectacle that in the districts where the rate of pay is highest the week's wages are lowest, and in those where the rate of pay is lowest the week's wages are highest. The inevitable issue of it all is that while northern collieries are doing fairly well, the Midland collieries are doing very badly. It is stated, and believed to be true, that only one colliery in three in the Midland district is paying. In many cases the pits are being continued at a loss, a policy which, of course, can only last for a certain time, and there are many collieries where the machinery is simply being turned round without any gain whatever. All this can only have one end. It has already had its ending in the case of most of the small collieries, not a few of which have gone to the wall, and others are rapidly drifting that way. Every day it becomes more and more apparent that the work of the future is to be in the hands of the great coal concerns, such as are now opening practically virgin coalfields under conditions which admit of vast output at a low price. There are coalowners in the Midland district who are concerned both in the old style of collieries and in the new. It would be hard to find any of the old collieries where any hope of profitable work is entertained. The eyes of the owner, even in that case, are fixed upon his new collieries, where mechanical appliances are as perfect as can be procured, and the man indeed is elbowed out of the pit as much as possible by the machine. All these things do not make for the benefit of the miner, and the coalowner frankly tells him so. But the miner is loyal to his Union. All that he says is this—that to-day, though working less than he used to do, he is getting more money for it; and this seems to fit in with the humour of the majority of the Midland miners. There is, of course, an intelligent minority who hold with their brethren in the North that the wage is not what one gets per hour or per ton, but what one takes home at the week end. But then that is not the policy of the Unions, and the men themselves cling to the present condition of affairs in the hope that somehow or other they will yet have a full week's work at the full wages they are now receiving. They never believe—they are counselled not to believe—what coalowners state about losses made down the pits, and they blame the coalowners themselves, thus again following the argument of their leaders, for the low values obtained for coal as due entirely to the keen competition between coalowners for the orders in the market. Mr. William Parratt, one of the ablest of the Yorkshire miners' agents, stated very plainly at Barnsley, on Thursday, that if coalowners would agree that coal should not be sold below a certain price, they would be "black sheep" who sold below that price, "and the men would help them to punish the black sheep by stopping their pits and not allowing them to work until they repented of their error, as the men would go in heart and soul for keeping up prices and wages." From such utterances as these and other signs, it is quite clear to-day that there is danger ahead. The Miners' Federation say now, as they said in 1893, "No Reduction." What is more, they demand that under no circumstances whatever shall there ever be a reduction below the present rate. They interpret the proposition of the employers as meaning practically the establishment of a sliding scale which shall regulate wages according to values. Outsiders regard that as a sensible solution of the problem, but the miners' leaders take a diametrically opposite view. They candidly declare that they have done with the law of supply and demand. They hold that instead of values regulating wages, wages in future shall regulate values. Nor do they merely hold that doctrine. It has been cordially endorsed by the various lodge meetings throughout the Midland districts, and those here and there who dissent are as the voices of a few crying in the wilderness. That is where the difficulty is greatest. Coalowners say that they cannot continue unless the cost of output is reduced, and there is only one way left to reduce it, and that is in regard to wages. The miners' representatives put their backs to the wall and practically say—"You can help yourselves if you please. You can stop cutting each other's throats in the market, and get better prices for your product. Under any circumstances we are not going to work to let you give your coal away, and we will submit to no alteration which means less money per ton than we are now receiving." The various miners' lodges are to be "ballotted" on this point. No one who knows the coalfield can doubt what the answer will be. They will follow their leaders, and the coalowners will be face to face with the old difficulty of carrying on their industry under conditions which prevent profit, or of engaging in a fresh conflict to enforce concessions which are voluntarily refused. Things, it is to be hoped, will not come to the worst, but if a great calamity is to be averted there will have to be a much clearer and brighter understanding between both parties than there seems any prospect of while this is written.

THE GREAT MAP OF THE WORLD.

The idea of constructing a map of the world on a very large scale has long been a favourite one with geographical and other learned and scientific societies both at home and abroad. Some four or five years ago the matter was seriously and energetically discussed at an important international Congress which met at Berne. For some time the project was held in abeyance, but has recently been revived with encouraging prospects for its future execution. Although we have termed the scale a very large one, it may not perhaps appear to be so when it is stated that it is to be a natural scale of one millionth. This is equivalent to nearly 15¾ miles to the inch, which, supposing the two hemispheres to be projected on the same plane, would make the map 100ft. long. While the general consensus of those who have studied and investigated the subject appears to be nearly unanimous with regard to its ultimate value, yet it is admitted that many and grave drawbacks—we will not call them objections—exist with reference to its present practical adoption. It is the same with the proposed new map as with any other novelty of merit, improvement or reform which modify, and even sometimes completely subvert previous ideas, habits, and methods of accomplishing the same results. There must always be, more or less, a wrench when the change does come, and the proper course to adopt is to render the pressure as light and as bearable as possible. It must be borne in mind that English people, as a rule, are averse from change, though by no means averse from progress. On the contrary, they are in one sense the most progressive people in the whole world; but they prefer to make the advance and to progress in their own way, and they are also perfectly well aware that "change" is not always a synonymous term with progress.

It may not appear at first sight that there is anything particularly novel or interesting in the construction of a map of the world on a scale hitherto unattempted. Nor is there; but in connection with the project there are some attendant changes and results to which we propose to call attention, which may materially affect the subject of international time and the interests of navigation and navigators. Among these the principal are, the unification of a prime meridian, combined with a new reckoning of time and a uniformity in, at least, linear measure.

Were we disposed as a nation to regard this subject from the purely selfish point of view, we could afford to do so with more justice than the majority of our neighbours, but the interests of science and of international relationship would be at a great disadvantage if cold water were thrown upon the discoveries, inventions and industries of other people, together with their practical applications, by those who were not so immediately affected by any proposed novelty. It is well known that our meridian of Greenwich does not fulfil all the conditions desirable for so important a starting point, which could moreover be ensured by the selection of a new and universal departure. Nevertheless, at the congress held at Washington in 1884, twenty-two of the States represented there were in favour of the adoption of our meridian. Among other reasons, it was alleged, on the score of economy, that at the time the great majority of marine charts and maps were delineated with the degrees of longitude, commencing at Greenwich. No actual resolution was arrived at, because neither France nor Brazil would give their adhesion to it. Admitting for the moment that the expense—which would be very large—of providing new maps and charts, instruments, timekeepers, and other appliances indispensable to the adoption of a different zero of longitude, would be justifiable, and would in the long run repay the outlay, there are other considerations which, if they do not exactly militate against the proposed alteration, have fair claims to be heard on the other side. In 1882 the number of charts printed for the Royal Navy, the Government, and the general public was 230,000. It is very questionable with regard to astronomy, for instance, whether the meridional unification would be altogether a boon. In England, France, Russia, and other principal nations the initial meridian passes practically through the chief observatories of those countries. This coincidence is particularly favourable in making many celestial observations, and very much facilitates the working out of the arduous and difficult calculations and valuable series of tables for which we are indebted to the able astronomers stationed in different parts of the world. Again, it is extremely doubtful whether the establishment of a fresh zero of longitude would lead to a corresponding alteration in the general reckoning of time. As it is, with the exception of Greece, the greater part of the central and southern countries of Europe have already committed themselves to the adoption of a time which would not indicate noon at any of the meridional localities suggested as preferable to those already in use. Nearly all the principal European Powers have virtually given their adhesion to the recognition of the time of Central Europe, and the division of the day into twenty-four hours. The railway stations in Italy have recently employed clocks with dials which show both the old and new hourly notation. Our readers will probably recollect that some years ago attempts were made to introduce the twenty-four-hour dials in watches and clocks here. Some were purchased, possibly more from curiosity than any other motive, but the movement fell through.

More than two centuries ago Hierro, one of the Canary Islands, was put forward by the French geographers to receive the honour of being selected as the *locale* of the first meridian, but since it was reckoned as exactly 20 deg. west of Paris, its individuality was merged in that of the French capital. As a suitable zero of longitude its fame dates as far back as 140 B.C., when it formed one of the "Fortunate Isles," which was the title given by the ancients to the present Canary Islands. The Arab geographers had also reckoned their longitude from the same locality. One of the recommendations put forward in its favour at the Congress of Washington was that it did not traverse the site of any established observatory, and that its anti-meridian passing through the antipodes possessed especial advantages from a terrestrial point of view. Previously to the Assembly in America, the Seventh International Geodetic Congress held at Rome had pronounced in favour of the unification of the longitude and hour with those of Greenwich. Apart from other considerations, the economical reasons for adhering to the English first meridian are enormous. Even the opponents of the present, or perhaps we should say, the advocates of another datum point, admit the value of the existing maps and charts referring to, and based upon the Greenwich zero, and that it would require an outlay of over a couple of millions to replace them by substitutes. The production of the proposed map itself, in the number of proof sheets necessary to complete the total, is estimated at about a quarter of a million. It will be some time yet before, in the supposed interests of international science, geography, and astronomy, we shall have to shift our meridian in coincidence with that of the Canary Islands.

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THE MERSEY AND IRWELL JOINT COMMITTEE.

Mr. R. A. Tatten, M. Inst. C.E., presented his annual report at the meeting of the Joint Committee of the representatives of the County Councils and County Boroughs of Lancashire and Cheshire, held on the 30th ult. It is a voluminous document, and deals very fully with the work accomplished since the Committee was constituted in October, 1891. Within the district under the jurisdiction of the Committee are seven county boroughs, with a population of 1,148,674, and a rateable value of £5,214,252; eleven boroughs, population 294,277, and a rateable value of £974,411; sixty-two urban district councils, population 127,914, rateable value £867,623. On the Irwell the population numbered 998,625, and number of works 272; on the Isk the population numbered 297,217, and number of works 44; on the Medlock the population numbered 261,981, and number of works 18; on the Mersey the population numbered 633,496, and number of works 60. The report states that the practice of cinder-tipping direct into the rivers or on the banks, so that the floods carried them away, had been practically stopped, and the river beds were consequently improved. The Ship Canal dredgings now included comparatively few cinders. The number of works to prevent pollution in operation under urban and rural authorities had increased from twenty-seven to fifty-two, while those under construction had risen from eight to thirty. Orders of Court to cease pollution had been obtained in thirty-eight cases in Lancashire and Cheshire, and two in Derbyshire. The progress made by manufacturers had been greater than by local authorities. The good result on the Irwell was noticeable, while the Mersey lagged behind. Generally speaking, Lancashire was in advance of Cheshire in the improvement effected. This was partly due to the fact that some of the tributaries flowed from Yorkshire and Derbyshire into Cheshire, and were polluted before entering the latter county. In Yorkshire a Rivers Board was constituted in 1894, and had not yet got into working order. The Joint Committee are waiting to see the result of the action taken by Yorkshire. Derbyshire refused to send representatives to the Committee, and it was hoped that the County Council would take measures to deal with pollution, but as they have held back, action must be taken. In common fairness to those persons who have been compelled to spend money, their competitors must be brought under similar regulations. As a rule, the manufacturers had met the Committee in a fair spirit, although to many the cost of constructing works had been very considerable. Sir Henry Roscoe was reappointed chemical adviser to the Committee for a period of twelve months.

THE INCREASED YIELD OF THE BLAST FURNACE.

The enlargement of the output of the blast furnace of late has been more than once referred to, but usually the illustrations have been of single furnaces only. The facts allowing of a comparison on a large scale, however, are obtainable now, and they may be stated briefly. In the North-Eastern district in 1878 there were 94 blast-furnaces at work in July, and the output of these furnaces was 166,603 tons, or just about 1772 tons for the month of 31 days. In January of this year, in the same district, there were also 94 blast-furnaces in operation, but the production was enlarged to 269,195 tons, or roughly, 2863 tons per furnace for the month of 31 days. In other words, there has been on the average an increase in the output of the furnaces in the district of about 1091 tons in the month—that increase being the work of eighteen years. It is partly to be traced to the greater use of the hematite ores. In the earlier year there were only 17 furnaces engaged in smelting iron from these imported ores; but in the later year there were no fewer than 42. But it is also traceable in some considerable degree to the furnaces being of larger average capacity now, so that the work is done in a numerically smaller smelting plant; and probably it is effected in an area that is less, for the furnaces a score of years ago or so were dispersed over a large part of the North, and included many furnaces that were old and in some degree antiquated. In the renovation and renewal of the furnace plant in the largest of our iron-producing districts, there has, however, been not only the rebuilding of stacks of larger dimensions, but there has also been the employment of every resource of the metallurgist and the engineer that could be expected to add to the yield of the furnace, and hence it is that there is now traceable much of that rapid increase we have above shown. Nor is there any finality as yet attained in the average yield of the furnaces, for it is well known that furnaces of larger dimensions, and driven more powerfully, are being now employed, and that experiments in regard to the form of the plant are also being tried, so that there may be expected a further increase which has yet to be tabulated. But there is not now so rapid an enlargement as there was of the use of hematite iron ores, though no reduction of the proportion is to be anticipated, as far as can be seen.

A CORNER IN ENGINEERING MATERIAL.

We are accustomed to hear of pools and syndicates in various departments of the iron trade of America; the pig iron trade in different parts of the Continent is often subjected to the same treatment, and it is known that the steel rail combination of British makers has lately been re-formed. It is rather, however, a novelty to find that an attempt has been made to corner engineers' material, but such is the nature of the newest European ring. The story reaches us this week from France of the establishment of a strong combination designed to sustain prices in the interest of the mill owners. We learn that across the Channel twenty-three makers of structural iron and steel have completed an arrangement by which they undertake to deliver all their product to a central company in Paris. The new company is to be sole purchaser. No one is permitted to carry out orders of third parties. Only the requirements of the French State Department—army, navy, &c.—are excepted. On the other hand, the syndicate agrees to provide for the sale of the products, and therefore buys the entire output of the different works for subsequent re-sale. Each of the works is allotted a certain tonnage. No member is allowed under any circumstances to have orders given by the syndicate carried out by any other member of the syndicate, either by exchange or special arrangement. The sales territory of the syndicate is divided into a certain number of zones. The general assembly decide every month what the selling price for each zone shall be, and at the same time also determine the price at works at which the different plants must deliver the base sizes to the syndicate. The contract between the twenty-three works and the central organisation has been concluded for five years. Combinations of this sort tend to raise the price of iron and steel. But in all probability the ordinary healthy competition of the French works outside the ring, combined with that of English and German firms, will be too much for it.

LITERATURE.

Elementary Treatise on Electricity and Magnetism, founded on Joubert's "Traité Elémentaire d'Electricité. By G. C. Foster, F.R.S., and E. Atkinson, Ph.D. Longmans, Green and Co. 1896.

The authors originally intended merely to translate the French work introducing such small modifications as might seem to make it better adapted to English needs. But on further consideration they thought it desirable, while adhering to the general plan of the original, to introduce into it that view of the nature of electrical phenomena which was originated by Faraday and developed by Maxwell in his classical treatise. The adoption of this idea has necessitated the re-writing of several chapters, and it will also be found that a somewhat greater knowledge of mathematics is assumed on the part of the reader than is necessary for the comprehension of the original work. The earlier chapters deal with frictional electricity, difference of potential and induction, and are very clearly written. Chapter V. deals with "General Theorems," and here the authors explain the properties of tubes of force. These theorems are made use of in Chapter VI., which deals with "Electrical Capacity and Condensers."

The elementary nature of the work appears to have been forgotten here, as the differential calculus is used, the authors having departed widely from the simplicity of the original work. What is the use of pointing out to a young student that "The value of the integral $\int \frac{de}{s}$ which occurs in this expression depends on the size and shape of the tube, &c." All he can do is to skip the entire chapter. We fear that the same remark applies to several other parts of the work, and that it will tend to diminish its usefulness for junior classes. In the chapter upon frictional machines the authors work out the power of a double-plate Holtz machine, and conclude that it was for this particular machine 1·06 watts, or 1·06 joules per second.

Dealing with cells, the authors discuss the question as to whether the difference of potential between the plates is due to the action at the separating surface of the two metals—which may be termed the contact theory—or to the action between the metals of the surrounding air—which may be termed the chemical theory—but they do not decide this difficult question, and consider it impossible of solution. In the chapter upon thermo-electricity, a useful table is given which the authors call a thermo-electric diagram, due to Professor Tait. If the nature of the two metals is known, and also the respective heat of the junctions, the electro-motive force of the couple can be read off. For example, the iron-copper couple with one junction at 50 deg. and the other at 250 deg. gives 2000 microvolts.

The chapter upon magnetic induction is well written, and gives the results obtained by Professor Ewing. The authors refer to Professor Lodge's work, and in their chapter upon lightning conductors sum up the results of recent work by stating that the most certain way to protect a building from the effects of lightning is to encase it in a metal network in perfect conducting communication with the earth. We fear that it will be some time before architects and their clients will be induced to go so far as to afford such perfect protection as this to a building. Although the work is probably above the heads of elementary students, the authors have succeeded in putting forward the physical aspects of electricity and magnetism in the light of the most recent discoveries.

Practical Trigonometry, for the use of Engineers, Architects, and Surveyors. By Henry Adams, M.I.C.E., Professor of Engineering at the City of London College. Whitaker and Co. 1896.

This is likely to prove a very useful book, especially to young surveyors, in guiding their first timid steps in the mystery of Trigonometry. The usefulness and indispensability of the subject is shown by a few well chosen practical applications worked out completely by means of sines or cosines, or the equivalent co-ordinate steps, North and South, East and West. The definitions are given in a more interesting manner than will be found in the ordinary school books. When will mathematical writers begin the natural way of counting angles, like time, starting from 12 o'clock? At present they always start at 3 o'clock and work backwards on the clock face. The addition formulas are quoted without demonstration, but in most of the applications the trigonometry of one angle is found sufficient. In explaining the use of logarithms the author should point out that four-figure logarithms are sufficient for most practical purposes; this table as an appendix would form a very useful addition, not occupying more than four pages.

Elasticität und Festigkeit. Von C. Bach. Berlin: Julius Springer. 1894. 16s.

This is a treatise on the strength and elasticity of the materials, steel especially, which are employed by engineers. The first edition appeared in 1889, and the author, from his position as professor of mechanical engineering in the Technical High School of Stuttgart, is well qualified to act as an exponent of this subject. The diagrams are very well chosen, and a notable feature of the book are the photographic reproductions of the testing of various typical specimens and forms of material. In the mathematical part the author displays a commendable restraint; he does not choke off the practical man in search of useful information by a tropical jungle of unnecessary analytical formulas. The treatment of the difficult question of the strength of a flat plate exposed to pressure, such as the flat end of a boiler, may be instanced as a specimen of the author's best method. Under the severe requirements of modern engineers in quick-running machinery and marine work the designer cannot afford to be ignorant of the most modern developments of theory as prepared for immediate application.

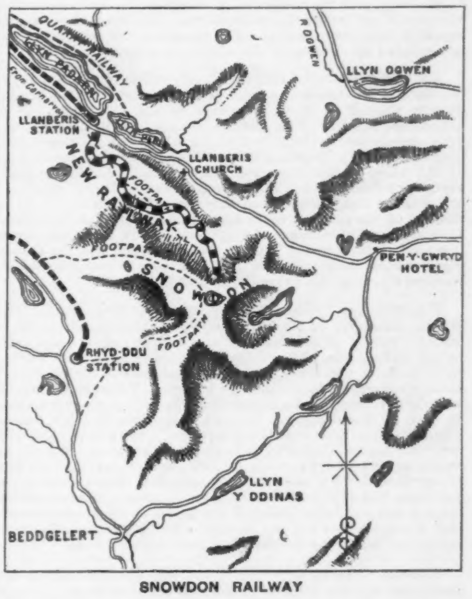
ROLLING MILL ENGINES FOR THE DOWLAIS WORKS.

The illustration on our double-page represents one of two pairs of geared rolling mill engines as constructed by Messrs. Daniel Adamson and Co., Engineering Works, Dukinfield, near Manchester, for the Dowlais Iron Company, for the new steel works lately established on the seaboard at Cardiff. Both pairs of engines are exactly similar in design and construction, and only differ in the sizes of their cylinders; the smaller pair put down being used for driving the slabbing mill, having cylinders 48in. by 60in. stroke, whilst the larger pair, now illustrated, are used for driving the plate mills, and have cylinders 54in. diameter by 60in. stroke, both engines being geared to the mill shafts by gearing having a ratio of two to one. As will be noticed, the design of the engines generally is in the direction of providing ample strength and proportions for the heavy and intermittent strain to which they are subject. Some idea of the strengths and proportions adopted in the engine under notice will be formed when we say that the gearing is in cast steel, having teeth of the double helical form, and shrouded on both sides up to the pitch line, the pinion wheel being 5ft. 8¾in. diameter, 9in. pitch, and 30in. broad on the working face, whilst the second motion wheel into which the pinion gears is 11ft. 2⅝in. diameter, the second motion shaft being of forged steel, having bearings 24in. diameter; and the crank shaft also of forged steel, with bearings 22in. diameter; the crank and crosshead pins are also of the same material, and respectively 10½in. and 14in. diameter, whilst the piston rods are 9¾in. diameter. The total delivered weight of these engines is about 280 tons. The chief feature, however, in these engines lies in the novelty of the valves and gear adopted, which are of the patent and improved Wheelock type, of which Messrs. Daniel Adamson and Co. are the sole manufacturers in Great Britain, it being one of their specialities. The general arrangement of these valves, as shown in section in our illustration, embodies the principle and adoption of valves and seats of the flat grid type, giving multiplicity of opening, ample areas, and small frictional movements. Both steam and exhaust valves are contained in one chest at each end of the cylinder, the seats of the valves being in the form of a plug turned to fit the cylinder, the chest of which is bored a little tapering for this purpose; at the same time the valves and their seats, being separate parts from the cylinder itself, can be constructed of specially hard and durable iron; thus spare valves and seats can be kept in stock, and all wear on the cylinder dispensed with; the valve shells or plugs, being in duplicate, enables one to be withdrawn for examination or replacement in the minimum of time and stoppage. It will also be noticed that the whole of the valves are placed immediately underneath the cylinders, with direct ports and passages, so that it is impossible for the water of condensation to collect in the cylinders or passages, as it drains away naturally. The whole arrangement of the valves and gear is extremely compact and perfectly accessible in every part. The reversing gear is of the Allen straight link type, and is worked by hydraulic power controlled from the driver's platform, the driver's platform being arranged at such a level as enables the driver to clearly see the mill floor; another feature is a somewhat special arrangement of the reversing and handling gear, which is in duplicate, the platform being so arranged that the engines can be handled from either side, it being the ultimate intention to put down mills on each side of the engines, and for which the necessary clutches are provided.

We may say, in conclusion, that the engines have now been at work some time, and have given every satisfaction, and have fully justified the claim of the makers that the arrangement of valves and gear as adopted is the most superior and economical for the purpose. Messrs. Daniel Adamson and Co. have also supplied the whole of the boiler plant and receiver range, supplying steam for all purposes to this most modern example of steel works.

THE ACCIDENT ON THE SNOWDON RAILWAY.

As our readers are generally aware, a very regrettable and fatal accident occurred on the Snowdon Railway on Monday. A train consisting of an engine and two carriages, followed by a second train composed of an engine and one carriage, safely ascended the mountain by noon. In descending, however, about one mile from the summit the engine of the first train mounted the rails near or at the curve which is seen in one of the engravings we publish on page 371, where it leaped the rails and tumbled down the slope. The brakes were immediately applied to the carriages by Mr. Oswell, the resident engineer of the line, and Mr. Aitcheson, the manager, who stuck to their posts, and called on the passengers to keep their seats. The brakes acted at once, the carriages came to a standstill, and the passengers alighted. Unfortunately, one passenger, despite the warning of his friends and of Mr. Aitcheson, jumped over the low side door—the sides of the carriages being open—and struck the rock; he broke his legs, and has since died. Another passenger jumped, but he was only slightly hurt. After the passengers had alighted, the second train, which is supposed somehow to have been signalled by the first engine striking a wire in falling, came on. The driver, perceiving the carriages of the first train at a standstill ahead of him, put on the brake, but the engine came into collision with the carriages, which it sent off the road, but itself remained on the rails.



SNOWDON RAILWAY

The driver and stoker of the engine which went over the slope both jumped from it and saved themselves almost unhurt. There were eighty-three passengers in the first train, all of whom were almost unhurt, except the two who jumped off. The permament way is, we learn, not in the least damaged. The safety of the passengers is probably due to the method of working. The engines are not coupled to the train, but in going up simply push the rear carriage, and in descending allow the front carriage to push it. The carriages being provided with ample brake power are thus unaffected by any defect in the working of the engine. A general description of the railway was published in The Engineer, vol. lxxix., from which we reproduce the accompanying plan, showing the route and position of the line. The photographs which we reproduce on page 371 have been taken for us by Mr. R. C. Symons, of Llanberis.

No. 1 is taken from a position looking up from the derailed carriages towards the scene of disaster. It shows the starting place where the engine run away, viz., at the place where an engine and carriage is seen standing in the distance. The engine left the rails and tumbled over, where the group of men in white trousers are standing in the near distance, a little to the right, and behind the telegraph post. No. 2 view is taken from the point where engine left the rails. Looking down from this it will be seen that the line is not damaged, and in the immediate foreground is the spot where the engine turned over. View No. 3 is from the front of the derailed carriages looking up over the embankment, a nearer view than No. 1. View No. 4 shows the derailed carriages.

On Wednesday at the request of Sir Douglas Fox, the engineer of the line, Major Marindin, on behalf of the Board of Trade, visited the scene of the accident, but the line being private property, the Board has no power to hold an inquiry.

RAILWAY MATTERS.

The Cambrian Railways Company have decided to reduce the first-class fares over the whole of its system to 1½d. per mile for single tickets. It is understood that the alteration will be effected in time to give summer visitors the full benefit of the reduction.

In the current session twenty-two tramway Bills, constructing nearly 103 miles, and proposing capital to the amount of £2,353,200, are being promoted. As compared with 1895, the number of Bills shows an increase of sixteen, and the capital proposed an increase of £2,116,146.

A general classification of the accidents on American railways in February last gives the following:—Defects of road, 6; defects of equipment, 27; negligence in operating, 22; unforeseen obstructions, 17; unexplained, 57; or a total of 129. Of these no less than 91 were derailments, and 42 of these were unexplained derailments.

Rapid progress is being made with the extension of the Liverpool Overhead Railway to the southern extremity of the city, and it is expected that by the end of August the line will be so far completed as to provide for the direct conveyance of passengers from the Dingle to Seaforth. The railway at present terminates at the Herculaneum Dock, and to bring the Dingle into connection there will be 250 yards of iron viaduct and 800 yards of tunnel, both built for double line.

According to an official statement of revenue and expenditure for six months ending December 31st, 1894 and 1895 respectively, on the West Australian Government Railways, the miles opened were 550. The revenue to December 31st, 1894, was £132,818, and for 1895 £214,286, or an increase of £81,468, or over 60 per cent. The expenditure was £77,094 in 1894, and £108,960 in 1895, or an increase of £31,866, or 41 per cent. The expenditure per cent. of revenue fell from 58·04 to 50·84.

An attempt to wreck a train was discovered early on the morning of the 1st inst. on the Manchester, Sheffield, and Lincolnshire line, between Sheffield and Doncaster, just in time to avert the disaster. Near Conisborough two blocks of limestone, each weighing about a hundredweight, were found on the rails, and further on a third obstruction of a similar character was found. Fortunately, a goods driver noticed the stones, and warned the nearest signalman in time to enable him to stop an approaching passenger train.

An unusual accident occurred on the London and North-Western Railway main line, between Lancaster and Preston, and near to Garstang Station, on Tuesday, to a goods train from Carlisle, which included a wagon laden with heavy machinery consigned to Blackpool. The weight caused the spring of the wagon to give way, with the result that it caught in the chairs supporting the metals, and before the accident was discovered about a mile length of chairs were broken. The damage to the permanent way necessitated the conduct of the traffic over a single line.

An important development in connection with the purchase of the tramway system of the metropolis by the London County Council is likely, according to the *City Press*, to be announced shortly. Negotiations, it says, are in progress, and have already reached an advanced stage, for the formation of what may be termed a Tramway Trust. This trust will acquire a lease of the whole of the tramways, and pay to the Council a yearly rent, to be determined. The movement has the hearty support of the existing companies, whose directors realise that it is the best solution of the problem to be found; and it is also understood that amongst the members of the Council there is a general consensus of opinion in its favour. Wonder when will the Council carry out the work entrusted to it, and cease to constitute itself a business scheming and promoting concern.

Writing on "Co-operation by Rail and Road," Mr. H. M. Kennedy, of Plumpton, says:—"Cumberland should be among the first of the counties to use light railways and automotors on its roads. The centre of the arable area with which I have to do is nine miles from the nearest railway station, though three broad-gauge lines bound the triangle. To make the coming transits pay, co-operation is essential. To such movement we hope to have an impulse given by Lord Winchilsea and Mr. Horace Plunkett, from whom visits are expected. We now pay £400,000 a day for imports similar to those produced at home. The bill for butter and margarine exceeds £45,000 per day, and that for eggs is nearly £73,000 a week. By co-operation, facile transit, and judicious technical instruction, these enormous imports can be greatly and profitably reduced and home products substituted." Mr. Kennedy does not say in what way "judicious technical instruction" is to bring about any of these desirable ends.

A new railway was completed last summer along the west coast of Italy from a junction 45 miles south of Naples to Reggio, nearly opposite Messina, in Sicily, a distance of 227 miles. The approach by rail to Sicily heretofore was made by going nearly due east across the peninsula, 169 miles from Naples to Metaponto, on the instep of the boot, and then following the sole of the foot south, southeast, and finally around the toe northward a little way to Reggio, 267 miles further. The time required was 21 hours, which was some hours longer than the steamer voyage between Naples and Messina, and naturally even the comfort of a Pullman sleeping car, which was attached to the through train, attracted few passengers, especially as the fare was nearly 16 dols., to say nothing of the sleeper. By the new line the distance of 272 miles between Naples and Reggio is made in 13½ hours. The *Railroad Gazette* says there is a Pullman car, as before, and the cars are ferried across the straits, only a few miles below Scylla and Charybdis, to Messina. The construction of the new line has extended through many years, and has been very costly. There are about 100 bridges of considerable size on the line, and 82 tunnels, one about 3 miles long, one 2¾ miles, two about 2 miles, and fifteen more from ⅝ to 2 miles long.

The Great Northern Railway Company has just completed at its Doncaster Plant Works two new first-class and third-class dining cars, which have been sent on a trial trip from Doncaster to Retford, thence to Newark, Grantham, and Nottingham, returning in the evening to Doncaster. The cars, which excited much interest *en route*, ran with perfect smoothness, there being nothing to choose in that respect between the first-class and the third. The first-class dining saloon is 55ft. 6in. long; the length over platforms, 62ft. 0½in.; extreme length over vestibules, 64ft.; extreme width, 9ft.; extreme height from rails, 13ft. 4in. The car is carried on two six-wheeled bogies, and weighs 36 tons 19 cwt. The saloon compartment is a model of elegant appointment and comfortable arrangement, and all the accessories in lavatories, kitchens, &c., leave nothing to be desired. A special feature is Gould's patent vestibule, continuous platform, buffer, and automatic coupler. By this means the cars are joined together, and the passenger can walk from one end of the train to the other. The third-class dining car has a length in body extending to 64ft. 5¾in.; the extreme length of the vestibule, 69ft. 9¾in.; extreme width, 9ft.; and extreme height from the rails, 13ft. 4½in. This car is also carried on two six-wheeled bogies, and fitted with the Gould patent vestibule, &c. The appointments of the third-class are so complete that there seems practically little difference betwixt the two. The furnishing, fittings, lighting, illumination, and heating being on the most sumptuous and elaborate scale, both for third-class and first-class passengers. These cars, which are believed to be the largest in England, are to be used on the Leeds and London service, commencing this month.

NOTES AND MEMORANDA.

New South Wales produced in 1894, 452,756 cwt. of sugar, and 1,573,886 gallons of molasses.

From the experiments described in a paper on the "Origin of the Röntgen Rays," by M. Jean Perrin, the conclusion is drawn that the Röntgen rays are developed only at those points where the kathode rays are arrested, and that this is true whatever material may be used for the tube.

The number of letters passing through the New South Wales Post-office in 1894 was 67,993,400, of which 11,125,500 were for places beyond the Colony, as were 9,503,900 of the 41,667,300 posted during the same period. In 1855 the number of letters and newspapers—inland and foreign—was about 2,000,000.

The *Revue des Sciences*, in the course of an article on aluminium, gives some very striking statistics to show how rapidly the production of it has increased in the United States since 1883, in which year it did not exceed 83 lb. In 1886 the production had increased to 3000 lb.; in 1889, to 47,468 lb.; in 1891, to 150,050 lb.; and in 1893 to 339,629 lb.; while in 1894 the total was 550,000 lb. The *Iron Age* puts the production for 1895 at 850,000 lb., and estimates that this year it will not fall short of 6000 lb. per diem.

A paper was recently read before the Paris Academy of Sciences on "The Invisible Radiations Emitted by the Salts of Uranium," by M. H. Becquerel. A confirmation and extension of previous experiments upon potassium uranyl sulphate. Uranium salts appear to be unique in the length of time during which they give off photographically active rays in the dark. On comparing the rate of discharge of a gold leaf electroscope by the radiations from a crystal of potassium-uranyl sulphate and a Crookes' tube respectively, the effect of the tube was found to be, *Nature* says, over one hundred times greater than that of the crystal.

A paper was recently read before the Paris Academy of Sciences on "The Mechanical Action proceeding from a Crookes' Tube," by M. J. R. Rydberg. On repeating the experiments of MM. Gossart and Chevallier, it was found that the actions observed on the radiometer had their origin in the well-known layer of positive electricity with which the external antikathodic surface of the Crookes' tube is covered during the discharge. By covering the radiometer with a metallic gauze screen, it is possible to take Röntgen photographs through it, without any rotation or mechanical effect being observable.

A means of communicating to the *x* rays the property of being deviated by the magnet, is described in a recent number of the *Comptes Rendus*, by M. A. Lafay. A bundle of rays from a Crookes' tube was allowed to imprint on a sensitive plate the shadow of a platinum wire supported on a very thin sheet of silver. When the whole was placed in a powerful magnetic field—400 C.G.S. units—the reversal of the current produced a sensible deflection of the image, if the needle was strongly electrified by being placed in connection with the negative pole of the induction coil. If the needle was not electrified, no sensible deflection of the image could be produced.

M. Eugene Fariot, an engineer of some repute and a worker in aëronautics, one of the siege aëronauts who escaped from Paris in the Louis Blanc, died recently at the age of sixty-eight. *Nature* says he has bequeathed a sum of £4000 to the Société Française de Navigation Aerienne, of which he was a member. One half of this sum is to pay the expenses of experiments, and the other half to be funded in the name of the society; the interest to be expended yearly on its behalf. Consequently, it is expected that an end will be put to the long stagnation in scientific aëronautics in France, owing to the indifference of the public authorities for an art so popular in that country. The result shows the wisdom of the authorities.

Mr. J. H. McConnell, in a recent paper before the Western Railroad Club, made some interesting comparisons of rolling stock of to-day and of twenty-five years ago. At that time a large portion of the traffic was handled by 16in. by 24in. cylinder locomotives, and the maximum load for a freight car was 20,000 lb. To-day cars of 60,000 lb. capacity are common, and sometimes they reach 80,000 lb. The latest refrigerator cars when fully loaded weigh as high as 100,000 lb. The early cars carried 300 bushels of grain; the modern cars carry 1000 bushels. The early sleeping cars weighed 60,000 lb.; the modern sleeper weighs 100,000 lb. The 30-ton engine has grown to weigh 60 tons; the ten-wheel engine has increased from 45 tons to 90 tons; and the consolidation from 50 to 80 tons. An 1870 engine weighing 100,000 lb., and carrying 140 lb. of steam, hauled 24 loads, weighing 582 tons; the 1895 engine weighs 150,000 lb., carries 180 lb. steam pressure, and hauls 35 loads weighing 1120 tons over the same division. Twenty-five years ago, with a time schedule of 22 miles an hour, it would have been considered an impossibility to make an engine haul ten cars on a schedule of 40 miles an hour; yet it is now done every day, and these engines maintain a speed of 55 miles per hour between stations, with ten cars.

On February 6th, Mr. Morris R. Sherrerd, of the Newark, N.J., Board of Public Works, in conjunction with the officials of the East Jersey Water Company, made some experiments on the carrying power of mains. The main selected was the 36in. branch to the high-service supply, and in preparation for it the water in the South Orange Avenue reservoir in Newark was drawn down 3ft. Observations were taken at eight points. The normal pressure of the 48in. line at Belleville was increased from 70 lb. to 84 lb., and at the South Orange Avenue end of the 36in. main from a normal pressure of 20 lb. to 28½ lb. The test was continued for one hour, and during that time the 36in. Venturi meter readings showed an average daily flow of 22,500,000 gallons under the contract requirement as to height of delivery, which in this case was measured by pressure. The 36in. main is 25,000ft. long, and the pressure under which it delivered the 22,500,000 gallons would be equivalent to a grade of 2·4ft. per 1000ft. Previous to the test the average daily draught through the 39in. main was 11,000,000 gallons, and the highest 16,000,000 gallons, or 6,500,000 less than the actual capacity. The test showed the actual capacity of the 48in. main to be about 35,400,000 gallons in twenty-four hours. The *Engineering Record* says the 48in. conduit was designed for a delivery of 50,000,000 gallons, and the 36in. conduit for 25,000,000 gallons in twenty-four hours.

The cost and the difficulties of transport in Persia are great and curious. Not long ago the cost of transport from the port of Bushire to Shiraz and Ispahan rose to four times the ordinary rates, and it fluctuates violently at short periods. Recently the main cause was a mortality amongst horses, mules, and donkeys in the south of Persia. They died along the road of murrain, and their bodies were left by the wayside, tainting the air and the grazing, and so increasing the epidemic. A constant source of disturbance to transport is the travelling of local officials. They all require a large amount of carriage, and their messengers are sent into the bazaars and the surrounding country to impound all the animals they can get. The muleteers object, as their animals are overloaded and ill-treated, while they get no adequate hire, are kept away from their homes for indefinite periods at their own cost, and are abused and beaten by the great man's hirelings. The system of seizing baggage animals is called "*Mal bigiry*," and when it becomes known that it is intended, the muleteers flee with their beasts to the hills and hide. Those who are on the road leave their loads at the nearest village and disappear to some place for security, so that for a fortnight or more it is quite impossible to get any animals, for until the muleteers know that the place has returned to its ordinary state they will keep away. In consequence of the frequency of this disorganisation in the south of Persia, Manchester goods which reached Isaphan by the Persian Gulf now go by Baghdad, Kermanshah, and Hamadan—a longer and apparently more expensive route.

MISCELLANEA.

The new battleship about to be built at Devonport will have engines developing 15,000 indicated horse-power with forced draught, with which it is estimated that the vessel will attain a speed of 18·75 knots.

The Royal Agricultural Society will offer prizes for self-moving vehicles for light and heavy loads such as have commonly to be carried by farmers and others dealing in farm and dairy produce, but not for passenger vehicles, the trials to take place in connection with the Manchester meeting next year.

The Admiralty, says the *Army and Navy Gazette*, have directed that in future the torpedo boat destroyers are to be subjected to a two hours' steam trial after commissioning, and before leaving port for service each vessel is to attain a mean indicated horse-power of at least nine-tenths of the engine-power guaranteed by contract.

The Sheffield City Council, at its meeting on the 8th inst., decided, by 29 votes to 14, to advance the Borough Surveyor's salary from £800 to £1000. At a recent meeting the Council refused a smaller advance to the Medical Officer of Health, who has consequently become a candidate for the post of Medical Officer of Health for the West Riding.

The first-class barbette battleship Benbow is to undergo an extensive refit at Devonport. Her masts will be lengthened to give greater signalling facilities at sea; her ten 6in. breech-loading guns will be replaced by ten quick-firers, and hand-loading arrangements will be fitted to her heavy guns. The cost is estimated at about £5000. She is to be completed by the second week in May.

At a meeting of the Manchester City Council on the 1st inst., the report of the Corporation Committee charged with the Ship Canal affairs was received and adopted. The report contained a number of statistics relating to the Canal, and concluded by recommending the Council to levy a special rate of 14d. in the pound to defray interest on the money raised by the Corporation on behalf of the Canal Company.

A collision took place on the 1st inst. on the Mersey, resulting in the sinking of a Dock Board dredger. The dredger ran into the Isle of Man steamer King Orry while the latter was at anchor in the river. The steamer was only slightly damaged, but the dredger sank in a few minutes, the crew being thrown into the water. All were rescued, after an exciting scene, by the steamer's boats and Customs launch.

His Honour Judge Ellison, of the Sheffield Court, who died suddenly in London on the 7th inst., was umpire between the Yorkshire coalowners and colliers in the great wages dispute of 1879. His award was in favour of the men, his Honour holding that they were then receiving barely a decent maintenance, and considering the nature of the work, he held that the coalowners had not made out a case for reduction in the area covered by the arbitration. The miners' leaders regard Judge Ellison's ruling as the forerunner of the principle of a living wage.

In connection with the Crystal Palace International Horse-drawn and Horseless-Carriage and Roads Locomotion Exhibition to be opened on May 2nd, by the Lord Mayor, there will be a chronological collection of cycles from the earliest times, marking the birth, rise, and development of the cycle—1818-1893. Those in possession of and willing to lend specimens are requested to communicate with Mr. H. Hewitt Griffin, Putney, giving full particulars of tyre, maker, and exact date manufactured. Only distinct types are required. The carriage of specimens to and from the Crystal Palace will be paid by the Crystal Palace Company.

After reaching the depth of 400ft. at Messrs. Eastman's, Latimer-road, a copious supply of water has been tapped after passing through the following beds, viz.:—Made ground, 12ft.; ballast, 18ft.; blue clay, 124ft.; mottled clays, 47ft. 6in.; black pebbles and sand, 6ft.; brown and red sand, 4ft.; green sand, 23ft.; flints, 1ft.; chalk and flints, 164ft. 6in. Total 400ft. Mr. William Whiteley's well is 600ft. deep at West Kensington. Messrs. Crosse and Blackwell, Soho-square, and Messrs. Welford and Sons, Elgin-avenue, Maida Vale, are having similar work carried out by Messrs. C. Isler and Co., who are also engaged to do similar work for the Hastings Corporation and the Wolverhampton Corporation.

The telephone service between London and Paris has been so successful that the postal authorities are about to lay a second cable across the English Channel, to meet the increasing demands for the use of the wires. The work on the land wires is now being proceeded with on both sides of the Channel. The second cable is to be laid from Lydden Spout, about two miles to the west of Dover. The land wires of the present system terminate at St. Margaret's Bay, from which point the cable starts. For the second cable, the English land wires will branch off from the old line to the north of Folkestone, and be continued across to the cliffs. It is stated that when the second cable is laid, Manchester and Liverpool and some other large centres are likely to be directly connected.

It is proposed to hold another Milling Exhibition next year in the Agricultural Hall. A writer in the *Miller* says:—"Milling engineers never felt less like exhibiting than to-day. The cry is that orders are just now as wary and shy as the African gorilla, and until that state of things alters for the better, it would be useless to look for anything like support of a milling exhibition. It is beside the mark to point to the successful Exhibition of 1881, as at that day the conditions were altogether different. There was then a comparatively large amount of virgin soil to be worked, whereas now the requirements of our millers have to a great extent been met. Again, in 1881 roller plants on any system were rarities, which, in general, proprietors were not over anxious to exhibit. For that reason the milling engineers of that day were willing to go to considerable expense in erecting more or less complete plants in the Agricultural Hall. But nowadays, with roller mills of all capacities scattered over the kingdom, the conditions are altogether reversed. What inducement is there for engineers to play at installing machinery on scaffolding more or less rickety, when, for a railway fare of a few shillings, any miller can see the same plant under the best conditions?"

A Bombay firm, Messrs. W. and A. Graham and Co., are constructing gigantic iron tanks for the storage of petroleum oil upon the Port Trust reclamation at Mody Bay. The consumption of kerosine oil in the Bombay Presidency has become more and more extensive; and the idea occurred to Messrs. Graham and Co. to import the oil in large tanks, and without shifting the tanks, to remove the oil into other tanks and reservoirs on the bunder, to fill small tins with it, and put them in the market for sale like the tins at present imported into the city. For that purpose four large round iron tanks are being constructed on the reclamation, each of which is 35ft. in height, and 64ft. in diameter, capable of holding 2500 tons of oil. Round the four tanks will be constructed a stone wall with the object of gathering in the leakage from any of the tanks. An underground store-room will also be provided, so that in case of fire or accident the oil might be poured into it. A wooden jetty, 200ft. long, will be erected, alongside which the steamers will be placed; and by means of pipes the oil will be transferred from the tanks on board into the firm's tanks on shore. A "settling tank," 17ft. in diameter, is also to be constructed by means of which the oil will be filtered and purified before being put into small tins for the market. Either the above dimensions are wrong or the 2500 tons is given by the Indian contemporary from whom we quote, instead of about 1500 tons.

LETTERS TO THE EDITOR.

(*Continued from page 372.*)

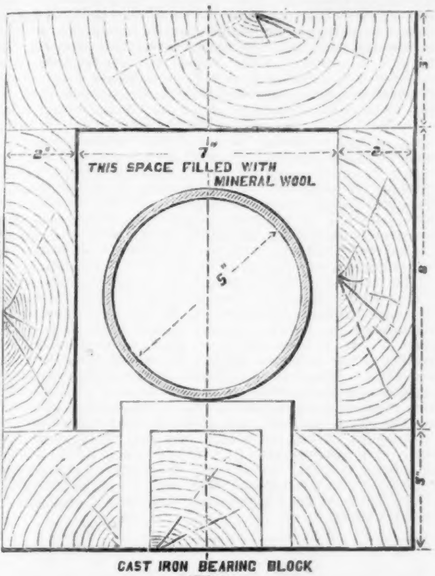
INSULATING UNDERGROUND STEAM PIPES.

SIR,—In your issue of February 21st you print a paper by R. C. Carpenter on "Methods of Insulating Underground Systems of Steam Piping." To me, all these methods appear to be good examples of how "not to do it." So far as my experience goes, it is impossible to make any wooden conduit that will keep tight. Place a section of any of the wooden conduits Mr. Carpenter describes in an ordinary steam-heated room, and in a few weeks you will find it full of season cracks. It is clear that the case will be worse when the interior of the conduit is exposed to steam heat and the outside is in contact with the earth, and I have found that when the spring thaws occur these conduits leak like baskets, and water is always running through them into the boiler room.

Cement or tile conduits can be kept tight, provided they are properly laid on solid ground. In most cases such conduits have to pass over some made ground, and are liable to crack from settlement. In such cases under drainage will not prevent them from leaking. Such conduits are also objectionable, because it is very difficult to get at the pipe, except where split tile is used. It therefore appears to me that no conduit can be considered perfect unless we know that it will at all times be water-tight, in spite of slight settlements.

I once had to convey steam underground for a low-pressure gravity-return system of steam heating. The conditions were unfavourable, as the main had to slope toward the boiler-room, and local conditions made the maximum depth to top of casing 3ft. 6in., and for part of the run the depth was only 2ft. 8in. This, too, was in a situation where the prevailing wind seldom permitted the snow to become over 5in. deep. The outside temperature is frequently – 20 deg. Fah., and occasionally drops as low as – 40 deg. Fah. The pipe had to pass over several fills caused by previously laid sewerage and water systems. For about five weeks in the spring when the "break-up" is in progress the ground is covered with several inches of slush and water.

To meet these conditions I designed the conduit as in Fig. 1. The lumber was all edged and quite dry. A trough was built in 14ft. sections, with halved joints 1ft. long. To insure rigidity the bottom joints were located 2ft. from those in the side, and all the joints were firmly screwed together after the conduit was lined up. It has been my experience that in cases like this roller bearings are of little account, since we have no guarantee that they will operate after the pipe has been in use for some time, and the roller journals have become rusted, or stick from the gumming of the oil. I therefore discarded rollers, and placed under each pipe coupling a cast iron chair, Fig. 2, which is faced on top, and allows the pipe to slide easily. This plan has been used for years by one concern which employs many hundred feet of 12in. pipe carrying steam up to 160 lb., and in no case has trouble developed.



CAST IRON BEARING BLOCK
FIG I
SECTION THROUGH CASING

To insure tightness the following plan was adopted:—Makers of planished copper can supply sheets which are slightly defective in the tinning, and have to be sold as scrap. We purchased sheets of this copper, 14 oz. and 16 oz. weights, in widths of 11in. and 41in., riveted and soldered similar widths end to end, then turned up the broad width into a trough 11½in. wide. This was first put into the trench, the wooden trough was then lowered into it, the work was then lined up, the pipe was next laid, and then the trough was filled to the top with mineral wool loosely packed in place. The wooden cover was then secured with 5in. screws, the 11in. copper was next rolled along the cover, and the joints along the top edges of conduit were then carefully soldered. The metal covering was carried through the walls of the buildings at each end of the pipe line, and pieces of copper soldered to the casing were flushed into the outside face of the walls.

To guard against any chance of the pipe getting out of line by reason of decay of the wood, the chairs were provided with two lugs, Fig. 2, which passed clear through the bottom plank and rested directly on the copper, and beneath the latter a large flat stone was carefully bedded into the earth. The chairs were secured to the plank to prevent any motion and the consequent wear on the copper. Where fills were encountered care was taken to put a bearing stone and cast chair on each side of it, so that any deflection of the conduit could not affect the pipe. The soil was very gravelly, so that no under drainage was provided, and it is questionable whether such drainage would ever be necessary with a conduit like this. A conduit like this can stand a great deal of distortion without any harm. As to its insulating qualities, I may say that it has been in use several years, has given perfect satisfaction, and at no time is there any external evidence that the pipe line exists. I have never been able to detect any escape of heat through melting of snow over the trench. Cost of the work was as follows. Cost of pipe and laying, mineral wool, and excavating trench are not included, as they form no part of the conduit proper:—

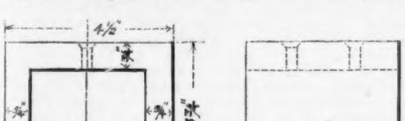


FIG. 2
BEARING BLOCK UNDER COUPLINGS
FACED ON TOP

Length of conduit	142ft.
	Dols.
Copper smith, 2¼ days, at 4·00 dols.	9·00
Steam fitter—lining up—1¼ days, at 4·00 dols.	5·00
Three labourers, 1¼ days, at 1·50 dols.	5·63
Carpenter, 9 days, at 3·00 dols.	27·00
Solder, copper tacks, and rivets	2·20
4 grs. 5in. No. 20 wood screws	5·72
1 grs. 2in. No. 14 " "	·06
1350ft. white pine at 17 per m.	22·95
520 lb. tinned copper scrap at ·11	57·20
135 lb. castings at ·03½	4·73
Carting	1·50
Total	141·09

Or about 1 dol. per lineal foot. No charges are made for stone-bearing plates or for planing chairs. Lathe work was done in our shops by students. We had left from a new building some stone which we had no other use for, and were glad to get rid of it by putting it under the conduit.

Mr. Carpenter describes a conduit consisting of a tile pipe placed inside a wooden casing. To me this seems a wholly mistaken construction. As the wood shrinks and swells it will loosen the joints in the tile. The wood will also absorb water, and be of little use as a heat insulator. It would have been better, I think, to have used a large tile and put the wood casing inside of it. If the tile is properly laid on a sand or gravel foundation and fills are carefully looked after, it can be kept tight, so that the wooden casing will be dry and of some use as a heat insulator.

The conduit I have described permits the pipe to be got at easily. A few minutes' application of the blast lamp is all that is needed to open up the sheathing, and as the screws were dipped in lard and plumbago before driving, they can be easily drawn. If no provision is to be made for opening the conduit, it seems to me that the best form of casing is galvanised spiral-riveted or welded pipe, with proper chairs for the steam main to slide on. Such pipe is made by various firms in this country, and also, I think, by Thos. Piggott and Co., Atlas Works, Birmingham, and Mechan and Sons, Glasgow. If the steam pipe is properly covered, and the work is made tight at the beginning, it will stay so, and in the end save money for its owners.

EDGAR KIDWELL.

Michigan Mining School, Houghton,
Mich., U.S.A.

ENGINE POWER IN PADDLE STEAMERS.

SIR,—I thank your correspondent "J. M." for the particulars of the paddle-wheels of the old and new Flushing steamers. The comparison, although favouring a large diameter of wheel, does not prove that the excessive indicated horse-power required to drive those vessels 21 knots is due to a small diameter of wheel. It certainly is due to an insufficient area of resistance in the wheel race. Given a sufficient area of resistance there, then the nearer the centre of the shaft can be brought to the centre of effort of that surface, the lighter the engines will be, and the less the space they will occupy in the ship. Any error occurring in this area on the small side has usually to be rectified by enlarging the wheels, because there is no room in the boxes to increase their width, and as this increases the moment of inertia, it therefore involves more power to do the same work. Apparent error in this area may be due to a fault in the ship, which makes it more difficult without largely increased power to attain the required speed.

Taking "J. M.'s" particulars of the wheels as they now are—viz., effective diameter 18ft. 6in. (?), float area 124·68 square feet—assume the speed of the wheel 26 knots, ship 21 knots, slip 5 knots. Under these conditions the power at the floats is exactly 6600 indicated horse-power, and, taking the usual efficiency of engines, the power at the cylinders is 7780 indicated horse-power. This is much in excess of what is usually fitted for similar vessels, and yet falls short of the required power by 1200 indicated horse-power. Certainly increased slip would account for this difference, but for a trial obtained in the smooth deep water of the Clyde such slip would be abnormal.

A small diameter of wheel might cause excessive slip, but a badly designed one certainly would; and certainly, after the alterations which have been made on these wheels, the design cannot now be perfect, and a ship designed for a slower speed than that intended would cause still more. This latter seems to be the trouble with these ships, and however interesting and useful the discussion of a small diameter of wheel *versus* a large may be, I submit that we do not have in these ships a practical example by which it can be settled.

R. B. S.

Birkenhead, March 31st.

SIR,—Your correspondents write about big wheels and little wheels. They overlook the essence of the whole matter. The Flushing steamers are far too short for the speed, and that is the reason they require such enormous power. To attempt to drive a vessel less than 500ft. long at anything over 20 knots is brutal.

SPONSON.

Dumbarton, April 6th.

NORTH LONDON RAILWAY LOCOMOTIVES.

SIR,—I see in the book entitled "British Locomotives," by C. J. Bowen Cooke, page 283, that the North London locomotives were designed by Mr. J. C. Park. Surely this is a mistake. Were not these engines originally designed by Mr. Adams, late locomotive superintendent of the London and South-Western Railway, who some years ago was locomotive superintendent of the North London Railway? I think I have seen in Colburn's work on the locomotive that the designer of these engines was Mr. Adams.

April 7th. F. J. P.

[The standard North London Railway locomotive was designed by Mr. Adams.—ED. E.]

BRITISH COAL IN NORTHERN FRANCE.—British coal is one of the largest imports of Rouen, amounting to an average of 400,000 tons a year, while in 1893 and 1894 the import in French ports from Calais to La Rochelle reached 3,500,000 tons. The whole of Normandy and Brittany is largely dependent on our coal for its industries as well as for domestic consumption. The duty is 1f. 20c. per ton.

THE INSTITUTION OF CIVIL ENGINEERS, YORKSHIRE STUDENTS' ASSOCIATION.—The third annual general meeting of the above Association was held in the Law Institute, Albion-place, Leeds, on March 26th. A report of the work done during the past session was read by the hon. secretary, and unanimously adopted. The following gentlemen were elected as officers for the ensuing year:—President, Mr. Arthur Greenwood, M. Inst. C.E.; vice-presidents—Mr. Thomas Hudson, M. Inst. C.E., Mr. A. T. Walker, M. Inst. C.E., Mr. W. H. Bartholomew, M. Inst. C.E., Mr. A. E. Seaton, M. Inst. C.E.; members of Council—Mr. J. Cornock, Stud. Inst. C.E., Mr. J. Duncan, Stud. Inst. C.E., Mr. C. J. Rafard, Stud. Inst. C.E., Mr. E. B. Martin, Stud. Inst. C.E., Mr. R. H. Slade, Stud. Inst. C.E., Mr. F. L. Watson, Stud. Inst. C.E.; hon. sec., Mr. Ralph P. Morrison, Stud. Inst. C.E. A hearty vote of thanks was passed to Mr. W. E. Garforth, M. Inst. C.E., the retiring president and chairman of the meeting, and also to the vice-presidents, and Mr. F L. Watson, the hon. secretary of the Association during the past session.

THE CAUSES OF MYSTERIOUS FRACTURES IN THE STEEL USED BY MARINE ENGINEERS AS REVEALED BY THE MICROSCOPE.*

By Mr. A. E. SEATON, Member of Council.

I SUPPOSE at some time or another every engineer has had personal experience of what are known as mysterious fractures in steel. Their origin and causes have been discussed here and elsewhere, but more often in doing so the question has been begged rather than settled. That there have been an equal number of fractures with wrought iron there is every reason to believe; but owing to its laminated nature the fractures have been small and localised, and seldom of so large and important a character as with steel. I do not propose to dwell at any length on the instances I am about to give, or of others that have come under my notice from time to time of unexpected and, to a great extent, mysterious fractures in steel plates, steel forgings, and steel castings, but rather to direct the attention of the members of this Institution to the researches of Professor Arnold, of the Technical School at Sheffield, who, following the theory and line of argument of Dr. Sorby, of Sheffield, has by many years of constant application and unwearying investigation confirmed them, and demonstrated the causes of the peculiar behaviour of alloyed metals when under mechanical treatment, very notable instances of which were given by Mr. Milton in his paper on copper pipes read before this Institution last year.

The particular case to which I would call attention is the sudden and unexpected total fracture of a steel shaft end, which took place in June, 1895, as shown by the drawing marked A. The shaft in question was made of Siemens steel by a well-known and old-established firm. It was specified to be of "steel containing from 0·2 to 0·25 per cent. of carbon," and its ultimate tensile strength was to be not more than 30 tons, with an elongation of 25 per cent. in 5in. This shaft, in company with the other shafts in the ship, was surveyed, tested, and passed, not only by the owners' representative, but also by the Board of Trade surveyor for the district. There was no indication on the turning of these shafts in the lathe but that the steel was of excellent quality, and, considering that the ship ran continuously from the summer of 1883 until the time of the breakage, there was, judging by the old standards, not much fault to be found; but considering that under close examination a few months before the accident there were no visible cracks or other signs of coming danger, and certainly nothing to indicate such a complete compound fracture as took place close behind one of the collars, several fragments coming out, I think you will agree with me that it is, from an engineering point of view, not satisfactory.

A few years ago both owners and all concerned would have been content with the statement that the accident was probably due to fatigue, seeing that the shaft was so many years old, and had run so many thousands of miles, but I am somewhat sceptical of the fatigue theory, for I fail to conceive how any material, such as mild steel—or, shall I say, soft iron?—can by any application of force, which results in a stress far below the elastic limit of the material, produce any internal change in the structure of the material corresponding with what is shown by the diagram; nor, indeed, do I think that any originally sound structure in which no portion is ever stressed to the elastic limit can give way by what is known as fatigue. I therefore submitted a section of the shaft to Professor Arnold, the nature of whose researches had just previously come under my notice, and I append hereto his report and opinion on the whole matter, to which I attach more importance than anything I have so far said, or can say:—

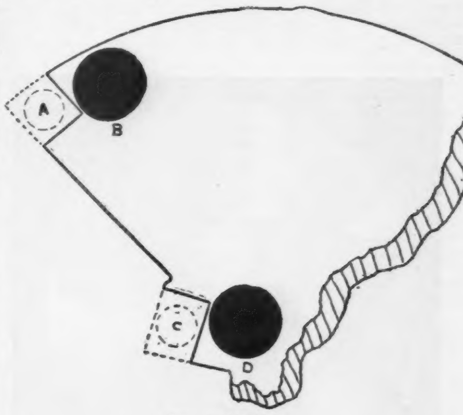


Fig. 1 Half-size

REPORT ON FRACTURED TAIL SHAFT OF S.S. N.

The transverse half-section received was broken into two quadrants. It was noted on fracture that the core of the shaft was very brittle, and showed irregular grey patches, strongly suggesting that the ingot from which the shaft was forged had "piped." The outer ring of steel surrounding the fragile core seemed fairly tough. One of the quadrants was examined chemically and microscopically. It is figured half-size in Fig. 1. The black circular holes B D indicate the positions from which the drillings were taken for analysis, the centres being 3¼in. apart. The areas A C, adjacent to the drill holes, show the position from which the micro-sections were machined.

Chemical analysis.—The figures registered on analysis were as follow:—

Sample B.—Outside of Shaft.

Combined carbon	0·310
Silicon	0·037
Manganese	0·828
Phosphorus	0·058
Sulphur	0·055

Sample D.—Inside of Shaft.

Combined carbon	0·470
Silicon	0·031
Manganese	0·986
Phosphorus	0·167
Sulphur	0·150

The above analyses show most clearly that the ingot from which the shaft was forged must have been cast very hot, and, for an ingot of the moderate dimensions necessary for the size of the shaft, a very pronounced liquation took place. In round numbers the carbon in the centre of the shaft is 50 per cent. higher than that near the circumference. The manganese has liquated with the carbon to some extent, probably in the form of a double carbide of iron and manganese. The phosphorus and sulphur of the core are each three times greater in quantity than at the circumference. It will be obvious that, even taking the mean analysis, the composition of the original steel was highly unsatisfactory as regards purity, and it was also too hard for the purpose intended.

Micrographic analysis.—The results obtained in the microscopic examinations of the sections are of a most instructive character. It will be well to discuss the microstructures under two heads.

(1) *Distribution of the carbide.*—Fig. 2 shows a portion of section C, or the hard core of the shaft, magnified about twenty-three diameters. The gray areas, constituting most of the field, consist of

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* Read at the Thirty-seventh Session of the Institution of Naval Architects, March 26th, 1896.

iron through which is diffused irregular plates and granules of the double carbide of iron and manganese. A magnification of twenty-three diameters is not sufficient to resolve the irregular laminæ and grains of carbide which will presently be represented in Fig. 3. The dark areas of the micrographs will be hereinafter referred to as "steel." The white areas consist of fairly pure "iron." Remembering that Fig. 2 is a section, it will be obvious on mentally translating it into the solid, that the metal consists essentially of a series of "steel" cells surrounded by irregular and sometimes broken cell walls of "iron," the line of demarcation between the two constituents being very sharp, as will be seen on reference to the next figure. Fig. 3—section C—shows a point towards which the angles of three "steel" cells converge. The magnification is about 170 diameters, which in the present case is sufficient to reveal the irregular laminations of carbide. A structure of this type is always more or less brittle. The sharp junction lines between two diverse constituents are always liable to rupture under vibratory stresses, because the cohesion or adhesion is inferior to that existing between interlocked constituents. Another cause of brittleness in this material is the fact that the metal is approaching "saturation,"† *i.e.*, "steel" is the preponderating constituent, which should never be the case in material about to be employed for screw shafts. Fig. 4 shows the outer shell of the shaft, section A, magnified about 170 diameters. The contrast with Fig. 3 is startling. In the present section it will be seen that "iron" is the "predominant partner," the "steel" crystals being decisively outnumbered; the structure, in fact, consisting of irregular grains of "steel" suspended in a mass of "iron." Notwithstanding this, the structure is not altogether satisfactory, because the junction lines between the "iron" and "steel" are very sharp and definite, with little or no intrusive interlocking. This fault is always well marked in unannealed steel castings, and suggests that in the present case too little work was put upon the ingot in forging the shaft.

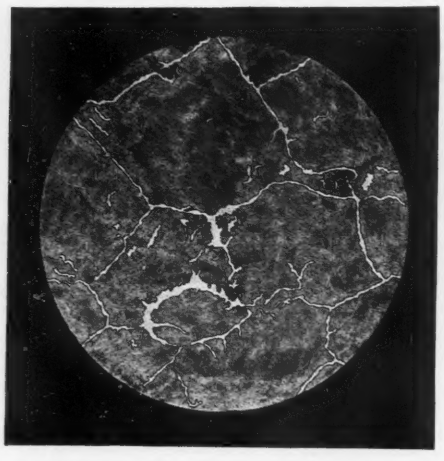
Fig. 2—Section C. Magnified about 23 Diameters. Direct Light

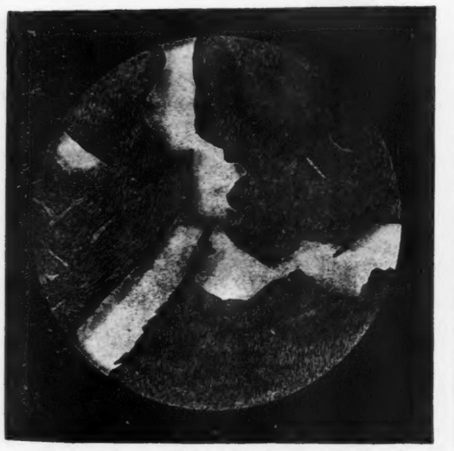
Fig. 3—Section C. Magnified about 170 Diameters. Direct Light

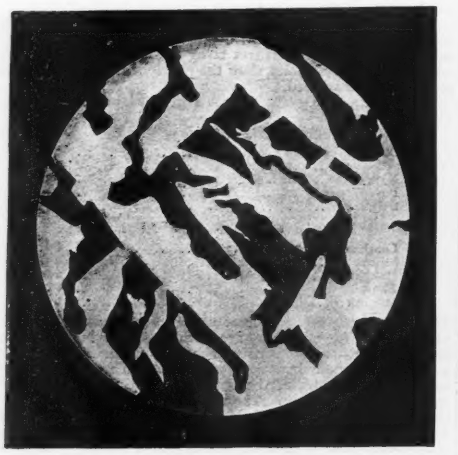
Fig. 4—Section A. Magnified about 170 Diameters. Direct Light

(2) *Distribution of the sulphide.*—Sulphide of iron, even in minute quantity, is readily recognised in steel by the microscope, but it assumes various forms all more or less dangerous to the cohesion of the mass. Its low fusion point causes it to remain liquid or semi-liquid during or after the solidification of the other constituents; and, under favourable thermal conditions, it is capable of producing the most disastrous effects. The distribution of the sulphide‡ in the interior of the present shaft assumes three forms, which are respectively exemplified in Figs. 5, 6, and 7—all section C:—(1) In large isolated globules or irregular masses, Fig. 5; (2) in smaller globules or ovoids forming an irregular train, Fig. 6; (3) in successive elongated streaks: this form is by far the most dangerous, Fig. 7. The sulphide generally, but not invariably, occurs in the iron areas, and its adhesion to the adjacent structure is practically nil; in fact, it is extremely probable that each mass of sulphide is a loose kernel separated by a microscopic fissure from the metal in which it is embedded. Well seggregated masses of sulphide, like those in the shaft under consideration, present, after etching, a hard, smooth sectional surface of a dove-grey colour, surrounded often by irregular brown rings. These may be described as rust, formed subsequently to etching, by the acid which has penetrated the surrounding fissures and which is not removed by the desiccating process to which the samples are submitted. These brown rings are therefore unconnected with the structure, but they serve to throw the sulphide into apparent relief. The sections figured are all transverse, and it is more than probable that an examination of a series of longitudinal sections would reveal the fact that some of the rounded sectional areas are the end views of lines of sulphide similar to those reproduced in Fig. 7, and mechanically equivalent to a series of minute cracks in the interior of the shaft.

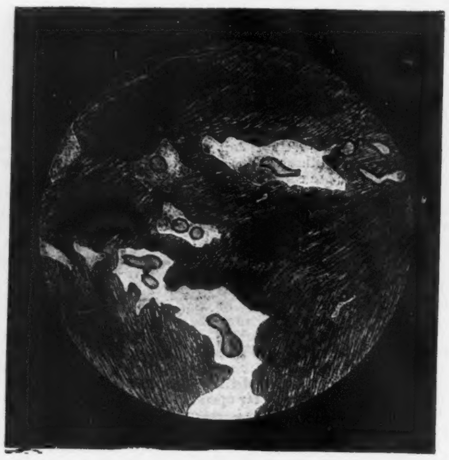
Fig. 5—Section C. Magnified about 170 Diameters. Direct Light

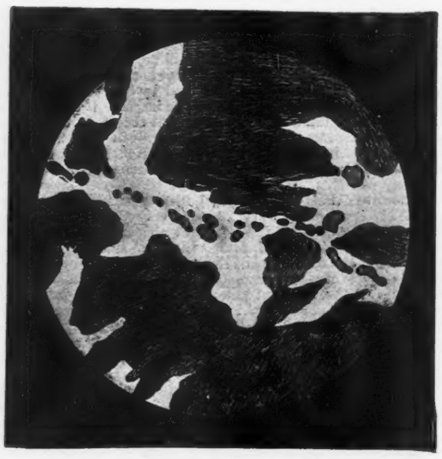
Fig. 6—Section C. Magnified about 170 Diameters. Direct Light

Summary.—It may be stated that the core of the shaft, dealt with in the foregoing report, suffered from several of the most fatal diseases to which steel is heir, namely:—(1) Bad chemical composition aggravated by liquation. (2) Pipe. (3) Unfavourable structural arrangement of constituents. With reference to the influence of the high phosphorus present, it may be stated that the microscopical evidence extant indicates that the phosphide distributes itself like the carbide, but the cohesion between crystals rich in phosphide is very faulty under vibratory shocks. The centre of the shaft, weakened by pipe, carbon and phosphorus hardness, brittle structure, and riddled with sulphide of iron, is little tougher than good grey pig iron. It is almost certain that a number of sulphide flaws in the interior gradually worked outwards along the crystalline junctions of the fairly tough metal outside, until under a vibratory shock of unusual force the whole mass ruptured. The above report is written in ignorance of the circumstances of fracture and of the history of the shaft, and although such knowledge might modify some of the deductions drawn, still, on the whole, the experimental indications obtained from the sections examined are so decisive that I think the conclusions arrived at are substantially accurate.

J. O. ARNOLD.

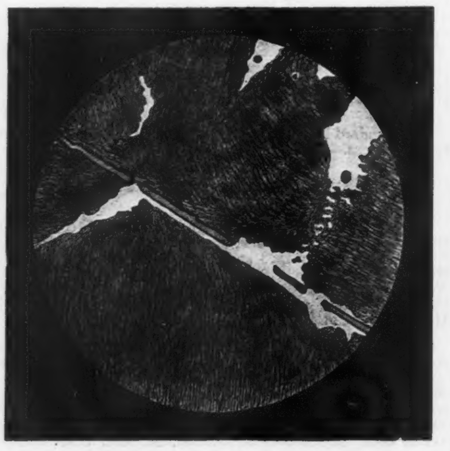
Fig. 7—Section C. Magnified about 170 Diameters. Direct Light

It will be observed that the amount of carbon present, as shown by analysis, is high, in fact much higher than it should have been; but still it certainly is not high enough to account for fracture, and I believe yet that steel with an equal amount of carbon may with advantage be used for shafts. The presence of phosphorus and sulphur is, of course, most objectionable, even in minute quantities; but Professor Arnold has demonstrated to me elsewhere that sulphur may be present to a considerable extent in a steel casting or forging and be of no serious moment, whereas the same quantity may be present in another form and be conducive to most disastrous destruction of the material. The chemist has hitherto only been able to inform us of the quantity of sulphur present; but as to whether in the dangerous or non-dangerous form he is unable to say. In fact, he can throw no light whatever on the subject, beyond stating the composition of the material, and expressing the opinion that, judging by other specimens he has examined, it is possible, and perhaps probable, that the amount of sulphur indicated by his analysis will render the steel unreliable. It seems to me, therefore, that chemical analysis alone is sufficient neither for steel nor for any other compound metal used by the engineer; while, on the other hand, the microscope reveals to us the actual structure of the material, and shows most distinctly whether it is a safe or unsafe one; it is also capable in the hands of an experienced person of practically determining the chemical analysis—certainly it will determine the chemical analysis very much more usefully than a chemist can determine the mechanical properties of the steel he has analysed; so that it appears that the use of the microscope is likely to be of the utmost advantage to the marine engineer, inasmuch as with a little experience, aided by illustrations such as I have shown in Figs. 2, 3, and 4, &c., he can see for himself whether the material he is called upon to use is such as is to be trusted; also to the steel manufacturer it will serve an equally good purpose, and one savouring of that of the skilled eye of the steel caster, whose selections of fractured blister steel enabled Sheffield manufacturers in the old days, as well as to-day, to make with certainty the different qualities of steel required in cutlery, and so establish the reputation of that great and growing place whose progress and enlightenment are so well shown by the splendid means provided by its Technical School for such investigations by Professor Arnold as I have been able to illustrate to you here to-day. I take this opportunity of thanking him for the investigations he has made for me and for his written report, as well as for the illustrations which he furnished specially for the benefit of this Institution.

The result of Professor Arnold's investigations with this particular shaft tends to show the liability of all steel shafts to begin disintegration from the centre, and the fractures and fissures, when commenced, no doubt gradually spread until they reach the surface. It is true that such fractures may occupy only a portion of the transverse section, instead of being spread over the whole. Also that such degradation proceeds without visible indication, and total rupture consequently occurs without warning, and apparently mysteriously. It follows, therefore, that to bore out the centre of a shaft, as is the practice of the Admiralty, which only slightly reduces the nominal strength, really renders it much safer, as it removes that part of the forging which is liable to be of inferior material, and in which disintegration is most likely to commence. In conclusion, I trust that the discussion which may follow will be of more importance, and possibly of more interest than the paper.

THE NOTTINGHAM WATER SUPPLY.—Last week an inquiry was opened at the Guildhall, Nottingham, as to an application made by the Corporation to the Local Government Board for power to supply water to seven rural parishes in the county. The interest in the proceedings was keen, mainly in consequence of the opposition of certain landowners and several public authorities, although the Corporation have, on the other hand, the cordial support of the villages and the Parish Councils who will reap the benefits of an improved water supply. It seems to us, says the *Nottingham Argus*, that the main question has not been considered, whether the Corporation have adopted every means to increase the existing wells and taken measures for the prevention of the present waste. "We are convinced that if the Local Government Inspector had had the assistance of an independent expert water engineer the present application would be postponed for some years," with "a saving to the town of £30,000 in interest alone."

LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—At the last meeting of this Association, Mr. Wm. Royal read a paper on "The Manufacture of Crank and Propeller Shafts, and some of the Causes of their Breakage." He described the process of welding up scrap balls, shingling and piling the slabs to form the crank web, and illustrated this by reference to diagrams on the walls. He stated that shafts made of scrap steel were built up in the same way, and considered those preferable to shafts made from ingot steel, which were difficult, if not impossible, to make into sound forgings. The weight of the hammer used is an important factor, as if it is too light the outside of the mass will be drawn or extended until the ends are quite hollow, while if the hammer is well equal to its work, the ends of the forging will be round, showing that the centre is being acted on as well as the outside. When a coupling is forged on the end of a shaft it is advisable to drill a hole up to the depth of the thickness of the coupling, as the metal is frequently hollow and defective there, owing to the drawing of the outside of the mass forming the coupling. Propeller shafts of proper size and best iron, carefully sheathed with gun-metal, seldom give trouble, except from defective fitting of the propeller boss; but if neglected the action of the salt water on the gun-metal liners sets up galvanic action, and sometimes extensive corrosion takes place at the ends of the liners. Steel is not so suitable as iron for propeller shafts, as it corrodes more rapidly, and would have to be lined throughout its whole length, which is practically impossible, as it is difficult to get liners over 7ft. long in one piece. Although these shafts are easier to forge than crank shafts, they are liable to flaws of a very serious character, owing to the contraction of the mass of metal forming the coupling, as the outside cools first and tears the centre open. Another seat of flaws is often found abaft the gun-metal liner in front of the propeller, which may be induced by galvanic action, assisted by the rotation of the shaft, or by the finishing of the shaft under the steam hammer at too low a temperature. The risk in the manufacturing of crank shafts has been greatly reduced by the introduction of built shafts, which have great advantages over forged shafts. The parts being forged separately, can be relied on as being sound. Mr. Royal said a great cause of the breakage of crank shafts had been the presence of the hot well within the foundation plate of the engines, which caused the shaft to be forced out of line by the unequal expansion and contraction of the parts, and mentioned a case where three shafts had broken in two years, and further breakage stopped by planing ⅛in. off the bottom of the two centre brasses, but the best remedy was not to put the hot well in that position.

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† The saturation point of pure iron and carbon steel is at about 0·9 per cent. of carbon. In steels containing 1 per cent. of manganese it is lowered to about 0·65 per cent. of carbon.

‡ It must be remembered that the 0·15 per cent. of sulphur present is probably equivalent to nearly 1 per cent. of sulphide, which is the substance with which the engineer has to reckon.

MEASUREMENT OF FEED AND CIRCULATING WATER, &c., BY CHEMICAL MEANS.*

By Mr. C. E. **STROMEYER**, Member.

IT is well known that the quantity of air which enters a furnace, or of the gases which pass up the funnel, cannot be accurately measured by any mechanical means, and in all modern boiler trials, where it is desired to estimate the true weight of the waste gases, recourse is had to chemical determinations. A careful analysis is made of the carbon contained in the coal, and of the carbon—in the form of carbonic acid—contained in the waste gases, then by multiplying this ratio into the weight of coal burnt per hour, the weight of the waste products is obtained. This weight is then multiplied into the specific heat, and into the difference of temperature of the air which enters the furnace, and that of the gases which pass up the funnel; and the product is the heat carried away. Complicated though this method may appear, it gives results which are far more accurate than any that can be obtained by direct measurements with an anemometer, and it therefore occurred to me that a similar process, if simplified, might with advantage be applied to the measurement of streams of water not only on land, but also at sea. As will be seen by the experiments detailed in this paper, I have succeeded in measuring both the amount of steam condensed and the circulating water of a marine engine, a task which does not appear to have been previously attempted; the results, too, are sufficiently accurate to compare well with those obtained under more favourable conditions on land engines, in which cases the measurements have always been made by positive and mechanical means.

An inquiry amongst my chemical friends elicited the fact that there are many simple tests for chemical substances, which might be depended upon for estimating them to within one-millionth of the weight of water in which they may be dissolved. The nitrate of silver test for salt—sodium chloride—is one of these, and it was therefore decided to try by this method a preliminary experiment on the feed-water of a marine engine. A measured quantity of salt—sea—water was slowly injected into the condenser of the engine while at work, and subsequently a chemical analysis for salt was carried out, both on a sample of sea water and on a sample of this adulterated feed. Supposing that their salinities stood in the ratio of 100 to 1, and supposing that the rate of injection of the sea water was half a gallon per minute, then evidently 495 lb. of steam had been condensed during the same period, with which the injected sea water had been diluted down to a 1 per cent. solution. 49½ gallons per minute would therefore be the volume of condensed steam.

Measurement of feed supply to land boilers.—The value of such a method of measuring quantities of water will, of course, depend upon the accuracy attainable, not only as regards the chemical tests, but also as regards the whole process. Being unable to make comparative tests by this process as well as by calculated measurement of the feed-water of a marine engine, an experiment was carried out ashore, in which the results could be compared with the readings of a water meter. It is well known that all town waters contain small quantities of salt in solution; in order, therefore, to find the quantity of water which has been fed into a land boiler, it was only necessary to take daily samples, both of the feed-water—town water—and of the boiler water, and to ascertain the relative daily increase of weight of salt in the boiler. Now, although the Glasgow supply, which is considered to be one of the purest drinking waters, contains only between one and two grains of salt per gallon, or about one five-hundredth per cent. by weight, yet the nitrate of silver test is so accurate that it can be depended upon to determine the exact amount to within 1 per cent. In carrying out this experiment I was at first seriously inconvenienced by irregular results, but found that these were due to condensed water in the water-gauge pipe from which the samples had been drawn. In subsequent experiments a cock was fitted direct to the boiler shell, and from that day the readings were regular. The results are contained in a table given by the author. The meter readings were commenced on Monday about noon, and ended on Saturday at about the same time. The town water was constantly running into a large tank holding about 5000 gallons, from which a sample was daily taken for analysis. The feed was drawn from this tank and pumped into two externally-fired boilers, of which the smaller one was worked 9¾ hours per day, while the large one was worked irregularly, sometimes thoughout the night. The respective working hours during the five days of the trial were 48½ and 78¼ hours. Of course, these boilers were under steam for nearly the whole period of 119¼ hours. Another set of samples of water was daily taken from each boiler and analysed. On these occasions the height of water in the gauge glass was noted, as well as the steam pressure, for the salinity of the boiler water had to be corrected on account of the evaporation which would take place during the time that it was being blown into a bucket for sampling. Thus the heat contained in the water while in the boiler would be proportional to its temperature, say 322 deg. Fah. Immediately after leaving the boiler its temperature would be lowered to 212 deg. Fah., and the heat thus liberated would evaporate a certain amount of water, which ought, of course, to be returned to the samples when cold. It amounted to about 15 per cent. The readings of the water level were necessary in order to be able to estimate the volume of water in the boiler, which had also to be corrected on account of the difference of expansion of the boiler and the water within it. Both corrections have been carried out in the table, and amount roughly to 20 per cent. The absolute weight of salt in both boilers could be estimated from the chemical test. It slowly increased from 10,830 grains (= 1½ lb.) to 56,930 grains (= 8⅛ lb.), or from ·006 per cent. to ·032 per cent. As the average saltness of the town water was 1·31 grains per gallon, it required 35,430 gallons to supply the 6⅝ lb.—or exactly 46,100 grains—of salt, and that is the estimated volume of the feed. During this period of 119¼ hours, the water meter recorded 37,270 gallons. The difference, exactly 1840 gallons, may be due either to an error of 5 per cent. in the chemical determination of the feed, equal to one-fifteenth of a grain per gallon—which will be discussed later on—or it may be due to a slight leakage of 30 gallons per day, say 1¼ gallons per hour, which is only ·4 per cent. of the feed supply. It must be remembered that the average saltness of the boiler water is 16 grains per gallon, while the feed only contains 1·31 grains, and a leakage of 150 gallons in five days would carry away 2420 grains of salt, which is as much as would be supplied by the above-mentioned 1840 gallons of missing feed-water. A method which will, under such exceedingly difficult conditions, give a result that is correct to within ·4 per cent., is surely worthy of a more general application. I would, however, wish to point out that, although in this case all the readings and the samples were taken by the boiler attendant, so that it would seem as if this method could be easily applied to land boilers, yet, as there are certain precautions which must be taken to ensure the desired accuracy, I would not recommend it for general use. These precautions are, that the boilers should be filled with fresh water before starting, otherwise the loss of salt due to even small leakages will be excessive; leakages should, if possible, be stopped entirely; and, unless the samples and water gauge readings are only taken on two succeeding Sundays, when there is no steam in the boiler, it will be necessary to make careful allowances for the boiler temperatures, the corrections amounting to about 20 per cent. for a working pressure of 80 lb. per square inch.

Measurement of feed by salt brine injections.—The above experiments were, as already mentioned, undertaken for the purpose of checking the results of some trials at sea, which, it had been vainly hoped, would contain sufficient internal evidence either to confirm or condemn the method. It was believed that the steam weights, as estimated from the indicator cards, would be found to stand in some definite relation to the feed-water; but that no dependence can be placed on them will be evident from a glance at Mr. D. Croll's paper—"Transactions" of the Institution of Naval Architects, 1894, vol. xxxv., page 425—in which, out of seven engine trials, the indicator cards only accounted for from 90 to 67 per cent. of the total steam. In the full power trials of the Research Committee on Marine Engine Trials, which lasted many hours, the variations are even greater, as will be seen from Table II., and in the exhaustive trials which were made by Professor Osborne Reynolds, F.R.S.—"Proceedings" Institution Civil Engineers, vol. xcix., page 194—similar results are obtained.

TABLE I.

"Proceedings" Mechanical Engineers, year and page.	Vessel.	Feed-water per hour. 189[illegible], page 160-1.	H.P. cyl. after cut-off.	M.P. cyl. at 0·6 stroke.	L.P. cyl. before release.
		lb.	P. c.	P. c.	P. c.
1890, page 211 ..	Fusi Yama	7,860	16·9	—	29·2
1890, page 223 ..	Colchester	43,020	28·0	—	47·3
1890, page 235 ..	Tartar*	21,564	54·8	50·9	39·7
1891, page 215 ..	Iona*	8,616	36·6	25·1	40·9
1892, page 155 ..	Ville de Douvre:	66,180	19·4	—	27·5

* NOTE.—The jacket water is included.

TABLE II.—*Moisture in Steam. Estimated from Indicator Cards at Mid Stroke. Experimental Engine, Owens College, Manchester.*

High-Pressure Cylinder.		Mean-Pressure Cylinder		Low-Pressure Cylinder.	
Revolution.	Moisture.	Revolution.	Moisture.	Revolution.	Moisture.
	Per cent.		Per cent.		Per cent.
146	39	127	34·5	109	48
229	27	215	34	184	47
322	21	320	27	276	36

It is also a matter of everyday experience that the steam weights estimated from indicator cards of different cylinders of the same engine rarely agree, and nobody should be surprised to find that the feed-water measurements obtained by me during very short trials differ from the indicator card readings. The author holds that the results of the experiments which are detailed in tables which we do not give cannot be looked upon as proving the accuracy of the method, but they possess a relative value.

The method of carrying out these experiments was as follows:—

FIG I

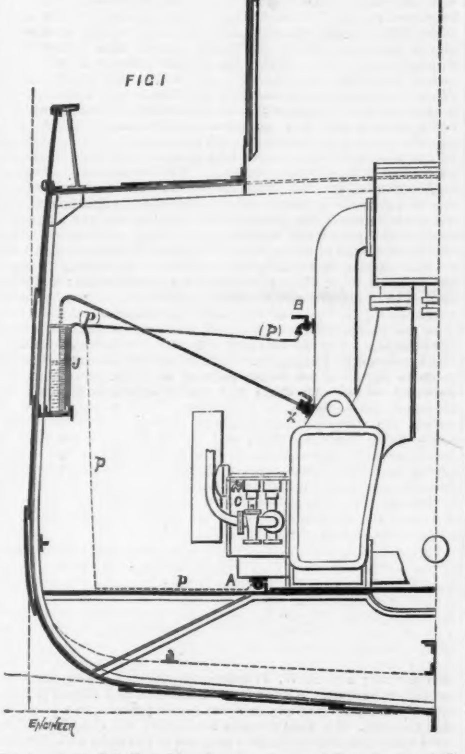

Fig. 1. A small india-rubber hose was connected to a sea cock X, and supplied sea water to a graduated glass jar J; a pipe P, capable of withstanding an internal vacuum, was led from the bottom of the jar J to a special cock A under the air pump. Both the cocks X and A were kept open for about five or ten minutes before each experiment, so that a small but steady flow of water from the sea took place, passing through the condenser into the feed pumps, from which a sample was now taken at the third cock C. A sample of sea water was also collected, and the cock X was then closed, care being taken to see that the jar J was full of water. The suction to the condenser being still open, the water-level in J would sink, and the rate of injection could easily be ascertained by noting the times at which the various marks on J were being passed. The collected samples were now chemically analysed, as will be explained later on, and the estimate of the volume of condensed steam was then a simple matter. Thus, in the case of experiment No. 1, it was found that the sample of feed-water contained 63·3 grains of salt per gallon, while the sea-water contained 1963 grains. The rate at which the condenser sucked the sea-water out of the jar J was 12·68 gallons per hour, and therefore the amount of steam condensed per hour was 12·68 × (1963 − 63·3) ÷ 63·3 = 380·5 gallons. Generally speaking, the process is somewhat more complicated, because of possible leakages of the condenser and priming. To estimate these, preliminary samples of feed and boiler water have to be collected before the injection is commenced. If the former are found to contain salt, corrections must be made which, although they are simple enough, introduce some uncertainty into the calculations, because one cannot depend on the leakages or priming being constant. All experiments with sea-water in which any leakage was detected have been rejected, but in every case samples were taken both before and after starting to inject, in order to be sure that there was no leakage.

Measurement of feed by caustic soda injections.—For this reason, and also because of the possibility which presented itself of also measuring the volume of circulating water, other experiments were made in which the chemicals injected were in one case caustic soda, and, in another trial, carbonate of soda. The results of the caustic soda trials are given in a table. Two jars were used on the trial, one for supplying the condenser and one for the circulating pump; but this arrangement did not work well, except as regards the feed, for which the injected solution amounted to less than three gallons per hour. The supply to the circulating pump could not be maintained at a constant rate, because the jar had to be constantly refilled by jugs, which left no time for accurate observation.

Measurement of circulating water by soda injections.—One of the objects of measuring the circulating water was to obtain a check on the feed-water estimate, which could be done by comparing the heat contained in the steam when it leaves the low-pressure cylinder, with the heat which is carried overboard by the circulating water. The exact amount of heat which is thus wasted has not yet been calculated, but it is evidently less than that contained in the steam when it enters the low-pressure cylinder, but it may be more than the heat contained in the steam at its exhaust temperature. Reckoning from 32 deg. Fah. these two limits are about 1150 and 1130 thermal units. The moisture contained in the steam ought, perhaps, only to be credited with from 130 to 200 thermal units, unless the whole phenomena of moisture in the cylinders can be explained by initial condensation and final re-evaporation, in which case the total feed-water—which includes the moisture—if cooled down to 32 deg. Fah., may be assumed to have parted with about 1140 thermal units. No experiments on this subject have been made on marine engines, and as regards land engines the feed and condensing water are rarely kept separate; and being mixed, they have to be measured together, and even when surface condensers have been used, only the feed which is supplied to the boiler, and not the condensed steam which leaves the engine, has been determined. The mechanical means employed for measurement are generally, tanks for the feed, and overflow weirs for the discharge water. On referring to the author's last trials, it would be seen that the observed amounts of heat rejected per pound of feed-water were 1176·5, 969, 1037, 1120. The first value may be slightly high, for although both injection cocks were opened at 3.52 p.m., the one which supplied the circulating pump was accidentally closed again until 4.10 p.m., while that for the feed was full open all the time. The error cannot be a serious one, because it takes only fifteen double strokes of the circulating pump to fill all the water spaces of the condenser. The engine having accidentally been stopped between Nos. 15 and 16, it is reasonable to assume that water had accumulated in the cylinders, which accounts for the low results in Nos. 16 and 17, and perhaps even No. 18; the latter was measured about twenty minutes after restarting. Water meters have unquestionably been brought to a high state of perfection, but none give correct readings if air should get mixed with the water, as is sure to be the case in a marine engine, unless the feed-pump is worked automatically, and unless the circulating pump is driven by a separate engine. In the author's experiments, however, the trouble to be expected with a meter, if used for measuring the flow of brine, was not that air would get into it, but that its frictional resistance would produce an irregularity in the supply. In fact, the only practical plan of using a meter would be to couple it to the engine, and thus drive the brine into the feed or circulating water, making the necessary allowances for leakages.

Chemical determinations: (1) *Salt tests.*—In the experiments the nitrate of silver test for salt was used. A large stock solution was prepared of nitrate of silver and distilled water—about 120 grains to the gallon—from which the accurately graduated burette was replenished. The sample of water to be tested was poured into the beaker, to which a few drops of a strong solution of yellow chromate of potash had been added. All the sea-water samples were first diluted down to the strength of the salted feed-water. A reading was now taken of the upper level of the nitrate of silver solution, of which as much was then run into the beaker as would just cause the sample to change its colour from a pale yellow to a reddish brown. With a little practice this could be done with the greatest nicety, as is shown by the readings of the salinity of Glasgow town water, in which there were only 1·3 grains of salt per gallon. The change of colour could not be read with the same precision when there were larger percentages of salt, because of a heavy milky precipitate of silver chloride. For fairly accurate and rapid determinations this test cannot easily be surpassed, but in inexperienced hands there is always a danger of obtaining too high a reading, because the change of colour must have taken place before it is noticed. To minimise this danger the sea-water samples were diluted down to the strengths of the feed-waters with which they had to be compared.

M. Volhardt's method: A more accurate test for salt is the following:—Prepare a weak aqueous solution of nitrate of silver and nitric acid, also a weak solution of sulphocyanate of ammonia; the two fluids should be of equal strengths. A preliminary determination of the salinity of a small portion of the sample is made as described, then a carefully measured volume of the sample is mixed with a carefully measured volume of nitrate of silver solution, but slightly more than required, so as to precipitate all the chlorides. This sample is put aside for a day in a dark place, and the clear fluid is drawn off and tested with the help of the above standard solutions. A drop or two of ferric alum salt index is first added, and then the sulphocyanate is nitrated into it out of the burette until a change of colour takes place. If this is too marked, a little nitrate of silver solution is added, and this zigzag titration continued until the neutral point has been reached. The differences of the readings of the two burettes are then subtracted from the volume of nitrate originally added to the sample, and the remainder is the exact volume of the weak nitrate of silver which was required to neutralise the salt in the sample. Both the above named tests ought to be carried out by artificial light. The clearing is net necessary with weak salt waters.

(2) *Alkali test.*—Many substances are known which change colour if transferred from an acid bath into an alkali one; but for the determination of the alkalinity of sea-water nothing is likely to surpass aurine as an index, if used as recommended by Mr. Tornö. Weak solutions of hydrochloric acid and water, and of caustic soda and water, are prepared, the two being made exactly equal in strength. They are poured into two burettes. A carefully measured volume of the water sample to be tested is poured into a Berlin bowl, a few drops of aurine dissolved in water are added, and the whole is then boiled over a Bunsen burner. The colour of the fluid will at once change from an imperceptible pale amber to a beautiful rose pink; measured quantities of hydrochloric acid are from time to time added from the burette until the rose colour has permanently disappeared, which is a sign that the hydrochloric acid is in excess. Boiling is necessary in order that all the carbonic acid in the sea-water, both free and combined, may be driven out. Drop by drop alkali solution is now added until the pink colour returns, then acid is added until it just disappears. The difference of the loss of solution from the two burettes is a measure of the alkalinity of the sample. A second sample from the same bottle is now measured out, and a slight excess—about 1 per cent.—of acid solution added, the boiling is proceeded with for about fifteen minutes, and then the neutralisation is effected as before. The strengths of the acid and alkali solutions were those adopted by the late Professor W. Dittmar, viz., each cubic centimetre contained as much caustic soda as would exactly neutralise one milligram of carbonic acid. These are the units adopted in the tables. Experiments which were subsequently carried out by me, with solutions having only one-tenth of the above strength, proved that a change of colour of the aurine index was quite perceptible on adding only ·01 cubic centimetre of the standard fluid, a quantity which affected the levels in the burettes by less than $\frac{1}{100}$in. However, having commenced the chemical determinations before I was fully aware of this extraordinary accuracy, I did not venture to dilute the fluids, and all

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* Read at the Thirty-seventh Session of the Institution of Naval Architects, March 26th, 1896, slightly condensed.

the readings are made with the normal strengths. A still more accurate determination than any to be found in this paper could have been made if, instead of salt or soda, the rather expensive chemical, nitrate of soda, had been injected into the waters. The accuracy attainable with this substance is such that the capacity of one of the Tilbury graving docks, holding about 60,000 tons of water, could be determined chemically to within 1 per cent. of its true amount, if only 1 cwt. of nitrate were to be dissolved in the water, of which a few ounces would suffice for the analysis, which is a colourimetric one. The experiment would cost about £20. A notice will be found that the thermal capacity of sea-water is 0·973. No direct experiments on the subject seem to have been made, but the author discovered some by Mr. Schüller—Poggend. Ann., vol. cxxxvi.—on the specific heats of salt solutions, from which the above value has been estimated. The specific heat of chloride of soda is 0·21401, and the density of sea-water has been assumed to be 1·026.

Conclusions.—Having demonstrated the accuracy of this chemical method of estimating water quantities, it only remains to point out the advantages which can be obtained by its use. (1) The circulating water of a marine engine can be measured at sea; this has not been done before. The quantity of carbonate of soda—washing soda—required is approximately 2 cwt. per 1000 indicated horse-power per hour, which should be dissolved in a tank of fresh water holding about 60 gallons. (2) The feed-water of marine engines—300 c.c. samples should be collected—not fitted with slow working automatic pumps, can be measured either by injecting carbonate of soda brine or sea water. On account of the air which is mixed with the feed-water when the pumps are worked by the main engines, mechanical feed meters would not give accurate results under such conditions. (3) The method can be applied to the accurate measurement of the volume of water in small streams, and would be of special value in a mountainous district. It being possible to determine the salinity of water, holding only one grain per gallon in solution, to within 1 per cent. of its true amount, it would be necessary to add salt brine—containing 50 oz. to the gallon—at the rate of only one gallon per minute to a stream which delivers 350 gallons of water per second, and to collect a sample after thorough mixing has taken place. The measurement of the volume of water supplied to towns for drinking purposes is frequently done by weir gaugings, which are said to be unreliable to the extent of 5 per cent. In conclusion the author begged to thank Messrs. R. Napier and Sons, Messrs. Ross and Duncan, Messrs. Muir and Houston, Mr. C. M. Aikman, Mr. R. J. Beveridge, Mr. Sinclair Couper, Mr. D. Johnson, and Mr. J. Thom for their assistance during these experiments, which have now extended over a period of two years, and have entailed an amount of labour which is only faintly indicated by the five trials that have been submitted in this paper.

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

Tramways.—The mileage of tramways in the United States averages about 15,000 miles, owned by nearly 1000 companies, with a capital stock aggregating £150,000,000, or 10,000 dols. per mile. Of this total mileage about 75 per cent. is operated by electricity, 14 per cent. by horses, 5 per cent. by cable, and 6 per cent. by miscellaneous systems. In all the large cities there is a great network of city and suburban lines, the former extending into the densest parts of the cities—sometimes with single tracks in narrow streets, the cars going in one direction along one street and in the opposite direction in the next street—and the latter extending to the farthest suburban settlements. The following table gives an idea of the great extent of tramway mileage in some of the principal cities:—

	Miles.
Louisville	150
Philadelphia	400
New York (including 100 miles of elevated railway)	427
Boston (including suburban lines)	550
Brooklyn (including 55 miles of elevated railway)	405
Chicago (including 66 miles of elevated railway)	659
St. Louis	291
Baltimore	225
Washington	140
San Francisco	231
Pittsburgh	242
Cincinnati	261
Cleveland	192
Detroit	166

Railway operating statistics, Chicago, St. Paul, Minneapolis, and Omaha Railway.—The following is a summary of the operating statistics of this road for the year 1895:—

Passenger trains, number	23,804
Passenger trains, mileage	1,776,140
Number of cars per train, average	5·03
Passengers per train-mile	39·09
Journey per passenger, miles	44·95
Earnings per train-mile, dollars	1·19
Rate per passenger per mile, cents	2·479
Receipts per passenger, dollars	1·114
Total number of passengers	1,544,387
Freight trains, number	48,290
Freight trains, mileage	2,972,741
Number of cars per train, average	19·16
Number of miles run per train	61·56
Distance hauled per ton, miles	148·24
Earnings per train-mile, dollars	1·80
Rate per ton per mile, cents	1·150
Receipts per ton, dollars	1·705
Total tons of freight	3,141,062
Length of railway, miles	1492·23
Gross earnings per mile, dollars	5031·91
Operating expenses per mile, dollars	3241·23
Net earnings per mile, dollars	1790·68
Total mileage of engines	6,398,149
Repairs of engines and tenders per mile, cents	4·44
Enginemen, firemen, and wipers per mile, cents	7·05
Oil, waste, and tallow per mile, cents	0·24
Fuel, per mile, cents	10·30
Total cost per engine-mile run, cents	22·03
Miles run per ton of coal	25·46
Miles run per pint of oil	18·20
Miles run per pound of waste	134·38
Earnings per train-mile, dollars	1·58
Expenses per train-mile, dollars	1·02
Net earnings per train-mile, dollars	0·56
Passenger car mileage	9,821,868
Freight car mileage	56,077,449
Coal consumed by locomotives	246,887
Coal, cost per ton, dollars	2·57
Earnings—	
Passenger, per cent.	22·92
Freight, per cent.	71·31
Express, per cent.	2·10
Mail, per cent.	2·73
Miscellaneous, per cent.	·94
Total	100·00
Operating expenses—	
Maintenance of way and structures, per cent.	19·31
Maintenance of equipment, per cent.	17·79
Conducting transportation, per cent.	47·54
General expenses, per cent.	9·02
Taxes, per cent.	6·34
Total	100·00
Operating expenses, per cent. of gross earnings	60·33

Pumping station.—The new Queen-lane pumping station for the water supply of Philadelphia is within the limits of Fairmont Park, and had to be made of architecturally pleasing design, in order to meet the requirements of the Park Commission. It is in the Italian renaissance style, and has an engine-house for four great pumping engines, a boiler-house for twenty-four boilers, and an intermediate building containing the engineer's office, electrical room, dressing room, and offices for the Park Commission. The engine-house is 136ft. long by 81ft. wide, one storey high, with a height of 48ft. from floor to roof-plates. The basement is 21ft. in the clear. The walls are faced internally and externally with buff bricks, the inside being glazed for a space of 6ft. from the floor. The boiler-house is 180ft. long by 81ft. wide, and is also in one storey, brick-faced, similarly to the engine-house, with a height of 36ft. from floor to roof-plates. It has a basement 17ft. by 75ft. in each end, that in the south end being used as a machine shop, while that in the north end contains two hydraulic lifts, and opens into the mouth of the tunnel to the coal shed. The south basement has a clear space of 10ft., the north of 12ft. The intermediate building is two stories high; the first 16ft. in the clear, the second 10ft. The external walls of the buildings are enriched with belt courses, arch mouldings and foliated terra-cotta frieze. A large granite tablet, 15ft. long by 8ft. high, set in terra-cotta ornamentation, occupies the centre space over the door in the front wall. The cut stone used in the buildings is Indiana limestone. The floor of the boiler house and of all the basements is composed of cement concrete, with a granolithic finish. There is in the engine house, at a height of 42ft. from the floor, an electric travelling crane, with a clear span of 75ft. It has a lifting capacity of 20 tons, and has assisted materially in facilitating the work of erecting the engines. The lifting tackle can be placed over any point in the engine-room, except a narrow space around the walls. The chimney or stack is built central to the front wall of the boiler house, but separated from it by a space of 9ft. The inside diameter of the barrel is 12ft., and it rises to a height of 201ft. above the ground in front of the building. The external wall of the stack is built in the form of a tower, with a base 27ft. square. At a height of 181ft., where the tower ends, it is 24ft. on a side. The foundation of the stack is about 24ft. below grade level, the bottom course being 37ft. square and 2ft. thick, the stepping courses averaging 18in. in thickness. There is a cut stone base 6ft. in height from grade level. All the superstructure is of hard stretcher bricks, faced with buff bricks. The top of the tower portion of the chimney, for a height of 38ft., is decorated with terra-cotta moulded brick pilasters, with foliated caps, and an ornamental balustrade. On the four sides of the chimney below the main cornice there are ornamental terra-cotta panels, 11ft. by 14ft. Wire-glass is used in the boiler-house ventilators, but as it was found to crack—though it did not leak or give way—it is not used in the lights of the ventilators on the engine-house roof.

Water-works pumping engines.—The Queen-lane pumping station of the Philadelphia water-works has four vertical triple-expansion engines, with single-acting plungers, each engine having a capacity of 20,000,000 gallons in twenty-four hours. They work under an initial steam pressure of 140 lb., and pump through a rising main of 48in. diameter, about 8000ft. long, into a reservoir at a height which will give a static head of about 250ft., equal to a pressure, allowing for friction, of about 110 lb. The cylinders are 37in., 62in., and 96in. diameter. There are three single-acting plungers, each 34½in. diameter, all of 54in. stroke. The steam inlet to each high-pressure cylinder is 8in. diameter, and the suction and discharge pipes are each 40in. diameter at the pump, enlarging to 48in. a few feet away. There is a 48in. check valve placed in each discharge pipe, and the suction pipes are provided with foot valves. The length of suction pipes is about 300ft. The height of suction lift at ordinary stage of water in the river is about 17ft. Each pump chamber contains ninety suction and ninety discharge valves, with a net area of nine square inches through each valve. The area of the plunger is 934 square inches, and the area through the valves 810 square inches. When the pump is running 22½ revolutions per minute, which is the required speed to deliver 20,000,000 gallons of water in twenty-four hours, with an allowance of about 3 per cent. for slip, the speed of the water through the valves is 3·6ft. per second. The admission of steam to the high-pressure cylinder is controlled automatically by a Porter governor. The steam gear is of special design to give the best steam distribution and highest economy, and is particularly simple and accessible for adjustments. The steam valves are of the gridiron slide pattern, and are actuated by cams, which give quick opening and closing movements. These valves are placed at an angle so as to insure their seating, and they are held against the seats by the pressure of the steam. Being of the gridiron type, they have very small movements; and being located in the heads, give the minimum clearance, not exceeding in any case 2½ per cent. of the piston displacement. All the cylinders are jacketed with steam, and there are re-heaters between the cylinders. The jackets and re-heaters, with the exception of the low-pressure jacket, use steam of boiler pressure, the low-pressure jacket steam being reduced to 50 lb. by means of a reducing valve. All drain and jacket steam is trapped, and returned automatically to the boilers. Each pump has two fly-wheels 18ft. diameter, and weighing 40,000 lb. The air pump is single-acting, 28in. by 36in., and is driven by a beam from the low-pressure plunger crosshead. The total weight of the engines, piping, and steel substructure is 2500 tons. The greatest height from the foundation is 56ft., and the space occupied by each pump is 46ft. by 18ft. The guaranteed duty is 110,000,000 foot-pounds, during a run of thirty days by the regular city employés, and using a fair quality of coal.

Garbage disposal.—Tenders were received recently for disposing of the garbage of New York City as follows:—H. L. Fox, 2s. per ton—2000 lb.—using the Vivartas furnace cremation process, with a furnace at each of the twenty garbage dumps on the river front; Z. F. Magill, 5s. 8d. per ton, using the Brown cremation process, with one large central plant; Kelly and McGelhan, 6s. 2d. per ton, using a new cremating process with an inclined rotating cylinder; Merz Extractor Company, 3s. 9d. per ton, using the Merz utilisation process; and R. W. Peterson, 6s. per ton, using the Arnold utilisation process. All the bidders but Fox and Magill proposed to carry the garbage away in scows, as at present, to a plant outside the city. All the processes mentioned are already in actual service in other cities with the exception of the Kelly and McGelhan furnace. The city estimated that there would be 800 tons of garbage per day to be disposed of, but some of the bidders considered this to be too high. All the tenders were rejected, as on a former occasion, and it is expected that new specifications will be issued and new bids asked for on the basis of a lump sum per year, regardless of the quantity of garbage, instead of a price per ton, as the number of tons is an uncertain quantity, and if the quantity fell much below the estimate it would not pay a contractor to put in an expensive permanent plant. At San Francisco, a contract for operating a garbage crematory for fifty years has been given to M. L. V. Merle for £1000, although two other bidders tendered £430 and £213 in cash, and from 2 per cent. to 5 per cent. of the gross receipts. The contractor will put up a cremating furnace with a capacity of 250 tons per day.

The first-class battleship Majestic, flagship of the Channel Squadron, is to undergo a long series of trials. The programme, as arranged by the Admiralty, includes runs over the measured mile in Stoke's Bay as follows:—Two runs at 60 revolutions with a corresponding speed of 10 knots; four runs at 75 revolutions—12½ knots; four runs at 85 revolutions—14 knots; four runs at an indicated horse-power of 10,000 with a corresponding speed of 16½ knots; and two runs at the slowest possible speed consistent with having the vessel under proper control. The second series will be point-to-point trials between Start Point and the Lizard. This provides for the vessel steaming at 12,000 indicated horse-power—forced draught—for 4½ hours, heading westward for one-half the time, and in the opposite direction the other half. Before the trials are commenced the vessel is to be brought to a draught of 27ft. forward and 28ft. aft.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

The April quarterly meeting of the Midland iron trade was held in Birmingham to-day—Thursday—and it may be considered a satisfactory gathering. Confidence was expressed that although the trade improvement is not very marked at present, yet that the improvement would become more emphasised as the year proceeded. Some well-known authorities prophesied two or three years of prosperity, and pointed to the progress of shipbuilding, and to the following by foreign Governments of the liberal policy adopted by England; also to the extension of railways in various parts of the world, more particularly in Africa and in the East. The light railway movement at home was another feature which such critics regard with hopefulness.

All branches of the engineering trades of the city and district were reported to be well occupied, and to have had a good quarter.

Marked bars were re-declared at £7 as the basis price, with 12s. 6d. extra for the L.W.R O. brand of the Earl of Dudley. Demand is improving. Merchant bars are quoted £6 to £6 5s., and common £5 5s. to £5 10s. Black sheets were obtainable at £6 12s. 6d. to £6 15s. for doubles, and £8 for lattens. In this department the great production has caused a weakening of prices, and doubles are easier to buy than in January by about 10s. per ton. Compared, however, with this time a year ago, current prices are an improvement of about 10s. on doubles and £1 on lattens. Galvanised corrugated sheets in Liverpool are £10 2s. 6d. to £10 5s. for 24 gauge, compared with £10 7s. 6d. to £10 10s. in January, or a drop of about 5s. on the quarter. But a year ago they were quoted £9 10s. f.o.b. Liverpool, so that progress has been made during the twelve months to the extent of 17s. 6d. Stamping sheets this afternoon were quoted £9 10s., and best thin sheets £11. For hoops and thin strip, £6 7s. 6d. was asked; for nail rods, £6 10s.; and for tube strip, £5 10s.

With reference to steel, the Scotch and North of England firms are so busy upon shipbuilding orders that they have been lately allowing orders for other descriptions of work—including mainly engineering sorts—to pass them—a circumstance which on several occasions has proved advantageous to this district. Prices are steady at £4 10s. for Bessemer blooms and billets, £5 12s. 6d. to £5 17s. 6d. for angles and boiler plates, £7 5s. to £7 10s. for sheets, and £5 15s. to £6 for bars. Basic steel girders and angles are £5 10s., and boiler plates £6 5s. Activity has characterised the whole of the quarter in steel, and makers are still well placed. Of structural steel generally it may be said that it is 10s. a ton better than this time last year. An excellent business was done this afternoon.

Staffordshire cinder pigs were quoted this afternoon 36s.; part-mines, 42s. 6d.; all-mine hot blast, 55s. to 57s. 6d.; and cold blast, 90s. These values are about the same as in January. The production has been heavy throughout the quarter. Values, however, are somewhat better than a year ago, the quotation for Staffordshire all-mine hot blast being then 52s. 6d. to 55s.; part-mines, 38s.; and cinder sorts, 36s. to 37s. A good deal of business was done this afternoon in Northamptons, Derbyshires, and Lincolns. Derbyshires were quoted 42s. to 43s.; Northampton forge, 41s. to 42s. 6d.; and Lincolns, 44s. to 45s. These figures are about the same as in January; but they show a considerable advance upon this time a year ago, when Lincolns were only 39s. to 40s. at stations, net. Derbyshires, 38s. to 38s. 6d., less 2½ per cent. delivered to works in this district, and Northamptons 37s. 6d. upwards.

Touching the probable future of the mechanical carriage trade, interesting reference was made at the recent annual meeting in Birmingham of Forder and Company, the hansom cab manufacturers. Mr. Hipwell thought that by the exercise of a little ingenuity on the part of the directors, some novelty might be brought out. He did not know whether the horseless conveyance would be likely to make headway in England, but it was possible it might, and he did not see why the company should not be the first in the field with mechanical cabs. The chairman—Mr. C. Forder—said he and his brother were the founders of the company. When they went out the turnover was up to £36,000 a year, but when they returned it had gone down to £17,000. They were gradually getting the trade back, and when the turnover reached £25,000 a year they would be able to pay a dividend of 10 per cent. As to the new motor, that was engineers' work at present, and not a carriage-builder's. They held all the best patents for hansom cabs, and watched every new invention very narrowly. When the new motor was perfected they would be able to supply the carriages, but it would be out of the company's line to undertake the engineering part of the work.

S. A. Daniell, Limited, is the title of a company which has been registered with a capital of £10,000 to carry on the business now conducted by Howard S. Pearson, at the Lion Works, Edward-street, Parade, and St. Peter's-place, Birmingham, as the executor of Samuel A. Daniell, deceased, as manufacturers of engineers' and other tools, copying presses, &c., iron and brass founders, and mechanical engineers. The first director is Mr. Fred Hadley, manufacturer, King's Heath, the qualification being £300, and the remuneration £200 per annum.

The Tipton Mines drainage engineering scheme was stated at the last meeting held of the South Staffordshire Mines Drainage Commissioners, to be proceeding as rapidly as possible; but it was pointed out that until the whole of the agreements with the various authorities and private owners had been signed, sealed, and delivered, no plant could be laid down.

An instructive speech upon light railways was made by Sir Alfred Hickman, M.P., at Wolverhampton a day or two ago at the annual meeting of the Locomotive Steam-enginemen and Firemen's Friendly Society. He trusted various existing restrictions would be removed by the Light Railways Bill. With regard to the cost of a light railway, he might say that a firm had offered to make a line for about £3000 a mile, and equip it with carriages and rolling stock, whereas he understood that some lines had cost from £15,000 to £16,000. Light railways, he contended, would be beneficial for farmers and other members of the community, and they would give an impetus to railway enterprise.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The holidays during the past week have tended for the time being to still further slacken off buying, and there has been a general absence of animation throughout the market. In some quarters the immediate outlook is scarcely regarded with so much satisfaction as recently, and there would certainly seem to be a quieter tone in this district as compared with other important centres of the iron trade. Generally, however, the position continues strong as regards prices, makers showing no disposition whatever to give way in the least, whilst in the steel trade the tendency is decidedly in an upward direction, the large Government inquiries now coming forward necessarily helping up this section of the market. The lull just now being experienced as regards new buying is for the most part looked upon as not more than temporary, and the only effect is perhaps to force second-hand iron upon the market, here and there, at lower figures, where merchants or dealers are not in a position to hold on.

There was only a small attendance on Tuesday's Manchester iron market, with little or no inquiry of any weight stirring. Pig iron was in but slow request, owing, in some measure, to the holidays, but chiefly to the fact that both merchants and users are well covered in most cases, so far as present requirements are concerned. Prices, however, generally maintain a firm tone, although in some cases odd parcels in second-hands might be bought for immediate delivery at under market rates. Makers hold strongly to late quotations, and for local brands are getting their full list rates of 46s. 6d., less 2½, for foundry qualities, whilst in district brands it was decided, at a meeting of Lincolnshire makers, to maintain the minimum quotations at 42s. for forge to 44s. for foundry, net cash, delivered Manchester, a trifle over these figures being got in some cases, and Derbyshire foundry remains at 46s. 6d. to 47s. net cash, delivered Manchester. With regard to outside brands offering in this market, makers are asking rather higher prices, and are not taking anything under 47s. 1d. net cash for No. 3 foundry, Middlesbrough, delivered Manchester, whilst merchants scarcely go more than 3d. below this figure, but for delivery Dock Quays 45s. 6d. would still be taken in some cases; Eglinton, delivered Lancashire ports, is now generally quoted about 47s. 6d., and for delivery Dock Quays, Manchester, 49s. 9d. to 50s. net prompt cash.

A fair amount of new business is being secured by manufactured iron makers, and forges are kept fully engaged, with a firm tone as regards prices. Lancashire bars, delivered Manchester district, are steady at about £5 10s. to £5 12s. 6d., and North Staffordshire qualities £5 12s. 6d. to £5 15s.; whilst sheets remain at about £7 10s. to £7 12s. 6d., and hoops at the Association list rates of £6 2s. 6d. for random to £6 7s. 6d. for special cut lengths, with 2s. 6d. less for shipment.

In the steel trade a strong tone is reported generally, with a steady upward movement in hematites, good foundry qualities not now being quoted by makers under 58s. and 58s. 6d., less 2½, and ordinary steel billets range from £4 10s. up to £4 15s. net cash, with boiler plates averaging £6 7s. 6d. to £6 10s. per ton, delivered in the Manchester district.

No material change is noticeable in the metal market; business in all descriptions is satisfactory, with an active demand generally. There has been no further advance in the official list rates for manufactured goods; but, as I have previously noted, makers are getting ½d. per lb. above their quoted rates, on small orders for brazed brass and copper tubes.

The position in the engineering trades is one of continued increasing activity, and evidence of this is afforded in the out-of-work returns of the trades union societies, which show a steady decrease in the unemployed list for this immediate district. The Steam Engine Makers' Society has now only 1 per cent. of the total membership of the society on donation benefit, which is less than one-quarter of the number reported on the unemployed list for the corresponding period of last year, and the tendency is in the direction of a still further reduction. The reports received by the above society from the different districts as to the condition of trade are again of a most satisfactory character, practically all departments being in a good position as regards work in hand, and it is very exceptional where establishments are not fully employed, with new orders coming forward freely, especially amongst heavy stationary engine builders. Marine centres also show a continued steady improvement, although in one or two isolated cases the position is still not very satisfactory.

Messrs. B. and S. Massey, of Openshaw, have just completed a large foreign order, which includes, among numerous other hammers, six of the Rigby type, with framing composed entirely of riveted steel plates and angles. This arrangement secures special advantages even in small sizes of hammers, and much more so in large hammers, by reducing the cost of transport, and the risk of breakage through carelessness in transhipment. The hammers, which are of the 5 cwt. and 10 cwt. sizes, are fitted with Messrs. Massey's combined self-acting and hand-worked valve gear, and have an exceptionally large "overhang" or space from the anvil pallette backwards to the upright part of the standard, so that the greatest possible working space is afforded for operating the hammer. Messrs. Massey have also just completed two unusually large and powerful steam stamps of the pillar form, with a falling weight of 15 cwt. for stamping parts of guns, the tup sliding between round iron pillars, which are hollow tubes, and strong stout bolts passing from the bottom of the base-block to the nuts at the top of the stamp for binding the whole firmly together. These stamps, of which an illustration with more complete details, will shortly be given in THE ENGINEER, are double-acting, the steam being employed not only for lifting, but also for accelerating the fall of the tup.

In the coal trade the position shows no signs of any improvement, at any rate in the immediate future. Only the slowest possible demand comes forward for all descriptions of round coal, and both in the better qualities and the inferior descriptions, even with the present limited output, supplies continue in excess of requirements, with an easing tendency in prices. The demand for house-fire qualities is necessarily largely affected by the mildness of the season, and many of the collieries closed the winter with heavy stocks on hand. Nominally there is no quotable change in list rates, but these are only being got on small orders, very low figures having to be taken for anything like quantities. The low class of round coals used for steam, forge, and general manufacturing requirements, continue a drug upon the market, and in the keen competition to secure orders prices are forced down to an excessively low point.

At the pit-mouth, best Wigan Arley coals do not average more than 9s. 6d. to 10s. per ton; Pemberton four-feet and second qualities of Arley, 8s. to 8s. 6d.; common house-fire coals, 7s. to 7s. 6d.; with about 5s. 3d. up to 6s. 3d., according to quality, representing the full average prices that are obtainable for ordinary steam and forge coals at the pit-mouth. Engine fuel is becoming rather scarce, if anything, owing partly to the limited demand upon round coals, and partly to the increased requirements for slack for coke-making purposes, owing to the general activity in the iron trade. Prices necessarily show a hardening tendency, and although it is exceptional where any really appreciable advance is being got, ordinary slack could scarcely be bought under 3s. 6d., with better qualities, 4s. 6d. to 4s. 9d.; and some special sorts, 5s. at the pit.

The shipping trade remains depressed, with common round coals, for bunker purposes, not fetching more than 6s. 9d. to 7s. 3d., and better sorts 7s. 6d. to 7s. 9d. delivered at the Garston Docks or High Level, Liverpool.

Barrow.—The week's business in hematite pig iron has been on a comparatively large scale, and the Easter holidays do not seem as usual to have checked the influx of orders. Bessemer qualities are in especial request, and orders are well held. 39 furnaces remain in blast, as compared with 28 in the corresponding week of last year. Stocks have been reduced during the week to the extent of 2090 tons, and now stand at 300,939 tons. Prices show an upward tendency. Warrant iron is quoted at 47s. 8½d. net cash sellers, 47s. 8d. buyers. Makers are still quoting 50s. per ton net f.o.b. for mixed Bessemer numbers.

Iron ore mines are more busily employed, and the trade in native qualities shows a distinct improvement. Ordinary sorts are at 10s. per ton net at mines. Spanish is still largely used, and is quoted at 12s. 9d. at West Coast ports.

Practically every branch of the steel trade is busy. Orders are plentiful for rails, ship and boiler plates, hoops, billets, and merchant steel generally, and there are indications, what with the orders on hand and those offering, that a very brisk continuance of trade will be experienced throughout the year.

There is nothing new to report in the shipbuilding and marine engineering branches of trade.

Coal and coke find good markets, and prices are firm, but not quotably higher.

Shipping is more active. The exports of pig iron during last week represented, from West Coast ports, 5650 tons, and of steel 7670 tons, as compared with 4156 tons and 5120 tons respectively in the corresponding week of last year, an increase of 1494 tons of pig iron and 2550 tons of steel. The aggregate shipments to date this year show 84,168 tons of pig iron and 113,313 tons of steel, as compared with 67,310 tons of pig iron and 98,587 tons of steel in the corresponding period of last year, an increase of 16,858 tons of pig iron and 14,726 tons of steel.

There is every prospect of a big scheme being started at Barrow for the development of the great salt deposit on Walney Island. It is proposed to build works on the south end of the island, and to ship manufactured salt from a pier already in existence alongside the site of operations. Other works for the manufacture of alkali and other chemicals are contemplated. The new works are likely to be of very great advantage to the trade and commerce of Barrow.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

VERY little work has been done of late, owing to the Easter holidays, which have been most freely enjoyed, the exceptionally beautiful weather and the slackness of trade alike contributing to that issue. Trade is now being resumed, and the general state of coal continues very much as previously reported. Both the house and steam coal pits are quiet, and considerable concessions have to be made to clear off stocks. The tonnage sent to the metropolis does not increase, and is not likely to do so now, as summer weather gets more assured. Another serious factor in keeping prices low is the keen competition of the seaborne fuel. Quotations, though unaltered on the lists, are exhibiting a downward tendency, and merchants stocks are not commanding above the low rates ruling last summer, while in the case of secondary qualities even lower values have to be accepted:—Best Silkstones, 8s. to 9s. 6d. per ton; ordinary ruling from 6s. 9d. per ton; Barnsley house from 7s. 6d. to 8s.; Flockton, 6s. 9d.; and thin seam, 6s. per ton.

The Eastern Counties are doing but a slight business. Steam coal is in fair request, and, though competition is very keen, the local collieries are forwarding an average tonnage to the Humber ports. Freights are very low at present. The majority of the business is being transacted by the larger collieries both with the Humber and the other ports. A fairly good weight is being called for by the railway companies on contract account, although the large supplies have the effect of making prices low. Barnsley hards command from 6s. 6d. to 7s. per ton; inferior sorts, 6s. per ton. Gas coal is in about the same moderate condition as steam sorts. Prices are scarcely maintained, the coal contracts recently entered into by Durham firms at the rate of 6s. 3d. per ton, having the effect of keeping values down. Manufacturing fuel is in good demand, supplies being abundant, though lower than was the case a few weeks ago. Quotations remain about the same. Small nuts, 4s. 6s. to 5s. 6d. per ton; screened slack, 3s. 6d. to 4s. 6d. per ton; pit slack, 2s. 6d. per ton, and smudge 1s. per ton. Coke is in a better condition, and Derbyshire, Northamptonshire, and Lincolnshire are taking a good supply for smelting purposes. Prices are firm at 8s. to 10s. per ton.

The heavy industries of the city continue satisfactory. Makers who booked a large number of orders in the early part of the year have now the pleasant prospect of being in a position to find full employment for their men for a considerable time to come. A few manufacturers are complaining of the absence of orders. The trouble in the Transvaal has had rather an adverse effect on one or two departments of the Sheffield trades. The demand for machines, bars, sheets, and similar goods are not coming in so freely as was the case before Dr. Jameson crossed the border. It is expected that matters will settle down peacefully ere long, and the business done before the outbreak will be resumed with some large additions. It has not had the effect of stopping the large consignments of steel, tools, and general hardware goods now leaving Sheffield for the South African market. Many firms are doing quite as large a business with that part as they did before. The iron trade, as well as the steel, is in the same healthy condition. Values are well maintained. Hematites realise—West Coast, 55s. 6d. to 57s. 6d.; East Coast, 54s. 6d. to 55s. 6d. at makers' works; Lincolnshire pig iron, 41s. 6d.; foundry, 42s. 6d.; Derbyshire forge, 39s. 6d.; with foundry, 42s. 6d.; bar iron, £5 10s.; and sheets, £7 10s. Many of the local companies have issued their balance-sheets during the last week or two, and they show a healthy state of affairs all round. Good employment is reported in the rolling mills. At the carriage and wagon works in this district better business is coming in, and the men are more fully engaged than was the case a few weeks ago, while the wheel makers report large accessions of business.

In the lighter industries the end of the quarter is finishing very quietly for many houses. March is generally one of the quietest months the silver platers have during the whole year, and the present month has been no exception to the rule. The business at this season is nearly all concentrated on the requirements of hotel and boarding-house keepers at the summer resorts, as well as goods suitable for prizes, &c., at shows and sports, in which a very large business is now done. The request for forks and spoons is quite equal to what it was a week or two ago. The tendency of buyers to purchase the sterling silver goods in preference to plated wares or hollow ware goods still continues. In some of our larger establishments special attention is being paid to a pressing demand for old Sheffield patterns. The cutlery and tool makers report that they have as much business on hand as will keep their hands employed well into the autumn. The business with the Australasian Colonies has considerably advanced. There is a very large request for sheep shears from these markets as well as from New Zealand, and several houses have booked some very good orders in cutlery and similar hardware goods. A large quantity of electro-plate, in the cheaper kind, is being sent to these Colonies. The trade with India is not so good, the value of the rupee showing a distinct tendency to falling lower. The very mild weather at present being experienced has had the effect of causing an excellent request for field and garden tools, a business which has set in much earlier than is usual. In many cases makers cannot cope with the enormous requests of their customers. A good number of scythes and similar goods are being despatched to both the home and distant markets, and the prospects are exceedingly encouraging for the coming season.

The annual meetings of shareholders in local companies now being held do not exhibit any great improvement in the trading up to December 31st, 1895. The report in each case invariably sets forth that the revival set in during the latter half of the year, and that its effects will not be fully apparent until the current twelve months' trading is ascertained. The companies who make up their balance-sheets to March 31st or the middle of this year will afford a clearer idea of the volume and value of business done. At every meeting the prospects of 1896 are always accompanied with the significant proviso, "If the colliers keep the peace."

The reports from the Consular District of Sheffield to the United States during the quarter ended March 31st show a total value of £166,444, against £112,602 for the corresponding period in 1895 and £57,957 for the corresponding three months in 1894. Cutlery was sent to the States to the value of £29,819, and steel to the value of £84,444, the corresponding values having been £28,678 and £71,924 respectively.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

ON account of the holidays the market is quiet this week, but that was only what was looked for, and prices are fully maintained in all branches of the iron and allied industries. Pig iron makers especially are firm, as they have every reason to expect that, busy as they have been in March, they will be still busier in the current month, as the shipping season is now nearly in full swing. Thus the good prospects counteract any detrimental influence that might have resulted from the rather disappointing statistics issued by the Ironmasters' Association, an increase in stocks being reported where a decrease was generally expected, especially after the almost unprecedented exports.

The March shipments of pig iron were unprecedented, so far as the corresponding month in any previous year is concerned, for they reached from the Cleveland district no less than 102,908 tons, that being 33,646 tons more than in February, and 25,026 tons more than in March, 1895, and a March average is scarcely more than 80,000 tons. As compared with last year it is to be borne in mind that not only was the trade better this year, but the weather was very much better also, and permitted of shipments being made to ports which last year were icebound throughout the month. A large business was done with continental consumers and merchants last month, much more than is usual in March, and deliveries to Germany especially have never been heavier than they were last month, even in the busiest period of the year. This is due to the mild weather having allowed the inland waterways on the Continent to be open much earlier in the year than usual. Last month over 32,000 tons of pig iron were shipped directly and indirectly to Germany, that being one-third of all the pig iron shipped from the Tees, and three-fifths of the quantity sent over sea. A larger trade than the average was done with Belgium, France and Spain, but by far the greatest increase was to Germany, which had last month double the quantity usually sent in March. Altogether the tonnage of pig iron shipped from the Cleveland district last month, as compared with the periods named, has been as under:—

	Coastwise. Tons.	Foreign. Tons.	Total. Tons.
March, 1896	50,425	52,483	102,908
February, 1896 ..	44,400	24,864	69,264
March, 1895	42,696	35,188	77,884
March, 1894	46,560	40,197	86,757

Seldom, indeed, do the shipments of pig iron from the Cleveland district exceed a hundred thousand tons per month, and that this quantity should be exceeded so early in the year as March is specially worthy of attention.

The price quoted for prompt f.o.b. deliveries of No. 3 Cleveland pig iron this week has been steady at 38s. 6d.; this is both makers' and merchants' figure, and practically the makers are not now being undersold by the merchants and speculators; in fact most sellers think it is to their interest to hold off for better prices. There is no pressure among second-hands to sell, as it is the early part of the month, and as they have nearly the whole month in which to take out their iron, they are not so much concerned in finding customers as towards the end.

The difference between the prices of Scotch and Cleveland warrants is being reduced, as the latter have advanced more quickly than the former. A few weeks ago the difference between the prices for the two was 9s. 3d., and even more; to-day it is only 8s. 6d., but it should be only 4s. 6d. or 5s., which is what it costs to deliver Cleveland iron to the Scotch founders. The intrinsic worth of the two classes of iron does not justify anything like such a difference as now is reported. And such a difference is having the effect of causing a greatly increased consumption of Cleveland pig iron at the Scotch foundries, as the owners of the latter can get it at considerably lower rates than they have to pay for native iron. Never in the history of the trade, except once, has more Cleveland pig iron been sent to Scotland than in the last quarter. The average of the corresponding quarter during the last ten years has been about 85,000 tons, but this year the quantity has been 111,426 tons, of which 9519 tons went from Skinningrove. Only in 1894 was this quantity exceeded, 118,932 tons being then sent. Of the pig iron exported from the Cleveland district, nearly one half was despatched to Scotland last quarter. It will thus be seen that the Cleveland ironmasters could ill afford to lose the Scotch market.

The Cleveland ironmasters' March statistics did not come up to expectations, as an increase of 3701 tons was reported where a decrease of at least as much had been looked for, especially after such heavy shipments. The stocks of Cleveland pig iron have been increasing ever since the end of October last, and the total increase has been 88,285 tons. The total output of pig iron in the North of England in March was 274,950 tons, or 20,170 tons more than in February, but the daily output was no more. The production of pig iron during the quarter was the best on record, and if continued at the same rate, it will for the year exceed 3,000,000 tons, the best hitherto reported being 2,963,000 tons in 1894. Altogether 798,925 tons of pig were made last quarter, of which 400,541 tons were Cleveland pig, and 398,394 tons hematite, basic, and spiegel. The Cleveland iron in the quarter exceeded the requirements by 49,886 tons. The following is the official record of the production and stocks of pig iron for the North of England:—

Make of Pig Iron.

	1896.		Increase	Decrease
	March	February		
	Tons	Tons	Tons	Tons
Make of Cleveland pig iron, Port of Middlesbrough	117,206	110,548	6,658	—
Do. do. outside Port of Middlesbrough	21,018	19,458	1,565	—
Do. do., whole district	138,224	130,001	8,223	—
Make of other kinds of pig (including hematite, spiegel, and basic pig iron), whole district	136,726	124,779	11,947	—
Total of all kinds, whole district ..	274,950	254,780	20,170	—
No. of furnaces on Cleveland pig iron at end of month, whole district	52	52	—	—
Do. on hematite, &c., at end of month, whole district	44	44	—	—
Total	96	96	—	—

Stocks of Pig Iron.

	1896.		Increase	Decrease
	Mar. 31	Feb. 29		
	Tons	Tons	Tons	Tons
Makers' stocks of Cleveland pig iron, Port of Middlesbrough ..	101,513	100,409	1,104	—
Do. do., outside Port of Middlesbrough	10,640	10,604	36	—
Do. do., whole district	112,153	111,013	1,140	—
Makers' stores of Cleveland pig iron, whole district	29,958	30,511	—	553
Pig iron in public stores:—				
The N.E. Railway Company's stores	25,970	24,820	1,150	—
Connal's stores	187,474	185,510	1,964	—
Total	355,555	351,854	3,701	—

The quarter's exports of pig iron from the Cleveland district have been much above the average, affording good evidence of the improvement in trade. The average of the first quarter over the last ten years has been about 180,000 tons, but last quarter's was 241,912 tons, or 33 per cent. more. Never have there been larger oversea shipments, these reaching 100,723 tons, whereas the best previous was 87,316 tons in 1890. As compared with the first quarter of last year there was an increase of 67,249 tons.

The finished iron and steel industries are generally well employed, and prices are very firm. Manufacturers are well booked ahead, especially those producing rails and plates, and the settlement of the wages difficulty in the shipbuilding and engineering industries will give stability to the trade, particularly as the matter has been disposed of for a twelvemonth, and employers can enter into contracts with some amount of confidence, as they know what they will have to pay for labour, which forms such a heavy item in determining the cost of building and engining vessels. Manufacturers of plates ask £5 2s. 6d., less 2½ per cent. f.o.t., for steel ship plates, and £5, less 2½ per cent. f.o.t., has to be given for steel ship angles. Iron plates and angles do not seem to be in much demand, at least, the inquiry is much below what is reported for steel, and iron angles may be had as low as £4 15s., less 2½ per cent. f.o.t. Rails are in fair request, and work at the mills is plentiful. The export of railway material from the Tees is large to Western Australia, India, and Japan.

The wages question at the shipyards and engineering establishments in the North of England has been adjusted. The boilermakers have accepted the same terms as were granted to the Amalgamated Society of Engineers, viz., the men to receive an immediate advance of 1s. per week on time and 5 per cent. on piece prices, to be followed by a further 1s. advance on time wages in September, no further changes to be made until March next at the soonest. The shipbuilders have settled for 1s. 6d. per week on time wages and 5 per cent. on piece prices, to come into operation next month, and six months are to elapse before any further change can be made. The newly formed Conciliation Board in the ironmoulding business of the North-East Coast at its first meeting a few days ago had under consideration the application of the men for an immediate advance of 2s. per week on time wages, and 5 per cent. on piece prices.

It was settled that the men should receive an immediate advance of 1s. per week on time wages and 5 per cent. on piece prices, the question of a second advance being adjourned for a month. The brassworkers and the members of the National United Society of Engineers have settled on the same terms as the boilermakers. Only the enginemen and cranemen, the patternmakers, the drillers, and the strikers yet remain to be treated with, and it is not expected that any difficulty will be experienced.

The annual report for 1895 of the United Society of Boilermakers and Iron Shipbuilders, which has a membership of 40,000 and a history of sixty-one years, remarks that the demands on the employers for additional wages, which have been moderate in character, have generally been courteously conceded, and the disputes have been few and unimportant. The year was commenced with a balance of £157,546 17s. 5d., but the terrible weather in the first quarter completely stopped all shipyard work, and disastrously affected the boiler shops and bridge yards, and a large amount of money had to come out of the society's funds. The trouble on the Clyde and at Belfast was also a source of loss to the society, and the funds at the end of 1895 were £3500 10s. short of what was reported at the beginning. The total income of the society was £117,741 1s. 3d., and the expenditure £121,241 11s. 3d.

The steam coal trade of the North shows some improvement, and prospects are good, as the Baltic season is commencing; but as yet prices do not improve, and 7s. 9d. per ton f.o.b. is still accepted for best Northumberland steam coal. The exports of coal from North-Eastern ports last month were 1,343,284 tons, or 35,194 tons decrease on March, 1895. From Welsh ports 1,512,769 tons were shipped, decrease 150,453 tons. Coke is very firm, and there is not much on sale, but the little that is to be bought cannot be had under 13s. 6d. per ton delivered at Middlesbrough furnaces, while some sellers ask and realise 14s.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The Glasgow pig iron warrant market was closed from Thursday till Tuesday owing to the holidays, and this week there has only been a moderate business done. The market has been fairly steady, but operators do not appear to have sufficient inducement to turn over much iron at present. Transactions took place in Scotch warrants from 46s. 8½d. to 46s. 10½d. cash, and 46s. 11d. to 47s. 0½d. one month. There is very little doing in Cleveland warrants in our market, and the monthly report of the Cleveland stocks being less favourable than was expected, did not encourage investors in this iron. Cleveland warrants are quoted 38s. 3½d. to 38s. 4½d. cash, and 38s. 5½d. to 38s. 6½d. one month. There has been a moderate business in Cumberland hematite warrants from 48s. 5d. to 48s. 8d. cash, and 48s. 7½d. to 48s. 10d. one month. The state of the open market does not at present supply a very accurate idea of the condition of the pig iron trade, there being a very good legitimate business passing. Scotch-made hematite pigs are in active demand.

There are forty-three furnaces producing ordinary pig iron, thirty-five hematite, and three basic; the total of eighty-one, comparing with seventy-five at this time last year. Only a small quantity of pig iron was added to the stock in Glasgow warrant stores, partly due no doubt to the holidays; but apart from these, there has been less iron available for storing.

The prices of the special brands of Scotch makers' pig iron are steady, as follow:—Govan, Monkland, and Carnbroe, Nos. 1, 48s.; Nos. 3, 46s. 6d.; Clyde, No. 1, 50s. 6d.; No. 3, 47s. 6d.; Gartsherrie, Calder, and Summerlee, Nos. 1, 51s.; Nos. 3, 48s. 6d.; Coltness, No. 1, 53s. 6d.; No. 3, 49s.; Glengarnock, at Ardrossan, No. 1, 51s.; No. 3, 47s.; Eglinton, No. 1, 48s.; No. 3, 46s.; Dalmellington, at Ayr, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Shotts, at Leith, No. 1, 52s. 6d.; No. 3, 49s. 6d.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 49s.

The pig iron shipments, as was to be expected, are smaller than usual, amounting to only 5913 tons, compared with 7931 in the corresponding week of last year. The larger proportion of the shipments continue to be sent coastwise, and the state of the export trade is very unsatisfactory. Indeed, were it not that the consumption at home is just now exceptionally good, the Scotch pig iron trade would be in a deplorable condition. Not only are the Americans taking hardly any iron from us, but merchants there are offering to ship iron to the Clyde, Liverpool, Barrow, and Workington at prices which appear to make it almost worth the attention of consumers on this side.

The market for finished iron has been quiet in consequence of the holidays, but makers and merchants are looking forward to an increased business as the season advances. In the home trade the likelihood is that this idea may be realised, and it is hoped too that some improvement may be experienced in the foreign branch of the trade, which has long been in an unsatisfactory state.

At the steel works there was as short an interruption for the holidays as could well be. Some of the workers were inclined to be attracted to local races, and in a number of instances it is found that the men are less anxious about making full time than in times when work is slack. Upon the whole, however, the steel works this week have been well manned, and are turning out large quantities of material. The demand for shipbuilding steel is greater, perhaps, at present than at any former time, and the contracts being placed would appear to indicate that this branch will be busy for a long time to come. Makers are not at all satisfied with the returns they are getting from this produce. Notwithstanding the increased quantities of steel that are being required, it is very difficult to obtain any increase in price. Merchants state that they are still able to place orders, when these are of any importance, rather below the prices that makers are quoting.

The shipping trade in coals has been moderately well employed, taking into account the interruptions caused by the holidays. Inquiries from the Baltic ports are now more encouraging, and the prospect altogether is not unsatisfactory, so far as the volume of business likely to be done is concerned. Prices are still very low. There is a rather better demand for superior qualities of household coals for shipment, but, on the other hand, the home demand for these is easing off to some extent. A large quantity of splint coal is being got rid of, but the market is slack, owing to full supplies. Coalmasters report that the demand for steam coals is particularly backward. The total coal shipments from Scottish ports during the week amounted to 162,738 tons, against 137,191 in the corresponding week of last year. Main coal is quoted, f.o.b. at Glasgow, 5s. 9d.; splint, 6s. 3d. to 6s. 6d.; ell, 6s. 3d. to 6s. 9d.; and steam, 7s. 6d. per ton.

A conference of Scotch miners' delegates was held in Glasgow a few days ago to ascertain the result of the ballot recently ordered to be taken to show whether the men are willing to adopt a four days' working week. Representatives were in attendance from Fife, Kinross, Clackmannan, Mid, East, and West Lothians, Lanarkshire, Renfrewshire, and Ayrshire. The reports showed that a ballot had been taken only in Clackmannan and Lanark. This should not occasion any surprise to those acquainted with the state of the coal trade and the circumstances of the miners. The Lanarkshire ballot could not be of any weight, inasmuch as out of a total of 30,000 miners in that county, only about 3000 have any connection with the miners. The colliers seem for the time to have little confidence in the ability of their so-called leaders to afford them any substantial assistance, and wherever they can obtain free employment they are only too glad to take the full advantage.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

The usual Easter "upset," as matter-of-fact coalowners and shippers term the people's holiday, has passed, leaving the condition of trade practically unchanged, coal firm, with respect to its best class, iron and steel moderately good, tin-plate deplorably bad. One feature of the Easter week was the despatch from Newport, Mon., of a fine cargo of over 3000 tons of steel rails to Progresso. Another was the continuance of large cargoes of coal from Cardiff to Bombay, one of 5000 tons.

Up to, and including mid-week, the attendance on 'Change, Cardiff, was very small. On Tuesday there was quite a holiday character, and all the offices were closed at 10 a.m. A little degree of animation was becoming perceptible at the time of my dispatch, and possibly by Friday, something of the old vivacity will be exhibited. There is not much ahead that is disquieting. The Plymouth strike is relegated to the limbo of the strikes innumerable that have ended in comprises—which should have been initiated at the beginning—and the discharge note is evidently thrown over.

Cardiff coal prices, first, second and small, and also house coal quotations, remain unaltered; and it is not likely that any change, one way or the other, will be made before next week. Swansea Exchange quotations were published this week, though indicating little change. Best anthracite, 11s. to 11s. 6d.; second quality, 9s. to 10s.; ordinary large, 8s. to 8s. 9d.; small rubbly culm, 4s. to 4s. 6d., f.o.b. Swansea, cash thirty days, less 2½ per cent. Steam coals, best, 9s. to 10s.; seconds, 8s. 3d. to 9s.; bunkers, 7s. 9d. to 9s.; small, 4s. 3d. to 4s. 6d. Bituminous coals, No. 3 Rhondda, 9s. 6d. to 10s.; through, 8s. to 8s. 9d.; small, 6s. 3d. to 6s. 9d.; No. 2 Rhondda, 8s. 6d. to 9s. 6d.; through, 6s. 6d. to 6s. 9d.; small, 5s. to 5s. 3d. Other quotations were coke, furnace, 12s. to 12s. 6d.; foundry, 16s. to 17s. Patent fuel, 9s. 9d. to 10s. 3d. Pitwood, 10s. 9d. per ton into trucks.

The following quotations are the last issued at Swansea:—Pig iron, Glasgow, 46s. 9d.; Middlesbrough, No. 3, 38s. 4½d.; hematite, 45s. 10½d.; Welsh bars, £5 10s. to £5 12s. 6d.; sheet iron, £6 15s. to £6 17s. 6d.; steel, £6 10s. to £6 12s. 6d.; steel rails, heavy, £4 10s. to £4 12s. 6d.; light, £4 17s. 6d. to £5 7s. 6d. Bessemer steel, tin-plate bars, £3 17s. 6d.; Siemens, £3 18s. Steel rails in fair demand. Bar trade bad.

Tin plates, makers' quotations:—Bessemer steel coke, 9s. to 9s. 1½d.; Siemens, 9s. 1½d. to 9s. 3d.; ternes, per double box, 28 by 20 C., 16s. 6d.; best charcoal, 12s. 6d. to 12s. 9d.; wasters, 6d. to 1s. less; block tin, £60 7s. 6d. to £60 8s. 9d.

Cardiff report this week is to the effect that there was little or nothing doing in the house coal, coke, or patent fuel makes, and only a few inquiries for steam coal shipment after the holidays.

Pitwood remains at 14s. 9d. to 15s.; furnace coke, 13s. to 15s.; no higher figures having been maintained; foundry, 15s. 6d. to 19s. 6d., according to quality.

The tin-plate trade appears to be entering upon most trying times, the stoppage of Cwmfelin, Worcester, and other important works shows this in the most striking manner, and at a late meeting Sir John Jones Jenkins, who has always been looked up to as the man at the helm, expressed his intention of retiring practically from business. This step has been necessitated by his health, and though personally his loss from the councils of the plate manufacturers will be great, it is hoped that he will still be represented in the trade. His aim has been a steady and consistent one to introduce mutual goodwill and union amongst masters and men, but at no one time has he seen such a divided condition as at present, rates of reduction ranging from 10 per cent. to 25 per cent. Sir John told his hearers that they had driven the trade away not only to America, but to Germany and even to France and Spain. He looked upon tinning as having departed from them for a length of time. He could not say it had altogether departed, because a large quantity was used in this country, and he hoped they would keep that, and not open our own markets to foreign nations and lead the foreigner to send tin-plates into this country. The last rumour, and fairly authenticated, is the transfer of Gowerton steel works to Landore. One of the principals is stated to have confirmed this, and said that having melting furnaces at Landore, they would add mills, and carry on the manufacture of bars. In this case Gowerton will cease, at all events for the present, to work on the old lines.

In the Briton Ferry district the outlook is very gloomy. The Vernon Mills are stopped. At the Gwalia only two of the three mills have been at work of late, and the workmen at Baglan Bay are working upon a 10 per cent. reduction. Six mills are at work at the Villiers, and three at the Earlswood. At the Briton Ferry Works an average make of pig iron has been made, and the make at the steel works and at the Albion is satisfactory.

At Melincrythan, Neath, works are to start shortly by the Neath Steel Sheet and Galvanising Co.

The shipments of tin-plates from Swansea last week totalled 35,492 boxes; received from works, 39,864 boxes.

News from the United States reveals a condition of things little, if any better, than in Wales, and bands of Welsh platers are returning.

One item of good news I am glad to chronicle, and that is that a settlement has been effected at the Old Castle Works Llanelly. The management has agreed to accept a reduction of 15 per cent. on all piecework, and 10 per cent. on all day work; wages of labourers to remain.

A good deal of satisfaction has been expressed at Cardiff that the Bristolians have decided to forego the able and expensive projects of Mr. Wolfe Barry, and will be satisfied with the expenditure of only £93,000 in, as, a Cardiff authority states "tinkering the Avon." This leaves practically the Bristol Channel and the transatlantic trade at the direction of Cardiff. Swansea Harbour Bill has passed the third reading.

I am sorry to record a mishap to the Snowdonian Railway, and for a time, until the facts of the case have been brought before the public—by the aid, I should suggest, of a Governmen official —the people will fight shy of the introduction of Swiss railway methods into Wales. At present the question is whether the permanent way was to blame, or defects in the engine, or carriages, or brakes, or cogs. As one poor fellow who jumped off has since died, an inquest will be held. Travellers who constantly use the Festiniog line, which has been long in use without accident, are satisfied that the Snowdonian Railway is certain to come out all right in the end, and eventually be one of our great engineering successes. Mr. Aitchison, the general manager, is highly commended for his ability and presence of mind.

A new industry is foreshadowed for Swansea, the treatment of sulphwores from Australia by a new method, and the utilisation of the waste sulphates from local chemical works. It is yet early to mention the matter in detail, though it is stated that a large works has been selected for trial.

A case of record loading has just taken place at Roath Dock. The steamer Totosa, 5400 tons capacity, docked at Cardiff Tuesday week at 2 a.m., and began loading fuel at the Crown Wharf, finishing it Friday morning 3.45. Her actual working hours were only 57, during which 407,780 blocks of fuel were stowed.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

Changes of importance have not taken place on the continental iron market since last week, and there is consequently very little of interest to be related. On the whole, a further upward movement can be perceived in the different branches of the iron industry.

The accounts given of the iron trade in Silesia continue to be of a decidedly favourable character, almost all the makers and manufacturers having their order books well filled with contracts. Prices continue to improve, and are expected to rise still further when the liveliest season of the year has arrived. Pig iron is actively inquired for, and in a few instances up to M. 60 p.t. has been paid for forge pig. In the bar and girder trade the position of affairs is specially gratifying. The Silesian Rolling Mill Convention resolved to raise the prices for home demand and also for export to Russia M. 5 p.t.; for export to other countries prices remain the same as before.

Throughout the iron-producing districts of Austria-Hungary trade in raw and manufactured iron continues satisfactory. The various departments are pretty full of work. In railway material business is steadily improving. The hardware manufacturers, though better off for work than they were some months ago, still complain of being only partially well employed, and are looking forward to a more active demand in the new quarter. Official quotations are:—For common forge pig, 45 to 47 fl.; grey pig, 48 to 51 fl.; Bessemer, 48 to 51 fl.; ingots, 76 to 80 fl.; Styrian bars, 115 to 120 fl.; girders, 107 to 120 fl., according to quality; heavy plates for boilermaking purposes, 150 to 160 fl., in some cases 180 fl.; tank do., 130 to 135 fl.; steel plates, 140 to 160 fl. p.t.; tin sheets, 26 fl. per box; galvanised sheets, 205 to 260 fl. per ton.

The French iron market is very firm, and prices are well maintained. Forge pig, No. 2, is quoted 140f. p.t. in the North. In Paris merchant bars fetch 145f. to 150f. p.t., while for girders 155f. to 160f. p.t. is given. The engineering and building line is briskly occupied on the whole, and there is more work expected to be given out after Easter. French output in iron and steel was for 1895 as follows:—Forge pig, 1,516,168 t.; foundry pig, 489,721 t.; merchant bars, sectional iron, 654,645 t.; iron rails, 427 t.; iron plates, 88,599 t.; steel rails, 160,417 t.; ingots, blooms, &c., 362,527 t.; steel plates, 170,346 t. Output during the last three years was:—

	1895. Tons.	1894. Tons.	1893. Tons.
Forge pig	1,516,168 ..	1,600,113 ..	1,522,115
Foundry pig	489,721 ..	469,601 ..	480,981
Totals	2,005,889 ..	2,069,714 ..	2,003,096
Bars in iron	654,645 ..	685,319 ..	696,184
Iron rails	427 ..	684 ..	775
Iron plates	88,599 ..	99,778 ..	111,212
Totals	743,671 ..	785,781 ..	808,171
Bars in steel	386,168 ..	340,116 ..	323,023
Steel rails	160,317 ..	182,510 ..	207,358
Steel plates	170,346 ..	151,564 ..	133,651
Totals	716,831 ..	674,190 ..	664,032

In the Belgian iron industry a further increase in activity can be reported, all departments being likely to remain in healthy occupation for this quarter and the next. As to prices, there is an undeniable inclination to move upwards.

Satisfactory reports continue to come in from nearly all branches of the iron and steel trades in Rheinland-Westphalia. Only here and there establishments are still but moderately off for work; but this is mostly due to some special causes. The leading firms report a considerable quantity of new orders coming forward, which will secure employment for the remainder of the year. A strong demand prevails on the pig iron market, not only on home, but also on foreign account. Increasing firmness is also reported in the malleable iron business, bars and girders selling briskly; even hoops have been enjoying a better inquiry for some time past, and all round the lately advanced prices are well maintained. A slow but steady increase in demand is also noticeable in the plate department. The sheet mills continue to be vigorously engaged, and a further rise in quotations is likely to take place next week. Rivets, which for a long time remained neglected, have visibly improved of late, both as regards prices and demand. The machine and construction shops are very busy; the same may be told of the foundries, generally.

Output of pig iron in Germany, including Luxemburg, was, for February, 1896, 500,929 t., of which 135,687 t. were forge pig and spiegeleisen 35,276 t. Bessemer, 261,633 basic, and 68,333 foundry pig. Production in February, 1895, amounted to 434,704 t., that for January of present year having been 517,988 t.; from January 1st to 29th of February, 1896, 1,018,917 t. were produced, against 924,279 t. for the same period the year before.

Shipments of coke from the Rhenish-Westphalian district to the western iron-producing districts were:—

	To Luxemburg.	To Lorraine.	To Eastern France.	Totals.
1889	418,300 ..	442,250 ..	128,280 ..	988,830
1890	454,320 ..	549,860 ..	295,280 ..	1,299,470
1891	422,369 ..	624,367 ..	427,696 ..	1,474,432
1892	415,882 ..	473,508 ..	817,036 ..	1,706,426
1893	453,443 ..	420,496 ..	982,727 ..	1,856,666
1894	626,398 ..	482,955 ..	1,112,650 ..	2,222,003
1895	599,665 ..	497,075 ..	973,586 ..	2,070,326

which shows a decrease for 1895 of 151,677 t., or nearly 7 per cent

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

The shipments of steam coal during the past week reached, notwithstanding the holiday, over 76,000 tons. The demand, now that work is resumed, is fairly good, and prices are steady. The house coal trade remains without change. Tin-plates continue dull, without any alteration in quotations. The iron and steel works are all fairly well employed.

Prices:—Coal: Best steam, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s.; house coal, best, 10s. to 10s. 3d.; dock screenings, 5s.; colliery small, 4s. 3d. to 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 46s. 10½d.; hematite warrants, 48s. 8d., f.o.b. Cumberland; Middlesbrough No. 3, 38s. 5d. prompt; Middlesbrough hematite, 46s. 1d. Iron ore: Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel rails, heavy sections, £4 15s.; light ditto, £5 to £5 5s., f.o.b.; Bessemer steel tin-plate bars, £4; Siemens tin-plate bars, best, £4 2s. 6d., all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel cokes, 9s.; Siemens coke finish, 9s. 3d.; ternes, per double box, 28 by 20 C., 18s. 6d. to 20s. Pitwood, 15s. 3d to 15s. 6d. London Exchange telegram: Copper, £45 6s 3d.; Straits tin £60 2s. 6d. Freights steady.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, April 2nd.

RECIPROCITY relations with Central and South American countries so abruptly terminated a short time ago are now meeting with fresh and unexpected support and endorsement in commercial, manufacturing, and financial circles. The incoming administration will take up the issue, and re-enact all the main features. The commercial situation is still unfavourable. The development of trade is slow, although railroad traffic is increasing, and the weekly bank clearings show that there is a much larger volume of business being done. The business situation is far from satisfactory. The iron trade is pretty active. The Lake ore vikings have chased the Bessemer steel people from the seas, and are declaring that 4 dol. ore shall be the only ore that shall be sold, except Meseba and one or two others. Coke is 2 dols. a ton. These figures mean firm and possibly higher prices for all iron and steel products into which Lake ores enter. The plate and tank mills are busy, but structural iron goes slowly. The smaller iron interests are in need of a special stimulus. Building operations are multiplying. Surprises in trade and manufacturing may toss all the present depression to the winds within any forty-eight hours.

LAUNCHES AND TRIAL TRIPS.

On Wednesday, April 1st, 1896, there was launched from the Cleveland Dockyard of Sir Raylton Dixon and Co., Middlesbrough, a spar deck steel screw steamer, No. 422. Dimensions, 322ft. by 40ft. 6in. by 28in., built to Lloyds' 100 A1 class, and with a deadweight capacity of about 4650 tons. She is built on the deep frame system, with five bulkheads, and cellular double bottom for water ballast. The spar deck is of iron, main deck of steel, and poop, bridge, and forecastle decks of wood, with handsome accommodation under bridge for captain, officers, and engineers. The engines will be supplied by Messrs. Thos. Richardson and Sons, Hartlepool, the diameter of the cylinders being 23in., 36in., 59in. by 42in. stroke, with two large steel boilers. This vessel is sister ship to the On Sang and Ilaro lately built by the same builders.

On Tuesday week last, the large new steel screw steamer Fitzpatric, built by the Tyne Iron Shipbuilding Company, Willington Quay, to the order of Messrs. Burrell and Son, of Glasgow, was taken to sea off the mouth of the Tyne for her official trial trip. The vessel is a very fine type of cargo steamer, having a deadweight carrying capacity of nearly 7000 tons, and her dimensions are 365ft. by 47ft. by 29ft. 9in. moulded. She is fitted throughout with the most modern appliances for the economical working of ship and cargo. The propelling machinery, which has been constructed by the North-Eastern Marine Engineering Company, at the Wallsend works, consists of triple-expansion engines having cylinders, 27in., 43in., 72in., by 45in. stroke, with two large multitubular steel boilers suitable for a working pressure of 170 lb. per square inch. The working of the machinery throughout the trial gave the most satisfactory results. Mr. Stewart, who has superintended the construction of ship and engines, expressed his entire satisfaction with both vessel and machinery. After the trial the vessel proceeded to Cardiff to load for Bombay. This is the fifth vessel the Tyne Iron Shipbuilding Company have recently built for Messrs. Burrell and Son, three of which vessels have been engined by the North-Eastern Marine Engineering Company, at Wallsend. The shipbuilders were represented by Mr. Bone, managing-director, and the engine builders by Mr. S. Hunter.

On the 1st inst. Messrs. Swan and Hunter launched from their yard at Wallsend the first half of the large pontoon dock they are building for the Smiths' Dock Company, of North Shields. This dock, which has been designed to lift vessels of a deadweight of 6500 tons in a space of thirty minutes, is one of Messrs. Clark and Stanfield's well-known off-shore docks, which have been already described in our columns—see December 25th, 1891, and March 14th, 1892—and has been constructed from the designs of this firm. It will be remarkable for the great rapidity with which it will be able to deal with vessels of large tonnage, and also for the fact that electricity is being used as the motive power for the pumps, the current being supplied from the yard installation. The present pontoon will be the second one that the owners have put down, the first having been so successful from every point of view, and when completed, which will be very shortly, it will make this yard the most complete and most modern equipped ship-repairing establishment in the world. Messrs. Lindbergs, of Stockholm, are also fitting their yard with one of these off-shore docks, the first portion of which was launched from their yard on the 28th ult., they being in the present case their own constructors under the supervision of the patentees, Clark and Standfield. The lifting power of this dock will be a little over 2000 tons, the motive power in this case being supplied by oil engines on the dock itself.

ON Tuesday night at Aston Cross, near Birmingham, a tram engine, with car attached, standing near Aston Church, commenced to move without the driver. The conductor was not apprised of the driver's absence until his repeated ringing of the bell failed to stop the car. The engine was rapidly descending Park-road-hill when the conductor applied the brake, but without affecting the momentum of the car, which rushed along at a rate of nearly thirty miles an hour, and dashed with terrific force into an engine and car at the foot of the hill. The runaway engine was smashed to fragments by the force of the impact, the woodwork was set on fire and blazed furiously. There were nine passengers on the runaway car, all of whom suffered more or less from shock. Fortunately most of the passengers had alighted from the standing car, but the engine driver sustained severe injuries, and was removed to the General Hospital. The driver of the runaway engine was charged at the police-court on Wednesday with drunkenness.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

24th March, 1896.

6494. Incandescent Light, W. P. Thompson.—(*The Continental-Gas-Glühlicht-Actien-Gesellschaft "Meteor" vormals Kroll, Berger, and Co., Germany.*)
6495. Cycles, W. P. Thompson.—(*M. Linman, Germany.*)
6496. Preserving Food Products, W. Nägeli, Liverpool.
6497. Twisting Yarns, S. H. and J. S. Brooks, Manchester.
6498. Soap Dishes, I. Parkinson, Liverpool.
6499. Stair Rod Fastenings, I. Parkinson, Liverpool.
6500. Rest for Fire-arms, J. Livischak, London.
6501. Vats, W. H. Smith, Liverpool.
6502. Postal Wrappers, B. T. Newnham, London.
6503. Mechanism of Kinetoscopic Apparatus, G. W. de Bedts, London.
6504. Devices for Advertising, J. Lengyel and A. Schlesinger, London.
6505. Combined Spark Arrester, &c., R. Deissler, London.
6506. Combined Spark Arrester, &c., R. Deissler, London.
6507. Horseshoes, C. Eisenberg, London.
6508. Extraction of Sugar from Molasses, W. Feld, London.
6509. Generating Electricity, L. Epstein and F. Marza, London.
6510. Lamps, J. Brookie, London.
6511. Bottles, M. M. J. O. O'Conor and A. L. Gruggen, London.
6512. Pneumatic Tires, F. J. McStocker, London.
6513. Tires for Velocipedes, C. F. A. H. Bagot, London.
6514. Surveying Instruments, D. Röther, London.
6515. Flutes, C. T. Giorgi, London.
6516. Cigarettes, R. C. Spurin and R. Cohen, London.
6517. Bolt Fasteners, J. Tyzick and J. F. Lawton, London.

25th March, 1896.

6518. Ankle Supports for Skates, B. A. Dorst, London.
6519. Linoleum, &c., J. Ingleby and E. Ostlere, Leeds.
6520. Knife Board, R. Macgregor and J. F. Bellamy, London.
6521. Oiling Doubling Spindles, W. Madigan, Manchester.
6522. Baggage Carrier, A. Paget, London.
6523. Blast Furnace Tuyeres, C. Wilkes, Stockton-on-Tees.
6524. Counters, F. G. Robinson, Liverpool.
6525. Ball Bearings, T. C. Fawcett and T. C. Fawcett, Ld., Halifax.
6526. Hammers, L. F. Massey, Manchester.
6527. Yarns, J. L. Bottomley, Manchester.
6528. Sliding Cover for Omnibuses, A. Cross, Birmingham.
6529. Tires for Vehicles, D. Halpin and L. Sterne, London.
6530. Hand Levers for Velocipedes, A. Vonhausen, Manchester.
6531. Making Wearing Apparel, L. L. Noar, Manchester.
6532. Pistons, F. S. Carter, Manchester.
6533. Saddles, E. Woods, Liverpool.
6534. Water Cans, H. Summers, London.
6535. Slip Bolts, A. Lyall and J. Fairley, Glasgow.
6536. Window Fasteners, R. L. Young, Glasgow.
6537. Adding and Subtracting Machine, W. Kerr, jun., Paisley.
6538. Crank Actions for Cycles, &c., W. J. Howells, London.
6539. Bulkhead Doors, J. Thom and J. S. Clark, Liverpool.
6540. Gentlemen's Hat-bands or Linings, F. Breese, Occold.
6541. Gas Engines, J. P. Lea, Bath.
6542. Cycle Stands, J. Neilson, Glasgow.
6543. Hoist, J. and J. Harper, Glasgow.
6544. Paper Bags, T. Orr, Glasgow.
6545. Window Fasteners, T. A. Langhorne, Keighley.
6546. Cranes, C. Coda, Birmingham.
6547. Cover for Pneumatic Tires, H. G. Turner, Manchester.
6548. Candles, J. J. P. Lawler, Cape Town.
6549. Carbon Holder for Dynamo Rubbers, F. J. Head, Brussels.
6550. Pipes, S. Dumont, Brussels.
6551. Self-acting Spinning Frames, J. B. Glaentzlen, Brussels.
6552. Knitted Knee-caps for Horses, E. G. Cuthbert, Blackrock.
6553. Rabbit, Rat, and Mouse Trap, R. Punshon, London.
6554. Propeller Wheel, M. R. Rouble, London.
6555. Explosives, R. Pierre and W. Pottgiesser, London.
6556. Sash Fittings, J. W. Mackenzie.—(*F. H. Peters, Canada.*)
6557. Harness, W. A. Allen, London.
6558. Soap, E. Benz, London.
6559. Bottles, T. R. Jordan, London.
6560. Knife Sharpeners, H. Landgraf, London.
6561. Bicycle Supports, G. W. Barry, London.
6562. Can Openers, C. V. Zinn, London.
6563. Oven for Bakehouses, W., E., and D. Pickering, London.
6564. Plug Taps or Valves, R. Owen and T. Owen, London.
6565. Furniture, W. H. Vaughan, London.
6566. Pulverising Machinery, T. Andrew, Richmond.
6567. Opening Fanlights, F. and C. G. Smith, Birmingham.
6568. Cabinet, G. Rogers, London.
5569. Cover for Books, F. Tölle and H. Vossen, Cologne.
6570. Billiard Sticks, C. Haase and T. Buschmann, Cologne.
6571. Feed Mechanisms, C. D. Abel.—(*M. and R. Mannesmann, Germany.*)
6572. Separating Metals, J. Imray.—(*M. A. J. Roux, France.*)
6573. Engines, H. J. Dowsing and H. S. Keating, London.
6574. Device for Receiving Money, F. A. Wimble, London.
6575. Water Velocipedes, W. P. Thompson.—(*W. Demarco, Malta.*)
6576. Microphones, P. Hardegen, Liverpool.
6577. Wheel Hubs, L. Delabere and R. White, Birmingham.
6578. Tea-leaf Rolling Machinery, N. W. H. Sharpe, London.
6579. Telephonic Apparatus, A. Graham, London.
6580. Burning Petroleum, S. H Gladstone.—(*G. W. Lyth, Sweden.*)
6581. Incandescent Gas Burners, J. B. P. W. de Malberg, London.
6582. Photographic Cameras, L. J. R. Holst, London.
6583. Manufacture of Paper Tubes, E. L. Bell, London.
6584. Glueing the Backs of Books, J. V. Galicher, London.
6585. Igniting Incandescent Gas Lamps, J. F. Duke, London.
6586. Regulation for Incubators, E. L. Godfrey, London.
6587. Billiard Marking Apparatus, J. G. Dixon, London.
6588. Bullets for Rifled Small-arms, W. J. Jeffery, London.
6589. Spoons for Mixing Absinthe, A. J. Boult.—(*L. Rouge, France.*)
6590. Speed Gears, J. W. Hall, London.
6591. Houses, &c., A. J. Boult.—(*S. Elton, United States.*)
6592. Garden Edging and Border, A. W. Davies, London.
6593. Sprocket Chains and Wheels, F. H. Smith, London.
6594. Bottles, E. L. Forsgren, London.
6595. Window Sashes, C. J. Conlon, London.
6596. Puzzles, E. V. D. Rousseau, London.
6597. Toilet Preparations, F. T. James, London.
6598. Bale Ties, E. A. G. Schutt, London.
6599. Augmenting Quantities of Mercury, L. Ehmann and H. Obermayer, London.
6600. Lip Protector for Cigarettes, M. Lumley, London.
6601. Clinical Thermometer Cases, A. E. Dean, London.
6602. Indicating Appliances, A. E. Farrants, London.
6603. Scarifiers, H. F. Rutty, London.
6604. Exhibiting Photographs, A. G. Bessemer, jun., London.
6605. Dress Holders, A. Riddell, London.

26th March, 1896.

6606. An Electric Cyclometer, T. G. Smith, London.
6607. Shifting Spanners, Callipers, &c., F. Mitchell, Surrey.
6608. Parastudio for Photography, W. Watson, Glasgow.
6609. Trellis, F. C. Freeman, London.
6610. Adjusting Cycle Handles, A. P. J. Archbold, London.
6611. Plate Lifter, C. P. Watson, Leeds.
6612. Fishing Reel, A. Allcock, Redditch
6613. T-squares, J. Granz, Manchester.
6614. Manufacture of Bells, F. Bosshardt.—(*R. D. Freres, France.*)
6615. Indicating the Day of the Month, J. Gordon-Smith, Edinburgh.
6616. Violins and other Instruments, A. Shelmerdine, Liverpool.
6617. Copying Documents, &c., E. L. Woodward, Coventry.
6618. Rudder, W. J. Darling and J. G. Walliker, Bristol.
6619. Boots, J. A. Mayo, Bristol.
6620. Attaching Knobs to Doors, F. Parlour and T. T. Harrison, Bristol.
6621. Manufacture of Millboard, G. E. Stead, Manchester.
6622. Boots, G. E. Stead, Manchester.
6623. Loom Pickers, J. Greenwood, Manchester.
6624. Air-tight Receptacles, W. C. Johnson, Bournemouth.
6625. Holder for Telephone Receivers, A. J. Fippard, Bournemouth.
6626. Flexible Hair Curler, G. Adams, London.
6627. Anchors, E. Darby, Lowestoft.
6628. Attachment for Analogous Machine, J. Robins Glasgow.
6629. Badges, F. Sugg, Liverpool.
6630. Bats, F. Sugg, Liverpool.
6631. Folding Perambulator, R. R. Thom, Kilmarnock.
6632. Suspending a Ball of Wool, E. M. T. Huskisson, London.
6633. Lamps, J. Potter, London.
6634. Chain of Fine Steel Plates, H. W. Boucher, Wigan.
6635. Window Fasteners, J. Bryce, Leeds.
6636. Engines, W. H. Griffiths, Liverpool.
6637. Magic-lantern Slide Carriers, A. E. Bingemann, London.
6638. Machine for Cigar Manufacture, O. Wartmann, London.
6639. Connecting the Barrels of Guns, A. Reichwald.—(*Fried. Krupp, Germany.*)
6640. Night Lights, J. A. Glenveere, London.
6641. Ladders, J. Zurek, London.
6642. Construction of Chandeliers, J. Hunt, Birmingham.
6643. Velocipedes, G. D. Warren, London.
6644. Collars, T. A. French, London.
6645. Tooth, Nail, and other Brushes, R. Addis, London.
6646. Clip for Saving Candle Ends, A. O. Morley, Birmingham.
6647. Milk Steriliser, H. M. and J. T. Myers, London.
6648. Mechanism for Looms, A. Gartner and R. Atherton, London.
6649. Shoe Fasteners, E. Compton, London.
6650. Adjustable School Desk, W. L. Starkey, London.
6651. Chemical Composition, P. E. Schoenfelder and E. Kehle, London.
6652. Breeches, H. J. Nicholls, London.
6653. Silk Net, B. J. B. Mills.—(*E. Vial and Co., France*)
6654. Production of Iron, A. Karyscheff and S. Demmanie, London.
6655. Producing Carbonate, The Chemical and Electrolytic Syndicate, Ld., O. J. Steinhart, and J. L. F. Vogel, London.
6656. Savings Box, H. Mecklenburg and W. Quasching, London.
6657. Photographic Apparatus, &c., E. Pothier, London.
6658. Webs, Belts, Straps, &c., F. T. Burrows, Middlesex.
6659. Fluid Engines, R. Christian, and J. and G. Dicken, London.
6660. Pneumatic Tires, W. Fletcher, London.
6661. Pumps, M. W. Hall, London.
6662. Producing Photographic Negatives, F. H. Wood, London.
6663. Maximum, &c., Thermometers, R. A. Grosse, London.
6664. Holders or Clips for Wire, J. G. Flint, London.
6665. Device for Use with Gas Burners, C. Crastin, London.
6666. Type-writing Machines, H. E. Payne, London.
6667. Lock Mechanism for Guns, T. Horsley, jun., London.
6668. Prepayment Gas Meters, W. N. Milstead, London.
6669. Engraving Machines, F. W. Sabel, London.
6670. Houses, C. H. Leonard, London.
6671. Foundations of Lighthouses, A. F. Eells, London.
6672. Tip Parts of Boots and Shoes, G. D. Pike, London.
6673. Applying Starch to Wearing Apparel, A. G Brookes.—(*W. A. H. Henrici, United States.*)
6674. Means for Draining Brushes, W. C. Hawtin, London.
6675. Apparatus for Working Buttonholes, W. Ross, London.
6676. Tubulous Steam Boilers, D. Purves, London.
6677. Buckles, W. Hampson, J. Scott, and H. Vincent, London.
6678. Turbines, W. P. Thompson.—(*O. Lindner, Belgium.*)
6679. Babies' Feeding Bottles, A. Haworth, Liverpool.
6680. Permanent Way of Railways, A. Haworth, Liverpool.
6681. Manufacture of Brushes, C. B. Walker, Manchester.
6682. Cycles, J. T. Whittingslowe, Liverpool.
6683. Domestic Fire Grates, I. Parkinson, Liverpool.
6684. Boots, A. J. Reed, Liverpool.
6685. Insufflator, B. R. Martin, London
6686. Chairs, J. G. McCaffrey and A. D Lenty, London.
6687. Spectacle Side End Cushion, T J. Phipps, Watford.
6688. Apparatus for Mining, T. Parker and Sir J. B. Stone, London.
6689. Warp Guides, &c., T. Wray and J. T. Fletcher, London.
6690. Skate Sharpeners, H. H. Lake.—(*A. D. Banker, United States.*)
6691. Smoke-consuming Furnaces, P. A. Archipenko, London.
6692. Electric Cut-outs, A. B. Blackburn and W. L. Spence, London.
6693. Removing Wrinkles, W. S. Simpson, London.
6694. Cycles, F. S. D. Scott, London.
6695. Securing Railway Rails, M. P. Herfurth and L. Gocht, London.

27th March, 1896.

6696. Self-fastening Knob, J. G. Walthew, Bolton.
6697. Steam Guard Kettle Holder, H. M. Peak, Liverpool.
6698. Brooches, G. Davis and L. H. Bennett, Birmingham.
6699. Umbrellas, Parasols, &c., E. Flude, Leicester.
6700. Cycle Gear, C. Bell, Derby.
6701. Process of Annealing Steel, D. C. Dalzell, Birmingham.
6702. Damping Apparatus, S. R. Armitage and R. Johnson, Manchester.
6703. Compound Machines for Planing, G. Pickles, Halifax.
6704. Pumping Apparatus, P. Poggi.—(*G. M. J. Schedelin, France.*)
6705. Dolly Washing Machine, M. A. Swinburn, Great Grimsby.
6706. Brown Boot Polisher, W. J. Clarke, Great Yarmouth.
6707. Washing Machine, M. Kerr and J. Cunningham, Liverpool.
6708. Blackboards, R. M. Hall, Manchester.
6709. Calculating Instrument, H. E. Gladdum, Manchester.
6710. Cuff Guard and Protector, J. G. Williams, Manchester.
6711. Rail Joint, F. J. Reynolds, London.
6712. Coating Iron, J. Ruffle, Neath.,
6713. Coating Iron, J. Ruffle, Neath.
6714. Coating Iron, J. Ruffle, Neath.
6715. Automatic Bell Communication, A. J. Blyde, Sheffield.
6716. Cleaning Grain, C. Lampitt and J. E. Bennett, London.
6717. Filtration of Running Streams, C. Lampitt and J. E. Bennett, London.
6718. Combustion Motors, &c., F. O'Connor Prince, London.
6719. Apparatus for Heating, R. Reitmeyer.—(*A. Cerckel, France.*)
6720. Printing Processes, S. Z. de Ferranti, London.
6721. Cycles, J. Gutmann, London.
6722. Oil Colours, A. H. Holland, Sheffield.
6723. Roof Lights, A. S. Nixon, Birmingham.
6724. Box Nailing Machine, C. Cristadoro, Birmingham.
6725. Sandals, S. Ibbotson, London.
6726. Collapsible Bag Hold-all, R. E. A Maclean, London.
6727. Plate for Cooling Substances, J. L. Collier, London.
6728. Bottle-stoppers, R. W. Papineau, London.
6729. Thermometers, P. Cossor, London.
6730. Wheels for Road Vehicles, &c., W. H. Kitto, London.
6731. Kinematographs, J. H. Rigg and E. O. Kumberg, Leeds.
6732. Advertising Devices, &c., J. H. Collings, London.
6733. Pneumatic Wheel, E. Clark and F. W. Sage, London.
6734. Signalling, R. Hacking and C. G. Bennett, London.
6735. Brake for Cycles, L. W. Broadwell and F. Oxborrow, London.
6736. Cycle Lamps, C. A. Allison.—(*F. Rind and the Bridgeport Brass Company, United States.*)
6737. Removing Furnace Ashes, &c., J. Patterson, London.
6738. Hydrocarburetted Air Engines, W. D. and S. Priestman, and H. Richardson, London.
6739. Storing Acetylene Gas, J. C. Bayley, Bournemouth.
6740. Hydrocarbon Vapour Engines, J. Ibbett, London.
6741. Railway Switch Points, W. S. Frost, London.
6742. Garment for Gentlemen's Wear, A. M. Burberry, London.
6743. Hand Road Scraper or Receiver, E. Bliss, London.
6744. Introducing Liquid Reagents, J. G. Daw, London.
6745. Wheels, A. Kotin and A. J. Wallis-Tayler, London.
6746. Ensuring Safety on Railways, S. T. Dutton and R. H. C. Neville, London.
6747. Ammunition Cartridge Cases, G. C. Baker, London.
6748. Cycles, C. Challand, London.
6749. Cooling Apparatus for Liquids, H. Krack, London.
6750. Fruit Gatherer, F. C. E. Simon and A. P. L. Launay, London.
6751. Carbons for Electricity, W. P. Thompson.—(*A. Lessing, Germany.*)
6752. Locking Railway Switches, C. H. Schager and J. M. J. Lundin, London.
6753. Drive Chain, A. Appleby, Birmingham.
6754. Boiler Furnaces, W. O. A. Lowe and D. Lister, Liverpool.
6755. Fire-arms, J. W. Lundgren and M. Z. Viau, Liverpool.
6756. Detonating or Shooting Toys, J. Gage, Liverpool.
6757. Manufacture of Viscose, H. Spicer, London.
6758. Feeding Bottles and other Flasks, F. Delas, London.
6759. Tufted Pile Carpets, Henderson and Co., Ld., and R. Britton, London.
6760. Braces for Trousers, J. Guisinde, London.
6761. Drawing Boards, A. J. Boult.—(*A. Schmidt, Germany.*)
6762. Velocipedes, W. D. Hodgkinson, London.
6763. Cooking Stoves, E. B. Parnell, London.
6764. Funnels, E. B. Parnell, London.
6765. Manœuvring Ships, E. Smethurst and J. Knight, London.
6766. Photographic Pressure Frames, L. A. Marion, H. Guibout, G. Bishop, F. Bishop, and J. P. Kirk, London.
6767. Knives and Corn Holders, A. Anderson, London.
6768. Puzzles, W. H. Pepper, London.
6769. Pull-blocks, &c., for Vehicles, S. Parks, London.
6770. Steam Gauge Attachment, H. and W. J. Browning, London.
6771. Bottles, J. Meyer, London.
6772. Mucilage Bottles, J. S. L'Hommedieu, London.
6773. Puzzles, C. A. Edwards, London.
6774. Bicycle Holders, C. E. and M. R. Jewell, London.
6775. Wax Matches, G. D. Day, London.
6776. Elevators, J. S. Mucklé and W. H. B. Teamer, London.
6777. Thrashing-machine Drum, A. Ferri and E. Behles, London.
6778. Manufacture of Cigarettes, H. H. Wills, London.
6779. Treatment of Gold Ore, A. de C. Scott, London.

28th March, 1896.

6780. Platen Printing Machines, A. Carswell, Belfast.
6781. Protector for Heels of Boots, J. C. Tutt, London.
6782. Check Valves, H. Burns, London.
6783. Pneumatic Band, T. D. Bell, York.
6784. Beetle Mountings for Cloth, W. N. Brown and W. F. Reynolds, Antrim.
6785. Pottery Worms, H. L. Doulton, London.
6786. Cycle Pedal, E. Mattei, London.
6787. Flushing Water-closets, C. Church, London.
6788. Disengaging Boats, T. Hudson, Portsmouth.
6789. Controlling Sewage Gas, S. H. Adams and M. J. Adams, York.
6790. Stationery Cabinets, A. E. Mitchell, Bristol.
6791. Photographic Cameras, W. J. Lancaster, Birmingham.
6792. Variable Speed Gearing, W. Bowden and R. J. Urquhart, Manchester.
6793. Eyes of Hoes, R. P. Yates, Birmingham.
6794. Prepayment Gas Meters, J. Anderson, Glasgow.
6795. Explosive Shells, W. G. Hay, Liverpool.
6796. Stench Trap for Waste Pipes, T. Acton, Manchester.
6797. Educational Toy, H. Evans, Manchester.
6798. Needle Knitting Machines, J. W. Watts, Leicester.
6799. Roller Blind Furniture, J. Evans, Manchester.
6800. Boot Polishing Machine, W. H. Green, Southampton.
6801. Roller Forks for Printing Machines, F. Ullmer, London.
6802. Guiding Gasholders, E. L. Pease and Ashmore, Benson, Pease, and Co., Ld., Stockton-on-Tees.
6803. Dressing Woven Fabrics, W. Clark, Glasgow.
6804. Apparatus for Ships' Boats, J. Hamilton, Glasgow.
6805. Photographic Cameras, G. H. Banister, Woolwich.
6806. Machines for Glossing Collars, S. Barrett, Keighley.
6807. Cycle Brakes, M. I. Wilkins, Bristol.
6808. Ammonium Chloride, F. Bale, Droitwich.
6809. Distributing Artificial Manure, E. P. Smith, Gloucester.
6810. Boot Attachment, H. T. Baxter, Dundee.
6811. Preventing Draught in Chimneys, F. T. Huffam, Manchester.
6812. Adjustable Trench Plough, J. Rempl, Berlin.
6813. Golf Ball Net, G. Melville, Glasgow.
6814. Road Vehicles, R. O. Rowland, London.
6815. Window Sash Hanger, J. Browne, Dublin.
6816. Machine Potato Lifter, A. Burns, Ratho, N.B.
6817. Portable Desk, J. H. H. Hogge, W. J. Boniface, and the Pax File Syndicate, London.
6818. File Cases, J. H. H. Hogge, W. J. Boniface, and the Pax File Syndicate, London.
6819. Pad for Moistening Stamps, &c., D. Fulton, Glasgow.
6820. Automatic Vent Peg, W. C. Sanderson and F. C. Cawdell, Barnsley.
6821. Stoppers for Aerated Water Bottles, G. Hirst, London.
6822. Saddle for Cycles and the like, E. R. F. Mason, London.
6823. Measuring and Registering Cloth, J. E. Wilkinson, London.
6824. Drying Shoes and the like, W. V. Wickede, London.
6825. Pianofortes, J. and A. Acock and W. Miller, Blockley.
6826. Cleaning the Meshes of Sieves, T. C. Heath, Liverpool.
6827. Bookbinding, W. Slight, London.
6828. Rails, H. Cane, London.
6829. Centre-finding Instrument, H. Cane, London.
6830. India-rubber, W. J. Clapp and F. S. Dauncey, London.
6831. Propelling Road Carriages, M. W. W. Mackie, London.
6832. Spring Balances, I. A. Timmis and P. Ward, London.
6833. Convertible Cycle Skirt, W. Morford, London.
6834. Horseless Carriages, E. Gascoine and C. D. Courtois, London.
6835. Carbonic Acid Gas, B. T. L. Thomson, London.
6836. Substitute for Celluloid, S. W. Wilkinson, London.
6837. Hair Pins, W. Schwahn, London.
6838. Toys, H. J. Garbutt and G. C. Marks, London.
6839. Castors, R. McLeod, London.
6840. Spring Tires for Velocipedes, L. I. Perry, London.
6841. Cullender, W. G. Hugh, London.
6842. Ornamental Anklet, G. A. Boughton-Leigh, London.
6843. Securing Broom-heads to Handles, E. Nash, London.
6844. Window Fastener, A. V. Fenton, London.
6845. Composing Machines, S. H. and P. E. Hodgkin, London.
6846. Blocks for Ceilings and Roofs, O. Förster, London.
6847. Gas Lamps, W. Katofius, London.
6848. Preparing and Applying Motive Fluid, E. Field, London.
6849. Playing Games of Marbles, G. W. Thomas, London.
6850. Case for Bicycles for Transport, C. A. Pearson, London.
6851. Tool for Driving and Forcing, W. Sellar, London.
6852. Pressing Artificial Fuel, H. C. B. Forester, London.
6853. Making Artificial Fuel, H. C. B. Forester, London.
6854. Gasholders, C. C. Walker, London.
6855. Cleaning and Sorting Water, O. Schmidt, London.
6856. Washing and Bleaching Composition, C. M. Lévy, London.
6857. Coke Ovens, G. Hilgenstock, London.
6858. Solutions of Tetranitro Cellulose, C. D. Abel.—(*E. Bronnert and T. Schlumberger, Austria.*)
6859. Tires for Carriage Wheels, H. W. Brüning, London.
6860. Bottles, A. Lechenich and B. Schomann, London.
6861. Fastening Device, A. Stelzer and E. Schulthess, Brussels.
6862. Bicycles, J. G. Ferguson, London.
6863. Cowls, A. Ransom, Farnham.
6864. Short Circuiting Devices, G. A. Jewett, London.
6865. Assembling Soles of Boots, C. S. Luitwieler, London.
6866. Letter Files, A. Krah, London.
6867. Counting Mechanism, S. Berditschewsky, London.
6868. Automatic Floating Packing, E. T. Ferrier, Cardiff.
6869. Ammunition Chests, J. Ramsay and P. W. Masson, London.
6870. A Portable Bicycle House, A. P. Crouch, London.

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6871. Water-closets, W. P. Thompson.—(*J. C. Febiger, jun., United States.*)
6872. Motor for Propelling Vessels, J. Pinkert, London.
6873. Filter Presses, W. E. Heys.—(*J. Hundhausen, Germany.*)
6874. Incandescent Gas Burners, &c., W. R. Clay, Keighley.
6875. Bearings for Shafts, J. Bradbury, Manchester.
6876. Pneumatic Brakes, S. Tweedale and J. Clegg, Rochdale,
6877. Covers for Pneumatic Tires, J. Newhouse, Colne.
6878. Banjos, H. Riley, W. J. Riley, and F. Baker, Birmingham.
6879. Brakes for Cycles, W. H. Sewell and J. Aiken, Glasgow.
6880. Tea and Coffee Save-all, C. Brome, Llandinam.
6881. Wheel for Cycle Gearing, F. J. Smedley, Nottingham.
6882. Wheels for Chains, R. Hutchinson and T. Bowler, Nottingham.
6883. Mowing Machines, H. P. Saunderson, London.
6884. Pneumatic Tires for Cycles, F. W. Willcox, Sunderland.
6885. Tool Holder or Cutter Bar, C. Ferguson, Cromarty.
6886. Washing Machines, J. W. and G. T. Shepard, Cheltenham.
6887. Extracting Cyanides from Dust, R. Addie, Glasgow.
6888. Box Irons, J. A. Perks and S. Allen, Birmingham.
6889. Keyboard Appliance for Pianos, S. Suckley, Sheffield.
6890. Distributing Currents, S. Berditschewsky, London.
6891. Ashlar Block for Walling, &c., C. Wall, London.
6892. Carrying Off Obnoxious Fumes, A. H. Sach, London.
6893. Copying Books, F. G. Fender and W. Coleman, London.
6894. Tobacco Pipes, R. Whittaker, London.
6895. Spinning Frames, &c., A. V. V. Wichelin, London.
6896. Coin-freed Apparatus, G. Knight and G. Ellis, London.
6897. Preventing Re-filling Bottles, F. Rovedino, London.
6898. Bale Tie, J. Knott, London.
6899. Finger Support for Pencils, &c., H. Lombard, London.
6900. Bottle Stopper, W. Millar, London.
6901. Muzzles for Dogs and other Animals, A. Wood, London.
6902. Steam Traps, E. A. Adams, London.
6903. Jointing of Pipes and Tubes, J. W. Wyles, London.
6904. Automatic Water-tight Door, J. W. Graydon, London.
6905. Locks and Latches for Doors, H. T. Poate, London.
6906. Extensible Chair or Seat, W. Nordberg, London.
6907. Frames for Photographs, &c., E. Griffiths, London.
6908. Flower Pots, A. Young, London.
6909. Vertical Turbines, J. G. Marshall, London.
6910. Driving Mechanism, T. Hann, W. Bromley, J. Price, A. H. Smith, and D. E. Radclyffe, London.
6911. Tins for Preserved Meats, &c., A. Maconochie, London.
6912. Typewriting Machines, J. C. Fell.—(*Wyckoff, Seamans, and Benedict, United States.*)
6913. Embossing Lithographed Sheets, D. Price, Hanley.
6914. Shades and Screens, A. H. Synge and C. E. Challis, London.
6915. Motor Cycles and the like, W. Hildebrand, London.
6916. Saddles, G. Beckett, Liverpool.
6917. Locks and Lock Gates of Canals, A. Johnson, Manchester.
6918. Envelopes, J. E. Dohen and W. H. Grace, London.
6919. Making Combustible Gas, J. E. Dowson, London.
6920. Preservation of Meat, C. L. Villar, London.
6921. Extracting Metals from Ores, O. Frölich, London.
6922. Production of Illuminating Gas, V. B. Lewes, London.
6923. Compressing Hay, C. T. and W. B. Burgess, London.
6924. Curing Stinking Casks, T. Middleton and C. A. Verner, London.
6925. Electric Water Gauge, &c., H. Biermann, London.
6926. Securing Tires to Wheel Rims, R. Corsham, London.
6927. Cigar and Ash Holders, G. F. Prendergast, London.
6928. Valve for Liquid Pumps, J. S. Porter, London.
6929. New Pharmaceutical Product, S. Fränkel, London.
6930. Treating Acetylene, J. C. Mewburn.—(*A. C. Fraser, United States.*)
6931. Bicycles, P. L. Girardet, London.
6932. Moquette Fabrics, P. A. Newton.—(*W. B. Smith, United States.*)
6933. Explosion Engine, W. Hornsby, R. Edwards, D. Roberts, and J. Young, London.
6934. Filtering Material, F. Jurschina, Z. Schnitzer, and F. Hirsch, London.
6935. Rotary Pumps, H. Morris and F. Bastert, London.
6936. Kitchen Dressers, F. Mann and H. H. Akers, London.
6937. Explosives, W. Greaves and E. M. Hann, London.
6938. Briquette-making Apparatus, F. J. Müller, London.

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6939. Pocket Knives, J. M. Moss and W. Smith, Manchester.
6940. Pumps for Railway Air Brakes, G. S. Lee, Birmingham.
6941. Governor for Railway Air Brakes, G. S. Lee, Birmingham.
6942. Valve for Railway Air Brakes, G. S. Lee, Birmingham.
6943. Electric Light Door Switch, W. J. Fryer, London.
6944. New Cover for Pudding Basins, H. Wood, London.
6945. Carriage Steps, J. Whitehead and J. A. Crane, Birmingham.
6946. Reversing Gear for Engines, A. H. Truelove, Blackpool.
6947. Brushes and Brooms, H. Coombs and W. C. Seager, London.
6948. Ploughs for Cleaning Land, A. J. Lyon, Cambridge.
6949. Reversible Window Sashes, J. Shaw, Willington-on-Tyne.
6950. Fixing Tips on Cues, G. E. Cockle and S. Kyle, Clontarf, Co. Dublin.
6951. Water Trap, B. R. Phillipson, Dublin.
6952. Mechanical Horse for Riding, C. Blackmore, Bristol.
6953. Willeys for Wool, &c., H. and W. Morton, Leeds.
6954. School Slate, Drawing Board, &c., W. H. Friend, Rye.
6955. Curtain Holder, P. Philpot, Birmingham.
6956. Mantel Shelves, &c., P. Philpot, Birmingham.
6957. Roller Bands, W. and J. Richardson, Birmingham.
6858. Controlling Gear for Trucks, J. D. Bell, Glasgow.
6959. Machine for Treating Fabrics, H. C. Longsdon, Keighley.
6960. Construction of Valves, D. P. G. Matthews, Newport, Mon.
6961. Wheel Tires, J. E. Rogers, Birmingham.
6962. Self-closing Umbrellas, A. Kortenbach, Manchester.
6963. Drawing Scales, T. Jackson, Leeds.
6964. Arrangement of Torpedo Screws, F. R. Mazzinghi, Birmingham.
6965. Water-closets, E. A. Green, Sheffield.
6966. Soles for Boots and Shoes, F. T. Lehmann, Cologne.
6967. Looms, J. Fallenschmid, Cologne.
6968. Connecting Metal Pipes, A. Fletcher, jun., Glasgow.
6969. Railway Chairs, J. Paterson, Glasgow.
6970. Railway Signal Wires, T. J. Phipps, Watford.
6971. Railway Guide, T. Fox and T. F. Shepherd, Barnsley.
6972. Envelopes, J. M. Young, Glasgow.
6973. Shuttle Guard, J. Monk, J. Lang, and J. Catterall, Preston.
6974. Engines, J. S., R. D., W. D., and H. C. Cundall, Halifax.
6975. Shuttle Guards for Looms, &c., F. Baynes, Halifax.
6976. Hair-brushes, F., W. S., E., and H. Claughton, Leeds.
6977. Photographic Printing Frames, W. Tylar, Birmingham.
6978. Tobacco Pipes and Holders, J. R. Boulcott, Birmingham.
6979. Weaving Turkish Towelling, W. H. Hacking, Manchester.
6980. Boat Propeller, J. Entwisle.—(*S. N. Smith and E. S. Baring-Gould, United States.*)
6981. Electric Batteries, J. Entwisle.—(*S. N. Smith and E. S. Baring-Gould, United States.*)
6982. Screw-cutting Machines, F. Cornil, Brussels.
6983. Leather Horseshoe, P. Prince, Brussels.
6984. Water-tight Doors, J. W. Proctor, Manchester.
6985. Gas Meters, J. Hawkyard and J. Braddock, Manchester.
6986. Stokers, F. Clayton, Manchester.
6987. Method of Packing Meat, &c., S. M. Okell, London.
6988. Fire Extinguisher, H. A. Mansfield, Birmingham.
6989. Holder for Geographical Maps, I. Uschakoff, Glasgow.
6990. Mud-guard for Cycles, &c., W. Nicholls, Birmingham.
6991. Supporting Railway Tracks, F. Lessner, London.
6992. Raising Vessels, F. Kindt and J. C. Davis, London.
6993. Coin-freed Electric Meter, R. Hacking, London.
6994. Consolidated Soups, T. F. Garrett and W. M'Spouse, London.
6995. Holdfast, F. Rowbotham, Manchester.
6996. Bracelets, E. Murrle.—(*E. Kun, Germany.*)
6997. Heating Food, J. Bohensky, London.
6998. Fasteners for Shoes, W. L. Judson and H. L. Earle, London.
6999. Horizontal Coke Ovens, &c., A. Hüssener, London.
7000. Potassium Chloride, L. Epstein and F. Marza, London.

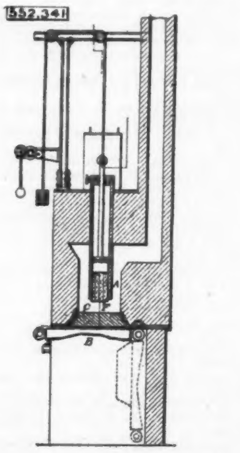
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

552,341. Electric Smelting Furnace, *J. A. Vincent and J. E. Hewes, Philadelphia, Pa.—Filed July* 18*th*, 1895.

Claim.—(1) In an electric smelting furnace, the combination of the hearth, with a removable bottom constituting one of the electrodes, an adjustable electrode arranged above the bottom and movable vertically, and feeding devices at the upper part of the hearth or furnace for delivering the materials to be smelted into the hearth. (2) In an electric furnace, the combination of the hearth A, the movable bottom B having the electrode C closing the bottom of the hearth, the vertically adjustable electrode F, the inclosing shield I surrounding the electrode F, a flue L between the shield and wall of the hearth, and feeding devices for feeding the materials to be smelted into said flue L. (3) In an electric furnace, the combination of the hearth A having a gas flue opening from its side walls, the movable bottom B having the electrode C closing the bottom of the hearth, the vertically adjustable electrode F, the inclosing shield I surrounding the electrode F, a flue L between the shield and wall of the hearth and above the gas flue, and feeding devices for feeding the materials to be smelted into said flue L.

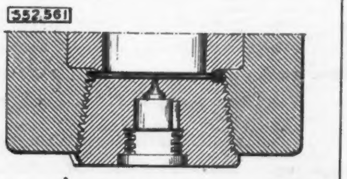
552,341



552,561. Screw-threaded Breech Block, *A. Welin, London, England.—Filed September* 16*th*, 1895.

Claim.—(1) The combination of a tapering breech block, a corresponding breech opening, a divided screw on the block such that the front face of each of the threads makes a greater angle with the axis of the block than the rear face, and a corresponding screw in the breech. (2) The combination of a tapering breech block, a corresponding breech opening, a divided screw on the block having the front face of each of its threads at right angles to the axis of the block and the rear face inclined thereto, and a corresponding screw in the breech.

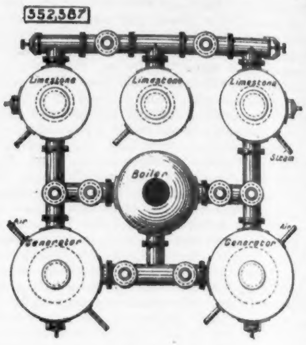
552,561



552,587. Cupola Gas-making Apparatus, *J. M. Rose, Allegheny, Pa.—Filed March* 16*th*, 1888.

Claim.—(1) A gas-making apparatus having a central boiler, two separate cupola gas generators on one side of said boiler and having valve controlled pipe connections therewith, and a series of casings containing auxiliary gas generating or treating chambers on the other side of said boiler having valve controlled connecting pipes, and valve controlled connecting pipe between the end chambers of said series and the cupola generators, substantially as and for the purposes set forth. (2) A gas-making apparatus having a central steam boiler, two generators on one side of the same, a series of casings containing connected auxiliary gas generating or treating chambers on the other side of the boiler, and valve controlled pipe connecting pipes between the end chambers of the series, and the boiler and generators, substantially as and for purposes set forth.

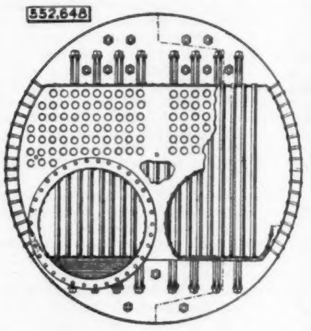
552,587



552,648. Steam Boiler, *C. Starke, Milwaukee, Wis.—Filed November* 26*th*, 1894.

Claim.—In a marine boiler of the so-called "Scotch" type, a combustion chamber flat at the top and bottom but otherwise circular, a series of vertical tubes in said chamber extending through the top and bottom of the same, and a deflector extending rearward from the front wall of the aforesaid chamber below horizontal flues through which products of combustion find their escape.

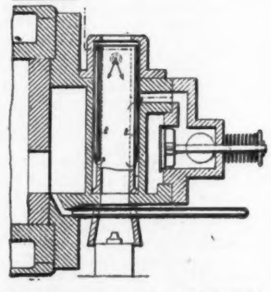
552,648



552,686. Petroleum Oil Engine, *J., S., F., and E. Carter, Billingshurst, England.—Filed April* 17*th*, 1895.

Claim.—In an explosive engine, the combination with a heater, and a tube for carrying off the products of combustion, of a sleeve surrounding said tube and forming a vaporising chamber between it and said tube, said vaporising chamber being provided with ribs *t*, *t* for causing the oil to pass over the whole surface of the heater; means for supplying oil to said vaporising chamber, an air inlet adjacent to the oil inlet to admit air to allow circulation of vapour in the vaporiser so as to empty the vaporiser on out stroke of piston, a mixing chamber in communication with said vaporising chamber, an air supplying pipe for said mixing chamber and an igniting device passing through the said tube, substantially as described.

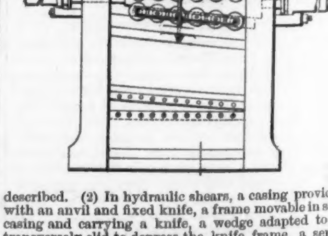
552,686



552,710. Hydraulic Shears, *E. A. W. Jefferies, Philadelphia, Pa.—Filed September* 27*th*, 1895.

Claim.—(1) In a hydraulic shears, a casing provided with an anvil and fixed knife, a frame movable in said casing and provided with a knife, a transversely slidable wedge, two series of connected rollers, one series being interposed between the wedge and casing and the other between the wedge and knife frame, both series of rollers moving slightly in the same direction in which the wedge is slid, and means for actuating said wedge, substantially as and for the purposes described. (2) In hydraulic shears, a casing provided with an anvil and fixed knife, a frame movable in said casing and carrying a knife, a wedge adapted to be transversely slid to depress the knife frame, a series of rollers connected together and interposed between the wedge and knife frame, a series of rollers connected together and interposed between the casing and wedge, said two series of rollers travelling slightly in the same direction in which the wedge is slid, means for operating said wedge and means adapted to counterbalance said knife frame and to return the same when not depressed by the wedge, substantially as and for the purposes described,

552,710



"THE ENGINEER"

1100 GUINEA ROAD-CARRIAGE COMPETITION.

On the fifth of July last we announced that the sum of 1000 guineas would be given by the proprietors of The Engineer by way of prizes for the encouragement of manufacturers and designers of horseless carriages, believing as we did that an important trade could be created in this class of machinery, and that the removal of the restrictions on the use of mechanically-propelled vehicles would result in great benefit to our farmers. As our readers are aware, we followed up this announcement by the circulation of a memorial to the President of the Local Government Board, praying for the introduction of a Bill for the amendment of the law—a memorial which was very extensively signed, and which was laid before the President, accompanied by some suggestions, invited by him, as to the form the Bill should take. The Bill has been introduced and printed in our columns. It is framed—as we ventured to hope it would be—very much on the lines we suggested. In the month of November, and, of course, before the Bill was prepared, we thought it right to publish certain preliminary conditions to enable designers and manufacturers to set to work. These conditions prescribed four classes of vehicles, and, as they have no doubt been acted upon, no change can fairly be made in them. As the law then stood, and as it stands at the present moment, the use of "light" oil or spirit is practically prohibited, because of the onerous conditions laid down by Statute for its carriage and storage, and for that reason vehicles using petroleum spirit were excluded from our competition. As, however, we gather from the Bill now before Parliament that a change in the law may be made in this respect, we have determined to admit to the competition vehicles using the hitherto prohibited spirit, and as no departure could be made from the published conditions, we have determined to offer a "supplemental" prize of 100 guineas for competition amongst vehicles of this class. The full conditions as now finally settled are given below.

The Crystal Palace has been selected as the centre from which the vehicles competing for the prizes offered by The Engineer will start, and to which they will return at the end of their long run. The Crystal Palace is well adapted for the purpose. The grounds of the Palace contain miles of gravelled roads with hills and levels, on which minor trials can be carried out by the judges with much convenience. The building is perfectly accessible, and well known to the whole world. There is ample room, and competitors will secure all the publicity they can desire.

CONDITIONS OF COMPETITION.

Note.—*These are drawn up on the assumption that the present restrictive Legislation will cease to be in force prior to the date of the Competition, and that a new Act of Parliament will have been passed giving greater facilities. It may be, however, that this new Act will not allow of all the following Conditions remaining exactly as now set forth, and they may possibly have, when the Legislation is complete, to be modified. If, unfortunately, the state of the law should make it impossible, in the judgment of the Proprietors of* The Engineer, *to hold the Competition as at present contemplated, no blame or responsibility shall attach to them or the Judges, or to the Crystal Palace Company.*

The Proprietors of **The Engineer** have agreed with the Crystal Palace Company, who have offered facilities at the Crystal Palace for showing the carriages in work there, and for holding the subsidiary trials hereafter referred to.

Judges.

The following are the names of the judges:—

Sir Frederick Bramwell, Bart., F.R.S., M. Inst. C.E.

Mr. John Audley F. Aspinall, M. Inst. C.E., Chief Engineer to the Lancashire and Yorkshire Railway.

Dr. John Hopkinson, F.R.S., M. Inst. C.E.

The competition is to be international.

Classes.

The vehicles will be divided into four classes, and one supplemental class, in each of which a prize will be given, as follows:—

A.—For the best mechanically propelled vehicle constructed to carry—including the driver—four or more persons, the total weight, when fully loaded, not exceeding two tons, a prize of **350 Guineas** will be given.

B.—For the best mechanically propelled vehicle constructed to carry either one or two or three persons, the total weight, when fully loaded, not exceeding one ton, a prize of **250 Guineas** will be given.

C.—For the best mechanically propelled vehicle constructed to carry, in addition to the driver, not more than 1 ton of goods, or parcels, the total weight, when fully loaded, not exceeding 2 tons, a prize of **250 Guineas** will be given.

D.—For the best mechanically propelled vehicle constructed to carry, in addition to the driver, 5 cwt. of goods or parcels, the weight, when fully loaded, not exceeding 1 ton, a prize of **150 Guineas** will be given.

Supplemental.—For the vehicle, whether for passengers or goods, propelled solely by a motor actuated by the vapour of oil or spirit, having a lower specific gravity than 0·8, or a flashing point lower than 73 deg. Fah., Abel's test, and constructed to satisfy the requirements of any Act of Parliament, and the rules to be made thereunder for the time being respectively in force, which, in the opinion of the judges, best satisfies the purpose for which it is built, a prize of **100 Guineas** will be given.

The judges are to have the power to divide any prize in case of vehicles proving of equal merit.

Propelling Power.

Any method of propulsion other than muscular power may be employed, provided it be contained in the vehicle.

Quality of Oil for Power Purposes.

Except in the Supplemental Class, no oil or other liquid used in any engine, whether for the production of an explosive mixture, vapour, or for fuel, shall have a lower specific gravity than 0·8, or a lower flashing point than 73 deg. Fah., Abel's test.

Entries.

Entries are to be made on printed forms—to be obtained at the offices of The Engineer—at any time prior to 6 p.m. on the last day of July, 1896, being forwarded by registered letter, addressed to the Editor of The Engineer, 33, Norfolk-street, Strand, W.C., and accompanied by a deposit of £1 for each entry; this deposit will be forfeited if the vehicle entered is not submitted for competition.

Delivery.—Description and Descriptive Drawings.

The competing vehicles must be delivered at the Crystal Palace, Sydenham, between the hours of 10 a.m. and 6 p.m. on some day prior to 2nd of October next. Prior to the delivery of each of the vehicles, there must be forwarded to the Editor of The Engineer, 33, Norfolk-street, Strand, W.C., a docket showing the weight of the unloaded vehicle, in complete running order, with its store of fuel and water—if these are to be used—this docket being furnished by a weighmaster of some public weighing machine. At the same time there must be forwarded six, at least, type-written or printed descriptions of the machines, setting out, as briefly as possible, any peculiarities of construction or of working to which the competitors desire to draw the attention of the judges, and also six sets of clear blueprint drawings or sketch tracings, to a scale of not less than 1½in. to the foot, illustrating the construction. These documents will not be returned, but on their receipt, a printed Form of Request to The Crystal Palace Company, to accept delivery of the vehicle, will be forwarded to each competitor by the Editor of The Engineer, and this Form of Request will have to be produced to the authorities at Sydenham when the vehicle is delivered.

Opening-up of Machines.

After delivery, and before the practical working run, hereinafter referred to, each vehicle is to be opened up by a skilled attendant representing the competitor, in the presence of one or more of the judges, or their representative, for their information.

Preliminary Runs.

Preliminary runs in the grounds of the Crystal Palace will be made with each of the vehicles in succession by the competitors in the presence of the judges or of someone representing them.

Practical Working Run.

This will consist of a run on the public roads of not less than 100 miles out and 100 miles home, or a total of not less than 200 miles over a course to be announced three days prior to that fixed for the run. It is impossible at present to fix the exact date for this run, but it will probably be arranged for Monday, the 12th day of October next. On starting for this run from the Crystal Palace, each vehicle is to be fully loaded and is to have its full store of fuel and water—if these are used—and is also to carry the number of adult passengers for the class in which it is entered, one of whom is to be a representative of the judges, who will be counted as part of the load.

Route Map.

There will be provided for each competitor, on making application at the office of The Engineer three days before the practical working run commences, a route map indicating the course which it is suggested the vehicles shall take, but the competitors will be free to take any road they think proper between the Crystal Palace and their destination and back.

Order of Starting.

Lots will be drawn to determine the order in which the vehicles are to start. It is intended that the first shall leave at or about 10 a.m., and the remainder at intervals of ten minutes. During the run the representative of the judges shall keep, on a printed form which he will have with him, a "log" of the run.

Change of Drivers.

Any competitor may change his driver at any place *en route*, if he should think proper.

Inspection of Vehicles on Return.

After the return of the vehicle to the Crystal Palace, it shall again be opened up by the competitor and submitted to the inspection of the judges, or their representatives, and this prior to anything being done to the vehicle in the way of repair or renewal, except such as may have been effected during the run.

Further Runs.

Should the judges so determine, further runs are to be made on subsequent days by all or any of the vehicles in the premises of the Crystal Palace Company or on the public roads.

Disqualification.

The judges reserve to themselves the right of absolutely disqualifying any vehicle or competitor from the competition for any infraction of these rules, or for any cause whatsoever, and without in any way being bound to state the reason or reasons for which such disqualification is made.

Number of Vehicles to be Exhibited by each Competitor.

No competitor, either directly or by any agent or otherwise, is to enter for competition two similar vehicles in any one of the classes above referred to; and each vehicle is to be entered by not more than one person, that is to say, in the name of one individual or firm.

Responsibility.

While obeying in all respects the instructions of the judges, it is to be fully understood and agreed by every competitor that no responsibility, legal or otherwise, is to attach either to the judges, to the proprietors of The Engineer, or to the Crystal Palace Company in respect of anything, or for any damage or injury caused to any person or thing, but all responsibility of every sort and kind, whether pecuniary or otherwise, is to attach to the competitor, and is to be borne by him.

Length of Practical Working Run.

Any vehicle which does not complete the "practical working run" at a minimum average speed of five miles an hour, to include all stoppages, shall be disqualified. The distance upon which such time allowance will be computed will be fixed by the judges and stated on the route map.

Note.—*As the attainment of high speeds is not one of the objects sought, it has been determined that nothing in speed over ten miles an hour will be placed to the credit of any competitor, but, subject to this condition, the competitors may go as they please, at any speed they think proper, running continuously day and night, or stopping as they think best.*

The following are the points which will be taken into consideration by the judges in awarding the prizes:—

(*a*) Distance run without stop for any purpose whatsoever, or without taking or receiving supplies of fuel, oil, gas, electrical, or chemical materials or electrical current or of whatever is employed for actuating the motor. Freedom from stoppages for repairs, adjustment, or for oiling or any other purpose or cause.

(*b*) Suitability of design and excellence of workmanship, not only of the actuating machinery but of the carriage.

(*c*) Safety.

(*d*) Simplicity, durability, accessibility and facilities for repairs and absence of offensive smells.

(*e*) Time occupied in getting to work and ease of starting.

(*f*) Speed (up to ten miles per hour) and hill climbing.

(*g*) Completeness of control by and certainty and decision of steering and steering gear, and efficiency and durability of brakes and brake gear.

(*h*) Weight of carriage and motor machinery and appliances.

(*i*) First cost and (to a limited extent) the cost of working.

(*j*) General efficiency.

Note.—*The quantity of fuel, oil, gas or power-giving material or electricity used during the long duration run will not be specially taken into account, although observations will be made by the judges on this subject; but trials of short duration of the vehicles selected for further tests will be made if deemed necessary for the purpose of ascertaining the cost of working of the vehicles.*

Judges' Decision to be Final.

The decision of the judges expressed in writing on any point shall be final and binding on all parties, and from such decision there shall be no appeal.

COPY OF RULES TO BE FURNISHED TO EACH COMPETITOR AND SIGNED BY HIM.

Three printed copies of these rules will be supplied to each competitor or his accredited representative, and no competitor will be allowed to deliver his vehicle at the Crystal Palace until he has signed one of these copies, and it has been handed in to the Editor of THE ENGINEER and formally acknowledged and accepted by him. In signing and forwarding this copy of these rules the competitor shall accept all the conditions herein imposed upon him, and shall agree to be bound in all respects by them.

OFFICIAL NUMBER AND STAMP ON VEHICLES.

Prior to the start for the long-distance competition there will be attached to each vehicle, in some convenient place, a card stamped with the judge's seal and bearing upon it the number assigned to that particular vehicle for the purposes of the competition. The seal must not be broken, otherwise the vehicle will be disqualified.

PARAGRAPH TO BE SIGNED BY COMPETITORS.

I agree to abide, and be bound, by the above rules and conditions, or any modifications of them which the judges may think desirable or necessary.

Signed..

Address ....

Competitor in class............

....

THE FAILSWORTH SEWAGE PURIFICATION WORKS.

THE formal opening of the Failsworth Sewage Outfall Works took place on Thursday, April 2nd. The ceremony was attended by a large company, and was presided over by Mr. Councillor Wild, J.P., Chairman of the District Council. Mr. Councillor Dunkerley, chairman of the Sewage Committee, declared the works open. Mr. C. J. Lomax, A.M.I.C.E.—Messrs. Lomax and Lomax, Manchester and Bolton—is the engineer who has carried out the scheme. Messrs. Freeman, of Hollinwood, are the contractors, the process adopted being the "International."

The Outfall Purification Works which have been constructed embody all the latest improvements in sewage treatment, and are on a scale which will ensure the continual and successful treatment of the sewage. The sewage enters the outfall works at an elevation of 12ft. above the water level in the tanks, advantage being taken of the fall by utilising the water power for chemical mixing purposes and other minor work. Sufficient power is also obtained to work an air compressing engine which will supply the necessary power to a ram for elevating the sewage from the few houses situate somewhere about 35ft. below the water level in the tanks. The sewage passes from the mixing house into two detritus tanks. The action of the precipitant "ferozone," which has been previously mixed with the sewage, shows itself to a striking degree in these tanks. The sewage passes out by troughs into six upward-flow tanks, and the degree of clarification that takes place in these tanks is excellent; from the tanks the effluent passes on to the 6in. polarite filter beds. The filter beds adopted are on an entirely new system, the patent rights being the property of the International Water and Sewage Purification Company, Limited. In the ordinary method of filtration the beds are in the first instance slowly filled up until about 1ft. of water stands upon the surface, the process of filtration then commences. The water in passing through the bed is exposed to the purifying action of the oxygen contained in the atmosphere, but the available oxygen in the bed is rapidly exhausted, and so long as a head of water is kept upon the surface of the bed, it is physically impossible for the air to penetrate into the interstices of the filtering material. To overcome this difficulty the International Company is now using a new process, Failsworth being the second successful installation. The filter beds, being six in number, are grouped three on each side, with a central inlet channel dividing them. This inlet channel is of sufficient capacity to cover the filter beds 3in. in depth with water.

Each bed is supplied by two automatic flushing syphons, which discharge the water from the inlet channel in the space of about thirty seconds over the entire area of the filter; the water then sinks through the bed and disappears in about five minutes. The flow of water to the inlet channels is so regulated that it takes exactly twenty minutes to fill and discharge, therefore the filter bed is entirely empty and exposed to the atmosphere for fifteen minutes out of every twenty. Three inches of water spread over the surface every twenty minutes is equal to 1000 gallons to the square yard in twenty-four hours, and this is the speed at which the Failsworth filter beds are now working.

By the intermittent method of filtration purification is obtained not only by direct oxygination, but also by the organisms that have been proved to rapidly increase in the beds. The effluent as it leaves the filter beds is clear and sparkling, devoid of froth on shaking, and is free from odour. The area of the filter beds is 960 square yards. One singular feature in the intermittent filtration is, that whilst this large volume of water is being rapidly flushed upon the bed not one particle of sand is disturbed from its place.

THE CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—At the meeting held on Thursday, April 9th, a paper was read by Mr. A. Hanssen, C.E., on the "Commercial Efficiency of Steam Boilers." This was an exceedingly interesting paper, the author having been at considerable trouble to collect and tabulate, not only the cost of a number of various classes of boilers, but the cost of their settings, flues, and chimneys; and having ascertained their capital value and their average life, he compared the sums that it was necessary to set apart annually, to recoup the owners for the capital originally invested in them, at the termination of their average lives. The question of the use or otherwise of economisers, to be used in connection with boilers for the raising of steam, was also entered into; and the discussion that took place after the reading of the paper was directed very largely to this point. The president, Mr. S. à Court, A.M.I.C.E., was in the chair; and among those who took part in the discussion were C. T. Walrond, E. H. G. Brewster, Chester Dawson, D. Allport, A. F. White, and B. G. Willmott.

NAVAL ARCHITECTURE.—A FEW PRINCIPLES POPULARLY EXPLAINED.

No. V.—CURVES OF STABILITY.

IN the third paper of this series it was shown that B N—Figs. 13 to 16—or the perpendicular distance from the centre of buoyancy in the upright condition to the vertical, through the centre of buoyancy in the inclined condition of the vessel, is the arm of the lever at which the weight D of the displacement acts at that angle of inclination, when the centre of gravity coincides with the centre of buoyancy. In other words D × B N is the moment of the vessel's surface stability, or the stability due to her form alone at that angle.

It was further shown that when the centre of gravity does not coincide with the centre of buoyancy, as is almost always the case, then D × G Z is the moment of statical stability at that angle.

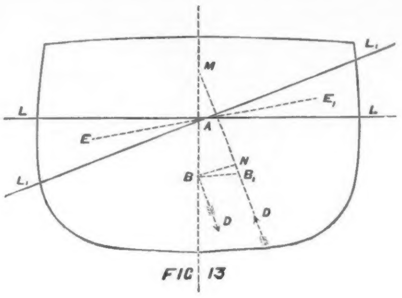


FIG 13

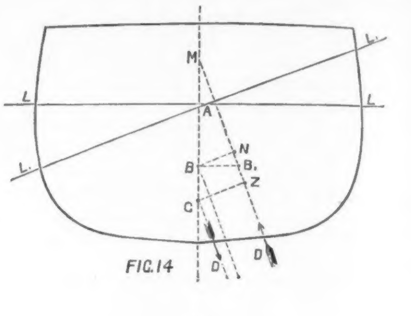


FIG. 14

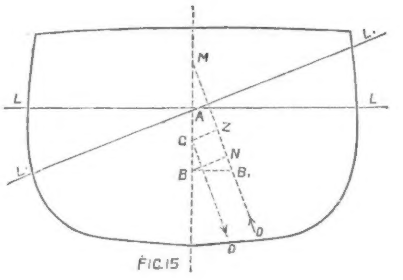


FIG. 15

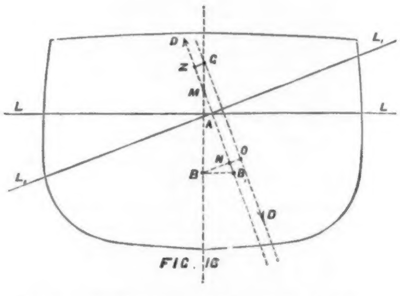


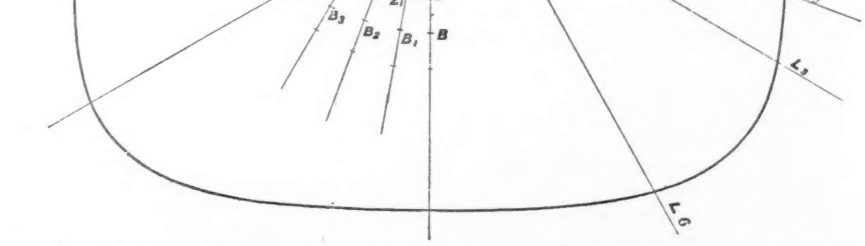
FIG. 16

Again, referring to Figs. 13 to 16, it will be observed that when G is below B, then G Z is greater than B N, and when G is above B, G Z is less than B N. Finally, when G is above the transverse metacentre M, then G Z becomes negative, and the moment is an upsetting one.

Ordinarily G is above B, and throughout a large angle of inclination from the upright G is below M; or, rather, M is above G, for M is the variable point while the vessel is being inclined.

Let us now consider a specific vessel—see Fig. 21—with her centre of buoyancy in the upright position situated at B, and her centre of gravity at G; her load water-line under these conditions is L L.

Fig 21.



We will now incline this vessel through a small angle—say 10 deg.—when her load water line appears as L_1 L_1. This inclination is accompanied by a certain transference in the position of her centre of buoyancy, the extent of which may be calculated by a method alluded to in the second article of this series, but which is of too intricate and laborious a character to admit of description in these elementary papers. Let B_1 be the altered position of B at the 10 deg. inclination, and let G Z_1 be the perpendicular distance from G to the vertical line through B_1.

Again, incline the vessel through another 10 deg., so that now her total inclination from the upright is 20 deg. Let L_2 L_2 be the load water-line at this inclination, B_2 the centre of buoyancy, and G Z_2 the perpendicular distance from G to the vertical line through B_2. Once more incline the vessel through another 10 deg., so that now her total inclination from the upright is 30 deg. Let L_3 L_3 be the load water-line at this inclination, B_3 the centre of buoyancy, and G Z_3 the perpendicular distance from G to the vertical line through B_3.

Also let M_1, M_2, M_3, &c., be the various successive positions of the transverse metacentre at these angles of inclination. These will be almost coincident at first, but as the angles of inclination increase the positions of M will vary more considerably.

To avoid confusion we have omitted in Fig. 21 the load water-lines at 40 deg. and 50 deg., but have drawn L_6 L_6 the load water-line at 60 deg. inclination. The centre of buoyancy at that angle is B_6, the metacentre is M_6, and G Z_6 is the perpendicular from the centre of gravity upon the vertical through B_6.

This figure shows us the arms of the righting couples at 10, 20, 30 and 60 deg. of inclination; and if we further drew the nine water-lines at intervals of 10 deg. between the upright and the 90 deg. inclination, also the nine positions of the centre of buoyancy and metacentre, as well as the nine values of G Z ranging from G Z_1 to G Z_9, we would have on our diagram the materials for constructing a curve of stability.

Turning to Fig. 22, we have a horizontal line divided up into a number of equal divisions—or abscissæ—of 10 deg., and at its left-hand extremity we have a vertical scale of feet.

At the 10 deg. division on the horizontal line an ordinate has been set up representing the value of G Z in feet at that inclination, as determined by calculation for a certain vessel. Similarly at the 20 deg., 30 deg., &c., divisions, values of G Z in feet are set off, as determined by calculation for the corresponding angles of inclination. These values in this particular case increase up to an inclination of about 50 deg., after which they rapidly diminish until at an inclination of 80 deg. G Z becomes zero. That is to say, the righting leverage in this instance increases up to an angle of inclination of about 50 deg., where it is a maximum; it then diminishes continuously, until at an inclination of 80 deg. the vessel ceases to possess any righting moment, and from thence capsizes. The curve A B C drawn through the extremities of the ordinates given by values of G Z at the several angles of inclination of the vessel, is termed a curve of stability. As will be seen by comparing Figs. 21 and 22, the values of G Z in the former are not nearly so instructive regarding the stability of the vessel as when plotted in the manner shown by the latter figure, and then represented by a curve. Moreover, the curve of stability affords us values of G Z at all the intermediate inclinations between 10 deg. and 20 deg., 20 deg. and 30 deg., and so on.

But the graphical representation of the vessel's stability, as in Fig. 22, is even still further instructive if we duly consider it. This will be seen by reference to Fig. 23, which shows the curves of stability of several vessels so superimposed as to show the conditions of stability of each relatively to the others.

The curve marked *a* commences with a direction making a greater angle of inclination to the base line than either of the other curves. This indicates that the vessel to which it refers has high initial stability, due to M being at a greater height above G than in the vessels to which the other curves relate. This may be in consequence of the centre of gravity being unusually low; but more probably it results from M being unusually high. If the latter is the true explanation then the vessel is doubtless broad in proportion to her volume of displacement.

It will further be noticed that the maximum stability is attained at an angle of only 20 deg. of inclination, at which the value of G Z is about 1ft. 6in. From this it is evident that the vessel has a very low freeboard, so that an inclination of but a few degrees from the upright is sufficient to bring her gunwale below water, and that when an inclination of 20 deg. is passed so much of the upper works are submerged as to result in further inclinations being attended with a diminished value of G Z, until at about 45 deg. the latter becomes zero, and the vessel is on the point of capsizing.

These peculiarities of the curve of stability *a* in Fig. 23 point to the fact that the vessel is of such a form as that of the monitors employed in the American Civil War, or of the floating batteries built for our own navy for service in the Baltic forty years ago.

The curve indicated by letter *b* in Fig. 23 shows slightly less initial stability than *a* with a maximum value of G Z at about 35 deg., and a vanishing value at 79 deg.

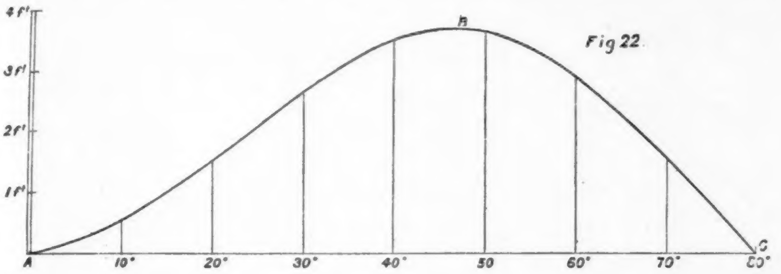


Fig 22

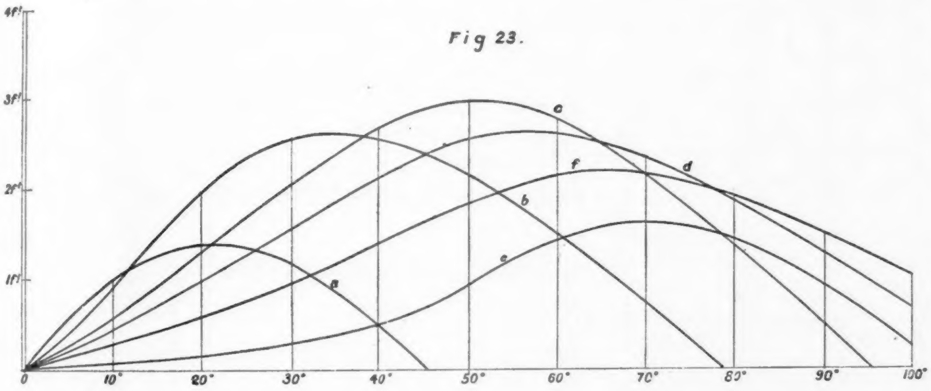


Fig 23.

This vessel has also a comparatively large G M, due probably to considerable breadth in proportion to her depth and length, as well as to a low position of the centre of gravity. She has, however, a much higher freeboard than the vessel previously considered, although her upper deck is not so high above the water-line as in the cases of *c* and *d* curves.

In both cases the vessels are doubtless uneasy rollers, and require large bilge keels to make them at all steady in a seaway. But while great breadth of beam was essential for safety in the case of the vessel shown by curve *a* in view of her low freeboard, the high initial stability was not so necessary in the case of *b*, which has sufficiently lofty sides to give her a range of stability extending to an inclination of nearly 80 deg.

The vessel, of which *c* is the curve of stability, has better sea-going qualities than either of the other two. In her case the maximum righting moment is not reached until the vessel is inclined to an angle of 50 deg. from the upright, and it is not until an inclination of more than 90 deg. is attained that her stability wholly vanishes. Of course, in supposing such large angles as these, it is understood that all openings in the deck and sides of the vessel are hermetically sealed against the admission of the sea. Moreover, the vessel is supposed to be heeled over in still water and not among waves.

The vessel, of which *d* is the curve of stability, is perhaps the most desirable sea-going type of the four. She has comparatively small initial stability, and is therefore an easy roller. Her maximum stability is not attained until an angle of 58 deg. is reached, in which condition the value of G Z, while less than in the *c* curve, is yet sufficient. But, best of all, her range of stability is such that at 90 deg. the value of G Z is the same as at 25 deg., and a state of instability is not reached until the vessel is heeled over to nearly 110 deg.

The curves marked *e* and *f* relate to the same vessel, but in different conditions of lading and immersion. The curve *e* represents the vessel when in the light condition; that is to say, without any cargo on board, while *f* is the curve of stability when loaded and ready for sea. This is a steamer with a comparatively low metacentric height, but with an awning deck which gives her a high freeboard. Hence her centre of gravity being lowered when the cargo is in, she has in that condition a greater initial stability than when her cargo holds are empty. In both cases she has a high range of stability, but is comparatively "tender" or "crank," and therefore readily inclined from the upright.

From what has been said, it will be evident that curves of stability present to the eye of an expert very important facts in relation to the sea-going qualities of the vessel to which they refer. A naval architect would not dream of giving sail power to the vessel represented by *a*, and would be very reluctant to employ her on any but coasting or harbour duties. On the other hand, *c* and *d* curves show that the vessels to which they relate are fit to carry sails, and so far as stability is concerned, to go anywhere.

But not only does the naval architect seek to know the condition of stability of a ship when at her load immersion, and with the cargo stowed so as to give a mean or average position of centre of gravity, it is often his further aim to learn something about the vessel's stability at different angles of inclination, when at lighter draughts of water, and even when in ballast trim. Hence it is no uncommon thing to find curves of stability drawn corresponding to successive depths of immersion, and their corresponding positions of M and G. During recent years several expedients have been devised for simplifying the calculations necessary to determine the movements in the position of the centre of buoyancy, due to inclining the vessel through successive angles when at different draughts of water. The particulars of these devices are of too intricate a character to admit of description in these articles; it must be sufficient to say that, thanks to the common use of mechanical calculating appliances, such as the planimeter and integrator, in our shipyards, and the simplification of methods to which allusion has been made, not only can curves of stability be calculated in about one-tenth the time occupied on such work a quarter of a century ago, but the results are also attended with greater accuracy and fuller detail.

With the facilities now possessed for determining curves of stability for the different conditions of a vessel's immersion and lading, there should be no difficulty in providing such particulars for every ship that leaves her builder's premises. Nor should there be any difficulty in instilling into the minds of shipmasters precisely what these curves are able to teach to those who will consult them. Probably the time will come when such knowledge will be demanded of all master mariners, and when all vessels will carry not only charts of the seas they will traverse, but also charts showing their conditions of stability under different conditions of loading and immersion.

THE COAL PRODUCTION OF FRANCE IN 1894.

The total quantity of mineral fuel raised in the mines of France in 1894—for which the official returns have lately appeared—was 27,417,000 tons– metric—being 1,766,000 tons, or about 7 per cent., above the production of 1893; the different classes of minerals making up this amount being:—

Coal..	25,599,000 tons	93 per cent.
Anthracite	1,365,000 ,, ...	5 ,,
Lignite	453,000 ,, ...	2 ,,
	27,417,000 ,, ...	100 ,,

The value at the pit's mouth was £12,310,400, or £520,000 above that of 1893.

Nearly the whole of the increase was due to increased productivity in the mines of the northern basins—Nord and Pas de Calais—which together furnish about 57 per cent. of the whole output, in the form of gas coking, steam, and house coals. Anthracite is got principally in the North Burgundy and Alpine districts, and lignite in Provence, nearly the whole being obtained from Fuveau, in the neighbourhood of Marseilles.

The largest individual producers, with an output exceeding 1,000,000 tons, were the mines of the following companies, all of which, with the exception of Blanzy, are in the northern basin:—Anzin, 2,826,000 tons; Lens, 2,287,000 tons; Courrières, 1,497,000 tons; Blenzy, 1,411,000 tons; Vicoigne-Noeux, 1,087,000 tons; Bethune, 1,069,000 tons; Bruay, 1,020,000 tons. Eleven other companies raised more than half-a-million tons each, the individual amounts ranging between 502,000 tons and 871,000 tons.

The deepest pits are at Salles de Gagnieres (810 metres), in Gard; Plat de Gier (777 metres), Villebœuf (650 metres), and Comberegol (606 metres), in the Loire; Montchanin (710 metres), Epinac (648 metres), and Blanzy (533 metres), in the Centre; and Anzin (700 metres), Courcelles (636 metres), and Drocourt (620 metres), in the North. The average depth of the workings is, however, considerably less, the principal output being obtained above the 500 metres level.

In the northern basins, which are the most productive, the seams are thin, but this is compensated by their large number. At Anzin there are sixty-six in all, averaging 32 inches in thickness each. At Alais the average is 4¾ft., and at Saint Etienne 9¾ft. At S. Eloy there are two seams, each of 82ft., and at Aubin one of 98½ft.

The number of hands employed in the different classes, both underground and at surface, was:—

	Men.	Youths. 16—18.	Boys. 13—16.	Women.	Totals.
Underground	86,400 ..	5,500 ..	4,500 ..	— ..	96,400
Surface ..	27,600 ..	2,500 ..	4,400 ..	3,700 ..	38,200
Total ..	114,000 ..	8,000 ..	8,900 ..	3,700 ..	134,600

There was an increase in the number of men employed underground to the extent of 2700, but the surface hands have decreased by 800, the latter being principally women and older youths, while the younger hands have increased by about 300. Female labour is now considerably restricted in the French collieries, women not being allowed to work more than eight hours daily, and that only between the hours of 9 a.m. and 5 p.m. The only night work permitted to them is in the lamp room, in which case they must not make more than seven hours' time in the twenty-four hours.

The average wages paid were for miners 4·37f.—3s. 6d.—and for surface hands 3·15f.—2s. 6d.—per day; the former averaging 280 and the latter 288 days at work in the year, giving 1278f.—£50 14s.—and 939f.—£37 5s.—as the annual earnings in each class. The annual output was 285 tons per underground hand, and 204 tons on both surface and underground men taken together, giving an average of 5·80f.—4s. 5d.—as the wages cost per ton of coal.

The selling price averaged 11·12f.—8s. 10d.—per ton taken at the pit, and 19·53f.—15s. 6d.—per ton delivered to the consumer. The extreme range in prices varied with the distance from the mines; the manufacturers in the north getting their coal at about 8s., while in the Jura and Alpine districts, owing to the long railway lead, as much as 30s. was paid. The domestic supply was not sufficient to meet the whole demands of the country, and required to be supplemented by foreign coal to the extent of 11,664,000 tons, 42 per cent. of which quantity, or 4,893,000 tons, was obtained from the United Kingdom. Nearly £500,000 was paid in customs duties upon the coal imported.

Peat is produced in the valleys of the Somme and other northern rivers, but owing to the wet season the yield fell off 174,000 tons in 1893 to 132,000 tons in 1894, the average value being 13·54f.—12s. 10d.—per ton. A considerable proportion of this is, however, used for stable litter and other than heating purposes.

BRITISH ASSOCIATION OF WATERWORKS ENGINEERS.

The establishment meeting took place on the 11th inst., at the Westminster Palace Hotel, under the presidency of Mr. D. M. F. Gaskin, M. Inst. C.E., Nottingham. Representatives were present from all parts of the country, including London, Birmingham, Birkenhead, Widnes, Oldham, Batley, South Staffordshire, Devonshire, Kent, Suffolk, Yorkshire, and Somersetshire.

The Chairman congratulated the meeting upon its representative character, and submitted a draft copy of constitution and rules for the management of the Association, which had been drawn up by a provisional committee. It was pointed out that the object of the Association would be to promote and facilitate the interchange of information, ideas, and practice amongst its members on all matters pertaining to waterworks undertakings, and the mutual advantage of water authorities and consumers; to invite from the members and others communications, written or oral, relating to waterworks engineering, management, and finance, and to receive, hear, and discuss such communications at meetings of the Association or elsewhere; to invite the exhibition of, and to exhibit at meetings of the Association or elsewhere, any new or improved machinery, apparatus, plans, drawings, or models calculated to advance the knowledge of waterworks engineering and management; to assist the Legislature, public bodies, and others in ascertaining the views of persons engaged or interested in waterworks undertakings; to originate and promote improvements in the law, and to support or oppose alterations therein, in all matters relating to waterworks; to watch over, promote, and protect the mutual interests of its members; and to provide facilities for promoting and maintaining, professionally and socially, a spirit of fraternity amongst its members. One of the objects of the Association, and by no means the least important, will be to appoint examiners and to hold examinations. The Association is to consist of three classes—members, associates, and hon. members; and the council will have power to establish a graduate class for pupils of waterworks engineers, and to elect candidates upon such conditions as they may deem advisable. Hon. members will be persons of distinguished scientific attainments whose knowledge on matters relating to water and water supply recommend them to the council. They are to be nominated and elected by the council, and are not to exceed twelve in number. The affairs of the Association are to be managed by a council of members, consisting of a president, two vice-presidents, ten members, and an honorary secretary and treasurer; and annual and general meetings are to be held at such times and places as the council may consider desirable.

The rules having been agreed to, with slight verbal alterations, Mr. Gaskin was elected the first president; Messrs. H. A. Hill, M. Inst. C.E., South Staffordshire Waterworks Company, and W. Matthews, M. Inst. C.E., Southampton, vice-presidents; and Mr. W. G. Pierce, Richmond, hon. secretary and treasurer. The council of ten, elected by ballot, are Messrs. Priestly, Cardiff; Woodward, Wolverhampton; Roberts, Ipswich; Watts, Oldham; Jones, Chesterfield; Richardson, Birkenhead; Leggett, London; Terry, Sheffield; Sandeman, Plymouth; and Bowker, Mid-Kent. It was resolved that the first annual gathering of the Association, which will take place at the end of July or the beginning of August, should be held in Nottingham. The meeting will occupy three or four days, and will cover presidential address and reading of papers, excursions, and visits to and examination of works. At a subsequent meeting of the council, Mr. W. H. Brothers, of Birmingham, was appointed general secretary. The offices are at Palace Chambers, 9, Bridge-street, Westminster.

THE HEINRICHSBURG FLOATING CANAL LIFT

MESSRS. HANIEL AND LUEG, DUSSELDORF, ENGINEERS

(For description see page 389)

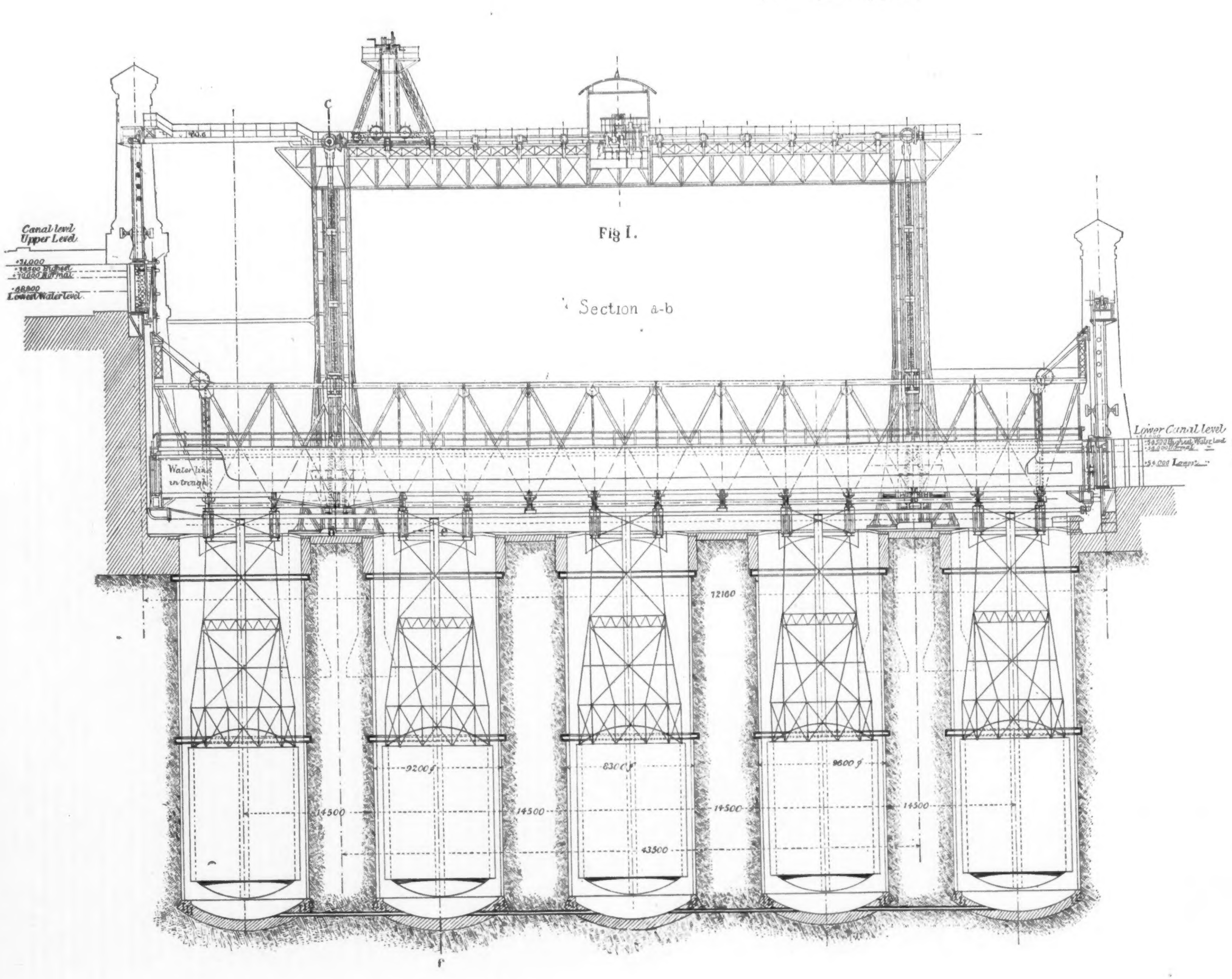


Fig I.

Section a-b
Canal level Upper Level
·71,000
·70500 Highest
·70000 Normal
·68800 Lowest Water level
Lower Canal level
·57,000
·56,500 Highest Water level
·56,000 Normal
·54,000 Lowest
Water line in trough
c
f
12160
9200 ϕ
8300 ϕ
9600 ϕ
14500
14500
14500
14500
43500

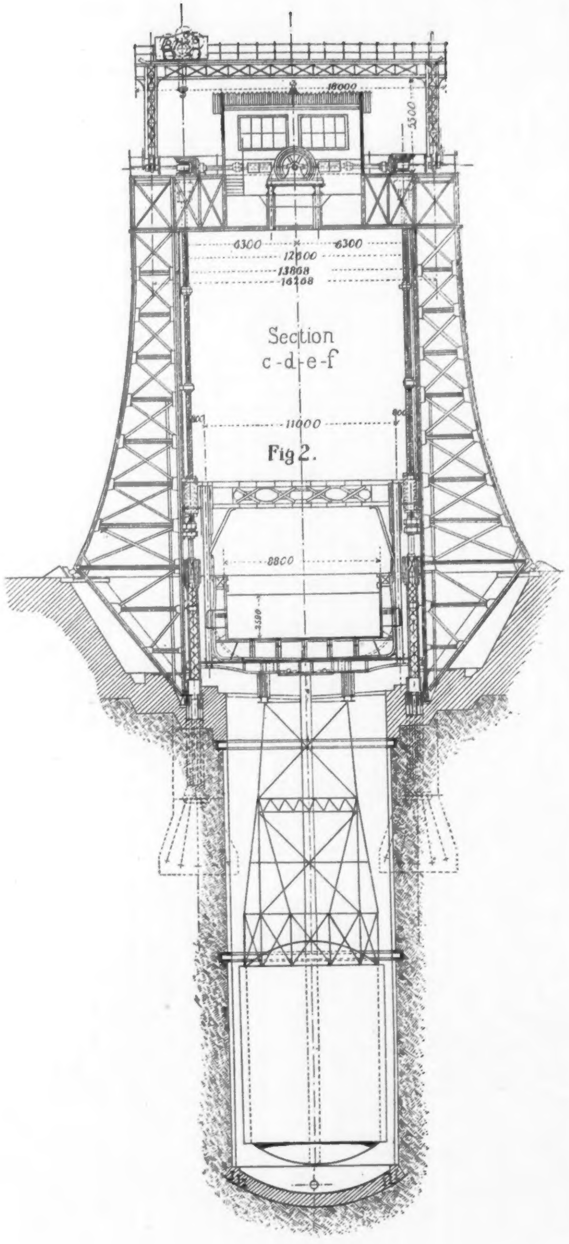


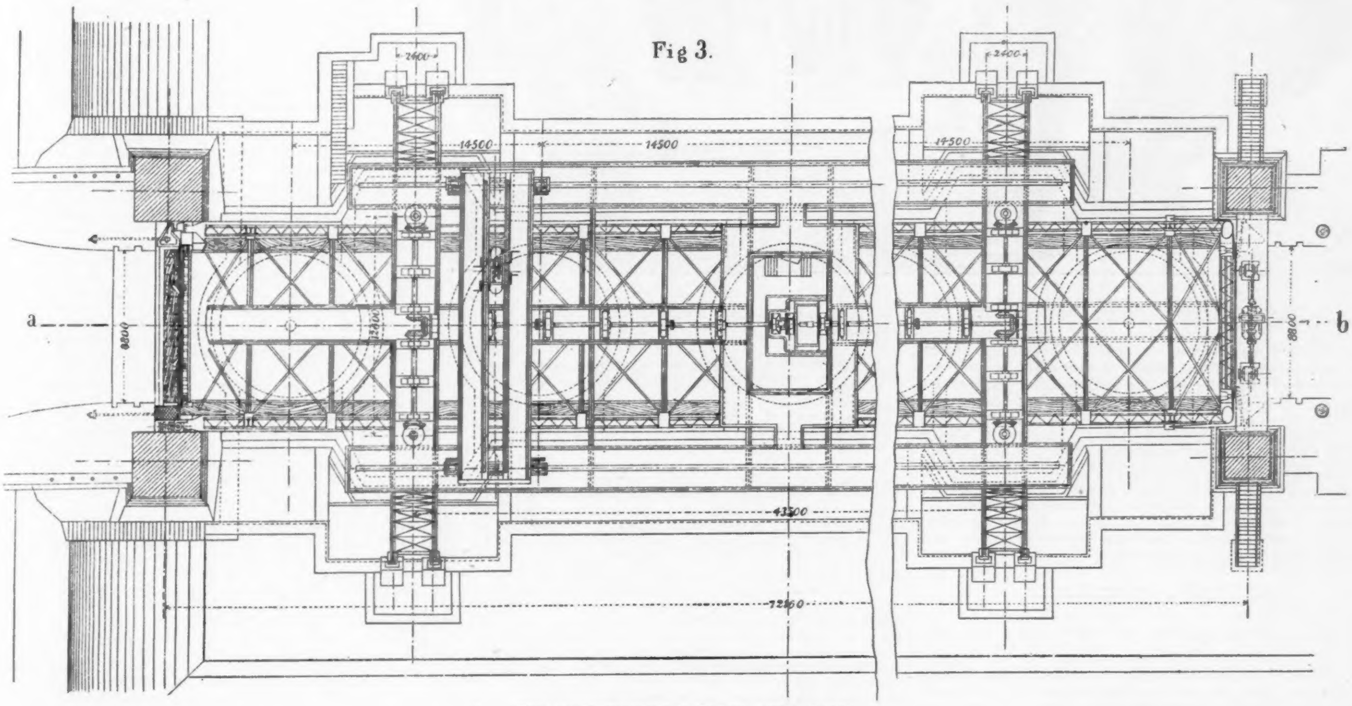
Fig 2.

Section c-d-e-f
16000
5500
6300
12600
6300
13808
16108
11000
8800

THE HEINRICHSBURG CANAL LIFT.

ON the new canal joining the Port of Emden with the Westphalian coalfield, the Dortmund district is reached by a branch about ten miles long, which joins the main line at Heinrichsburg, but at a higher level. This difference, in amounting to a maximum of about 52½ft., is to be overcome by a floating lift, which is represented in the illustration on page 388. The lifting power is derived from a series of five large floats moving in water-tight pits below the level of the lower canal, which carry the boat trough or cradle, and are made to rise or fall by adding or removing water to the trough to the extent necessary to overcome or reduce the upward thrust. The trough is made to move horizontally by running upon guide screws at the four corners of the framing, provision being also made for driving these screws from a central motor, so that the lift can be effected mechanically in the event of shortness of water or other accidental causes putting the hydrostatic balance out of use. The cradle, which is 239ft. clear length, 28¼ft. broad, and 8ft. 2in. deep, taking a boat of about 600 tons carrying capacity, is carried between two bridge girders, which are connected by lattice framed pillars with the floats below. The weight of the ironwork in these parts is about 1400 tons, and that of the water in the trough 1650 tons, giving a total for the moving weight of rather more than 3000 tons. The work, which has been undertaken by Messrs. Haniel and Lueg, of Düsseldorf, was begun in the spring of 1894 with the excavation of the basin for the cradle, and the sinking of the pits for the floats. These are of the uniform dimension of 30ft. 3in. diameter, 92ft. deep, with the distance of 46½ft. from centre to centre, leaving a rib of solid ground 17ft. wide between each. In order to disturb the solid ground as little as possible, the sinking was carried out simultaneously, the excavation being secured by a water-tight lining put in in short lengths as the ground was cut, so as to avoid exposure to the atmosphere. The first curb put in, about 10ft. down, is a cast iron ring which carries a 32in. wall of rammed concrete extending to the surface, while the top ring line of cast iron tubbing is attached to it below. This tubbing is made up of rings 5ft. high, divided into sixteen segments, with planed faces and flanges, and worked together by screw bolts with strips of lead packing in the joints, each ring being built in and backed with cement as soon as a sufficient depth of ground was excavated for placing it, so that no timbering or other obstruction was necessary. The bottoms of the pits are lined with inverts on concrete, forming spherical segments of 24ft. 8in. radius, the ends of the floats being dished to the same curvature. A 4in. horizontal bore hole lined with an iron pipe connects the whole line of pits at their lowest point, in order to ensure equality of water level in all of them.

Fig 3.



THE HEINRICHSBURG CANAL LIFT—PLAN

The sinking was completed in February, 1895, in about seven months' working time, giving an average progress of about 65ft. per month, the total contents of the ground excavated being about 15,000 cubic yards. The floats, 26ft. 3in. in diameter, 33ft. 9in. high in the cylindrical part, and about 42ft. 8in. including the curved ends, are built of mild steel plates from 0·72in. to 0·8in. thick, stiffened by twelve vertical stringers with intermediate horizontal struts, the former being of H and the latter of Z section, but no internal framing is used, in order to keep down the weight. The design of these floats has necessitated special experiments, as the existing data were not sufficient to determine the proper thickness to be given to the plating, the structures being of exceptional size, and intended to bear a pressure of nearly 100ft. of water.

The boat trough or cradle is built of plates of varying thicknesses, the upright sides being from 0·4in. to 0·56in., while in the bottom 0·32in. buckled plates are used in the middle, and 0·64in. flat ones at the sides; the whole being stiffened at intervals by cross bearers. The bearers are attached to the main girders of the lift by flat bars, giving an elastic connection so that each part may expand independently of the other. This is a point of importance, as in bright sunshine the girders are likely to elongate more than the water-cooled trough so that the rivetted seams of the latter would probably draw if the two were rigidly connected.

The trough is closed at each end by a vertical sluice gate moving on roller guides, a similar gate being placed at the end of each of the canal levels, and wedge-shaped packing pieces fixed to the ends of the trough, which bear against similar pieces on the canal end, form a water-tight joint when the trough is in position for transferring a boat. The small clearance space between the two doors is filled with water by a paddle from the canal gate, and when the level is established the two doors are locked and lifted together by the same motor. The clearance water for the upper level runs into a pipe below the cradle, where its weight is utilised in lowering the boat, and is finally discharged into the bottom canal at the other end.

The most interesting and important feature in the design, the guide screws, intended to ensure the regularity of the movement of the cradle, are attached by collar bearings to lattice frame standards at the corner of the lift, as shown in the transverse section on page 388. They are made of mild steel of 30 tons tensile strength, and 14 tons elastic limit, the maximum strain likely to be brought on them of 595 tons each, representing about 9½ tons per square inch. The total length is 80ft. 9in. and the diameter 11·2in., with a 4in. hole bored through from end to end. The screwed portion, 57½ft. long, carries a double thread 1·4in. deep, with a rise of 1 in 8. The guide nuts on the trough are made of gun-metal in two parts, each 5ft. long, enclosed in a steel plate casing. In order to keep the screws in longitudinal tension and prevent sagging, the top collar bearing is carried on a hydraulic press ram, acting upwards under the constant strain of a small accumulator. A further provision is made against bending by four sliding collars, which are moved in pairs by the trough, so that there can never be more than one-third of the length of the screw unsupported. It is intended to enclose the screws in a casing with hinged doors, opening from the passage of the nuts and closing automatically by sprigs, in order to protect the thread against dust and other disturbing influences. As the screws would, in the event of the trough being emptied, have to bear the whole upward thrust of the floats, or about 1600 tons, the pillars carrying the lower bearings are very securely anchored in pits about 8ft. square, filled with concrete, as shown in the dotted lines in the cross section.

The excess weight required to lower the trough against the thrust of the floats is about 30 tons, or about 2in. depth of water in the trough, in which case the screws only act as guides. They are, however, geared together by bevel wheels and shafting at the top, so that they can be driven by an electro-motor carried on the top of the framing above the lift, by an expenditure of 60 to 80-horse power. With sixty revolutions of the screw per minute, the trough is moved at a uniform speed of about 20ft. per minute, or 2½ minutes for the entire lift, so that allowing time for the accessory operations of warping in and out, the boats may pass through at intervals of about fifteen minutes each. The opening and shutting of the sluice gates and the working of the warping capstans are also effected by an electro-motor of about 100-horse power, the current being provided by a dynamo driven directly by a steam engine of 220-horse power, with three water-tube boilers placed in an engine-house adjoining the lift, which will also be provided with the necessary pumps for drawing the float and for feeding the high level canal.

It is expected that this lift, which will probably be completed at the end of the present year, will be much more economical in working than those depending upon hydraulic presses for balancing power. The total cost is estimated at about £112,000.

OPENING OF THE NEW MIDLAND RAILWAY STATION, GLOUCESTER.

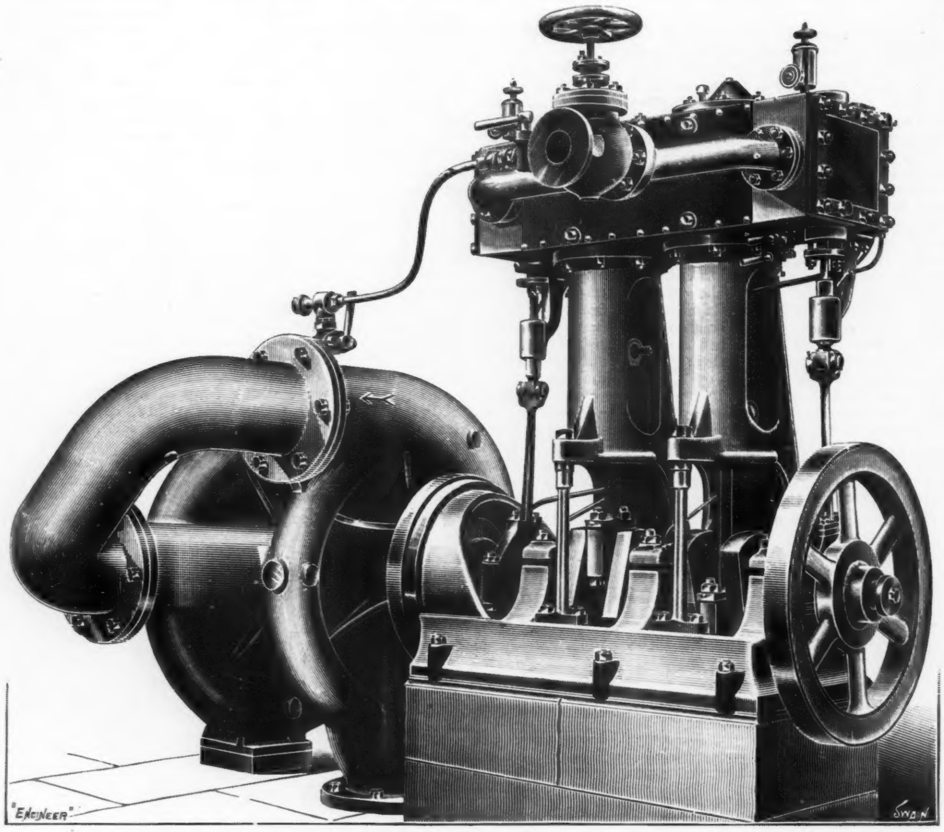
THE new Midland Railway station, Gloucester, was formally opened for all future traffic on Sunday. The new and handsome structure has been built on the site of the old engine and wagon sheds, the work being commenced in January, 1895. The architecture is of modern design, and the buildings are in three blocks—the main block and two sets of waiting and refreshment rooms and offices on the up and down platforms. The station front is 147ft. long, and is built of red pressed bricks with terra-cotta facings. A balustrade runs the whole length of the building, ornamented with panels bearing the railway company's shield. A tower has been erected up to the roof, and the original design was to extend the tower, and place in it a three-faced clock. This may yet be done. The platform frontages of the buildings are of pressed brick with Bisley stone dressings. They are covered with glazed awnings, those projecting from the waiting-rooms being built upon the cantilever principle, thus increasing the platform area, which is 40ft. in front of the main block and 16ft. off the waiting-rooms. The interior of the main block consists of an entrance 40ft. by 18ft., the walls being of buff glazed bricks, and the roof of iron, with ornamental spandrils and glazed rough plate glass. The booking hall is 40ft. by 28ft. The joinery work throughout is chiefly carried out in varnished pitch pine. Most of the ceilings of the halls and offices are fitted with lantern lights. At least two-thirds of the glazing is on the Meliowe's system. The booking-office is 40ft. by 15ft. Leading from and adjoining this department are the clerks' and station master's offices, a cloak-room 32ft. by 20ft., and a parcels office 42ft. by 20ft. A porters' room, lamp room, and other offices have yet to be built to complete the main block. Situated north-east of the new block are the up and down platform waiting-rooms, &c., which in size and number are in keeping with the general substantial and liberal character of the work. On the up platform is a telegraph office 23ft. by 19ft., with a battery room beneath. This department is fitted with ten instruments and three telephones, and is illuminated with Wenham lights. On the up platform is a handsomely appointed dining and refreshment room 52ft. long by 18ft. wide, with a mosaic floor and tiled walls in different patterns. There are four platforms in all, between 700ft. and 800ft. long. These are connected by an iron bridge with Hawkesley patent treads, and when complete will be provided with hydraulic lifts, supplied by Messrs. Armstrong, Mitchell, and Co., for luggage. This bridge, which has been erected by the Horsley Company, Greatbridge, is being extended on stone piers to the Great Western Railway Station, a distance of about 190 yards. It is 14ft. wide, and some of the spans are 136ft. long, the girders weighing about 26 tons each. The girders are 11ft. deep, and are of the lattice strutt type. The roof will be covered with panelled sheeting. The iron work connected with the station has been supplied by Messrs. Grimson and Co., Leicester.

The contractors are Messrs. J. Walker and Sons, Wirksworth, Derbyshire; Mr. C. Trubshaw is the architect, Mr. J. A. Macdonald the engineer, and Mr. T. Wright clerk of the works for the railway company. Much of the work is at present in a very rough and incomplete state, and will not be finished until the autumn, but until the old lines were converted it was impossible to progress with the work. The last train to make use of the old metals at the Barton-street curve, Gloucester, was the 5 a.m. Scotch express, and as soon as it had passed into the old Midland Station, gangs of men in readiness commenced to deflect the lines at that point, and connect them with the new route. The departure of the 7.40 a.m. train for Birmingham was the signal for closing the old station, and the 8.40 a.m. train for Bristol saw the opening of the new station for all future passenger trains. The work of the men engaged—some 300—was continued the greater part of the day in completing connections ready for the Monday's ordinary and heavy traffic. Under the full and efficient management provided everything passed off without a hitch, and no delay to trains was occasioned. The signalling had all to be re-arranged, and two new signal-boxes erected, the north-east box, prepared on Sunday, containing forty levers. The signalling work was carried out under the direction of Mr. Woodward, the company's signalling engineer. The telegraph wires had also to be re-arranged under the superintendence of Mr. Langdon. The lines of the old station will be used as carriage sidings. The new station will enable four trains to be dealt with at the station at one time, and they will not have to back in and out of the station as formerly, but will pass direct through Gloucester. It is contemplated eventually to divide and amalgamate express trains in the new station, which has hitherto been done at Cheltenham. It is estimated the entire cost of the new buildings, the engine shed, and other work contemplated in connection with the present station, will be little short of £100,000. The old Midland Station was opened for traffic in 1840.

JUMEAU, who has for many years been the chief engineer of French India, in the Franco-Indian Public Works Department, has retired on a pension. As his successor, Gurree, the deputy chief, and Fontaneilles, an engineer lately sent out from France to superintend the construction of the Karikal-Peralom Railway, have been mentioned.

DIRECT-ACTING CENTRIFUGAL SERIES PUMP AND ENGINES

MESSRS. JOHN AND HENRY GWYNNE, ENGINEERS, LONDON.



CENTRIFUGAL SERIES PUMP AND ENGINES.

THE illustration shows a vertical double-cylinder steam engine and two centrifugal pumps in series, all driven from one spindle and connected directly to the engine crank shaft. It is suitable for working against heads of 100ft., and will be found to possess many advantages over pumps of reciprocating type. The construction of the pump is simplicity itself; it has no valves, air-vessels, vibration, nor obstruction whatever, and the water passes through it in one continuous stream. It will be found to possess the merit of cheapness in first cost, and the annual charge for repairs is almost nil. By combining the pumps in series, the lift can be augmented to 150ft. We need scarcely add that the workmanship and material leave nothing to be desired.

FOREIGN COMPETITION IN THE IRON TRADE.

THE British Iron Trade Association's report on foreign competition was once more the subject of discussion before the South Staffordshire Institute of Iron and Steel Works' Managers, at Dudley, on Saturday last, when a paper dealing more particularly with practical suggestions upon the matter was read by Mr. H. M. Punnett, of Punnett, Thompson, and Co., galvanised iron manufacturers, the Cape, Smethwick, near Birmingham. Mr. Punnett was understood to voice the views of the Midland Iron and Steel Wages Board, of which he is a prominent member. The chair was occupied by Mr. W. Rubery—of W. P. Parkes and Co., Tipton Green Chain and Anchor Works, Tipton—President of the Institute.

The secretary, Mr. W. H. Carder, announced apologies for non-attendance from several members of the Commission.

Mr. H. M. Punnett said that whatever the general opinion might be as to the completeness of the report of the delegation of the British Iron Trade Association to the Continent, there could be no doubt as to its importance to both employers and employed. In truth, the facts recorded, however short they fell of that which the practical man might desire, were of the greatest interest, and provided them with matter for serious reflection. The delegation was organised by the British Iron Trade Association, but the Midland Iron and Steel Wages Board had long perceived the necessity of arousing the trade of the Midlands to inevitable changes in methods, and gladly joined in the work. As finally arranged, the combination of the several branches of the iron and steel trades gave an almost national interest to the report. At the same time the comprehensiveness of the task created difficulties in finding suitable men able to be absent together, and the large number of delegates compelled a somewhat hurried glance at a subject which required slow and careful investigation. They in Staffordshire, the centre of the sheet iron trade, had on this latter point a right to express some disappointment, for a careful examination of the appendices to the report showed that only three establishments were visited in which either iron or steel sheets were being rolled—one in Belgium and two in Germany. Further, in each of these three cases, the sheet mills were simply supplementary to extensive iron and steel plants, and were in no sense parallel to one of the South Staffordshire sheet rolling mills. It would not, therefore, be doing any injustice to say that conclusions drawn from such a very limited field of inquiry must be accepted with great caution. We all knew that Germany had several great iron centres. The delegation confined its attention to one of those areas only, that of Rhenish-Westphalia, a district which has been aptly described as the "home of the aristocracy of labour in Germany," and he did not hesitate to say that if the inquiry had been extended to the other six important iron producing centres in that country the conclusions drawn would have been very different. In support of that statement, it was only necessary to quote the report issued by our Consul-General, Sir Charles Oppenheimer, in 1893, entitled "Labour Times and Labour Wages in Germany." From that report he extracted the following figures, being the average yearly wages paid to skilled workmen in the seven districts where either iron or steel, or both, are made on a large scale.

	£	s.	d.
Rhenish-Westphalia forge and rolling mills ..	50	2	0
North-Western iron and steel industries	44	14	0
North-Eastern	44	4	0
South-Western	42	3	0
Southern	41	17	0
Saxony Thuringia	41	8	0
Silesian	30	6	0

So much for the assertion he unhesitatingly made that the report hardly touched the fringe of the great question of foreign competition. It was not, however, his purpose in that paper to criticise the report so much as to offer some practical points for consideration, and despite what he said as to the limited area examined by the delegates, it was a matter for congratulation that they selected works of the most efficient kind, and replete with every modern appliance, since they had put before them clearly what was being done, and could be done, by modern machinery, suitable material, and good workmen. Mr. Punnett said he must here ask them to remember that in his following remarks on the works visited he should confine himself to the sheet mills and forges attached thereto. The only sheet mills visited in Belgium were at "A" works, where they were told the costs of coal and pig iron were very much the same as in this district. The puddlers there, as well as in most parts of the Continent, were paid day wages, and the average was about 5s. per day. The quantity puddled per turn was rather more than with them. The hammer men and forge bar rollers earned also about 5s. per day. The wages costs, therefore, of puddled bars was much under that of England. The report added that this was somewhat due to the character of the pig used, and after saying this, one regretted that an analysis of it was not given. As to the quality of the puddled bar, the evidence was difficult to understand. Mr. Trow said, "If the iron had either been hammered or squeezed equal to ours there would have been another 7½ per cent. waste on the puddled bar;" whilst of the sheets, he said "the quality of the pig enables them to put on a superior finish," from which they must conclude that, although the puddled did not seem to him clean, it was good enough for a highly finished superior sheet commanding a very high price. One naturally asked, why, even if possible, make it better? Surely the highest art in economical manufacture was to produce a quality sufficiently good for the purpose to which it was to be applied. This remark of Mr. Trow's reminded him of the criticisms on that most interesting paper read before the Iron and Steel Institute in Birmingham last autumn, by Mr. Bonehill, on the "Puddling of Molten Iron direct from the Blast Furnace," which were directed not to the suitability of the quality produced to its required use, but to its purity compared with bars made by a much more expensive process. Thus the main object of the paper, the economic production of a common iron, was largely overlooked. The sheet mills at A works consisted of three pairs of hard rolls turning out Russian sheets of a very high class. The output was small, but Mr. Thackray said he was told "They could easily treble the output if they did not put so much finish on it." That was to say, each mill was capable of rolling 33 tons per week if necessary, instead of 11 tons which they were then doing. The number of men employed at each pair of rolls was four, say, one roller and one catcher, each getting 5s. per day, two furnacemen at about the same wage, and one boy at the rack. Now this rack arrangement, which was usual in the new mills in Germany as well as in Belgium, was one by which the last end of the pack as it leaves the rolls was lifted by a lever under the control of the catcher or a boy, and appeared to be an excellent contrivance, as it hastened the operation and relieved the catcher of the most arduous part of his duty. The extra cost must be trifling. To sum up the position of the sheet manufacturers in Belgium, they could only conclude that fewer men were employed in the mills, whilst the wages from the pig to the finished sheets were much less than in England. To pass to the German sheet mills spoken of as at H and I works. It was first necessary to point out that the few sheet rolls at each works were but a very small portion of two very large steel making plants. He would take the two works together, as they were either rolling bars or waste materials from other departments of the works. What struck our sheet rolling experts in all these millls was the very high speed at which the rolls were running, say upwards of 120 revolutions per minute, or three times as fast as was usual in this district. Severe comments had been made on this statement as to speed, but he could not see any practical difficulty in the matter with the appliances described. These consisted first of an arrangement by which the screws were not touched by the roller or his breaker down, but were regulated by a boy controlling a central wheel moving both screws at the same time. In the second place, of the before-mentioned rack for helping the catcher to return the pack quickly. Then of distinct soft rolls for breaking down the bars; and, lastly, of three high hard rolls for finishing the sheets. These appliances together meant a large output and comparatively light labour. The German sheet rollers earned 7s. per day, the furnacemen the same, and the underhands from 4s. to 5s. Thus here again the total wages cost was below that of this country. He thought they must, on the evidence of the report, credit the works visited with machinery of a high order for rolling either iron or steel sheets. As to material rolled in Germany, little need be said, since the scrap and steel bars spoken of in the report were very much what they were with them. The only great advantage Germany possessed in this respect was in its large supplies of minette ores of most suitable composition for basic steel manufacture. He would now pass to labour, which, of necessity, occupied much space in the report. All the delegates, employers and employed alike, were evidently astonished at the splendid physical appearance, manly bearing, and quiet order of the workmen engaged in the mills and works. Now this problem of labour was one of great international interest, and from that point of view the first thing that struck one was the strange difference that existed in the relations between capital and labour in the three largest iron-producing countries in the world—Germany, England, and the United States. The races inhabiting those countries were sprung from a common stock, but the necessities of life, and the influence of environment, had modified the views of each in regard to this question in the most remarkable manner. In Germany, the old idea was still in force that those entrusted by Divine Right with authority must take a paternal interest in those they are called upon to rule, and cannot permit combinations against authority. In England, the land of freedom, where everyone was at liberty to combine against those they deemed opponents, individual claims were often mistaken for national ends, and labour fought its battles without regard to capital. In the United States they found vigorous action born of new surroundings, freed from prejudices, and stimulated by undeveloped opportunities. The result of these different conditions on the quantity and quality of what was produced was very great, and must be fully understood to appreciate the power each possesses in competing with the others. The German working-man was well trained in his youth, and disciplined in early manhood by two years' compulsory service in the army. On entering a trade he was compelled to keep a record of his occupations, without which it would be most difficult for him to obtain employment. He was not allowed to combine on the lines of their trades unions; these restrictions were heavy, and had raised a spirit of dissatisfaction amongst the labouring population of Germany, which curiously enough was not even hinted at in the report. On the other hand, as a set-off against the restrictions put on personal liberty, and to compensate for our poor law and free hospital system, employers, and especially those having works in isolated districts, had hospitals and special homes for their workmen, whilst the Government had established and enforced upon the whole population a system of accident funds and old age pensions, which bade fair to produce a spirit of contentment. It was impossible to ignore the fact that the social measures in force in Germany had aided manufacturers, and if the wages were low as compared with England and America, there was a more even distribution of the wage fund, provision during illness or accident, and a pension in old age without shame or disgrace. Their English labour population was trained under other conditions. It had inherited as its birthright freedom to act alone or in concert with others. It had no obligation to the State but what it chose to give voluntarily, and it was not amenable to order as all Germans were. In the matter of discipline our lads were not as well trained as they were in the old days of apprenticeships, and after leaving school they often wasted years in any sort of occupation that could be obtained until an opening offered in some definite trade to which, if they were sharp and steady, they became attached, probably joined some trades union, and considered themselves efficient workmen. This was not an ideal system, and did not tend to a spirit of regularity and thrift, or discipline of mind and body. For all that their English working population made as fine workmen as any in the world, but one grieved that they were not trained to appreciate discipline and self-restraint. In the United States the area was too large, and the interests of different districts too much opposed to permit of effective combinations of workmen in any one trade or occupation. In the ranks of all trades in that country were to be found some of the most enterprising of all our European nationalities. They lived in an atmosphere of push and hurry, and became, by force of their surroundings, worshippers of the almighty dollar. To succeed they must give of their best, or others equally good were ready to undertake the work. The employers recognised the fact that to obtain much they must give much, and in return for dollars the workman gave of his best. He had been induced to give this general sketch from the expressed opinion of the delegation that the lot of the workmen in the few works they saw—and he must ask them to remember they saw only the picked works of the best part of Germany—was better than that of the same class in England. Such a general assertion was not just or reasonable. Were their workmen willing to give up their freedom? He for one trusted not. The great lesson which labour and capital had to learn from the report was that the continental races by industry, regularity, discipline, and thrift were doing as good work as they at their best with greater happiness at less cost. A large German manufacturer said to him years ago, "Our masters and men are not opposed to changes, but welcome the introduction of new ideas." Now, unfortunately, he declared this country was daily losing trade which belonged to her, because she failed to throw away worn-out methods and processes. At the same time, she had driven trade to the Continent through continual struggles between labour and capital. Fortunately in the iron trade they had in their wages board an automatic arrangement for the rise and fall of wages as the price of iron rose and fell. By this means they had been for many years removed from the atmosphere of strikes. Still, here they were in great danger of suffering from the deadening influence of that form of trade unionism which maintained that a rule once made cannot be altered, whether it applied to the heats a puddler might work, whatever his furnace might be capable of, or to the schedule of the sheet mill wages which was spoken of as almost inspired, although those who framed it knew only too well that it was simply a compromise between the highest and the lowest wages paid in the different works at the time it was drawn up. What they all had to do was to recognise that their trade was not English but international, and that if they could not modify their ideas and habits as readily as the best of their competitors, whether in Europe or America, those competitors and not the English will eventually command the trade. He trusted that Institute of Managers would give earnest consideration to the following points:—(1) A more even distribution of the wage fund. (2) The adoption of the American principle of a minimum stint in rolling mills. (3) A shortening of hours rather than to a decrease in the number of hands. (4) To the inculcation of a spirit of thrift and consequent self-respect on the part of those who labour in the iron trade. If they undertook this task, he was sure the Wages Board would be only too glad to receive any suggestions that might appear to them desirable. Continuing, Mr. Punnett said he had left until the last the question of carriage, not because it was the least important, but because it affected not the iron trade only, but the whole community of the Midlands. For many years they had known how seriously this district suffered from excessive charges for the carriage of their heavy materials, coal and iron, to London and Liverpool, charges twice as great as for similar distances in Germany and Belgium. and three times as much as in the United States. Much energy was at first expended in endeavours to obtain reductions from the railway companies; but all efforts in that direction had long ceased, and there did not remain a shadow of a hope of any reduction from the railways. It was now indeed universally admitted that they must fall back upon their canals, as all other nations had been driven to do. France, Belgium, Germany, and the United States came to that conclusion long ago, and those countries were now honeycombed with splendid systems of large canals with small feeders. But although they had not as yet accomplished much in the Midlands, in that district the ground had been much cleared by the efforts of many public-spirited men. He was indebted to Sir A. Hickman, M.P., for a copy of the memorandum presented by him, as chairman of one of the committees which did splendid work, to the Wolverhampton Town Council. It was entitled, "Memorandum on the Improvement of the Canal Communication between Wolverhampton and London," and as he wished to make this matter very clear, having some proposals to offer thereon, he had taken the following facts from it. The committee estimated that the traffic between Wolverhampton and London was three times as great as between Wolverhampton and Liverpool, and seven times as great as between Wolverhampton and Bristol. They concluded, therefore, that it was most important first to enlarge the waterway to London. Another reason for undertaking this special part first was the fact that the canals between Birmingham and London were free from railway control, and were all now in the hands of the Grand Junction Canal Company. An engineer—Mr. Martin—was employed to survey and draw up estimates of cost of enlarging the existing canals, which they must please remember were still paying their way, although they had to charge a very high rate on account of the smallness of the boats they were compelled to use, so as to permit of the passage of boats or steamers of 140 tons burden. The total expenditure on this enlargement was estimated at £1,250,000, whilst the benefit to be derived therefrom was a reduction in carriage charges on iron from 12s. 6d. to 6s., and on coal from 6s. 9d. to 4s. per ton. This would be an admittedly splendid result. The scheme was put before the Town Councils of Birmingham and Wolverhampton, in the hope that conjointly they would be willing to guarantee a low rate of interest on the capital required, taking into account the enormous advantages the undertaking would be to the whole community. Unfortunately at that very time the Manchester Canal was being finished, and the municipalities appealed to declined to move in the matter. Sir Alfred, in a letter which he had sent him, and which he permitted him to quote, said, "Of course the Wolverhampton and London project is conceived on very different lines to the Manchester Ship Canal, and personally I have no doubt whatever that it could be made a commercial success, and at the same time confer enormous benefits upon South Staffordshire." It seemed to him the two schemes had no earthly relation to one another. One was an attempt to create an inland port for large ocean steamers at a point not fitted by position for the collection even of the varied goods which make large steam freights profitable. The other was the improvement of an existing system of canals for carrying natural products and the goods manufactured therefrom, and bringing back in return the requirements of an enormous population, to the greatest port in the world, which sends steamers laden with passengers and goods, collected not only from England, but from the whole of North Europe, to every region of the earth. In other words, the Manchester Canal could not succeed without drawing from many other districts profitable freights for ocean-going steamers, whilst Birmingham and Wolverhampton had all that was required to supply an abundant traffic for an enlarged canal without the creation of any new thing. Now it had been often stated that the iron trade in the Midlands should be removed to the coast, and it was therefore wise in urging even the comparatively small outlay suggested to see what good reasons there were for its remaining there permanently. In the first place, they had in South Staffordshire an abundant supply of most excellent coal for manufacturing purposes. In the second place, there were large beds of iron ore in Oxfordshire, Northamptonshire, and Lincolnshire, all within a small distance of the existing works of this district by good canals, and two of them would be served by the proposed enlarged one, and the cost would make the mouths water of many an owner of German blast furnaces. Then there were a vast number of trades dependent for their very existence on a good supply of cheap iron and steel. It was not indeed any exaggeration to say, that there were not many localities in Germany as well placed for the manufacture of iron, in most of its branches, as the neighbourhood of the coalfield of South Staffordshire. The point therefore remained, how could they set about this most necessary and great undertaking? The Municipal Councils in the area had declined to find the guarantee, and were not likely to do much for the carrying out of the work, although there were many members in each council whose assistance could be safely depended upon. Putting aside the Municipal, they had next the County and District Councils, which from their very constitution were much more likely to appreciate the grave necessity for this relief to the hard-pressed Midlands. He ventured to suggest that a complete scheme be prepared again and put before every Council likely to be affected both in the immediate neighbourhood and all along the route to London. Then every colliery proprietor and ironworks owner should be invited to bring the scheme before their associations, and lastly wages boards and trade unions should be asked to co-operate. If by such means as these the whole population were convinced that the work had to be done, and were, above all, willing to make sacrifices for that purpose, the congested money bags of the wealthy would be readily opened. Canals were not a popular investment with the public. They were, as a stockbroker once said to him, "too slow," and, as he added, the average investor prefers a gold mine, not requiring any proofs as to the existence even of gold in it. They must, therefore, look to their own initiatory efforts to be prepared to make sacrifices in the present that they might assure the future. To those good men and true who had already done much of the work, he would tell the following story, and he hoped they would forgive him its somewhat personal character. Many years ago when technical education and technical instruction were much sneered at, he was a member of the Council of the Birmingham Midland Institute and desirous of establishing classes for technical instruction. The opposition he met with somewhat disheartened him, when he fortunately met the late Dr. R. W. Dale, who said to him, "I am sorry to hear you are giving up that idea of yours. Let me give you my experience of the patience and time required to carry out even the simplest reforms. Many years ago I desired some alterations in the arrangements at Carr's-lane Chapel, but my ideas were not acceptable, and I had to wait. Well, not very long since those original proposals of mine were carried out—just ten years after I first made them."

The discussion upon the foregoing papers was opened by Mr. A. W. Hickman, eldest son of Sir Alfred Hickman, of the South Staffordshire Steel and Ingot Iron Company, and of the Spring Vale Furnaces, who briefly observed that he thought Mr. Punnett's suggestions with regard to the enlargement of the canals to London was well worth consideration, and he hoped they would all do their best to carry out the scheme.

Mr. Moses Millard—Isaac Jenks and Sons, Minerva Iron and Steel Works, Wolverhampton—said in his opinion Mr. Punnett was wrong in his figures respecting the wages in Germany and Belgium as compared with England, for he thought it would be found that the sheet mill wages in those two countries were as high, if not higher, than the wages paid for the like work here. It appeared to him desirable that we should look at our trade as international. He was afraid, however, that the discussion of that evening would all end in smoke, inasmuch as, in the majority of cases, the masters were satisfied with the present conditions of manufacture, and did not show a desire to move forward as their foreign competitors had. Sheets were rolled in Germany and Belgium from very thin bars. If they were rolled from thick bars, such as $1\frac{1}{8}$in. or $1\frac{1}{16}$in., like the English use, then the concussion would be so great, with the rolls running at so high a speed, that serious breakages to the machinery would occur. As to the military bearing of the workmen, he admitted that we ought in England to have a little more discipline than we got, but he hoped the time was a long way off before we should see the same sort of discipline as they had in Belgium and Germany, for he looked upon that as being just one remove from serfdom. He hoped Mr. Punnett was right when he declared that there was a good feeling existing between the masters and men on the Continent. He hoped the men really were perfectly satisfied with their position, but his own opinion was that there was a good deal of unrest among the working class in Germany. In fact, it was a seething mass of unrest and ferment, which would just now break out into open rebellion, and then the much-vaunted military system would be displayed to disadvantage. He was sorry to say the men's unions were very much averse to any changes that seemed to go against them, even though they were for the good of the trade generally. For ten or twelve years that Institute had been constantly advocating various improvements both in machinery and methods, and also in water carriage, but the manufacturers do not seem inclined to take up the matter, and therefore things practically remain where they were. A certain employer said to him not very many years ago when improvements dealing with machinery had been suggested, "Yes, that's all very well, Millard, it might effect a saving, but the machinery in its present condition will serve my time." He, Mr. Millard, was afraid that was the opinion of most of the masters in the English iron trade at the present time.

Mr. J. W. Hall, Lloyds' Steel Foundry Company, James Bridge, commenting upon the remarks of previous speakers, contended that masters were tired of laying down improved machinery, and then finding that because prices kept falling they were no better off. He recollected the time when a certain steel works was inaugurated, as he had a little to do with making some of the plant. Steel rails then were £22 a ton; he happened a little later on to see some of the rails rolled at £19 10s.; and the last rails were rolled at £4 10s. The works were stopped, and it was reported that the proprietors had lost half a million of money over them, though whether that was correct he could not say. Both masters and men could not help but recognise how greatly conditions had altered in recent years. Formerly our foreign competitors were handicapped in various ways. Take, for instance, the steel trade of Germany. At that time there was no basic process. All the ores for the steel process as then carried on had to be obtained in Cumberland, where our English works were situated, or from Spain, whence they could be brought cheaply into South Wales and the East Coast, and not at great expense into Sheffield itself. But that was all altered now. Phosphoric ores could now be used. The Germans were adopting the very best mills they could put down, and that they should be able to give us "a shaking up" was only to be expected. At present Germany was actually buying ores, and paying per unit upon the percentage of phosphorus, actually paying more for the phosphorus in order to get sufficient heat, which heat was formerly supplied by the silicon in the hematite process. In Belgium also they had splendid pig iron, and could produce steel at a price we could not touch. It seemed to be universally agreed that there was no possibility of our railway companies further reducing their rates to any material extent, for English lines were much more difficult both to make and maintain than continental ones. There was more tunnelling and embanking to be done in England, on account of the geographical nature of the country, and land was also dearer here. He thought we should have to rely on cheap water communication, and hoped the Midlands to London canal scheme referred to by the author would be again taken in hand. London was decidedly the best port to make for.

Mr. Le Neve Foster, Mr. George Wright, and Mr. Yeomans also contributed to the discussion, corroborating the author's opinions.

Mr. Chambers, of Messrs. Hill and Smith, galvanised iron manufacturers, Brierley Hill, also took part in the discussion, and went into various points, arguing that English masters would not feel foreign competition so severely if they would but spend capital in improving their plant.

The Chairman said that scarcely a word of praise had been meted out to the delegation for the work they had done. He had read the report, and the first thing that struck him was that the delegation did so much in so short a time. He found that there was a great deal in the report which specially commended itself to the British workman, more to the British works manager, and still more to the masters of this country. They had, it appeared to him, to dissociate from their minds entirely the old idea that the continental workmen worked for very low wages, lived in hovels, and had no home comforts. If they believed the report, they must come to the conclusion that most of their competitive workmen were well paid, not in wages, but in equivalents. They were also well housed and well educated, and they might depend upon it that it was owing a great deal to their education that they had the discipline which was made so much of in the report, and which was a very important factor in works. In this country they had no desire to see their workmen converted into automatons, but it was desirable that they should conform to the rules of the works better than they had done. Discipline was a thing almost unknown in the majority of their works.

The proceedings terminated with a vote of thanks to Mr. Punnett.

A PIECE-RATE SYSTEM.*

THE following is considered to be a step toward partial solution of the labour problem, by Fred. W. Taylor, Germantown, Philadelphia, Pa., member of the Society.

INTRODUCTION.

The ordinary piece-work system involves a permanent antagonism between employers and men, and a certainty of punishment for each workman who reaches a high rate of efficiency. The demoralising effect of this system is most serious. Under it, even the best workmen are forced continually to act the part of hypocrites, to hold their own in the struggle against the encroachments of their employers. The system introduced by the writer, however, is directly the opposite, both in theory and in its results. It makes each workman's interests the same as that of the employer, pays a premium for high efficiency, and soon convinces each man that it is for his permanent advantage to turn out each day the best quality and maximum quantity of work. The writer has endeavoured in the following pages to describe the system of management introduced by him in the works of the Midvale Steel Company, of Philadelphia, which has been employed by them during the past ten years with the most satisfactory results. The system consists of three principal elements:—(1) An elementary rate-fixing department. (2) The differential rate system of piece-work. (3) What he believes to be the best method of managing men who work by the day.

Elementary rate-fixing differs from other methods of making piece-work prices in that a careful study is made of the time required to do each of the many elementary operations into which the manufacturing of an establishment may be analysed or divided. These elementary operations are then classified, recorded, and indexed, and when a piece-work price is wanted for work, the job is first divided into its elementary operations, the time required to do each elementary operation is found from the records, and the total time for the job is summed up from these data. While this method seems complicated at the first glance, it is, in fact, far simpler and more effective than the old method of recording the time required to do whole jobs of work, and then, after looking over the records of similar jobs, guessing at the time required for any new piece of work. The differential rate system of piece-work consists briefly in offering two different rates for the same job; a high price per piece, in case the work is finished in the shortest possible time and in perfect condition, and a low price, if it takes a longer time to do the job, or if there are any imperfections in the work. The high rate should be such that the workman can earn more per day than is usually paid in similar establishments. This is directly the opposite of the ordinary plan of piece-work, in which the wages of the workman are reduced when they increase their productivity.

The system by which the writer proposes managing the men who are on day-work consists in paying men and not positions. Each man's wages, as far as possible, are fixed according to the skill and energy with which he performs his work, and not according to the position which he fills. Every endeavour is made to stimulate each man's personal ambition. This involves keeping systematic and careful records of the performance of each man, as to his punctuality, attendance, integrity, rapidity, skill, and accuracy, and a readjustment from time to time of the wages paid him, in accordance with this record. The advantages of this system of management are:—First: that the manufactures are produced cheaper under it, while at the same time the workmen earn higher wages than are usually paid. Second: since the rate-fixing is done from accurate knowledge instead of more or less by guess-work, the motive for holding back on work, or "soldiering," and endeavouring to deceive the employers as to the time required to do work, is entirely removed, and with it the greatest cause for hard feeling and war between the management and the men. Third: since the basis from which piece-work, as well as day-rates, are fixed is that of exact observation, instead of being founded upon accident or deception, as is too frequently the case under ordinary systems, the men are treated with greater uniformity and justice, and respond by doing more and better work. Fourth: it is for the common interest of both the management and the men to co-operate in every way, so as to turn out each day the maximum quantity and best quality of work. Fifth: The system is rapid, while other systems are slow, in attaining the maximum productivity of each machine and man; and when this maximum is once reached, it is automatically maintained by the differential rate. Sixth: it automatically selects and attracts the best men for each class of work, and it developes many first-class men who would otherwise remain slow or inaccurate, while at the same time it discourages and shifts out men who are incurably lazy or inferior. Finally: one of the chief advantages derived from the above effects of the system is, that it promotes a most friendly feeling between the men and their employers, and so renders labour unions and strikes unnecessary.

There has never been a strike under the differential rate system of piece-work, although it has been in operation for the past ten years in the steel business, which has been during this period more subject to strikes and labour troubles than almost any other industry. In describing the above system of management, the writer has been obliged to refer to other piece-work methods, and to indicate briefly what he believes to be their shortcomings.

(1) Capital demands fully twice the return for money placed in manufacturing enterprises that it does for real estate or transportation ventures. And this probably represents the difference in the risk between these classes of investments.

(2) Among the risks of a manufacturing business, by far the greatest is that of bad management; and of the three managing departments, the commercial, the financiering, and the productive, the latter, in most cases, receives the least attention from those that have invested their money in the business, and contains the greatest elements of risk. This risk arises not so much from the evident mismanagement, which plainly discloses itself through occasional strikes and similar troubles, as from the daily more insidious and fatal failure on the part of the superintendents to secure anything even approaching the maximum work from their men and machines.

(3) It is not unusual for the manager of a manufacturing business to go most minutely into every detail of the buying and selling and financiering, and arrange every element of these branches in the most systematic manner, and according to principles that have been carefully planned to ensure the business against almost any contingency which may arise, while the manufacturing is turned over to a superintendent or foreman, with little or no restrictions as to the principles and methods which he is to pursue, either in the management of his men or the care of the company's plant.

(4) Such managers belong distinctly to the old school of manufacturers; and among them are to be found, in spite of their lack of system, many of the best and most successful men of the country. They believe in men, not in methods, in the management of their shops; and what they would call system in the office and sales departments, would be called red tape by them in the factory. Through their keen insight and knowledge of character they are able to select and train good superintendents, who in turn secure good workmen; and frequently the business prospers under this system—or rather, lack of system—for a term of years.

(5) The modern manufacturer, however, seeks not only to secure the best superintendents and workmen, but to surround each department of his manufacture with the most carefully woven network of system and method, which should render the business, for a considerable period, at least, independent of the loss of any one man, and frequently of any combination of men.

(6) It is the lack of this system and method which, in the judgment of the writer, constitutes the greatest risk in manufacturing; placing, as it frequently does, the success of the business at the hazard of the health or whims of a few employés.

(7) Even after fully realising the importance of adopting the best possible system and methods of management for securing a proper return from employés and as an insurance against strikes and the carelessness and laziness of men, there are difficulties in the problem of selecting methods of management which shall be adequate to the purpose, and yet be free from red tape, and inexpensive.

(8) The literature on the subject is meagre, especially that which comes from men of practical experience and observation. And the problem is usually solved, after but little investigation, by the adoption of the system with which the managers are most familiar, or by taking a system which has worked well in similar lines of manufacture.

(9) Now, among the methods of management in common use there is certainly a great choice; and before describing the "differential rate" system it is desirable to briefly consider the more important of the other methods.

(10) The simplest of all systems is the "day-work" plan, in which the employés are divided into certain classes, and a standard rate of wages is paid to each class of men; the labourers all receiving one rate of pay, the machinists all another rate, and the engineers all another, &c. The men are paid according to the position which they fill, and not according to their individual character, energy, skill, and reliability.

(11) The effect of this system is distinctly demoralising and levelling; even the ambitious men soon conclude that since there is no profit to them in working hard, the best thing for them to do is to work just as little as they can and still keep their position. And under these conditions the invariable tendency is to drag them all down even below the level of the medium.

(12) The proper and legitimate answer to this herding of men together into classes, regardless of personal character and performance, is the formation of the labour union, and the strike,

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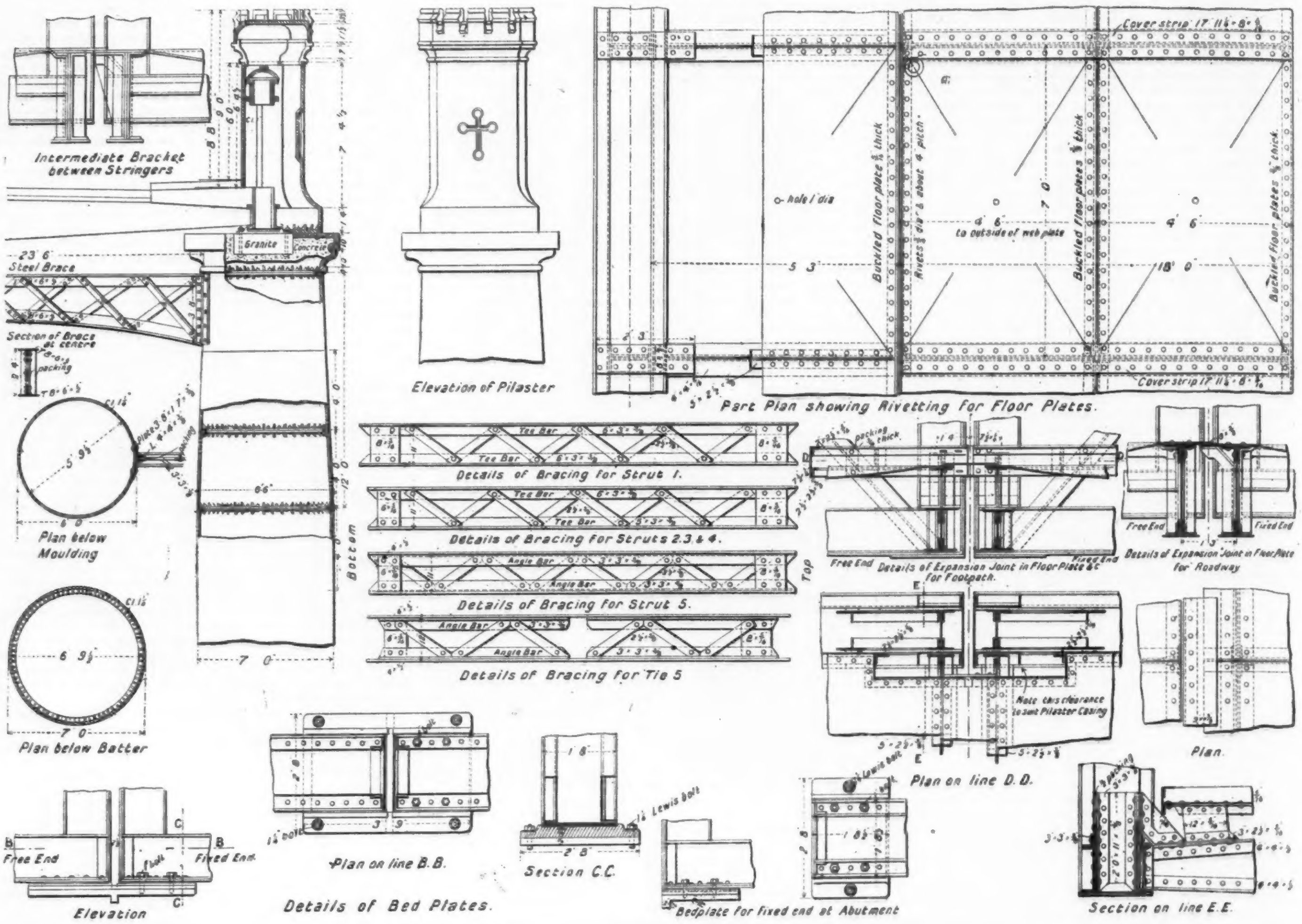
* Presented at the Detroit meeting of the American Society of Mechanical Engineers.

THE WATERLOO BRIDGE AT INVERNESS

MR. J. A. MACKENZIE INVERNESS ENGINEER

(*For description see page 367*)


Intermediate Bracket between Stringers
Granite
Concrete
23' 6"
Steel Brace
Section of Brace at centre
Plan below Moulding
5' 9½"
6' 0"
Plan below Batter
6' 9½"
7' 0"
Bottom
Top
Elevation of Pilaster
Part Plan showing Rivetting for Floor Plates
Cover strip 17' 11½ · 6 · ⅜
hole 1 dia
5' 3"
Buckled Floor plates ⅜ thick
4' 6" to outside of web plate
7' 0"
18' 0"
4' 6"
Details of Bracing for Strut 1
Tee Bar
Details of Bracing for Struts 2.3 & 4
Angle Bar
Details of Bracing for Strut 5
Details of Bracing for Tie 5
Free End
Fixed End
Details of Expansion Joint in Floor Plate &c for Footpath
Details of Expansion Joint in Floor Plate for Roadway
Note this clearance to suit Pilaster Casing
Plan on line D.D.
Plan
Elevation
Plan on line B.B.
Section C.C.
2' 8"
Lewis bolt
Details of Bed Plates.
Bedplate for fixed end at Abutment
Section on line E.E.

either to increase the rate of pay and improve conditions of employment, or to resist the lowering of wages and other encroachments on the part of employers.

(13) The necessity for the labour union, however, disappears when men are paid, and not positions; that is, when the employers take pains to study the character and performance of each of their employés and pay them accordingly, when accurate records are kept of each man's attendance, punctuality, the amount and quality of work done by him, and his attitude towards his employers and fellow-workmen. As soon as the men recognise that they have free scope for the exercise of their proper ambition, that as they work harder and better their wages are from time to time increased, and that they are given a better class of work to do—when they recognise this, the best of them have no use for the labour union.

(14) Every manufacturer must from necessity employ a certain amount of day labour which cannot come under the piece-work system; and yet how few employers are willing to go to the trouble and expense of the slight organisation necessary to handle their men in this way! How few of them realise that, by the employment of an extra clerk and foreman, and a simple system of labour returns, to record the performance and readjust the wages of their men, so as to stimulate their personal ambition, the output of a gang of twenty or thirty men can be readily doubled in many cases, and at a comparatively slight increase of wages per capita!

(15) The clerk in the factory is the particular horror of the old-style manufacturer. He realises the expense each time that he looks at him, and fails to see any adequate return; yet by the plan here described the clerk becomes one of the most valuable agents of the company.

(16) If the plan of grading labour and recording each man's performance is so much superior to the old day-work method of handling men, why is it not all that is required? Because no foreman can watch and study all of his men all of the time, and because any system of laying out and apportioning work, and of returns and records, which is sufficiently elaborate to keep proper account of the performance of each workman, is more complicated than piece-work. It is evident that that system is the best which, in attaining the desired result, presents in the long run the course of least resistance.

(17) The inherent and most serious defect of even the best managed day-work lies in the fact that there is nothing about the system that is self-sustaining. When once the men are working at a rapid pace, there is nothing but the constant unremitting watchfulness and energy of the management to keep them there; while with every form of piece-work each new rate that is fixed ensures a given speed for another section of work, and to that extent relieves the foreman from worry.

(18) From the best type of day-work to ordinary piece-work the step is a short one. With good day-work the various operations of manufacturing should have been divided into small sections or jobs, in order to properly gauge the efficiency of the men; and the quickest time should have been recorded in which each operation has been performed. The change from paying by the hour to paying by the job is then readily accomplished.

(19) The theory upon which the ordinary system of piece-work operates to the benefit of the manufacturer is exceedingly simple. Each workman, with a definite price for each job before him, contrives a way of doing it in a shorter time, either by working harder or by improving his method; and he thus makes a larger profit. After the job has been repeated a number of times at the more rapid rate, the manufacturer thinks that he should also begin to share in the gain, and therefore reduces the price of the job to a figure at which the workman, although working harder, earns, perhaps, but little more than he originally did when on day-work.

(20) The actual working of the system, however, is far different. Even the most stupid man, after receiving two or three piece-work "cuts" as a reward for his having worked harder, resents this treatment and seeks a remedy for it in the future. Thus begins a war, generally an amicable war, but none the less a war, between the workmen and the management. The latter endeavours by every means to induce the workmen to increase the output, and the men gauge the rapidity with which they work, so as never to earn over a certain rate of wages, knowing that if they exceed this amount the piece-work price will surely be cut, sooner or later.

(21) But the war is by no means restricted to piece-work. Every intelligent workman realises the importance, to his own interest, of starting in on each new job as slowly as possible. There are few foremen or superintendents who have anything but a general idea as to how long it should take to do a piece of work that is new to them. Therefore, before fixing a piece-work price, they prefer to have the job done for the first time by the day. They watch the progress of the work as closely as their other duties will permit, and make up their minds how quickly it can be done. It becomes the workman's interest then to go just as slowly as possible, and still convince his foreman that he is working well.

(22) The extent to which, even in our largest and best-managed establishments, this plan of holding back on the work—"marking time," or "soldiering," as it is called—is carried on by the men, can scarcely be understood by one who has not worked among them. It is by no means uncommon for men to work at the rate of one-third, or even one-quarter, their maximum speed, and still preserve the appearance of working hard. And when a rate has once been fixed on such a false basis, it is easy for the men to nurse successfully "a soft snap" of this sort through a term of years, earning in the meanwhile just as much wages as they think they can without having the rate cut.

(23) Thus arises a system of hypocrisy and deceit on the part of the men which is thoroughly demoralising, and which has led many workmen to regard their employers as their natural enemies, to be opposed in whatever they want, believing that whatever is for the interest of the management must necessarily be to their detriment.

(24) The effect of this system of piece-work on the character of the men is in many cases so serious as to make it doubtful whether, on the whole, well-managed day-work is not preferable.

(25) There are several modifications of the ordinary method of piece-work which tend to lessen the evils of the system, but I know of none that can eradicate the fundamental causes for war, and enable the managers and the men to heartily co-operate in obtaining the maximum product from the establishment. It is the writer's opinion, however, that the differential rate system of piece-work, which will be described later, in most cases entirely harmonises the interests of both parties.

(26) One method of temporarily relieving the strain between workmen and employers consists in reducing the price paid for work, and at the same time guaranteeing the men against further reduction for a definite period. If this period be made sufficiently long the men are tempted to let themselves out and earn as much money as they can, thus "spoiling" their own job by another "cut" in rates when the period has expired.

(27) Perhaps the most successful modification of the ordinary system of piece-work is the "gain-sharing plan." This was invented by Mr. Henry R. Towne, in 1886, and has since been extensively and successfully applied by him in the Yale and Towne Manufacturing Company, at Stamford, Conn. It was admirably described in a paper which he read before this society in 1888. This system of paying men is, however, subject to the serious, and I think fatal, defect that it does not recognise the personal merit of each workman; the tendency being rather to herd men together and promote trades unionism, than to develope each man's individuality.

(*To be continued.*)

IRON AND STEEL INSTITUTE.

THE annual meeting will be held at the Institution of Civil Engineers, Great George-street, Westminster, on Thursday and Friday, May 7th and 8th, 1896, commencing each day at 10.30 a.m. The following programme of arrangements has just been issued:—

Thursday, May 7th.—9.30 a.m., meeting of Council at 25, Great George-street. 10.30 a.m., general meeting of members. The Council will present their report for the year 1895. The hon. treasurer, Mr. William Whitwell, will present the statement of account for 1895. Scrutineers will be appointed for the examination of the voting papers. The Bessemer Gold Medal for 1896 will be presented to Dr. Hermann Wedding, of Berlin. A selection of papers will be read and discussed. Seven p.m., annual dinner of the Institute, at the Freemasons' Tavern. Tickets, 10s. 6d. each, not including wine. Members may purchase tickets for friends.

Friday, May 8th.—10.30 a.m., general meeting of members at the Institution of Civil Engineers. A selection of papers will be read and discussed.

The following is a list of the papers that are expected to be read and discussed:—(1) "On the Rate of Diffusion of Carbon in Iron," by Professor W. C. Roberts-Austen, C.B., F.R.S., Member of Council.

(2) "On some Alloys with Iron Carbides," by J. S. de Benneville, Philadelphia.

(3) "On Mond Gas, as applied to Steelmaking," by John H. Darby, Brymbo.

(4) "On Hot-Blast Stoves," by B. J. Hall, Westminster.

(5) "On the Hardening of Steel," by H. M. Howe, Boston. Adjourned discussion.

(6) "On the Introduction of Standard Methods of Analysis," by the Baron Hanns Jüptner von Jonstorff, Neuberg, Austria.

(7) "On the Production of Metallic Bars of any Section by Extrusion," by Perry F. Nursey, London.

(8) "On Mr. Howe's Researches on the Hardening of Steel," by F. Osmond, Paris.

(9) "On the Treatment of Magnetic Iron Sand," by E. Metcalf Smith, New Zealand.

(10) "On the Making of the Iron Ores of Oxfordshire," b E. A. Walford, F.G.S., Banbury.

TRADE AND BUSINESS APPOINTMENTS.—For the convenience of their Lancashire and North of England customers, Messrs. Merryweather & Sons, London, have just opened a branch establishment at 39 & 40, Arcade Chambers, St. Mary's-gate, Manchester.—Messrs. G. Waller and Co. notify removal of their offices to 165, Queen Victoria-street, E.C.—Messrs. Rose, Downs, and Thompson, Limited, have opened offices at Dunster House, Mark-lane, London, E.C. Mr. Charles White, who has been with the firm in Hull for the last seven years, will represent them permanently in London.—Messrs. H. and S. Barker and Co., Mexborough, Rotherham, announce that they have appointed Mr. A. W. Harvey, of 110, Cannon-street, E.C., to be their sole London agent for the sale of their railway wheels, axles, buffers, and springs.—Messrs. Fleming and Ferguson, Limited, shipbuilders and engineers, Paisley, have received an order from the Queensland Government to build a powerful pump and bucket hopper dredger, and have also contracted with the Cork Harbour Commissioners to build a self-propelling side-ladder bucket dredger.

RAILWAY MATTERS.

WE regret to announce the death of Mr. John Jones, Secretary of the Taff Vale Railway for thirty years. He was long associated with Mr. Geo. Fisher, O. Fisher, J. Hurman, and Mr. Brewer, the leading minds of the Taff Vale Railway under the old *régime*.

A GANG of platelayers were at work about five o'clock on Tuesday evening in Sapperton Tunnel, on the Great Western Railway, four miles east of Stroud, when, in getting out of the way of a down train, they failed to notice the approach of an up train. The latter dashed into their midst, killing two on the spot and injuring another so terribly that he died on the way to the hospital.

IN the enumeration of train accidents in the report of the accidents on our lines last year it is shown that 26 consisted of collisions between passenger trains or portions of such. There were 46 collisions between passenger trains and goods or mineral trains, and 49 instances in which passenger trains or some of the vehicles left the rails. There were only 12 cases in which goods trains or parts of them were derailed. Thirty-nine trains ran through gates at level crossings, and 148 ran over cattle or other obstructions on the line. There were 188 failures of axles, 314 broken rails, and 454 failures of tires. Only three of the rails which broke were made of iron, the remainder being of steel. It is stated that the failures of rails and tires caused no personal injury; but this seems to ignore the fatal result of the broken rails at St. Neots in November last.

AT the annual general meeting of the northern section of the Société de l'Industrie Minerale, held at Douai, M. Baily gave an account of the progress achieved in underground haulage by electricity at the Marles Colliery, in No. 4 pit, of which the first experiment in underground haulage by electric locomotives was made in 1890. At first nothing but difficulty was encountered, but in 1891 everything worked satisfactorily, and after three years' practical experience it was decided to apply the system on a much larger scale to No. 5 pit. A 500-horse compound steam engine will drive four 80,000-watt dynamos, making 350 revolutions per minute, for actuating eleven locomotives in Nos. 3 and 5 pits. In the roads are laid rolled joists, weighing 8·75 kilos. per metre; and each locomotive, weighing 3·2 tons, is actuated by a Gramme-wound dynamo making 10,000 revolutions per minute, receiving the electric current at 500 volts, and giving out a useful work of fifteen horses. Each locomotive draws a set of thirty tubs, each holding half a ton of coal, and moving at a mean speed of 14 kiloms.—8½ miles—per hour.

THE first Government railway in Western Australia, from Geraldton to Northampton, was opened on the 26th July, 1879, but the progress of construction was slow, and on the 31st December, 1890, only 183 miles of Government railways were open for traffic; since then, however, great strides have been made—due almost entirely to the goldfields. On the 30th June, 1895, 573 miles were worked, and 382 miles either under construction or about to be constructed; in addition to this there are also 572 miles of private railways. The first railway line in South Australia—Goolwa to Port Elliot—was opened on 18th March, 1854; and the first line in Queensland on 31st July, 1865, from Ipswich to Grandchester. In Victoria the railways are under State control, although they were initiated by private enterprise. By March, 1853, three companies had been incorporated and secured extraordinary concessions in the shape of land and guaranteed interest. The Melbourne and Murray River Company was forced to sell to the Government in 1855, before any of their lines had been opened for traffic. The Geelong-Melbourne Company followed the same course in 1860, and only the Hobson's Bay Railway Company held its own for some years, but in 1878 sold its interests to the Government for the sum of £1,320,800.

THE annual report of the Japanese Imperial Railway Department for the year ending March, 1894, recently published, shows great progress made in less than a quarter of a century. The first railway constructed in Japan was the short line, eighteen miles long, between Tokyo and Yokohama, which was begun April, 1870, and completed September, 1872. At the date of the report there were 558 miles of Government railways and 138 miles of private railways in operation. For some years past the Government has practically ceased constructing railways, and during the year dealt with in the report only seven miles of special construction were added, while sixty-one miles of new private lines were opened during the same time. There were on March 31st, 1894, 995 miles of railway either under construction or for which surveys had been made and charters granted, a considerable part of which has since been completed. There were thirty-four applications during the year for permission to form companies for the construction and working of railways. Besides these, applications for extensions of existing lines were made by eleven railway companies. The whole of these forty-five projects come under application for provisional charters. The number of railway charters granted during the year amounted to eleven, and of provisional charters to five.

THE returns of accidents and casualties reported to the Board of Trade as having occurred upon the railways in the United Kingdom during the twelve months ended December 31st, 1895, show that in the lists of both killed and wounded there is a decrease since the record of last year. The total number of killed was 1024, a decrease of 91, and of injured 4021, a decrease of 99 on the year 1894. The numbers are classified as follows:—Passengers killed from accidents to trains, rolling stock, permanent way, &c., 5; injured, 399; by accidents from other causes—killed, 78; injured, 710. In 1894, 117 passengers were killed, and 1168 injured. These figures show a decrease of 34 passengers killed, and a decrease of 59 injured, on the preceding year. Turning to servants of railways or contractors, we find that 12 were killed, and 88 injured by accidents to trains, rolling stock, permanent way, &c., and 430 killed, and 2566 injured by accidents from other causes. Of persons passing over railways at level crossings, 65 were killed, and 33 injured; trespassers, including suicides, 381 killed, and 144 injured; other persons not included in the above classification, 53 killed, and 81 injured. If all the accidents occurring on railway premises, in addition to those caused by the movement of railway vehicles, be reckoned, it will be found that the total number of personal accidents reported to the Board of Trade during the year amounted to 1090 persons killed, and 9318 injured.

THE railways in the colonies of Victoria and Queensland belong exclusively to the State; in New South Wales there are 84 miles of private line, besides about 200 miles of "coal lines," owned by various collieries; in South Australia 16½ miles; and Western Australia possesses 572 miles of private lines. In New South Wales the first railways were projected as far back as 1846, and a few years afterwards a company—the Sydney Tram and Railway Company—was formed. The company undertook the construction of a line from Sydney to Parramatta, a distance of 14 miles, but as the capital became absorbed before the work was completed, the company was unable to carry on operations, and in the end the Government had to take over the line, which was finished on September 26th, 1855. A company also contemplated constructing a line from Newcastle to Maitland, but was unable to surmount the preliminary difficulties. There are in New South Wales two important public lines constructed and maintained by private companies:—(1) The railway between Deniliquin, in Riverina, and Moama, on the Murray, 45 miles in length. (2) The private line between Broken Hill and Cockburn, on the South Australian border—35 miles—connects with the South Australian lines, and is, owing to the large traffic done with the Broken Hill mines, a great financial success. In the Newcastle and Illawarra districts there are about 200 miles of private lines almost entirely used for the coal traffic.

NOTES AND MEMORANDA.

THE quantity of tallow produced in New South Wales during 1894 was 1,066,100 cwt., of which 847,236 cwt. were exported.

THE value of the gold converted into coin at the Sydney Mint during the period 1855—1894 was £76,072,000, of which £3,067,000 was coined in 1894.

THERE are in New South Wales eighty-three flour-mills, employing 696 hands, with an annual output of over 118,000 tons of flour or about 1400 tons on an average per mill.

IN 1840 there were 736 flour mills in Pennsylvania, with an annual capacity of 1,193,405 barrels. There were also 2554 grist mills. The capacity of the comparatively few mills reported by members of the Pennsylvania Millers' State Association at the present time is nearly 8,000,000 barrels a year.

MAGNESIUM paper, used for producing the magnesium light, is made in the following manner:—Powdered magnesium is placed between two sheets of impermeable paper which have been covered with starch paste, and they then adhere together. After drying, a sheet covered with potassium chlorate is pasted on each side, so that the powdered magnesium contained between the first sheets has a layer of potassium chlorate on each side. A further sheet pasted on serves as covering, and the whole, which forms a thick sheet, can be cut into strips. On lighting the end of a strip, the white dazzling magnesium light is obtained. According to the *Journal* of the Society of Chemical Industry, this paper is said to to be free from danger, and to keep well.

PROF. KAMERLINGH ONNES, starting from his theorem that Van der Waals's corresponding states are dynamically similar, inferred in a recent communication to the Amsterdam Academy of Sciences, that the cooling of the gas in Thomson and Joule's porous plug will, according to their experiments with hydrogen, 1862, become zero and turn into heating, with all gases, at sufficiently high temperatures. The author extended the theorem to thermo-dynamical similarity, and thus supplied the means to find the dimensions of an apparatus to liquefy hydrogen, if there is given one liquefying oxygen in a satisfactory manner. Linde's and Hampson's methods were considered from this point of view. The author also commented on his endeavours to get a small self-cooling motor, liquefying oxygen, to be used as a model for apparatus to liquefy hydrogen by doing work adiabatically after the manner of Solvay, and intended to form part of a series of theoretically perfect cooling apparatus. Finally the author pointed out the great importance of vacuum-jackets for low temperature work.

THE action of sulphuric acid in refining petroleum is very complicated, and its clarifying effect on the oil is influenced by the duration of exposure as well as by the strength of the acid. The deeper colour of oil that has been too long in contact with the acid would appear to be due, in part at least, to the decomposition of the acid tar at first formed and the re-solution of some of its asphaltic constituents by the oil. For this reason the practice prevailing in Baku, of using sludge acid over again in the process of preliminary acidification, is not recommended, since in its diluted condition this acid cannot possess such solvent properties as fresh acid. The other novel practice in Baku, of running into the acid agitator just before the end of the process about 1 per cent. of 30 deg. B. soda-lye and mixing the whole up for ten or fifteen minutes, causes, it is true, a rapid deposit of the sludge in the oil, but in some cases brings it down in big hard lumps difficult of removal from the agitator; it is, therefore, says the *Journal* of the Society of Chemical Industry, unavailable for Galician, Hungarian, and Roumanian oils.

AT a recent meeting of the Amsterdam Academy of Sciences Mr. D. van Gulik made a communication concerning an investigation made, under the direction of Prof. Haga, at Groningen, into the cause of the variation of resistance in microphonic contacts brought about by electric vibrations. In investigating the cause of the diminution of resistance through electric vibrations generated in bad microphonic contacts, it has been ascertained that the ends of a current-chain, when brought very close together, attract each other if the wires are exposed to Hertz's waves. The arrangements being made with proper care, the movable ends were seen under a microscope to touch each other as soon as electric vibrations were generated near them. The original air-gap must not be larger than four microns, and a contact arisen in this way offered a resistance of $\frac{1}{2}\,\Omega$ to the current. The removal of the element from the chain had no influence upon the phenomenon. When the air-gap was a few microns too large, then small sparks resulted on the wires being acted upon by the above-mentioned waves.

AMONGST the experiments on Röntgen x rays made during the past month by Italian physicists, several contributions may be cited which either tend to confirm the results established by other workers, or to establish new results. Signor A. Roiti describes (*Atti R. Acad. Lincei*) a series of experiments now in progress bearing on the question as to where these rays emanate. The principal conclusions arrived at are:—(1) That fluorescence does not necessarily accompany the emission of x rays; (2) that the rays are only emitted when kathodic rays impinge on certain substances, notably glass, aluminium, mica, platinum, and porcelain. Signor Roiti establishes some interesting results relating to the leakage of electricity which takes place when x rays fall on a charged body. When the body in question is placed in a vessel from which air is exhausted, this leakage effect is found to diminish rapidly after the pressure falls below a certain limit, showing, *Nature* says, that the leakage effect depends on the presence of molecules, by which electricity is conducted from the charged body to the containing vessel.

THE United States Consul in Liége describes, in a recent report, the manufacture of, and trade in, damascus gun barrels, wholly hand-made, in the valley of the Vesdre, in Liége province. These barrels are for sporting guns, and the industry is many years old, the workmen in the villages in the valley being almost all gun-barrel makers, and the trade descending from father to son. The best barrels are a combination of the best primary substances, welded and forged by the *martelage à froid* process; the steel comes from Westphalia, the iron is manufactured at Couvin, in Belgium, the coal, which is specially suited for the work, from the Hervé highlands in Belgium, while the motive power of the factories is obtained from the river Vesdre. Medium quality barrels are made of coke, iron, and steel, while the superior quality, which are produced in the Vesdre valley, are made of charcoal, iron and steel. An ingenious "marriage" of these metals gives a composition which, when manufactured, guarantees the required solidity and resistance. The improvement in these damascus barrels dates from the introduction of percussion caps in place of the old flint lock. Formerly iron barrels alone were produced; now, to manufacture the curled damascus, the ingot is composed of thirty sheets of iron and steel, each having a thickness of four millimetres, which are enveloped in a sheet-iron box, placed in an oven, and welded together at the lowest possible temperature. Each barrel receives 150 welding beats while being forged, and if a single one of these is unsuccessful, the barrel may be a failure, either by alteration of the damascened work, or an imperfection in the welding. The annual production of damascus barrels in the Vesdre valley is about 300,000 pairs, of the value of about three and a-half million francs. Of this the wages alone amount to about two million francs. The principal markets are Great Britain and the United States. About half the barrels made in the Vesdre valley are sold to manufacturers of arms in Liége to be mounted.

MISCELLANEA.

THE Lord President of the Council has appointed Professor J. Perry, D.Sc., F.R.S., to the vacant chair of Mechanics and Mathematics at the Royal College of Science, South Kensington.

THE Bombay Corporation has rejected a motion in favour of the purchase of one or two horseless carriages by way of trial, on the ground that the invention had not yet passed through the experimental stage.

AT a meeting of the Court of the Coach and Coach-harness Makers' Company, held in London, on the 9th inst., under the presidency of the Lord Mayor, who is Master of the Company, the honorary freedom of the ancient company was presented to Mr. John Philipson, jun., of the firm of Atkinson and Philipson, carriage and harness manufacturers, Newcastle, in recognition of his work during the past twelve years in the promotion of technical education.

A WELSH contemporary has published an original letter from the late William Crawshay, the "Iron King," sent to the *Times* some fifty years ago when the Bank of England held possession of Cwmavon Works on account of a large overdraft. The Bank, by one of its agents, carried on the works for several years, and Mr. Crawshay's indignation was great because the Bank undersold him in iron bars. The ironmaster tersely commented upon the injustice done by the Bank in bringing the great influence of its capital, which represented public money, to crush out private enterprise.

THE old Foudroyant, after many adventures, says the *Army and Navy Gazette*, is shortly to be placed on exhibition in the Thames. She is being restored in every respect to the condition in which she was at the time when Nelson's flag flew from her masthead. The guns are actually those in use when the ship was in commission, having been purchased from the Admiralty for the purpose. No trouble or expense, indeed, appears to have been spared to make her a unique specimen of the "wooden walls" of England. Masts, sails, fittings above and 'tween decks, and even the old character will be carried out so far as the crew is concerned by dressing the men in the costume of the period. The Foudroyant will also visit the Naval Exhibition at Kiel, and it is intended during the summer to show her at all the principal ports in the United Kingdom. If a success, as is pretty certain to be the case in this country, the Foudroyant will eventually visit the Colonies and the United States.

IN the coroner's inquiry into the result of an explosion at the Huddersfield Gasworks on Saturday, the evidence showed that on Saturday morning two men were working at the oxy-oil retorts, when an explosion took place, and both men were injured, one fatally. Mr. W. R. Herring, manager of the gasworks, said that from investigation he found that there had apparently been a defect of the nature of a porous blister in the cast iron work of one of the retorts. This defect would have a tendency to draw in the hot air from the brick setting in which it was fixed, and the mixture of the hot air and the oil gas had not only produced an explosive substance, but the hot air had been sufficient to cause ignition. The retorts were regularly examined, and on Wednesday all the retorts were found to be, it was thought, in a perfect condition. The jury returned a verdict of "Accidental death," expressing the opinion that neither the manager nor any of his staff were to blame for the occurrence.

DURING the last few weeks Lord Masham has been making extensive additions to his Ackton Hall Colliery, near Pontefract, which up to a few months ago only consisted of the Warren House seam. Some little time ago digging was commenced at the Haigh Moor seam, where some 150 to 200 extra hands have been employed, and when the shaft is opened out it is expected that another 250 or 300 men will be needed. At the start considerable difficulties were met with in the sinking. His lordship, however, had made up his mind that coal was to be found of a good thickness, and after working away for many weeks, and striking out in four different directions, the seam was struck at a depth of 620 yards, and found to be a thickness of 3ft. 10in. The depth of the newly-opened Haigh Moor is 400 yards, and the wheels of the pulley at the shaft head are 17ft. in diameter. Fifty new coke ovens have been erected, as well as a large slack washer, and from these ovens the gas travels into four large boilers, which works the machinery of the establishment. The whole of the colliery above ground is lighted by electricity, and for a hundred yards into the actual workings besides.

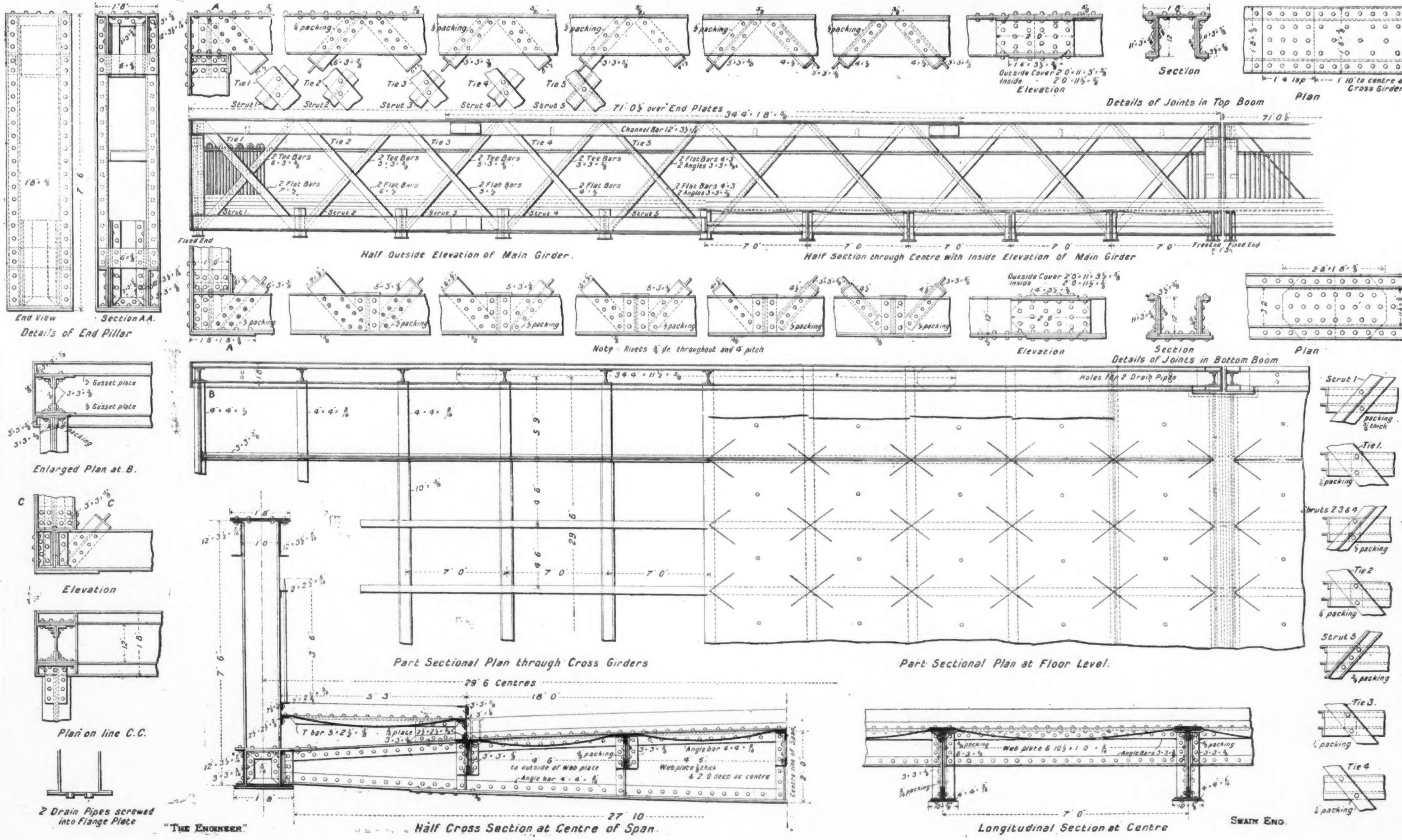
THE proposed or required new water supply for Cochin seems to be beset with difficulties. According to a contemporary several suggestions were put forward, viz.:—(1) The supply by pipes across the backwater from the mainland; (2) from the Periyar at Alwaye by pipes and pumping; (3) from Alwaye by water-in-bulk steamers; (4) by condensation; and (5) by boring. The first four suggestions had to be given up, as the cost of any one of them was found to be prohibitive, and now the trial boring, which has been in progress for some time, has had to be abandoned, as the Government has, owing to the opinion given by the Government Geologist that rock would not be reached for probably many thousand feet, refused to proceed further with it. The boring had reached a depth of 325ft., and on it a sum of Rs. 13,000 had been expended, inclusive of the cost of the apparatus. To continue it to a depth of 400ft. would involve the expenditure of an additional Rs. 5000, and to proceed further fresh plant would be necessary. The Municipal Council has been given the option of continuing it, the apparatus being placed at its disposal; but want of funds will scarcely admit of its doing this, and it seems as if the question of a water supply for Cochin must be indefinitely postponed.

IN his concluding lecture on "Light" at the Royal Institution on Saturday, the 11th inst., Lord Rayleigh deemed it meet to say a few words on the mysterious "Röntgen rays," although not without some scruples, since he thinks it has not yet been shown that the x rays are strictly "light," or even vibrations. The mere fact of photographing by invisible rays was of course no new thing at all; but Röntgen rays were not ordinary light waves. It might be doubted whether they were rays at all. Röntgen called them "strahlen," but "strahl" in German signified a jet or stream as well as a ray—a jet, it might be, of electrified particles. And some held that these rays really were electrified particles, running, of course, at an enormously high speed, and so far as the idea was confined to what was happening inside the vacuum tube, there were no particular difficulties in the way. But when you got outside the vacuum tube this theory was not so easy. It required rather a stretch to say the particles could penetrate through the glass. However, no one, as far as he understood, believed that the particles went right through. One idea was that they might bombard one side and cause corresponding particles to be shot or torn off the other side, just as happened when billiard balls were put in a row. One end ball being struck, the opposite end ball flew off. It was, of course, not very easy to understand how such a thing could happen as was supposed by this theory. Still, as they had to deal with a phenomenon so new and strange as this, the theory must not be excluded. On the other hand, suppose we imagined these rays to be vibrations of the ether. Then came the question, were they transverse vibrations—oscillating across the path in which they were travelling, like ordinary light waves—or were they longitudinal vibrations, a series of alternating compressions and rarefactions travelling in the direction of propagation, as was the case with sound? To answer this question there was at present little evidence one way or the other. However, although we could not decide at present whether they were longitudinal or transverse vibrations, we could not doubt but that they were of extremely short wave-length, otherwise they could never throw such good shadows. If they were transverse vibrations they must certainly be very much shorter than anything within our knowledge in the ordinary spectrum.

THE WATERLOO BRIDGE OVER THE RIVER NESS AT INVERNESS—DETAILS

MR. J. A. MACKENZIE, INVERNESS, ENGINEER

(*For description see page 367*)


End View
Section A.A.
Details of End Pillar
Tie 1
Tie 2
Tie 3
Tie 4
Tie 5
Strut 1
Strut 2
Strut 3
Strut 4
Strut 5
½ packing
Outside Cover 2' 0" × 11 · 3½ · ⅝
Inside 2' 0" · 11½ · ⅝
Elevation
Section
Plan
Details of Joints in Top Boom
1' 10" to centre of Cross Girder
71' 0½" over End Plates
34' 4" · 1' 8" · ⅝
Channel Bar 12" · 3½
2 Tee Bars
2 Flat Bars
2 Flat Bars 4 · 3
2 Angles 3 · 3
Fixed End
Free End
Half Outside Elevation of Main Girder.
Half Section through Centre with Inside Elevation of Main Girder
Note - Rivets ⅞ dr. throughout and 4" pitch
Details of Joints in Bottom Boom
Holes for 2 Drain Pipes
½ Gusset plate
Enlarged Plan at B.
Elevation
Plan on line C.C.
2 Drain Pipes screwed into Flange Plate
Part Sectional Plan through Cross Girders
Part Sectional Plan at Floor Level.
29' 6" Centres
18' 0"
T bar 5 · 2½
Angle bar 4 · 4 · ⅝
to outside of web plate
Web plate ⅝ thick & 2' 0" deep at centre
Centre line of Span
27' 10"
Half Cross Section at Centre of Span.
Web plate 6' 10½" × 1' 0" · ⅝
Angle Bars 3 · 3
Longitudinal Section at Centre
Riveting of Side Plate to Struts and Ties
Struts 2 3 & 4
packing ⅝ thick
"THE ENGINEER"
SWAIN ENG.

MILLING PLANING MACHINE

MESSRS. KENDALL AND GENT, MANCHESTER, ENGINEERS

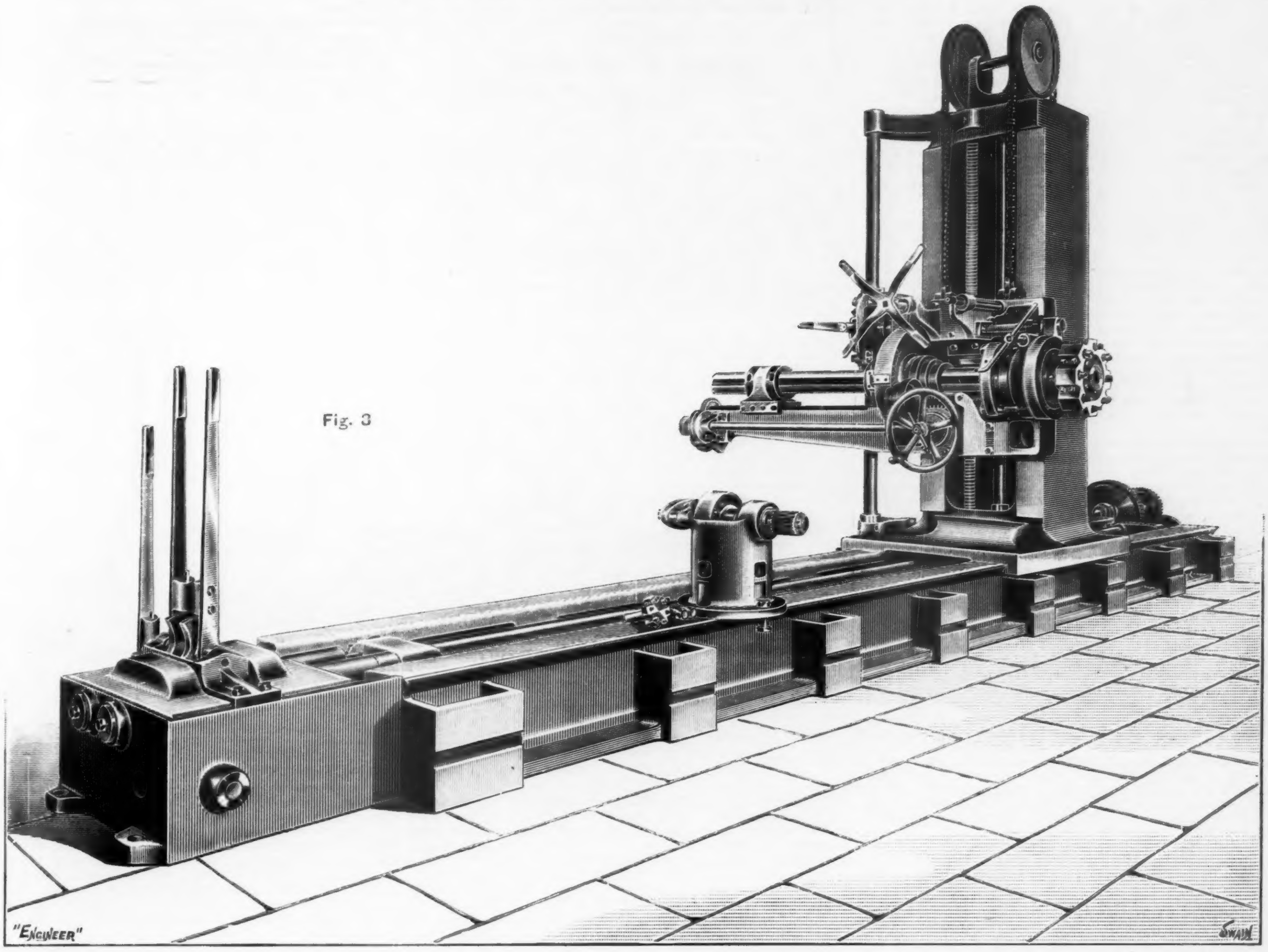


Fig. 3

"ENGINEER"

SWAIN

THE DEVELOPMENT OF THE MILLING MACHINE FOR HEAVY ENGINEERING WORK.

MR. SAMUEL DIXON, M.I.M.E., read before the members of the Manchester Association of Engineers, at their last ordinary meeting, a paper, in which he dealt with the development of milling during recent years for all classes of heavy engineering work, and pointed out the broad lines on which further progress in the same direction was still being made. One of the hindrances to the development of milling, he said, had been the existence of many surfaces which were originally designed for machining by a single tool, and on which a series of rotary cutters could not be employed. The chief aim in most modern designed milling machines had been to arrange the cutters to work on practically any surface that could be presented. Surfaces which were formerly finished on shaping machines were now almost invariably finished on horizontal milling machines with the ordinary spiral cutter where simple flat surfaces were concerned, or with gang cutters where several surfaces could be finished at one cut, as in the caps of pedestals and similar objects. In such work there was an enormous saving, for not only was a plain surface finished more quickly by milling than by shaping, but where several surfaces had to come together, or were required to be uniform in thickness or width, this uniformity could be ensured with the greatest certainty, whereas by the old process of shaping, the setting of the tool to every surface, and again to every object, introduced such a number of small errors and variations amongst the objects machined that the liberal use of the file and consequent expense was unavoidable. They might take a very simple illustration in such objects as screwing machine dies, which were plain bars of cast steel, machined all over, but which required to be uniform in thickness and in breadth. By the older process of shaping or planing, the cost of machining alone was quite double, if not treble that of milling, but even after machining a great difference came in, for slight deviations were always to be found among the dies shaped, and these had to be rectified by filing. By milling, however, these could be produced perfectly uniform, both in thickness and breadth, so that in such simple objects as keys for fly-wheels, pulleys, &c., uniformity could be attained with the greatest ease. Again, as to the quality of surface, there could be no question that the finish of a surface from milling was far superior in most objects to that of shaping, and was in fact superior to what could be produced even by the shaping machine and file together. Milled surfaces might therefore be regarded as surfaces which were so perfectly finished that they might in many cases be left from the machine. In addition to those plain surfaces which could be best milled with the plain spiral cutter, came a large number, in fact, the largest number, which could be done by face cutters. These face cutters, for comparatively small objects, were often made solid, but when made with inserted teeth, could be of practically any size.

It was this form of cutter which lent itself so admirably to almost every class of work, and which was doing so much for the development of milling. Another advantage of this cutter with inserted teeth was its comparative cheapness. The weight of steel used in any one cutter was also so small and of such a simple section that any ordinary workman could make, harden, and insert it; and seeing that so small a quantity was required in such a simple form, a steel of the highest quality could be employed, giving the same advantages in milling as was derived from the use of such steel in tool-holders for turning, planing, slotting, &c. There was one erroneous idea to be found occasionally amongst engineers as regards milling, and that was the supposition that it was not suitable for general miscellaneous surfaces, and was only of advantage where a number of objects were to be made exactly alike. This idea, he believed, arose from a recollection of the field in which milling first made its mark, *i.e.*, among small objects for sewing machines, knitting machines, small arms, &c. For such work the machines were very special, and had an extremely limited capacity, so much so that objects with a slight variation in form could not be dealt with by them. To-day this condition of things was entirely altered, for whilst there must ever remain a large number of machines specially intended for certain work, there were also machines having a perfectly universal character, ready for machining any surface upon which a little common sense had been expended in the design. It was, therefore, necessary to point out that the common spiral cutter and the face milling cutter, with either solid or inserted teeth, were together capable of machining almost any surface whatever. The only thing required was a machine so constructed as to be able to quickly present one or other of the cutters to the surface requiring machining, and at the same time to be able to support these cutters in such a manner as to get out the maximum amount of work.

With regard to work formerly done upon slotting machines, the gain in the adoption of milling was perhaps the greatest in the whole range of engineering practice. For the operations of key-grooving, and the machining of few extremely odd—often badly designed—surfaces, the slotting machine would perhaps always be necessary, but as a machine for producing finished surfaces in the wider sense, its use might be regarded as becoming rapidly obsolete. Not only was the work done more quickly on the milling machine, but it was, when finished, infinitely superior to that from the slotting machine, so that the saving of fitters' time formerly expended on adjusting and draw-filing was very great; in fact, the work of the fitter would, in the near future, be almost entirely confined to setting out work, and assembling the parts, after they had been finished on the machine. This, undoubtedly, was what should be the case, for fitters were simply men who, in the past, had been almost entirely occupied in correcting, by hand labour, the imperfections left in the work by the machines. Whether they would ever arrive at the state of perfection when hand work could be abolished in the production of all ordinary surfaces it was impossible to foretell, but with the introduction of milling it was tending very rapidly in that direction, and the ideal might now very fairly be regarded as within measurable distances.

Of all the tools in an engineer's shop, the vertical milling machine of the slotting machine type was perhaps the best, and as showing what he referred to, he had selected the one shown in the illustration Fig. 1 as a type of this class of machine. From the photograph it would be seen that whilst the cutter was firmly supported both above and below, it was driven by a strong spindle and spur-gearing. The circular table was provided with all adjustments and self-acting feeds, so that work could be rapidly mounted and brought to the cutter, much in the same way as in slotting machines. An interesting point about the driving was that spur-wheels only were employed, which could be entirely suppressed, and the belt alone used with light cuts, or for brass work. Where bevel gears were used for driving, it should be noted that these could never be suppressed. The spindle of the machine selected as a type was 5in. diameter in the body, and much larger in the front bearing, and being carried in conical bearings, formed an efficient driver to the mandril, without torsion and consequent vibration. A special feature was that the feed motions were entirely independent of the driving of the spindle, so that the speed of the spindle could be varied to suit the different diameters of the cutters without varying the rate of traverse; hence the amount of metal cut away by any individual tooth remained the same, whatever might be the diameter of the cutter. It would be noticed that the feed motion was positive, and not dependent on any frictional device after the strap, so that once the rate of feed, as given on the index attached to the machine, was decided, a uniform traverse could be relied upon, which was of great importance where a smooth uniform surface was required, for should the feed slip so that an additional number of revolutions of the cutter was taken on any one spot, a line or mark was certainly left upon the work.

Circular milling machines were, before all others, the type for use where all such objects as cranks, levers, &c., with circular ends had to be machined; but there was a wide field open for completely milling circular objects more economically than turning, even carrying the idea out as far as milling the edges and faces of pulleys and similar objects at the same time. The profile milling machine also lent itself well to profiling, or the milling of objects of irregular forms such as cams, burrs, &c. For this purpose the table was left free to slide longitudinally, so that a template of the same shape placed under the work determined the advance or withdrawal of the work as it passed before the cutter during the action of the transverse feed. It was of great importance when taking heavy cuts to have a bearing for the lower end of the mandril; yet it was surprising how much could be done on such a machine without any support. In fact, he had seen cutters being effectually used even 9in. long, and not more than 1¼in. diameter, without any support whatever. For general engineers the question of profile milling was only of secondary interest, seeing that good designers almost invariably succeeded in working out all their forms as combinations of straight lines and circles, so that fancy ogees and similar forms of a costly character were practically abandoned. This type of machine, which he felt tempted to name the slotto-milling machine, was also capable of doing an immense amount of work with face milling cutters, quite apart from its general work as an edge miller. Such work was formerly done on shaping machines, so that by using face as well as spiral cutters, objects could be milled on the top and all four sides at one setting. This was a point of much importance and often overlooked by engineers, who usually regarded its function as one of edge milling only.

A very interesting group of machines was comprised in those designed for doing work formerly done on planing machines, which, from their similarity in outlines and function, were now known as plano-milling machines. These were usually of the horizontal type or of a combined vertical and horizontal type. It was well known amongst engineers that quite one-third of a man's time, and also that of the producing capacity of many valuable machines, was lost in the setting of work, and this was unavoidable in planing machines, as nothing could be set on the table while in motion, and the difficulty could only be mitigated by the man having two machines, so that one was often working whilst the other was stopped for setting. It was at this point where a great advantage in milling came in, for the movement of the table was so slow that by having the machine sufficiently long, a second object could often be set ready while the other was being machined. The man and the machine could therefore be continuously occupied, so that a saving of about one-third the producing capacity of the machine could often be effected from this circumstance alone, quite apart from the gain arising from the use of a series of cutting edges as compared with that of a single point. For the milling of many objects formerly done on the chuck lathe, horizontal turning mill, &c., circular milling machines presented many advantages, and the illustration Fig. 2 might be taken as a type, though as shown it represented a special form adapted for milling round the flanges of cylinders, valve chests, &c., and was provided also with a radial drilling arm on the cross slide for drilling and tapping the stud holes when so set for milling. The machine shown admitted objects up to 7ft. 6in. diameter, and up to 8ft. 6in. high. When milling at such a height from the table it would be readily seen that provision had to be made for resisting strains of a totally different kind to those met with in planing machines, so that to ensure perfect rigidity the uprights for carrying the cross-slide were provided with transverse wings, and not merely the common form of upright usually found in planing machines. For the rapid adjustment of the work to the tool, and also the raising and lowering of the cross-slide, as well as the traversing of the saddles on the cross-slide, quick power motions were provided, in addition to the series of graduated speeds for feeding up the work when milling.

The necessity for milling machines for large fixed objects had sprung up just as did that for wall or side-planing machines In one important feature, however, they differed, for, seeing that powerful machines with strong spindles, having longitudinal, vertical, and transverse adjustments, were necessary for milling, it required but a slight addition to make the same machines into perfect boring, drilling, tapping, and studding machines. This combination had many advantages, for when an object was once set all the surfaces in most cases could be milled over, and the holes bored, drilled, or tapped, as the case might be. The economy arising therefrom was very great in heavy work, where operations were comparatively short when once set, and also where the cost of handling and setting in different machines was often very great. This was only another illustration of the tendency of all good machine designs to eliminate as far as possible the great cost of setting work accurately on machines. The machine shown in the illustration Fig. 3 was typical of this class, made in several sizes, the largest covering surfaces up to 30ft. long and 10ft. high, and not only was it suitable for milling over these surfaces, but also for boring. This machine might be taken as a type of these large boring and milling machines, the smaller sizes having spindles 4in. and the larger 6in. diameter. In addition to the large milling head, which could be used on the horizontal spindle, an extremely useful milling or boring head with a transverse spindle could be attached. It would be noted that this was mounted on a circular base, so that this spindle could be used vertically, horizontally, or set round to any angle, as in the universal plano-milling machine. It would not be of advantage to describe all the details of the various motions which it was necessary that such machines should be provided with, but as they had grown beyond the range of simple adjustment, they were now furnished with rapid-power adjustments in every direction, and well within the range of the workman and under such perfect control that only very slight adjustments for sizing and fine setting were ever required by hand.

Returning once more to the general question of milling, it would, he thought, be conceded, after comparing the capacities of the machines he had selected as types, that the whole range of engineering work was now well covered; not that every cranky surface which an inexperienced draughtsman had designed could be milled, but there was no reason why almost all surfaces should not be brought within the range of the milling machine, especially if, in designing, the few simple requirements of milling were kept in mind. At this point he might say that machine tool makers themselves had had, perhaps, more difficulties to contend with than other branches of engineering, but these difficulties were disappearing, and would very soon cease to exist. In treating thus fully the broad features of milling, he would not be understood to imply that planing machines would be put out of use in engineering shops, but, considering the advantages of milling, it behoved engineers to consider more carefully whether, in the classification of their work for economical production, a very much greater share should not be allotted to the milling machine. His object in preparing the paper had been not so much to present the novel features of any particular type of milling machine, but to emphasise what he considered two important advantages that would arise from a more extended use of milling machines, viz., increased economy of production, and greater accuracy or higher quality of the work produced. The former of these was a point which appealed to engineers of every class, and he rejoiced to think that the latter, increased accuracy of production, was a matter which was daily becoming more appreciated by engineers throughout the world.

A discussion followed the reading of the paper.

Mr. Hans Renold said he would have liked to hear more about the construction of the cutters used in milling machines, as this was, to his mind, a far more important question than that of the machines themselves. They might do good work with a good cutter and a badly designed machine, but they could not do good work with a bad cutter, however good the machine itself might be. With regard to driving the cutter, he did not believe in the cone-bearing adopted by the author; a parallel bearing was the best. Milling would, no doubt, in the future become a general operation in engineering works.

Mr. Saxon remarked that the question arose as to whether our existing general tools had been developed and improved to the extent that was possible. He thought great improvement was possible in the direction of utilising the return strokes in planing and slotting machines. Then he would like to know whether the operation of milling had got to such a point beyond the experimental stage that where they had only a limited number of ordinary machines, it would be advisable to entirely replace them with milling machines, or would it be better to adopt the system slowly, and gradually educate their men in the methods of milling, by first obtaining one machine and then steadily increasing the number as they became more familiar with the system. Then there was the matter of the cost of the milling machines, as compared with slotting or planing machines of the same sizes; the author had not dealt with that point. He did not think the ordinary tools would ever be dispensed with. In cases of breakdown work, for instance, they would always be necessary.

Mr. Daniels asked whether the author would recommend special tools for special work, or the universal tool, as, for example, in locomotive work.

Mr. Alfred Muir said Mr. Adams, of the Great Eastern Railway, was the first man to use milling machines for locomotive work. Mr. Webb, of Crewe, afterwards adopted them. There was no doubt as to the general usefulness of milling machines, and the larger the surface to be operated upon the more advantage they got from their use.

Mr. Webb asked whether milling could be recommended for slotting large cranks for mill engines.

Mr. Blastow said that, as far as he knew, Mr. Bodmer, of Chorlton-street, Oxford-road, Manchester, was the first maker of a milling machine, as he had made one in 1824. Milling machines had their place in an engineer's shop, and so had slotting and planing machines, but they must get the planing machine to cut without any loss of time if it was to hold its own. He believed that special machines, and not universal ones, were the most satisfactory machines for a large engineering shop, and with that condition they would hold their own, but would not displace the other tools.

The Chairman spoke very strongly against the common practice of insisting upon makers constructing a specially shaped tool for them for every small operation, instead of being satisfied with the standard pattern. This was often done when the question was simply one of chucks, and not of the general design of the machine itself. He thought circular milling should be more widely adopted in some directions than it was. There was no doubt the cardinal feature of a good milling machine was the cutters, and the grinding of these was a very important operation.

Mr. Blastow moved, and Mr. Saxon seconded, a vote of thanks to the author, which was carried with acclamation.

Mr. Dixon, in responding, said with regard to milling machines for heavy engineering work, they could not be made by the gross, and had to be specially constructed for the firm for whom they were intended. The remarks of Mr. Nasmith might apply to small machines, but not so decidedly to those with which he had been dealing. He did not agree with Mr. Renolds' remarks as to driving, as a solid drive was far preferable to a frictional drive such as was mentioned by that gentleman. He thought that milling machines should be adopted slowly at first in engineering shops where the ordinary tools were in use, or else the men would never become familiar with their working. Of course milling machines were more costly than ordinary tools, but this was owing to the better finish, mechanism, &c., required. With regard to breakdowns, Mr. Saxon was mistaken in thinking milling was not applicable. With the ordinary spiral cutter and face cutter, they could practically cover any surface. As to using special machines for special work, these were, no doubt, the best for locomotive work, and there was a large number of machines of different classes to choose from, but he had been dealing rather with general engineering work, and for this "universal" machines were often very useful. For the heavy cranks mentioned by Mr. Webb, the ordinary slotters were the best machines to use, though the cranks might be finished with a milling machine.

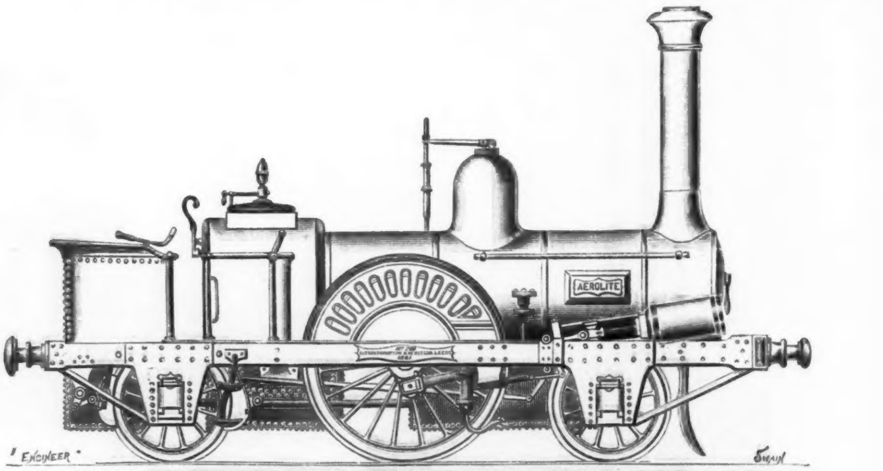
LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

THE LINKS IN THE HISTORY OF THE LOCOMOTIVE.

Sir,—I am enclosing print of an old single wheel tank engine which will, no doubt, be interesting to many of your readers, The engine in question was built in 1851 by Messrs. Kitsont Thompson, and Hewitson, of Leeds, and exhibited at the great exhibition in the same year.

The dimensions are as follows:—Cylinder, 11in. diameter by 22in. stroke; driving wheels, 6ft. diameter; leading and trailing wheels, 3ft. 6in. diameter. The engine is described as being "constructed to run light express trains, will run without tender, having two water tanks beneath the boiler and foot-plate to carry 500 gallons of water, and sufficient coke space upon the foot-plate to run for a journey of fifty miles."



TANK ENGINE, LEEDS NORTHERN RAILWAY, 1851

The engine afterwards ran for some years on the Leeds Northern Railway. W. J. Barker.

Woodsley View, Leeds, April 6th.

THE LIQUEFACTION OF GASES.

Sir,—I am sorry that your correspondent, "Cryos," does not find my theory of the action of Dr. Hampson's apparatus quite convincing. Incidentally I may point out that it is not a theory, but a simple statement of facts. If "Cryos" had read my letter with more care, I do not think he could have avoided conviction.

His difficulty is in accounting for the heat energy expended by the compressing engine. "If," he says, "no heat can escape from the apparatus, it must become red hot." I have not my copy of The Engineer with my letter by me, but so far as I remember I did not say that no heat escaped from the apparatus. I did say that none of the original heat in the air or oxygen could escape, or did escape, which is a very different thing.

Let us suppose that 100 lb. of air at atmospheric pressure, occupying at 62 deg. a space of, in round numbers, 1300 cubic feet, is isothermally compressed until it occupies 13 cubic feet, and has a pressure of 1500 lb. on the square inch. Its temperature is still 62 deg., because it has been cooled during the process of compression. Its intrinsic energy before compression was $100 \times 62 \times {\cdot}23 = 1426$ thermal units. Its energy after compression will be precisely the same, because the energy in a gas is a function of its temperature, and of nothing else. Now, in Dr. Hampson's apparatus we have, say, 100 lb. of air compressed to 3000 lb. on the square inch, or to any other pressure necessary. The energy in it is just what it was before compression. It has lost nothing; but it may have gained a little, because the heat due to compression has been abstracted from it in the surface condenser or cooler. Now the lowest temperature that can be got in the cooler, without the aid of ice or some refrigerating agent, is that of the surroundings, or 62 deg. by hypothesis; and as an infinitely large condenser, which is inadmissible, would be needed to get the temperature down to this—unless the principle of contrary flow were fully carried out—because air at 63 deg., for instance, would give up heat very slowly to water at 62 deg.; the air is delivered into the Hampson apparatus, no doubt, at a higher temperature by a few degrees than that of the atmosphere; but there can be no accumulation of heat, for reasons which will, I think, be obvious. We may say, then, that some 90 per cent. of all the heat due to compression is taken out in the cooler; the remainder escapes through the walls of the compressing pump, &c., the pump radiating freely because of the high temperature of the air in it.

Here I may with advantage digress, to direct attention to the fact that I am speaking of heat, not temperature. The heat may be taken out of air or converted into work at very different temperatures. It may be taken out in the cooler at 62 deg., and it may be taken out in the air pump at 300 deg. It would simplify matters, no doubt, if "Cryos" would avoid the use of the word "heat" altogether, and speak only of energy and temperature. Thus, then, he would understand that in the Hampson apparatus the energy remains unaltered, but the temperature varies in the same body of air, in just the same way that we have at the North Pole − 80 deg. and at the equator 120 deg.

If we turn now to the apparatus proper, we find that every portion of it is far below the temperature of the surroundings. The compressing pump is at a distance of several feet from the apparatus, to which it is united by a couple of small copper pipes only—one suction, the other delivery; because, it must be remembered, that the same air is used over and over again, additions being made to compensate for the small percentage of the total weight of air being liquefied. There may be 200 lb. or 300 lb. of air at a time in Dr. Hampson's apparatus, which is being liquefied at the rate of, say, half an ounce a minute.

Into the reason why air expanding is cooled, I do not suppose that "Cryos" needs any information. Concerning the so-called Joule's effect, however, I may say that, as has already been pointed out in your columns, it has nothing to do with the matter in hand.

After the air has left the cooler, there is no possibility of escape of heat or energy in any form. The air enters the apparatus, it is true, a little hotter than the cooler, but we may neglect this. For the rest, everything about the apparatus is colder than the surroundings, and so heat cannot escape. There is no external work done by the air in the apparatus. The result is that the great bulk of the air being worked on has an average temperature of a little over 62 deg., but, as I have said, at one end of the apparatus we have, say, − 200 deg., while at the other, in the pump, we have 300 deg. The Hampson process is simply one of getting two different temperatures at the same time in the same body of gas.

As to "Cryos'" suggestion about hydrogen, that gas will behave in all respects like oxygen and like air, only it is necessary to reduce the intrinsic energy of the gas to begin very much, and this can only be done by using a frigorific mixture in the surface condenser. Air cannot be conveniently liquefied without the use of a mixture of ice and salt in the cooler, but oxygen liquefies with the cooler at 60 deg. or a little less.

"Cryos" is in error concerning the work done by Professor Dewar. He thought on dogmatic thermodynamic lines, and used an apparatus costing some thousands of pounds, and totally different from Hampson's. He never dreamed, so far as is known, of applying the Hampson principle until after Dr. Linde and Herr Schröter had published the results of their inquiries. I call it the Hampson principle for convenience, but far be it from me to award originality to either Hampson or Linde. Professor Dewar has never claimed to have originated the process. The apparatus he uses was recently described in your pages, and differs from Dr. Linde's principally in the use of frigorific agents, such as liquid CO_2. If "Cryos" will look up the recent literature of the subject he will see that he is claiming more for Professor Dewar than that gentleman ever claimed for himself.

It may be worth while to repeat that the "permanent" cooling due to Joule's effect is much too small in amount to be of any commercial value whatever, and that no satisfactory explanation of the cause to which it is due has ever been broached. Lord Kelvin's so-called explanation is based on the pure assumption that the molecules of a gas attract each other—an assumption which appears to have been invented to explain the phenomenon.

April 13th. Zero.

LOCOMOTIVE FIRE-BOXES.

Sir,—I was much interested in seeing in your issue of March 28th the illustration of the new engines for the M., S. and L. Railway, and especially in the announcement of Mr. Pollitt's adoption of the Belpaire fire-box. It would be interesting to know why this form of fire-box has not received more favour from English locomotive superintendents, since it appears to be much liked on the Continent, and, I believe, is largely used on some of the Indian State Railways. I suppose one is right in assuming that the ordinary form of fire-box has satisfied English locomotive engineers for the last fifty years, and, if that is the case, what are the special merits of the Belpaire? It does not appear to have "caught on" in Britain. But is that due to sturdy conservatism, or to the feeling that the old-fashioned form is "good enough?" I have had something to do with the Belpaire, but, in case I am steeped in insular prejudice, I will say no more than that I am unable to see its special advantages. Could any of your correspondents enlighten me?

I have been much struck with the contrast between English and foreign practice in the manner of staying the crowns of fire-boxes. I have before me twelve types of English locomotives, and ten of these have girder stays, while two types have direct stays. Of ten continental types, nine have direct stays and one has girder stays; and, if I am not mistaken, direct stays find much favour in the Colonies. But the direct stay has been tried in England. Mr. Stroudley used it, and he said it was not a success, and went back to girders, and, unless I am mistaken, the late Mr. P. Stirling reverted to girder stays in his latest engines. Now, as outside of England the direct stay is almost universally used, and is therefore presumably a success, what are the causes which prevent its success in England? Is it insular prejudice, or is it that the girder stay is not only "good enough," but is the best? My own impression is that the answer will be found in a comparison of the cost of boiler repairs at home and abroad; and I have ventured to trouble you with this letter in hope that you may be able to deal with the subject in an early issue, and that any of your readers who have had experience will favour with their views on such an interesting subject. It is obviously more important than a wordy war about dates and "wind-cutters." Adriatic.

April 8th.

TYPEWRITERS.

Sir,—I do not know whether this subject has ever been discussed in your columns; if it has not, I venture to think it fairly deserves that honour, considering the growing use of these machines. I say growing use advisedly, because I am convinced that, were it not for the graspingness and short-sighted policy of dealers and manufacturers, that the public demand for these useful labour-savers would be infinitely greater than at present.

Primarily the excessive cost, which is absolutely prohibitive to many, is one of the causes, and is, I understand, due to a combination among makers to keep up prices. £20, the usual charge for a new machine, is an utterly absurd figure in these days when most of the patents have expired, and the instruments themselves are turned out by machinery by the hundred. Indeed, I believe, like modern bicycles, typewriters cost little more than £5 to produce, and could easily be retailed for some such price were it not for the existence of the before-mentioned ring.

Another matter which naturally influences the public is the fact that all machines now in the market are more or less imperfect. This may seem rank heresy to some, but it is the truth, nevertheless. One fault common to the whole genus, I believe, is this:—If the operator can see the writing he can never read what he has written, and *vice versâ*. This is a grave defect to everyone except mere copyists. The shift-key also, though not present in every typewriter, is an abomination wherever it occurs, and a serious impediment to that rapidity of work generally required. One objection to the shift-key is its position, almost invariably at the side, where it can only be manipulated by the "little," or weakest finger. Were this key placed in front of each machine—so that it could be worked by either thumb—with the touch board or boards at either side, much of the objection to its existence might be removed.

As to the "universal" key-board, I regard it simply as the direct creation of the Evil One in order to harass poor mortals; for every letter appears to have been carefully placed exactly where it should not be. As far as I can ascertain, this satisfactory result was arrived at in the first instance by the usual happy-go-lucky methods, and in these days of stick-in-the-mud conservatism no one has dared to introduce any alteration or reform in accordance with the dictates of common sense.

The perfect typewriter has yet to be constructed, but if anyone had spare time and energy to improve upon existing models, and introduce such machine at a cheap rate, a grateful public would quickly reward its benefactor. A Distracted Typist.

April 12th.

PERMANENT WAY.

Sir,—Referring to the recent accident on the Great Northern Railway at Little Bytham, and the subsequent article thereon in your columns of The Engineer of March 20th, I am induced to send you some particulars of an altered form of permanent way I conceived in January, 1883, and which is at the service of the Great Northern Railway or any other railway who may feel inclined to test it in practice on some short length of line, with a view of preventing a repetition of the above-named sad occurrence. The road I proposed was to be laid with flat-bottomed Vignoles rails, 4in. wide in bottom flange, laid on two longitudinal sleepers—minimum size 9in. by 3in.—sawn rakingly on upper surface to give the requisite "cant" to the rails, which were secured to same by coach screws. The joints were to be secured by wrought iron bed-plates—morticed in the longitudinal sleepers—and fish-plates carefully moulded to fit the rails.

The two longitudinal sleepers were to be bolted to transverse sleepers—ten in a 30ft. length—with fang bolts, and the road lined and levelled. Additional sleepers were then to be driven in between the ten sleepers above named, and ballast sufficient for complete "boxing up" added, thus making the bearing of the rails and longitudinal sleepers continuous. By the addition of the longitudinal sleepers, the road would be really more elastic in its actual construction than before, as the hard points of bearing in the customary iron chairs were thus eliminated, and road resistance diminished by the additional bearing given.

An ordinary cross-sleepered road would give, say, in a 30ft. length, the following bearing:—10 sleepers × 9ft. × 10in. = 75ft.; the new road would give 30ft. × 9ft. = 270ft., or 3·60 more sleeper bearing. Rail bearing, as for an ordinary chair-rail road, would give for rails:—No. 20 chairs × 6in. × 2in. = 1ft. 8in. bearing; the new road would give 2/30ft. × 4in. = 20ft., or 12·07 more rail bearing. And the weight of both locomotive and carriages being so well supported, it was believed that the running would be as smooth as if over a table, whilst in case of a "run-off" there would be less damage done to track and train, and inferentially to passengers or freight. The track, if it went down at all, would do so in long, easy slacks, and repairs would probably be much lessened. If necessary to lift the track the extra sleepers would be drawn out or driven out with the beetle, and again replaced after the road had been lifted and straightened.

In further reference to the late accident, the testimony of the guard describes the train as skidding down the greasy rails whilst sparks were flying up as if the train was on fire. This means that the wheels were locked by the action of the brakes, and from the intense friction each one would probably be found afterwards to have a flat place worn in its periphery. Here appears room for improvement to be effected by the skill of some master mechanic, who shall devise the means of applying the necessary friction resulting from braking to the rails direct, instead of, as at present, through the medium of the wheels. A wheel of 3ft. diameter can only offer a longitudinal friction on the rail head of 1½in. say, whilst if friction be applied to the rail at least 1½ yards may be obtained. The problem is how safely to apply the requisite pressure to the rail, without risk of lifting the vehicles from which it is applied dangerously, or catching ends of check rails, point rod coverings, &c. The problem is a difficult one, but I believe it can be solved by the mechanical ingenuity to be found so abundantly in this country. J. H. R. Rose.

3, Derby-road, Wrexham, April 13th.

Sir,—In a letter published in your last issue your correspondent, "J. C.," has gone to the root of the problem of resistance by treating it as useless work. He also points out the difficulty of apportioning the waste energy between the train and the road, and he appears to look for a remedy in improving the former rather than the latter. As my present theme is permanent way, I will neglect the work done on passengers and rolling stock, and confine myself as far as possible to the track.

To eliminate needless complications, let us suppose a straight and originally level road, and consider the resistance it opposes to a rolling load passing over it, which resistance is, of course, equal to the work done below rail level, minus whatever may be rendered back to the train by resiliance. If the road could be made absolutely uniform and absolutely rigid, no work could be imposed upon it, and it could offer no resistance. Neither condition is attainable, but, as "J. C." has observed, "a consideration of what is theoretically perfect often points the way to practical improvement."

In attempting to approach the ideal permanent way, we may easily find that of the two main conditions rigidity is, in practice, easier of approximation than uniformity; and hence the trouble with the "lathe bed" road in rock cutting, to which your correspondent, "F. J. P.," has alluded. The two conditions are interdependent—that is to say, the more uniform the road can be kept, the more rigid it may be made with advantage; and thus the want of uniformity is the beginning of evil.

The causes of this fundamental evil may, for convenience, be broadly divided between inherent unevenness in the track, arising from fish joints, intermittent supports, loose fastenings, weak sleepers, unequally packed ballast, &c.; and secondly, the long undulation which accompanies the rolling load. The former are accountable for shocks and hammering, and consequent vibrations set up in both train and track, and constitute, perhaps, the more important class as regards resistance, wear, and deterioration of material, and danger; whilst the latter imposes upon the locomotion that fruitless expenditure of power which has been compared to the labour of Sisyphus.

The mere enumeration of the faults included in the first category points to their remedies:—Longer, stiffer, and better fitted fish-plates, stiffer and longer rails, secure fastenings, improved sleepers, better ballast, and more attention to packing. It must be admitted that in the matter of rails, joints, and fastenings, modern English practice leaves little to be desired; but beneath the chairs there is less reason for satisfaction. The sleepers and the ballast have received less attention than they deserve.

Turning to the latter source of resistance—the great wave which causes the rolling load to press continually upon an up-grade when traversing a road originally level—it is easily seen that the resistance under uniform conditions is a constant retarding force $R = W \tan i$, W being the load, and i the inclination to the horizon of the tangent to the curvature of rails at the points of contact with the wheels; and if we knew the value of i, the number of foot-pounds per mile or per minute, at a given train velocity, could be of course ascertained by a simple arithmetical process.

Now this inclination depends upon the nature of the wave, which, on account of inertia, is probably deeper and shorter at slow than at high speeds, thus favouring the latter. But, on the other hand, it seems likely that the wave is more equimetrical about a vertical plane through the points of contact at slow than at high speeds; that is to say, for the same depth of wave, the inclination, i, would be steeper at high speeds.

In view of the practical importance of the matter, it seems strange that no efforts have been made, as far as I know, to ascertain the nature of this wave by actual observation. It is not, perhaps, so easy to do so as might at first sight appear, owing to what "J. C." calls "the earthquake" accompanying a train; but it is surely not beyond the powers of modern electricians and photographers to record what happens in a manner serviceable for the purpose indicated. However, in the absence of such records, we may, by the exercise of common sense, acquire some knowledge of the matter.

The wave is, at slow speeds, often very apparent to the eye, and is not at all a microscopic affair. It is certainly very much more than could be accounted for by the direct compression of the wooden sleepers; and, as the line returns nearly to its normal level after the passage of the load, it is difficult to believe that all this resiliance is due to the ballast and the formation below it. I am inclined to think that the greater part of the depression is due to the springing of the sleepers and displacement of ballast under the chairs. In other words, if the sleepers were twice as thick, or if they were repacked after the passage of each train, there would be far less wave; and I suppose no one could suggest that the road would be the worse in either case, whilst its resistance would no doubt be less.

If this is true, and if there is sufficient elasticity when the ballast is well packed, there must be too much elasticity—or too little stiffness—in the usual condition of the road; and it should be noted that too great flexibility in the sleepers is, to a great extent, the cause of the ballast being displaced.

The remedy I have suggested is the use of steel sleepers, which may be made of any degree of flexibility desired by adjusting their form, and without wasteful excess of material; and, moreover, the bearing area may be increased where it is most required, under the chairs, which is not possible with wooden sleepers. With properly designed steel sleepers there would be less disturbance of ballast, and, consequently, less packing required than at present, although I am aware that a prejudice to the contrary prevails.

As regards the nature of the ballast, I suppose it could not be contended that burnt clay, sand, gravel, broken stone, and cinders, are all equally good for the purpose. Assuming that they are not, and bearing in mind that the main cost is the first cost, it seems to me false economy to accept the first insoluble and porous material that presents itself in any particular locality as good enough for ballasting a railway.

I believe that the general opinion is in favour of broken stone; and, on *á priori* grounds, it seems to be the most suitable in having greater stability than rounded pebbles; in its freedom from dust, and the excellent drainage it affords; and in the uniformity of quality that can be insured by its use.

I hope, Sir, that you will before long revert in a leading article to the subject of permanent way which is still a very "live question." James Whitestone.

113, Queen Victoria-street, E.C., April 14th.

Sir,—The ink was figuratively—if not positively—not dry on the copy of The Engineer containing my letter of last week when the Snowdon accident occurred, where a slight depression of the permanent way resulted in the actual loss of one valuable life, and endangered scores of others. An entire page of your estimable journal would not suffice me to tell you what I think of the whole matter, practically and economically, and I will therefore do no more now than thank you for the prominence you are giving to the subject of permanent way, and express the hope that it will result in good for the travelling public.

As I read the report of the inquest in this day's newspapers, I gather that the manufacturers of the engines will not admit that their part of the work was in fault, and the makers of the line had to fall back upon the imperfection of the road, as "thawing after freezing possibly might have softened the ground and caused the depression." Can your readers imagine where the track-sleepers and all would be, with specially long fish-plated joints and a rigid rack also bolted to the sleepers, when the formation had left it—if not in mid air?

Perhaps, after a Snowdon accident as a beginning, some engineers may look closer to the dangers besetting the permanent way, before other accidents occur resulting in a much greater loss of life. J. W. Wilkins.

15, Lilford-road, S.E., April 15th.

CIRCULATION IN WATER-TUBE BOILERS.

Sir,—Whatever Professor Watkinson may think, it is to me clear that, as you have said, there is no circulation proper in the Belleville boiler, because the passage of plugs of water along the tubes is certainly not circulation. But Professor Watkinson has overlooked the important circumstance that, in his real boiler, no action of the kind takes place. It happens in the model; but only because it is a model.

Furthermore, those who like myself had an opportunity of seeing the model at work, must have noticed that the rate of evaporation was comparatively quite small. The heat available was very moderate, as compared to that from a real furnace. In text books we are told that the temperature of the Bunsen flame is very high; and it is taken for granted that when a Bunsen flame is used in a model boiler the temperature is very considerable. I have had a somewhat extended experience with models, and with real boilers. I have been working at water-tube boilers for over a quarter of a century, and more than 300 boilers of my invention have been made and put to work, and there is no record of a burst tube, or an accident of any kind whatever. But all this is history now, and I only mention the matter as an evidence that I know something of my subject.

Now, I used Bunsen flames, and I very soon found out that they are very treacherous, and may mean anything or nothing.

In a furnace such as the Thornycroft or Yarrow, the radiant heat from the fuel and fire-brick plays a most important part; but a Bunsen gas flame radiates practically no heat at all. We must have direct contact. A model boiler which would work beautifully with very powerful Bunsen burners, went mad when a charcoal fire urged by a good draught was substituted. The water, instead of circulating, was blown clean out of the tubes. Even with Bunsen burners Professor Watkinson burst the tubes of all the boilers he tried at the Institution of Naval Architects except the straight tube Yarrow. His experience is mine, only mine came when Professor Watkinson was at school.

A very good boiler may be made in which there is very little circulation. All that is wanted is to keep the tubes fairly well supplied with water. We may take a single tube and boil water in it with perfect success, with a little care.

The proper way to test the value of any boiler is a very cheap one, and was first suggested by Dr. Alban, from whom I have learned at least as much about water-tube boilers as from any one else. Make a full-sized model of a section of any proposed water-tube boiler of tin-plate soft soldered, work at atmospheric pressure; use not gas but coke, wood, or charcoal for a fuel in a properly enclosed furnace. If any overheating takes place, the soft solder will melt and tell the story. If the soft solder stands, the circulation is all right. That was how I arrived at my results.

The oil and water experiment suggested by your correspondent "Senex" is just what is to be expected, but it is not applicable to the case you have stated, for reasons which should suggest themselves at once. The oil and water column is not longer than the water column until the oil has separated itself from the water and floats on it. I accept Professor Watkinson's explanation of circulation as quite true. There is none other of which the same can be said.

Birmingham, April 14th. Old Tubulous.

Sir,—Having read a great many explanations as to the circulation of water in water-tube boilers, I am led to think that if, instead of commencing to explain as to the action of bubbles of steam in the water, the simpler plan would be to state what takes place at the earlier stages, when the water commences to be heated. Taking, for example, the case so frequently mentioned of the U tube with heat applied under one leg, I take it that the heat communicated to the water causes the water which has received the heat to expand and rise, and that the rising of this heated water commences the system of circulation, a fresh quantity of the colder water taking the place of the first water heated. If this be correct with *water*, one may fairly expect that it will continue after steam bubbles commence to form.

With regard to the relative weights of water in the two legs, the leg containing the heated, and consequently expanded, water must require to be longer than the "downcomer" leg with the colder water. Obviously, the pressure produced by the height of a column of water must depend on its weight; the heated column of water being lighter per unit of length than the colder column, would require a longer leg of hot water to make the balance in the two legs even. I find this to be the case when a pipe bringing hot water through a vertical pipe inside a tank delivers the water above the level of the colder water in the tank, the height of the internal pipe at which regular discharge takes place varying with the temperature of the hot water. Iron.

London, April 14th.

[Our correspondent forgets that, once boiling takes place, the water must be at practically the same temperature in all the tubes. The pressure produced by a column of water depends on the height of the column, and not on its weight.—Ed. E.]

THE CRYSTAL PALACE.

Sir,—Will you permit me to use your pages to direct the attention of the Crystal Palace authorities to the crying need which exists for facilitating access from the low-level station to the Palace. There are first two steep flights of stair to be climbed from the railway platform. Then comes a long weary tramp up a steep incline, at the end of which is another steep flight. Then comes a short bit of level and two more flights, another level, and two more flights yet steeper, and then the weary visitor finds himself in the Palace. To many people this is all very well, but to the middle-aged and the valetudinarian it is a very serious matter indeed.

And it could be so easily avoided. An electric tramway running where the old switchback did run would solve the whole problem as far as the Palace is concerned, and at halfpenny fares it would earn a fortune. Nothing has stood more in the way of the Palace than its inaccessibility. Now that a big exhibition is to be held of the means of locomotion, the glaring inconvenience of the existing method of getting into the building becomes more than ever prominent. Norwood.

April 14th.

THE SNOWDON RAILWAY.

Sir,—Having read the account of the opening of the Snowdon Railway to the public, it may be of interest to know that it is now sixteen years since the scheme was mooted. At the time the late Mr. Spooner, C.E., and myself planned a line from Llanberis to the top of Snowdon and down to Rhyddu on the Beddgelert side of the mountain.

Having taken much interest in mountain railways, I afterwards planned a line to the summit of Snaefell, in the Isle of Man, also to the top of Skiddaw, in Cumberland, and Ben Lomond, in Scotland, thus taking in the chief mountains in the British Isles. It was, however, too early for mountain railways in this country. The landowners would not agree to any arrangement for the land, and as such lines could not be put on the same footing as to public utility or necessity like railways in general, an Act of Parliament with compulsory powers could not be got.

I am glad, however, to see that matters have changed for the better. Out of the complete schemes which I have prepared as named, there are now two, viz., the Snaefell Railway and the Snowdon Railway, completed. The others will no doubt follow in time to be largely patronised by the British public.

J. S. Hughes, M. Inst. C.E.

Festiniog Railway, Engineers' Office, Portmadoc, April 9th.

ENGINE POWER IN PADDLE STEAMERS.

Sir,—For the information of your correspondent "Sponson." I am acquainted with a paddle steamer 225ft. long which has attained a speed of over 20 knots per hour, showing a coefficient

$$\frac{D^{\frac{2}{3}} \times V^3}{\text{I.H.P.}} = 242.$$

Your other correspondent, "R. B. S.," considers 19 per cent. of slip to be a full allowance for this type of vessel. I should like him to give an instance of any paddle steamer of 18 knots speed and upwards which shows less than 25 per cent. slip. To my mind the reason for such great power being required in Dutch steamers must be looked for in the model and position of shaft, as I find that very good results can be attained with short vessels and small wheels. Mareotis.

April 15th.

NAVAL ARCHITECTURE—NO. IV. STABILITY.

Sir,—Your correspondent, B. C. Laws, seems to consider that the height at which the ballast is placed in "inclining experiments" is only then of consequence when the angle of heel exceeds 10 deg.

I differ with him entirely in this respect, and consider that the height or depth of W above or below G must always be allowed for by calculation to obtain accurate results. The loss or gain in M G is only a matter of proportion.

My object in writing my first letter to you was to direct the attention of beginners to the fact that the ordinary formula for finding M G by inclining experiments does *not* take note of the position of the ballast to be shifted, and would give the same height for M G whether the ballast was any number of feet above or below G. The angle of heel is all that is considered.

It is always necessary to correct the metacentric height obtained by formula by a calculation of the influence of the height above or below the centre of gravity at which the shifted ballast is placed.

April 11th. F. W. C.

HORSELESS CARRIAGES.

Sir,—Having just returned from a tour of inspection in France, made for the purpose of ascertaining the present position of automobilism, I think it advisable to at once advise my brother engineers through your valuable instrumentality of the fact that I am officially informed by the secretary of the Automobile Club of France that the carefully planned trial of "automobiles" between Paris and Marseilles, which it has been arranged should take place in July, has been postponed until October.

I cannot here give the result of my investigation of the subject of continental self-propelling road vehicles more than to say they still leave much to be desired, and I therefore hasten to make known the fact of this postponement in the hope that it may be of value to English engineers proposing to build vehicles for entry in friendly rivalry with our neighbours in these races.

I shall, moreover, be pleased to give any further information in my power. Alfred R. Sennett, A.M. Inst. C.E.,

Hon. Executive Commissioner International Horse and
Horseless Carriage Exhibition, Crystal Palace.

MACHINE TOOLS

MESSRS. KENDALL AND GENT, MANCHESTER, ENGINEERS

(For description see page 395)

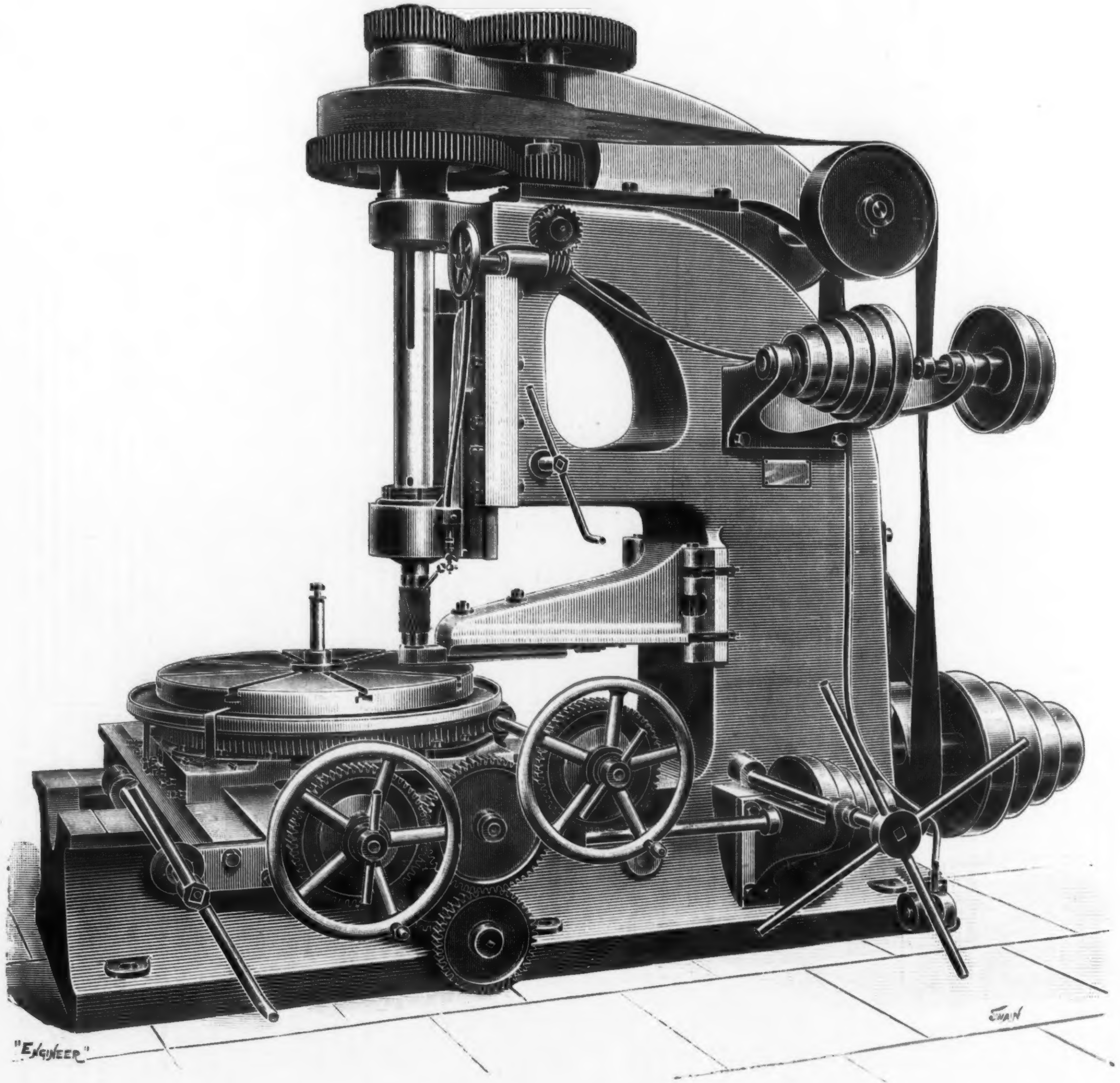

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Fig. 1—VERTICAL MILLING MACHINE

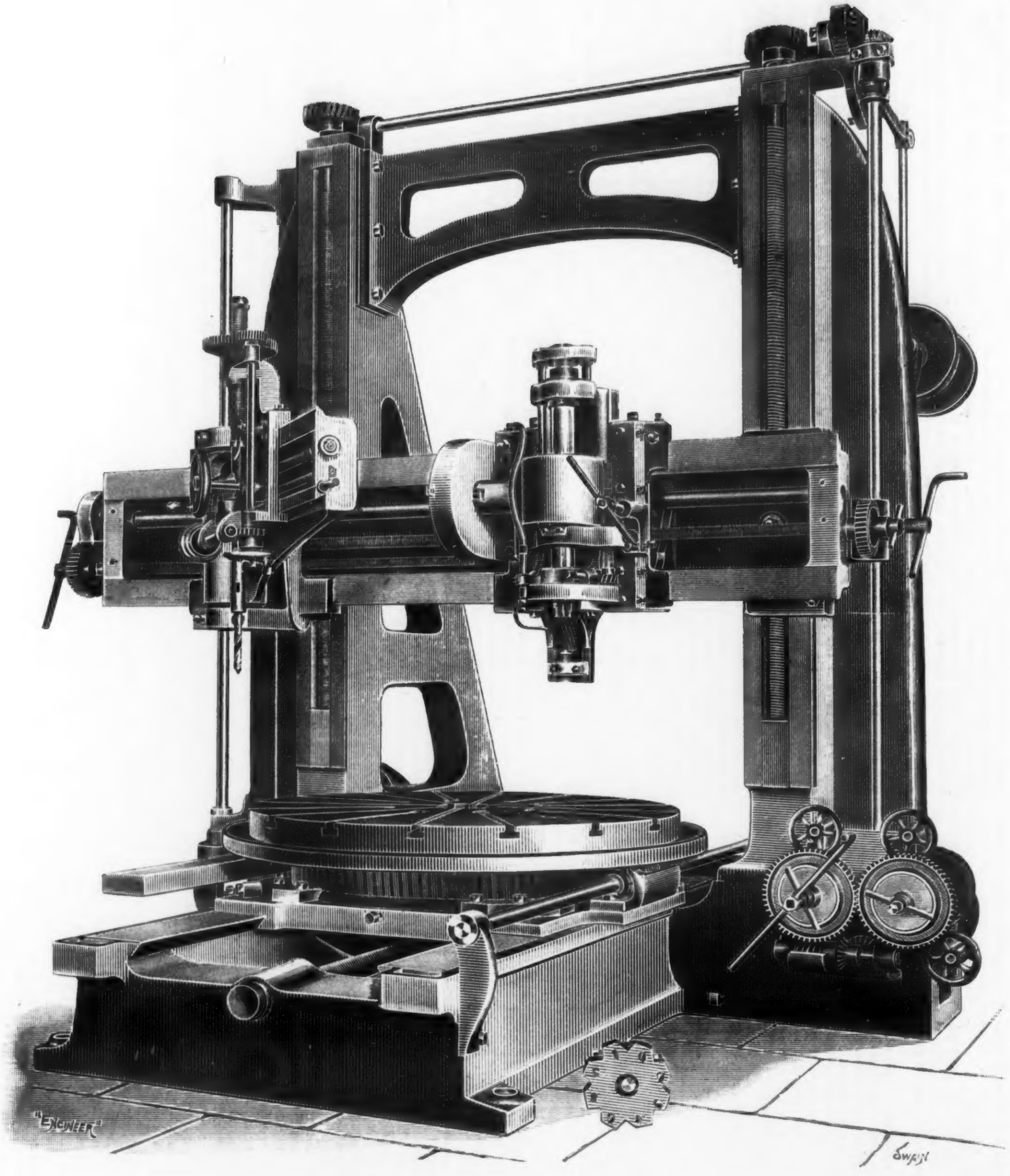
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Fig. 2—CIRCULAR MILLING AND DRILLING MACHINE

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*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies*

F. B.—*See* THE ENGINEER, *19th July and 9th August, 1895.*

C. W. R. (Devonport).—*Your idea was illustrated and described during the discussion on water-tight doors. The great space occupied is a serious objection to the scheme, which was simply ignored by those who took part in the discussion.*

H. G.—*There is no special treatise on governors such as you ask for. The subject has been fully dealt with in almost every treatise on the steam engine, while papers have been read about them in considerable numbers. The eighth chapter of "Goodeve's Treatise on the Steam Engine" will probably answer your purpose.*

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

HULL AND DISTRICT INSTITUTION OF ENGINEERS AND NAVAL ARCHITECTS.—Monday, April 20th, at 8 p.m. "Paper: "Narrow Gauge Railways," by Mr. J. B. Hutchinson.

SOCIETY OF ARTS.—Monday, April 20th, at 8 p.m. Cantor Lectures. Paper: "Precious Stones," by Professor Henry A. Miers, M.A. Lecture II. Wednesday, April 22nd, at 8 p.m. Paper: "The Perfected Photochromoscope and its Colour Photographs," by F. E. Ives. Thursday, April 23rd, at 8.30 p.m. Indian Section. Paper: "The Deserted City of Vijianagar," by Captain Charles Rolleston.

ROYAL INSTITUTION OF GREAT BRITAIN.—Saturday, April 18th. Afternoon Lectures, at 3 a.m.: "The Vault of the Sixtine Chapel (I.)," by Professor W. B. Richmond, R.A. Tuesday, April 21st. "Child Study and Education (Lecture II.)," by Professor James Sully, M.A., LL.D Thursday, April 23rd. "Recent Chemical Progress (Lecture II)," by Professor Dewar, M.A., LL.D., F.R.S., M.R.I. Friday, April 24th, at 9 p.m. Paper: "The Circulation of Organic Matter," by Professor G. V. Poore, M.D., F.R.C.P.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, April 21st, at 8 p.m. Papers to be discussed: "The Thirlmere Works for the Water Supply of Manchester," by Mr. G. H. Hill, M. Inst. C.E. "The Vyrnwy Works for the Water Supply of Liverpool," by Mr. G. F. Deacon, M. Inst. C.E. Thursday, April 23rd, at 2.30 p.m. Students' visit to the Linde British Refrigeration Company's Works at Lower Shadwell.

"THE ENGINEER"

1100 GUINEA ROAD CARRIAGE COMPETITION.

We are now able to publish the full conditions which will apply to our competition. They will be found on page 385. Many of our readers will perhaps be glad to note that we have seen our way to add another substantial prize to the list previously announced.

THE ENGINEER.

APRIL 17, 1896.

ENGINEERS OF THE ROYAL NAVAL RESERVE.

IT will probably be news to the majority of our readers that there exists a Royal Naval Reserve of Engineers. It is well known that there is a Royal Naval Reserve of officers and men, but the engineer branch of the same reserve is in quite a different and indeed obscure position. The R. N. E. R., as it is commonly called, exists more in name than in fact, and yet strangely enough the Admiralty appear to rely on it to help them out of difficulties. Probably nothing more remarkable or anomalous is to be found in the whole of our naval policy than the history and position of this body of marine engineers. On the 17th of March Mr. Cooper read a paper before the Institute of Marine Engineers, which contains probably all the information which exists on the subject. It was followed by a discussion which extended over a couple of evenings, and to this paper and the discussion we are indebted for most of our facts.

From the earliest period of the introduction of steam into the navy there has been a scarcity of engineers. About sixteen years ago the Admiralty determined to form a reserve of mercantile engineers who would be willing to serve, when called upon, in her Majesty's ships. We reproduce the conditions of service in a somewhat condensed form:—"The officers of the Royal Naval Reserve are to rank with, but after, officers of the Royal Navy of their corresponding rank. A senior engineer must hold a first-class engineer's certificate; have had at least three years' service in sole charge of machinery of a high speed British ship of not less than 500-horse power, and not less than eight years' service at sea as an engineer. An engineer officer must hold a first-class engineer's certificate, and have served at sea for at least three years as a certificated engineer, and have had at least one year's service as chief engineer of a British ship of 200-horse power, or as second engineer of a high-speed British ship of not less than 500-horse power. An assistant-engineer must hold a first or second-class engineer's certificate; have served at sea on a British ship for not less than one year as a certificated engineer. The age on first appointments of officers shall not exceed—for senior engineers, 50 years; engineers, 40 years; and assistant-engineers, 30 years. Officers of the Royal Naval Reserve are to wear the same uniform as officers of corresponding rank in the Royal Navy, with a few slight exceptions in buttons, braid, &c. Officers of the Royal Naval Reserve will be called out for active service by Royal Proclamation, and they will be liable to serve during the continuance of any national emergency, or until they may be regularly discharged by the direction of the Lords Commissioners of the Admiralty. Officers whilst embarked for voluntary service or for naval training will be subject to the Naval Discipline Act, and will receive the same pay and allowances, and share in prize money, with officers of the corresponding rank in the Royal Navy, and they will whilst on service be treated in the same manner in every respect. Officers who may receive hurt or wounds whilst on active service in the Royal Navy, or whilst undergoing drill, will receive the same pensions and allowances to which officers in the Royal Navy would be entitled under similar circumstances. Widows and children—if any—of officers who whilst on actual service may be killed in action or die from accident resulting from the performance of their duty will receive the same pensions as the widows of naval officers of corresponding rank would be entitled to under similar circumstances."

All this appears to be reasonable enough, but it is only reasonable on paper. The oldest commission held by a Royal Naval Reserve Engineer dates back to 1881. At one period a good deal of pressure was brought to bear to induce men to join, but according to the last Navy List, while the Admiralty provides for 150 engineers and 150 assistant-engineers, the total number on the list is 149 senior engineers and engineers and 52 assistant-engineers. Thus, then, while the Admiralty have asked for 300 men, they have got but 201. The smallest number of engineers that will suffice to man our ships in war time is about 1100. According to the Navy List, we have about 800 available, and the Reserve men. For full information on this point, however, we must refer our readers to the table prepared from official sources published in our impression for March 7th, 1895. It is not our purpose now to go into the question of how many engineers are wanted. It will be enough if we say that there is absolutely no provision whatever made for the loss of engineers in service. The Admiralty appear to think that the naval engineer is endowed with a charmed life, and that he will neither break down mentally nor bodily during war-time, and that he will never be shot or drowned. or scalded to death. In short, engineers are never to be "expended." Common sense tells us that, although a ship in time of peace may do with two engineers, or even with one, in time of war the number should be doubled. But leaving this question, let us consider why and how it is that mercantile engineers have not enrolled themselves in the reserve. The explanation is simply that they have nothing to gain by the enrolment. It is about as useful as a foreign order; there is no pay attached to it. It does not confer position. It does not teach. It is very frequently, and no doubt truly, said that if war broke out hundreds of merchant steamers would be laid up, and that from their engine-rooms the Admiralty could obtain plenty of men but the men so obtained would be in all respects on the same footing as the men of the R. N. E. R. What possible inducement, then, exists for joining that body now? None that we can see.

When the Reserve was formed it was generally believed that the men of the Reserve would undergo a special training to fit them for service on board men-of-war, but nothing of the kind takes place. Some misapprehension exists on this point. We have often heard it argued—and the argument was freely used in the course of the discussion on Mr. Cooper's paper—that the mercantile engineer who holds a chief's certificate is competent to take charge of the machinery in any ship of war at a moment's notice. Now we mean no disparagement when we assert that this is a thorough mistake. The man whose experience has been confined to triple-expansion engines, with long connecting-rods, indicating from 800 to 2000-horse power, and making 60 revolutions per minute, is not thereby qualified to take charge of engines indicating 4000 or 6000-horse power, with short connecting-rods, and making 160 to 180 revolutions per minute. We say nothing of forced draught. The cramped space in the engine-room of a ship of war is enough to strike the inexperienced with dismay. But even if we admit that the mercantile engineer knew all about the machinery of the warship, it still remains a fact that he can know nothing about the life on board a man-of-war—the rigid discipline, the special conditions under which he would have to live and move and have his being. As one speaker said, the newcomer would not even know from their uniforms the relative rank of the executive officers. The obvious remedy is, of course, to give all the engineers of the Reserve an opportunity of acquiring practical insight by taking them on board men-of-war in commission. All the other reserve forces of the nation get practical training, and in many instances this training is very thorough; in none can it be called superficial. Mr. Cooper, in his paper, advocated a training of twelve months on board ship. We agree with several of his hearers that the period is too long, and it would not take account of progress. Thus, for example, a man who had twelve months' training in 1896-97, and was not called on to serve again until well into the twentieth century, would be very little better off than the man who had not served at all. The proper course is each year during the naval manœuvres to draft for service on board a certain number of engineers of the Reserve to act as supernumeraries. Their presence would be a very welcome relief to the strain now put on the engine-room staffs, and the opportunities for learning would be very considerable. By taking in this way a couple of dozen men every year, the whole body would by degrees be passed through the Navy. This service should be compulsory, but, of course, properly paid for; and there would be very little difficulty met with in avoiding the infliction of any hardship. But besides this compulsory service, special facilities should be provided for giving a longer training, say three or six months, to those who desired it. We have no doubt but that this training would be highly popular, and that the ranks of the R. N. E. R. would very quickly be filled to overflowing under the new conditions. It is impossible to overrate the valne of a body of 500 or 600 men, fairly well versed in the routine of life on board a man-of-war, and possessing some practical acquaintance with the highly specialised steam engines used in propelling them. So great are the advantages, indeed, to be secured in this way, that we find it impossible to frame any legitimate explanation of the curious policy pursued by the Admiralty. They do not consider any man competent to take charge of machinery in a ship of war unless he has undergone a most expensive and elaborate training; and yet they are content to accept an engineer out of a tramp steamer without any special training whatever in war time, when experience and special knowledge are most needed. The only feasible explanation of the matter is that the Admiralty regard the R. N. E. R. as a sham—a thing got up to meet a political temporary difficulty, and consequently my Lords will not spend sixpence to render the Reserve really efficient. Truly, the ways of Whitehall are wonderful. Possibly the authorities think that ships of war are still propelled by sails, and only make believe that the sailor is extinct and the engineer has taken his place.

BOILERS FOR ELECTRIC LIGHT STATIONS.

THREE of our electrical contemporaries have done us the honour of considering at some length our article on "Boilers for Electric Light Stations," which appeared in our impression for the 27th of March. One of them has reprinted the article. All three criticise our statements, but they are not agreed among themselves. It will be remembered that we stated that the Lancashire boiler, as used in mills, was as well adapted for producing electricity as cotton cloth, and we added that electric light engineers were beginning to find this out, and that the water-tube boiler was by no means the only one adapted to his wants, or competent to satisfy his wishes. The comments of the *Electrician* are not the least interesting of the criticisms to which we refer, and to them we shall for the moment confine our attention. Our contemporary begins by saying that it is "not unnatural that the mechanical engineer should regard an electric light station as nothing else but a factory, and often fail to see why the mill engines and Lancashire boilers have been discarded." Now, as a matter of fact, the mill engine is used pretty freely; but we are not now dealing with engines, and need not further refer to them. Confining our attention, then, to boilers, we find that our contemporary after all not only admits that the Lancashire boiler will do, but that it is doing to such an extent that over 60 per cent. of the boilers used in the provinces for the production of electricity are of the Lancashire type, while only 22·3 per cent. are of the water-tube type. "It is only in the metropolis that the compact inexplosive boiler has a prominent place." The *Electrical Review* says much harder things of the water-tube boiler than anything we have uttered, while of the Lancashire boiler it says:—"As a matter of fact, a Lancashire boiler can be made equal to its 160 lb. or 200 lb. pressure easily enough, and it is then far safer than water-tube boilers, and will remain safe and in good order for a period of time sufficient to end a boiler of locomotive type, and to renew a water-tube boiler several times over. It thus happens that both in first cost, steam dryness, efficiency, upkeep and scrap value, the Lancashire boiler has not yet been equalled by any other type for genuine hard work, and as it can hardly be fired to the extent of damage, and so can burn coal at a greater rate per square foot than its rival, there appears no reason to suppose that, in well-designed electrical works, it will be found absent to anything like the extent that has been the case in the past."

The *Electrical Engineer* holds that the Lancashire boiler will not answer where the load varies considerably, and goes on:—"In the electric light stations in London the water-tube boiler has carried all before it, and we would uphold this practice. The chief reason for this result has doubtless been its quick steaming properties. The electric light supply must necessarily be continuous, and the sudden demand when a fog arises in London could not be met with Lancashire boilers without considerable loss due to boilers standing under steam." But it adds that the Lancashire boiler does very well in such towns as Bristol, Newcastle-on-Tyne, Manchester, and some other towns named; and, further, it claims that where ground space is very valuable the water-tube boiler has a great advantage. So much for our contemporaries. We may now proceed to call their attention to a few facts which they have not unreasonably overlooked. We take it for granted that their criticisms in question have been written by electricians or electric light engineers; and it is no discourtesy to assume that these gentlemen have had practically no personal experience with the Lancashire boiler; nor do they know at first hand what it can and what it cannot do. They are in precisely the same position as the gentlemen who first put up electric light installations, who knew nothing practically about the Lancashire boiler, and adopted the water-tube boiler for reasons which we have already fully explained and need not repeat here. This ignorance has led our contemporaries to make certain statements which are contrary to the facts. The first is that the water-tube boiler is a necessity, because steam can be got quickly in it, and cannot be got up quickly in the Lancashire boiler; and the necessity for getting up steam quickly is the sudden advent of fogs. Now a very moderate acquaintance with Manchester would convince our contemporaries that the metropolis does not stand alone in the matter of fogs, and that if Manchester can get on with Lancashire boilers so can London. But the sudden advent of fogs is a very rare occurrence, and can only affect the proceedings of the electrical engineer when it occurs in the day time. Every night those in charge are ready for their load, and that is the same to all intents and purposes, fog or no fog. It is a complete mistake to imagine that a water-tube boiler can be rushed in the way our contemporary supposes. Any attempt to do that will bring a more or less heavy reckoning. In an electric light station, provided with Lancashire boilers, steam would never be let down in those on duty. The dampers would be closed and the fires banked. These boilers would stand for twelve or fourteen hours, neither making nor losing steam, with an extremely small consumption of fuel. In case of emergency, they could be got into full work in a number of minutes fixed by the getting away of the fires; the water in them is boiling hot, and with a good draught the fires soon burn up, if they are not smothered at the outset by an injudicious fireman. Fifteen to twenty minutes ought to suffice to get a Lancashire boiler into full work from the moment the dampers are raised and the fires drawn forward. The water-tube boiler, on the other hand, "stands" very badly. The volume of water in it is small, and the size and shape of the grate are such as to make banking without an extravagant consumption of coal, very difficult. Let us suppose that three large Lancashire boilers supplying, say, 600-horse power each, are sufficient for the top load of a station. All three will be under steam. One takes the day load, perhaps 300-horse power, with the dampers partly closed. As the load augments the dampers are drawn. Then the second boiler is started, and finally all three are in use. Now, the advent of a fog in the daytime could only mean drawing the dampers, say, at 10 a.m. instead of 7 p.m.; and we have not the smallest hesitation in asserting that working in this way less coal would be burned than would be needed to light up each afternoon a couple of water-tube boilers which had had their fires drawn the night before. We say this as the result of practical experience with water-tube, Lancashire, and locomotive boilers. Of course, it is possible to work the Lancashire boiler with disastrous results. It is only necessary to draw the fires and let it cool down every day to secure that undesirable end. But any man who understands how the boiler ought to be managed will find that it is just as ready to meet an emergency as any other type in the market.

The second erroneous assumption made by our contemporaries is that the space occupied by the water-tube boiler is much less than that filled by Lancashire boilers of equal power. This is very far from being necessarily true. We need scarcely tell our readers that the water-tube boiler bears forcing very badly. It is one thing to have heating surface, and another to be able to make use of it. We think we may venture to say that the power that can be got out of a set of properly designed Lancashire boilers in a twelvemonth will be at least as great as that which can be got out of a set of water-tube boilers filling the same ground space in the same time. The time required for cleaning must be included in our calculations. It would be interesting to know what percentage of all the water-tube boilers in any given installation—say the City of London for example—is available for steam making all the year round. This is the proper way to look at the question. If a water-tube boiler has to be cleaned every five weeks, and a week is spent in the cleaning, then it is clear that not more than 80 per cent. of the boiler power is at any time available; and the fact must be taken into consideration in estimating ground space.

Lastly, we may point out that the water-tube boiler possesses certain advantages, and should always be used when these advantages can be displayed. A waterproof coat is an extremely useful and even necessary garment at times; but it does not at all follow that it is really the best coat a man can wear. The talent of an engineer is shown by the way in which he adapts himself to circumstances, and selects out of the multitude of expedients presenting themselves that which is most suitable to the circumstances. It would be very bad engineering to spend large sums in pulling down buildings in order to make a road for a large Lancashire boiler into some of the contracted courts of London while a water-tube boiler was ready to hand. In engineering there is a proper place for everything. Our quarrel, if such it may be called, with the electrical engineer is not that he has used the water-tube boiler, but that he has adopted it to the exclusion of that type which by long and excellent service has proved its claims to consideration. We confess that until we had read the statement which we have quoted from a contemporary, we had no idea that the weight of these claims had been so fully recognised in just those places where the most extended experience in the production of steam is available for the guidance of the electrical engineer.

THE DISCHARGE NOTE SYSTEM IN COLLIERIES.

There was an issue raised of more than local concern in the Discharge Note crisis, which, for a while, threatened the South Wales and Monmouthshire coalfields with a calamitous strike. The representatives of The Engineer in those districts have informed our readers of the origin of the problem, and the happy solution which was found for it. There is no fear of a strike now, or any reason to fear a strike in the immediate future on this particular point of South Wales colliery regulations. The position nevertheless was grave, and if the acuteness of the gravity has been diminished, it leaves the original questions open for discussion on either side, and for the matter of that, in every coal mining region in the kingdom. The cause of the troubles in South Wales was the sudden and, as it appears to us, the injudicious enforcement of a practice of requiring every miner seeking employment in another pit to produce a circular letter of recommendation from his former manager. It meant this, that no man should be taken into occupation who could not show "a clear discharge," as it is called, in the mercantile marine. There is little doubt that the Discharge Note was an institution at a few collieries in the district twenty years or more ago; and then the men, so far from being averse to it, welcomed the document as a voucher to their skill and character. Of recent years, however, the custom appears—with one or two exceptions—to have fallen into disuse, until, a few months ago, the South Wales Coalowners' Association determined to revive it, and make it of universal application in the collieries under their control. So long as it remained in practice in a pit here and a pit there it was at least tolerated. It was when the employers directed that the Discharge Note system should be made obligatory everywhere that the colliers revolted, and began to exhibit an indignation and resentment which so cautious a miners' leader as Mr. W. Abraham, M.P., described as more ominous than any outburst of feeling he had known since the sliding scale was established seventeen years ago. The protests were general, and proceeded directly from the colliers, not from their agents on the Sliding Scale Joint Committee. The withdrawal of the note was demanded or a strike was the alternative, and only by a majority of ten votes in a delegate meeting representing 93,000 miners was a strike averted pending renewed negotiations with the Coalowners' Association. Well, that is all over, and because it is all over it is additionally well.

It is not easy at a distance to discover the secret of an agitation which came so near to being a catastrophe. It is certainly difficult to understand why the coalowners should have taken up a position from which they have already in a measure been forced to recede; or why the colliers should have shown such a temper over a regulation, which, even if an innovation, must operate as much to the benefit of the skilled and steady workman as to the detriment of the ne'er-do-weels, who are no fewer among the Welsh colliers than in other mining communities. Some facts, however, are on the surface, and with these and a recollection of the bitter contention over the almost similar "character note" in the Northern coalfield in the seventies, it is possible to explain, and perhaps with some profit, the causes of what momentarily looked like a very dangerous position. The employers are continually being urged by the miners to institute safeguards against the admission of unskilled men to the underground workings. That has been the theme of fervent speeches at trade congresses and miners' conferences for time out of mind, and more than once the wisdom of Westminster has been invoked, though without effect, to put a check upon the underground employment of all sorts of casual labourers and hobbledehoys. Whether the Discharge Note would or would not serve that purpose—whether a less obnoxious means of ascertaining a man's competency could not be adopted—may be an open question. It is intelligible, at any rate, that the South Wales coalowners should have thought that they had hit upon a serviceable device to protect the trained miner from the amateur, and at the same time secure for themselves efficient service in the workings. It is claimed, moreover, that the Discharge Note would place a check upon a practice which vexes the soul of every colliery manager, and nowhere more than in Glamorganshire. Every one connected with mining operations is familiar with a class of men, unmarried men as a rule, who drop their tools after two or three days' work, or who will not descend the pit until mid-week, or who seize the flimsiest pretexts for finding fault with the timbering, or the ventilation, and sow the seeds of discontent wherever they go. A note which indicated the reason for the dismissal of a man of this kind, it is argued, would operate as a timely warning to other managers to whom he might apply for work.

But the strong point in the remonstrance of the South Wales workmen, and one that seems to have been practically admitted, is that the introduction of the Discharge Note is a breach of the sliding scale agreement of 1879, which provided that no alteration in the customs of the trade should be valid unless approved after consultation between the two parties on the Joint Committee. Other objections strike much deeper, but there the men are upon less stable ground. They complained that the note system is not only open to abuse, but was being abused. It enabled a spiteful or capricious manager, they say, to "mark" a man by some cryptic sign on the otherwise fair-seeming paper, and thus prevent him from gaining employment anywhere in the coal basin. The Welsh miner is possibly no more superstitious than his fellows, despite his delusions about the "red dog" and the "voices" as the forerunners of an explosion; but he has more than the ordinary Celt's share of suspicion, and it has manifested itself in connection with the Discharge Note agitation in a manner which would be ludicrous but for the seriousness of the issue then impending. The Discharge Note shall be clean on the surface; and, in fact, to all appearance as good a recommendation as a collier can desire. Workmen have actually been known to hold it to the light, and scrutinise it dubiously, because the report had been spread that the watermark bore a mysterious message from one manager to the other. Nonsense of this description is, of course, beneath notice. The allegation that the Discharge Notes were privately endorsed by colliery officers—though the charge appears incredible—was deemed important enough to be dealt with, and the Coalowners' Association issued a circular to pit managers enjoining them strictly to observe, and add nothing to, the printed form. But the main fact is that the Discharge Note, more especially the manner of its introduction, was resisted—and very angrily resisted—by close upon 100,000 colliers, who threatened to strike work if the employers persisted in its use.

It would be a thankless task from any point of view to discuss the question as to who was responsible for the Discharge Note fiasco in South Wales. It would appear from the information placed at our readers' disposal from the Principality that the colliers themselves would have been glad to accept certificates of competence if they had only been consulted beforehand. The one question, serious as it might have been, raises a question which may become more serious still. The position of mine-owners is changing with the course of the years. We used to have the "Father of the Mine," literally the founder of the industry, which occupied four or five hundred hands. The collieries now-a-days in the West as in the North seem to be day by day being converted into limited liability companies. The transmutation is a good thing in its way, no doubt, but it alters very materially the old relations of master and man. The situation we have been describing can be summed up in a compendious sentence. Under the old private ownership Discharge Notes were never thought of, never needed. They may be necessary in this later time; but the necessity, it may fairly be suggested, is caused by the people who have created the changed conditions.

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COPPER MINING IN SPAIN.

Perhaps the most notable of the mining companies that British capital has formed to work in Spain is the Tharsis Sulphur and Copper Company, and it is certainly one of the most lucrative. In twenty-nine years it has had gross profits to the extent of £8,343,378; and after providing for depreciation, reserves, &c., it has divided more than £5,500,000 amongst its shareholders. In its last year it extracted from the famous Tharsis mines 278,441 tons of mineral; and at the Calanas mines the mineral extracted was 298,424 tons; whilst the extraction of ore has now been begun at the Lagunazo mines, 35,618 tons having been obtained. Thus, the Tharsis Company raised at its mines over 612,000 tons of mineral last year, and the copper produced showed a considerable increase on that for the preceding year. By the policy of writing off depreciation liberally, the value of the property is kept low. The original value, for instance, of the Tharsis and Calanas mines was £709,228, but £564,228 have been written off, so that the book value of those two great mines is very moderate; and this is the policy pursued with other property. It is thus partly to the low price at first, to the system of writing depreciation out of profits, and the comparatively low cost of production of the mineral in Spain, that the great mining companies of which the Tharsis is the type have been able to realise profits that are undoubtedly large. For instance, in the company of which we have given the above particulars, the average dividend since the formation has been slightly over 17½ per cent. per annum on the average—a return that must be considered an excellent one. As a matter of course, it has been aided by the fall in the freight for the ore from Spain to the smelting and extracting works—the rate being about half what it was. Naturally the price of copper, as well as of sulphur, has fallen considerably, but the enlargement of the output and the making of a fuller use of the mineral raised has been in degree a counterpoise. There are few industries in which there has been so marked a removal of the waste as is now the case in the sulphur-copper ore treatment, and hence there is the very admirable result that has been indicated; and should the movement in prices continue upwards, it is quite probable that the results of the next year to be reported on may prove even better than those of the last.

LITERATURE.

Life and Letters of the late Admiral Sir Bartholomew James Sulivan, K.C.B. 1810—1890. Edited by his son, Henry Norton Sulivan, with an introduction by Admiral Sir G. H. Richards, K.C.B., F.R.S. London: John Murray. 1896.

During the last few years there has been a happy increase in the number of naval biographies and books on naval subjects. This is as it should be. A people so largely dependent upon a navy as we are cannot neglect any means of arousing and maintaining a popular interest in naval subjects. Mr. Sulivan has done good work in giving to the world this life of his father, and his brother, Commander Sulivan, is doing the like for their maternal grandfather, Admiral Bartholomew James, whose life will form one of the publications of the Navy Records Society. Admiral Sulivan was a remarkable man in many ways, and in his own branch of the service probably no officer excelled him in seamanship and the peculiar qualities which go to the making of a navigator and hydrographer. His training began as midshipman of the Thetis. In 1828 he joined the Beagle, under Fitzroy, who had been lieutenant of the former vessel. The six years passed by him in the Beagle in the tempestuous region of the Magellan Straits and Cape Horn were such, Admiral Richard says, as few men had experienced, and it is not too much to suppose that the experience so gained went a long way in the forming of that reputation which he afterwards acquired for judgment, coolness, and promptitude of action. He subsequently commanded the Philomel, which was engaged in the surveys of the Falkland Isles, the river La Plata, and the upper waters of the Paraguay and Parana, and it was while so employed that the combined operations of the English and French squadrons against the Dictator Rosas in 1845 gave him ample opportunities for the exercise of his special qualities as a strategist and pilot. How magnificently he succeeded, how he safely piloted the ships, with one or two exceptions without steam power, for months in difficult and almost unknown waters, to the admiration of both squadrons, must be read in the book itself. In 1854, when we were at war with Russia, he was appointed to command the Lightning paddle-steamer of three guns, the first steam vessel built for the Navy. His instructions were to join Sir Charles Napier in the Baltic, for surveying and pilotage duties. Sir Charles did not receive him very cordially. He told Captain Sulivan, before several officers, that he did not know what he had come out for, or what was the use of a surveying ship, unless to make a fire vessel of! However, after many disappointing, not to say irritating experiences, the value of the "surveying ship" and her commander were ultimately recognised by the admiral, and still more warmly by his successor, Sir R. A. Dundas. The long and detailed accounts of the almost daily work of the fleet in the Baltic which Captain Sulivan sent home in his letters to his wife, under strict injunctions to treat them as confidential, are deeply interesting, and it is not too much to say that they form an important contribution to the history of our naval operations in those parts. We have not space to make extracts from them, we can only recommend them to the perusal of our readers, who will find much in them of interest from a professional point of view, and will derive not a little pleasure and amusement in drawing comparisons between the then and present conditions of our Navy, comparisons which make strikingly conspicuous the changes which forty years only have brought about. What should we think now-a-days of a captain who, in a moment of emergency, did not hesitate to force a large frigate by press of sail over an extensive reef in a gale of wind, when every blow in the hollow of each sea jerked up the boats on the upper deck? Yet Captain Cooper Key's proceeding does not seem to have been exceptional. Indeed, Captain Sulivan expressed an opinion that iron vessels were not useful for surveying, because they would not bear knocking about on the ground. The steamers of our fleet at that time seem to have had a speed of 8 or 10 knots. One of Captain Sulivan's letters tells us that "the James Watt, built especially for the screw, has expended 45 tons—of coal—to keep her station during the last twenty-four hours, whereas the old lump of a three-decker—Royal George—has only expended 33 tons, though under sail a slower ship. We—the Merlin—have done much the best of the paddles, having, with 312-horse power, only used 12 tons; Firefly, of 240-horse power, 16 tons; and Locust, of 100-horse power, 10 tons; little Lightning, 100-horse power, 5 tons." Cholera seems to have attacked the crews of the steam vessels, while the ships companies of vessels which had no steam power escaped. This was put down to the heat from the boilers. In proof that there is nothing new under the sun, we find Captain Sulivan elaborating with his brother a scheme for sounding operations at the barrier in the Cronstadt Channel, to be conducted by them in something very like Boyton swimming dresses. Again we have an account of the trial in Poole Harbour of a submarine boat, which, by the way, nearly drowned its occupants. This boat is described as like a large inverted whale boat of iron, with a chamber at each end filled with compressed air. It was lowered keel uppermost, the crew being under the thwarts. When the boat was allowed to sink nearly to the bottom, the men got down and, with their heads in the air-filled boat, pushed it along as they walked on the ground. It was intended for use against the boom at Cronstadt. The volume contains an illustrated description of the submarine mine, or "infernal machine," used by the Russians in the Baltic. It differs in some respects from that used by them in the Black Sea, an illustration of which, if we remember rightly, appeared in the *Illustrated London News* of the time. The volume is supplied with an excellent map of the Baltic.

Proceedings of the United States Naval Institute. Vol. xxxi. No. 4. Whole No. 76.

It is possibly because we do not anticipate a conflict with the United States Navy that we in England do not regard it with that attention and interest which we devote to the navies of other Powers. We are wrong in this comparative indifference, not from any political point of view, but from a purely scientific one. The American navy is a navy of experimental vessels, and is, therefore, worthy of the keenest scrutiny, for whether failure or success attend them, experiments costing some millions of money are not to be lightly regarded. In the new United States battleships that skyward tendency which is so well marked a characteristic of American work, as shown in multiple-storied houses and "cloud-capped" funnels, is again exemplified. The turrets of the new battleships are two-storied; on the lower level are placed two 13in. guns, and on the upper level two 8in. guns. The double turret is trained as a whole, so that all four guns point simultaneously in the same direction, except in so far as affected by the angles of elevation. Ensign Joseph Strauss contributes a paper to the current number of the "Proceedings" of the United States Naval Institute, setting forth the reasons that have led to the adoption of this peculiar arrangement. The principal of these are the economising of space and the reduction of weight. Various other arrangements have been tried or proposed, but all have drawbacks. In one, in order that the zone of fire may not be reduced, four turrets, each with two 8in. guns, are used; in another design the 8in. turrets are directly behind and above the 13in. turrets; the objection to this arrangement is that the blast from the overhead guns, however, damages the structures beneath, or interferes with the lower gun crew, so that the design is not practicable. To the writer of the paper the arrangement adopted appears to be nearly perfection. All the difficulties raised he disposes of entirely to his satisfaction; the concentration of weight is nothing, it is not as great as on the Victoria—an excessive case, by the way—the training of all four guns on to one point is "not an objection;" the risk of having "all one's eggs in one basket" is counterbalanced by the omission of at least two entire sets of rotating gear per ship, and so on; and the advantages are, reduced target, simplicity, and "best possible command," &c. This is all very well, but it seems to us that a very serious point has been disregarded, that is, the strain produced if all four guns are fired simultaneously. It is well known that the greatest difficulty the naval constructor has to contend with in building his emplacement for large guns is the necessary structural strength to withstand the tremendous recoil blow. Two guns on one centre have been as much as any one has cared to face up to the present, and such marked success has not attended them as would warrant adding at least fifty per cent. more to the stress. It may be that means will be taken to prevent the four guns firing at once—that in itself will be a drawback—but at the best the guns must for good practice be fired in pairs, for as there is probably a turning moment of, at the least, 4ft. on the 13in. guns, no brake can prevent the turret from jerking out of train if a gun is fired singly. Further, the 8in. guns, though placed in such a position that they tend to balance the turrets, are at such a height above the roller path that the blow downwards and upwards, due to the tilting effects of the fire, will be exceedingly severe. In fact, though up to the present a badly indented roller path or broken roller is almost unknown, we doubt if either roller paths or rollers can be made which would stand the shock produced by simultaneous fire from the four guns at maximum elevation. From a sketch which accompanies the paper, we see that the centre of the 8in. guns above the roller path is about half as long again as the radius of the roller path, so that the blow downwards on the rollers due to the 8in. guns alone would be about equal to three-quarters of the force of recoil supposing the guns were fired vertically; to this must be added the blow from the 13in. guns. The leverage here is about half, and the trunnion being nearly over the front rollers, the blow will be almost entirely downwards on the rear rollers. The maximum pressure in these guns will probably reach about 15 tons per square inch. We leave our readers to estimate what the pressure per square inch of contact of the rollers will be. However, it is not safe to go too far with these calculations from a mere sketch, and we may be overestimating the difficulty. We also notice from the section that the angle of depression for the bigger guns is exceedingly slight, and to meet this they are probably not high above water-line, which experience has shown to be an unsatisfactory position.

By far the most important features in this number of the "Proceedings" are a paper on "Armour for Ships of War," by Professor P. R. Alger, U.S.N., and a part of Assistant Naval Constructor Hobson's reply to the discussion on his paper on the "Disappearing Gun Afloat," which was published in the last number. The conclusions arrived at by both these writers with regard to the distribution of armour run so nearly parallel that they may be advantageously considered together. Professor Alger, after sketching the history of naval armour and the process of manufacture, describes the result of progress in the construction of projectiles and guns, and shows that the attack up to the present has always managed to keep ahead of the protection. He then asks the question, "But if guns now overmatch all practicable armour, and continue to progress as they have in the past, more rapidly than armour, will not they, or even new weapons of offence now unknown, cause the use of armour for ships to be abandoned and become obsolete, as the invention of gunpowder drove out of use armour for men?" There are two arguments in favour of an affirmative reply to this question. The first is based on the "supposed analogy" of ships to men, which is readily disposed of by showing the weakness of the analogy; the second depends on the belief in the advent of a more powerful projectile than any yet known "high explosive shell," so powerful, indeed, that it will destroy armour without actual impact. Professor Alger does not believe that such shells will ever be produced; but even if they are, he points out that armour must be retained for the purpose of excluding projectiles of lesser calibre; and taking an armament of four 13in., four 8in., fourteen 5in. quick, and twenty-six smaller quick-fire guns, he shows that "3in. armour will keep out at least $81\frac{3}{10}$ per cent. of all projectiles, 6in. armour will keep out at least 98 per cent., and 12in. armour will keep out $99\frac{4}{10}$. When we consider the fact that most impacts will not be normal, and that the range will usually be considerable, we may safely say that, under any probable future conditions, armour of about 7in. thickness will keep out 98 per cent. of all projectiles fired against it." The results which the author arrives at are so clearly to the point, that we feel induced to epitomise them here, at the same time commending attention to the paper as it stands. "The following are the principles upon which I believe the armour distribution of battleships should be governed:—(1) The position of the belt should be fixed with reference to the deep-laden draught of the ship, not her light draught. The practice of placing the belt with three-fifths or two-thirds below water at what is called normal draught is bad, because when a ship goes into action she will probably be laden down with extra ammunition, and carry every pound of coal possible. (2) Belt armour should be thick enough to keep out all explosive shell. This will probably require a thickness equal to the calibre of the largest gun brought against it. The new English battleships are to have only 9in. side armour; but I think this is hardly sufficient. Our 13in. common steel shell will carry a bursting charge of 60 lb. through that armour if they hit normally. (3) The heavy guns should be protected normally by turrets, and their supports by barbettes. The armour on both 'should be thick enough to keep out explosive shell, but the turret should, if possible, be thick enough to keep out all projectiles.' Compare this with Mr. Hobson's views given below. (4) Ammunition tubes or other means of protecting ammunition in transit from magazine to turret are worse than useless, except in the case of the heaviest guns, where any damage to the mechanical hoists would put the guns out of action. The danger of a hoist being stopped by indentation of the protecting tube is a grave objection. (5) Heavy conning towers are also worse than useless. The impossibility of getting a commanding view from such a station would certainly prevent the captain of a ship from occupying the conning tower in action." A comparison between two existing American ships and the new battleships is given, which we tabulate here, as it is of considerable interest.

	Indiana. Tons.	Iowa Tons.	New Ships. Tons.
Protective deck	534	562	556
12in. or 13in., and 8in. gun position	1556	1440	1600
Side and bulkhead	1085	1045	1083
Protection to secondary battery	38	39	381
Conning tower and tube ...	55	56	57
Cellulose	55	65	60
Bolts and backing	201	168	235
Total weight of protection ...	3524	3375	3982

Professor Alger, in conclusion of a very able paper, urges the necessity of keeping up the calibre of the guns. "The increase of 1in., from 12in. to 13in., seems small, but it means an actual increase of energy of one-third, and a sight of the results of firing the 12in. and 13in. guns at the same plate would convince anyone of the great value of this increase."

Let us now turn to a section of Mr. Hobson's reply. As regards the protection to be allotted to the guns, that on the turrets and barbettes is most efficient, and should therefore be given most favour, but at the same time, as big guns are practically invulnerable, the protection should as much as possible be kept to the rear end, to protect the loading and breech mechanism, and the crew. On the other hand, medium calibre guns are comparatively vulnerable, and should be more amply protected than is the custom at present.

As regards the protection devoted to the hull, the buoyancy, stability, and uprightness of the vessel have chiefly to be considered, and as these depend imtimately on the "vitals" of the ship, extra weight, or weight saved from the gun protection, should be devoted to making the armour deck powerful enough to resist all shell entering at an angle of 7 deg., and the belt armour must be taken so far down that at maximum roll in which a vessel could be fought, no part of the hull entirely unarmoured should be exposed. But "the effectiveness of armour weight applied to hull protection is not great, the armour being spread over large areas, which form only a fraction of the areas necessary to be armoured to ensure security, and the disposition on these areas not furnishing a high degree of security;" however, "in the case of the hull the demand for armour protection is absolute, but the meeting of this demand can at best be but partial on account of the ineffectiveness of the armour thus employed."

It is satisfactory to know that both these writers speak in high terms of the system of armouring adopted in our own new battleships of the Majestic class. We have considered these two papers at some length, as they are of great importance, and we strongly recommend a careful study of them to such of our readers as are interested in ships of war.

SHORT NOTICES.

Association of Surveyors of H.M.S. Service. Occasional papers. Second series. December, 1895. Brighton: Trill and Sons, 21 and 22, Duke-street. Price 2s.—This part includes, amongst others papers on approximate estimates, cylinder press for bridges and on small gas plants.

How to Cheapen Inland Transit. By J. E. Palmer, Director of the Grand Canal Company of Ireland. Dublin: Hodges, Figgis and Co., Ltd. 1896. Price 3d.—This a reprint of an article from the *New Inland Review*, and its object is to show how valuable for inland transit canals have proved to be, especially in countries, including France, Belgium, and Holland, whose traders compete severely with those of Ireland. The author suggests a clause in the forthcoming Irish Light Railways Bill, making all the Tramway and Light Railway Acts applicable to navigable inland waterways.

The Slide Rule: A practical manual. By Charles N. Pickworth, N.H., Sc. Second edition. Revised. Manchester and London: Emmott and Co., Ltd. Price 2s.—Since the Gravêt or Mannheim slide rule has been introduced into this country, and particularly since the white celluloid faced rule has been made, it has rapidly grown in favour amongst engineers, and although its simpler applications are rapidly learned, the more complex uses require more study and a better knowledge of the principles involved. The mechanical principle is cleverly, because simply, put in this little book, and the reader with moderate patience is led on by easy steps to a comprehension of the whole of the uses of this very convenient form of calculation. As an observer in one of the northern counties of Great Britain once said to a user who was getting ten results of engine power during some brake trials whilst he could get one, "Aye mon, 'ats a grahn bit of stuck." The numerous examples worked out by the author are very valuable as means of learning, and add to the usefulness of what appears to be the best book on the subject.

We have received the first two numbers of *Architecture*, a "monthly magazine of architectural art." They are interesting, abundantly illustrated, and thoroughly well got up.

BOOKS RECEIVED.

Administration Report of the Public Works Department, Irrigation Branch, in the Madras Presidency, for the year 1894-95. Madras: Printed by the Superintendent, Government Press. 1896.

Argon and Newton: A realisation. By Lieut.-Colonel W. Sedgwick, late of the Royal Engineers. London: W. B. Wittingham and Co., Ltd. 1896. Price 7s. 6d.

The Magnetic Circuit. In Theory and Practice. By Dr. H. du Bois. Translated by Dr. Atkinson. With ninety-four figures in the text. London: Longmans, Green, and Co. 1896. Price 12s. net.

The Sheet-metal Workers' Instructor, comprising a selection of Geometrical Problems and Practical Rules for describing the various patterns required by zinc, sheet-iron, copper, and tin-plate workers. By Reuben Henry Warn. New edition. Revised and greatly enlarged by Joseph G. Horner, A.M.I.M.E. With more than 400 illustrations. London: Crosby Lockwood and Son. 1896.

The Nicaragua Canal and the Monroe Doctrine. By Lindley M. Keasby, Ph.D.—*The Advantages of the Nicaragua Route.* By J. W. Miller.—*The Nicaragua Canal and the Economic Development of the United States.* By Emory R. Johnson, Ph.D.—*Papers submitted to the American Academy of Political and Social Science.* Issued fortnightly. Philadelphia.—*American Academy of Political and Social Science.* London: P. S. King and Son.

INSTITUTION OF CIVIL ENGINEERS.

SIR BENJAMIN BAKER presided on Tuesday evening at the dinner of the Institution of Civil Engineers, which was held in the Queen's Hall, and at which a very large number of members of the Institution and their guests sat down, including the American Ambassador, the Duke of Teck, Mr. Goschen, M.P., Sir Redvers Buller, Lord Medway, Lord Balfour of Burleigh, Mr. Shaw-Lefevre, M.P., Mr. Bryce, M.P., Sir A. Arnold, Mr. Courtney, M.P., Sir F. Abel, Major-General Sir Charles Wilson, Sir G. Molesworth, Sir E. H. Carbutt, Sir M. Ommanney, General Sir E. Williams, Judge Waddy, General Sir R. Grant, Sir J. Kitson, M.P., Sir M. Fraser, Sir D. Galton, Sir R. Herbert, Sir G. Bruce, Mr. Hayter, Mr. A. J. Barry, Mr. J. W. Barry, Sir Lowthian Bell, Mr. Brunel, Mr. H. Brunlees, Mr. J. Brunlees, Lord Colville of Culross, Professor Dewar, and many others.

The toast of the evening was given by the President, who proposed "The Navy, Army, and Auxiliary Forces," and said that in Sir James Graham's time the difference between danger and safety, as respected the Navy, was represented by a sum of £195,000. In our time a First Lord would indeed be glad if he could make a statement of that kind. Mr. Goschen replied at considerable length, who, among other things, said that whatever improvements were suggested it was the duty of the Admiralty to examine them apart from prejudice or preconceived ideas. One of the leading features of modern naval programmes was the new class, the torpedo boat destroyers. These had been built by English enterprise and English skill, and were considered to have a great success at the Admiralty, and had achieved the astonishing speed of 29 to 30 knots. Such an invention as this was not to be laid up in cotton-wool. On the contrary, the Admiralty thought it their duty to submit this new class of ship to the most stringent test of actual experience, to discover what defects could be detected, and what improvements effected. It was their duty in times of peace to discover what weaknesses existed and to remedy them for times of danger.

As regarded naval construction, the Admiralty were assisted by the genius of the civil engineers; and of one thing he was certain, that after the outbreak of war, if disaster should occur, the First Lord of the Admiralty would be hung by an indignant public, and if he should happen to be that unfortunate individual, when he was in the shades and conveyed across the Styx by the ferryman Charon, he would be hailed by a fellow-passenger, who would be the Minister of the country with which we were at war, and who would be in the same condition as himself, and he would be for the first time able to take sweet counsel with his rival, and deplore with his foreign comrade the result of not having followed the advice of the civil engineers.

Sir R. Buller, Adjutant-General, responded for the Army and Auxiliary Forces.

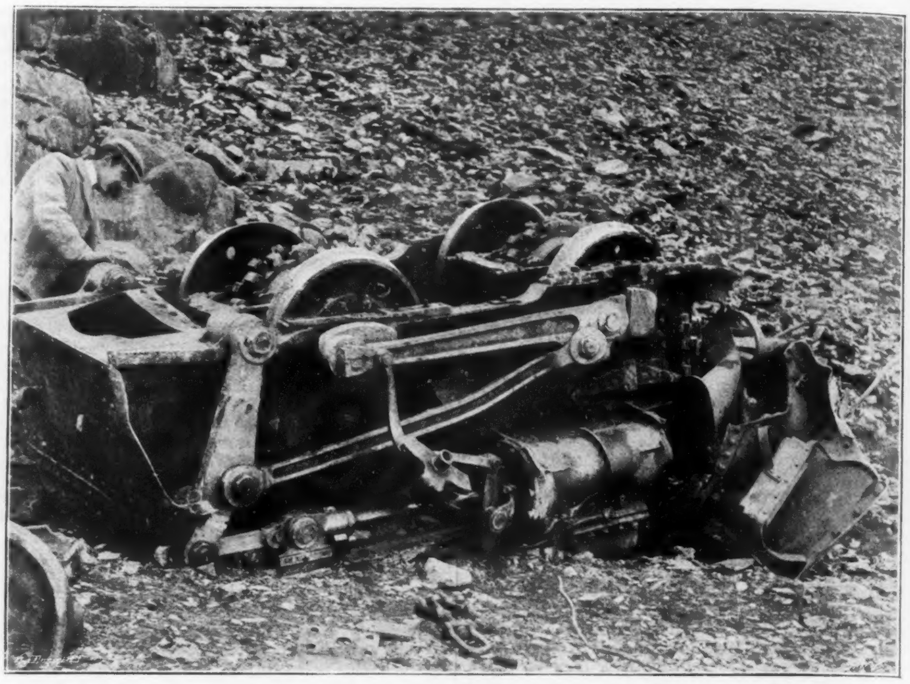
The President proposed "The Houses of Lords and Commons," and observed that Lord Balfour was well known in engineering circles, not only in his work as chairman of the Railway Rates Commission, but on many other occasions, and Mr. Courtney had filled many posts, and filled them all with distinction.

Lord Balfour replied for the House of Lords, and Mr. Courtney for the House of Commons.

The American Ambassador responded to the toast of "Our Guests," proposed by the President.

Mr. Bryce proposed "The Institution," to which Sir Benjamin Baker, the President, made due acknowledgment.

THE DERAILED LOCOMOTIVE, SNOWDON RAILWAY



THE SNOWDON RAILWAY ACCIDENT.

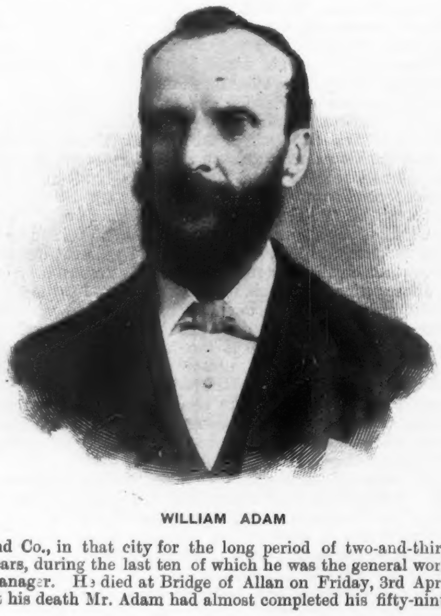
THE above engraving is from a photograph of the mangled locomotive at the bottom of the slope down which it rolled when derailed on the 5th inst., as described in our last impression. It will be seen that the boiler is absent, and that even the framework and heavy motion parts are very much broken. The engine is of small size, of the type much used on the Continent, in which the piston-rod is connected to a rocking lever to which a connecting-rod at a great angle is attached, this rod being connected to a side rod near one end. The wheel base is short and the gauge a narrow one. The coroner's inquiry commenced on Tuesday at Llanberis, and from evidence then given, it would appear that the cause of the accident was a depression of the rails by slight settlement, attributed to thaw of the ground after having been frozen solid. The Board of Trade was represented at the inquiry, at which the engineer of the line, Sir Douglas Fox; Mr. Oswell, resident engineer; and Mr. Aitchison, the manager, and others, were present. Mr. Lloyd Carter appeared for the company, and Mr. Leyland appeared for Messrs. Holme and King, the contractors.

Sir Douglas Fox said that it was not easy to give evidence as to the cause of the accident. There certainly had been a slight subsidence of the permanent way. This depression was one of about 2in., and extended some distance. Five or six of the sleepers had been disturbed, but none fractured. The cutting had been filled with snow, which, no doubt, had frozen hard, but the snow had disappeared when witness visited the place, and that possibly might have softened the ground and caused a depression.

The jury, after deliberating for fifteen minutes, found a verdict that the engine had left the rack, and that the deceased, seeing the engine-driver and stoker leaping from the engine when going at too great a speed, jumped out of the carriage and met his death, but there was no sufficient evidence to show why the engine mounted the rack. Our photograph is by Mr. Symons, of Llanberis.

WILLIAM ADAM.

WE regret to have to announce the death of Mr. William Adam, locomotive engineer, Glasgow, who was connected in various capacities with the works of Messrs. Dubs and Co., in that city for the long period of two-and-thirty years, during the last ten of which he was the general works manager. He died at Bridge of Allan on Friday, 3rd April. At his death Mr. Adam had almost completed his fifty-ninth year, and he had been for so long a period closely identified with locomotive engineers in its "head centre," so far as this country is concerned, that he had become well known in many countries abroad where railways have been established. He was as much esteemed as he was well known.



WILLIAM ADAM

Mr. Adam commenced his apprenticeship under the late Mr. James Reid, who was then the manager of the old Hyde Park Locomotive Works, of Messrs. Neilson and Co., a famous nursery for locomotive engineers of mark; indeed, the deceased was Mr. Reid's first apprentice. Before he completed his time, however, he came under the influence of Mr. Henry Dubs, who eventually became a very notable locomotive engineer. That gentleman was successor to Mr. Reid, who had been induced to take service with Messrs. Sharp, Stewart, and Co., Manchester. Mr. Dubs also became partner with Mr. W. M. Neilson, as well as manager. He had formed a very high opinion of Mr. Adam, who had already earned a reputation.

For a time, however, he was away from the Hyde Park Works seeking professional insight "over the Border." He spent about two years at the Wolverton Locomotive Works of the London and North-Western Railway Company, where he considerably increased his skill as a workman. Returning to Glasgow, he spent about six months in the famous Centre Street Works of Messrs. Randolph, Elder and Co. That was in the early sixties, when the compound marine engines of that firm were getting into very extensive use.

Having now seen something of the world, he was invited to return to the Hyde Park Works—the "new" works at Springburn, in a totally different part of the city, and quite close by two of the leading railways of the Northern kingdom. These works had been designed and laid out by Mr. Dubs, but he did not long remain there, as proposals had been made to him by two or three city capitalists to form a new company, and build new works for the prosecution of the same branch of industry. Mr. Adam had begun to climb the ladder, for he was already an under-foreman. Mr. Dubs began to build his own works on the south side of the city in the year 1864, and he had no difficulty in persuading Mr. Adam to accompany him and become one of his trusted servants, by-and-bye reaching the post of foreman of the fitting-shop. The first engine—one of a small order for the Caledonian Railway Company—left the works on 1st May, 1865; and since then thousands of others have left the same works, many of them for the Colonies, India, and other foreign countries.

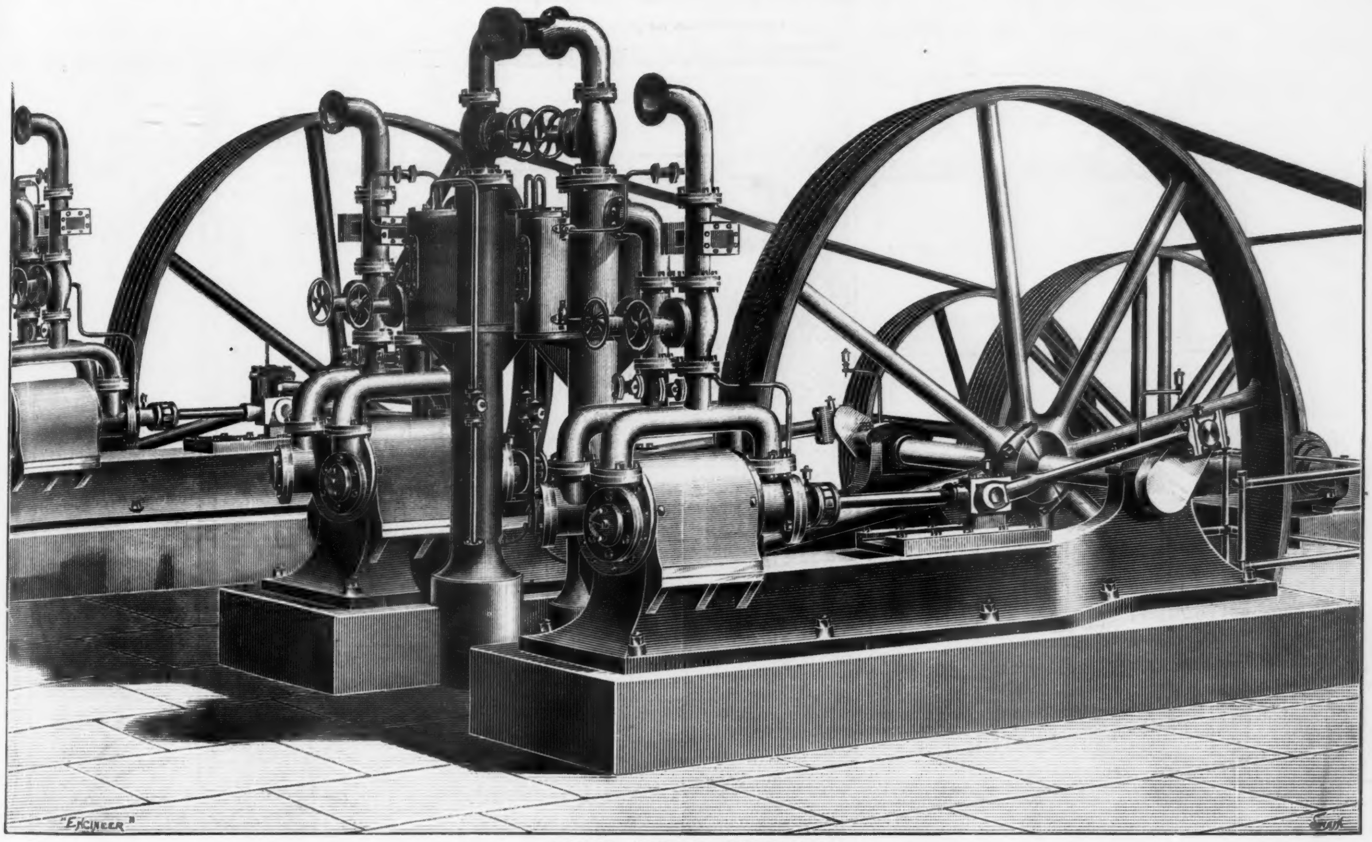
After the death of Mr. Dubs, Mr. Adam continued in the employment of the firm. Ten years ago, almost to a week, he was promoted to the highly responsible position of works' manager, on the death of Mr. Peter Andrew, who was also an able engineer. Mr. Adam knew the works from the very breaking of the ground, and as they became more and more permanently established, and from time to time extended, the army of workmen was greatly increased, but scarcely a single one of them who had been any time within the gates was unknown to him.

Mr. Adam did not set himself up as an inventor, nor did he desire to be regarded in that light; but he thoroughly knew every item in the structure of a locomotive engine. From time to time he made or suggested quite a number of minor improvements in the construction of the finished machine, and he was able to devise numerous ready methods of facilitating work.

His loss will be severely felt by the members of the firm, as also by many of his professional brethren.

SOCIETY OF ARTS.—The Council of the Society of Arts offer the Fothergill prize of £25 and a silver medal for a paper on "The best means of effectually Preventing the Leakage of Current to Earth in Electrical Installations from Generating Heat and Setting Buildings on Fire." The paper should consist of about eight thousand words, and be written with a view to being read and discussed at an ordinary meeting of the Society. Papers submitted for the prize must be sent to the secretary on or before October 1st, 1896. Each paper must be type-written, and bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto. The judges will be appointed by the Council. The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the judges no essay deserving the full award is sent in.

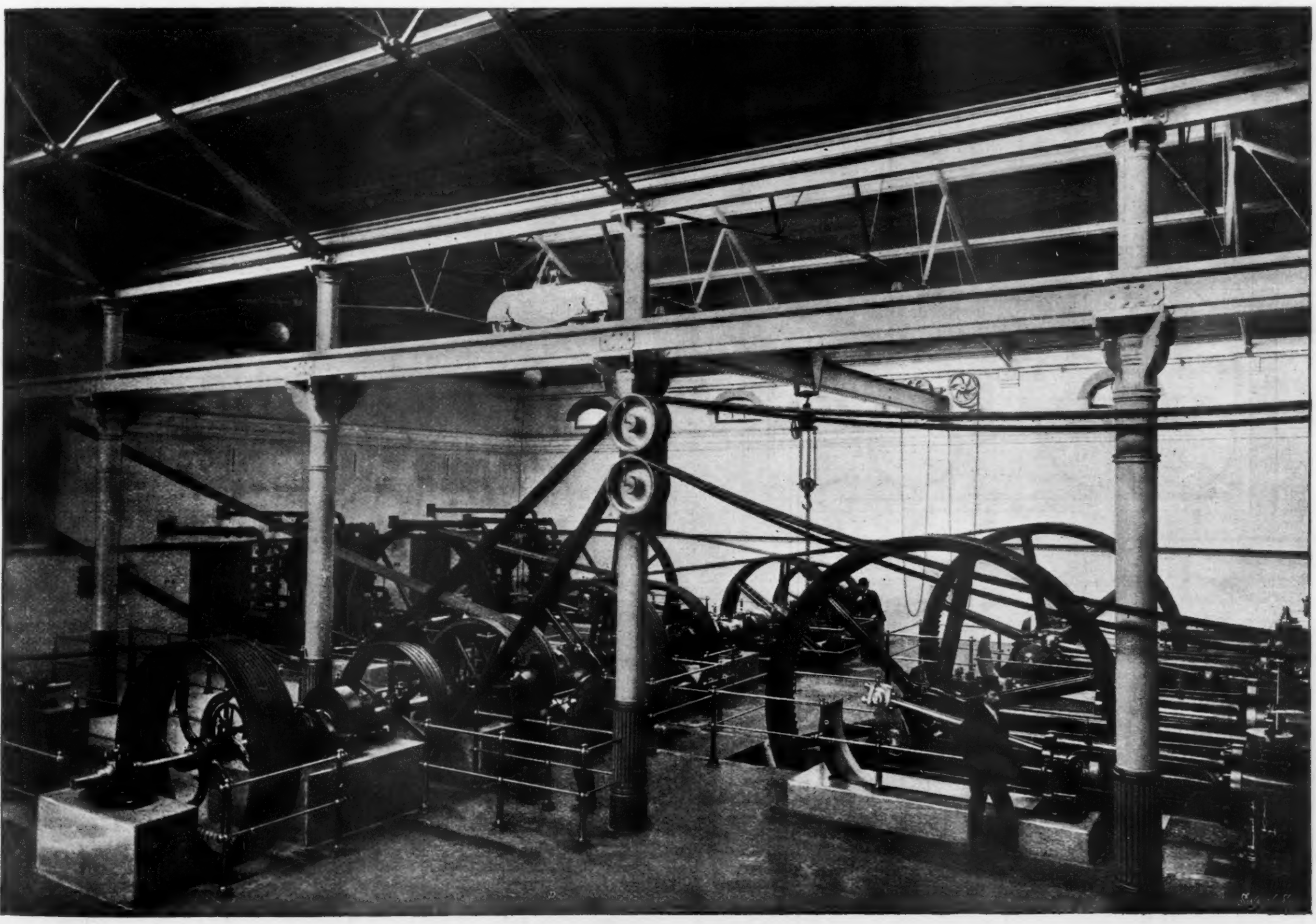
MONSTED'S MARGARINE FACTORY, SOUTHALL



SCHOU'S AMMONIA COMPRESSORS

MONSTED'S MARGARINE FACTORY, SOUTHALL.

On a piece of ground of about sixteen acres in extent near the Great Western Railway, at Southall, Mr. Otto Mönsted has erected a large factory for the conversion of beef suet, milk, and vegetable oil into the now widely-used product known as margarine. The factory only covers a small part of the sixteen acres, perhaps two acres, but the buildings are all large, airy, attractive, and remarkable for cleanness, and the arrangements adopted for securing the absolute purity of the product. A visit to the works removes any doubts any one might have as to the desirableness of margarine as a food, and convinces one that as made in a factory like this it is far preferable to the butter made in small insanitary dairies, where the work is done with hands, where the milk stands in an atmosphere not too innocent of farmyard effluvia, and where contamination is as easy as uniformity in the product is difficult. Margarine cannot take the place of butter of the best kinds made in large, well-appointed dairies, but it is infinitely preferable and superior to the cheap butters for cooking purposes, and is better, though not so readily accepted, for table purposes. Since, however, the manufacture of margarine has ceased to be a mystery, and it has been sold under its own name, the sentimental objections to it have rapidly faded, and prejudice founded on ignorance has disappeared.



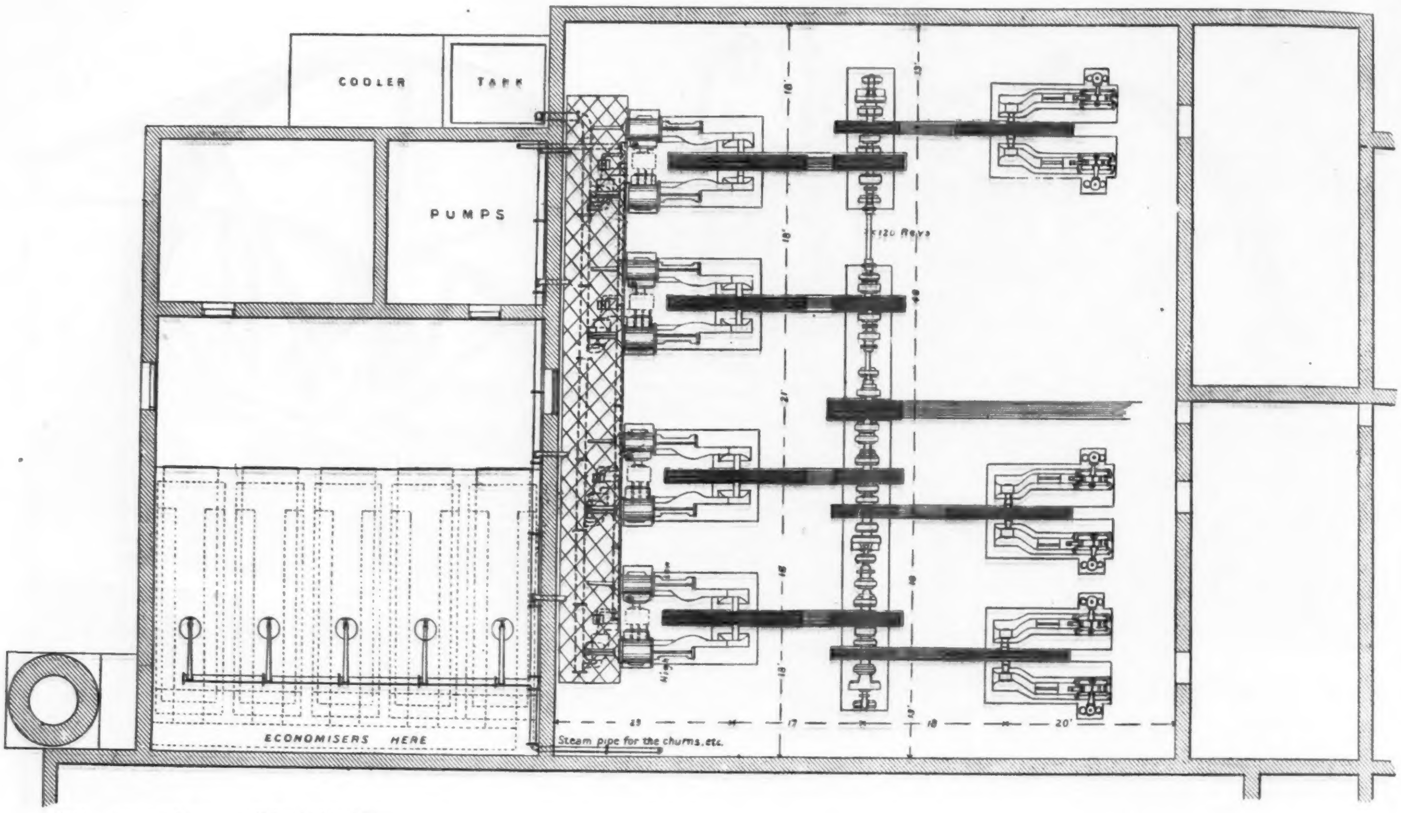
VIEW IN THE LARGE MACHINERY HALL

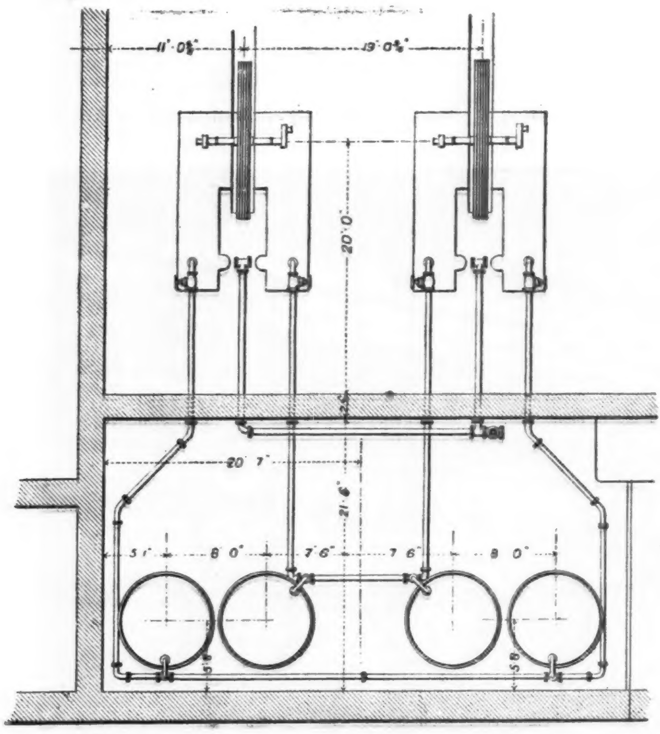
The Southall factory has been carried out from designs which are probably the most elaborate adopted for any industrial buildings in England. The offices and the accommodation for the workpeople are on a scale which is lavish in every respect that relates to light, air, cleanliness, and ample ornament. The architecture and ornament, and the provisions for comfort and scrupulous cleanliness in every

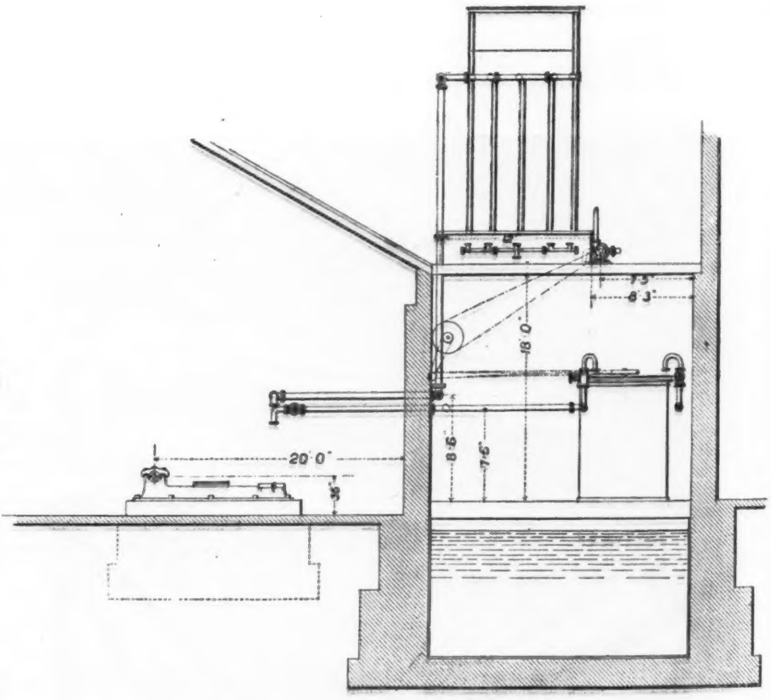
MONSTED'S MARGARINE FACTORY, SOUTHALL

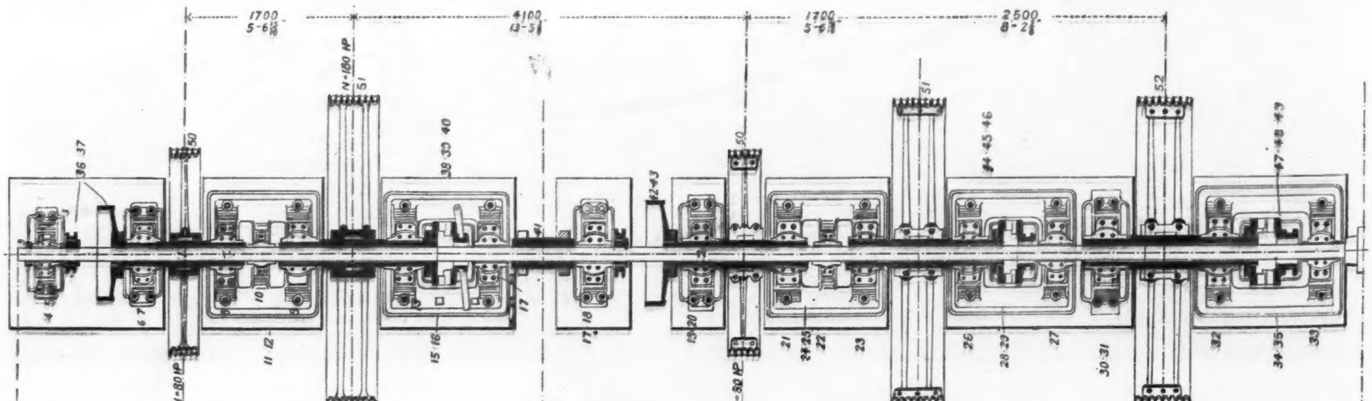
MR. P. SCHOU, MANCHESTER, ENGINEER

(*For description see page 403*)


COOLER
TANK
PUMPS
ECONOMISERS HERE
Steam pipe for the churns, etc.
120 Revs
18'
21'
43
17
18
20'


11' 0½"
19' 0½"
20' 0"
20' 7"
21' 6"
5' 1"
8' 0"
7' 6"
7' 6"
8' 0"

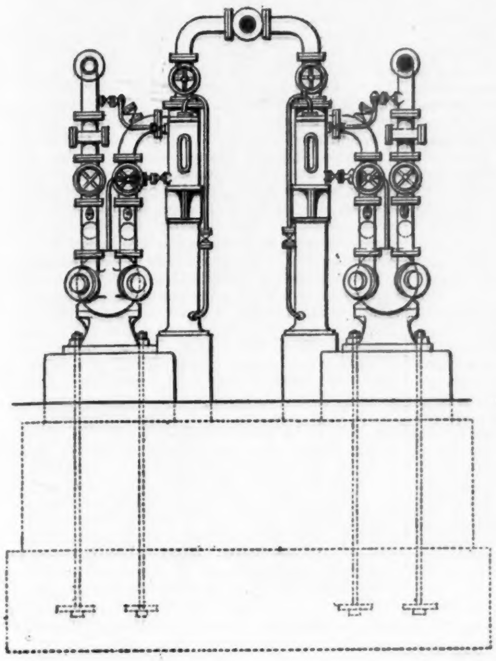

18' 0"
20' 0"
8' 6"
7' 6"
7' 5"
8' 3"

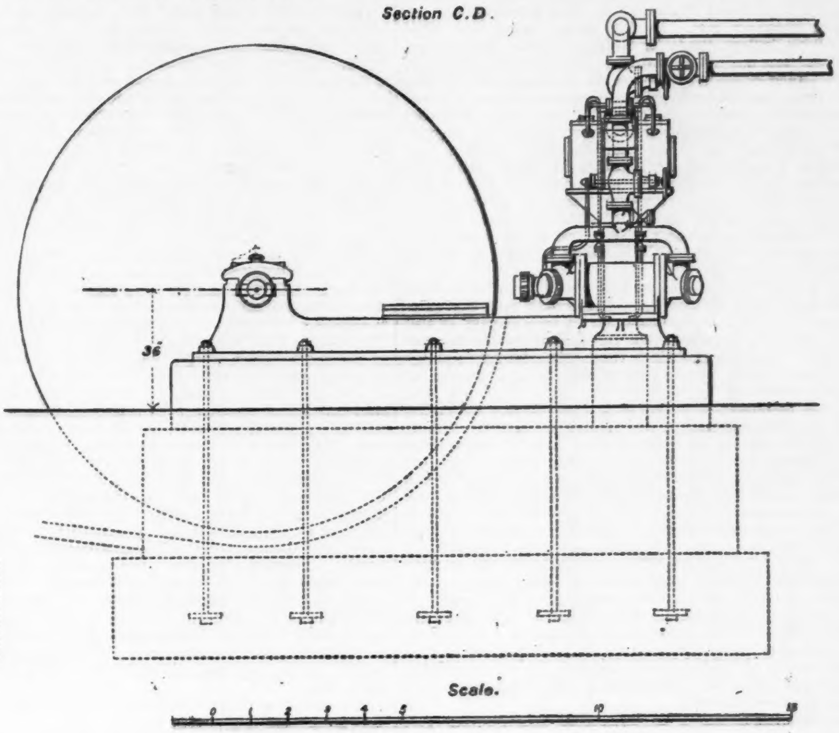

1700
5-6⅞
4100
13-5⅜
1700
5-6⅞
2500
8-2⅜
N=180 HP
N=80 HP
N=50 HP
N=2×100 HP
5400
8350

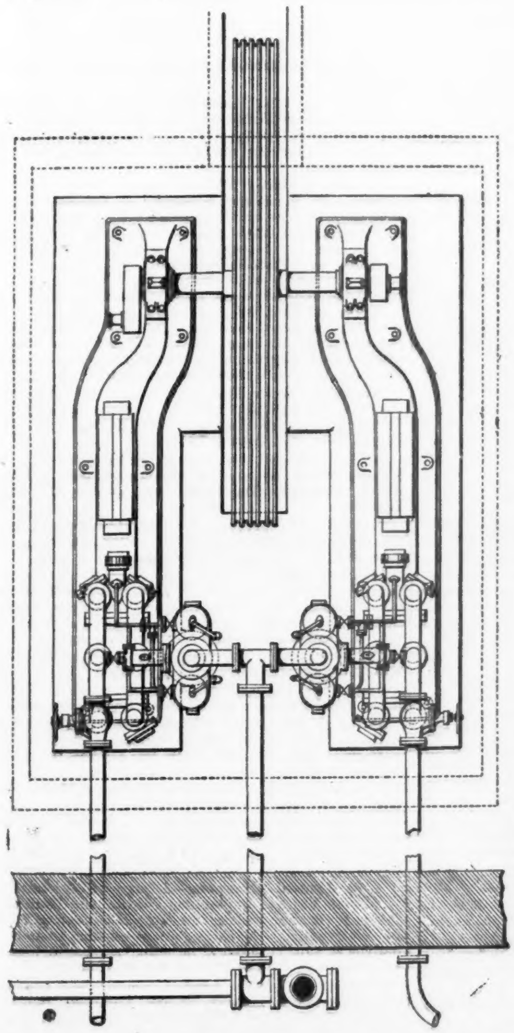
PLAN OF MACHINERY HALL, BOILER HOUSE, AMMONIA COMPRESSOR, CONDENSER, AND MAIN SHAFTING

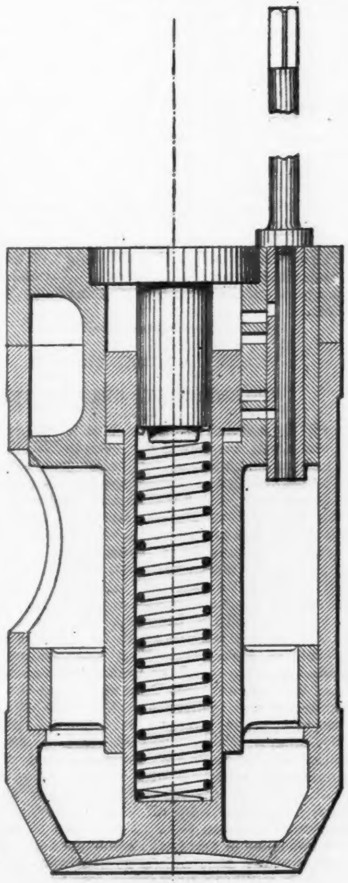
AMMONIA COMPRESSORS, MONSTED'S MARGARINE FACTORY, SOUTHALL

MR. P. SCHOU, MANCHESTER, ENGINEER

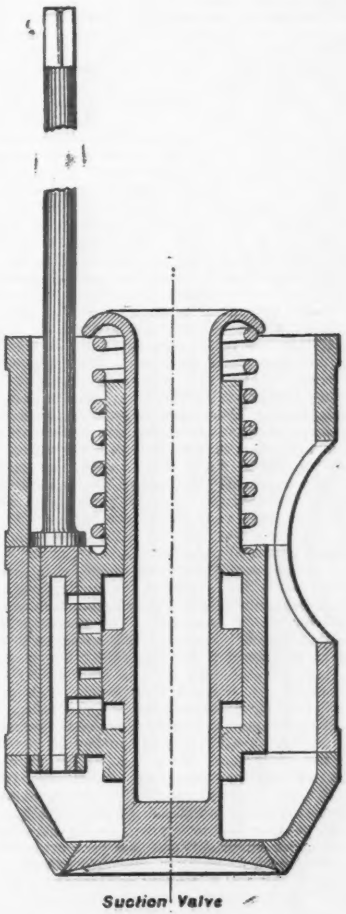








Discharge Valve



Suction Valve

department, inspire the workpeople with a feeling of pride and of dignity in their work and the works.

The raw materials are, firstly, beef suet, which is received in large barrels from Birkenhead and Deptford and from the great stockyards in America and elsewhere. It is beef suet in a splendid condition, all the insoluble stearine having been pressed out of it. In this condition it is known as oleomargarine. The second ingredient is sweetnut oil, and the third milk. The milk is taken from the dairy farmers of the district, and when in full working order this factory will be able to take and deal with 30,000 gallons a week. On entering the factory the receiving rooms for the milk, where about 5000 gallons per day are now dealt with, are first seen. Here the milk, passing through the receiving tanks, travels by gravitation into ripening tanks below, which are arranged on the Danish process, and from thence by centrifugal pumps it is sent into the churns above.

From this milk store the visitor passes to the stores of the two other products—the oleomargarine, and the sweetnut oil. Both these are stored in casks in warehouses, in which a regular temperature is maintained. From both these stores, the visitor may follow by one of the lifts the barrels of oleomargarine and of nut oil, and see them opened. Most of the beef suet is of a rich yellow and minus its stearine. It is broken up into convenient pieces, and then turned into one of sixteen large vats, capable of dealing with about fifty tons of oleomargarine at once. These vats are steam jacketted. After melting, the liquid fat is conveyed through pipes at the bottom of the vat to meet the milk at the churns below. The vegetable oil is simply pumped from the tanks, into which it is emptied from the barrels, into the churns with the oleomargarine and milk. In the churnery are nine churns, driven by steam power, and jacketed with steam and hot water to keep the contents at a proper temperature during the process of churning. These nine churns are capable of turning out about fifty tons of margarine a day.

From the churns the bubbling, yellow, warm margarine runs down a wooden shoot, where it is met by a disintegrating and ice cold jet of water, the width of the trough, and by it driven into a cooling tank below. This is built of white glazed bricks, and presents a spacious surface for the heated fat globules to crystallise upon. They spread themselves over an area of 30ft. by 20ft. of ice water until they have quite solidified. There are four of these cooling tanks in this building, and as they stand side by side they present a very pretty and curious appearance, and are entirely overlooked from the churn platform at the end of the hall, which covers about an acre.

When properly cooled, the margarine, in crystals resembling butter granules, are collected with long handled wooden tools, and placed in piles on wooden wagons, where for two hours draining goes on, so that the water may run off, after which these piles are taken to the huge circular working tables, like large fluted conical roller butter workers, of which there are four in the hall. There the margarine is slowly milled together, so that all the particles are combined into solid masses. During this process the margarine is "salted to taste."

From here, on other machines, the margarine is submitted to a finer and more complete working process, so as to produce a more regular and perfect texture, after which it is ready to be moulded into lumps, pats, rolls, or any shape demanded by each of the many markets to which Mr. Monsted's manufactures go. From the time we saw the raw products in the stores or the churn rooms until they had been weighed up and packed as the finished article, they had not been touched once by the human hand. The raw materials are weighed into the churns and the weight automatically recorded.

Turning now to the refrigerating pumping machinery and to the motive power for dealing with all the machinery, the engines will be found illustrated in The Engineer of the 14th of February last. In the boiler house are three Lancashire boilers, made by Tinker's, Hyde, Manchester, each 30ft. long and 8ft. in diameter, with a steam pressure of 120 lb. Each boiler has two flues 3ft. 3in. diameter, tapering to 2ft. 9in. One of Calvert's circulating economisers is placed in the position shown in the engraving, page 404. The coal is led in upon a miniature railway and tipped into hoppers after each load has been automatically weighed and registered. Water supply is obtained from thirty-two Abyssinian wells, probably the most extensive nest of this description of wells in this country. These are all connected, the pipes being brought into the pumping room, and through them 10,000 gallons of water an hour can be elevated by the powerful pumps into the tanks in the water tower at the top of the main building.

The engine and machinery hall covers an area of 7200 square feet, and is 31ft. high, with a lantern roof that gives it a very light and airy appearance. A view of part of this hall is given on page 403. On the floor there are the two compound condensing engines, fitted with Collman's patent valve gear, made by J. Jessop and Son, Leicester, as recently described by us. In the same hall are four ammonia compressors, which form a part of the refrigating plant constructed under the patents of Mr. P. Schou, and used for cooling the water from its natural temperature down almost to freezing point. This plant is of the 150 tons capacity, and the compressors, made by Messrs. Tuxen and Hammerich, are shown by the engraving on pages 403 and 405. In the same hall is the electric plant, which is driven from the large steam engines. This plant consists of four dynamos, the one being used for charging the accumulators only. The total capacity of this installation is 800 ampères working with 110 volts, representing an illuminating power equal to 26,000 candles. The accumulators are capable of lighting a part of the factory for six hours. The plant was made by Messrs. Calvert and Co., of Manchester. The whole of this engine hall plant is arranged in duplicate, so that repairs can be effected without stopping the work, and the repairing is facilitated by a travelling crane with gear which runs over the whole room.

The compressors are of the horizontal double-acting type, with a compression cylinder, $10\frac{5}{8}$in. diameter, $21\frac{1}{4}$in. stroke, running at 65 revolutions per minute. The cylinders are fitted with one suction and one discharge valve at each end, as shown by the general and sectional views on page 405, the cover being concave on the insides, to give more room for the valves. The valves are the most important part of an ammonia compression machine, and they are a special feature of Mr. Schou's machine. He claims for them that the troubles inherent to compression cylinder valves have been practically eliminated by them. The chief troubles with ordinary valves arise from the fact that there is no means of regulating the velocity or force with which they strike against the seats when closing, the result being that in a comparatively short time, they hammer and destroy themselves and their seats and become leaky. In the valves designed by Mr. Schou an air cushion device is attached to the valve spindle of each valve, by means of which the velocity and force of closing may be regulated at will by the simple manipulation of a stop cock, the spindle of which is carried through the valve chest to the outside, and so may be regulated by the attendant at will, while the machine is working. This is shown by the valve sections on page 405. The effect of this has been great durability of the valves, some of which have been used with this appliance for a number of years, without any repairs or apparent signs of wear, and they are still as tight and as efficient in their action as when first started. The number of parts has been reduced so as to eliminate any screwed connections which are apt to work loose and interfere with the action of the valves. As in this system the gas is never heated above its saturation point, and as consequently the compressor has only to deal with humid or saturated gas, no water jacket is necessary or is used. An important point in this compressor is the small amount of clearance required, not more than $\frac{3}{64}$in. being allowed at each end of the stroke. This clearance is maintained by a special arrangement of crosshead, by means of which any alteration due to wear of the moving parts to this clearance can be seen outside the cylinder, and can be at once allowed for at the crosshead. The clearance being so small no oil is required to take up this space, only such oil being used as is necessary for lubricating the piston, &c. This is a feature which also adds to the efficiency of the compressor, as in Mr. Schou's view the use of large quantities of oil to take up clearance space is undesirable, because the oil absorbs the vapour of ammonia during the compression stroke, and gives it up again during the suction stroke, thus preventing the compressor from drawing in during that stroke as large a weight of vapour as it would otherwise have done had the oil not been used. To prevent leakage of ammonia vapour passing the piston-rod stuffing-box, a specially designed packing box is applied, which fits closely to the rod, the space between these two compartments being charged with oil from an oil filter, described hereafter. This oil chamber acts as a seal to prevent any leakage of ammonia at this point. At each back stroke a certain amount of this oil escapes past the composition rings into the cylinder, and a specially made apparatus, called an oil separator, is supplied for separating the oil from the ammonia.

The oil separator is an apparatus consisting of a large chamber, through which the compressed ammonia is passed on its way to the condenser. The passage of ammonia through this vessel takes place at a comparatively slow speed, and the oil has time to gravitate to the lower part of the vessel, from which it is forced into the oil filter, which is placed above the piston-rod gland. A certain amount of gas is necessarily carried over with the oil, and this gas is drawn away by means of a pipe connecting the top of the oil filter to the suction pipe of the compression cylinder. The oil, after being filtered and cleansed, is used over again in the oil chamber in the piston-rod gland, as above described. The total consumption of oil for this purpose in the compressor does not exceed two gallons in four weeks. The manipulation of the oil separator is exceedingly simple, as the only duty required of the attendant is to regulate the opening of two simple cocks. There are two filters, as described above, fitted to each machine, so that one may be used while the other is let off for cleaning purposes, and this is an important feature of the system, as it avoids all necessity for stoppage. The position of these oil separators is shown on stands at the side of the cylinders in the end elevation and plan, page 405. The refrigerator of each set consists of a circular wrought iron cistern—see page 404, containing a series of coils of lap-welded pipes, $1\frac{1}{4}$in. diameter inside, tested to a pressure of 2000 lb. per square inch. The total length of this piping is 3300ft., or equal to a cooling surface of 1300 square feet. This is made up of six coils of equal lengths, each coil consisting of one complete pipe; these coils are arranged spirally, one inside the other, and are connected together at the ends by suitable couplings, in such a way that any one length may be taken out at will. As is well known, these pipes are apt to become rapidly corroded above and just about the water level, and to prevent this corrosion the pipes are covered above the water-line and to 6in. below with lead. For keeping the water in the tank in circulation an agitator revolving on a spindle in the centre of the tank, and driven by means of a small countershaft placed at the top of the tank, which in turn receives its motion from the line shaft, as shown in the vertical section, page 404, which also gives a section of the large underground tank used in connection with these refrigerators. The two ammonia condensers are placed on the top of the roof, one for each pair of compressors. They are constructed on the surface evaporation system, with the object of reducing the amount of condensing water required to a minimum. With this arrangement a saving of 90 per cent. of water is obtained, compared with the water required in an ordinary submerged condenser. The water is used over and over again, and is circulated by means of centrifugal pumps. Each condenser consists of five sets of $1\frac{1}{4}$in. lap welded coils, tested to a pressure of 2000 lb. per square inch, arranged in such a way that one or more sets can be cleaned while the machine is working. A special feature in the construction of this condenser is the few joints used for connecting the coils. The ammonia vapour enters at the top of the condenser, leaving it at the bottom, after being condensed. It is then led into an apparatus called a recipient, through a pipe entering at the top of the recipient, and terminating near the bottom. Another pipe also leads from the bottom of this vessel, then carries the ammonia forward to the top of the refrigerator, passing through a regulating valve on the way. The object of the recipient is to prevent any vapour which may possibly leave the condenser without being condensed from entering the refrigerator, and it also extracts any foreign matter which may pass through the condenser with the ammonia.

The ammonia condensers above referred to we shall illustrate in another impression.

The shafting shown at the foot of page 404 is particularly worthy of attention. It is desirable that alternative sets of machinery should be put to work as required, and that the pulleys by which they are driven should not be running as loose pulleys on bushes when not driving the machinery, as is usually the case. To achieve this, the hollow shafting made by the Eisenwerk Wülfel, of Hannover, is used. In this, as shown at page 404, the main line of ordinary shafting is carried by bearings in the ordinary way, but between these bearings it is enclosed by hollow shafts running on separate bearings and carrying the outer part of the clutch necessary for connecting the two shafts, the inner part of the clutch being on the solid central shaft. In this way any of the machinery driven by the pulleys on the hollow shafts can be stopped, and the pulleys themselves also stop, no pulleys running either on bushes or on shafts running uselessly in bearings. The arrangement illustrated works exceedingly well, and avoids much of the trouble with ordinary clutches and loose pulleys. Various forms of this shafting and connecting gearing are made by the Eisenwerk Wülfel.

(To be continued.)

PROVISIONAL ORDERS, 1896.

It will be necessary to give a brief retrospective glance in connection with our article on "Private Bills" for the present session in a recent impression, before proceeding to consider the Provisional Orders now in progress through Parliament. In the first place, one Royal Assent has been given, and it is to the Metropolitan District Railway (Extension of Time). Probably the fact of its being a "suspended" Bill from last session may account for it becoming an Act at so early a stage. Eight or nine other Bills, some of which are fortunately entitled to rank as "unopposed," have passed the third reading; but necessarily as yet not much progress can be expected. Three tramway Bills, it is much to be regretted, have of their free will been erased from the roll-call—that is, withdrawn. They are, one promoted by the Corporation of the northern granite city, another under the title of the Cork Junction Tramways, and the third hailing from Derby and Ashbourne. The first of these may be disregarded, as it proposes to construct nothing, but to borrow money, the amount of which is not stated. The secession of the other two deserves a word of notice, since the mileage of both amounted to over twelve miles, and the capital asked for reached the fair total of £240,000. It is not quite apparent, even allowing for cost of buildings and equipment for electrical or other modes of traction, how or why 12·48 miles of tramway should cost this large sum. If tramways which have not to purchase any land to lay down their track, and build no stations, run to this figure per mile, it might be fairly asked, what about the price of light railways, which have to incur an expenditure on both these items? Of the eight London Water Transfer Bills two have been withdrawn, and the other six classified as those belonging to the list of "Second reading negatived."

In passing on to the "Provisional Orders," there is no tramway project of any particular importance, if we except that asked for by the Corporation of Hull, who propose to spend £300,000 in laying down new lines, and an additional sum of £15,000 for buildings and equipment in the borough, town, and county of Kingston-upon-Hull. About half a million is the total capital required by the fifteen Tramway Provisional Orders sought for in England, Scotland, and Wales, which, as the total mileage is fifty miles, allows £10,000 per mile for the carrying out of the work. It would appear that whether it is a question of a "Bill" or a "Provisional Order," there is not much difference so far as the capital required is concerned. With regard to the Gas and Water Orders, there is nothing worth chronicling, but there is something to be said respecting those pertaining to electric lighting. It is not that the number applied for is particularly large, being but thirty-eight for England, Ireland, and Wales, nor the capital excessive, not surpassing one and a quarter millions, but it is the wide range which this method of lighting is gradually embracing, which distinguishes its advancing career. Comparatively small places, such, for instance, as Ambleside and Keswick, ask for a modest few thousands to light their respective districts with the *fin de siècle* illuminant. It is noticeable that Scotland appears to make no sign in this respect this session. Foremost in this especial category is to be found the Liverpool Electric Lighting Order for a supply to the whole city, with a proposed expenditure of nearly one-third of the total capital of the whole list. Bath comes next with £120,000, and Manchester with £100,000. Ireland is by no means behind, as Dublin, Cork, and Queenstown are good for £100,000 in the aggregate. It has long been a reproach, and in some measure deservedly so, to not only ourselves, but to our continental neighbours also, that we have not availed ourselves of the great motive power which for ages, so to speak, has laid dormant and in abeyance, although always existent, in our natural water supplies. These have always been used for purposes of irrigation on a small scale, but on a much larger scale for those of navigation in the form of canals and canalised parts of navigable rivers. It has remained for electricity in the more advanced stage to develope the utilisation of this important physical motor in the production of the electric light.

In mountainous regions there is always a certain amount of apparently hidden power to be obtained from even a very small cataract or fall of water, the immediate effect or productive action of which is not restricted to simply the near vicinity of the motive force. In this respect water has an advantage over steam, which with all preventive precaution cannot be taken beyond a very reasonable distance, even in tropical climates, from its generative source—that is, the boiler, if its pressure, which is equivalent to the power developed, is to be maintained constant. Regarded from this point of view, electricity has no compeer. Distance, so far as mere transmission of current is concerned, is nothing. A telegraphic message, if the "line be clear," can be sent from Downing-street to Calcutta and the answer returned in less than three minutes. It may be noticed that, in its application for a Provisional Order, the London United Tramways propose to empower the Company to place posts and wires in or over streets and roads in the County of London for purposes of traction by electrical or mechanical power. Although the trolley or overhead mode of transmission has been inaugurated in England, yet so far as London is concerned, this is quite a novel departure.

CATALOGUES.

Since our last acknowledgement we have received the following catalogues.

R. Hunt and Co., Earles Colne, Essex. Shafting, Couplings, Collars, Plummer Blocks, and Cast Iron Pulleys.—A printed and well-illustrated catalogue of fittings, including the swivel bearings, with very large proportions of length to diameter, and the makers muff coupling.

The London Emery Works Company, 10 and 12, Vine-street, London.—An exhaustive catalogue of polishing and grinding machinery, and one which shows the large part now played by emery wheels, not only in grinding tools, but in finishing and giving minute accuracy to work, such as parts of steam engines and machinery not obtainable otherwise. This catalogue contains 169 pages, and there is an illustration of a different machine on a large part of the whole of these, these machines including many forms of simple grinders, cutter grinders, polishing machines, shaping machines, finishing, and truing lathes and roller lathes. With the catalogue are some samples of emery and glass cloth, of which the company manufacture on a large scale with special plant. The name is not as it should be on the back.

Bennett and Sayer, Engineers, Derby. Brick Machines, Crushing Mills, Pug Mills, Roller Mill Brick Machines, Plastic Brick Plant, Presses, Brickyard Railways, and Endless Chain Tramways, Mixers, Dies, and Cutting Tables.

C. A. Zadig and Co., 11, Queen Victoria-street, London.—Tipping Wagon, Portable and Permanent Railway Gear, Wheels, Axles, Bearings, Turntables, and Double and Single Bogie Wagons.

The Butterley Company, Limited, Butterley.—A handy little pocket list of the dimensions of Iron and Steel Bars, Angles, Sheets, Buckled Plate, and other Bridge Floors.

John and Henry Gwynne, 89, Cannon-street, London, E.C.—Centrifugal Salvage Machinery, with illustrations of some of the vessels recovered by salvage companies employing Gwynne's invincible pumps; the floating of H.M.S. Sultan and of the s.s. Utopia being feats of which the firm is deservedly proud.

J. H. Wilson and Co., Limited, Sandhills, Liverpool.—Lifting Machinery, including cranes large and small, jib and derrick, steam and hydraulic, and excavating, grabs, winches, Carey's concrete mixer, and Duckham's and Denison's weighing machines.

Southgate Engineering Company, Limited, New Southgate.—A catalogue in four parts, all well illustrated. No. 1 of Cranes, No. 2 of Machine Tools, No. 3 of Steam Pile Drivers, No. 4 Coalwashing and Briquette Machinery.

C. Cadle, Dublin.—Catalogue of Duplex Jet Water-wheels of the hurdy-gurdy type, but with double buckets in pairs on either side of the disc carrying them, and fed by a double nozzle mounted on a spherical joint, which is raised or lowered by a governor, which puts the jets into the best or a less efficient position, the water remaining constant except as controlled by a hand sluice.

A. G. Mumford, Colchester.—A large well-illustrated catalogue of Marine Engines, Duplex and Vertical and Horizontal Donkey Pumps for feeding Boilers, and large Direct-acting Duplex Pumps for Waterworks. The catalogue also contains a number of special designs of ship machinery, including ash hoists, winches, valves, fan and fan engines, and launch and other boilers.

Robinson and Auden, Limited, Wantage.—A new catalogue of this firm's Steam Engines, Boilers, Thrashing Machinery, Fixed and Semi-fixed Engines, High-speed Vertical Engines, Power Chaff Cutters, and other machinery.

Sharp and Kent, engineers' and contractors, 34, Victoria-street, Westminster.—Electrical Fittings, Materials, and Machines.

Tangyes, Limited, Birmingham.—A new catalogue and revised lists and prices for the 1891 catalogue, containing Wall and other Cranes, Pulley Blocks, Ship and other Jacks and Pumps, Governors, Pump Fittings, Boiler Fittings.

John Spencer, Globe Tube Works, Wednesbury.—A new and revised edition, comprising Iron and Steel Tubes and all kinds of Fittings, Short Lengths, Valves, Pipe, Fitters' Tools, Iron Sewer Pipes, and Taper Ventilating Pipes.

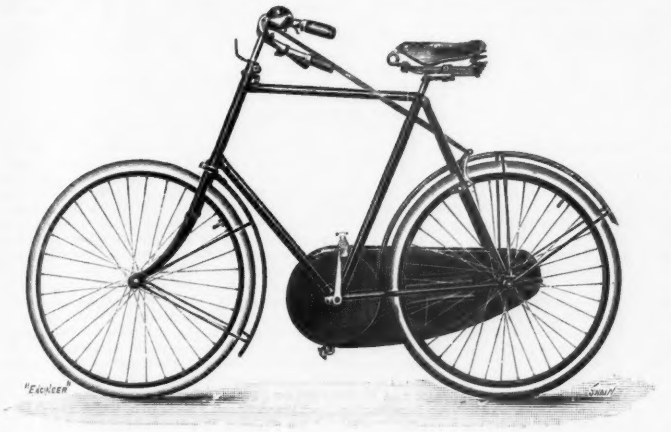
Johnson and Phillips, London.—An illustrated catalogue of Cable Making and Wire Covering, Sheathing, and Measuring Machinery. Well printed, with illustrations taken from photographs of the actual machines, many of which are of novel design. The catalogue has the name on the back, so that it may be easily found.

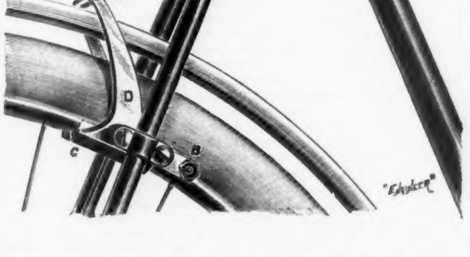
Professor Seeley, F.R.S., will begin the summer course of lecture-excursions with the London Geological Field Class at the end of April. The subject of the series will be "The Physical Geography and Geology of the Thames and its Tributaries. This is the eleventh annual course." Mr. R. H. Bentley, 31, Adolphus-road, South Hornsey, N., is the hon. secretary to the society.

HUDSON'S REAR-ACTING CYCLE BRAKE.

The objections to brakes acting on pneumatic tires, more especially of the lighter forms, are well known to cycle users and tire makers, and the objection to the application of the brake to the light front wheel in the fork is also well understood. The brake illustrated has been made to overcome these objections, and trials of it have proved its value as a powerful brake applied where it can do no harm to the tire, and give rise to no danger of buckling either the front wheel or the forks, whilst it secures certainty of action and safety so far as a trustworthy brake can obtain it.

The engravings show the brake as applied to a machine, the brake handle being altered to lie and work in front of the handle bar, and in the plane of the steel rod or wire partly rubber covered, by which the brake handle is connected to the brake proper. The brake itself is shown by the enlarged view of the upper part of the rear or driving wheel, on the rim of which it acts. Clips of suitable form attached to the vertical members of the frame hold the pivots B of the pair of bent levers D, the lower parts of which carry at C a leather or india-rubber pad, which bears upon the rim at an angle of about 45 deg. To the upper ends of the bent levers D the wire A is attached and led to the brake handle similar to an ordinary brake handle on the handle bar. After several months' severe use the wear on the rim is found inappreciable, and apparently limited to polishing the bead or roll. It took a long time to remove the enamel, and with rubber in place of leather there is no doubt the wear would be inappreciable in many years. It is claimed for this brake that firstly it is trustworthy, owing to its directness and simplicity, that it visits no strain on forks, does not damage the tires, that its efficiency does not depend on the tire being inflated, that it puts no strain on the spokes, such as occurs with a band brake, that it is unaffected by mud in the dirtiest weather, and that it is extremely powerful, one finger on the lever being sufficient for all ordinary purposes, while the wheel is readily skidded with two. The machine shown, it may be mentioned, is one to which Mr. J. G. Hudson, of Bromley Cross, Bolton, had large chain wheels fitted for experimental reasons, and he has found within the limits of ordinary pressure on the pedals the friction of the machine is only 1 per cent., thus confirming the figures we mentioned some time ago when remarking that certain friction-reducing devices were based on a fallacy, or worse.





THE ACCELERATION OF RAILWAY SPEEDS.

The question is frequently asked as to how fast a passenger train can be run. The various conditions which affect the making of railroad records are intimately correlated, some being found in the engine, some in the train, and some in the roadbed and track upon which they run. Taking the standard fast train of to-day as represented by the Empire State Express on the N. Y. C. and H. R. R. R., it can safely be said that when in 1893 it ran for a short distance at over 100 miles an hour, it was for that short spurt travelling up to the very limit of the possibilities of our present system of railway locomotion. The whole tendency of the age toward time saving makes it certain that, before the twentieth century is far advanced, the travelling public will be clamouring for a vastly increased rate of speed over present rates. The experience of the past teaches that when the patrons of a wealthy transportation company, whether on sea or land, demand a faster service—and are willing to pay for it—they usually get it. We state a few suggestions as to the proper lines of investigation to be pursued in order to effect such improvements.

The track.—This must be straightened as much as possible. On a tangent the whole tractive effort of the engine is available on the drawbar of the train. On a curve the effort is split into two components, one of which is expended against the outer rail of the curve, while the other is available to haul the train. The component, which is lost in the outer rail, increases with the increase of the sharpness of the curve; and *vice versâ*, the more we can straighten out or "ease" the curve, the less will be the loss from this cause.

Grade must be lightened.—The resistance due to grade is too obvious to call for elaboration here.

Heavier rails must be provided.—No amount of care can keep a roadbed in perfect level. The storms and frost of winter and the drought of summer will develope soft places. If the steel rail be deep and heavy, it will bridge these weak spots, and preserve the general level. The load of the train is concentrated at certain points of contact, where the steel tire meets the steel rail. The ideal track will distribute this concentrated load as evenly as possible to the widest possible surface of roadbed. For a speed of 75 miles an hour, 100 lb. to 125 lb. rail should be laid upon ties 6in. by 10in. by 10ft. long.

Better rail joints will be required.—The joints are to-day by far the weakest point, even in our best tracks. The perfect joint should be as rigid, and yet as elastic, as the rail itself. To get the required depth for stiffness it should be of the sub-rail type, associated with some form of angle bar to secure alignment. With the introduction of 60ft. rails, the number of joints will be reduced to one-half, and some of the expense thus saved could be well spent in improving their quality. Whenever it is possible to hear the "click" or "hammer" of a joint, we may be sure that a certain amount of the momentum of the train is being absorbed at that point. A perfect track involves a silent joint.

Engines.—The fast express engine of the future will be a single driver. It has been abundantly proved that 20 tons on one pair of drivers will give all the adhesion necessary to haul an express train of to-day. Engines with single drivers are not troubled with slipping of wheels, except occasionally in damp weather. At such a time steam sanding apparatus gives the drivers the necessary adhesion. Where the loads are heavy, as in the slower and heavier passenger trains or in freight trains, it becomes necessary to couple on an extra pair of wheels. The Philadelphia and Reading engine is doing better work with a single driver than its sister engines of the four-coupled type. The single driver engine is easy to counterbalance and the internal friction is largely reduced. The drivers will not be of less than 7ft. or 8ft. diameter, and running as they will on 100 lb. to 125 lb. rail they can be safely loaded up to 25 tons. This will give sufficient adhesion for 20in. or 21in.-cylinders, which, with a steam pressure of 200 lb. to 225 lb. and large steam ports, would give us a locomotive of very large high-speed hauling capacity.

Cars.—It is in the reconstruction of cars that the greatest gain will be made. We have for many years been of the opinion that the weight of a Pullman car was out of all proportion to the number of people it carried. In the train made up of Pullman cars, the engine has to haul not less than 1½ tons of dead load for each passenger carried. On the race track the bicycle carries its load at average railroad speed on a deadweight basis of 20 lb. to the passenger. One hundred and fifty times as much deadweight to be carried per passenger on a railroad as on a bicycle. Making all allowance for the shelter and convenience of car travel, there is evidently something wrong. The weight of the car is excessive, and it is the outcome of the rough and dangerous condition of the earlier railroads, and of the competition among the builders to excel in providing a luxurious "palace" car. The car was made heavy in order that it might ride easily on rough track and hold together when it jumped the track; it was loaded down with heavy plate mirrors, solid hard wood carving and moulding, and massive brass and plated work in the attempt to beautify it. The two causes have both disappeared. Our trains stay on the track and automatic signalling has done away with collisions. They can safely be built lighter. A better taste has been cultivated among us in the matter of decorations and fittings, and Pullman cars could be relieved of much silver plating and glass plate, and yet be made artistic and pleasing in their interior fittings.

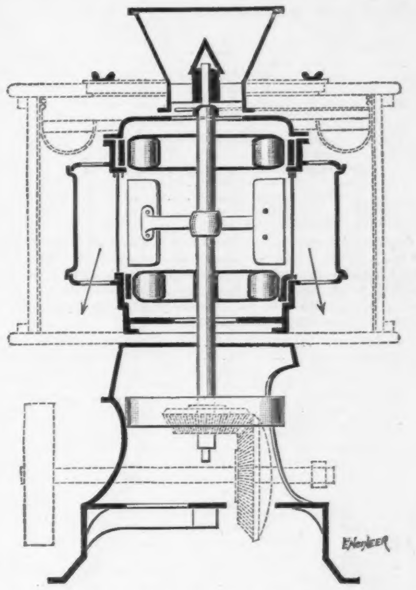
The weight per linear foot of an express train could be greatly reduced by reducing the length of the individual cars. A car rests upon its two trucks in the same way as a bridge upon its abutments. Like the bridge, its weight per foot will increase rapidly with its length. Two 40ft. cars would not weigh as much as one 80ft. car; and though there would be four trucks for two, they would be of very much lighter construction. Moreover, the distribution of the load upon double the number of trucks would cause it to haul with greater ease. The trucks of a 50-ton Pullman car depress the track by their excessive concentration of load, and are always running in a hollow or, as it has been well expressed, "climbing up hill." The cars could be further lightened in their construction by the substitution of high grade steel for timber. The use of nickel steel for the floors and side trusses, with thin plating for sides and roof, would result in a light but very stiff and strong car. By furnishing the interior with rattan or basket work chairs and lounges, such as are to be found on some lines to-day, a further saving of weight could be effected. It is a mistake to claim that light cars ride roughly. On rough track they do; but on first-class track weight ceases to be at a premium.—*Scientific American.*

THE PROPFE MILL FOR GRINDING COAL DUST FUEL.*

One of the chief drawbacks to the extension of the use of coal dust fuel is the difficulty of procuring a sufficient supply of the comminuted material in a homogeneous condition. This is owing to the class of mill—centrifugal disintegrators—hitherto employed for grinding the coal. These mostly depend for their efficiency on the impact of the lumps of coal against a number of spikes or pins mounted on a frame rotated at high speed, but as the force of the impact and its effect on the material are dependent on the specific gravity and brittleness of the latter, the results obtained with coal are less satisfactory than with any other substances exhibiting more suitable structure. Another point, too, is that the excessive speed at which the mills must be run, in order to obtain sufficient force for pulverising the coal, both necessitates more substantial and costly construction, and gives rise to rapid currents of air which allow the material to become overheated. Again, notwithstanding the use of safety appliances, the risk of damage to the apparatus from extraneous substances, fragments of iron, &c., at such high speeds is considerable, and the repairs bill consequently heavy. On the other hand, ball mills are of too insignificant capacity to supply the demand, on account of their relatively small available grinding surface, and diminished effect due to injurious friction.

The Propfe mill has been designed to obviate the defects and combine the advantages possessed by mills of both the classes just referred to. The ideas embodied in its construction are:—A rotating frame affixed to a vertical spindle, and surrounded by a ring of great strength, carries at its periphery a series of vertical rollers so arranged that their pressure against the grinding surface of the outer ring increases, by centrifugal force, with the speed at which the apparatus is worked, and *vice versâ*. This will admit of irregular-sized lumps being fed to the mill, and will remedy the defect alluded to in ball mills, viz., the small amount of utilisable surface, by the substitution of centrifugal pressure for that of gravity. The employment of these rollers also allows of greatly reduced speed as compared with the ordinary disintegrator, since here the comminution is effected by pressure between two metal surfaces instead of by the force of the coal itself; in fact, the rate of peripheral rotation is between one-seventh and one-twelfth that of ordinary disintegrators.

The annexed figure will assist in the comprehension of the verbal description. It will be seen that there are two sets of rollers, one at the top and the other at the base of the milling chamber, the latter set being for the purpose of grinding down any portions left by the upper rollers in too coarse a condition to pass through the sieves constituting the inner walls of the apparatus. In the central space between the two sets of rollers the ground coal is exposed to a current of air induced by a number of vanes mounted on a main axle, and is thereby forced through the sieves into the outer annular space for collection and removal. The feed-hopper is fitted with a rotating arm to assist the descent of the coal on to the roller frame, centrifugal force then directing it to the space between the rollers and the ring. An automatic valve prevents the mill getting stopped up, and the whole is enclosed in a wooden cover lined with sheet metal. The power is applied by belting to the pulley at the lower extremity of the axle, but, for large sizes, bevelled gearing, as suggested by the dotted lines in the figure, is preferable.



The efficiency of a 12 to 18-horse power mill of this description—costing about £190—is:—Delivery, per hour, hard coal, 20 to 50 cwt.; delivery, per hour, brown coal, 15 to 45 cwt.; working at 200 revolutions per minute. The cost of grinding is estimated at about 1s. 3d. to 1s. 6d. per ton, producing a dust that will all pass through a sieve containing 900 meshes per square centimetre. Recent tests made with this mill at the Anhalt Colliery, at Frose, showed that with 17·1-horse power—about 4·5 of which may be taken as necessary for driving the subsidiary machinery, elevator, &c.—30 cwt. of coal dust were produced in the hour, or about 2½ cwt. per horse-power per hour.

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

Heavy rails.—In view of the recent discussion as to rail sections, it may be of interest to give here the dimensions of the 90 lb. rail of the Lehigh Valley Railroad, representative of the clumsy, large-headed type, as compared with the 90 lb. section recommended by the rail committee of the American Society of Civil Engineers, the latter being representative of the stiff, well-designed rail, specially designed for a good distribution of the metal and a thorough rolling of the metal at a uniform low temperature:—

	L. V. R. R. In.	Am. Soc. C.E. In.
Height	5	5⅜
Width of base	5	5⅜
Width of head (maximum)	2¾	2⅝
Side of head	Inc. 5 deg.	Vert.
Depth of head	1 53-64	1 19-32
Height of web	2 15-64	2 55-64
Depth of base	15-16	59-64
Thickness of web	⅝	9-16
Height to centre of bolt hole	2 1-16	—
Radius of top of head	12	12
Radius of top corners of head	¼	5-16
Radius of bottom corners of head	½	1-16
Radius of top fillets	¼	¼
Radius of bottom fillets	¼	¼
Radius of corner of base	1-16	1-16
Radius of sides of web	9	12
Fishing angles of head and base	14 deg.	13 deg.
Metal in head, per cent.	47·8	42
Metal in web, per cent.	18·2	21
Metal in base, per cent.	34·0	37

Electric locomotive.—The latest electric locomotive actually constructed is one built jointly by the Baldwin Locomotive Works and the Westinghouse Electric Company. It resembles somewhat a large passenger car or tramcar, with doors in the middle, and mounted on two four-wheel trucks or bogies. The framing is of steel channels, fitted with a pilot or cowcatcher at each end. There is a short platform at each end, and a headlight is mounted on the hood of the roof over the platform. The dimensions are 32ft. in length and 9ft. in width. Each truck has a heavy steel frame, with plate springs over the axle-boxes, and double elliptical plate springs under each end of the bolsters. The wheels are 42in. diameter, with 6½in. axles, and each truck has two motors of 100-horse power, or 400-horse power in all, while designs have been prepared for a similar engine with four motors of 200-horse power. Air brakes are fitted, the air being supplied to the reservoirs by an air compressor within the cab, which also sounds the whistle. The motors are of the single gear type. The cab is of steel plate, with large windows, and can be used for baggage or passengers, a locomotive of this kind being adapted for the service of branch lines. The engine weighs about 50 net tons, and is capable of attaining high speeds. Arrangements have been made by the two firms mentioned for building all kinds of electric locomotives, for every kind of service, from switching or shunting engines to main line engines, and including engines for rack railways, light railways, street railways, &c.

Heavy goods engines.—The Union Pacific Railway has now in service an enormous locomotive of the Consolidation type—having eight driving wheels, and a two-wheel loading truck or bogie—with cylinders 22in. × 28in., and weighing 160,000 lb., of which 142,000 lb. are on the driving wheels, 4ft. 3in. diameter. The driving wheel base is 14ft. The boiler is 6ft. diameter, with 270 tubes 2¼in. diameter, and 13ft. 6in. long, while the fire-box is 3ft. 6in. × 10ft. 1in. An engine of similar type, but somewhat smaller, built for the Midland Terminal Railway, of Colorado, has the following dimensions :—

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* Oesterreichs Wollen-und Leinen-Industrie, xvi., 174.

Cylinders	21in. × 26in.
Steam ports	18in. × 1¼in.
Exhaust ports	18in. × 2¾in.
Driving wheels	4ft. 4in.
Truck wheels	2ft. 6in.
Wheel base, driving	14ft. 4in.
Wheel base, total	22ft. 3in.
Weight on driving wheels	132,000 lb.
Weight, total	149,000 lb.
Blind tires on four middle wheels	
Boiler, wagon top ; diameter	5ft. 2¼in.
Boiler pressure	170 lb.
Fire-box, length	9ft.
„ width	3ft. 6¼in.
„ depth	5ft. 0¾in. to 5ft. 3¾in.
„ crown staying	crown bars
Tubes, number	258
„ diameter	2¼in.
„ length	13ft.
Grate area	31¾ square feet
Heating surface, tubes	1962¼ square feet
„ „ fire-box	162·3 square feet
„ „ total	2124·5 square feet
Smokestack, diameter at throat	16in.
„ diameter at top	19in.
Rail to top of smokestack	14ft. 9in.
Tender, eight wheels, diameter	2ft. 9in.
„ wheel base	15ft. 6½in.
„ capacity of tank	4000 galls.
„ capacity of coal space	11 tons.
„ weight, empty	40,100 lb.
Wheel base of engine and tender	48ft. 9⅜in.
Length over engine and tender	57ft. 6½in.

Compound locomotives.—The Chesapeake and Ohio Railway has recently put in service five compound locomotives of the Consolidation type—having eight coupled driving wheels and a two-wheeled leading truck or bogie—for the mountain division, where the ruling grades are 1 in 64. The engine has two cylinders, and its general dimensions are as follows :—

Cylinders	21in. × 24in. and 33in. × 24in.
Steam ports	1¼in. × 23in. and 1¾in. × 23in.
Exhaust ports	3in. × 23in. and 3½in. × 23in.
Connecting-rod, length	6ft. 11½in.
Driving wheels	4ft. 2in.
Truck wheels	2ft. 6in.
Journals, driving axles	7¾in. × 8½in.
Journal, truck axles	5in. × 9½in.
Main crank-pin	6in. × 6½in.
Wheel base, driving	15ft. 8in.
Wheel base, total	23ft. 5in.
Weight on driving wheels	127,000 lb.
Weight, total	143,000 lb.
Boiler (extended wagon top), diameter	5ft. 2in.
Fire-box	10ft. 1⅝in. × 2ft. 9⅜in.
Fire-box, thickness of plates	⅜in.
Tube plates, thickness	½in.
Crown sheet	radial-stay
Boiler pressure	200 lb.
Tubes, number	281
Tubes, diameter outside	2in.
Tubes, length over tube sheets	11ft. 10½in.
Grate, area	28·18 sq. feet
Heating surface, tubes	1744 sq. feet
Heating surface, fire-box	228 sq. feet
Heating surface, total	1972 sq. feet
Vaves, travel, high-pressure	6in.
Valves, travel, low-pressure	5½in.
Valves, outside lap, high-pressure and low-pressure	⁵⁄₁₆in.
Tender wheel (two four-wheeled bogies)	2ft. 9in.
Tender, length of frame	21ft. 2in.
Coal capacity	6 tons
Water capacity of tank	4000 gallons
Piston, high-pressure	cast iron
Piston, low-pressure	cast steel
Piston-rod, diameter	3¾in.

Well boring in Manitoba.—The return made by the Minister of Public Works as to well boring machines has some interesting information. The cost of the machines was : No. 1, 905 dols.; Nos. 2 and 3, 815 dols. The duty has been refunded by the Dominion Government. No 4. is an auger purchased from the Vulcan Iron Company for 150 dols. Duplicate parts and tools cost 572 dols. The cost of running the machines was: No. 1, wages expenses, 1505·32 dols.; repairs, 135 dols.; total, 1640 dols. No. 2, wages expenses, 1150·35 dols.; repairs, 35·90 dols.; total, 1186·25. No. 3, wages expenses, 1764·48 dols.; repairs, 31.88 dols.; total, 1796·36 dols. No. 4, wages expenses, 295·85 dols.; repairs, 24·41 dols.; total, 320·26 dols. The number of wells bored was as follows :—No. 1, 24 ; No. 2, 28 ; No. 3, 20 ; No. 4, 9. The plan of working is roughly to bore one well in a township in those parts of the province where difficulty has been experienced in finding water. The object is to prove at what depth water can be found, so that municipalities may purchase machines and bore wells for settlers. In this respect the effort has been fairly satisfactory. Of the wells put down two were in creameries, eight in public places, and the rest on private property. Where wells are bored on private land no charge is made the owners. They have to provide all the horses and manual labour required to run the machines, and board all employed on the work, including the superintendent in charge. When test wells have been sunk in all parts of the province the Government will have fulfilled the work undertaken and dispose of the machines.

A conduit electric railway in winter.—The two electric railways in New York which have the conductors laid in an underground conduit, like that of a cable railway, have recently been put to a severe practical test by heavy snowstorms, but neither the covering of the tracks by snow, or the subsequent slush in the tracks and in the conduit, caused any electrical trouble either in the conduit or on the cars. On the Lennox-avenue line the heavy storm of March 16th caused little interruption to traffic, the track being kept clear by sweeping machines, and no trouble being experienced with the electric conductors in the conduit. During the snowstorm of March 11th the operation of the road was hardly interfered with. The snow began to fall about 8 a.m., and the snow sweeper was started out over the line, but before it could make the complete trip the sprocket wheels of the broom broke, and it was necessary to push the sweeper back into the barn for repairs, where it remained until 4 p.m. Meanwhile the cars ran over the unswept tracks with no greater delay than would be ordinarily caused by considerable slipping of the car wheels on the snow-covered rails, the trips being about eight or ten minutes longer than usual. At some points the snow was drifted over the tracks by the wind, making it necessary for the motor man to back his car to get the necessary momentum to force the car through. After 4 p.m. the snow sweeper cleared the line, and schedule time was resumed. About 8 p.m. the storm turned to sleet and hail, which covered the rails with ice, but the cars were able to make their usual headway. On the Lexington-avenue electric conduit line a gang of men swept the tracks, and the cars made schedule time while the bad weather prevailed.

United States Navy.—The House of Representatives Committee on Naval Affairs has reached a formal agreement on the features of the Appropriation Bill for the next fiscal year, and has voted for four new battleships, five torpedo boats of the first-class, and ten torpedo boats of the second-class. The total amount carried by the Bill is 32,050,000 dols., or about 3,000,000 dols. more than that authorised by Congress last year. But included in this big sum are 5,300,000 dols. for construction and machinery and 3,890,000 dols. for armour and armament of vessels heretofore authorised. Not including the cost of the new vessels in this year's measure, it only carries about 28,000,000 dols. The cost of each new battleship is limited to 3,750,000 dols., and only 500,000 dols. is to be expended on each of them during the next fiscal year, or only 2,000,000 dols. in all. The contract price of the five first-class torpedo boats is not to exceed 175,000 dols., and the sum which can be spent on all of them between now and July 1st, 1897, by the Navy Department is limited to 656,000 dols. The cost of the ten second-class torpedo boats is fixed at 80,000 dols. each, and for the whole number only 600,000 dols. can be drawn upon in the next fiscal year· The majority of the committee, mindful of the condition of the Treasury and the discouraging outlook, voted, therefore, to keep down the expenditures for new ships to 3,256,000 dols. for the coming year. In the way of new legislation the Bill will provide for 1000 additional sailors and 500 more marines. The construction of dry docks at Algiers, La. ; Mare Island, Cal. ; and Portsmouth, N.-H., is authorised at a cost of 800,000 dols. for the former and 575,000 dols. for each of the two latter places. Only 100,000 dols. for each dock is to be available next year, however. Towards the armament of modern guns for auxiliary cruisers 250,000 dols. is appropriated, and for improvements at the Washington Gun Foundry 50,000 dols. The torpedo station gets 60,000 dols., and 50,000 dols. can be drawn upon to arm and equip the Naval Militia. For public works at the New York Navy Yard 75,000 dols., and 25,000 dols. to the Brooklyn Hospital for improvements. For repairs on the Miantonomoh, Bennington, Baltimore, Petrel, Mohican, Ranger, Atlanta, and Vesuvius, 350,000 dols. is made available. The Bill says that hereafter no wooden ships are to be repaired if the improvements exceed 10 per cent. of the original cost. For new boiler tubes for the Columbia, New York, and Minneapolis, the committee assigned 30,000 dols. New boilers for the Atlanta and Dolphin were authorised, and 150,000 dols. were provided to continue work on the machinery of the Chicago.

AUSTRALIAN NOTES.

The Victorian Government has passed a Bill embodying the engagement of a general manager for railways at a salary of £3500 per annum. An attempt was made to confine the selection within the Australasian colonies, but since the conference with the Upper House this clause has been rescinded.

Messrs. Joseph Baker and Sons, Melbourne, have secured the order for the supply of four large "Trusty" oil engines for driving the electric light at Coolgardie.

The New South Wales Government have offered a bonus of £1000 for the first discovery of payable gold at a depth of 2000ft. from the surface—hitherto all the gold won in the colony has been from very near the surface, while in Victoria mining has been carried on for some time at depths exceeding 2000ft.

Messrs. Hudson Brothers, Limited, engineers, Sydney, are proposing to adopt the co-operative principle with their employés such as that which has been in practice for some time with James Martin and Co., Gawler, South Australia. The system which obtains with the latter engineering firm is that those workmen in receipt of over 10s. per day have 15 per cent. taken off their wages, and those earning 10s. per day and under, 10 per cent. off, to go towards the purchase of shares. When the money thus retained reaches £4, a £5 share, of which £4 is paid up, is issued to the workmen.

Lysaght Brothers and Co. have secured the contract from the New South Wales Government for the supply of 105 miles of galvanised rabbit-proof wire netting.

The want of more rolling stock and locomotives on the West Australian railways is being severely felt, the goods arriving at the ports accumulating until transit is almost at a standstill. It is stated that within the last month 11,000 tons of goods are blocked at Freemantle, and no actual relief can be obtained until further supplies of rolling stock are received from England.

The railway department has placed orders with English firms for some £60,000 worth of rolling stock, and a similar expenditure on locomotives. Orders for locomotives are also placed with a colonial firm, so great is the demand.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, April 8th.

The extraordinary expansion of capacity in all industries has stimulated a spirit of trade organisation in several directions. The anthracite coal interests expect to restrict production and advance prices, and even to enter upon a heavy exportation of coal to Germany, for which preparations are in an advanced state. The business outlook is improving. Large foreign loans of capital are offered at 4 per cent. Bank clearings throughout the States during March were 5½ per cent. larger than March, 1895, 7 per cent. larger than March, 1894, and 11 per cent. less than March, 1893. For three months the aggregate clearings were 8 per cent. larger than same time last year, 16 per cent. larger than same time 1894, and nearly 25 per cent. less than same time 1893. Commercial failures for the last quarter are very large, 18 per cent. in excess of same time last year. The liabilities are unusually heavy. Gold exports begin to-day. The railroads are now profiting by the enormous corn movement. Steel billets have been advanced by a combination of manufacturers to 20 dols. Steel rails are 28 dols., Forge iron 11·50. The rolling mills are running slack. Plate mills are busier than others, and manufacturers of structural iron expect to be crowded with summer contract work in a few weeks. There is hesitation to rush into new industrial enterprises. Raw material is firm. Stocks of finished material are light, and mill, shop, and factory interests are waiting for orders to come. The tone of the market is strong, even with a moderate demand. Gold mining production this year will surprise the world, Colorado alone expects to dig out 30,000,000 dols. The rest of the region will double this.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

Fair attendance on 'Change. The demand for steam coal is moderate, pending arrival of vessels fixed for loading. Prices are without change. House coal shipments are good for the season, with prices steady. Tin-plates show no improvement, either in demand or price.

Prices :—Coal : Best steam, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s.; house coal, best, 10s. to 10s. 3d.; dock screenings, 5s.; colliery small, 4s. 3d. to 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron : Scotch warrants, 46s. 4½d.; hematite warrants, 48s. 2d., f.o.b. Cumberland ; Middlesbrough No. 3, 38s. 1d. prompt ; Middlesbrough hematite, 45s. 7½d. Iron ore : Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel rails, heavy sections, £4 12s. 6d.; light ditto, £5 to £5 5s., f.o.b.; Bessemer steel tin-plate bars, £4 ; Siemens tin-plate bars, best, £4 2s. 6d., all delivered in the district, cash less 2½ per cent. Tin-plates : Bessemer steel cokes, 9s.; Siemens coke finish, 9s. 3d.; ternes, per double box, 28 by 20 C., 18s. 6d. to 20s. Pitwood, 15s. 3d. to 15s. 6d. London Exchange telegram : Copper, £44 10s.; Straits tin, £59. Freights steady.

A serious difficulty experienced with the screw propellers of torpedo-boat craft taken in connection with the thinness of the blades is the quickness with which they corrode. In one case the common steel propeller was found to be seriously corroded after three months. In the German Navy, a correspondent writes to the *Naval and Military Record*, experiments in the hope of getting rid of this drawback are being made with nickel steel for propeller blades in small crafts. So far the tests have proved satisfactory. After three months' trial the nickel steel was not corroded, while the common steel, with but an eight months' test, showed both metals to be corroded, though the nickel steel stood the best.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

During the week orders given verbally at the quarterly meeting have been confirmed by letter, and the works are now again engaged after the Easter holidays. A fair amount of work has been forthcoming as the result of those gatherings, and prices remain on the level then quoted.

Much satisfaction is expressed at the circumstance that the iron and steel exports for the quarter are so favourable. It is pointed out that the improvement in value for the quarter of iron and steel exports to all countries, compared with last year, has been 27 per cent., and in quantity as much as 36 per cent. The following advances in value, compared with last year, for the month and quarter respectively, are also received with feelings of gratification: Pig and puddled iron, 60 per cent. and 75 per cent.; bar, angle, bolt, and rod, 15 per cent. and 23 per cent.; railroad, 72 per cent. and 10 per cent.; ordinary wire, 22 per cent. and 28 per cent.; telegraph wire, 23 per cent. and 25 per cent.; cast and wrought iron, 18 per cent. and 28 per cent.; old iron, 91 per cent. and 104 per cent.; unwrought steel, 39 per cent. and 58 per cent.; galvanised sheets, 40 per cent. and 61 per cent. Hoops and sheets are better on the month by 8 per cent., but they show a decline for the quarter of 7 per cent.

The figure of £7, at which marked bars have remained for nearly three years, is still being quoted, and business in this class of iron has lately shown improvement. Unmarked bar quotations are irregular, the members of the Association being unable to obtain the list value of £5 15s., delivered, for common bars. Staffordshire and Shropshire common bars are sold as low as £5 5s. delivered, but the average is about £5 10s.; good merchant bars range from £5 12s. 6d. to £6. Galvanised sheet manufacturers are suffering from over-production and the competition of Welsh and a number of English and German houses, especially in the steel sheet branch. Galvanised corrugated sheets were quoted to-day at £10 to £11 per ton for 24 gauge, being at least £1 a ton lower than three months ago. The bulk of the contracts are accepted at the former figure, though sales involve loss rather than profit. Some of the best-known houses refuse to quote rather than accept the low rates offered by merchants and customers. Plain rolled sheets are suffering from the depression in the galvanised branch, singles realising £6 12s. 6d. to £7, and doubles £7 to £7 7s. 6d.

The competition in the tinned sheet trade has assumed a ruinous form, Welsh makers quoting lower prices than those of Staffordshire and Worcestershire houses, and a proposal has been moved for terminating the Tinned Sheet Association, which is an amalgamation of about half a dozen Worcestershire and Staffordshire firms, but it has been decided to carry on the Association for the present. The members of this body, at their recent quarterly meeting, resolved to reduce prices 2s. per cwt., which brings values down to the level at which they opened this year. Best coke sheets become 21s. per cwt. for two-ton lots, and charcoal sheets of large size 23s. Intermediate sizes are also reduced by 2s., and they now become :—Best cokes, 18s. per cwt.; and best charcoal, 19s. The new rate for any quantity under two-ton lots is 1s. extra on these prices.

In steel there is a steady business doing, Siemens marked steel slabs being imported from South Yorkshire at £5 a ton at stations ; basic quality, £4 7s. 6d. to £4 10s.; steel bars realise £6 to £6 10s. for Siemens, and £5 7s. 6d. to £6 for Bessemer quality ; Bessemer ship plates realising £5 15s., delivered, and best Siemens boiler plates, £7 to £8 10s., varying according to tests and size.

Derbyshire forge pig iron realises 42s. 6d. as an average; Northamptonshires, 41s.; Lincolns, 44s. 7d., at stations. Staffordshire cinder pig is well maintained at 36s. to 37s. for forge, and about 2s. more for foundry. All-mine are 55s. to 60s.

Cycle engineers in Birmingham and the district note with considerable curiosity the circumstance that at an extraordinary meeting in Dublin on the 13th inst. of the Pneumatic Tire Company, a resolution was passed authorising the disposal of the company to an English syndicate for the handsome sum of £3,000,000—three millions. The chairman announced that he had received a deposit of £1,000,000, which would become the property of the company if the purchase arrangements were not carried out. He mentioned that the shareholders had provided £75,000 in capital, and £185,000 in premiums, and had received £657,000 in dividends, while it was now proposed to give them £2,887,500, making altogether a total of some £3,545,000 in exchange for the money provided by them. A feature of the scheme adopted yesterday is to retain £80,000 for distribution among the employés and directors, when the sale is completed. When the auto-motor cars come into vogue perhaps a new era of usefulness will dawn for the pneumatic tire. It is understood that a wealthy rubber company is at the back of the new syndicate of purchasers.

Members of the Birmingham gun trade are perusing with interest a recent report in which the United States Consul in Liége describes the manufacture of and trade in Damascus gun-barrels, wholly hand-made, in the valley of the Vesdre, in that province. These barrels are for sporting guns. The annual production of Damascus barrels in the Vesdre Valley is about 300,000 pairs, of a value of about 3½ million francs. Of this the wages alone amount to about two million francs. The principal markets are Great Britain and the United States. About half the barrels made in the Vesdre Valley are sold to manufacturers of arms in Liége, to be mounted. The best sorts are made of a mixture of charcoal-iron and steel. Each barrel receives 150 welding heats whilst being forged.

The new Technical Schools which have been erected at Bath, at a cost of over £20,000, were opened on the 14th inst. by Sir William Hart Dyke.

Hydraulic engineers should note that Mr. E. P. Burd, one of the inspectors to the Local Government Board, has attended at the Guildhall, Shrewsbury, to hear evidence in reference to an application which has been made by the Town Council to the Board for a provisional order to amend the Waterworks Act of the Borough, so as to enable the Council to borrow a further amount for the purpose of water supply. Mr. Graham, of the Oxford Circuit, appeared for the Corporation, and Mr. Spearman for the Ratepayers' Association of the Borough. Mr. Graham explained that several schemes for a better water supply of the town had been adopted by the Council, but as they failed to meet with the approval of the ratepayers, none of them could be carried out. The present supply was, he declared, a disgrace to any town that called itself civilised, and was pumped from the Severn at Coton Hill, and supplied to the town without being filtered or strained.

About a year ago the New Conveyor Company acquired the engineering works of Messrs. Stone Bros. and Company, Smethwick, Birmingham, and all the workshops are now in full operation, equipped with modern tools for the economical and efficient manufacture of conveyors, elevators, gearing, coal screening, and coal-washing machinery.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The continued lull in the iron market here—due, however, mainly to special causes, to which I have previously referred in my notes—is having a temporary weakening effect upon prices. Not that makers are giving way to any appreciable extent, as for the present they prefer to go on with the contracts they have still on their books, rather than attempt to push sales ; but in the open market there is low selling going on, and the absence of buying of any weight coming forward in pig iron is necessarily rendering the position of makers of raw material not quite so strong as it has been. With, however, the steady improvement in the principal iron-using industries, the feeling remains one of general confidence with regard to the future. I have been making inquiries with regard to the shipment of American pig iron into this district, and other parts of the country, which have recently attracted some attention. In well-informed quarters these shipments do not excite any real concern, as they are looked upon as merely the result of American makers getting rid of surplus supplies at prices which they do not care to take at home, and which the exceptionally low freights ruling of late have enabled them to ship to this country under advantageous conditions. Certainly they are not looked upon as any attempt to establish a permanent business in the way of shipping iron to this country. I also hear from representatives of the iron trade just returned from America that the position of affairs in the States is not just now anything like so satisfactory as it has been, and this may further account for the getting rid of surplus iron by export.

There was again only a slow tone reported on Tuesday's Manchester Iron Exchange, and not more than a moderate attendance. For pig iron especially inquiry continues limited to small quantities, buyers who could place orders of any moment preferring to wait in the expectation that prices may be lower. Makers, however, who have generally sufficient iron under contract to go on with for the present, are holding to their list rates, but are booking only occasional small lots on this basis, and the general tone of the market is easier, iron in second hands being offered, in some cases, at under makers' prices. With regard to local and district brands, makers' quotations are unchanged, but not so firm in all cases, and in the open market Lincolnshire could be bought at about 6d. under quoted rates. Outside brands offering here are weaker in price. For delivery Manchester Docks, special brands of foundry Middlesbrough are offered at 45s., and at railway stations, 46s. 6d.; although makers' quotations are fully 6d. above these rates. Scotch iron makers ask about 47s. 6d. for Eglinton, and 48s. 6d. for Glengarnock, net prompt cash, delivered Lancashire ports, and 49s. 9d. to 50s. 6d. for Eglinton and Glengarnock respectively delivered dock quays Manchester, but quite 6d. under these figures would be taken by merchants.

In the manufactured iron trade makers are still securing a fair weight of new orders, and forges are kept fully employed, with late quotations well maintained. Delivered Manchester district, £5 10s. is the minimum for Lancashire, £5 12s. 6d. for North Staffordshire bars, and £7 10s. for sheets, with £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths, 2s. 6d. less for shipment, still the Association list rates for hoops.

Nut and bolt makers, although not quite so busy as they were recently, are kept well engaged and prices are steady at recent rates.

No appreciable development of activity is noticeable in the steel trade here. For good foundry hematites makers do not quote under 58s. to 58s. 6d., less 2½, but merchants are prepared to sell at 6d. to 1s. below these prices, whilst ordinary steel billets are obtainable at £4 7s. 6d. to £4 10s. net cash, and £6 7s. 6d. represents about the average figure at which boiler-plates can be bought for delivery in this district.

In the metal market the recent push of buying has rather fallen off, but an active demand is still reported; and although the extra ¼d. per pound on brass and copper tubes is scarcely now being got, prices for these, as well as for other descriptions of manufactured goods, are firm at the full list rates.

I continue to hear very satisfactory reports from representatives of the engineering trades attending 'Change. Amongst boilermakers especially there has been a large amount of work given out recently, and one firm, which has a special plant for stamping boiler ends for most of the makers in the district, informed me that last month was a record in the number they had turned out, and that the present month promised to beat even last month. New work also still comes forward freely amongst locomotive builders, one or two good orders having been placed in this district during the last few days. With regard to other branches of engineering, the position remains much as I have previously reported, machine tool makers being all well supplied with work, stationary engine builders kept fully going, and other branches all well engaged.

The monthly report of the Amalgamated Society of Engineers, issued during the past week is equally as satisfactory as that of the Steam Engine Makers' Society, to which I referred in my last notes, with regard to the continued steady improvement in trade, the number of out-of-work members showing a further decrease, as compared with the previous month, and the reports as to the state of trade are of a more satisfactory character than they have been for several years past. Nearly all the districts record increasing activity generally, and in practically every department it is very exceptional where establishments have not work in hand to keep them fully employed. The Society has now under 3 per cent. of its total membership on the unemployed list, and the officials are hopeful that this percentage may be still further reduced during the next few months. In the Manchester district the position is even better than throughout the Society generally, the out-of-work list representing very little over 2 per cent. of the local membership, practically all the shops in the neighbourhood being fully employed.

Mr. Henry Hall, one of her Majesty's inspectors of mines, brought before the members of the Manchester Geological Society, at their meeting on Tuesday, a couple of self-igniting safety lamps, such as are now being largely used in German mines. One of these was a Wolf lamp, a German patent, and the other an ordinary Clanny lamp, both fitted with self-igniting apparatus, one of the lamps burning benzine, and the other colza oil, the igniting apparatus being equally effective in re-lighting either of the lamps. The igniting arrangement consists of a narrow tape, carrying on its surface at intervals small patches of fulminating material, this tape being fitted inside the lamp, in connection with a small upright shaft, similar to the pricker wire of an ordinary safety lamp. The tape passes from the bottom of the lamp up to the wick through a toothed clip, and by drawing the small shaft, which projects from underneath the lamp, quickly downwards, the fulminate on the tape is brought in contact with the teeth of the clip, and at once ignites, setting the portion of the tape projecting towards the lamp wick in flame, and then by leaning the lamp a little on one side this flame is brought in contact with the wick, and relights the lamp. One length of this tape is sufficient to relight the lamp from fifty to sixty times, so that under ordinary conditions the lamp might be in use for about a month without interfering with the apparatus. Mr. Hall, having experimented with the lamps, in order to show the working of the igniting apparatus, remarked that there were objections in some quarters to placing an apparatus of that kind in the hands of a collier, as it was held by many mining engineers that when a lamp was put out through any accident, it ought to be examined by some responsible person before being re-lighted. Against this objection, however, there were several advantages, the chief of which was that lamps were subject to being accidentally knocked out by the lads employed in carrying them to and from the face and the lamp stations, and there was the danger with the ordinary lamps of the men continuing their work in the dark, owing to their having no means to re-light them. The view taken in Germany, where these lamps with self-igniting apparatus were in general use, was that in case of a large explosion the use of such lamps enabled the workmen who were not injured, but whose lamps would in all probability be put out, to again procure a light which would, and had often, been the means of saving a considerable number of lives. He—Mr. Hall—thought this view of the matter was very important, as there could be no doubt that in case of an explosion a miner could scarcely be left in a more terrible position than being deprived of any means of procuring a light to help him in his escape. If it was thought unwise to put this apparatus for re-lighting lamps in the hands of a collier on the ground that an insecure lamp might thus be re-lighted, the apparatus might be so designed that it could only be operated by a fireman. Certainly such a re-lighting arrangement would take away the temptation to improperly open a lamp which had gone out, and there would be a saving of the expense incurred in employing boys to carry lamps from point to point for re-lighting. In a short discussion which followed, several inspectors of mines and mining engineers who were present expressed the opinion that such an igniting apparatus as had been shown would have to be very fully considered before it could be introduced into the mines of this country, and before it could be placed in the hands of the miners it would in all probability necessitate some special alteration of the present colliery rules. The general opinion, however, was that under certain conditions the colliers should have a means of re-lighting their lamps such as had been shown by Mr. Hall.

In the coal trade a depressed tone is the more or less general report. Pits are only in exceptional cases working more than four days per week, and supplies of all descriptions, except engine fuel, are plentiful in the market. House-fire qualities have been moving off moderately considering the time of the year, and prices are steady at late rates, but do not average more than 10s. for best Wigan Arley—less than this being taken in some cases for quantities, 8s. 6d. to 9s. for Pemberton four-foot and seconds Arley, and 6s. 6d. to 7s. for common house coals, at the pit mouth. Steam and forge coals still hang upon the market, with prices cut excessively low to effect clearances, whilst competition for ordinary business is exceedingly keen, and ordinary qualities at the pit mouth do not average more than 6s. to 6s. 6d. per ton. Engine fuel meets with a ready sale, some of the better qualities being rather scarce, if anything, and prices are firm at fully late rates, but, so far, attempts to secure advances have met with very little success, apart from one or two special cases. At the pit mouth common slack averages 3s. to 3s. 6d., and better sorts 4s. to 4s. 6d. per ton.

For shipment business continues slow, with prices as low as ever, common steam coals, delivered Garston Docks or High Level, Liverpool, or at the Partington Tips, Manchester Ship Canal, being readily obtainable at 6s. 9d. to 7s. 3d. per ton.

Barrow.—The hematite trade this week is rather weaker, but this is attributable to speculative influences, and not to any fluctuations in demand. Makers of pig iron are busy all round, and are very fully sold forward. Orders are offering freely for forward delivery, and prompt sales are at the moment the exception to the rule. Prices are firm at 50s. for mixed Bessemer numbers, net, f.o.b. Warrant iron is quoted at 48s. 2½d. sellers, 48s. 1½d. buyers, net cash. Stocks during the week have been reduced by 2979 tons, probably on account of the holidays and transactions of some weak holders. They now represent 303,918 tons held in warrant store-yards. There are still thirty-nine furnaces in blast, as compared with twenty-eight in the corresponding week of last year.

Iron ore is in brisk inquiry, and the local mines are being more actively worked, and particularly those that produce the best descriptions of metal; 10s. to 14s. 6d. is the range of prices from ordinary to best descriptions. Spanish ores are being more largely imported. This week five or six large cargoes have arrived at the docks at Barrow. Most of the smelters in the district are now using a proportion of Spanish ore. The price is steady at 12s. 6d. to 13s. per ton, f.o.b., 60 per cent. qualities, at West Coast ports.

Steel makers are very well off for orders, and rail and plate mills are very busy. Billets are in good demand, and the hoop trade remains very satisfactory. Overtime is being worked at the steel casting foundries, and good orders are on the market. Prices generally are firm. Ship plates are at £5 2s. 6d., but steel rails of heavy sections are down a little at £4 12s. 6d. per ton net f.o.b.

Shipbuilders and engineers are beginning to run short of orders, but tenders have been out for work for the Admiralty and commercial tonnage, which it is expected will result in renewed activity. Much progress is being made with the Admiralty work in hand, and it is anticipated H.M.S. Powerful will be ready to make her steam trials by June next.

The coal and coke trades are busy, and prices are stiffer for the latter, but easy for coal.

Shipping shows a temporary depression. The exports of pig iron from West Coast ports during the past week were 1414 tons, and of steel 3215 tons, as compared with 7480 tons of pig iron and 7023 tons of steel in the corresponding week of last year, a decrease of 6066 tons of pig iron and 3808 tons steel. The total shipments this year have reached 85,582 tons of pig iron and 116,528 tons of steel, as compared with 74,790 tons of pig iron and 105,610 tons of steel on the corresponding period of last year, an increase of 10,972 tons of pig iron and 10,918 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE Easter holidays are now over, and notwithstanding the fact that a considerable number of the pits was standing until well into the following week, not much animation has been felt in the South Yorkshire district. The collieries have been steadily employed since they resumed work. There is no appreciable improvement in the demand for household qualities of coal, and stocks at pits have been rather increased than otherwise during the last few weeks. The request from the Metropolis continues much the same as usual. Neither the Midland nor the Great Northern is carrying an average tonnage over their respective lines. This state of things, of course, has no beneficial effect on values, and in spite of all attempts made by owners to keep them up, they still continue to decline. Best Silkstones are obtainable at 8s. to 9s. 3d. per ton; ordinary, 6s. 9d.; Barnsley house, 7s. 3d. to 8s. 3d.; Flockton, 6s. 9d.; and thin seam from 6s. per ton. A better demand has set in for steam coal, the mild season we are at present experiencing favouring the early development of the export business. Prices continue fairly steady, with little prospect of advancing in face of the present keen competition. Barnsley hards are quoted at from 6s. 6d. to 7s. per ton for best sorts, while inferior qualities command about 6s. per ton. Gas coal is in rather weaker request, many of the pits curtailing their output considerably. Values are low at 6s. to 7s. per ton. Better reports are coming in with regard to manufacturing fuel. Small nuts fetch 4s. 6d. to 5s. 6d.; screened slack, 2s. 6d.; pit slack, 2s. 6d.; and smudge about 1s. to 1s. 6d. per ton. Coke is rather brisker, the demand from Lincolnshire, Northamptonshire, and other centres having advanced, and quotations range about 8s. 6d. to 10s. 6d. per ton.

The report of the coal business done by the Yorkshire ports with Hull, issued by the Hull Chamber of Commerce and Shipping, during the month ending March 31st, shows that the export trade has advanced considerably both on the month and the three months. During March last the coastwise trade amounted to 16,515 tons, which is an increase of 2030 tons over March, 1895. The total tonnage sent by local collieries amounted to 161,568 tons for the month, and 465,904 for the three months, as compared with 127,728 and 413,824 tons respectively for the corresponding month and quarter of 1895. Denaby Main is, as usual, the chief contributing market, with 20,424 tons, an increase of 128 tons over March of 1895; and for the quarter the weight is 64,944 tons, which is an increase of a little over 6000 tons. Monk Bretton comes second with 9600, against 4704, a very large increase, closely followed by Manvers Main, Carlton Main, and Aldwarke Main, with a little over 8000 tons each. The exports to foreign countries during March were 48,548 tons, an increase of 10,395 tons, and for the three months 145,117 tons, which is also a large increase over the same period of 1895. The increasing markets for the month were Sweden and Norway—10,817 tons, against 3130, an increase of 7867 tons—North Russia, South America, and Malta. For the quarter the increasing markets were Sweden and Norway, Italy, Holland, and Germany.

In the heavy industries of the city the holidays have been unusually short this year owing to the large amount of work in hand. In many cases business was carried right up to Good Friday night, and resumed again on Easter Monday or Tuesday. The make of both Bessemer and Siemens steel still continues very large. Hematite iron manufacturers refuse to receive contracts for forward delivery at the present prices, and many of the steel establishments are making no effort to book orders except on improved values. There is an exceedingly active request for crucible steel, more especially in the higher grades, and one Sheffield firm has secured a large order for the very finest steel that can be made. The railway material trade is also in a very good condition. Full employment is being given. As soon as the present orders are worked off fresh requirements are being placed. The iron market continues quiet with steady values. The engineering trades are not so well off for work as they were a few months ago. It is stated that Sheffield pays the highest rate of wages, London excepted, of any engineering locality in England. The Sheffield manufacturers complain that they are unduly handicapped thereby in the fight for orders.

Messrs. Thomas Firth and Sons, Norfolk Works, Sheffield, have received a good order for 12in. armour-piercing shells, and the Hadfield Steel Foundry Company have also obtained satisfactory orders for shells of lighter calibre.

In the lighter industries many of the large firms are complaining very much of the changeable state of the market. In many instances houses are well off for orders, while in others they have to keep their men employed by making goods for stock. Firms engaged in the silver and plating trades are fairly well engaged. Some very good requirements have just been received from the Indian market, and it is expected that before long a good business will be established with the various seaside resorts. Sheffield houses are confidently expecting that before long they will be receiving orders from the Admiralty for appointments for the various ironclads now in course of construction. These will mean considerable work, and will provide employment for many firms who have little work on hand.

Hardware and cutlery were sent away during March last to foreign and colonial markets to a value of £180,256, as compared with £149,713 for March of 1895. The principal increasing market, it is pleasant to note, has been Australasia, which has advanced from £19,112 to £32,479. Increased business has also been done by Russia, Sweden and Norway, Germany, Holland, Belgium, Faance, Spain and Canaries, United States, Chili, Brazil, the Argentine Republic, British Possessions in South Africa, and British North America. The only decreasing markets on the month were Belgium, Foreign West Indies, and East Indies.

In unwrought steel the value of the foreign trade for the month was £212,770, against £152,608. All the markets show an increase except France and the United States, the former having fallen from £12,515 to £9678, and the latter from £32,978 to £29,850. Germany, on the other hand, has increased from £28,621 to £43,983; British East Indies, from £7525 to £17,673; and Australasia, from £6169 to £11,112. The greatest increase on the month has been in railroad material, the exports exhibiting a total value of £250,610, as compared with £146,787 for March of 1895. This increase is in spite of the fact that no business whatever was done with Russia, Germany, Italy, and United States—at one time a very profitable market—while several other countries took only trifling amounts. Japan, which was expected to show a great increase, has fallen from £49,380 to £24,300. On the other hand, Mexico, to which only £99 worth was sent in March of 1895, took last month £14,389. The greatest advance, however, has been with our own Colonies, Australasia increasing its demand from £2034 to £32,037, and this is exceeded by British East Indies, the trade with which has gone up from £14,995 to no less than £102,518. South American business has also improved, the Argentine Republic having advanced from £1682 to £19,926; Brazil from £7721 to £11,843.

Messrs. William France and Co., proprietors of the London and Goole steamers, have established a service of steam barges between this city and Goole, by which means the goods which took three days to arrive by water from Hull are now delivered in fifteen hours. The service will be accelerated with the improvement of the canal, which is being vigorously proceeded with.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE iron and allied industries are at present suffering from one of those lulls in demand which are looked for at intervals during the progress of a revival, and this week very little new business has been transacted, indeed the market must be described as somewhat depressed, and pig iron prices at any rate are easier, while Cleveland warrants have touched a lower figure than has been known since January last. As is usual in a falling market buyers are disinclined to operate, but makers are also indifferent about selling, as they have plenty of orders on their books. But some of the merchants are offering pig iron more freely, and are competing strongly with the makers, taking prices, in fact, which the latter will not look at.

The producers' position is satisfactory. There is no lack of contracts in hand, and deliveries are very heavy—brisker even than those of last month, and there is every reason now to believe that the consumption is exceeding the output, and that a decrease of stock will be reported at the end of the month. The output will shortly be reduced by the blowing out of a furnace at Messrs. Gjers, Mills, and Co.'s Ayrescme Ironworks, Middlesbrough, for re-lining. At another works the output of Cleveland ordinary pig is to be reduced and more basic iron is to be made.

The exports continue very heavy, but some profess to believe that they cannot continue long at the present rate, as there must be a slackening earlier than usual, seeing that the shipping season practically opened nearly a month before the ordinary time, owing to the mild weather, and consumers abroad, who have generally got their chief supplies in April heretofore, obtained them in March this year. As yet, however, the shipments show no sign of any abatement, and producers are therefore very firm. Up to Wednesday night the shipments of pig iron from the Cleveland district amounted to 54,094 tons, as compared with 45,061 tons in March, and 55,167 tons in April last year. As regards last year the shipping season began exceptionally late owing to the severe weather of the first three months, and there was quite a rush of exports in April.

Owing to the competition of second hands, the price of No. 3 Cleveland G.M.B. pig iron for April, f.o.b. delivery, has been brought down to 38s., and some makers have even taken this from old customers, but generally it is a merchant's, and not a maker's price. Buyers have been able to purchase No. 3 for delivery up to the end of the half year at 38s. 3d., but very few people are buying this week, and there is no tendency at present to speculate, though most traders believe in the early resumption of activity, and do not look upon the present slackening with any apprehension; in fact, they simply regard it as an incident in the upward movement, which must be experienced now and then. No. 1 Cleveland pig iron is sold at 39s. 3d.; No. 4 foundry, at 37s. 6d.; grey forge, at 37s.; mottled, at 36s. 6d.; and white, at 36s., all for early delivery, but of the last named practically only a few tons can be secured, as none is being made, and the stocks are almost exhausted. An order for a thousand tons of white iron has been hawked about all over the district, but could not be executed, and the buyers had to accept a higher quality. For mixed numbers of East Coast hematite pig iron 46s. 3d. per ton is accepted.

The official accountants representing the Cleveland Ironmasters' Association, the Cleveland Blast Furnacemen's Association, and the North-Eastern Railway Company, after having examined the books of the ironmasters, declare that the average price obtained for the No. 3, delivered during the three months ending March 31st last, was 37s. 2·54d. per ton, this being 9·48d. increase on the previous quarter's average, and a figure not far short of the average quoted price. In accordance with the sliding scale arrangement the wages of blast furnacemen will as from the 4th inst. be advanced 1 per cent., and railway rates for iron-making materials, which are also regulated by sliding scale, based on the realised price of pig iron, will be advanced 1 per cent. also.

The blast furnacemen of Cleveland have resolved that they will on July 29th next hold a demonstration similar to that of August 11th, 1894, to talk over their position, and to enable them to carry out this project they have resolved to take holiday on that day, which will mean that the furnaces will have to stand for twenty-four hours. This will detrimentally affect the quantity and quality of the pig iron produced for some time afterwards.

On Monday night a serious explosion occurred at the Brancepeth Colliery between Durham and Bishop Auckland, and carried on by Messrs. Strakers and Love. Seventeen lives have been lost, and the accident would have been much more fatal to human life than it was if it had not occurred just when the men were changing shifts, and scarcely any but the store men were in. This is one of the chief coking coal collieries in Durham county, and the accident will lessen the supply of coke to the furnaces. Previously the production of coke was barely equal to requirements, and now, until the colliery is able to resume operations, there must be a scarcity, and it may be possible during the next week or two to secure 1s. to 1s. 6d. per ton advance. The workings of the colliery have been a good deal damaged, and it will be ten days or a fortnight before operations can be resumed. Besides this the working of other collieries with which the Brancepeth was connected has been interrupted. Owing to the disaster, Messrs. Straker and Love's make of coke is now not more than one-third the normal quantity.

The quarterly statistics of the Middlesbrough Chamber of Commerce show that there are within the port of Middlesbrough 91 blast furnaces, of which 72 are in operation, 44 producing ordinary Cleveland iron and 28 hematite, &c. The make of pig iron during the quarter was 590,171 tons, against 547,114 tons in the corresponding period of last year. Of the pig iron, 341,171 tons were ordinary Cleveland—24,057 tons in the first quarter last year—and 249,000 tons hematite, &c.—19,000 tons increase. The stock of Cleveland pig at Middlesbrough at March 31st was 344,915 tons—increase for quarter, 47,450 tons. Exports of pig iron from Middlesbrough reached 217,156 tons, against 165,878 tons in first quarter of last year. Of manufactured iron 61,317 tons were shipped, and of steel 56,852 tons; total 118,169 tons, against 81,480 tons last year. Of iron ore, 394,143 tons were imported, as compared with 294,630 tons in the previous quarter, and 284,449 tons in the corresponding quarter of last year.

In a paper read by Mr. A. S. Keith, of Middlesbrough, before the Cleveland Institution of Engineers, on "The Economical Use of Blast Furnace Gases," the author emphasised strongly the necessity for arresting the dust in the gases before their admission to the stoves and boilers; the use of larger gas tubes, and the provision of facilities for cleaning whilst the blast is on; the prevention of the escape of gas when the bell of the furnace is lowered for charging purposes; the use of water gauges for determining the pressure of the gases in the flues, &c. Mr. Keith gave a description of an invention by Mr. Tate, of Workington, for heating the air previous to its admission under the boilers by a series of regenerator chambers in the boiler seating. An interesting discussion took place.

Experiments have recently been made in the presence of experts in shipbuilding and engineering circles at Messrs. C. S. Swan and Hunter's yard on the Tyne, with the patent hydraulic steering gear designed by Messrs. Fawcett, Preston, and Co. The new gear is worked by a duplex pump amidships, oil being used instead of water, with the advantage that atmospheric changes are unfelt, and the action of the machinery is noiseless. There is said to be no likelihood of a breakdown taking place in the event of a heavy sea striking the rudder, as the hydraulic cylinder supplying the power also acts as an elastic brake, allowing the rudder to recede before the impact, the automatic readjustment preventing injury to either the gear or rudder.

Finished iron and steel works are well occupied, and prices are maintained at the figures ruling before the holidays, but new orders are somewhat scarce. On Tuesday Sir W. G. Armstrong, Mitchell, and Co., at Elswick-on-Tyne, launched the cruiser Esmeralda for the Chilian Government. Thirteen years ago they built an Esmeralda for the same country, but that vessel was sold last year to the Japanese by the Chilians. The new Esmeralda is of 7000 tons displacement, whereas the older vessel was of 3000 tons. Her speed will be 22½ knots, against the 18 knots of the old cruiser. For defence the new Esmeralda has a belt of 6in. Harveyised steel, equal in extent to three-fourths of her length, which includes all the vital parts of the ship. For offence she has an armament consisting of two 8in. guns and sixteen 6in. guns, also six 12-pounder guns, and a large number of smaller guns, besides the usual proportion of torpedo tubes. All the guns will be supplied from the Elswick Works. The old screw collier John Bowes, which was built in 1852 by Palmers, and which revolutionised the seaborne coal trade between the Tyne and the Thames, has been sold to an Irish owner. This vessel was the first screw collier, and vessels of her type rapidly superseded the old collier brigs which previously did all the trade.

The steam coal trade is somewhat better, and there is need of some improvement, for the accountants report that the average realised price of Northumberland steam coal during the quarter ending February 29th was only 5s. 0·77d. per ton, f.o.b., a decrease of 4·3d. on the previous quarter, and the wages of miners are reduced 2½ per cent. The collieries in West Durham, where the bulk of the coke is produced, are doing well, but those in the east of the county, which ship a large part of their produce, are very badly employed; indeed, the depression of trade has led to the closing altogether of several collieries.

The death is reported of Mr. Joseph M. Scott, son of Mr. W. H. Scott, and partner in the firm of Scott Brothers, iron, &c., merchants, Newcastle, Middlesbrough, and Cardiff. He died on board the s.s. Sir Charles Tennant, while on a voyage to Savona for his health.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Glasgow pig iron market has been in a rather backward condition this week, prices giving way to a lower point than they touched in the preceding week, when a drop of about 6d. per ton took place in Scotch warrants. Seeing that the strength had gone out of the market for the time, holders of warrants have been disposed to realise, and in addition to this it is reported that there has been some disposition on the part of operators to sell for a fall in price. Business has been done in Scotch warrants from 46s. 5½d. to 46s. 3d. cash and 46s. 8d. to 46s. 5½d. one month. In Cleveland warrants there has been scarcely anything doing. The prices quoted on 'Change are 38s. 1½d. to 37s. 11d. cash and 38s. 3½d. to 38s. 1½d. one month. Hematite warrants have been quiet at 48s. 3½d. to 48s. 1½d. cash and 48s. 6d. to 48s. 3d. one month.

There is comparatively little Scotch pig iron now going into the Glasgow warrant stores, but it is understood that makers are of necessity increasing their private holdings to some extent. The furnaces in blast number 81, compared with 75 this time last year. Of these 43 are producing ordinary, 33 hematite, and 3 basic pigs.

The prices of Scotch makers' pig iron are easier, but nominally there is so far not much change:—Govan and Monkland, Nos. 1, are quoted f.o.b. at Glasgow, 47s. 6d.; Nos. 3, 46s.; Carnbroe, No. 1, 48s.; No. 3, 46s. 6d.; Clyde, No. 1, 50s. 6d.; No. 3, 47s. 6d.; Gartsherrie, Calder, and Summerlee, Nos. 1, 51s.; No. 3, 48s. 6d.; Coltness, No. 1, 53s.; No. 3, 48s. 6d.; Glengarnock, at Ardrossan, No. 1, 50s. 6d.; No. 3, 46s. 6d.; Eglinton, No. 1, 48s.; No. 3, 46s.; Dalmellington, at Ayr, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Shotts, at Leith, No. 1, 52s. 6d.; No. 3, 49s.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 49s.

The consumption of Scotch pigs at home is good, and fair quantities are also being dispatched to the English coast; but inquiries from abroad are poor, and the shipments have been going back in amount. The clearances from the different ports in the past week have amounted to 5593 tons, compared with 8117 tons in the corresponding week of last year.

The finished iron trade is quiet, with a fair amount of material going into use. So far as regards prices, the tone of the market has been adversely affected by reports from Staffordshire and elsewhere, which appear to indicate that trade is not progressing as could be desired. In the steel trade there is no abatement of activity. A great deal of work is in progress, and new orders are constantly being placed.

The prospects of the pipe-founding branch are a little more encouraging, there being numerous inquiries in the market for pipes for municipal contracts. The tube makers are in some instances very busy.

The position of the coal trade is very discouraging, especially in the shipping department, which in the regular order of things ought now to be looking better. The total clearances from the Scottish ports in the past week have amounted to only 114,878 tons, compared with 165,270 in the preceding week, and 141,968 in the corresponding week of last year. There is no change in prices.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

WHAT with holiday influences and depression in trade at the tin-plate works, the iron and steel works on the hills have not been in an active state of late, and for the first time for a long period the only activity seen at Cyfarthfa was at the blast furnaces, the mills being practically at stop owing to deficient orders. It is intended, I hear, that Cyfarthfa should resume its ore and steel rail manufacture, which may make partial amends for a failing steel bar trade. Welsh ironmasters generally are doing their best, both as regards quality and price, to secure the colonial and foreign orders that are moving about.

Only two despatches of any interest occurred last week—1400 tons of rails to Mombassa from Cardiff, and 190 tons from Newport for Exmouth. Slackness, however, should be expected for a little time, and I am glad to know that a strong impression exists in the revival of the iron and steel industry, though, as reported on 'Change, Cardiff, this week, "the new business coming in is of a very meagre character."

On 'Change, Swansea, mid week, a good deal of interest was aroused in the examination of a specimen of terne plate roofing, which it is hoped is to start a new industry, and do away with slates and tiles. After a thorough examination of quality and prices, a deputation was named to wait upon the Corporation this week, and urge them to roof the new market house with terne sheets, and in other respects follow the American lead. Colonel Wright, a well-known representative of the tin-plate trade, will head the deputation, and the movement is cordially hailed as a hopeful one, and calculated to improve the present condition of things.

Stocks of iron ore continue to come in pretty freely from Bilbao. At one of the leading works last week I was interested in seeing that the "stock" held—only a moderate one, by the way, as the tendency now is to run the ore wagons to the top of the furnaces—was not, as previously noticed, only of Spanish, Tafna, Bilbao, &c., but composed of Northampton ores, old Welsh argillaceous ores, and Bilbao. There is still a lurking regard for old Welsh, which is admirable for cold blast purposes and special requirements, and a constant trade for this article is going on between Wales and Staffordshire.

It will be seen from last quotations, Swansea Exchange this week, that prices are in abeyance. Pig iron, little doing, slight falling off from last week in Glasgow warrants, last prices 46s. 3d. cash buyers. Middlesbrough No. 3, 38s.; hematite, 45s. 8d.; Welsh bars, £5 10s. to £5 12s. 6d.; angles at usual extras. Sheet iron, £6 15s. to £6 17s. 6d.; steel sheets, £6 10s. to £6 12s. 6d.; steel rails, heavy section, £4 10s. to £4 12s. 6d.; light, £4 17s. 6d. to £5 7s. 6d. Bessemer steel, tin-plate bars, £3 17s. 6d.; Siemens tin-plate bars, best, £3 18s., all delivered in district, net cash. Siemens coke tin-plate, 9s. 1½d. to 9s. 3d.; Bessemer, 9s. to 9s. 1½d.; ternes per double box, 28 by 20 c., 16s. 6d., 17s. 6d. to 22s. 6d.; best charcoal, 12s. 6d. to 12s. 9d.

The Exchange report on the tin-plate situation conveys all of interest in a few lines. There is no improvement to report in tin-plates. The production and shipment are about equal, with a slight increase in the stocks, and the result of the Birmingham meeting did not bring many orders. Block tin is at £59 1s. 3d. to £59 3s. 9d. Copper shows a fall of about 27s. 6d. per ton on the week.

There is a slight improvement to be recorded at Llanelly, a settlement having been come to at the Old Castle Works. The "behinders" and the "risers" concede 10 per cent., and on all piece-work 15 per cent. is to be deducted.

The Pacific Steam Navigation Company directors are about entering into contract for a supply of 60,000 to 75,000 tons best Welsh coal, to be shipped at Cardiff, Newport, Barry, or Swansea.

The Dowlais Company at its deep sinking, Aberdare Junction, appears at length to have surmounted the formidable obstacles met with at the Dowlais-Cardiff Colliery, and in a very short time a steady output is assured, and a great increase in the number of men. Nothing but a very large capital at the back, and the greatest perseverance and skill, could have brought about a successful ending to this great enterprise.

The water trouble, which nearly wrecked Penrhiwceiber, has been the great enemy all along, and a source of incessant anxiety. A coalowner commenting upon the success, pertinently remarked that such great ventures were nearly, if not quite, at an end. But there is the uncertainty of winning coal at all, then the constant paying out of large sums, and when all is said to be plain sailing, coal won, and a demand secured, there is the difficulty with labour. As a large colliery owner remarked a few years ago to the writer, that had he known all this he should have put his money in the 3 per cents. I mention this in order to show that the lot of colliery owners is not all happiness.

The latest report from Cardiff Exchange indicates more activity in the outward freight market, and shows increased steamers secured for loading forthwith, several of large tonnage. Prices remain. Best steam is quoted at 10s. 3d. to 10s. 6d.; seconds, 9s. 3d. to 9s. 9d.; drys, 8s. 9d. to 9s. 3d.; best Monmouthshire, 8s. to 8s. 6d.; seconds, 7s. 9d. to 8s.; best small, 4s. 9d. to 5s.; second best, 4s. 6d.; seconds, 4s. to 4s. 3d.; drys, 3s. 6d. House coal remains dull. Prices:—Best, 10s. to 10s. 6d.; No. 3 Rhondda, 9s. 6d. to 9s. 7½d.; brush, 7s. 6d. to 7s. 9d.; small, 6s. to 6s. 3d.; No. 2 Rhondda, 7s. 1½d. to 7s. 3d.; through, 6s. to 6s. 3d.; small, 4s. to 4s. 3d.; patent fuel, 10s. 3d. to 10s. 6d.; coke, furnace, 12s. 9d. to 15s.; foundry, 18s. 6d. to 19s.; pitwood, 14s. 9d. to 15s. Patent fuel and coke are in good demand.

By a majority of three the Newport County Council this week carried Colonel Lyne's motion to go on with the waterworks. The minority wished again to consult the ratepayers.

A strong impression prevails in Cardiff that the union between the Bute Docks and the Rhymney Railway may soon be regarded as an accomplished fact. A difficulty has arisen at Swansea with regard to the dock extension, the Ocean Dry Dock and Corporation submitting alternative proposals, but no decision has yet been arrived at. The Llanelly Harbour improvements are temporarily blocked by an adverse report of the Board of Trade, which expresses the opinion that the south training wall is wholly unnecessary. There is an intention of selecting a deputation to confer with the Board, when Sir Alexander Rendel and Mr. Fowler will defend their case.

I much regret to announce the death of Captain Lewis Lewis, brother of Sir W. T. Lewis, Bart., and at one time chief mineral agent for the Dynevor estate. He was a gentleman of considerable ability, but had for many years retired from public life.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

DURING the week that followed the Easter holidays a certain quietness has naturally been noticeable on the iron markets, but prices continued to be firm and inclined to rise, and with the increasing demand that will undoubtedly be experienced after this week, the outlook in the iron trade will become even more favourable than before.

In Silesia the different branches of the iron industry have been steadily occupied; the bar and girder trade is specially well off for new work, and there is likewise a good activity secured to the railway department, orders of considerable weight having lately been given out.

The position of the Austro-Hungarian iron market does not show any material change. Both raw and manufactured iron continue in regular inquiry, and a further improvement in demand is expected to take place before long.

All sorts of structural iron are selling briskly, and for bars higher prices are willingly paid, consumers and dealers knowing well that they will have to pay more if they wait till next month. Hardware and tools have, until now, been in languid request generally.

On the French iron market the upward tendency in prices seems to have further increased upon the week. Bars are scarcely obtainable at 140f. p.t., girders being, as a rule, sold at 160f. p.t., which is about 10f. p.t. more than was asked last month. Thanks to the firm tone on foreign markets, the export quotations are pretty favourable. Steel rails have recently been sold at 162f. p.t., f.o.b. Bordeaux; for heavy plates, 172f. p.t. may be considered as basic quotation.

The activity in the various departments of the Belgian iron industry continues altogether favourable, though business has on the whole been a trifle more quiet during the past week. But there has been no yielding in prices, at least not for home demand.

In the export trade, on the other hand, English competition has of late been felt very keenly, and makers have repeatedly been obliged to grant concessions. The blast furnace works are specially well off for new work; Athus has just sold 8000 t., at 50f. p.t., which shows a difference of 8·50f. against the low rates of last quarter. In consequence of the increased cost of production plates have been raised 5f. p.t., No. 2, f.o.b. Antwerp now standing on 145f. p.t., No. 3 155f. p.t. Plates, No. 2, for export are quoted 140f. p.t.; No. 3, 150f. p.t.; steel plates rose on 155f. p.t. There is talk of some additional blast furnaces being blown in next month. Production of iron and steel in Belgium during the last three years was as under:—

	1893. Tons.	1894. Tons.	1895. Tons.
Foundry pig	74,630	80,110	85,450
Forge pig	428,480	378,045	329,651
Bessemer, basic	242,154	360,442	414,034
	745,264	818,597	829,135
Plates, rails	113,602	118,596	101,479
Various articles of manufactured iron	371,419	334,694	351,901
	485,021	453,290	453,380
Steel billets, cast steel	373,113	405,661	455,550
Plates, steel rails, &c.	224,922	341,318	392,332

Belgian export to East India, China, and Japan was, for the last three years, as under:—

British East India.

	1895. Tons.	1894. Tons.	1893. Tons.
Rolling material	2,280	1,715	119
Steel girders	3,061	614	111
Steel bars	5,193	2,791	1,938
Steel nails	468	—	—
Iron girders	4,929	4,486	4,773
Iron plates	11,663	9,640	10,238
Iron bars	42,928	35,506	28,860
Iron nails	61	149	453
Hardware	744	85	85
	71,827	55,751	46,577

	China.		*Japan.*	
	1895. Tons.	1894. Tons.	1895. Tons.	1894. Tons.
Cast iron (manufactured)	82	2	4835	1099
Foundry pig (manufactured)	125	347	607	1153
Iron nails	485	578	—	—
Bars	28,337	22,721	7405	3558
Iron plates	2,574	2,615	2068	1049
Iron girders	153	63	—	—
Iron wire	333	405	—	—
Raw cast iron	293	944	—	—
Steel nails	991	—	167	—
Steel rods	145	167	—	—
Steel rails	178	—	—	—
Steel wire	24	—	—	—
Machines	947	310	65	243
Rolling stock	23	107	—	—
	34,640	28,259	15,747	7102

This year's spring demand is very strong on the Rhenish-Westphalian iron market, and the firm, or rather increasing, tendency consequently continues. A healthy tone characterises the iron ore trade; only in the Siegerland the business in spathose iron ore has perhaps been a trifle more quiet just recently. List rates are for spathose iron ore, raw, M. 9 to 9·60 p.t.; the same, roasted, M. 12 to 13·70 p.t. Roasted calcined iron ore is quoted M. 12 to 14 p.t.; Nassau red iron ore, 50 p.c. contents, M. 9·50 p.t. For minette of Lorraine, which is in fairly active request, M. 2·60 to 2·80 and 3·40 p.t. is paid, according to the quality required. The tone of the pig iron market is strong, the majority of the blast-furnace works having already disposed of their output for this and the next quarter. In spite of the present favourable condition of the iron trade, owners have resolved to desist from a further rise in prices. Last week's quotations for the different sorts of pig iron were:—Spiegeleisen, 10 to 12 p.c. grade, M. 58 to 59 p.t.; forge pig, No. 1, both Siegerland and Rhenish-Westphalian qualities, M. 53 to 55 p.t.; No. 3, M. 42 p.t. Hematite, M. 65 p.t. Foundry pig, No. 1, M. 65 p.t.; No. 3, M. 57 p.t.; basic, M. 56 p.t. German Bessemer, M. 60 p.t. Iron for making steel, M. 56 p.t.

The business in malleable iron continues to show a very satisfactory improvement; prices are firm and are even yielding some profit. Bars and girders sell briskly, and there has been a change for the better noticeable in hoops lately. Plates as well as sheets continue in active demand. There is nothing of interest to be related concerning the wire and wire nail department, a limited business being generally done. Rivets, on the other hand, show more life, and a rise in prices has taken place.

The following are the latest list quotations per ton at works:—Good merchant bars, M. 118; angles, M. 128; girders, M. 92 to 95; hoops, M. 127 to 130; billets in basic and Bessemer, M. 84 to 85; heavy plates for boilermaking purposes, M. 160; tank do., M. 135 to 140; steel plates, M. 130 to 135; tank do., M. 120; sheets, M. 155 to 160; iron wire rods, common quality, M. 125; drawn wire in iron or steel, M. 138 to 140; wire nails, M. 127 to 130; rivet iron, M. 138 to 142; rivets, good merchant quality, for boilers, bridges, &c., M. 175 to 180; complete sets of wheels and axles, M. 280 to 290; axles, M. 220; steel tires, M. 200; steel rails, M. 118; steel sleepers, M. 110; fish-plates, M. 120; light section rails, M. 98 to 100.

LAUNCHES AND TRIAL TRIPS.

The largest turret steamer yet built, recently left the Wear for her trial trip. She is the s.s. Selma, built for Messrs. George Horsley and Son, of Hartlepool, by Messrs. William Doxford and Sons, Pallion, and has a deadweight capacity of rather over 5600 tons. After adjusting compasses the vessel was put on the measured mile, when a mean speed of 10. 6 knots was attained.

On the 10th inst. the steel twin-screw cable steamer Okinawa Maru completed her official trials on the Clyde. She is a spar-decked vessel, arranged and fitted for laying and repairing ocean telegraph cables, built and engined by Messrs. Lobnitz and Co., Renfrew, to the instructions of Mr. A. R. Brown, Glasgow, for the Japanese Government. Her dimensions are:—290ft. by 40ft. by 24ft. 6in., moulded; and the trials in all respects gave satisfactory results.

On Monday, the 13th inst., the s.s. Dorothy was handed over to her owners, Messrs. J. S. Allison and Co., West Hartlepool, by Messrs. Ropner and Son, Stockton-on-Tees, by whom she has been built. The steamer proceeded down the river with a large company of ladies and gentlemen on board, and on her arrival in the Tees Bay, the compasses were duly adjusted, after which a very pleasant and satisfactory run was made to the Tyne; the machinery, which has been supplied by Messrs. Thos. Richardson and Sons, Hartlepool, working in a highly satisfactory manner. The owners, who were present at the trip, expressed their entire satisfaction on the results of the trial, both in regard to the vessel and the machinery, &c. The steamer will load in the Tyne for a Mediterranean port.

On Friday, April 10th, 1896, the steel spar-deck steamer Minneburg, built by Sir Raylton Dixon and Co., Cleveland Dockyards, Middlesbrough, for the Hansa Steamship Company, Bremen, was taken out to sea for her official trial trip, under the command of Captain Schwarz. Her dimensions are:—Length, 323ft.; beam, extreme, 42ft. 6in.; depth, moulded, 25ft.; with a deadweight capacity of about 3600 tons. The poop, bridge, and forecastle decks are of teak, and handsome accommodation is provided for captain, officers, and engineers in houses on bridge deck. Quadruple expansion engines, built to German law requirements, have been supplied by Messrs. Wigham, Richardson, and Co., Newcastle-on-Tyne, having cylinders 19¼in., 28in., 42in., 61in., by 42in. stroke, with two large boilers working at 215 lb. pressure. The hull and machinery have been constructed under the supervision of Mr. D. Wulff, superintendent engineer of the Hansa Company, and have been specially designed for the River Plate trade. At the conclusion of the trial, which passed off most successfully, the vessel proceeded to Bremen to load.

Messrs. David J. Dunlop and Co., Inch Works, Port Glasgow, have recently launched the steel twin-screw steamer Ibadan, built to the order of the African Steamship Company, of London, for their branch service on the West Coast of Africa, and immediately thereafter was moored alongside the yard wharf to receive her machinery, &c., consisting of two sets of triple-expansion engines of the latest and most modern design. The Ibadan is a duplicate of a steamer built and engined by Messrs. Dunlop also for light draught service, her dimensions being:—Length, 204ft.; beam, 35ft.; and moulded depth, 13ft.; the gross tonnage being about 800 tons. All arrangements for easily maintaining steam in the tropics are being fitted. The steam steering gear is Harrison's patent, the engine being placed in the engine-room directly under the control of the engineers. The deck machinery includes direct steam windlass and five steam winches, all of Messrs. Clarke, Chapman, and Co.'s make, with their derricks. The poop, bridge, and forecastle, which are arranged to give exceptionally good light and ventilation, are fitted with cabins and saloons for officers, engineers, &c., the crew and firemen being located under the forecastle. The captain's cabin is fitted on the bridge deck in a large teak deckhouse. From this bridge the steamer is navigated. Awnings over the entire length of the vessel are provided, those over the poop and steam winches being fitted of steel framing, with canvas covered tongued and grooved planking. The rig is that of a two-masted fore-and-aft schooner. It is expected the Ibadan will be ready for sea in about a fortnight.

On Tuesday, April 14th, Messrs. Furness, Withy and Co., launched from their shipbuilding yard at Hartlepool a large steel screw steamer, built to the order of Messrs. T. Wilson, Sons and Co., Hull. She is a fine type of modern cargo boat, measuring over 340ft. in length, and built throughout of Siemens-Martin steel, with a large measurement and deadweight capacity, and built to the highest class at British Corporation, this being the third vessel built by Furness, Withy and Co., for Messrs. Wilson under this classification within the last twelve months. The vessel is built on the spar deck principle, with long bridge, poop, and topgallant forecastle. The holds are fitted with wood shifting boards, and all deck, deck erections, skylights, bulwarks, bulkheads, &c., are constructed of steel and iron. Cellular double-bottom fitted all fore-and-aft for water ballast, the after peak being also available as a tank. The greater portion of the plates are in 24ft. lengths, making the structure of the ship very strong. Six steam winches, patent steam steering gear amidships, screw gear aft, direct steam patent windlass, stockless anchors, hauling into hawse-pipes, and other modern appliances are fitted for the handy working of the vessel. The saloon and cabin providing accommodation for the captain, &c., is handsomely finished in polished hardwood. The steamer will be rigged as a two-masted fore-and-aft schooner, and has been constructed under the supervision of Mr. J. T. Wilkins. She will be fitted with three large boilers and triple-expansion engines of massive design by Messrs. Westgarth, English, and Co., Middlesbrough, with every provision for economical working at a minimum cost of upkeep. The machinery has been built under the supervision of Mr. Spear, superintendent engineer for Messrs. Wilson. On leaving the ways she was named Horatio by Mrs. H. Withy, Brantford House, West Hartlepool.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

31st March, 1896.

7001. Covering Lacing Studs, F. Egge and N. M Beach, London.
7002. Production of Ammonia, H. H. Lake.—(*L. Sternberg, United States.*)
7003. Separating Oil, J. S. L. Wharton and W. S. Hallowell, London.
7004. Machines for Knitting Socks, &c., F. Moore, London.
7005. Electric Hammers, H. H. Lake.—(*A. S. Barnes and P. S. Skinner, United States.*)
7006. Vices, W. Thompson, London.
7007. Printing Presses, H. H. Lake.—(*L. Benedict, United States.*)
7008. Universal and Geographical Clock, D. W. Thompson, London.
7009. Funeral Carriages, R. A. McCauley, London.
7010. Curling Stones, C. T. Jacoby, London.
7011. Scissors Protectors, W. I. Hadden, London.
7012. Steam Generators, G. F. G. Des Vignes and S. H. Terry, London.
7013. Electric Motors, J. Devonshire.—(*C. P. Steinmetz, United States.*)
7014. Regulating Valves, J. H. Gartrell, London.
7015. Dental Tools, A. J. Brown and R. S. Anderson, London.
7016. Toilet Tray, C. M. Pritt, London.
7017. A Self-adjusting Collar Stud, F. Garthwaite, London.
7018. Coffins, C. S. Bowker, London.
7019. Watch, Clock, and other Dials, W. H. Cox, London.
7020. Boots, A. Cornish, London.
7021. Making Tubes, W. P. Thompson.—(*La Société Delaperrière, Dida and Aubin, and L. Chambon, France.*)
7022. Match Receptacles, A. H. Booth, London.
7023. Manufacture of Cement, &c., O. J. Owen, Liverpool.
7024. Clarionets, J. Wallis and Son.—(*A. Cottereau, France.*)
7025. Washing Machines, J. Pickering, London.
7026. Cycle Racks, G. D. Young and W. F. Day, London.
7027. Cycle Stand, R. Willshaw and W. Dixon, Bedford.
7028. Machines for Breaking Coal, U. Ammann, London.
7029. Roofing Tiles, A. Weil, London.
7030. Cycles, W. F. Williams, London.
7031. Propulsion of Manumotive Carriages, H. V. Weyde, London.
7032. Treating Wood, A. M. Clark.—(*The Electric Fireproofing Company, United States.*)
7033. Cigarette-making Machines, A. J. Boult.—(*H. F. Wolf, Germany.*)
7034. Burial Casket Boxes, J. J. Stephens, London.
7035. Mine Trap Doors, J. O. Brien, London.
7036. Gas and other Motors, J. F. Duryea, London.
7037. Machines for Making Wire Handles, D. L. Hill, London.
7038. Regulators for Electric Arc Lamps, H. Bäurlin, London.
7039. Cycle Saddles, R. Haddan.—(*J. Chaix, France.*)
7040. Screw-cutting Tools, &c., M. Rosenhammer, London.
7041. Preservation of Milk, Cream, &c., H. Higgins, London.
7042. Preservation of Foods, &c., H. Higgins, London.
7043. Colour-producing Aromatic Diamine, G. H. Weiss, London.
7044. Ladies' Skirts, A. S. Phillips, London.
7045. Automatic Machine Guns, H. S. Maxim, London.
7046. Securing Canvas Covers to Barrels, H. C. McLean, London.
7047. Railway Spikes, H. J. Vaughan, London.
7048. Fastening Devices for Neckties, R. D'Altoni, London.
7049. Nut Locks, T. Oldroyd, London.
7050. Puzzles, W. E. Conger and F. J. McDonald, London.
7051. Cots, J. R. Patterson, London.
7052. Supports for Nursery Bottles, W. A. Rowan, London.
7053. Bottles, J. Neubauer, London.
7054. Electrical Signal Systems, L. C. Werner, London.
7055. Stoppers for Measuring Devices, C. E. Wyckoff, London.
7056. Cutting Machine, W. H. Wheatley.—(*The Seybold Machine Company, United States.*)

1st April, 1896.

7057. Pumps, Water Motors, &c., F. Lamplough, London.
7058. Ink Pads, J. H. Mason and A. M. Eaton, London.
7059. Motor Roof Ladders, J. R. Hamilton, Waltham Cross.
7060. Steadying Tip Carts, J. Newby, West Bromwich.
7061. Outlet Ventilator for Hats, D. Cross, Timperley.
7062. Obtaining Potassic Cyanides, A. C. Thomson, Glasgow.
7063. Connecting Blouses to Skirts, M. A. S. Jackson, Glasgow.
7064. Pole for Lowering Windows, W. Thomas, Glasgow.
7065. Decorating Fire Brasses, C. Meason, L. E. Wood, T. B. Davis, and A. Mawson, Birmingham.
7066. Bottles, J. Ireland, Blackpool.
7067. Laundry Irons, Richmond and Co., Ld., and E. W. T. Richmond, Liverpool.
7068. Coin-freed Automatic Machine, F. J. Shapley, Bristol.
7069. Syphon Flushing Cisterns, H. Crudgington, Birmingham.
7070. Domestic and the like Fire-places, S. Hurd, Leeds.
7071. Bed Rest, S. A. Lee, J. Studdard, and E. G. Coward, Huddersfield.
7072. Gas Stoves, J. E. Eccles, Halifax.
7073. Seats for Cycles, S. Rozene and W. Hobkirk, Halifax.
7074. Lamp for High Voltages, A. J. Beaumont, York.
7075. Method of Obtaining Motive Power, D. Cook, London.
7076. Infusing Coffee, Tea, &c., G. R. Burdass, Staffs.
7077. Dressing Grain, C. E. Mumford and W W. Willis, Ipswich.
7078. Jars, R. C. Baker, London.
7079. Pulley forDrawing Wire, E. Oddy and B. Woodcock, Yorks.
7080. Travelling Trunks, J. Lewis, Wolverhampton.
7081. Tool Holder, S. H. Wright and G. Webb, Monmouth.
7082. Production of Acetylene Gas, A. G. Wild, Sheffield.
7083. Roof Glazing, J. Mellowes, Sheffield.
7084. Pneumatic Tires for Cycles, G. H. Gardner, London.
7085. Manufacturing Fuel, W Wardle, Burton-on-Trent.
7086. Spring Centre for Wheels, F. E. Jones, Birmingham.
7087. Lamp, F. E. Jones, Birmingham.
7088. Toy, A. N. Mezzetti, London.
7089. Drawing-off Beef Tea, J. M. Tucker, Bedfordshire.
7090. Wheels and Tires for Cycles, W. C Morton, London.
7091. Manufacture of Boots and Shoes, A. Parry, Manchester.
7092. Knees for Wagons, J. Mather and G. Newman, Lancs.
7093. Roofing Dwelling Houses, A. W. Evans, Monmouthshire.
7094. Rendering Fabrics Waterproof, A. A. Haigh, Manchester.
7095. Engines, W. Bowden and R. J. Urquhart, Manchester.
7096. Bicycles, G. H. Richmond and J. Crowther, Manchester.
7097. Straps, &c., W. Brierley.—(*P. Eichelmann, Germany.*)
7098. Brushes, E. Cardot, Brussels.
7099. The "Rapid" Cartridge Carrier, J. Mecredy, London.
7100. Puzzle, F. C. Higgins, London.
7101. Permanent Way of Railways, C. H. Sadler, Cardiff.
7102. Construction of Reservoirs, D. K. C. Russell, Edinburgh.
7103. Spring Balances, I. A. Timmis and P. Ward, London.
7104. Dampening Device for Copying, W. S. Hampsher, New York.
7105. Safety Gear for Mining Cages, S. Arnold, London.
7106. Saucepans, Boiling-pans, T. and D. Llewellyn, London.
7107. Instrument for Shaping Teeth, F. Frost, London.
7108. Hats, J. A. Cumine, C. Woerner, and F. Ritter, London.
7109. Clubs for Playing Hockey, F. H. Ayres, London.
7110. Velocipede Handles, F. H. Ayres and E. Grimsdell, London.
7111. Paper Knife and Book Marker, W. Gallatly, London.
7112. Toasting Forks, W. Gallatly, London.
7113. Device for Clerical Purposes, H. Womack, London.
7114. Device for Curative Purposes, F. J. Reddaway, London.
7115. Device for Holding Cloaks, G. Warnkes, London.
7116. Funnels, G. John, London.
7117. Reels, R. Leslie, London.
7118. Device for Securing Scarf Pins, W. Johnson, jun., London.
7119. Brake for Mail-carts, &c., H. E. Richards, London.
7120. Governing Gear for Engines, C. H. Benton, Leeds.
7121. Making Shades for Gas Lights, A. F. Davies, London.
7122. Drilling and Tapping Pipes, W. Deighton, Harrogate.
7123. Working Metallic Sulphides, A. von Siemens, London.
7124. Ammonia, O. Imray.—(*La Société Christiania Minekompani, Norway.*)
7125. Carrier or Support for Cycles, F. W. Gunton, London,
7126. Brake Gear for Velocipedes, R. P. Moncrieff, London.
7127. Shuttle Guards, S. Hopkinson and T. Leach, London.
7128. Bobbins, G. Paley and J. A. Sutcliffe, London.
7129. Slack Adjuster, R. J. Nicholson.—(*T. E. Nicholson, United States.*)
7130. Assisting Propulsion of Cycles, L. Scoffield, London.
7131. Drying and Conditioning Cops, J. Brandwood, London.
7132. Curative or Antiseptic Compound, T. Hawkes, London.
7133. Cycling Skirts, M. Redhouse, London.
7134. Billiard and Bagatelle Cues, R. F. Jackson, London.
7135. Plate Rack, C. W. Spong, London.
7136. Copying Press, I. Rheinberg, London.
7137. Shaft Bearing, W. P. Thompson.—(*M. del Espino, India.*)
7138. Game for Parlour Tables, H. Mansergh, Liverpool.
7139. Closing Doors, J. Scheibe, Manchester.
7140. Driving Clocks by Electricity, A. Joyce, Liverpool.
7141. Picture Frames and the like, N. Myrstedt, London.
7142. Springs for Spring Mattresses, H. G. Semadeni, London.
7143. Holders for Billiard Chalks, &c., G. Hayes, London.
7144. Velocipedes, R. Kolbaba and H. Gliser, London.
7145. Hair Ornament, E. Murrle, London.
7146. Ornament for Ties and Scarves, E. Murrle, London.
7147. Gas Engines, P. Auriol, London.
7148. Ventilating Sewers, E. Holmes, London.
7149. Wire Fences, W. A. Badger and J. R. Smith, London.
7150 Golf Clubs, W. Hillman, London.
7151. Automatic Switches, F. H. Nalder, C. W. S. Crawley, and A. Soames, London.
7152. Ornamental Designs on Wood, C. Guattari, London.
7153. Cryptographic Instruments, R. Harte, London.
7154. Cycle Brakes, A. J. Haas, London.
7155. Tires of Wheels for Cycles, R. Corsham, London.
7156. Otter Boards for Trawling, &c., J. Inches, London.
7157 Cooking Stoves, A. J. Boult.—(*F. H. Buzzacott, United States.*)
7158. Frame Joints, C. T. Crowden, London.
7159. Incandescent Gas Burners, E. Attenborough, London.
7160. Steam Hammer Valves, T. Pattinson and T. Slater, London.
7161. Electric Light Fittings, F. A. Chapman, London.
7162. Secondary Batteries, A. J. Boult.—(*J. Julien, Belgium.*)
7163. Motive-power Engines, R. and C. E. Johnson, London.
7164. Cycles, G. C. Marks.—(*E. Leboucher and L. Dutheil, France.*)
7165. Bottle Brushes, A. J. Boult.—(*C. M. Higgins, United States.*)
7166. Electric Fire Alarms, M. A. Shanahan, London.
7167. Can Openers, J. M. Keen, London.
7168. Cycle Attachment, G. W. Aldrich, London.
7169. Pendulums of Clocks, T. Zee and I. Hwang, China.

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7170. Constructing Metallic Brushes, W. G. Gass, near Bolton.
7171. Loom Shuttles, W. N. Brown and the Belfast Flax Spinning and Weaving Co., Larne.
7172. Photographic Apparatus, &c., F. Townsend, London.
7173. Mathematical Appliance, H. Creegan and G. H. Stuart, Chester.
7174. Heating by Electricity, J. C. Green, Manitoba, Canada.
7175. Boot and Shoe Lasts, J. W. Phillips, London.
7176. Cabinet for Storing Music, M. Robinson, Winchester.
7177. Stoppering of Bottles, G. Davis, Birmingham.
7178. Heating of Shafting Bearings, J. Black, Liverpool.
7179. Toy, J. H. C. Boig, Liverpool.
7180. Printers' Blankets, J. Walker and J. Strang, Manchester.
7181. Shuttle Picking Appliances, W. Thompson and J. Mather, Halifax.
7182. Bedsteads, J. A. Crane, Handsworth.
7183. Folding Cardboard Boxes, M. Grünbaum, Berlin.
7184. Driving Band for Cycles, P. Erbrecht, Berlin.
7185. Casting Box, R. H. H. Baird and I. Hall, Glasgow.
7186. Attached Trousers Clip, R. Blacklock, Sunderland.
7187. Moistening Slivers, &c., J. T. Pearson, Burnley.
7188. Heating Water, J. Marcroft and C. Heap, Yorkshire.
7189. Printing, W. J. Cummins, Newcastle-on-Tyne.
7190. Target Frame, G. T. Cooper, Aldershot.
7191. Wire Puzzle, A. H. Hughes, Wrexham.
7192. Extension Woven Wire Mattress, J. Sawtell, Wiltshire.
7193. Apparatus for Lowering Weights, J. Swalwell, Newport.
7194. Oil Motor Engines, J. Southall, Worcester.
7195. Dynamos, S. Z. de Ferranti, London.
7196. Overwinding at Pits and Mines, J. T. Calow, Sheffield.
7197. Window Blinds, J. Jessop, Sheffield.
7198. Brick or Tile Die, G. Viggars, Newcastle.
7199. Corks, J. L. Seymour, Essex.
7200. Lamps adapted to Burn Vapour, J. T. Armstrong, London.
7201. Sheets of Paper, W. Kendrick, West Cowes.
7202. Looms, J. Mawdsley and G. Bateman, Manchester.
7203. Controlling Nozzle for Fire Appliances, J. Stone, Chester.
7204. Making Heels for Boots, J. V. Collier, Birmingham.
7205. Marking at Target Practice, T. B. Ralstone, Glasgow.
7206. "See-kwik," H. E. Ives and H. Neil, Halesworth, Suffolk.
7207. Detachable Mud Guard for Cycles, J. A. Phillips, Coventry.
7208. Lace Machines, F. Key and N. Guildford, Nottingham.
7209. Hydraulic Pumps, R. Howarth, London.
7210. Securing Duplicate Copy-books, F. G. Fender, London.
7211. Lay Figures, J. F. and A. Gems, Cobham, Surrey.
7212. Cans, Jugs, &c., W. Melville and H. Buddenborg, London.
7213. Domestic Fireplaces, J. Howarth, London.
7214. Key and Handle, A. G. H. Schröder, Birmingham.
7215. Hermetically-closing Jug, A. Heinemann, London.
7216. Golf Clubs, W. M. Bryson, London.
7217. Apparatus for Counting, F. A. Mills, jun., London.
7218. Envelopes, E. W. Walsh and R. P. Edwards, London.
7219. A New Carrying Clip or Holder, A. Fry, London.
7220. Rendering Ships Buoyant, E. G. Taylor, London.
7221. Apparatus for Corrugating Tubes, I. Rees, London.
7222. Manufacturing Tubes, A. S. Elmore.—(*J. O. S. Elmore, India.*)
7223. Flower Holders, J. Lightwood, Staffs.
7224. Rug or Mat Making Machines, A. Palmer, Ipswich.
7225. Foot Rests, F. Kollmorgen, London.
7226. Gas Enriching Apparatus, G. G. Schroeder, London.
7227. Ashlar Block for Walling, &c., C. Wall, London.
7228. Cigar and Cigarette Holder, J. Fitchie, London.
7229. Velocipedes, P. T. Godsal, London.
7230. Cleaning Pens, J. Davidson and D. F. Basden, London.
7231. Manufacture of Shaping Tools, A. Paul, London.
7232. Speed Gear for Velocipedes, &c., A. Tingle, London.
7233. Incandescent Gas Lamps, J. F. Duke, London.
7234. Manufacture of Xylonite, The British Xylonite Co., and S. W. Brooke, London.
7235. Grain Chutes, H. E. Gates, London.
7236. Sachets, O. S. Dean, London.
7237. Fire Alarms I. T. Bomar, London.
7238. Production of Artificial Planums, K. Mayer, London.
7239. Protectors for Boots, W. and J. Beeton and J. Wardall, London.
7240. Lever Bottle Stoppers, C. H. Brown, London.
7241. Magic-lantern Projection Apparatus, E. Smith, London.
7242. Method of Generating Acetylene, W. C. Clarke, London.
7243. Method of Generating Gas, W. C. Clarke, London.
7244. Thrashing Machines, C. A. Teleki, London.
7245. Playing Cards, C. H. Jones, London.
7246. Guns, H. F. Phillips, London.
7247. Polishers, H. H. Leigh.—(*Guitermann, Rosenfeld, and Co. United States.*)
7248. Machine for Filling Bottles, J. G. Fauvel, London.
7249. Parquet of Inlaid Flooring, J. G. Dietzch, London.
7250. Pumps, J. E. Bousfield.—(*La Société des Procédés Desgoffe et de Georges, France.*)
7251. Distilling Apparatus, L. M. G. Delaunay-Belleville, London.
7252. Rotary Knitting Machines, C. H. Aldridge, London.
7253. Pneumatic Tires for Cycles, F. E. V. Taylor, London.
7254. Electric Igniting Devices, G. F. Kreiger, London.
7255. Secondary Batteries, H. H. Lake.—(*J. Julien, Belgium.*)
7256. Tubes, J. W., T. T., and E. A. Boaz and W. Gillings, London.
7257. Funnels, G. Zihikian, London.
7258. Wheels, M. H. Smith, London.
7259. Construction of Electrodes, W. P. Thompson.—(*J. Julien, Belgium.*)
7260. Governing Devices for Engines, A. G. Parrot, Liverpool.
7261. Self-adjusting Clips, H. R. Ross and J. Butler, Manchester.
7262. Box Couches, J. Healy and J. L. Isaacs, London.
7263. Calculating Machine, C. A. Jensen.—(*A. Schabadt, Russia.*)
7264. Devices for Knitting Machines, L. N. D. Williams, London.
7265. Lead Pencils, R. Haddan.—(*H. and H. Hunt, jun., United States.*)
7266. Changeable Gearing, F. H. Lefroy, London.
7267. Driving Mechanism for Cycles, W. W. Green, London.
7268. Treatment of Fish Refuse, The Fish Utilisation Syndicate, Ld., and J. C. W. Stanley, London.
7269. Recovery of Oils, The Fish Utilisation Syndicate Ld., and J. C. W. Stanley, London.
7270. Kilns for Bricks, J. West and W. J. Jenkins, London.
7271. Automatic Production of Photographs, H. F. C. Sasse, London.

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7272. Manufacture of Steel, F. B. Last and J. R. Wright, London.
7273. Manufacture of Double Sulphides, D. A Peniakoff, London.

7274. Smoke-consuming Furnaces, R. Deissler, London.
7275. Hydraulic Presses, F. E. Plumb, Leeds.
7276. Lifts, &c., F. E. Plumb, Leeds.
7277. Manufacture of Pumping Appliances, F. E. Plumb, Leeds.
7278. Rotary Automatic Boring Machine, W. L. Rowe, Fence Houses.
7279. Drying Wet Boots, W. Snelgrove, Holly Wood, near Birmingham.
7280. Apparatus for Playing Croquet, F. H. Ayres, London.
7281. Instrument for Centreing Shafts, A. Borios, Manchester.
7282. Syphon-flushing Cisterns, T. S., W., and B. Stock, and H. W. and T. L. Taylor, Birmingham.
7283. Window Blind Rollers, H. Lomax and Lomax Ltd., Halifax.
7284. Fittings for Rigging of Yachts, W. L. Dobbie, Glasgow.
7285. Spinning Mules, A. Parker, J. Harrison, and J. H. Reddyhough, Keighley.
7286. Removing "Scurf" from Gas Retorts, C. Billington, jun., Longport.
7287. Telescopic Measuring Staffs, D. Barclay, jun., Glasgow.
7288. Cycles, J. Southall, Worcester.
7289. Gas Brackets, H. Brocklesby and S. Gratrix, jun., and Bros., Ld., Manchester.
7290. Pans for Culinary Purposes, P. Philpot, Birmingham.
7291. Dress Bindings, T. E. Perkins, Manchester.
7292. Coin-freed Machines, F. J. Shapley, Bristol.
7293. Window with Automatic Fittings, A. Haddow, Glasgow.
7294. Self-acting Mules, T. H. Rushton and W. Hamer, jun., Manchester.
7295. Drain Tests, J. W. Cowling, London.
7296. Apparatus for Making Tires, F. W. Brown, York.
7297. Steam Boilers, J. J. Butcher, Thompsonville, Connecticut, U.S.A.
7298. Preparing Iron as a Medicament, G. Dallmann, Berlin.
7299. Iron Barrels, J. M. Storrar and W. Crawford, Glasgow.
7300. Joining Sheet Metal, W. A. and D. Crabtree and A. Shaw, Keighley.
7301. Hosiery, O. Tabberer, A. Lorrimer, G. O. Tabberer, M. Lorrimer, and F. S. Shipp, Leicester.
7302. Preparation of Tonic Foods, H. E. Wright, Wickwar, Glos.
7303. Measuring the Power of Steam Engines, C. W. G. Little, Lincolnshire.
7304. Water Gauge Guards, C. R. Winn, Birmingham.
7305. Applying Portraiture to Pottery, T. Reeves, London.
7306. Construction of Bakers' Ovens, J. Melvin, Glasgow.
7307. Extracting Dust from Oats and Grain, S. Cowl, Leeds.
7308. Constructing Mechanical Stokers, J. Proctor, Manchester.
7309. Photographic Shutters, E. Underwood, Birmingham.
7310. Wall-works, C. J. Schulz, Berlin.
7311. Bicycle Tires, H. C. Dean, Glasgow.
7312. Instrument for Opening Cans, D. L. Baumgarten, London.
7313 Manufacturing Colouring Matters C. D. Abel.—(*The Actien Gesellschaft für Anilin Fabrikation, Germany.*)
7314. Spring Lens Cap, E. and E. Hodgson, Manchester.
7315. Amalgamating Apparatus, J. E. Preston, London.
7316. Mops, J. H. S. Livingston, Manchester.
7317. Metal Stay or Knife Rest, H. H. Hitchin, Liverpool.
7318. Electric Heaters, E. E. Gold, London.
7319. Motion of Dabbing Brushes, T. Burrows, London.
7320. Sewing Machines, W. P. Thompson.—(*F. W. Merrick, United States.*)
7321. Sewing Machines, W. P. Thompson.—(*F. W. Merrick, United States.*)
7322. Luggage Labels, A. Ritchie.—(*J. and A. Ritchie, France.*)
7323. Making Nails, E. Williams and W. T. Evans, Manchester.
7324. Guns, &c., F. O. Jerram and A. E. Jerram, Liverpool.
7325. Keys of Type-writers, F. Goossens, London.
7326. Incandescent Gas Lamps, F. Slaby, London.
7327. Hanging of Window Sashes, T. R. Fuller, London.
7328. Stockings, T. Jones, J. Jones, H. Langdale, and A. Langdale, London.
7329. Jointing of Tubular Frames, C. T. Crowden, London.
7330. Steam Engines, L. S. d'Iszoro, London.
7331. Holder for Cravats, &c., M. B. Cotterell, London.
7332. Method of Tensioning Cycle Saddles, J. Gerard, London.
7333. Supporting Windows, E. J. and V. W. Hill, London.
7334. Locking Bicycles, &c., H. van der Weyde, London.
7335. Evaporimeter, P. S. U. Pickering, London.
7336. Hermetically Closing Receptacles, J. Schafer, London.
7337. Method of Treating Bagasse, J. Périchon, London.
7338. Book-markers, C. J. Letts, London.
7339. Fumigating Composition, H. H. Lake.—(*Société Anonyme de la Fabrique de Carton de Grandson et d'éclairage électrique, Switzerland.*)
7340. Bottle Stoppers, J. B. Tauveron, London.
7341. Ball Slings, J. Waldmann, London.

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7342. Separable Bookcase, O. H. L. Wernicke, Manchester.
7343. Dust Trap Attachment, &c., J. Toppin, Bristol.
7344. Cigar Holders, W. R. Oliver, London.
7345. Bosses of Cycle Saddles, J. B. Brooks, Birmingham.
7346. Apparatus for Propelling Ships, A. G. Ramage, Leith.
7347. Awning Stanchions for Use on Ships, W. Bell, Glasgow.
7348. Tablets for Advertisements, T. Corser, Manchester.
7349. Gear Chains, J. Walker, Derby.
7350. Chimney Cowls, J. M. Macaulay, Glasgow.
7351. Obtaining Motive Power, &c., J. Newton, London.
7352. Means for Consuming Smoke, T. Brook, Huddersfield.
7353. Supporting Gas Burners, T. Redman, Bradford.
7354. Cocks, W. D. Ferguson, Belfast.
7355. Attaching Brackets to Upright Standards, G. Gibbon, London.
7356. Saws, D. Doyle, Cork.
7357. Hair Pins, G. M. Davies, Cardiff.
7358. Process of Nickel Plating, H. L. Haas, London.
7359. Car Couplers, J. Johnson.—(*C. A. Tower, United States.*)
7360. Shuttles, W. H. Inslee.—(*The Singer Manufacturing Co., United States.*)
7361. Machines for Expelling Water, M. S. Ayau, Glasgow.
7362. Steam Generators, J. Entwisle.—(*E. T. Sederholm, United States.*)
7363. Gas Burner Fittings, T. Pursey, Edinburgh.
7364. Wheel for Road Vehicles, R. W. Frost, Staffordshire.
7365. Self-adjusting Slide for Cameras, B. Moodie, Arbroath,
7366. Trap for Killing Game, J. McLaren, Dumbarton.
7367. Hoods for Incandescent Gas Lamps, H. Hill, Nottingham.
7368. Cuff Fastening and Retaining Stud, J. Cleland, Down.
7369. Driving Gear for Cycles, A. W. and S. Farnsworth, Derby.
7370. Syphons, J. Davey, Hitchin.
7371. Plates for Fixing in Letter-boxes, A. and C. Merriman, Redditch.
7372. Brackets for Curtain Rods, A. Newman, Birmingham.
7373. Fishing Apparatus, C. Willson and T. C. Robinson, Grimsby.
7374. Brush, J. C. Meyers, Dublin.
7375. Carpet Sweeping Machines, J. Gutmann, London.
7376. Liquid Heaters, M. G. Wilder, London.
7377. Gas Motors, W. H. Casey and A. F. Woodman, Exeter.
7378. Controlling Cages in Mines, J. H. Townsend and W. Dixon, London.
7379. Extracting Oil from Seeds, W. R. Harrison and E. Stephenson, London.
7380. Beer Engine Spouts, J. Griffin and W. E. C. Pinchbeck, London.
7381. Metallic Belting, W. Gibson and W. H. Palmer, London.
7382. Water-closets, D. S. Wallace, London.
7383. Producing Metal Tubes, &c., T. S. James, London.
7384. Waterways, C. N. Dutton, London.
7385. Horseshoes, J. B. Gillespie, London.
7386. Butter Box, A. Hart and C. A. Bramwell, London.
7387. Glove Fastener, G. H. Moller, London.
7388. Fire Extinguishers, H. H. Lake.—(*T. J. Vail, United States.*)
7389. Telephone Transmitters, W. L. Wilheim and B. J. Tillman, London.
7390. Musical Instruments, H. H. Lake.—(*J. E. Maynadier, United States.*)
7391. Wheels of Cycles, J. Morrison and W. T. Dale, London.
7392. Solder Plates or Tablets, J. J. Laffitte, London.
7393. Linoleum, W. P. Thompson.—(*T. Potter, Sons, and Co.,*——)
7394. Clasp Knives, W. P. Thompson.—(*A. K. Brauer, United States.*)
7395. Knitting Machines, J. Bennor, Liverpool.
7396. Box Iron, F. E. Hunter, Liverpool.
7397. Protecting Mantles of Burners, L. Teichmann and E. Hopkins, London.
7398. Paper and Cardboard Boxes, H. C. Norman, London.
7399. Making Justified Lines of Type, A. J. Boult.—(*The Lanston Monotype Machine Company, United States.*)
7400. Steering Gears for Vessels, C. E. Bergman, London.
7401. Cycle Handles, J. McRae, London.
7402. Dust-excluding Ring for Cycle Bearings, J. McRae, London.
7403. Type-writing Machines, B. C. Stickney, London.
7404. Sorting Machines, C. G. Poulson, London.
7405. Treatment of Vegetable Fibres, C. Efros, London.
7406. Dress Protector, A. R. Gahagan, London.
7407. Screw and Nail, C. Grundy, London.
7408. Transfer Pictures, Grimme and Hempel, London.
7409. Cork Pullers, E. Walker, London.
7410. Starch and Dextrine Combinations, A. Classen, London.
7411. Wash-boards, J. T. Sargent, London.
7412. Money Tills, F. O. Jerram and A. E. Jerram, London.
7413. Decorative Embossing, A. C. A. Rottmann and A. Silver, London.
7414. Screw-cutting Stocks and Dies, H. Reisiger, London.
7415. Controlling Apparatus for Dyeing, W. E. Curtis, London.
7416. Type-writing Machines, A. W. Steiger, London.
7417. Sole-laying Machines, &c., J. G. Lorrain.—(*The Goodyear Shoe Machinery Company, United States.*)
7418. Boots, W. Owen, London.
7419. Sack Holders, J. Marshall, London.
7420. Railway Couplings, S S. Bromhead.—(*The Society for the Exploitation of the Danischewsky Patents, Switzerland.*)
7421. Pneumatic Hub for Wheels, H. C. Bevan, London.
7422. Making Steel or Alloy of Iron, R. A. Hadfield, London.

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7423. Automatic Cork Extractors, A. Bodding, London.
7424. Extraction of Gold from Ores, J. B. Torres, London.
7425. Neckties, T. Day, Wolverhampton.
7426. Holding and Releasing Cords, J. S. Orton, Birmingham.
7427. Valves for Pneumatic Tires, W. Brookes, Manchester.
7428. Regulating Pumping Engines, J. Hodson and H. S. Clement, Glasgow.
7429. Mantles for Incandescent Lamps, J. B. de Léry, Manchester.
7430. Loom Shuttles, W. E. Heys.—(*A. Duhamal, France.*)
7431. Ship Steering Mechanism, R. Boutflour, Stockton-on-Tees.
7432. Cycle Attachment, W. Brice, Bristol.
7433. Folding Seats, J. D. Richardson and F. H. Young, Birmingham.
7434. Stay Busks, W. Wright, Sheffield.
7435. Oil Motors, G. Johnston, Glasgow.
7436. Blast Furnaces, W. Gibbings, Widnes.
7437. Fastening Braces, G. Crees, Ross.
7438. Incandescent Gas Burners, E. H. C. Oehlmann, Glasgow.
7439. Pockets for Garments, P. Hossfeld and S. Beer, Glasgow.
7440. Tracing Pin, A. P. R. Willis, Leatherhead.
7441. Driving Gear for Cycles, &c., J. W. Duncan, London.
7442. Tire, L. Schramm, London.
7443. Musical Instruments, G. Bortmann and A. Keller, London.
7444. Preventing Re-filling of Bottles, J. Lang, London.
7445. Ventilating, P. Lawrence.—(*T. A. Richards, United States.*)
7446. Exhaust Fans, P. Lawrence.—(*T. A. Richards, United States.*)
7447. Recovery of Zinc from Ores, H. R. Angel, London.
7448. Tripod Stands, H. J., A. S., and G. A. Spratt, London.
7449. Dry-docking Ships, S. Dure, London.
7450. Equipments, T. H. Cothill.—(*P. Lewis, Canada.*)
7451. Portable Water Bottles, T. H. Cothill.—(*P. Lewis, Canada.*)
7452. Making Iron-cutting Saws, E. Graf, Aix-la-Chapelle.
7453. Bicycles, H. F. Hill, Nottingham.
7454. Motor Engines for Auto-cars, A. Berrenberg, London.
7455. Steam Turbines, R. Hewson and Messrs. Whyte and De Rome, London.
7456. Arm Rest for Book-keepers, C. S. Gilman, London.
7457. Moulding Machines, W. P. Thompson.—(*C. Cristadoro, United States.*)
7458. Teaching Music, J. H. and E. M. Hendrey, London.
7459. Toilet Tables, Wardrobes, &c., J. Porter, London.
7460. Toilet Tables, Wardrobes, &c., J. Porter, London.
7461. Window Attachment, C. H. Clarke, London.
7462. Photographically Printing Strips, B. Acres, London.
7463. Incandescent Gas Lighting, L. Denayrouze, London.
7464. Treating Bay Salt, A. MacNab, London.
7465. Sinking Caissons, C. M. Johnson and S. W. Parker, London.
7466. Spindle Mechanism of Locks, &c., T. Jones, London.
7467. Brushes, J. J. Ashburner, London.
7468. Automatic Guns, H. S. Maxim, London.
7469. Systems for Preserving Paid Checks, T. M. Hurley, London.
7470. Ironing Boards, T. J. Sutton and G. J. Palmer, London.
7471. Supports for Pictures, &c., E. A. Swineford, London.
7472. Railway Spikes, R. W. Beidleman, London.
7473. Steam Valves for Steam Cylinders, M. Berger, London.
7474. Spring Grab Hooks, E. Dobbins, London.
7475. Shallow Water Signals for Vessels, H. H. Franklin, London.
7476. Car Fenders, F. J. Graf, London.
7477. Incandescence Gas Burners, P. Schroedter, London.
7478. Stop Valves, &c., A. J. Boult.—(*M. Groignard, France.*)
7479. Variable Speed Gear, J. W. Hall, London.
7480. Preservation of Organic Substances, A. J. Boult.—(*F. Fritzsche and Co., Germany.*)
7481. Dress Fastenings, H. Fuller, London.

9th April, 1896.

7482. Trunk, C. Manners, London.
7483. Fanlight and Clothes-line Fastener, &c., G. Chambers, London.
7484. Electric Meters, Evershed and Vignoles, Ltd., and S. Evershed, London.
7485. Oil Cups for Machines, A. Hitchon, Accrington.
7486. Nautical Instruments, J. Morton, Newcastle-on-Tyne.
7487. Oil Can, R. Hopper, Newcastle-on-Tyne.
7488. Reversible Sliding Window, G. Vincent, London.
7489. Combined Bottle and Measure, J. Renwick, Manchester.
7490. Controlling Railway Carriage Doors, J. Robinson, Liverpool.
7491. Filter, L. Classey, Limerick Junction.
7492. Combination Pie-crust Support, &c., R. H. Rowland, Suffolk.
7493. Opening, &c., Water-tight Doors, J. Carmichael, Glasgow.
7494. Manufacture of Drying Horses, D. K. Tullis, Glasgow.
7495. Sliding Window Sash Frames, T. F. Gaunt, Nottingham.
7496. Apparatus for Planing Boards, J. Barr, Renfrewshire.
7497. Gauge for Shoe-nailing Machines, J. Bootham, Manchester.
7498. Displaying Words, &c., E. Sandow, Manchester.
7499. Cotton Waste Breakers, J. Lobley, Manchester.

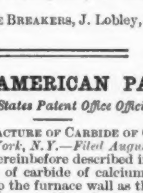
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

552,890. Manufacture of Carbide of Calcium, *W. C. Clarke, New York, N.Y.—Filed August, 24th,* 1895.

Claim.—(1) The hereinbefore described improvement in the manufacture of carbide of calcium, which consists in building up the furnace wall as the formation of the carbide progresses, adding fresh charges of the material to be treated as the wall is built up and keeping the lower end of the upper electrode at all times near the upper edge of the furnace wall. (2) The hereinbefore described improvement in the manufacture of carbide of calcium, which consists in forming around the lower of two vertically disposed electrodes an enclosure greater in diameter than such electrode, charging into such enclosure the material to be treated and subjecting it to a decomposing temperature by means of an electric current between such electrodes, adding fresh charges of material and separating the electrodes as required to continue the operation and building up the wall of the enclosure as required to contain the material added.

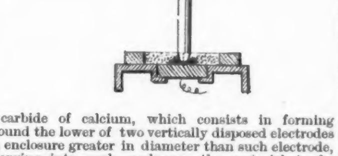
552,890



552,907. Tandem Attachment for Bicycles, *M. Jakobson, New York, N.Y.—Filed March 29th,* 1895.

Claim.—A three-wheeled tandem cycle, consisting of an ordinary safety bicycle, a tandem attachment having a single wheel and consisting of an ordinary frame provided with a seat and handle bar, a forwardly extending brace at the upper part of the auxiliary frame, a forwardly extending fork at the lower part of the frame, a pedal shaft and pedals, sprocket mechanism between the pedal shaft and the wheel of the tandem attachment, and means for detachably connecting the brace and fork of the tandem attachment with the rear fork of the main bicycle, substantially as set forth.

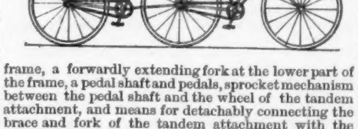
552,907



553,097. Hurdy-Gurdy Water Wheel, *F. M. Bookwalter, Springfield, Ohio.—Filed February 7th,* 1895.

Claim.—In a hurdy-gurdy water wheel, the combination with a horizontal wheel proper having buckets which discharge laterally, of one or more nozzles in a lower plane than the buckets and discharging into them.

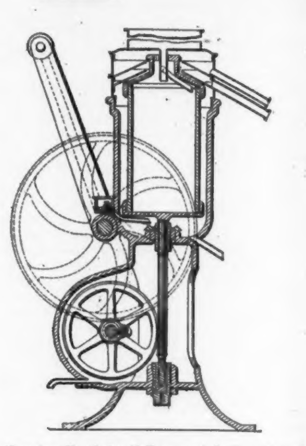
553,097



553,223. Centrifugal Creamer, *O. Anderson, Newark, N.J.—Filed May, 6th,* 1895.

Claim.—(1) The combination with the centrifugal bowl *a*, threaded shaft *b*, worm wheel *e*, shaft *f*, and nut *k*, provided with clutch teeth, of the clutching cog-wheel *h*, spring *l*, speeding wheel *m*, and means for turning the same, all said parts being arranged and combined, substantially as set forth. (2) The combination with the centrifugal bowl *a*, bowl carrying shaft *b*, shaft *f*, and train of means for transmitting power from one of said shafts to the other, of the clutch part *k*, fixed to said shaft *f*, and having teeth, a sliding cog-wheel *h* having co-operating teeth, a spring, a speeding wheel *m*, and means for transmitting power thereto, all substantially as set forth. (3) The combination with the centrifugal bowl *a*, shaft *b*, shaft *f*, and train of means for transmitting power from one shaft to the other, of the clutch part *k*, fixed to said shaft *f*, and having under-cut teeth, a sliding cog-wheel having correspondingly under-cut teeth, a spring, a speeding wheel and means for transmitting power thereto, all substantially as set forth. (4) The combination with the case *c*, centrifugal bowl *a*, bowl carrying shaft *b*, and means for rotating said shaft, of a supplemental piece *b′*, a cup-shaped adjustable chair or seat *p*, stepped interiorly as described, and a hardened and cushioned piece within said cup-shaped seat serving as a bearing for said supplemental piece, substantially as set forth.

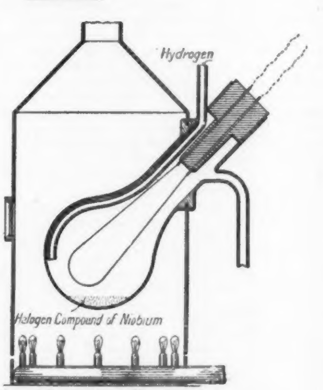
553,223.



553,296. Art of Manufacturing Electrical Incandescing Conductors, *J. W. Aylsworth, Newark, N.J.—Filed July 27th,* 1894.

Claim.—(1) The described method or process of depositing any of the hereinbefore named refractory metals upon a surface which consists in subjecting a halogen compound of such metal to the action of heat and a reducing vapour or gas as hydrogen, and at the same time electrically heating the surface upon which the metal is to be deposited. (2) The described method or process of constructing an incandescing conductor for an electric lamp, consisting in subjecting a halogen compound of a refractory metal and a reducing vapour or gas to heat and simultaneously passing a sufficient current of electricity through a conducting base or support to effect a deposit of the metal of the halogen compound upon said base or support. (3) The described method or process of preparing incandescing electrical conductors of highly refractory metals, consisting in subjecting a halogen compound of the metal to be used to the effects of heat and a reducing gas and simultaneously giving to a conducting base filament or support surrounded by said gas and the vapours emanating from the halogen compound an incandescence sufficient to effect a deposit of the metal of the compound upon the base filament or support. (4) The described method or process of producing or preparing incandescing filaments or wires from refractory metals as niobium, consisting in subjecting a halogen compound of the metal to the united influence of heat and a reducing gas and simultaneously giving to a conducting filament or base surrounded by the gas and the vapour of the halogen compound an incandescence sufficient to cause the metal of the halogen compound to be deposited thereon.

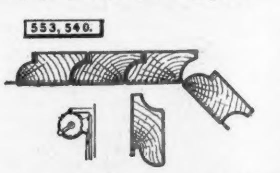
553,296.



553,540. Fire-proof Shutter, *F. E. Pollard, Worcester, Mass.—Filed March 30th,* 1894.

Claim.—(1) In a fire-proof shutter, the combination of a series of shells in the form of strips or leaves extending transversely across the shutter with their edges overlapping, a heat non-conducting material enclosed in said shells, said shells being arranged together at their abutting edges, substantially as described. (2) In a fire-proof shutter, the combination of a series of shells in the form of strips, or leaves, extending transversely across the shutter with their edges overlapping, said shells being united at their edges by a flexible connection, substantially as described. (3) In a fire-proof shutter, the combination of a series of shells formed of sheet metal and having a series of slits, or openings J upon opposite corners and a flexible metallic band extending through said slits, or openings, whereby said shells are united, substantially as described.

553,540.



THE GOHNA LANDSLIP AND FLOOD.

IT will be remembered that a mighty landslip occurred in the end of the year 1893 in one of the outliers of the Himalaya Mountains, on the north-west frontier of India. This, by blocking up the Birahi Gunga, one of the tributaries of the river Ganges, led to the formation of a large lake whose waters threatened, as soon as they had accumulated sufficiently to overtop the obstruction caused by the landslip, to overwhelm the valley below. The story is now two years old, yet so slowly do the official mills grind that up to the present—as we believe—no authoritative report has been presented to the public of the occurrence, and the measures adopted to meet the catastrophe. The first complete account of the event has come to us in a paper read before the Imperial Institute by the Secretary of the Indian Section, in the absence of its author, Mr. J. H. Glass, C.I.E., a chief engineer of the Bengal Public Works.

Seldom has the paternal care with which the Government of our Indian Empire safeguards its subjects been more clearly exemplified than in the case before us, when an enormous volume of water suddenly hurled itself along the river valley at the dead of night, raising the river in many places more than 100ft. above the level of ordinary flood, yet without causing, so far as is known, the loss of a single human life.

Gohna, where the landslip happened, is a small village of 200 souls situated in latitude 30 deg. 22 min. 18 sec. N., and longitude 79 deg. 31 min. 60 sec. E. in Garhwal, in the N.W. Province of British India. It lies on the right bank of the Birahi Ganga, a tributary of the Alaknanda river, which, after its junction with the Bhagirathi at Deopryag, sixty-two miles above Hardwar, is henceforth known as the Ganges.

At Hardwar, 150 miles below Gohna, the river passes through the last gorge in the hills and debouches on the plains of Northern India. Between these two places its course lies in narrow ravines, and this part of the river, famous as the resort of Hindoo pilgrims, is along its margin studded with sacred stations and holy shrines, between which streams of devotees pass to and fro.

The valley in general is sparsely inhabited, Srinagar, with a population of 2000, being the largest town, and the cultivation scant; yet in case of an unexpected release of the accumulated waters, owing to the presence of the pilgrims and the surrounding circumstances, the loss of life might have been immense, and the destruction of property would have been enormous if sufficient and timely precautionary measures had not been adopted.

Just below Hardwar, at Maiapur, on the river, are situated the headworks of the great Ganges Canal, and serious injury to this work would have caused enormous loss to the Government and the agricultural community, as well as doing incalculable damage to the country below, over which so large an area of cultivation with its revenue is dependent on irrigation by the canal.

The problem, therefore, that the Government set before itself in dealing with the catastrophe was to prevent, if possible, all loss of life among the pilgrims and villagers on the road leading to the shrines and in the valley, and to save from destruction, as much as could be done, all public and private property within the probable range of the avalanche of waters that was expected to result from the bursting of the dam formed at Gohna.

In connection with the measures to be adopted, the first and most important point to decide on was the period the lake would take to fill and overflow. In the nature of the case the data on which to base calculations were most insufficient; yet it speaks well for the care and judgment of the engineers that, when the surveys and contours of the basin were effected, and the rainfall and snowfall during the year on the catchment duly considered, the forecast of the date on which the barrier would be overtopped was only ten days earlier than the date—the 25th of August—on which the event acually occurred. The 15th of August was thus the date fixed as that by which all preparations for the overflow should be complete.

The first and chief precautionary measure was the construction of a telegraph line between Gohna and Hardwar, following the river course, and having stations at all important points along the line. It was decided that there should be in all ten telegraph signalling stations, selected with regard to their importance as camps or halting places for the pilgrims on their journey along the river. This provision, besides relieving the suspense both of the public and officials at the most critical periods, and facilitating operations generally, avoided the necessity that would have otherwise existed of closing the road along the valley used by the pilgrims; to have stopped all traffic would have inflicted great hardship on the people and been an extremely unpopular measure. This road admits only of foot traffic, but the Government has spent considerable sums of money on its improvement. Suspension bridges have been built, precipitous paths eased off and rendered safe, and bazaars established along it to provide the pilgrims with supplies. It was decided to dismantle the permanent suspension bridges along the road, and replace them by temporary rope structures, and this was done except in two cases, where at the special request of the local authorities, two bridges were left, which, in their opinion, were safely beyond any flood likely to occur. As a result, these bridges were completely wrecked.

Further, it was arranged to erect masonry signal pillars in the valley at a level of 200ft. above ordinary flood from Gohna to Srinagar, and at 100ft. above the same datum in the valley below Srinagar. These pillars were 4ft. square and 6ft. high, and were erected at all villages and camping grounds; and elsewhere at intervals of half a-mile; they marked a limit below which it would be unsafe for people and their property to remain after warning of the approach of the flood had been issued.

So much for the precautions above Hardwar; below it the safety of the headworks of the Ganges Canal demanded earnest attention, as a heavy flood bursting into the canal might not only carry the headworks away, but also seriously injure the great torrent works and falls as far as Roorkee. The following protection works were therefore carried out:—A massive crate dam filled with heavy boulders was constructed between the river weir and the canal head, with embankments leading to the rising ground to prevent the headworks from being outflanked by the flood. The canal head-gates were strengthened to make them better able to resist the exceptional head of water against them. Subsidiary boulder "bunds," or banks, were erected to prevent outflanking, and other minor provisions adopted. In the low lands, in the ninth mile of the canal, and immediately above the embankment of the Solani Aqueduct in the sixteenth mile, the canal banks were lowered so as to provide temporary escapes, which would relieve the canal and thus possibly aid in saving the great masonry works on the canal lower down at Roorkee, in case of the flood bursting into it at the headworks.

According to native reports—for no European, scientific or otherwise, visited the site till some time afterwards—what happened at Gohna was this:—In September, 1893, an enormous mass of material from the mountain of Maithana, on the right bank of the Bhirai Gunga, slipped into the river; and again in October of the same year there was another great fall. The mountain itself is 11,000ft. high, and the part of it from which the mass fell is 4000ft. above the bed of the stream. The material consisting of earth and rock came down with a deafening noise, and the neighbourhood for miles around was enveloped in clouds of dust, which whitened ths ground and the branches of trees like a fall of snow. The magnitude of the barrier formed across the stream by the landslip may be judged by the following rough measurements: The height was 900ft., the length measured across the gorge was 3000ft. along the top, and 600ft. at the bottom; and in cross section it was 2000ft. at the top and 11,000ft. at the base, so that the side slopes must have been about one in five.

It was calculated from the contoured map of the valley, prepared by Lieut. Crookshank, R.E., the officer in charge of the operations, that the area of the lake which would be formed, when the water was at the level of the top of the dam, would be thirty-seven millions of square feet, or say, 1½ square miles and its contents roughly estimated would be 16,650 millions of cubic feet. Its catchment was about ninety square miles, and was bounded on the north by a snow-clad ridge of the Himalayas rising to altitudes of 21,200ft. above the sea level.

The longitudinal bed fall of the Birahi Gunga is about 250ft. per mile at Gohna, and its course bends nearly at a right angle immediately below the site of the slip. It runs entirely through ravines with steep precipitous sides, grass covered at the base, and higher up clothed with oaks, firs, and rhododendrons.

The phenomenon of the landslip was adjudicated by an expert of the geological department to have been due to a combination of causes; such, for instance, as the alteration of the chemical condition of the substance of the strata, the solution of substance and reduction of friction among the beds by the action of water, all of which tended to prepare the mass for motion, while the expansion resulting from atmospheric effect, with changes of temperature seconded by hydrostatic pressure, may most probably have caused an impulse in the direction of least resistance, and thus produced the slip. An interesting report on the subject is published in the records of the Geological Survey of India, in which the author of the paper concludes with the following words:—"It may be of interest to remind the general reader of the fact that the folding of the Himalayan range having continued to times geologically recent, if not still in action, there has resulted a condition of strain frequently manifesting and relieving itself by earthquakes; and of steep slopes with rushing torrents, frequently resulting in landslips. When subsequently the inequalities of level have been sufficiently reduced by denudation, the slope will be more stable, rivers less violent, and the scenery tamer—a condition of affairs exemplified by the more geologically old-fashioned peninsular portion of India. Water, the great agent of denudation, has by its chemical and physical action been the cause of the landslip at Gohna."

The periodical rains commenced early in June, but before the end of July all arrangements were completed. The waters of the lake had for some time back been rising rapidly, owing to heavy rain and the melting of the snow on the mountains, and on the 9th there was a downpour on the dam itself. On the 10th of August the first symptoms of the approaching collapse developed themselves in the shape of a serious slip of the down stream face of the dam, leaving an almost perpendicular scarp of some 400ft. high. The section thus exposed showed a layer of stones at the top resting, so far as could be seen, on pulverised rock.

The first note of warning was in consequence of this slip telegraphed on the 11th August down the river to all concerned. Percolation became very copious, and a considerable stream, about 300 cubic feet per second, was to be seen running over the boulders of the former river bed laid bare by the slip of the dam. The water level was at this time within 50ft. of the top of the dam, and it was estimated that in fifteen days the overflow would take place.

On the 22nd, Lieutenant Crookshank essayed to hasten events by making a small cut through the crest of the dam, and thus hoped to produce the overflow early in the morning of the 24th, it being important that the flood should take place in the daytime; but owing to increased percolation and diminished rainfall in the interval, the lake rose more slowly than expected, and the first overflow did not take place till 6.35 o'clock on the morning of the 25th of August.

At first the destructive action of the water was slight, but before long the immensely increased percolation caused a rapid cutting back of the dam, and at 2 p.m. a message was despatched down the line announcing that the flood might be expected during the night. Unfortunately, at this time a thick mist had descended on the scene, and all the provisions for observing the subsidence of the water in the lake, and the action of the flood when passing over the dam, in the shape of masonry bench marks, were rendered nearly useless. These bench marks were placed on the top of the down stream face of the dam, at 50ft. apart, and numbered consecutively in large figures so as to be plainly observable from the sides of the valley. Their object was to allow of a reliable record being made of the way in which the water, when discharging itself, cut away the material of the dam. The rate at which the water of the lake subsided was to have been recorded every hour by observations of other bench marks placed on the hill side, and as the valley had been carefully contoured at verticals of 1ft., the outflow could have been easily calculated. In addition to the above arrangements at the lake, other bench marks were placed at observing stations down the river. By numbers on these the rise of the floods passing could be accurately observed by daylight, and at night lighted lanterns were placed on them at vertical intervals of 10ft.; the lights, as the waters rose, were extinguished, and thus the flood heights could be estimated.

At 11.30 p.m. a loud crash was heard, and in spite of the mist and rain, the air was filled with a fine dust which rose from the site, and so far as could be ascertained, the dam was completely breached, a fact at once telegraphed down the valley. The rush of water was very great, but owing to the atmospheric conditions it was impossible to gauge the discharge. At five in the morning, although the valley was full of mist and the light very unsatisfactory, it became evident that a considerable fall had taken place in the level of the lake, and the authorities at Hardwar were warned to expect a great flood. It was calculated that 10,000 millions of cubic feet of water had been discharged in the space of 4½ hours, as the lake had fallen 390ft. At the gorge immediately below the dam, the flood rose to 260ft. over its ordinary level. The valley was filled up with huge blocks; and the bed of the river was raised some 234ft., by a substantial weir with a long gentle slope stretching far down the valley. At thirteen miles down, the river bed was raised 50ft. by the *débris* deposited, and the flood reached a height of 160ft. above its ordinary level.

All down the valley, for fifty odd miles, the flood rose from 113ft. to 140ft., causing serious damage. Even at Shrinugar, seventy-two miles from the landslip, the flood, which was first observed at 3.25 a.m., attained a maximum height of 42ft. above ordinary flood level. Here the damage done was great. The entire town, with the Rajah's palace and the public buildings, were destroyed, and a thick layer of stones, sand and mud, deposited over the area. Several small villages in the valley, which here opens out into a large amphitheatre of between three and four miles long and one mile wide, were completely swept away. The flood reached Hardwar, 150 miles from Gohna, at 8.45 a.m. on the 26th August, and obtained a maximum height of 11ft. above the ordinary flood level. Fortunately, the main river was low at the time—lower, in fact, than at any time during the previous month. Had the extra Gohna flood arrived on top of one of the very heavy normal floods of the previous thirty days, the canal must have suffered grave disaster. As it was, considerable damage was done. The revetment walls at Hardwar and the marginal "band" or dam were topped, and the diversion channel breached. Four out of seven of the sluices in the Maiapur dam were put out of action by the *débris* brought down, and though the crate dam was not topped, yet some water broke into the canal through the head. In the town itself the flood is reported to have stood 6ft. deep in the main streets. The velocity of the torrent was gauged by observing the time that blocks of wood or other floating bodies took to pass between fixed points of known distances apart. By this method it was estimated that the average velocity of the flood in the upper seventy miles of its course was 26ft. per second, but in the stretch of twelve miles below Gohna it is considered that a maximum of at least 40ft. per second must have been attained.

At Srinagar a curious phenomenon occurred. Below the town the open valley contracts suddenly, at the Jakhni Gorge, and the bed is narrow and the sides precipitous. The effect of this conformation was that the flood water after spreading out at Srinagar was abruptly contracted at the gorge and a strong swirling backwater current was set up. The furious rush of this eddying water was terrifying in the darkness of night close below the observers, and many who had been securely placed in temporary shelter huts fled in terror still higher up the mountain side.

Although the greatest care was taken to keep down the expenditure, and every proposal was submitted to the strictest scrutiny, yet the total of the loss to Government and the outlay in measures for the protection of the life property of the people, the former of which formed a first consideration, amounted to Rs. 2,500,000. Of this sum the destruction of bridges and buildings down the valley as far as Hardwar may be taken as Rs. 100,000. The cost of the telegraph line and the housing of the staff engaged in the operations amounted to about Rs. 90,000, and the protection work, added to the repairs of the damage done by the flood to the Ganges Canal, is estimated at Rs. 50,000. The loss caused to private individuals has not been estimated.

The loss of life has been nil, if we except the case of the Gohna fakir and family; these perished in the slip of the dam slope on August 11th, a result due to their own fatuous obstinacy, and not necessarily a consequence of the flood. The fakir had persisted in remaining in a very dangerous position below the dam, though he had repeatedly received orders to leave it. He and his family had twice been forcibly removed; but each time they had returned, and were eventually overwhelmed in the slip, which we have described as taking place in its rear slope previous to the total failure of the dam.

One of the results of the landslip from the mountain is that a lake of considerable size has been established at Gohna. Its dimensions are about two miles long by a mile wide, and it has a maximum depth of 800ft. The large rocks and residual *débris* have been so consolidated and packed by the flood, that they now form a massive and solid dam or weir which is not likely to be disturbed, so that the lake is probably a permanent one, and Gohna may one day prove a pleasant resort from the plains below.

Naturally, while the preparations to meet the flood of 1894 were in progress, many criticisms were made on the operations in the public papers, and much advice was offered to the Government, both publicly and privately.

The chief question taken up by the influential section of the public was the advisability of cutting a channel through the dam to facilitate the escape of the water before it reached the full height of the obstruction. This proposal was set aside for the reason that the mass of water which would in any case be headed up, and must eventually cut through the upper layers of the dam, would cause a serious flood of practically the same intensity as if the dam were untouched, and because of the great expense, if not the impossibility, of making a sufficient cut within the time available. For example, a cut of, say, 50ft. deep would have still left over 700ft. of water in the lake, and have had no appreciable effect in lessening the flood; while the whole army of labourers to do the work would have had to be imported, housed, and fed in an almost inaccessible country during a season of heavy rainfall, at an estimated cost of three lakhs of rupees or more. Considerations, too, in connection with the danger at the temporary headworks, which are put up yearly at Hardwar for the purpose of supplying the Ganges Canal with water in the dry season, led Government to reject the proposal as a wasteful extravagance with no practical advantage.

Various other suggestions were rejected for different reasons, and some persons even urged that there would be no cutting back and no flood, but that the water would quietly pass over the crest of the dam and down the face of the talus, and so into the regular river channel, producing no more damage than an ordinary flood.

Other objectors urged that the velocity of twenty miles an hour, at which rate the flood was calculated to escape down the river, was exaggerated and impossible. Some ridiculed the provision of the safety pillars as an arbitrary and absurd arrangement. And the construction of the telegraph was set down as a wasteful extravagance, and the dismantling of the bridges was held to be quite unnecessary. However, the success which attended the operations sanctioned by Government was greater than could have been anticipated, and no higher testimony is possible to the efficiency of the protective measures, and to the care with which they were carried out, than that the people themselves recognise and are grateful for the consideration they have received in the precautions which were taken for their safety. We have no doubt that the recollection of the beneficent care shown by Government for the preservation of their lives and the protection of their property will remain for ever fresh in their memories. It speaks well for the administration of Sir Charles Crosthwaite, K.C.S.I., that the situation was so promptly and firmly grasped, and to prove that such has been the case, and to judge of what might have happened otherwise, we have only to compare the record of this flood with that of 1868. The latter flood was due to a similar cause, viz., the bursting of a lake, probably also formed by a landslip, at no great distance from Gohna, and it does not appear that any precautions, such as in the present instance, were taken to meet it. At that time Sir Henry Ramsay was Commissioner at Kumaaon, and in reporting the occurrence of the flood to Government, he stated that several bridges along the valley had been carried away, and that some houses, crowded at the time by pilgrims on their way, were submerged. The accumulated waters, he adds, came down so suddenly at night that there was no warning, and only a few pilgrims—most likely awakened by the noise of the rushing waters—were able to run up the hill and escape; all the others with the houses were swept away. Much animal life was lost and a considerable amount of property destroyed.

THE ENLARGEMENT OF LIVERPOOL-STREET STATION, GREAT EASTERN RAILWAY.

BRIDGE AT WORSHIP-STREET.

In carrying out the extensive works in connection with the widening of its metropolitan terminus, the Great Eastern Railway Company found it necessary to bridge over, stop up, divert, and otherwise unavoidably to interfere with several of the old streets, lanes, passages, and thoroughfares situated in the line of the new route. Among other collateral undertakings, three large over bridges were required to be built to carry Worship-street, Primrose-street, and Skinner-street, across the numerous lines of track all converging towards, and having for their common focus, Liverpool-street Station. All these three structures are on the skew, that at Worship-street, which we now intend describing and illustrating, forming an angle of 60 deg. with the line of roadway overhead. A general elevation of the bridge is shown in Fig. 1, and a plan in Fig. 2. From the former figure it will be seen that the main girders belong to what is known as the bastard type, that is, a form which is a cross between the horizontal lattice or open web girder, with parallel booms, and the bowstring. While, therefore, embodying in its design and construction the characteristics of the straight lattice, so far as the lower boom and web bracing are concerned, it trenches upon the bowstring type by the curvature of the upper boom. The vertical members shown in Fig. 1 are necessitated by practical requirements connected with the peculiar double section of the booms, which will be apparent when we proceed to treat of the details of their construction. Besides, vertical members are common to both types. Theoretically, the result of curving the upper boom of an open web girder is to increase the stresses towards the ends of both booms, while at the same time relieving the diagonal struts and ties in the web generally of a portion of the shearing stress. Practically, the effect is to impart a more graceful appearance to the contours of the structure, as in the example before us. Besides, the amount of curvature is small, and not sufficiently great to occasion much alteration in the nature of the stresses.

The span of Worship-street bridge is 73ft. on the square and 85ft. 7½in. on the skew. The height from rail level to the lowest point of the lower boom of the main girder is 14ft., and the distance from the same datum to the level of the roadway 20ft. 3in. At the centre, including cover plates, the depth from out to out is 10ft. 2in., diminishing to 7ft. 2in. at the ends over the bearings. From centre to centre the main girders are 43ft. 2in. apart, which dimension allows for a roadway 24ft., and two footpaths, each 8ft. wide respectively. The vertical members or diaphragms, which connect the two separate sections of the upper and lower booms, divide the span of the main girders into eleven bays, consisting of a pair of diagonal struts and ties riveted together at their central intersection. All the bays, except the two short ones forming the ends of the girders, are 8ft. in width, and, where the dividing diaphragms are riveted to the lower booms, the cross girders are attached. There are thirteen of these altogether, of which nine in the general plan, Fig. 2, run from one main girder to the other, and the remaining four rest partly upon girders and partly upon the abutments. A general cross section on the square, in Fig. 3, shows the double section of the upper and lower booms of the main girders, the cross girders, which are of the solid web or plate description, and a section of the side screens and supports. Over the bearings at the abutments the manner in which the bed plates and ends of both main and cross girders are arranged is indicated in Figs. 4 and 5, while Fig. 6 is a section through the line A A in Fig. 5, and shows the construction of the abutments, counterforts, and their foundation of concrete, 2ft. 3in. in thickness.

A half elevation of one of the principal girders, 97ft. 7½in. in total length, is given in Fig. 3*a*, a half sectional and half plan, or an inside and outside plan of the booms, in Figs. 7 and 11, together with elevations to a distorted scale of the number of plates and angle irons composing the upper and lower booms in Fig. 4. There are in each boom, not including the long extra plate doing duty as a cover plate or wrapper over all, seven horizontal flange plates, all 1ft. 6in. in width by ½in. in thickness, and varying in length from 29ft. 10in. to 10ft. 10in., riveted to the angle irons of the flanges by rivets ⅞in. in diameter, with a pitch of 4in. from centres. The flange angle irons, which are four in number, two to each separate section of the booms, are 4in. by 4in. by ½in.

In Fig. 3*a*, the diagonal struts are lettered S and the sloping ties T, and they both vary in dimensions, and consequently in sectional area, according to their position in the girder. For instance, the ties increase from 7in. by ⅝in. at or near the centre of the main girders to 1ft. 3in. by 1⅛in. at the ends. It will be observed that in the central bay, counting the whole number as thirteen, which includes the semi or incomplete bay over the east abutment, both the diagonal bars are ties, and each 7in. wide by ⅝in. thick, thus giving a gross sectional area of nearly exactly one-fourth of that of the diagonal ties in the end bays. In girders of the description under notice in which the dead load, that is the insistent, weight of the principal girders, and in fact of the whole superstructure together, may be regarded as uniformly distributed, and also when it bears a fairly high ratio to the rolling or live load, the stresses on the central diagonals of the web are comparatively small. When the girder is used solely to support a uniformly distributed dead or static load, there is theoretically no stress on the diagonals under notice, but it is as well even in an instance of this description not to adhere too closely to the abstract dictates of theory. As a case in point, we remember many years ago a young engineer, very zealous and energetic in matters pertaining to the designing and construction of girders, had some lattice girders built for carrying a large water tank, in which the central diagonal bars were absolutely left out. They were passed, it is true, after some difficulty, by the superintending engineer, but it was stipulated that for the sake of appearance, wooden bars were to be inserted, painted and fashioned so as closely to resemble their iron neighbours.

Apologising for our brief digression, we now return to the main girders of the bridge at Worship-street, and for further details refer our readers to Figs. 5—11. It will be seen from them that each main girder consists essentially of a pair of single open web girders, placed side by side and separated by a space equal to 1in., and as the boom of each girder is 1ft. 6in. broad, the distance between their centres is 1ft. 7in., and the total width from out to out 3ft. 1in. If, therefore, the girder had been in one piece—that is, if the booms had been continuous over their whole available width, a plate 3ft. in breadth would have been required. Unfortunately, the time by which the bridge had to be constructed did not permit of plates of this somewhat exceptional width being obtained, so that the engineer decided to build up the section in the manner described. In addition, therefore, to the plates and angle irons already specified, we have to add two vertical plates to each entire boom. These plates have, except over the bearings, a uniform depth of 1ft., but vary in thickness from ⅝in. at the centre to 1⅛in. in thickness at the ends of the girders, corresponding with respect to these dimensions with those similarly belonging to the respective diagonal tie bars, to which they are riveted by strong gusset pieces. Over the bearings these vertical plates have their depth increased to 1ft. 6in. The form and size of these latter vary with the width of the tie bars, and their thickness increases slightly towards the ends of the girders from ½in. to ⅝in. The ties, twelve in number, all pass outside the struts, and it will be observed from an inspection of Figs. 5 and 6, that neither the ties nor the struts extend down the sides of the vertical plates or between the angle irons of the flanges, but terminate flush, or nearly flush, with the free or uncovered edges of the vertical plate. On the other hand, the solid plate diaphragms extend in both the upper and lower booms to the angle irons of the flanges, as shown by the letters D in Figs. 5 and 3*a*, which represent them in front elevation, sectional plan, and in cross elevation in the plane of a transverse section of the main girder. The diaphragms which bridge over—that is, which are carried across the space of 1in. between the two separate parallel girders constituting the single main girder—are built of eight angle irons, each 3in. by 3in. by ½in., two plates 1ft. ½in. by ½in. riveted in between them, and covered at their joint in the centre of the space of 1in., already described, by a cover plate on each side of the joint, 8in. broad by ½in. in thickness. In order to make the diaphragms extend the whole distance between the angle irons of the flanges, the angle irons of the diaphragms are cranked so as to clear the vertical plates of the flanges.

In Figs. 8 and 9 are given an elevation and section of the struts comprised in the web of the main girders, which are all similarly built up, although varying in length and other dimensions. The section of struts 1 and 2 is made up of a pair of outside or flange plates 1ft. by 1⅛in., two tee irons 6in. by 4in. by ⅝in., cross braced in elevation by three tee irons 4in. by 2in. by ⅝in., or four diagonal flat bars 3in. wide by ⅝in. thick. These dimensions for the bracing are constant for all the struts, but in strut 3 the thickness of the outside plates is reduced to 1in., and that of the longitudinal tee irons to ½in. In strut 4 the corresponding scantlings are, outside plates 10in. by 1in., and tee irons 6in. by 3in. by ½in., which in struts 5 and 6 are reduced to 7in. by 1in. by ⅝in. respectively, and 6in. by 3in. by ⅝in. in both instances. The tee irons of all the struts are bent to allow the plates to pass in between the gusset pieces. Cast iron bed-plates—see Figs. 6 and 7—having a length of 5ft. 6in., a breadth of 4ft. 9in., and a thickness of 4in., are bolted to the abutments with two holding-down bolts, each 2¼in. in diameter, and form the bearings for the ends of the main girders. Temporary brackets, B in Figs. 3*a* and 5, were riveted to the ends of the main girders for the purpose of fixing them in position, but were subsequently removed when the bridge was completed. In Fig 10 is a transverse section on the square of the general disposition of the cross girders and the roadway and footpaths of the bridge. The cross girders, seen partly in elevation in Fig. 10, and partly in cross section in Fig. 12, are of the plate type, 40ft. 1in. in span, 3ft. 9in. deep at the centre, and composed of horizontal flange plates 1ft. 6in. by ½in., angle irons 3½in. by 3½in. by ½in., and a web plate ⅜in. thick at the centre, increasing towards the ends of the girders to ½in. At intervals of every 4ft. along the rib of the girder vertical stiffeners are riveted on both sides, consisting of plates 1ft. in breadth by ⅜in. in thickness, which are covered again by tee-irons measuring 6in. by 3in. by ⅜in. The spaces of 4ft. between the vertical stiffening plates and tee-irons decrease towards the ends of the girder to 3ft. 8in., 2ft. 8in., and 1ft. 4in. In all plate girders it is near the bearings where the rigidity of the web becomes of chief importance, and the necessity for vertical stiffeners the most urgent.

Considering the roadway for the moment as distinct from the footpaths, upon the cross girders are placed, every 4ft. apart, rolled steel joists 8in. deep by 5in. wide over each flange, and where their joints occur they are riveted together over the cross girders by a pair of cover plates 8in. by 6in. by ⅜in.—Fig. 12. Over the rolled steel joists are riveted to them, with rivets ⅝in. in diameter, wrought iron buckled plates 4ft. by 4ft. and ⅜in. thick, and with a rise or camber at the centre of 2½in.—Fig. 13. Transversely the rolled steel joists are connected together by tee-iron bearers 5in. by 3in. by ⅜in., shown by the letter T in Figs. 13 and 14, to which the other fillets of the buckled plates are riveted. A substratum of concrete overlaid by wooden sets—Figs. 10—completes the formation of the roadway, and the same figure shows the construction of the footpaths, which is as follows:—A strong rolled steel joist 12in. deep by 5in. in width, is carried by a wrought iron bracket or knee piece riveted to the stiffening tee-iron of the cross girder. To the upper flange of this joist are riveted the adjacent fillets of the two buckled plates supporting the materials of the footpaths, which consist of dry filling and concrete flushed over a layer of asphalte. In Figs. 3, 10, and 15, the side screens are shown, which, while doubtless an unavoidable item in the construction of the bridge, detract very much from its appearance. Fig. 15 is an elevation of one bay of the parapet or screen on the inside or roadway. Fig. 16 is a section of the cast iron moulding forming the upper edge of the parapet; and Fig. 17 is a section and elevation of the moulding around the edges of the panels in Fig. 15.

Although all the work in connection with the enlargement of the terminus was of a heavy and onerous character, yet at any rate, so far as bridges are concerned, that at Worship-street may be considered to have carried off the palm. In Fig. 1, is shown in dotted lines the original contours of the old bridge of two skew arches turned in brick, which previously spanned the tracks, with clear openings of 27ft. each on the square. Between parapets the width of the old bridge was 40ft., but if the depth of the warehouses on either side be added on, the total width amounted to 70ft. As it would have been impracticable to accommodate the number of new tracks fantailing into the enlarged terminus under the narrow area afforded by the two old skew arches, it was determined to demolish the structure altogether, including the central pier, which was of dimensions sufficient to absorb some twelve lineal feet in the cross section of the permanent way. The demolition or removal once accomplished, the restoration of the thoroughfare upon wrought iron girders spanning the entire width of line at this point would have, under ordinary circumstances, been unattended with any engineering difficulty especially worth recording. But the problem assumes a very different aspect when the work it embraced necessitated the execution of it without in any way interfering with the ordinary traffic of the railway below, and in a great measure with that above. To carry on to a successful termination the destruction of the old and the erection of the new bridge in a single span, when about eight hundred trains every twenty-four hours had to be allowed an uninterrupted passage during the operation, was the feat to be accomplished by the Great Eastern Railway and its contractors.

For the information respecting this stage of the work we are indebted to Mr. H. L. Batting, of the firm of The Horseley Company, Limited, of Tipton, Staffordshire, and Victoria-street, Westminster, who were the contractors for the construction and erection of all the ironwork, not only for the present bridge, but also for the adjacent similar structures at Primrose and Skinner streets. In commencing the work of destruction, the warehouses already referred to were first demolished, and a temporary bridge of timber was built to carry the water and gas mains which supplied the districts on the north-east side of the extension with those requisites demanded by modern civilisation. In addition to serving the purpose described, the temporary structure acted as a bridge for pedestrians until the original thoroughfare was completely re-opened for traffic; for it was never entirely closed during the whole of the work, except for a very brief interval of time, which will be subsequently alluded to. It should be mentioned here, before proceeding further with our description, that no less than three separate authorities or parties were concerned, and took an active part in the execution of the works in connection with the removal and re-erection of Worship-street bridge. They were the Great Eastern Railway, the Horseley Company, and the contractors for the earthwork, brickwork, and foundations, Messrs. Mowlem and Co., who carried out, with the exception of the ironwork, the building of the new parcels' office already described and illustrated in THE ENGINEER. Having cleared away the warehouses, the contractors were at liberty to utilise the space thus acquired for

LIVERPOOL-STREET STATION, GREAT EASTERN RAILWAY—WORSHIP-STREET BRIDGE

MR. WILSON, M. INST. C.E., ENGINEER

(For description see page 414)

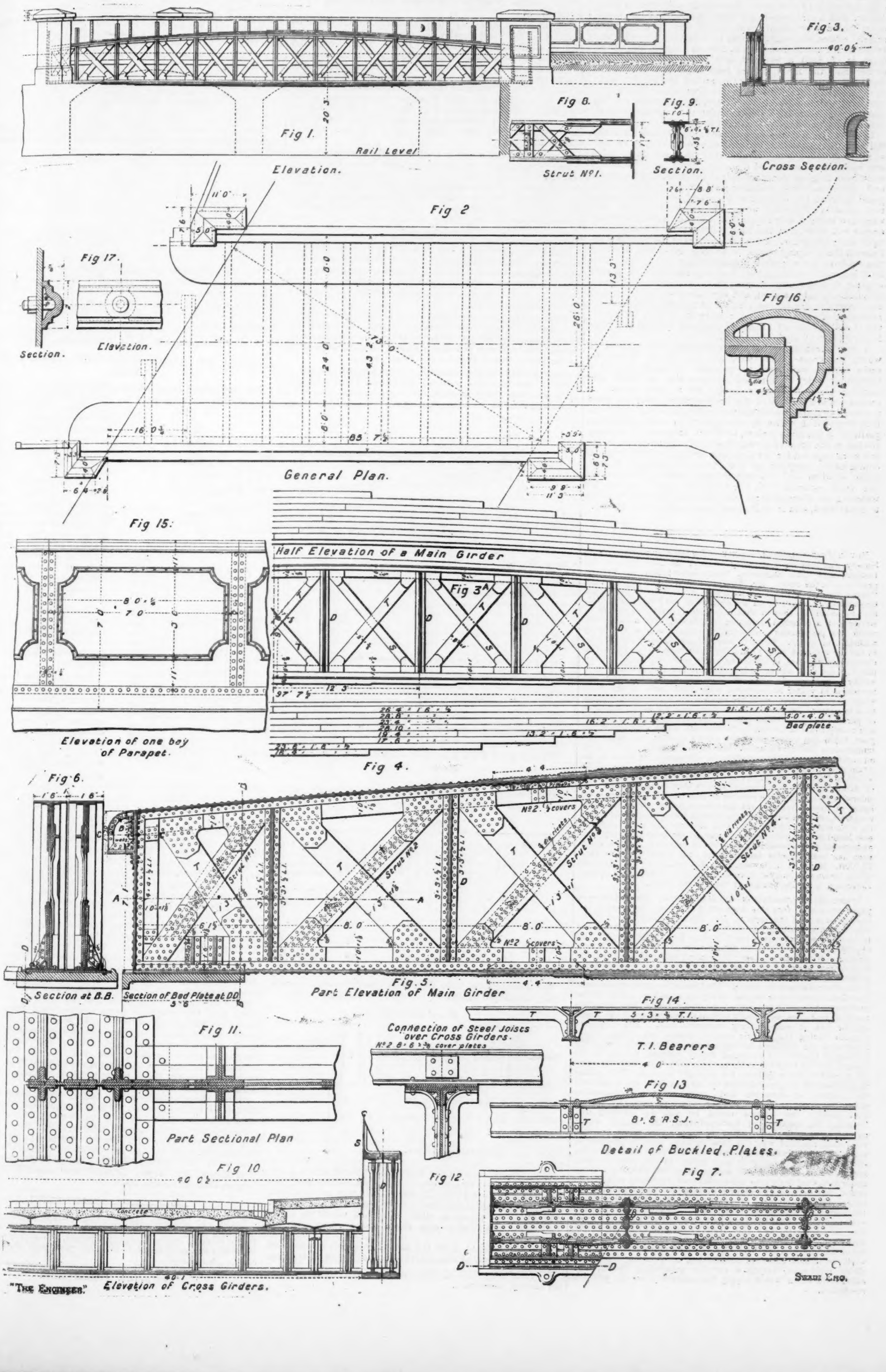


Fig 1.
Elevation.
Rail Level
20 3
Fig 8.
Strut No 1.
Fig 9.
Section.
Fig 3.
40 0½
Cross Section.
Fig 2
General Plan.
11 0
16 0½
24 0
43 2
26 0
13 3
75 0
85 7½
Fig 17.
Section.
Elevation.
Fig 16.
Fig 15.
Elevation of one bay of Parapet.
Half Elevation of a Main Girder
Fig 3A
12 3
97 7½
Bed plate
Fig 4.
Fig 6.
Section at B.B.
Section of Bed Plate at DD
Fig 5.
Part Elevation of Main Girder
No 2 ½ covers
Strut No 1
Strut No 2
Strut No 3
Strut No 4
8 0
Fig 14.
5·3·¼ T.I.
T.I. Bearers
4 0
Connection of Steel Joists over Cross Girders.
No 2 8·6·½ cover plates
Fig 11.
Part Sectional Plan
Fig 13
8·5 R.S.J.
Detail of Buckled Plates.
Fig 7.
Fig 12
Fig 10
40 0
Concrete
Elevation of Cross Girders.
40 1

"THE ENGINEER." SWAIN ENG.

the erection of the two main girders, of the largest of which we have given general and detail drawings in the present article. While so doing, the roadway had to be kept clear for the passage of the ordinary traffic. To those acquainted with the locality, the necessity for regulations so stringent with respect to the non-interruption with the ordinary road traffic, is not quite apparent. A small detour, with a correspondingly small sacrifice of time, would cause but a very insignificant interference with the main arterial routes, although, it must be admitted, the vehicular traffic in and about Bishopsgate, Norton Folgate, and Shoreditch is of both a frequent and heavy description. No sooner had the main girders been built *in situ*, than it became necessary to cut away the arches and all the brickwork underneath. This duty devolved upon the railway company and the resident engineer, Mr. Sherlock, and the district engineer, Mr. Wilmer, under the engineer-in-chief, Mr. Wilson, who had the charge of the work.

In order to protect the incoming and outgoing trains from the fall of the old materials, which were now nothing more than so much useless *débris*, old rails, iron odds and ends, balks and half balks of timber of a handy length, and scantlings and timber lagging, were pressed into the service, and a strong and substantial screen shield or platform was speedily interposed between the demolition above and the steam locomotion beneath. The steel wedge, the hammer and the pick were now brought into requisition, the side portions of the arches cut away, and the new main girders lowered down upon their bedstones. Under the powers of its Act of Parliament the company were able to stop the entire traffic of the roadway for a period not exceeding 168 hours. This brief interval was thus allotted among the different parties engaged in the work:—Messrs. Mowlem and Co., to remove all pitching, old material, and cart away earth, 24 hours; the Great Eastern Railway, to cut away completely all the brickwork of the arches and remove the shield, 96 hours; the Horseley Company, to fix all the cross girders and platform, 48 hours; total, 168 hours.

A few words must be said respecting the manner in which the cross girders were got into place. When the main girders were fixed in position, a rough sort of a travelling gantry was rigged up over the roadway, and running along the upper booms at a slow pace. A special goods train hauled the cross girders, weighing some five tons each, underneath the new bridge, and from the trucks they were lifted bodily by the gantry to their permanent position on the main girders, to which they were ultimately riveted in the manner already described. In addition to the ironwork required for the three new bridges over the terminal enlargement, supplied by the Horseley Company, Messrs. John Mowlem and Co. used a large quantity in carrying out their contract with the Great Eastern Company for widening the thoroughfares from Bishopsgate-street Without to Globe-road, and from Bethnal Green to Hackney Downs.

ROYAL METEOROLOGICAL SOCIETY.—The monthly meeting of this Society was held on Wednesday evening, the 15th inst., at the Institution of Civil Engineers, Westminster; Mr. E. Mawby, president, in the chair. Mr. W. Ellis, F.R.S, read a paper on the "Mean Amount of Cloud on Each Day of the Year at the Royal Observatory, Greenwich, on the average of the Fifty Years, 1841-90," in which he showed that a principal maximum occurs in winter and a principal minimum in autumn, with a secondary much less pronounced maximum in summer and a secondary minimum in spring. There is, however, considerable irregularity in the succession of daily values, the differences between which on consecutive days are, in numerous cases, relatively large. Cloudless days are most numerous in spring and autumn, and least so in winter and summer; days of little cloud are somewhat less numerous in winter as compared with other parts of the year, whilst days of medium cloud are much more numerous in summer than in winter. Days of much cloud are nearly equal in amount in all parts of the year, whilst overcast days are much more numerous and nearly equal in amount in the first and fourth quarters of the year, much less numerous in the second quarter, and again less numerous in the third quarter. Mr. E. D. Fridlander, B.Sc., gave an account of "Some Observations of the amount of Dust in the Atmosphere, made at Various Places during a Voyage Round the World in 1894-5." The experiments, which were made with a form of Aitken's pocket dust counter, showed that there are often considerable variations in the number of dust particles in a very short space of time. Not only did dust occur in the air of inhabited countries, over the water surfaces immediately adjoining them, and up to an altitude of 6000ft. or 7000ft. amongst the Alps, but it was also found in the open ocean, and that so far away from any land as to preclude the possibility of artificial pollution, and its existence has been directly demonstrated at a height of more than 13,000ft. Major H. E. Rawson, F.R. Met. Soc., gave an "Analysis of the Greenwich Rainfall Records from 1879 to 1890, with Special Reference to the Declination of the Sun and Moon."

BIRMINGHAM ASSOCIATION OF MECHANICAL ENGINEERS.—A paper was read before this Association at its last meeting by the first president of the society, Mr. Thomas Meacock, on "The Application of Electricity to Motive Power Purposes." The author treated the subject under the following four divisions:—(1) The application of electricity to tramcar propulsion; (2) to factory driving; (3) to domestic uses; (4) general application. Upon the topic of tramcar propulsion, the author defined the position of the three parties interested in tramways, viz., the tramway companies, the corporate Councils, and the public. The former having the paramount question of first cost or capital outlay to consider, turned to the overhead trolley electric system for the equipment or re-equipment of their lines, as the only system at present available which can be laid at comparatively moderate cost. The corporate councils finding the electric conduit system too costly, finally sanctioned the overhead trolley scheme. The public invariably petitioned against the overhead trolley scheme, but up to the present time had not been able to find a substitute, first cost being the barrier to other systems for ordinary services. The author then described a system devised by his own firm which removed the barrier of excessive first cost, gave no obstruction above the street level, and was perfectly insulated. He trusted that shortly the scheme would be put to practical use. Treating the question of factory-driving, the author whilst admitting that the application of an electric motor to each individual machine was the ideal system, still in practice he suggested a judicious grouping of the machines, with light line shaft and electric motor to each group, as the most practical scheme as regards first cost, maintenance, and efficiency. After going somewhat fully into the question of electricity as a motive power, he described a regulating slipping device he had designed for relieving the motor of all shocks from the machinery. Upon the third topic—the application of electricity to domestic purposes—he maintained that the time had now arrived when the great boon of electricity, now only available in towns, leading hotels, and public institutions, should be within reach of residents in suburban and rural districts. Mr. Meacock proposed a scheme of what he termed electrical colonisation, or grouping of, say, a dozen residences, having a common generating station, with attendant, which would supply the electricity for the group of residences.

EXPERIMENTS WITH ACCUMULATORS FOR LIGHTING RAILWAY CARRIAGES.*

DURING the past year a series of exhaustive experiments was carried out by the officials of the Hungarian State Railways on the lighting of railway carriages by electricity, and several systems of accumulators were made the subject of examination.

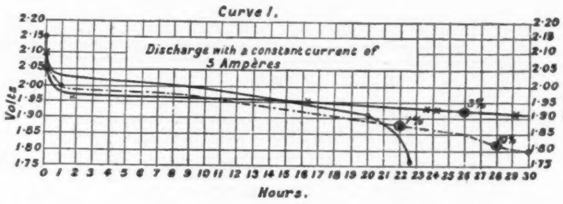
The conditions operating when vehicles in motion are to be illuminated differ appreciably from those obtaining in the case of stationary installations. In the latter event the weight of the accumulators is practically of little moment, and the diminution of the tension of the current as the discharge progresses can be easily compensated by the addition of reserve cells. This must, however, be avoided in railway work, as entailing too great a degree of complexity in the apparatus and inconvenience in application, and the following essentials, viz., lightness, regularity of current, and high capacity, are therefore insisted upon by the railway authorities.

Some makers endeavour to conform to the first-named condition by employing comparatively light plates containing very little metallic lead, but a great proportion of more active "paste." To this category belong the Austria and Boese accumulators. On the other hand, the Accumulator Manufacturing Company at the Hague adhere for railway work to a modification of their Tudor battery, wherein the plates have a very large surface, their capacity being increased by the superimposition of suitable "paste," with the object of reducing to a minimum the decrease of current while discharging. The importance of this latter condition is considerable, a diminution of 5 per cent. from the initial strength of the current being sufficient to lower the candle-power of the lamps to such a degree as to reduce the battery below the limit of practical efficiency.

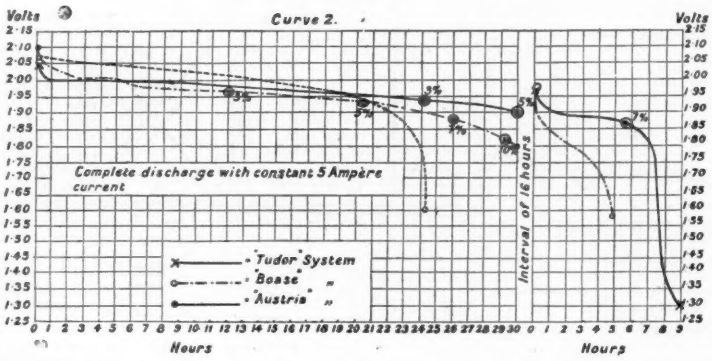
These two competitive systems being at disposal, a comparative examination of their respective merits fell within the scope of the experiments alluded to above, the batteries subjected to the different practical tests and measurements being of the Tudor, Boese, Austria, and Bristol types.

After having been in constant use for a period of over six months the batteries were all discharged and recharged, until gas was freely evolved. The discharging was then proceeded with at the strength of current, and until the final tension detailed in the subjoined tables, which, together with the curves, show the results obtained.

Curve 1.



Curve 2.



First Discharge.

System.	Strength of discharge current in ampères.	Final tension in volts per cell.	Guaranteed capacity in ampère-hours.	Actual capacity in ampère-hours.	Percentage diminution in tension.	Percentage of guaranteed capacity.	Density of the electrolyte at completion of discharge.
Tudor ..	5	1·85	150	150	3·3	100	16° and 15° Bé
Boese ..	5	1·80	150	150	10·0	100	14½° Bé
Austria ..	5	1·80	180	112	11·8	62	16½° and 16° Be
Bristöl ..	4	1·80	87·5	8·5	7·3	23	could not be measured

The accumulators were then fully charged once more and finally discharged completely—see second table and curve.

Second Discharge.

System.	Strength of discharge current in ampères.	Final tension in volts per cell.	Guaranteed capacity in ampère-hours.	Actual capacity in ampère-hours.	Percentage diminution in tension.	Percentage of guaranteed capacity.	Density of the electrolyte at completion of discharge.
Tudor ..	5	1·85	150	184	7·5	123	13° Bé
Boese ..	5	1·80	150	161	11·8	108	—
Austria ..	5	1·80	180	119	12·8	66	—
Bristöl ..	Not	tested	any fur	ther.			

After proceeding with the discharge for thirty hours, a rest of fifteen hours was allowed, and then discharging was resumed until complete. Finally a cell was selected from each of the batteries that had been in use for six months, and was taken to pieces to allow its eternal condition to be examined. The Tudor and Boese alone passed this test satisfactorily.

The tables below show the actual capacity—as obtained from the analysis of the curves—of the Tudor and Boese accumulators, at reductions of voltage amounting to 3, 5, and 7 per cent. respectively.

Initial tension per element in volts	Boese 2·000 Tudor 1·985	3 per cent.	5 per cent.	7 per cent
Final ditto	Boese	1·940 ..	1·900 ..	1·860
	Tudor	1·925 ..	1·886 ..	1·846
Actual capacity in ampère-hours.				
Boese		72·5 ..	107·5 ..	132·5
Tudor		146·3 ..	above 150·0 ..	above 157·0

Initial tension per element in volts	Boese 2·040 Tudor 2·000	3 per cent.	5 per cent.	7 per cent.
Final ditto	Boese	1·9788 ..	1·938 ..	1·8972
	Tudor	1·9400 ..	1·900 ..	1·8600
Actual capacity in ampère-hours.				
Boese		52·5	.. 100·0	127·5
Tudor		131·3	.. 167·5	181·3

Mean value of the foregoing measurements:—

	At 3 per cent. Ampère-hours.	At 5 per cent. Ampère-hours.	At 7 per cent. Ampère-hours.
Boese	62·50	103·75	130·00
Tudor	138·80 ..	about 167·50	181·30

The Tudor accumulator thus possesses an appreciably higher absolute capacity than the Boese battery. The weights of the accumulators used were:—

Tudor	12 elements in	6 troughs of	2·44 kilos.	per trough	=264 kilos.*	
Tudor	12 ,,	,, 6 ,,	,, 2·36½	,, ,, ,,	= 219 ,,	†
Boese	12 ,,	,, 6 ,,	,, 2·28	,, ,, ,,	= 168 ,,	
Austria	12 ,,	,, 2 ,,	,, 6·64	,, ,, ,,	= 128 ,,	
Bristol	48 ,,	,, 8 ,,	,, 6·27¾	,, ,, ,,	= 222 ,,	

Under equal conditions of reduction of tension the weight per ampère-hour of capacity is thus:—

	At 3 per cent. Kilos.	At 5 per cent. Kilos.	At 7 per cent. Kilos.
Boese	2·688	.. 1·619	1·290
Tudor	1·578	about 1·307	1·208

Therefore within the permissible limit of reduction, viz: 5 per cent., the Tudor accumulator is, notwithstanding its greater absolute weight, lighter in proportion to its effective capacity than the Boese battery, and it is only when the reduction of voltage amounts to 7 per cent. that the relative weights coincide.

LAUNCH OF A TORPEDO GUN VESSEL FOR CHILI.

THE Birkenhead Ironworks are at present very actively employed in the construction of war vessels of various types for our own naval service and for several friendly Powers, for whose navies as well as our own the acquisition of the most modern type of fighting ship of the very highest speed is of paramount importance, as is evidenced by the fact that the great majority of vessels now building at those works are designed for a speed of 30 knots, while there is nothing at present on the stocks of a less speed than 21 knots. A fortnight ago Messrs. Laird floated out of one of their building docks, H.M.S. Mars, of 14,900 tons and 12,000 indicated horse-power, which is now under the 90-ton crane in the west float, receiving the remainder of her machinery.

Last week they launched a very fast and formidable torpedo gunboat for the Chilian Government, very similar in design and dimensions to the Almirante Lynch and Almirante Condell, built by the same firm for the Chilian Government in 1890. The new vessel was named the Almirante Simpson, and was christened by Madame Goni, wife of Captain Luis A. Goni, of the Chilian Navy, late head of the Chilian Naval Commission in Europe. Her length over all is 240ft. with a beam of 27ft. 6in., and a depth of 16ft., and she measures 858 tons, o.m. She is, of course, constructed of steel. She has a forecastle and a half poop which provide good accommodation for officers and crew, there is a fore-and-aft bridge at the height of forecastle deck connecting with the poop, and to this level the casings of hatchways and engine-room skylights are carried, the openings on main deck level being water-tight. The hull is sub-divided into numerous water-tight compartments by transverse bulkheads, and longitudinal bulkheads divide the two sets of engines, and extend along the outer sides of the machinery spaces, so that great power of flotation is insured in case of injury. The side and deck plating abreast the machinery spaces are of increased thickness to afford protection, and the coal bunkers are also arranged with this object, and of large capacity. The armament, of the most recent type, will consist of one bow and two broadside torpedo tubes, two 4·7in. guns, four 3-pounder quick-firing guns, and two machine guns and mining plant. The machinery will consist of two sets of Messrs. Laird's high-speed triple-expansion engines, developing about 5000 indicated horse-power collectively, driving twin screws, and designed to give the vessel a speed of 21 knots. The boilers are four in number, of the Normand tubulous type, with a working pressure of 200 lb. per square inch. Range of action at 10 or 11 knots speed, about 4000 knots.

Among those present were Admiral Uribe, chief of the Chilian Naval Commission; Sir E. J. Reed, K.C.B., consulting naval architect; Captain Luis A. Goni, of the Chilian Naval Commission; Captain Romulo Medina, C.N.; Mr. J. Forbes, inspecting engineer; Mr. Bernal, engineer; Mr. C. B. Nichols, Mr. T. H. Wells; Mr. Cockbain, Chilian Consulate, Liverpool; Mr. Moller, Chilian Consul, Manchester, and Mrs. Moller; Mr. Meyer, German Vice-consul; Mons. Sève, Belgian Consul-General, &c.

TRADE AND BUSINESS ANNOUNCEMENT.—The Harrison Engine Company, Limited, has taken over the business of the Harrison Patent Steering Engine Company, Limited, and appointed Mr. R. W. White managing director—for many years with Messrs. Hulse and Co., Manchester.

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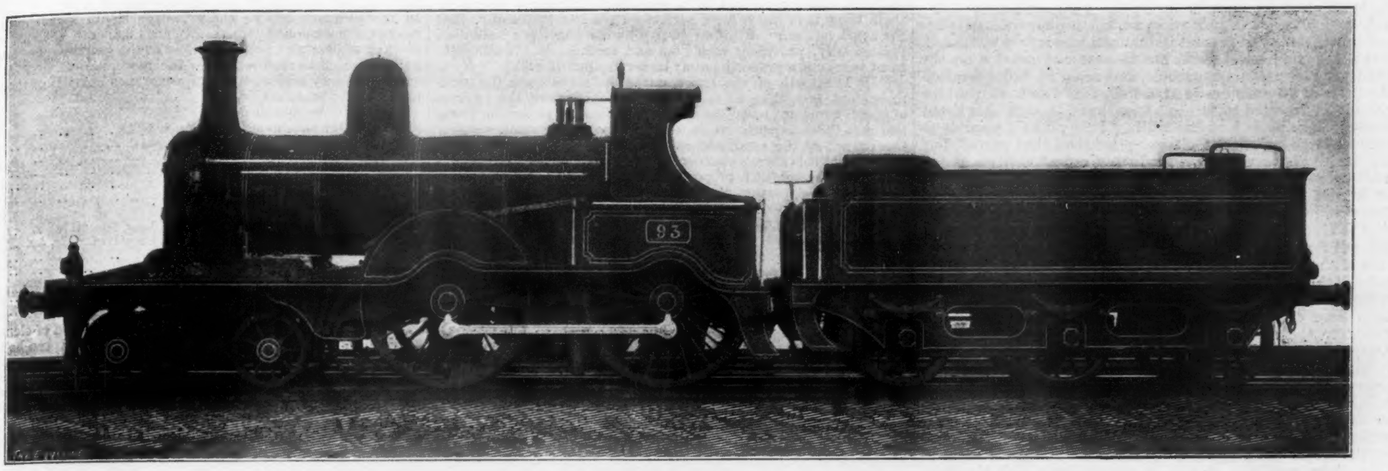
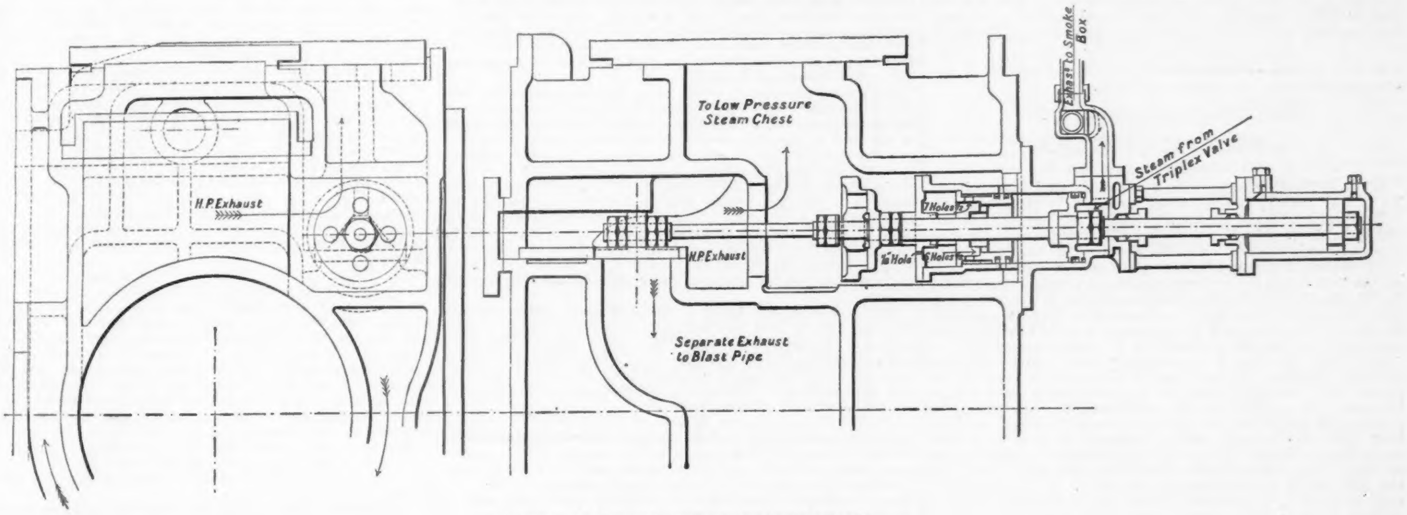
* G. Klose, "Zeitschrift des Oesterreichischen Ingenieur-ünd Architekten Vereines," xlviii. No. 7.

* First pattern. † Second pattern.

COMPOUND EXPRESS ENGINE, GREAT SOUTHERN AND WESTERN RAILWAY.

ABOUT five years ago the Great Southern and Western Railway Company converted one of its standard goods engines into a compound on the Worsdell and Von Borries plan. A pair of cylinders 18in. and 26in. diameter by 24in. stroke was substituted for the two 18in. cylinders. The compound cylinders were adapted to the existing standard crank centres, and with the 5ft. 3in. gauge, this left space for the low-pressure valve to be placed between the cylinders, in which position it is driven direct, the high-pressure valve is placed on the top of its cylinder and is driven with a rocking shaft. This arrangement enabled the standard motion to be retained, so that practically the engine could be altered to simple again at any time by changing the cylinders.


COMPOUND EXPRESS ENGINE, GREAT SOUTHERN AND WESTERN RAILWAY, IRELAND



IVATT'S COMPOUND ENGINE CHANGE VALVE

The pressure was purposely kept the same as in the standard goods engines, viz., 150 lb., in order to see whether the engine showed any economy due to the compounding alone. The result has been that the engine, which has now been at work for five years, shows a saving in coal consumed of about 10 per cent. as compared with other engines doing the same work. The cost for repairs, and lubrication, &c., has not been greater than in the case of other engines of the company's standard goods type.

Mr. Ivatt considered the results obtained with the goods-engine after an extended trial, sufficiently encouraging to warrant him in recommending his directors to sanction the construction of a compound express engine, of which we give on page 424 an elevation, and in a future impression we shall publish sectional drawings.

The chief dimensions are as follows:—Cylinders 18in. and 26in. by 24in. stroke. Wheels, 6ft. 7½in., four coupled. Heating surface: fire-box, 112 square feet; tubes, 824 square feet; total, 936 square feet; grate area, 18¾ square feet; steam pressure, 150 lb. Weight of engine in working order, 40 tons, distributed as follows: on bogie, 15 tons; driving, 13 tons; trailing, 12 tons. These weights are light compared with those common on many English lines, but the engine is designed for running on a 74 lb. rail. The engine is built under the Worsdell, von Borries and Lapage's patents, with an arrangement of change valve designed by Mr. Ivatt. This valve, of which we give a section, allows the engine to be worked "simple" or "compound" at will. It is actuated by a small lever and rod from the foot-plate, which, by suitable valves admits steam to a cylinder on the spindle of the change valve, and so moves it to either position, the movement being controlled by a dashpot. When in the "simple" position the valve opens a communication from the high-pressure exhaust to the blast pipe, round the underside of the high-pressure cylinder; at the same time it closes the communication from the high-pressure exhaust to the low-pressure steam chest, and opens a connection for live steam from the steam pipe to the low-pressure steam chest. This supply of live steam is wiredrawn so as not to exceed about 75 lb. pressure on the low-pressure side, and the low-pressure cylinder and steam chest are, as usual, provided with relief valves, set to blow at 75 lb. in case the pressure should exceed that amount.

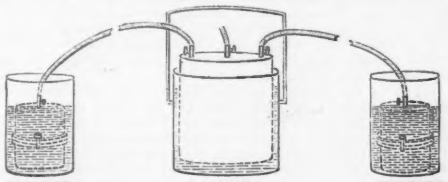
In ordinary working the engine is always run compound, and starts without any trouble, but for starting on an incline, or for getting away quickly with a heavy train, the arrangement for working simple is of great advantage, and enables the engine to exert as much power as a simple engine with two 18in. cylinders and the same steam pressure. The arrangement is also exceedingly handy for shunting; there is no steam locked up in the receiver, and the engine does not, in steam-shed phraseology, "beat two or three times after steam is shut off."

The working of the change valve is entirely in the hands of the driver. Mr. Ivatt does not believe in the theory that it is not advisable to give the driver the power of working simple if required. To argue that the driver of a compound engine so fitted is likely to work the engine simple any longer than is absolutely necessary, is about the same as saying that the driver of an ordinary engine cannot be trusted to pull the reversing gear up as soon as possible.

The engine has only been at work about eight months, consequently no accurate information as to comparative consumption of coal, &c., is yet available. She is doing the same work as other express engines with similar boiler and pressure, but with cylinders 18in. by 24in., four coupled, with same size of wheel.

COMMERCIAL VALUE OF ACETYLENE.

THE first practical demonstration, says a French correspondent, of the illuminating qualities of acetylene gas produced by the contact of calcium carbide with water was made at the meeting of the French Société du Gaz in June of last year. It was then generally admitted that the new gas was destined to revolutionise the existing systems of lighting, but few people could have anticipated that it would have made so much progress as a commercial product in the short time that has elapsed since then. The experiments carried out at the meeting were necessarily imperfect, and the amount of smoke given off by the flame had, of course, to be suppressed before the gas could be used for lighting purposes. This has been done simply by the employment of a special burner in which the orifice is smaller than in the ordinary gas burner. This economy is indeed one of the features of acetylene, for with one kilo. of calcium carbide and 500 grammes of water the amount of gas produced is 300 litres, and this, it is stated, will provide a light equal to fifteen ordinary gas jets for six hours, while, if a smaller burner is used, the duration is, of course, much greater. To give a comparison between the cost of ordinary gas and acetylene in France, where the latter is now being produced upon something like a commercial scale, it may be said that the price of coal gas per carcel hour is one centime, while acetylene gas costs 3·2 centimes, but as acetylene is so much more powerful, the two gases work out in practice to about the same figure. While admitting these enormous advantages, the question was raised in the early stages of development whether acetylene was not more poisonous than ordinary gas, but experiments have shown, it is said, that there must be at least 40 per cent. in the atmosphere before it can be dangerous, and its presence can be distinguished long before it attains to this proportion. In burning it has no perceptible odour whatever.



Another advantage claimed for acetylene, so far as lighting is concerned, is that it gives off very little heat, and this naturally tells against its employment for the many domestic purposes to which ordinary gas is applied upon such a large scale in France. Nor can it be compared with coal gas for the driving of motors, though it is believed that when acetylene comes to be generally adopted it will be used for cooking, heating, and power purposes simply by consuming the new gas in larger quantities than ordinary gas to give the same caloric result. But, for the moment, the only scope that is opened to acetylene is for lighting. The chances of explosion are held to be not greater than with ordinary gas, and it may even be deemed safer on account of the fact that it is produced upon a much smaller scale. This facility of manufacture is one of the arguments urged for acetylene. By the aid of small appliances the gas may be produced in any household, and may be manufactured as required on steamboats and trains. A great many such appliances have already been constructed, in which the chief objects aimed at are that they should occupy very little space, that they may be placed in the care of any servant or labourer without fear of accident, and that they should be very cheap. Until lately the appliances, such as those manufactured by MM. Escher Wyss and Co., of Zurich, have run into very high figures, but now acetylene producers, claimed to be of equal quality, are sold for about a sixth of the amount, while the cheapest on the market, having a capacity of 1 kilo. of calcium carbide, and providing a light equal to ten ordinary burners for six hours, is priced at £6. These appliances are now being supplied by a company which has just been formed in Paris under the title of Le Gaz Acétylene.

The company is placing on the market an apparatus known as an "At Home," and composed of a gas-holder and one or two producers, according to whether the supply is to be continuous or not. The producer contains a closed cylinder, into which an iron wire receptacle holding the calcium carbide is introduced. The two parts of the cylinder are brought together by catches which make it water-tight. The cylinder is then just covered with water which finds its way inside by means of a small pipe. The gas-holder is constructed upon the ordinary principle, and the pressure is so adjusted that when the bell rises the water cannot enter into the calcium carbide receptacle. Upon its descending, however, the water enters the producer in just the quantity necessary to again fill the gas-holder, and so on until the whole of the carbide is decomposed. When a constant supply is needed the installation comprises two producers, so that on one becoming exhausted the tap connecting it with the gasometer is closed, and the other producer is put into communication. The Company Le Gaz Acétylène possesses several other patents, notably the Boesmann apparatus, and another. The former will supply gas for from 200 to 1500 burners. A very simple form of home acetylene gas make was recently illustrated in the *Scientific American*. The company has also been experimenting with liquid acetylene under pressure, varying from 25 to 50 atmospheres, but in consequence of this great pressure it has not been thought advisable to use the liquid, the more so as the gas is produced in the apparatus described under a pressure of not more than 20 centimetres of water. Now that the necessary appliances for producing acetylene are on the market, or will be in a short time when Le Gaz Acétylène will be manufacturing ten producers a week, the only difficulty lies in procuring sufficient quantities of pure calcium carbide. At present its manufacture is very restricted, but a large number of works are in course of erection on the Continent for producing carbide, and when in full operation the price of 70 centimes to 1f. a kilo. that has to be paid for carbide is expected to fall to 50 centimes, though this is not likely to take place for some while. It is yet still possible to procure large supplies at a lower price than that quoted, but the quality is very inferior, producing only 150 litres of gas a kilo. instead of 300 litres. A good deal has been said of late as to the large quantities capable of being produced in America, but so far not a single kilo., it is said, has found its way to Europe. On this side, it would probably be extremely difficult for the moment to secure supplies of ten tons a day. One of the problems which Le Gaz Acétylène has set itself to solve is the finding of a portable lamp, but there are a great many difficulties in the way of this being done. Such lamps have been constructed, but they are entirely impracticable owing to their liability to explode. As to the future of acetylene, there can be little doubt but that in course of time it may be employed for lighting purposes upon a very considerable scale. For the moment, it cannot come into competition with ordinary gas for town lighting in Paris, owing to the fact that not only is the latter more suitable for cooking and heating, but the monopoly of lighting is enjoyed by the Paris Compagnie du Gaz, and no change is likely to take place until the monopoly expires, by which time the price of calcium carbide may be so cheap that the new concessionaires may see it to their advantage to employ the new gas, the more so as no great change in the present system of piping is necessary. In laying down new installations for acetylene smaller pipes need only be used, with a consequent economy in cost, while the manufacturing plant is, of course, infinitely more simple and less costly. The aim of Le Gaz Acétylène is, therefore, to supply the new gas in places where there is no ordinary gas or electricity, and the directors think that it is especially adapted to luminous advertising, and to other purposes where the ordinary gas does not give a sufficiently brilliant light. It is significant of the interest that is being taken in acetylene that though the company has only been recently formed it is yet receiving innumerable demands for information from all parts of the world, and, according to our correspondent, there is a prospect of the new gas taking up a prominent position.

A PIECE-RATE SYSTEM.*

(*Continued from page* 392.)

(28) A still further improvement of this method was made by Mr. F. A. Halsey, and described by him in a paper entitled, "The Premium Plan of Paying for Labour," and presented to this society in 1891. Mr. Halsey's plan allows free scope for each man's personal ambition, which Mr. Towne's does not.

(29) Messrs. Towne and Halsey's plans consist briefly in recording the cost of each job as a starting-point at a certain time; then, if, through the effort of the workmen in the future, the job is done in a shorter time and at a lower cost, the gain is divided among the workmen and the employer in a definite ratio, the workmen receiving, say, one-half, and the employer one-half.

(30) Under this plan, if the employer lives up to his promise, and the workman has confidence in his integrity, there is the proper basis for co-operation to secure sooner or later a large increase in the output of the establishment. Yet there still remains the temptation for the workman to "soldier" or hold back while on day-work, which is the most difficult thing to overcome. And in this, as well as in all the systems heretofore referred to, there is the common defect, that the starting point from which the first rate is fixed is unequal and unjust. Some of the rates may have resulted from records obtained when a good man was working close to his maximum speed, while others are based on the performance of a medium man at one-third or one-quarter speed. From this follows a great inequality and injustice in the reward even of the same man when at work on different jobs. The result is far from a realisation of the ideal condition in which the same return is uniformly received for a given expenditure of brains and energy. Other defects in the gain-sharing plan, and which are corrected by the differential rate system, are:—(*a*) That it is slow and irregular in its operation in reducing costs, being dependent upon the whims of the men working under it; (*b*) that it fails to especially attract first-class men and discourage inferior men; (*c*) that it does not automatically ensure the maximum output of the establishment per man and machine.

(31) Co-operation, or profit-sharing, has entered the mind of every student of the subject, as one of the possible and most attractive solutions of the problem; and there have been certain instances, both in England and France, of at least a partial success of co-operative experiments. So far as I know, however, these trials have been made either in small towns, remote from the manufacturing centres, or in industries which in many respects are not subject to ordinary manufacturing conditions.

(32) Co-operative experiments have failed, and, I think, are generally destined to fail, for several reasons; the first and most important of which is, that no form of co-operation has yet been devised in which each individual is allowed free scope for his personal ambition. This always has been and will remain a more powerful incentive to exertion than a desire for the general welfare. The few misplaced drones, who do the loafing and share equally in the profits with the rest, under co-operation are sure to drag the better men down towards their level.

(33) The second and almost equally strong reason for failure lies in the remoteness of the reward. The average workman—I don't say all men—cannot look forward to a profit which is six months or a year away. The nice time which they are sure to have to-day, if they take things easily, proves more attractive than hard work, with a possible reward to be shared with others six months later.

(34) Other and formidable difficulties in the path of co-operation are the equitable division of the profits, and the fact that, while workmen are always ready to share the profits, they are neither able nor willing to share the losses. Further than this, in many cases it is neither right nor just that they should share either in the profits or the losses, since these may be due in great part to causes entirely beyond their influence or control, and to which they do not contribute.

(35) When we recognise the real antagonism that exists between the interests of the men and their employers, under all of the systems of piece-work in common use; and when we remember the apparently irreconcilable conflict implied in the fundamental and perfectly ligitimate aims of the two—namely, on the part of the men: *The universal desire to receive the largest possible wages for their time;* and on the part of the employers: *The desire to receive the largest possible return for the wages paid;* what wonder that most of us arrive at the conclusion that no system of piece-work can be devised which shall enable the two to co-operate without antagonism, and to their mutual benefit!

(36) Yet it is the opinion of the writer that even if a system has not already been found which harmonises the interests of the two, still the basis for harmonious co-operation lies in the two following facts:—First, that the workmen in nearly* every trade can and will materially increase their present output per day, provided they are assured of a permanent and larger return for their time than they have heretofore received; secondly, that the employers can well afford to pay higher wages per piece even permanently, providing each man and machine in the establishment turns out a proportionately larger amount of work.

(37) The truth of the latter statement arises from the well-recognised fact that, in most lines of manufacture, the indirect expenses equal or exceed the wages paid directly to the workmen, and that these expenses remain approximately constant, whether the output of the establishment is great or small. From this it follows that it is always cheaper to pay higher wages to the workmen when the output is proportionately increased; the diminution in the indirect portion of the cost per piece being greater than the increase in wages. Many manufacturers, in considering the cost of production, fail to realise the effect that the *volume of output has on the cost.* They lose sight of the fact that taxes, insurance, depreciation, rent, interest, salaries, office expenses, miscellaneous labour, sales expenses, and frequently the cost of power—which in the aggregate amount to as much as wages paid to workmen—remain about the same whether the output of the establishment is great or small.

(38) In our endeavour to solve the piece-work problem by the application of the two fundamental facts above referred to, let us consider the obstacles in the path of harmonious co-operation, and suggest a method for their removal.

(39) The most formidable obstacle is the lack of knowledge on the part of both the men and the management—but chiefly the latter—of the quickest time in which each piece of work can be done; or, briefly, the lack of accurate time-tables for the work of the place.

(40) The remedy for this trouble lies in the establishment in every factory of a proper rate-fixing department; a department which shall have equal dignity and command equal respect with the engineering and managing departments, and which shall be organised and conducted in an equally scientific and practical manner.

(41) The rate-fixing as at present conducted, even in our best managed establishments, is very similar to the mechanical engineering of fifty or sixty years ago. Mechanical engineering at that time consisted in imitating machines which were in more or less successful use, or in guessing at the dimensions and strength of the parts of a new machine; and as the parts broke down or gave out, in replacing them with stronger ones. Thus each new machine presented a problem almost independent of former designs, and one which could only be solved by months or years of practical experience and a series of break-downs. Modern engineering, however, has become a study, not of individual machines, but of the resistance of materials, the fundamental principles of mechanics, and of the elements of design.

(42) On the other hand, the ordinary rate-fixing—even the best of it—like the old-style engineering, is done by a foreman or superintendent, who, with the aid of a clerk, looks over the record of the time in which a whole job was done as nearly like the new one as can be found, and then guesses at the time required to do the new job. No attempt is made to analyse and time each of the classes of work, or elements of which a job is composed; although it is a far simpler task to resolve each job into its elements, to make a careful study of the quickest time in which each of the elementary operations can be done, and then to properly classify, tabulate, and index this information, and use it when required for rate-fixing, than it is to fix rates with even an approximation to justice, under the common system of guessing.

(43) In fact, it has never occurred to most superintendents that the work of their establishments consists of various combinations of elementary operations which can be timed in this way; and a suggestion that this is a practical way of dealing with the piece-work problem usually meets with derision, or, at the best, with the answer that "It might do for some simple business, but my work is entirely too complicated."

(44) Yet this elementary system of fixing rates has been in successful operation for the past ten years, on work complicated in its nature, and covering almost as wide a range of variety as any manufacturing that the writer knows of. In 1883, while foreman of the machine shop of the Midvale Steel Company, of Philadelphia, it occurred to the writer that it was simpler to time each of the elements of the various kinds of work done in the place, and then find the quickest time in which each job could be done, by summing up the total times of its component parts, than it was to search through the records of former jobs, and guess at the proper price. After practising this method of rate-fixing himself for about a year, as well as circumstances would permit, it became evident that the system was a success. The writer then established the rate-fixing department, which has given out piece-work prices in the place ever since.

(45) This department far more than paid for itself from the very start; but it was several years before the full benefits of the system were felt, owing to the fact that the best methods of making and recording time observations of work done by the men, as well as of determining the maximum capacity of each of the machines in the place, and of making working tables and time tables, were not at first adopted.

(46) Before the best results were finally attained in the case of work done by metal-cutting tools, such as lathes, planers, boring mills, &c., a long and expensive series of experiments was made, to determine, formulate, and finally practically apply to each machine the law governing the proper cutting speed of tools; namely, the effect on the cutting speed of altering any one of the following variables; the shape of the tool—*i.e.*, lip angle, clearance angle, and the line of the cutting edge—the duration of the cut, the quality or hardness of the metal being cut, the depth of the cut, and the thickness of the feed or shaving.

(47) It is the writer's opinion that a more complicated and difficult piece of rate-fixing could not be found than that of determining the proper price for doing all kinds of machine work on miscellaneous steel and iron castings and forgings, which vary in their chemical composition from the softest iron to the hardest tool steel. Yet this problem was solved through the rate-fixing department and the "differential rate," with the final result of completely harmonising the men and the management, in place of the constant war that existed under the old system. At the same time the quality of the work was improved, and the output of the machinery and the men was doubled, and in many cases trebled. At the start there was naturally great opposition to the rate-fixing department, particularly to the man who was taking time observations of the various elements of the work; but when the men found that rates were fixed without regard to the records of the quickest time in which they had actually done each job, and that the knowledge of the department was more accurate than their own, the motive for hanging back or "soldiering" on this work ceased, and with it the greatest cause for antagonism and war between the men and the management.

(48) As an illustration of the great variety of work to which elementary rate-fixing has already been successfully applied, the writer would state that, while acting as general manager of two large sulphate pulp mills, he directed the application of piece-work to all of the complicated operations of manufacturing throughout one of these mills, by means of elementary rate-fixing, with the result, within eighteen months, of more than doubling the output of the mill. The difference between elementary rate-fixing and the ordinary plan can perhaps be best explained by a simple illustration. Suppose the work to be planing a surface on a piece of cast iron. In the ordinary system the rate-fixer would look through his records of work done by the planing machine, until he found a piece of work as nearly as possible similar to the proposed job, and then guess at the time required to do the new piece of work. Under the elementary system, however, some such analysis as the following would be made:—

Work done by man.	Minutes.
Time to lift piece from floor to planer table	—
Time to level and set work true on table	—
Time to put on stops and bolts	—
Time to remove stops and bolts	—
Time to remove piece to floor	—
Time to clean machine	—
Work done by machine.	**Minutes.**
Time to rough off cut ¼in. thick, 4ft. long, 2½in. wide	—
Time to rough off cut ⅛in. thick, 3ft. long, 12in. wide, &c. ..	—
Time to finish cut 4ft. long, 2½in. wide	—
Time to finish cut 3ft. long, 12in. wide, &c.	—
Total	—
Add ——per cent. for unavoidable delays	—

It is evident that this job consists of a combination of elementary operations, the time required to do each of which can be readily determined by observation. This exact combination of operations may never occur again, but elementary operations similar to these will be performed in differing combinations almost every day in the same shop. A man whose business it is to fix rates soon becomes so familiar with the time required to do each kind of elementary work performed by the men, that he can write down the time from memory. In the case of that part of the work which is done by the machine, the rate-fixer refers to tables which are made out for each machine, and from which he takes the time required for any combination of breadth, depth, and length of cut.

(49) While, however, the accurate knowledge of the quickest time in which work can be done, obtained by the rate-fixing department and accepted by the men as standard, is the greatest and most important step towards obtaining the maximum output of the establishment, it is one thing to know how much work can be done in a day, and an entirely different matter to get even the best men to work at their fastest speed or anywhere near it.

(50) The means which the writer has found to be by far the most effective in obtaining the maximum output of a shop, and which, so far as he can see, satisfies the legitimate requirements, both of the men and the management, is the *differential rate system of piece-work*. This consists briefly in paying a higher price per piece, or per unit, or per job, if the work is done in the shortest possible time, and without imperfections, than is paid if the work takes a longer time or is imperfectly done.

(51) To illustrate:—Suppose twenty units or pieces to be the largest amount of work of a certain kind that can be done in a day. Under the differential rate system, if a workman finishes twenty pieces per day, and all of these pieces are perfect, he receives, say, 15 cents per piece, making his pay for the day 15 × 20 = 3 dols. If, however, he works too slowly and turns out, say, only nineteen pieces, then, instead of receiving 15 cents per piece he gets only 12 cents per piece, making his pay for the day 12 × 19 = 2·28 dols., instead of 3 dols. per day. If he succeeds in finishing twenty pieces, some of which are imperfect, then he should receive a still lower rate of pay, say, 10 cents or 5 cents per piece, according to circumstances, making his pay for the day 2 dols., or only 1 dol., instead of 3 dols.

(52) It will be observed that this style of piece-work is directly the opposite of the ordinary plan. To make the difference between the two methods more clear: supposing, under the ordinary system of piece-work, that the workman has been turning out 16 pieces per day, and has received 15 cents per piece, then his day's wages would be 15 × 16 = 2·40 dols. Through extra exertion he succeeds in increasing his output to twenty pieces per day, and thereby increases his pay to 15 × 20 = 3 dols. The employer, under the old system, however, concludes that 3 dols. is too much for the man to earn per day, since other men are only getting from 2·25 dols. to 2·50 dols., and therefore cuts the price from 15 cents per piece to 12 cents, and the man finds himself working at a more rapid pace, and yet earning only the same old wages, 12 × 20 = 2·40 dols. per day. What wonder that men do not care to repeat this performance many times!

(53) Whether co-operation, the differential plan, or some other form of piece-work be chosen in connection with elementary rate-fixing, as the best method of working, there are certain fundamental facts and principles which must be recognised and incorporated in any system of management, before true and lasting success can be attained, and most of these facts and principles will be found to be not far removed from what the strictest moralists would call justice.

(54) The most important of these facts is, that *men will not do an extraordinary day's work for an ordinary day's pay*, and any attempt on the part of the employers to get the best work out of their men and give them the standard wages paid by their neighbours will surely be, and ought to be, doomed to failure.

(55) Justice, however, not only demands for the workman an increased reward for a large day's work, but should compel him to suffer an appropriate loss in case his work falls off either in quantity or quality. It is quite as important that the deductions for bad work should be just, and graded in proportion to the shortcomings of the workman, as that the reward should be proportional to the work done. The fear of being discharged, which is practically the only penalty applied in many establishments, is entirely inadequate to producing the best quantity and quality of work; since the workmen find that they can take many liberties before the management makes up its mind to apply this extreme penalty.

(56) It is clear that the differential rate satisfies automatically, as it were, the above conditions of properly graded rewards and deductions. Whenever a workman works for a day—or even a shorter period—at his maximum, he receives under this system unusually high wages; but when he falls off, either in quantity or quality, from the highest rate of efficiency, his pay falls below even the ordinary.

(57) The lower differential rate should be fixed at a figure which will allow the workman to earn scarcely an ordinary day's pay when he falls off from his maximum pace, so as to give him every inducement to work hard and well.

(*To be continued.*)

Leeds Association of Engineers.—The annual meeting for the election of officers was held April 16th. The following were elected to serve for the ensuing twelve months:—President, Mr. James Bowers; vice-president, Mr. William Sheldon; committee, Messrs. T. Craister, Robert Lupton, and Alfred Towler; librarian, Mr. W. J. Dickinson; auditor, Mr. A. J. Balkwill; treasurer, Mr. W. H. Drake; hon. secretary, Mr. George W. Blackburn. A vote of thanks to the retiring officers was passed, on the motion of Mr. J. C. Jefferson, seconded by Mr. Alfred Atkinson, and acknowledged on their behalf by Mr. Samuel Thornton, the retiring president.

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* Presented at the Detroit meeting of the American Society of Mechanical Engineers.

* The writer's knowledge of the speed attained in the manufacture of textile goods is very limited. It is his opinion, however, that owing to the comparative uniformity of this class of work, and the enormous number of machines and men engaged on similar operations, the maximum output per man and machine is more nearly realised in this class of manufactures than in any other. If this is the case, the opportunity for improvement does not exist to the same extent here as in other trades. Some illustrations of the possible increase in the daily output of men and machines are given in paragraphs 78 to 82.

RAILWAY MATTERS.

It is stated that a new express service from London to Paris, and *vice versâ*, *viâ* Folkestone and Boulogne, has been finally decided upon. It will be inaugurated on July 1st. Leaving London at half-past three and Paris four at p.m. respectively, the passengers will arrive at their destinations about half-past eleven at night.

It is stated that the North Metropolitan and the London Street Tramways have jointly agreed to sell their undertakings to the London County Council at once, and to pay a sum of £600,000 for the fourteen years' lease to be granted to them. This will be equivalent to 9 per cent. on the capital outlay. The committee of the Council have completed negotiations for leasing other tramways, which will return 5 per cent. on the capital outlay.

In Victoria a gauge of 5ft. 3in. has been adopted, while in New South Wales that known as the standard gauge, 4ft. 8½in., has been taken. The private line, Deniliquin to Moama —New South Wales—is laid to the Victorian gauge. South Australia has both the 5ft. 3in. and the 3ft. 6in. In Queensland the narrow gauge of 3ft. 6in. has been adopted throughout, and in Western Australia both the Government and private lines are laid on the narrow gauge of 3ft. 6in.

The many accidents to railway servants have caused frequent expressions of regret in the reports of the Board of Trade. Particulars are given in the recent returns as to the different classes concerned in the accidents during the past year. Of the 442 who were killed, 117 were men employed on the permanent way, 49 were porters, 37 were labourers, 35 were brakesmen and goods guards, 30 were firemen, 26 were shunters, and 22 were engine drivers. In a section of the report which enumerates the accidents to servants in the employ of railway companies or contractors, such accidents being caused by the travelling of trains or the movement of vehicles used exclusively upon railways, it is shown that 75 were killed and 648 injured during shunting operations. Sixteen were killed and 331 injured while coupling or uncoupling vehicles, and 93 were killed while walking or standing on the line on duty.

The record of train accidents in the United States in February includes 34 collisions, 91 derailments, and four other accidents, a total of 129 accidents, in which 37 persons were killed and 107 injured. These accidents are classified by the *Railroad Gazette* as follows:—Collisions: Trains breaking in two, 2; misplaced switch, 3; failure to give or observe signal, 6; mistake in giving or understanding orders, 3; miscellaneous, 5; unexplained, 15; total, 34. Derailments: Broken rail, 3; defective bridge, 2; defective switch, 1; broken wheel, 7; broken axle, 8; broken truck, 3; fallen brakebeam, 2; boiler explosion, 1; misplaced switch, 1; careless switching, 1; unfastened switch, 1; animals on track, 1; landslide, 5; washout, 2; flood, 1; malicious obstruction, 2; accidental obstruction, 4; ice, 1; wind, 1; unexplained, 42; total, 91. Other accidents: Boiler explosion, 1; broken side rod, 1; various breakages of rolling stock, 2; total, 4. Total number of accidents, 129.

On Monday, at the House of Commons, a deputation, representing the ratepayers of Sligo and Enniskillen, waited upon Mr. Hanbury, Secretary of the Treasury, for the purpose of opposing the proposed purchase of the Sligo, Leitrim, and Northern Counties Railway of Ireland by the Great Northern and Midland Railway Companies of Ireland. Sir Henry Gore Booth laid before Mr. Hanbury a short history of the formation of the line, and explained how it came to be in financial difficulties, as a result of which the Treasury, who had found some portion of the capital, applied about two years ago for tenders for the purchase of the line. The Great Northern and Midland Companies replied offering to purchase it for about £130,000, which was about one-third of the original cost of the undertaking. Sir Henry strongly urged the Treasury not to accept the offer, chiefly on the ground that the sale would result in a monopoly, with the evil consequences of increased rates, and of preventing the development of the district. Mr. Hanbury, in the course of a brief reply, said he was strongly in favour of not selling the line. He should be glad to receive details of the scheme of reconstruction, to which he would give his best attention.

The importance of railways in the development of Australia cannot be over estimated, as owing to the absence of natural waterways, almost all the traffic from the interior has to be carried by rail. The four principal cities of the Colonies are in direct railway communication; and viewed from the "population per mile of line" point, Australia can boast even now of being better served by its railways than any country in the world. New South Wales has at present 146½ miles of railway under construction; Victoria, 15½ miles authorised; Western Australia is pushing on with 382 miles of additional lines, 57 of which were to be opened in December last. The railways of Australia practically represent the assets for the national debts of each Colony. It is agreed that to a certain extent the railway administration should be separated from politics; the construction and direction of new lines may well be left to Parliament to determine, but the management of the lines and control of the railways daily working are matters for skilled and capable railway managers, untrammelled by the exigencies that political consideration would often cause to influence the political mind. These views have been given effect to in Victoria, South Australia, New South Wales, and Queensland, which provided to a certain extent for the management of the railways on commercial as separate from political lines. Each system was placed under the control of three commissioners, who had large powers to administer free from political interference, and the generally expressed opinion is that the system worked well. Victoria, however, amended her Railway Act of 1883 by limiting the powers of the Commissioners, and giving the Minister for Railways of the day greater power to interfere in the management. But this change has not brought about the desired result, and the Act is being again amended.

Four persons killed, a dozen seriously injured, and fifty others hurt more or less severely, is, says the *Railroad Gazette*, the result of the collision of electric cars at St. Louis, on March 8th. Recklessness, either of officers in failing to prescribe rules, or of motormen, generally ignorant, in carrying them out, is apparent on electric railroads all over the country, and collisions or runaways illustrating it occur every few days; but fortune favours the fatuous, fatalities are few, and the lessons bearing on future practice seem not to be heeded. Here, however, is a flagrant case, in many respects typical. The road—the St. Louis and Kirkwood —runs, a part of the way at least, on its own right of way, separate from the street, so that cars can be run as fast as may be desired. Grades are steep and cars pretty heavy, so that high speed down grade is easily made. The *Republic* reporter timed several cars and found them making forty miles an hour. The manager has had no experience on standard railroads, entrusts cars to men hired without adequate inquiry, and has no printed regulations. A written memorandum of some kind is given to motormen. Ruling trains are required to wait three minutes at meeting points, and those going in the opposite direction indefinitely; but it appears that this last provision is modified most of the time so as to permit an inferior train to proceed cautiously after ten minutes. Trains appear to be run in this way without any supervision, and inferior trains are in the habit of "stealing switches" whenever it seems desirable. An attempt to do this—to reach the next meeting point before the ruling train gets there, while the whereabouts of the latter is wholly unknown—was what caused this collision. To cap the climax, says the *Gazette*, the passengers on these forty miles an hour trains are allowed to crowd the front platforms of the cars.

NOTES AND MEMORANDA.

The weekly return of the Registrar-General shows that the deaths registered last week in 33 great towns of England and Wales corresponded to an annual rate of 19·0 per 1000 of their aggregate population.

In London 2836 births and 1654 deaths were registered, or 87 above and the deaths 27 below the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes, which had been 17·9, 17·9, and 20·3 in the preceding three weeks, fell again last week to 19·4

Chloride of lime, Traube has pointed out, provides the means of obtaining a germ-free drinking water, and has proved its utility by practical experiments. His tests were not conducted with pathogenic germs, though he concluded from his experiments that, used in the proportions he advocates, it would be fatal to all kinds of bacilli.

Sternberg and Delettre have, according to the *Moniteur de la Ceramique et de la Verrerie*, invented a new process for the production of refractory material. They claim that by adding 10 to 15 per cent. of asbestos, either fibrous or pulverised, the material is made more fire-proof and durable. The addition of asbestos is made while the clay, or whatever earth is used, is being mixed. Bricks produced from this material are said to prove excellent in the construction of converters, retorts, melting pots, &c.

In the French journal, *L'Industrie Velocipédique*, experiments by M. Wallington with ignition tubes for gas engines are referred to, and the mixture of materials for porcelain tubes which he has found to be best is given. It is as follows: Kaolin 62 parts, 4 chalk, 17 sand, and 17 feldspar. Each of these constituents is ground in water separately, and these waters, whilst all the fine particles are carried in suspension, are mixed together and decanted into a settling tank. After subsidence, the fine material obtained is moulded into tubes, which are at first air dried. They are then baked in clay cylinders for about fifteen hours with a wood fire. The cost is high, but the durability is high also.

Referring to statements advanced at the 1895 meeting of the Bavarian Society of Applied Chemistry—*Chem. Zeti.* 19, 1452—Mr. R. Kissling points out that the amount of paraffin in burning oils is very slight, and can, in any case, only affect the consumption of the oil—not its illuminating power. In connection with the assertion that Ohio oil containing a large proportion of sulphur is now in the market, necessitating the examination of such oil for the detection of sulphur, he remarks that those who ought to know deny that refined Ohio oil is dealt in in Germany, but that even if it be, the desulphurising processes this oil undergoes in refining render it undistinguishable from the Pennsylvania oil, containing but little sulphur.

The velocity of an earthquake-wave within a short distance from the epicentre is so difficult to ascertain on account of the large error resulting from a small error in the recorded times, that all estimates with an approach to accuracy are of value. In the Brescian earthquake of November 27th, 1894, good time-determinations were obtained at ten stations, all within 445 kiloms. from the epicentre. Assuming the velocity to be uniform in all directions, Dr. M. Baratta calculates it to be 1·411 kiloms. per second. Taking account of the nature and extent of the rock traversed by the earth wave, he also finds the average velocity to be ·782 kiloms. per second in alluvium, and 1·569 kiloms. per second in the older and more coherent rocks. The large scale experiments made at Holyhead by Mallet gave these results for sand, slightly discontinuous and discontinuous rocks. They were published in the "Transactions" Royal Society in 1873.

At a recent meeting of the Philadelphia Academy of Natural Sciences, General Isaac J. Wistar made a communication on the apparent capricious distribution of iron oxide as colouring matter in the rocks of the anthracite coal region. At several points, apparently, the accessible supply of iron was exhausted by complete distribution in the strata under process of deposit with intermediate and subsequent periods during which new supplies appear from some source not yet clearly explained. Professor A. P. Brown stated that it had been suggested by Russell that the red colour of certain formations may have originated from the subaërial decay of iron bearing rocks, and the subsequent deposit of this material as sediment forming the red rock. As far as the ash of coal is concerned, it is probable that the colour is due to the way in which pyrites is contained either in the coal itself or in the slate adjoining. Coal containing separable pyrites would give white ash, while if the pyrites is intimately mixed in the coal the ash will be red.

A novel series of exepriments is in progress at Wesleyan University, Middletown, Connecticut, to determine the nutritive and caloric value of food, and many other questions relative to nutrition and other vital processes. Quoting some source not named *Nature* says:—"For this purpose a calorimeter is employed, consisting of a copper-lined box, measuring inside 7ft. by 4ft. by 6½ft., thus giving 182 cubic feet of air, within which space a man is confined for several days at a time. It is fitted with glass windows of three thicknesses. Fifty litres of air per minute are pumped in. Food is passed in three times a day through an air-tight tube, and is carefully weighed, as are all the exudations and excretions, and the quantity of heat is measured. A telephone enables the subject to converse with the outer world. The experiments are conducted by Pro. Wm. O. Atwater, and the expense is shared by the Department of Agriculture of the United States Wesleyan University, and the Stores Experiment Station at New Bethel. A careful record is kept of every action of the subject—of his hours of sleep, minutes of exercise, respiration, appetite, &c. To this end there are two watchers and two assistants, a watcher, who is a professor in the university, and an assistant being constantly present."

The Department of State in Washington has published reports from Magdeburg, Dusseldorf, Frankfurt, and Stettin dealing with the slag cement trade. This cement, it seems, is made by mixing pulverised hydrate of lime with basic blast furnace slag, which has been granulated, dried, and reduced to powder by grinding. It is used for certain purposes as a substitute for Portland cement, for it is about 20 per cent. cheaper, and being of lower specific gravity, "spreads farther," so that on the whole the economy in using it is 30 to 40 per cent. It is also alleged that the mortar is more tenacious and elastic, and thus is more suitable for the foundations of bridges and other structures liable to unequal strain or to the shock of passing trains or vehicles. It was originally suggested by the excellent cement obtained from mixtures of hydraulic lime and *puzzolani* or pulverised lava, which was first produced in Germany in 1863. The essential element in basic slag for making cement is silicic acid in proper proportions, and then this must be "live" and in a condition to unite readily and firmly with the lime, while the slag must contain a due proportion of magnesia and not an excess of some impurity which will resist the combination and sooner or later cause crumbling or disintegration. In Western Germany there is only one small district—in the Saar Valley—where slag of perfect quality is produced, and here the slag cement manufacture is concentrated in the hands of two firms. This cement seems to be regarded with some suspicion by engineers, who will only use it when they know where, by whom, and from what materials it has been manufactured. When of good quality it may be used with advantage where the work will always be moist and protected from the sun. The consul at Magdeburg says the industry is dying out in Germany owing to the opposition of Portland cement, lack of support from the Government, and stagnation in the building trade; a factory opened at Stettin some years ago failed. In Germany it is generally called puzzolan cement.

MISCELLANEA.

Messrs. Earles' Shipbuilding and Engineering Company, of Hull, have received an order from the Admiralty to construct two 30-knot torpedo boat destroyers.

Even experienced carriers get into trouble under the present traction on roads regulations. At the Mansion House the Fardell Traction Haulage Company, Limited, were fined in all £10, with £10 10s. costs, for having on five occasions in March last used a traction engine in the City without being licensed by the Corporation under the Highway Act.

In reply to a correspondent, writing on high and low tension currents, the Board of Trade replied that they have been informed of nine cases of fatal accidents to employés at generating or transforming stations where high-pressure alternating currents are used, but that no instances have been reported in the case of low-pressure continuous currents. It may also be true that the Board of Trade have heard of the drowning of many people in the sea, but none in street gutters.

The new American torpedo boats or destroyers—for they are of 180 tons displacement—differ, according to the *Naval and Military Record*, from most other craft of their kind in that they have built-up forecastles, very much like our "catchers" of the Alarm, or 810-ton type. These forecastles gave them a freeboard forward of no less than 12ft. 6in., and should render them excellent boats for sea work. The speed is to be 26 knots, with 3200-horse-power and 395 revolutions. The armament consists of four 1-pounders and three torpedo-tubes, one being astern and two *en echelon* nearly amidships. There are three funnels and two conning towers.

A Sholapur correspondent writes to the *Bombay Gazette*:—"As a sign of the times, we hear that a patriotic and leading native of Pandurpur has opened a shop for the sale of country-made mill and hand-woven cloths in that town, and laid in a stock of over ten thousand rupees worth of cotton and woollen fabrics, in order to help the masses to patronise Indian industries only. His example is being followed in numerous other places. As these patriots are mostly wealthy men, content with the smallest profits to merely cover cost, it is probable that Manchester has raised a hornet's nest, and given an impetus to Indian, Chinese, and Japanese trade which it never contemplated, and from which it will suffer in the end."

Some floods prevention works are much wanted in Canada. Damage amounting to a million dollars has been done in the eastern townships by floods, the worst which have been experienced for twenty years. The town of Richmond and part of Sherbrooke have been submerged, and hundreds of families have been driven from their homes. Many mills and factories on the banks of the St. Francis River have been swept away, and the Quebec and the Central and Drummon County Railways have been crippled, iron bridges having been demolished. Twenty-four houses were swept away from St. Anne's and Isle de Grace on the 20th inst. The loss of life is fortunately very slight considering the serious character of the flood.

On January 7th, 1890, the Egyptian Government, having received the assent of the European Powers, issued a decree levying a tax of 1¼ millièmes—about 3s. 10d.—per ton on shipping entering and leaving the harbour, to become payable when a new pass having 300ft. width and 30ft. depth should be completed. This is now officially declared as accomplished, and that the tax will be levied from May 1st next, when compulsory pilotage dues will be abolished. The expense of excavating the pass was estimated at £60,000, to be borne equally by the Government and shipping, the latter to contribute £3000 additional for two years' interest. The tax is to cease absolutely so soon as it has realised the amount of £33,000 with 5 per cent. interest, and a special half-yearly report is to be published showing the receipts. The *Times* Cairo correspondent says the Government bears the expense and responsibility of keeping the new pass lighted at all times, and it is already freely used by ships entering and leaving during the night.

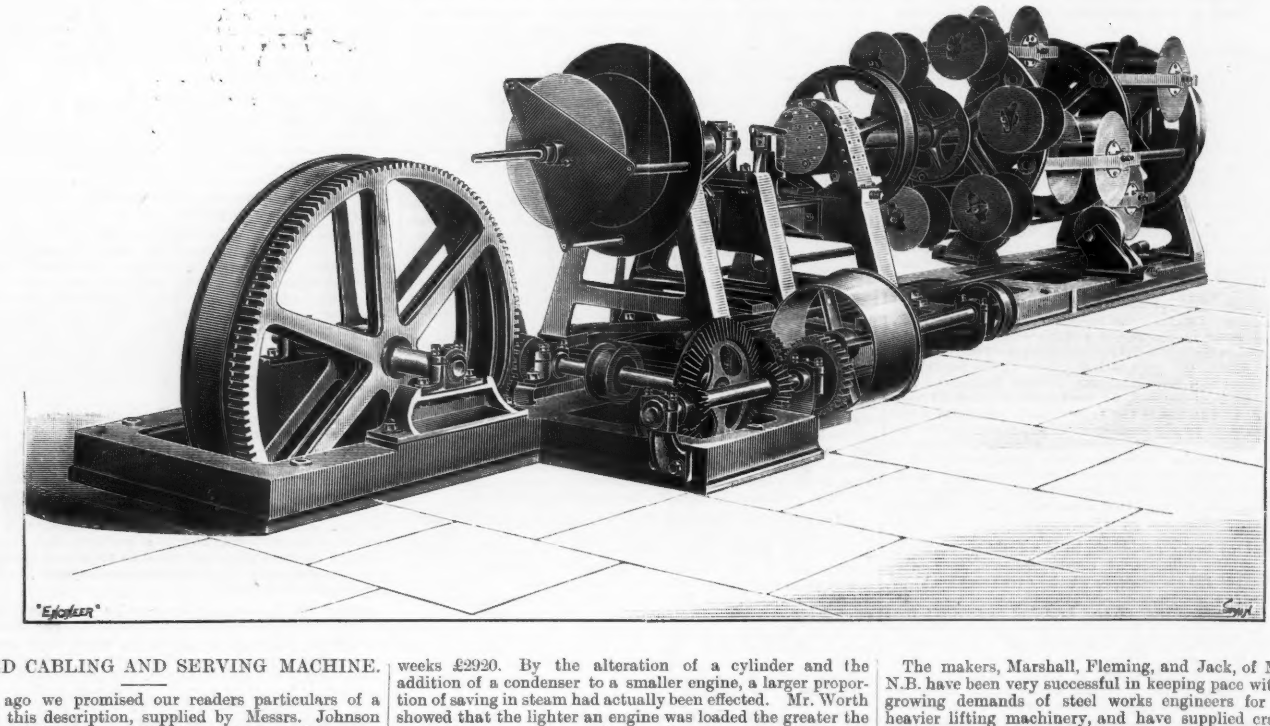
It is stated, the *Dover Standard* is authoritatively informed, that the Kent Coalfields Syndicate have definitely entered into a contract with a firm of mining engineers in the north of England to sink two colliery shafts at Hongham, two miles west of Dover. The shafts are to be 20ft. in diameter, and are to be sunk within twelve months. It is intended to make further borings. The syndicate consists of the following gentlemen:—Mr. Philip Stewart Mackenzie Arbuthnot, West Hoathley, Sussex; Mr. Richard Berens, St. Mary Cray, Kent; Mr. George Frederick Fry, Dover Harbour Commissioner; Mr. Frederick Pitts, County-chambers, Cornhill, London; and Sir Henry Beyer Robertson, Palé, Merionethshire. The experts calculate that there is sufficient coal in the measures already discovered, taking an area of not more than 6000 acres, to supply about 3000 tons a day for seventy years. The coal-bearing district in Kent is estimated at about 150 miles in length by about five or six miles in breadth.

A great engineering work of immense importance to the city of Venice has just been completed. Fifty-eight years ago, in order to prevent the damage caused by the occasional overflowing of the river Brenta, the Austrian Government, on the recommendation of the celebrated engineer Paleocapa, carried out certain works by which the months of that river were carried into the Chioggia Lagoon, some distance south of their original outlet. Since then the alluvium brought down by the river has threatened to convert a portion of Chioggia Lagoon into a fever-breeding swamp; and also to cause serious damage to the whole Venice Lagoon by silting. It was accordingly decided to construct a new channel for the Brenta, sixteen kilometres in length, giving the river a direct outlet into the sea near Brondolo, still further south. The scheme, which was estimated to cost eight million lire, and was begun in 1884, has now been brought to a successful conclusion. The new channel, by means of subsidiary canals, also provides a fresh outlet for the Bacchiglione and other rivers formerly flowing into the Venice Lagoon.

In the course of a lecture on "Recent Chemical Progress," given on the 16th inst. at the Royal Institution, Professor Dewar, F.R.S., commented on the great future opened out to synthetical chemistry by the employment of the temperature of the electric arc. Some of the most interesting results had been obtained from the electric furnace by the French chemist, M. Moissan, in the shape of carbides, stable bodies produced by the combination at high temperatures of carbon with various metals. Many of these carbides were decomposed by water, the hydrogen of the water combining with the carbon to form hydrocarbons. Thus with water some carbides, such as that of calcium, gave acetylene; others, like that of aluminium, gave marsh gas, while others again gave these and other gases, and, what was most wonderful, liquid petroleums. It was a curious fact that many years ago Professor Mendeleef speculated that the only reason for the immense localisation of petroleum at Baku was that it was being generated there—he suggested by the action of water on carbides. His idea was rather smiled at then, but now it was his turn to smile. When acetylene was heated to a dull red heat, it was polymerised to benzene. Benzene was the basis of all the new modern colours, and thus by three direct stages we were able to reach the nucleus of all the colours hitherto manufactured from coal-tar products. First there was the combination of lime and coke in the electric furnace; secondly, the decomposition of the carbide thus formed by water; and thirdly, the transformation into benzene of the resulting acetylene by means of heat. Professor Dewar concluded by briefly discussing some of the properties of acetylene, explaining, among other things, the cause of its extraordinarily great luminosity as due to its peculiar endothermic structure.

COMBINED CABLING AND SERVING MACHINE

MESSRS. JOHNSON AND PHILLIPS, CHARLTON, ENGINEERS



COMBINED CABLING AND SERVING MACHINE.

Some time ago we promised our readers particulars of a machine of this description, supplied by Messrs. Johnson and Phillips, of Charlton, to H.M. Postal Telegraph Department, for cabling their gutta-percha covered cables, and at the same time serving them with compounded tape. This machine, which we now illustrate, is arranged for cabling seven wires, *i.e.*, laying six wires round one, and at the same time laying a yarn in the recess formed between each pair of wires, so that when the cable is taped it forms a more perfect round.

The machine is erected on a strong cast iron bed-plate, and the six wire bobbins—arranged in two bays—are carried in forged wrought iron fliers between three discs, the third disc also carrying the six yarn bobbins. The central hollow steel shaft runs in a large gun-metal stepped bearing at one end, and the "lay-head" end and the central disc run on anti-friction rollers. The draw gear is driven from the "lay-head" end of this shaft by means of a belt driving on to a countershaft carried from the bed-plate of the machine. The motion is transmitted to the draw-through drum by means of spur and bevel gearing, change wheels being provided to give the requisite length of "lay" for the different sizes of wires. The taping head is designed to serve various widths of tapes, and for that purpose is driven by means of coned pulleys, which allow the "lay" and "lap" of the tape to be adjusted very minutely.

The bobbin of tape, as will be seen, is arranged concentrically with the cable, the tape being led from the bobbin by means of a series of rollers, &c., down through a slotted guide on to the cable. The wire bobbins are each arranged to hold one mile of gutta-percha covered wire, and the yarn and tape bobbins respectively hold sufficient tape to "worm" and "serve" this length of cable. The diameter of the tape bobbin is 21in.; the radius described by the taping head, measured over the guide rollers, is 16in., and the speed of this head is about 500 revolutions per minute. The central hollow shaft is 3in. diameter, and runs in large gun-metal stepped plummer blocks, having bearings two and a-half diameters long. All the bobbins are provided with means for adjusting the tension on the various wires, yarns, &c., as may be desired. The finished cable is led from the draw-through drum on to a receiving drum placed a few feet distant from the cabling machine, from which it is driven by means of a belt. This apparatus is provided with an automatic guiding-on and flaking gear, which is not shown in the illustration.

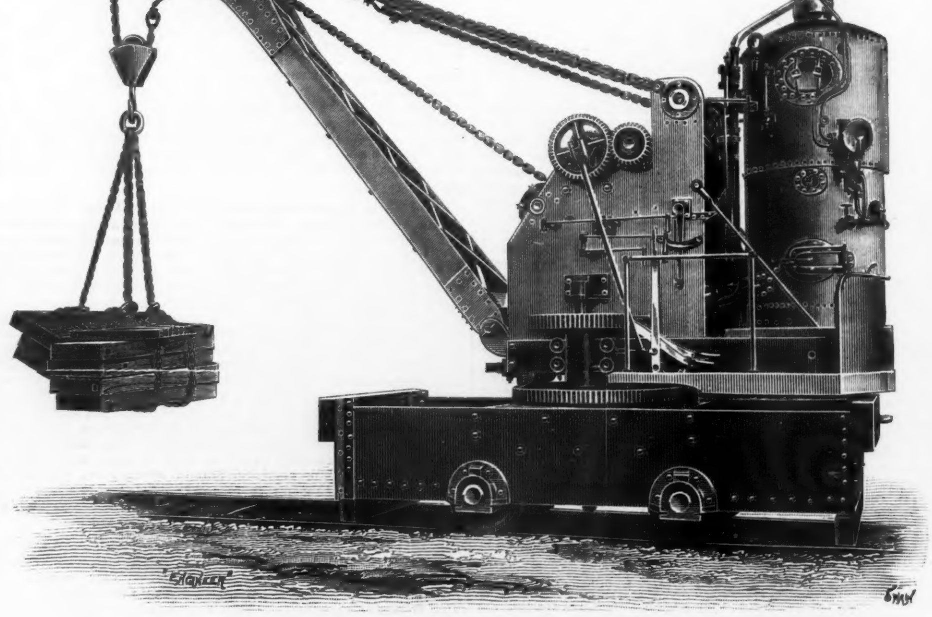
Besides the above-described machine we understand that Messrs. Johnson and Phillips have supplied H.M. Postal Telegraph Department with a four-wire combined cabling and serving machine, all complete with the necessary bobbin winders, swifts, and automatic winding and coiling gear, for making the finished cable up into coils, and have fitted it up at the Mount Pleasant factory.

CONDENSERS FOR ROLLING MILL ENGINES.

Mr. Robert J. Worth, of Worth, Mackenzie, and Co., Limited, engineers, Stockton-on-Tees, at the monthly meeting of the Middlesbrough District Association of Foremen Engineers and Mechanical Draughtsmen, read a paper on "The Application of Condensers to Rolling Mill Engines." He remarked that, owing to the fact that steel was rapidly superseding iron, the rolling mills no longer had that superabundance of steam which formerly was raised by the waste heat from the puddling furnaces. Economy of steam in rolling mill engines was formerly a matter of no consequence, but now it was becoming one of primary importance. The difference between a rolling mill with engines of the type usual in the North of England, and a mill laid out on the best system for economy of steam was, he believed, just the difference between one that barely paid and one that returned a good profit to the owners. Thus, if an engine of the usual size, with a pair of 42in. cylinders and 5ft. stroke reversing, were taken, the difference in the steam consumption between the ordinary type and a fairly economical type would be equivalent to a saving of about 5700 lb. of coal per hour during the time the engine was actually running. If the engine ran six hours per shift, and ten shifts per week, and the value of the coal delivered were 8s. per ton, there would be a saving of £61 per week, or on a year of forty-eight weeks £2920. By the alteration of a cylinder and the addition of a condenser to a smaller engine, a larger proportion of saving in steam had actually been effected. Mr. Worth showed that the lighter an engine was loaded the greater the saving in steam consumption, and, as in a "pull over" or "crab reversing" mill, the time during which the engine was running empty or lightly loaded formed a very large proportion of the total running, the saving with mills of this type and with engines well up to their maximum work would be very great. There were circumstances, however, when the saving effected by the use of a condenser was greater and more important than those mentioned, and these were when the engine was under its work, and when the workmen, in consequence, had to wait a considerable time for the engine to get up speed. The additional power and speed would generally be from 40 to 50 per cent., and that would represent a great saving in labour. The main engines using less steam would leave more for the auxiliary engines, and a more regular pressure would thus be maintained in the boilers. The author recommended Korting's ejector condenser on account of its great simplicity, the absence of any working parts, and the fact that it needed no attention.

LOCOMOTIVE STEAM CRANE.

The above engraving illustrates a handy size of locomotive steam crane, one of a class specially designed for use in steel works; it lifts and travels with 10 tons at 14ft. radius on 4ft. 8½in. gauge of rails. As very quick speeds are required, combined with immunity from breakages, all parts are made with an ample margin of strength. The framing of body and carriage is constructed of heavy steel plates, and the gearing throughout is of Siemens cast steel. The jib is swan-necked, to give plenty of clearance for the load at a short radius and under limited head room, and the radius is adjustable by worm gear from the engines. The carriage is provided with feet, so that should the crane leave the rails it cannot sink or overturn.



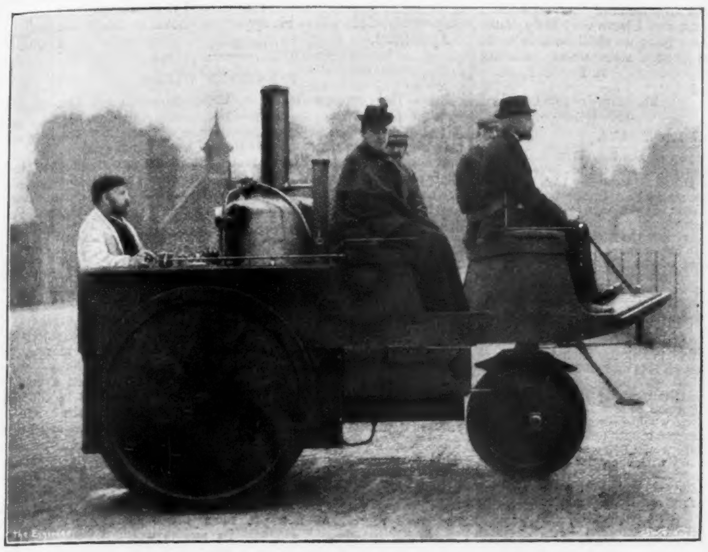
LOCOMOTIVE STEAM CRANE, MESSRS. MARSHALL, FLEMING, AND JACK, ENGINEERS

The makers, Marshall, Fleming, and Jack, of Motherwell, N.B. have been very successful in keeping pace with the ever-growing demands of steel works engineers for faster and heavier lifting machinery, and have supplied cranes of the above type for loads up to 20 tons to leading steel makers.

The Crystal Palace School of Engineering.—On Friday last Mr. A. T Walmisley, M. Inst. C.E., engineer to the Dover Harbour Board, distributed the certificates obtained during Easter term by students at the Crystal Palace School of Practical Engineering. In the course of his address he said that they had to congratulate themselves on the results of the first term of their twenty-fourth year. Very few people had any idea of the amount of educational work carried on at the Palace. Old students from that school were to be found exercising their profession all over the world, and no small portion of the success which had been attained was due to the personal influence which the principal, Mr. J. W. Wilson, had exercised over the 1172 students who had passed through the school since its foundation. In the first term of 1872, when the school was established, they had fifteen students. This term they numbered seventy-one. They demanded an entrance examination as a test of proficiency in general education. The Institution of Civil Engineers did the same for their class of students since the year 1889, when the Institution had 967 students on their books. The students' class at the Institution was established in 1867. Of course many had become transferred to corporate membership upon attaining the proper age, and the present number of students was 877. He strongly recommended all those who wished to come to the front in the profession to join the Institution of Civil Engineers as students as soon as they could, and felt sure the technical training they received at the Palace would prove an additional testimonial for their nomination, although the Council of the Institution of Civil Engineers simply demanded proof of a sound general education, and did not specially insist upon proof of previous technical education. He advised the students not to run away with the idea that what they had learned was incapable of improvement, and he strongly urged them not to put blind faith in formulas, but to examine each case on its merits. At the close of the distribution, Mr. G. T. Rait, chairman of the Palace Company, thanked Mr. Walmisley on behalf of the directors, and the proceedings terminated.

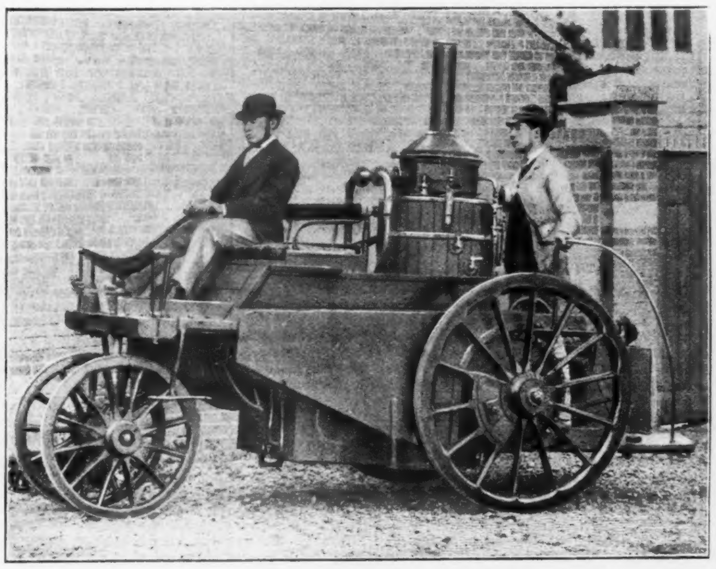
SOME MORE STEAM CARRIAGES.

THE two steam carriages illustrated by the engravings now published are of considerable interest, as showing the direction which design took from twenty to thirty years ago, or a quarter of a century after the very different designs of Hancock, Gurney, James, Hill, Macerone, Church, and others had been given up for various reasons, though they had been perfectly satisfactory as indicating the practical lines on which coaches could be thereafter built. Reasons other than mechanical or structural caused the cessation of efforts in this direction, and except spasmodically little was done for a quarter of a century, and then most of the designs were rather of the carriage for a steam engine and boiler than a comfortable passenger carriage operated by a steam engine. The engine was in many cases much better from the steam engine designer's point of view, but in nearly all cases the useful work done by Hancock, Gurney, and others, with reference to the boiler, was ignored, and no real progress from the carriage point of view was made, the weight of the engine and boiler and gear being excessive, much of it being due to the boiler, which in most cases was either the modern locomotive or the then modern vertical boiler, with large unstayed or unbalanced surfaces requiring heavy plates. Many of these steam carriages of a quarter of a century ago were from the mechanical engineer's point of view successful, and as they played an important part historically they are of interest even now in part as illustrations of what could be done or might be done, and partly as showing what not to do.



MR. NEVILLE GRENVILLE'S STEAM CARRIAGE, 1875

One of these shown by side and end views is of a steam carriage still existing. It was built for Mr. R. Neville Grenville, of Butleigh Court, Glastonbury, in 1875, by Messrs. T. Cooke and Sons, York. The boiler is a Shand and Mason cross-tube steam fire-engine type. It had a single inverted cylinder bolted outside of the boiler 5in. diameter by 6in. stroke. But this was found unsatisfactory, and was altered to two cylinders of the same size, and geared to half the original speed, and placed horizontally, the ratio of crank shaft to driving wheels being now 4 to 1. The driving wheels are 4ft. diameter with 3in. tires, and are solid disc wheels of teak. These, no doubt, are heavy, but the reason they were made so was that Mr. Neville Grenville heard that others had had trouble with spokes working loose. He questions now if this is really the fact, but the disc wheels are very easy to clean. The second motion shaft is linked to the driving axle at the right-hand end, and rises and falls with it by the action of the springs. The left-hand end has a ball-and-socket bearing, so the effect of this is slightly to throw the gear teeth across each other, but in the same plane, so no ill results and no wear are perceptible. In this way the difficulty attaching to the use of springs and gearing is perfectly overcome. The steering wheel is 2ft. 6in. diameter, with a 3in. tire, and works well. At first there was an arrangement for turning the exhaust into the tank when necessary; but this was not wanted, and, as it was at times inconvenient, it was taken off, and an exhaust tank and feed heater put on instead, the water from the condensed steam running back into the water tank. The boiler is fed by a pump and by an injector. The weight with coal and water is 45 cwt. The tank holds 55 gallons. The boiler heating surface is fire-box 13ft., tubes 16ft.; total, 29 square feet. The grate area is 2½ square feet. The carriage is still in working order, and Mr. Grenville ran it in the last few weeks 120 miles. The following is the account of the last two runs from Mr. Neville Grenville's diary, which will give an idea of what the carriage will do.



MR. KNIGHT'S STEAM CARRIAGE, 1368

Saturday, April 4th, 1896.—"After lunch to Baltonsborough with steam carriage; went to several places there and did my business and back by five. Distance run, seven miles."

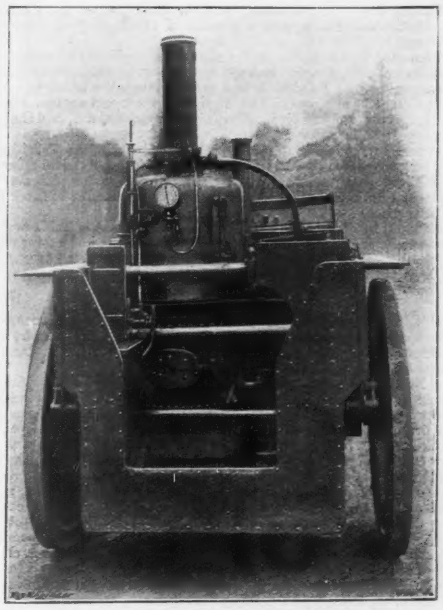
Tuesday, April 7th, 1896.—"Mr. Pinney came at 9.30 a.m., and we started with steam carriage at 9.45, George Mildred with me in front, and Noble firing, Mrs. N. G. and Mrs. Audry with us as far as the Horse and Lion; we on through Glastonbury and to Polsham; stopped there for five buckets of water, and on to Wells, arriving at the Palace at 10.50—ten miles in sixty-five minutes, including stops for horses, water, and at railway level crossing. Called on the Bishop as I promised, and took him and some friends for a run round the Palace. One of them thought I was a bagman come to try and sell the carriage to the Bishop for him to use in inspecting the diocese! Put up at the stables, Pinney and I to County Council meeting. . . . Barstow tells me he has been to London to see autocars, but did not get any satisfaction, so told him to come home on mine. After the meeting Sir R. Paget, Hobhouse, Dyke, Colonel Clarke, and other County Councillors came and had a ride, and were much pleased. Left for home at 4.40, having on board Barstow and Gibbons extra; a good run to Glastonbury; dropped Gibbons at Edgarley at 5.25, and on *viâ* Baltonsborough, stopping a few minutes for five buckets of water; arrived home at 6 p.m. Fourteen miles in eighty minutes, including stoppages and slowing down. Total run out, ten miles; home, fourteen miles; run in Wells, one mile; total, twenty-five miles. Coal burnt, 155 lb., equal about 6 lb. per mile, including getting up steam twice, as being some hours in Wells I let the fire out We need not have taken any water on the road either way, but thought we would be on the safe side. Water used for the twenty-five miles, about fifty-five gallons at most each way, or 1100 lb., not including drain from the feed-heater, which I had no means of measuring."

Mr. Knight's carriage, illustrated by the accompanying engravings, is one to which reference has several times been made, and it further shows the lines on which the designers of a quarter of a century ago chiefly worked. There are some points of interest and of guidance in them, although now we must look upon all these as rather vehicles for an engine, its gear and a boiler, than as a carriage. It was made by Mr. J. H. Knight, of Farnham, and was commenced in 1868. It was first fitted with one cylinder and a fly-wheel, but the difficulty of starting on inclines was considerable, and a second cylinder was added, the ratio of the gearing being reduced to 1 to 4, instead of 1 to 6, which was the ratio as originally arranged with the single cylinder.

The cylinders were 5in. by 7in., and were fitted between two angle irons, which formed the frame of the machine. They were fitted with link motion, the reversing quadrant and the steam lever being on the steersman's right. The steering wheels, 2ft. 8in. diameter, were on a gauge of 2ft., the hind wheels 4ft. diameter and 4ft. 2in. gauge. The steering wheels were moved by a tiller with a cross handle, but the tiller moved through an arc of twice the radius of the steering wheels; the steersman had thus good control over the carriage, and but little muscular effort was required in steering. Only one wheel was the driving wheel, and this was found sufficient for all practical purposes; it was only found to slip on wet grass. In motor carriages with one driving wheel it seems advisable, at least for use in England where vehicles pass one another on the left, to have the driving wheel on that side, for it is sometimes necessary to leave the crown of the road in passing, and if the right wheel be the driver there might be some difficulty in regaining the hard road. The boiler, originally a multitubular, was afterwards altered into a "Field," with about 26 square feet of heating surface. A tank under the engines carried 40 gallons of water, sufficient for six or seven miles' run. Coal for fourteen or eighteen miles was carried. The brake was worked by the stoker; the boiler was fed by one feed pump and a donkey pump; the weight in running order was 32 or 33 cwt. Three people sitting side by side were accommodated on the seat.

In fair running order the speed was eight to nine miles an hour. A small four-wheeled chaise, carrying three passengers, was often towed by it, and except on steep hills it did not appear to make any perceptible reduction to its speed. Unfortunately it was somewhat noisy in running, and a very sharp blast was necessary. To keep steam coal had to be used, as there was not draught enough to burn coke.

After being in use as a steam carriage for three or four years, it was sold. The purchaser converted it into a small traction engine. Writing of it Mr. Knight says:—



MR. NEVILLE GRENVILLE'S CARRIAGE, 1875

"I think this is a fair account. Some of these details are from memory. The carriage was so frequently altered that drawings would only show it as it was once."

HORSELESS CARRIAGE NOTES.

AN interesting lecture on "Horseless Carriages" was delivered on the 10th inst. before the Belfast Philosophical Society at Belfast by Mr. John Brown, the honorary treasurer. The latter part of the lecture dealt with modern horseless carriages, and necessarily with those of German, Swiss, and French make. Mr. Brown exhibited his own Serpollet steam carriage, purchased from M. Doarzan, of St. Omer. At the close of the lecture, Mr. George Andrews moved the following resolution:—"That this meeting approves of the proposed modification of the Locomotive Acts so as to promote the use of mechanically propelled carriages on public roads, subject to suitable provisions for the safety and convenience of the public." Such an amendment of the Acts as the resolution approved was, he considered, necessary. Though all sorts of motors might not be an unmixed benefit to the public, yet he felt, and he thought it was the feeling of the meeting also, that if these machines could be used safely in other countries they could be used with equal safety in this, and though they might be unsuitable for crowded towns, there could not be any reasonable objection to their use under proper provisions in the country districts. Professor Everett seconded the motion. He believed he was right in saying that a measure for the amendment of thy Acts on the lines of the resolution was at present in the wae of being passed in the Lords, and he hoped it would pass the Commons also, as he believed these carriages had a great future before them. The resolution was passed unanimously.

THE letter we publish on another page from Mr. Flood-Page draws particular attention to the questions which concern the construction and working of electrically-propelled vehicles, and no doubt his contentions will be supported by a great number, although the means of economical applications of electricity for this purpose are not very obvious except over a limited field where the many virtues of an electric motor outweigh the disadvantages of accumulators. This field, although limited at present to the short distance runs of vehicles for town and suburban use, will no doubt widen as accumulators are further improved, and as the necessity for the weight which high discharge capacity requires is lessened by improvements in the means of transmission, so that the maximum power used is never much in excess of the mean.

THERE is a question to which Mr. Flood Page does not allude, although it is one which must receive attention, namely, the proposed refusal of permission to allow one vehicle to haul another. It is, perhaps, early in the days of our hoped-for freedom from trammels which restrict mechanical and industrial enterprise in the design and use of self-propelled vehicles as they do in no other country, to ask for more than the Bill now in Parliament proposes to give; but we must not overlook the fact that it may in the first few years of the use of self-propelled carriages be very necessary to be able to make one haul another which has been disabled, or run short of current, or other power source.

THE haulage of a vehicle by a self-propelled carriage or by a separated light motor carriage, is according to present intentions, barred. This is presumably with the object of preventing anything like traction engine or road locomotive trains. With this object most people will sympathise, but it is undesirable it should also prevent the production of a satisfactory motor vehicle, which, though detachable from the passenger carriage or goods van it hauls, may when coupled to it form a complete whole. Such an arrangement offers some advantages and provides the means of using existing carriages, and of having spare motors, so that time occupied in their repairs shall not be idle time for the vehicles also.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

HORSELESS CARRIAGES.

Sir,—I am sending you a cutting from *L'Industrie Vélocipédique*, containing Mons. M. Mallet's account of his inspection of the Cugnot steam carriage, in which you will see he does not give all credit to his "Compatriotes," neither does he give the glowing description one reads from a perusal of the history of Cugnot's carriage.

I am glad to see Mons. Mallet share the credit between Cugnot and Trevithick. Cugnot had the support of the State to carry out his experiments; Trevithick had not, although the latter was one of the greatest pioneers of the high-pressure steam engine, steam road carriage, railway locomotive, traction engine, &c., and similar developments in latter-day use.

It is sad to conceive that such a "grand esprit" as Trevithick should have passed the latter years of his life in poverty and misery, and saved a pauper's funeral by subscription of his shopmates, and—as I am informed—without a stone or monument to mark his resting place.

I should be glad to see a subscription raised for a suitable monument to be erected in honour of the great inventor of motor road vehicles.

Chas. T. Crowden.

Beeston, Notts, April 10th.

"La voiture de Cugnot.

"M. Mallet, ingénieur est allé examiner l'ancètre de nos automobiles actuelles, le voiture de Cugnot, remisée au Conservatoire des Arts et Métiers, et rend compte de sa visite, comme suit, dans le *Bulletin de la Société des Ingénieurs civils de France.*"

"Nous ne cacherons pas que nous avons été profondément étonné. Certes, ce qui concerne le véhicle et même la machine proprement dite n'est pas mal combiné, surtout si on tient compte de l'époque et du peu d'expérience de l'auteur, mais la partie capitale, la chaudière, laisse tout à désirer.

"On a fréquemment signalé les mauvaises proportions du générateur, la disposition peu favorable du foyer, le peu de résistance de la chaudière pour soutenir l'effet de la vapeur, &c., mais ce n'est pas tout; dans la machine qui est au Conservatoire, et qui est, dit-on, la seconde machine de Cugnot—nous ignorons totalement comment était faite la première—il est absolument impossible de comprende comment on aurait pu mettre de l'eau dans la chaudière et faire du feu sous celle-ci. D'abord le générateur en forme d'ellipsoïde de révolution ne possède que deux ouvertures, l'une à la partie supérieure pour conduire la vapeur à la machine, l'autre directement en dessous et au fond fermée par un bouchon à vis assez mal placé au plus vif du feu—si ce feu pouvait être vif. On ne pourrait donc introduire d'eau qu'en démontant le tuyau de vapeur. Cette opération, délicate avant l'allumage, serait impraticable en route pour refournir de l'eau à la chaudière à mesure de l'évaporation. D'autre part, la chaudière est entièrement entourée d'une enveloppe en tôle fermée de toutes parts, sauf en haut où il y a deux petites cheminées, et sur le côté où est une porte pour introduire le combustible; il n'y a ni grille ni place pour la mettre, le fond de l'enveloppe étant à 0·22 m. seulement en contre-bas du fond de la chaudière. Par où l'air destiné à la combustion pourrait-il s'introduire?

"Cette chaudière, telle qu'elle est actuellement et telle que la représentent les dessins du portefeuille, ne pourrait donc fonctionner en aucune manière, à moins qu'on ne suppose que le foyer agissait comme dans un samovar, et alors quelle production de vapeur pouvait-on espérer? Nous laissons de côté l'absence de soupape de sûreté et de tout moyen propre à faire connaître le niveau de l'eau dans la chaudière.

"Ce sont, quelque importants qu'ils soient, des détails bien secondaires en présence des imperfections radicales de ce générateur, qui nous semblent entraîner une impossibilité de fonctionnement. Il semblerait vraiment que la chaudière dont nous nous occupons, n'a jamais été achevée ou n'a pas été faite pour fonctionner; si on ajoute qu'elle reproduit tous les dèfauts qu'on avait signalés dans le générateur de la première voiture, on reconnaîtra qu'il y a là un mystère auquel nous n'avons jamais vu faire la moindre allusion dans tout ce qui a été écrit sur la machine de Gugnot, même par des ècrivains très éminents.

"Toute autre était la voiture de Trevithick qui a circulé en 1803 pendant plusieurs mois dans les rues de Londres en portant huit ou dix personnes, et en marchant à des vitesses de 8 kilomètres à l'heure qui pouvaient facilement être portées au double. Cette voiture était parfaitement pratique et, si elle n'a pas eu de succès durable, il ne faut pas en chercher la raison autre part que dans l'épuisement des ressources de l'auteur, epuisement qui l'obligea à chercher ailleurs un travail plus immédiatement rémunérateur. La mélancolique devise de Bernard Palissy, encore un inventeur méconnu, *pôvreté empeshe les bons esprits de parvenir*, a trouvé là une application de plus. La voiture de Trevithick n'eut pas la chance d'être conservée comme celle de Gugnot, elle fut vendue à la ferraille et le moteur fut utilisé pour actionner un laminoir à cintrer les cercles de roues chez un fabricant de voitures.

"Nous croyons équitable de partager entre Cugnot et Trevithick mais dans des proportions inégales, d'avoir été les pionniers de la locomotion mécanique sur les routes, l'un ayant fait le premier véhicule à vapeur qui ait existé, l'autre le premier qui ait fonctionné régulièrement et avec un plein succès sur des dispositions et pour un but d'ailleurs entièrement différents de ceux du précédent.

"Ces deux hommes ont, de plus, partagé le même destin, celui d'être méconnus de leur vivant et peu favorisés par la fortune mais encore dans des proportions très inégales. En effet, Gugnot dont les travaux avaient été encouragés et même payés par l'Etat, les vit dans ses dernières années récompensés par l'obtention d'une pension; son œuvre a été pieusement conservée, sa mémoire honorée presque de suite après sa mort et ses mérites célébrés, peut-être avec quelque exagération.

"Trevithick, au contraire, passa ses dernières années et mourut dans la misère, fut enterré à la charité et quelques ouvriers qui avaient travaillé à la construction de ses machines durent se cotiser et payer une garde nocturne pour préserver ses restes contre les voleurs de cadavres. Il s'était vu refuser dans ses derniers jours un secours national qu'il avait sollicité et cependant cet homme avait inventé, ou tout au moins avait réalise pratiquement la machine à haute pression, la locomotive routière, la locomotive de chemin de fer, la drague à vapeur, les caisses à eau métalliques pour la marine, les bouées, mâts et vergues en fer, etc., toutes choses dont les résultats ont plus tard été immenses."

Mallet.

THE LIGHT LOCOMOTIVE BILL.

Sir,—The Light Locomotive Bill which was recently introduced in the House of Lords is of such vital importance to the electrical industry that perhaps you will find space for the following:—Mr. Chaplin received the deputation headed by Sir David Salomons on the 12th February, after which I had an interview with him, and I wrote to him at length on the following day. I need not, however, trouble you with my letter of that date or Mr. Chaplin's courteous answer. When, however, on the 30th March we were able to obtain a copy of the Bill, I wrote to Mr. Chaplin a letter—copy of which I enclose, together with his reply. I am glad to be able to add that on Tuesday last Mr. Chaplin and Lord Harris did me the honour of receiving me at the Local Government Board. I found them most anxious to do all in their power to meet the reasonable requirements of all the industries interested in this particular Bill. They, however, are of opinion that it is essential some restriction should be placed on weight, as otherwise they fear that heavy traction engines will be run about the country and through our towns at a considerable speed. I am glad, however, to be able to add that though they were not able, until after consulting with their technical advisers, to determine the exact limit of weight that the Government may think necessary, yet I have no doubt when the Bill is read a second time in the House of Lords we shall find, instead of two tons, if not five, at any rate four tons will be substituted. Mr. Chaplin said that this is a matter of experiment, and that the Government, while most anxious to assist the industries connected therewith in every possible way, felt that until some experience was gained on the subject, they must be very cautious. Electrical omnibus traffic can certainly be conducted with success with a weight of five tons, and I have very little doubt that even if we are restricted to four tons, we shall be able to do very well with this traffic in our London streets and in other towns.

S. Flood-Page.

[Copy.]

102, St. George's-square, S.W.,
April 1st, 1896.

LOCOMOTIVES ON HIGHWAYS.

Sir,—I have the honour to remind you of the interview which you accorded me, after you had received the deputation on the above subject, on February 12th, together with my letter of February 13th and the answer of your secretary thereto. I am afraid that in the multitude of the business connected with your department, you have overlooked your kind promise to bear in mind my representation as to the vital importance to the electrical industry of not limiting the weight of the omnibuses or carriages to be used in towns to two tons. I may state that this limit, which is unfortunately contained in the Bill, has created great consternation amongst those connected with the electrical industry! It was only the day before yesterday that we were able to obtain a copy of the Bill, and I have already received communications from several of the leading representatives of electrical work, suggesting my writing to the papers, holding meetings, &c. I have, however, such confidence in your promise as to feel assured that such public agitation will not be necessary. If this limit is maintained, it will practically exclude the use of electricity for horseless omnibuses, though it is undoubtedly the safest, cleanest, and best for such carriages.

On Wednesday last I was speaking at the meeting of the Associated Chambers of Commerce as one of the Council of the London Chamber, and remembering your promise that you would bear in mind my representations on this subject, I stated that we might look forward to this Bill with complete confidence that there would be no restriction put on horseless omnibuses not found necessary with the existing omnibuses, and no unnecessary interference with the natural development of the electrical industry as applied to omnibuses, &c., in towns. Judging from the welcome this announcement received from the delegates of the Associated Chambers, I have no hesitation in saying that if it had entered into my mind that this prohibitory restriction of weight would have found place in the Bill, I should have been able to get a resolution passed unanimously asking you to withdraw your present limit, if, in fact, you thought it essential that there should be any limit whatever, or any restriction beyond that for street traffic in London at the present moment. You are aware that laden wagons of sixteen tons are now legally permitted to traverse our streets, while the large three-horse omnibuses, weighing very many tons, are allowed the free use of the Paris streets.

This question is one of such absolutely vital importance to the electrical industry, which, as you are aware, has been most seriously hampered in this country by what is now recognised as erroneous legislation, that I do hope you will be able to remember your most kind promise to give effect to my representations, and that you will prevent the agitation which must immediately be excited if this most lamentable, unnecessary, and unjust restriction is maintained in the Bill.

Naturally I will not ask you to see me with one or two other representatives of the industry during the short Easter holidays, but I shall be most glad if, before any public meeting is called, you would see me with one or two representatives of the electrical and carriage building industries, so that if possible the necessity for this agitation may be done away with.

I have the honour to remain, Sir,
Your obedient servant,
(Signed) S. Flood-Page.

To the Right Hon. H. Chaplin, M.P., &c. &c.

[Copy.]

Local Government Board, Whitehall, S.W.,
April 2nd, 1896.

Dear Sir,—Mr. Chaplin desires me to reply to your letter on the subject of the Light Locomotives Bill.

The Bill has been introduced in the House of Lords in consequence of the pressure of other business in the House of Commons.

The question of the weight of the articles to which the Bill is to apply is a matter of detail, and Mr. Chaplin is perfectly ready to receive and consider suggestions on the subject, which is a new one to all concerned, and of which there has been so little practical experience. He has forwarded your letter to Lord Harris, who has charge of the Bill in the House of Lords, and from whom your suggestions will, he is sure, receive every attention.

When the Easter holidays are over, Mr. Chaplin will be very willing to see you, in company with Lord Harris, or to receive in writing any further statement on the subject which you may like to submit.

Yours faithfully,
(Signed) H. C. Munro.

THE LIQUEFACTION OF GASES.

Sir,—After careful perusal of both "Zero's" letters, I am still unable to agree with him. With your permission I will explain why.

When oxygen escapes at high pressure through a narrow orifice situated in a tube of some length, two things happen: (1) production of cold, owing to conversion of sensible heat into mechanical energy of motion of the issuing gas; and (2) production of heat, from reconversion of the mechanical energy into sensible heat. (Parenthetically, I may point out to "Zero" that the issuing gas does do external work, because it does not flow into a vacuum, but is opposed at least by the pressure of the atmosphere.) As a matter of fact, proved by experiment and observation, these two things neutralise each other within a few inches from the orifice, and therefore the temperature of the gas becomes substantially what it was before expansion. But only substantially; accurately speaking, it is rather cooler than it was, which means, of course, that energy has disappeared somehow. But as "Zero" says, "After the air has left the cooler, there is no possibility of escape of heat or energy in any form" from the apparatus proper. What then has become of it? There is only one way out of the difficulty; the missing energy must have gone in doing internal work on the gas itself. It is obvious that, if all the heat of the gas before expansion were restored after expansion, there could be no progressive cooling effect, since the regenerative coils would all be bathed in gas no cooler than the compressed gas contained in them.

This disappearance of energy in internal work is, of course, the Thompson and Joule effect, of which "Zero" appears to hold so poor an opinion. But liberal as he is in unsupported assertions that it has nothing to do with the matter in hand, he is very sparing of arguments. His only one, indeed, is that it is too trifling in amount to be of any commercial value. That may well be so, but its commercial value is not under discussion. Of course, the Joule effect is trifling, but so is the efficiency of the self-intensive refrigerating process, an ounce or so of liquid oxygen being all there is to show for the energy absorbed by a big compressor during twenty or thirty minutes' work. As to a satisfactory explanation of the effect I do not know, but I believe that Lord Kelvin, so far from patching up a theory to suit it, predicted its existence from theoretical considerations before it was experimentally discovered.

I was not concerned in my former letter to discuss questions of priority. It was only as some sort of reply to "Zero's" strictures on the shortcomings of "dogmatic science" that I pointed out that Professor Dewar had actually constructed a machine, giving progressive cooling by the expansion of gas through a small orifice, before Dr. Hampson had done so, and before his patent was published. Although at the time I wrote I find I was in error in stating that Dr. Hampson's patent had not been granted, my argument was quite valid, since the specification had not then been published, and was not till last Saturday. But as "Zero" has indulged in some comparisons, may I suggest that it is rather an abuse of language to say that Professor Dewar's apparatus differs from Dr. Linde's *chiefly* in the use of frigorific agents? One might as well say that the chief difference between a boy's toy steamer and an ironclad is that in one methylated spirit, in the other coal, is the source of power. If "Zero," in accordance with his own excellent suggestion about looking up the recent literature of the subject, will consult No. 158 of the Chemical Society's "Proceedings," he will find an illustration of an apparatus which works without frigorific agents, and probably does not weigh as many ounces as Linde's does hundredweights. That seems to me a more important difference than the use of initial cooling, while a yet more important one is the employment of vacuum vessels as a protection against heat. Of the latter device, which I imagine was the outcome of dogmatic thermodynamic reasoning, I noticed that Dr. Hampson very wisely made use in his apparatus shown at Brin's Works.

April 22nd.

Cryos.

PERMANENT WAY.

Sir,—The correspondence on this subject will not be complete without a reference to the chairs. Since railways began these have not altered in any particular, except that they are heavier, being in all cases made of cast iron of the poorest quality.

It seems an extraordinary fact that in an age of steel a steel chair cannot be made commercially and mechanically to supersede the cast iron chair, the present cast iron chair being quite out of touch with other improvements in railway engineering. For example, many of the chairs weigh 56 lb. each—that is, 56 lb. of cast iron to support every 80 lb. or 90 lb. of steel rail. This is surely an enormous waste of material. It is not as if the weight of the chair were any advantage; quite the reverse. There would be less shock if there were no chair, or if the chair were made lighter and of stronger material, such as steel, which has the requisite properties for this purpose. The relative strength of the two metals being, say, 5 to 1, the steel chair might with safety be reduced to 20 lb. or even less, and still have ample margin for safety.

We platelayers experience daily the fact that when a vehicle leaves the rails, every cast iron chair that is touched by the tire flange is broken. This could not happen were the chairs made of similar material to that of the rails. It must not be forgotten that until broken chairs are replaced, traffic is suspended on the line. This causes much delay and trouble, and is noticeable every day where there is a lot of shunting, and where heavy mineral traffic is passed.

It seems a very curious thing that up till now a steel chair of sufficient merit has not yet been introduced. With our still increasing speeds and weights, its merits would be all the more appreciated. Railways were started with cast iron rails. What would we think of cast iron rails to-day?

April 20th.

For the Platelayers.

Sir,—The interest that is now being directed to this subject by engineers is in itself an evidence of its importance. There is a new element in the question, which is likely to have an important bearing on the subject; I refer to a steel chair that is being laid down on some of the Northern and Scotch lines. The trials, which are of course of too short a time to arrive at a definite conclusion, have so far proved that it is vastly stronger than the old chair, having been submitted to some very rough work in the yards of several of the Lanarkshire steel works, where the derailing of wagons with heavy loads is an almost every-day occurrence.

One thing is clearly demonstrated, that the derailing of a train does not affect the steel chairs further than a slight indent on the base, where they are struck by the passing tire flange. The maker, a Glasgow firm, claims a deal for them; but time alone will soon disclose what, if any other merit beyond cheapness and strength, they may possess.

James Andrew.

Glasgow, April 19th

LOCOMOTIVE FIRE-BOXES.

Sir,—Referring to the letter from "Adriatic" on the above subject in your last issue, it is generally considered that direct stays for the crown of the fire-box are less than useless, owing to the fact that since the inner and outer fire-box shells are both attached to the fire-box ring at the bottom of the water space, the expansion due to the heat will be, in the case of the inner fire-box, in an upward direction, and as copper is frequently used for this portion of the fire-box, and as its coefficient of expansion is greater than that of iron or steel, the crown of the inner fire-box shell will approach to the upper part of the boiler; also the direct stays will expand and thereby cause a depression of the inner fire-box crown. Now, when crown or bar stays are used, since they support the flat surface of the inner fire-box crown and act independently of the upper part of the boiler in contradistinction to direct stays, they will not be affected by the expansion due to heat of the inner fire-box. It is also for this reason that sling stays are said not to be of much, if any, use. Even when steel fire-boxes are adopted the above action takes place to more or less extent, since the inner fire-box shell, being nearest to the source of heat, expands more than the outer shell, which is separated by the layer of water in the water space.

I agree with your correspondent with regard to the Belpaire type of fire-box, and do not see any advantage that it possesses over the ordinary type.

Edward J. M. Davies.

24, Harrington-square, London, N.W., April 18th.

THE JENNY LIND.

Sir,—A curious story has been circulated to the effect that the Jenny Lind locomotive was designed as the result of the heating of an outside axle-box. The driving wheels of a certain engine had inside and outside bearings. On one run one of the outer bearings heated, the journal was wrenched off, and the engine proceeded with her inside bearing only; thereupon the outside bearings were dispensed with, and behold the Jenny Lind.

The story is preposterous, and it has not the merit of being new. If your readers will turn to the "Life of Trevithick," published in 1872, they will find a somewhat similar story told of an engine running between Carlisle and Preston. In this case it was a leading axle, and there was not a smash, because "a small roundish knot, projecting from the end of the axle in the wheel boss, alone retained it in its place, while the torn-off bearing was embedded as a solid mass with the fused brass and iron of the axle-box."

I do not pretend to know who designed the Jenny Lind. I fancy the first idea of it was to be found in an engine by Gray on the Brighton line, but I feel quite confident that there is not a trace of truth in the broken axle story, which seems to have been taken without acknowledgment from Trevithick's work, vol. i., page 219.

There are multitudes of very incredible stories told about locomotives, such as that about the 6ft. driving tire left in the ditch at Tring, the driver knowing nothing about it till he got to Chalk Farm. A collection of them would be interesting; perhaps some of your readers will contribute one or two. This about the Jenny Lind may be taken as a sample.

L. and S. W.

St. Deny's, April 21st.

THE CRYSTAL PALACE.

Sir,—I am glad to see that you admit to your correspondence columns a discussion concerning the best way to get into the Palace. I have reason to think that the directors are not blind to the truth and if I am not mistaken, they have entertained proposals from more than one contractor, but negotiations have fallen through.

The problem is not easy of solution, unless the æsthetic is to be sacrificed. A line such as that suggested by your correspondent "Norwood" would be very ugly, unless a considerable sum was spent in ornamental screens. I am rather disposed to think that the construction of an iron viaduct, in strict keeping with the architecture of the Palace, extending from the present Low Level entrance and curving round at the west water tower, would be the best solution. No railway or vehicle would be used. Powerful lifts of the kind used for the electric railway at King William-street would be employed to raise visitors to the entrance end of the viaduct. As the dimensions of this last need not be great, it would not be expensive. I do not know the difference in levels precisely, but I fancy it is about 50ft.

Dulwich, April 20th. M. E.

SIR,—Referring to "Norwood's" letter in THE ENGINEER of the 17th inst., I can, from personal experience, confirm all he says as to the difficulty of getting from the Low Level Station into the Crystal Palace. The remedy for this which I adopt, is to take the train from West Norwood Station to Gipsy Hill Station, and walk thence to the High Level Station. The walk is a pleasant one, on good footpaths all the way, and the distance traversed rather less than that entailed by walking up the many long passages and staircases from the Low Level Station. Others of my family do the same, and we save thereby time, money, and fatigue. I cannot understand the short-sightedness of the Crystal Palace directors in not providing some better mode of access than the existing one into the Palace from the Low Level Station.

London, April 18th. WEST NORWOOD, *ætat* 76.

CIRCULATION IN WATER-TUBE BOILERS.

SIR,—I beg leave to correct the statement made by "Old Tubulous" in your issue of last week regarding the behaviour of the models shown by Professor Watkinson at the Institution of Naval Architects. Being present all the time the models were working, both before and during the meeting, I noticed that out of the five models which were working, only in two of them did the tubes fracture. I also noticed that one of the models—that of the Babcock—was working continuously for about four hours without any of the tubes being fractured. OBSERVER.

April 22nd.

THE INSTITUTION OF CIVIL ENGINEERS.

THE THIRLMERE WORKS FOR THE WATER SUPPLY OF MANCHESTER.

AT the ordinary meeting on Tuesday, the 14th April, Sir Benjamin Baker, K.C.M.G., the president, in the chair, two communications, dealing respectively with the water supply of Manchester and Liverpool, were read.

In the first paper, on "The Thirlmere Works for the Water Supply of Manchester," by Mr. G H. Hill, M. Inst. C.E., the Longdendale system of works, which, before the introduction of Thirlmere water, alone supplied the city, was first briefly described. The drainage area of Lake Thirlmere, the new source of supply, was 7400 acres, but the scheme included the taking of water from an additional area of 3600 acres. The geological formation was the lower silurian, and the water was remarkably clear, even in times of heavy flood. The mountains surrounding the lake were very precipitous, and the floods consequently very large. The rainfall varied between 100in. and 137in. in wet years, and between 60in. and 80in. in dry years; and the quantity of water available for the city, after giving 5½ million gallons per day as compensation to the river, was estimated at about 50 million gallons per day. The area of the lake in its natural condition was 328¼ acres, and when raised by the dam it would be 793 acres. The capacity of the reservoir then formed was more than 8000 million gallons, exclusive of the water below the surface of the original lake, which was not available.

The water in the lake was impounded by a masonry dam, the foundations of which were carried well into the rock, the maximum depth being 50ft. below the bed of the river. It was constructed of concrete, in which large masses of rock were imbedded, faced with heavy rock-faced masonry; and, to comply with the Act of Parliament, a public roadway had been made along the top. The discharge tunnel for carrying off surplus and compensation water was driven through the small isolated hill which rose on the centre-line of the dam. Upon it was sunk a shaft, in which the valves for controlling the water in the pipes laid in the tunnel were placed. The waste weir was constructed in the solid rock at one end of, and separate from, the dam; and a gauge basin, in which the compensation water could be measured, was provided. New roads, 7½ miles long, had been constructed round the lake.

The aqueduct to Manchester was 96 miles long, 14 miles of which was in tunnel, 37 miles in cut-and-over, and 45 miles in iron piping. It started at a circular straining well, lined with concrete and 40ft. in diameter, into which the water was admitted from the lake through a tunnel about 100 yards long. Upon this tunnel and adjoining the straining well was sunk a rectangular shaft lined with concrete in which the valves controlling the supply were placed. A hydraulic crane was provided for lifting the strainers in the straining well for washing, the valves were also worked by hydraulic power. The water after leaving the straining well entered the Dunmail Raise tunnel, 5188 yards in length. Some of the other long tunnels were the Moor Howe, 3040 yards; Nab Scar, 1419 yards; and the Skelgill, 1243 yards. Machinery worked by compressed air was largely used for driving the tunnels, which were lined with concrete sides and arching only where the nature of the ground required it, but the concrete invert was continuous throughout. Its internal width was 7ft. 1in., and the height 7ft.

The cut-and-cover portion of the aqueduct was constructed of concrete, the internal dimensions being the same as in the case of the tunnels. Manholes and ventilators were provided every quarter of a mile. The bridges were in all cases of masonry, and provision was made for emptying the aqueduct at convenient points. Throughout the tunnels and cut-and-cover the inclination was 20in. per mile.

Wherever the hydraulic gradient was intersected by valleys too deep to be crossed by bridges, five parallel lines of cast iron pipes were used, 40in. in diameter. As a first instalment of ten million gallons per day was at present only required by the city, only one of these pipes had been laid. They began, in the case of each syphon, in a rectangalar chamber, into which the concrete aqueduct discharged, and in which an automatic arrangement was placed at the mouth of each pipe to shut off the water from it in case of a burst. The total weight of one line of pipes, 45 miles long, was about 52,000 tons. The greatest care was taken in the manufacture, coating, testing, and handling of the pipes, each of which had a number cast on it, which was recorded, together with the tests applied, the dates, ultimate position on the aqueduct, and the name of the workman who made the joint. For turning angles, double-socketed bevel castings were used, about 12in. in length, and varying between 1 deg. and 10 deg. For larger angles a combination of these bevels was used, a spigot pipe 3ft. long being placed between each pair of bevels. All joints were run solid with lead, which was prevented from running into the pipe by a spring ring. The section of the lead was wedge-shaped, to avoid blown joints. The longest syphon, that crossing the valley of the Ribble, was 9½ miles in length, the greatest head of water being 427ft. at the crossing of the River Lune. At these crossings the pipes were carried by three 70ft. arches, each formed of cast iron ribs.

The number of valves on the 45 miles of piping was very large, and included stop valves and air valves, besides a large number of discharge valves, for emptying the pipes at convenient places. The self-acting valves had fulfilled their purpose perfectly in the case of the few bursts which had occurred, the water being completely shut off. The mechanism was set in motion by the increased energy of the water due to its greater velocity in the event of a burst: a pair of heavy weights was thus released, and closed a disc valve in the main, the operation being controlled and regulated by a cataract cylinder. An air vessel was provided to obviate shocks which might occur during the stoppage of the column of water; means were also provided for charging the air vessel. All stop valves, self-acting valves, and reflux valves were anchored, the latter in one direction only. Valve houses had been built over the large stop valves and self-acting valves, of sufficient size to cover the five lines of pipes; the roofs were of glass fixed in wrought iron framing; girders were fixed capable of carrying blocks and tackle for raising any part of the valves requiring repair.

The aqueduct delivered into a service reservoir at Prestwich, near Manchester, where a straining well was provided with lifting and washing arrangements.

The works had been let in nine and the ironwork in eighteen contracts. Portland cement concrete had been used throughout, the quantity being about 100,000 tons. The total cost of the works to the date of the opening was about £2,800,000, including Parliamentary expenses, which were exceptionally large. The complete scheme would cost about £4,400,000.

THE VYRNWY WORKS FOR THE WATER SUPPLY OF LIVERPOOL.

The second paper was entitled "The Vyrnwy Works for the Water Supply of Liverpool," by Mr. G. F. Deacon, M. Inst. C.E. The Vyrnwy reservoir, now known as Lake Vyrnwy, occupied the site of a post-glacial lake, which had been filled chiefly with alluvial detritus to a height of about 45ft. above the original water level. That level was maintained by a bar of rock at a narrow part of the valley such as was found in most glacial lake basins. On removal of the dislocated or otherwise unsound rock in this bar, a sound foundation was met with about 15ft. lower, so that the deepest part of the foundation was nearly 60ft. below the ground level; the height of the dam to the sill level being 84ft. above the river, and the water level above the lowest part of the foundation 144ft.

Below the sill of the dam and above the outlet to the aqueduct, Lake Vyrnwy contained 12,131 million gallons. Its area was 1121 acres, only reduced to 1036 acres 10ft. lower. An average cross-section did not differ widely from a figure with a horizontal base 2000ft. wide, having a depth of water over it of 70ft., and end slopes of 2½ to 1.

The author drew special attention to the methods adopted for securing water-tightness, and showed by the results obtained from this structure and from a concrete culvert—the walls of which were only 18in. thick—subject to a vertical pressure of water of 56ft., that concrete might be made perfectly water-tight by avoiding the use of so much water as to render it incompressible when first placed *in situ*, and by ramming it until the jelly-like condition indicative of incompressibility was obtained.

Thirty-three per cent. of the stones used in the dam weighed between four tons and ten tons each. The hearting-stones were roughly dressed on their beds, but were otherwise left quite rough. The face stones had rectangular faces, and no part of any stone was allowed to come within 1in. of any other stone. The stones and rock were rendered scrupulously clean with wire brushes and jets of water under pressure. The foundation rock was drained, except within about 15ft. of the face, by numerous funnels carried up to above the back-water level, and the total leakage from the central 8000 square yards of rock foundation, including that through the dam, if any, amounted to about two gallons a minute. The specific gravity of the rock of which the dam was built was 2·721, or 170 lb. per cubic foot; that of the concrete, when dry, averaged about 2·51, or about 156 lb. per cubic foot, and that of the whole dam was 2·595, or about 162 lb. per cubic foot, a figure ascertained by comparing the measured volume of the work with the total weight of the materials put into it, all of which were carefully weighed. Crushed rock was largely used in the preparation of the mortar.

The mode of securing water-tightness of the two culverts, 15ft. in diameter, through the dam was explained. The compensation water to the Vyrnwy and the Severn, of which it was a tributary, was 10 million gallons a day, and 40 million gallons a day in addition, during four successive days in each of the eight months from February to October inclusive. The modes of gauging were also set forth.

The aqueduct commenced at a valve-tower standing in the deep water of the lake, provided with strainers of copper wire gauze, which were removed, washed, and replaced wholly by hydraulic machinery. The outlet valves consisted of a series of short cylinders standing upon one another so as to form a vertical pipe, and the joint between any pair of such cylinders was capable of being opened very readily by hydraulic pressure. Thus the water was drawn off at any level desired. The aqueduct was constructed for the passage of 40 million gallons per day or more, with the exception of the iron syphon pipes and some other portions not required until later, and every part of the work now constructed would pass the full amount of between 13 million and 15 million gallons a day required as the first instalment of water. The gradient of the aqueduct being from 4·5ft. to 6·87ft. per mile, cast iron pipes under pressure had been used, except in the three tunnels constructed at the hydraulic gradient, and in certain special places where steel had been employed. Throughout the syphons the hydraulic gradient had been varied wherever it was economical to vary it, subject to the total loss of head amounting to whatever could be afforded in each case. All specially expensive parts, such as valves and pipes under heavy pressure or in tunnels, had been considerably reduced in diameter from that of the cheaper portions.

The filter-beds were at Oswestry, where a recording gauge gave full information as to the variations in the water passing through the aqueduct from time to time. The five balancing reservoirs on the aqueduct were generally described, and the Norton tank, where the balancing reservoir was at a height of 113ft. above Norton Hill, was particularly referred to. The tank contained about 650,000 gallons, and consisted mainly of a steel basin in the form of the segment of a sphere in tension, depending from a steel ring in compression, resting through the medium of an expansion ring, upon the masonry.

The six river crossings, thirteen railway crossings, and six canal crossings, including the Weaver Navigation and the Manchester Ship Canal, were generally described. The crossing under the river Mersey was the most difficult portion met with. The pipes had been originally intended to pass through the bed of the river, but Parliamentary exigencies rendered it necessary to submit to a reference clause which resulted in a tunnel having to be constructed through ground full of water under a head of 51ft. The work was, however, successfully performed by means of a shield, and was now in every respect satisfactory.

AMERICAN PATENTS RECORDS.—The U.S. Patent-office has issued 3075 patents for inventions, contrivances, and discoveries in telegraphy. Over 25,000 inventions for the manipulation of metals have been patented. There are 636 patented fuels or methods of preparing wood, coal, and coke for use. Over 16,000 patents have been issued for the various kinds of electrical appliances. There are 1771 patents on the mechanism employed in sinking artesian or oil wells. Railways and railway appliances are represented by 8334 models. The annealing and tempering of metals have called for much attention, no less than 736 devices for these purposes having been patented. There are 4240 models of patented pumps in the Washington office,

TRACTION ENGINES ON ROADS.

THE Select Committee of the House of Commons appointed to investigate the working of the laws relating to the above subject sat again for the first time since the Easter vacation on Thursday, the 16th inst. The first witness called to give evidence was Mr. F. Bacon Frank, vice-chairman of the West Riding of Yorkshire County Council, and chairman of the Rural District Council. Mr. Frank stated that there were forty-nine traction engines licensed in the West Riding, the revenue derived from which was £450 annually, which amount he did not consider was sufficient to compensate for the damage done to the roads. He complained that Clause 23 of the Highways and Locomotives (Amendment) Act of 1878 was not clear enough, and, in consequence, did not work satisfactorily.

Mr. Trevor Edwards, the solicitor to the West Riding County Council, the next witness, considered that the maximum limit of speed might be increased in towns and villages from two to three miles an hour, but that on the country roads should be maintained at the present limit, viz., four miles. Asked regarding the number of men employed on each engine, the witness gave it as his opinion that the present number—three—was not too many. He recommended that the drivers, as well as the engines, should be licensed—a course he considered necessary for public safety. This licensing he would place in the hands of the county authorities, which bodies ought also to be allowed, as at present, to make bye-laws restricting the hours of operation of the engines. Other recommendations made by the witness were that no more than three wagons should be hauled by one locomotive, and the total length of such train, including engines, be not more than 54ft.; that in addition to the two lights carried on the front of the engine at nights, there should also be a red light carried at the rear; and that the clause relating to extraordinary traffic should be amended.

Mr. Hulton, Chairman of the Main Roads and Bridges Committee of the Lancashire County Council, having charge of 683 miles of main road and 834 miles of "secondary" roads, at an annual cost of £137,000 and £25,000 respectively, stated that the annual cost per mile of these roads varied between £20 and £600, according to the district. The cost of a licence taken out within the jurisdiction of this Authority was stated to be £5, while engines licensed by neighbouring counties could have their licences endorsed for a nominal fee of 10s. 6d. Mr. Hulton endorsed the recommendation of the previous witness regarding the increase of the maximum limit of speed in towns and villages, but considered that the working of Clause 23 of the 1878 Act was satisfactory. He did not think that uniformity of prohibited hours could be achieved, since the conditions necessary for working in different counties and county boroughs were so dissimilar. He recommended the legalising of the Bolton block tires, which had given great satisfaction in Lancashire.

Mr. J. Vickers Edwards, the surveyor to the West Riding of Yorkhire County Council, next gave evidence, in which he stated that their roads were of a condition quite suitable for ordinary horse traffic, but not strong enough for locomotives. He approved of the principle of the Bolton block wheel, but considered it very liable to get out of order, and consequently inflict much damage to the road surface.

At the proceedings of the Committee on Monday, the 20th inst., Mr. J. Moncur, surveyor of main roads, Staffordshire; Mr. Thomas, A.M. Inst. C.E., county surveyor, Buckinghamshire; and Mr. Phillips, county surveyor, Gloucestershire, were the witnesses examined. Mr. Moncur said there were a large number of locomotives at work in Staffordshire, and the prohibited hours of working were during the early part of the night. He would not advocate the increase of the maximum limit of speed, but would place the choice of type of wheels in the power of the Local Government Board. He would limit the use of traction engines to roads 18ft. and upwards in width, and thought it advisable to restrict the net loads hauled by engines up gradients of 1 in 10 to five tons. The other chief recommendations of witnesses were: that no more than three trucks should be allowed to be hauled by one engine, and that a red light be carried in the rear at nights. Mr. Thomas stated that there were forty engines licensed in Bucks, the licence fee being £3, and that there were no prohibited hours for working. He would increase the maximum limit of speed on country roads to six miles, but recommended no addition to the speed in towns and villages. His experience of the construction of wagon wheels showed that the tires were frequently too narrow, and suggested that they should have a clear inch in width for each ton carried. As regards the extraordinary traffic clause, he had no complaint to make, but thought that, with the increase of speeds indicated, the man in front of the engines might be provided with a cycle.

The last witness, Mr. Phillips, informed the Committee that there were no prohibited hours for working in Gloucestershire, and that no accidents had resulted from this arrangement. The licence fees varied from £10 per annum for engines of 10 tons and upwards, decreasing £1 per ton below this weight. Mr. Phillips recommended the alteration of the clause which specified that all wheels should be cylindrical; the registration of all road engines, including rollers and agricultural engines, and the insistence of the inspection of engines by the registration authorities. In place of the annual licence the witness proposed a novel scheme for levying a tonnage rate on the net loads hauled, and suggested as a reasonable rate ¼d. per ton per mile. This would necessitate the forming of small sub-committees of County Councils, and the detective duties might be performed by the weights and measures authorities. He stated that by this arrangement about £700 per annum would be derived from the traffic in Gloucestershire, as against about £180 as at present with licence fees, and that owners had expressed themselves satisfied with the scheme, provided that the extraordinary traffic clause were abandoned. The witness stated that to raise the quality of the Gloucestershire roads, which had not yet been so treated, up to locomotive standard, would involve the expenditure of about £500 per mile, or £250,000 altogether, a sum which he did not consider ought to come out of the pockets of ratepayers.

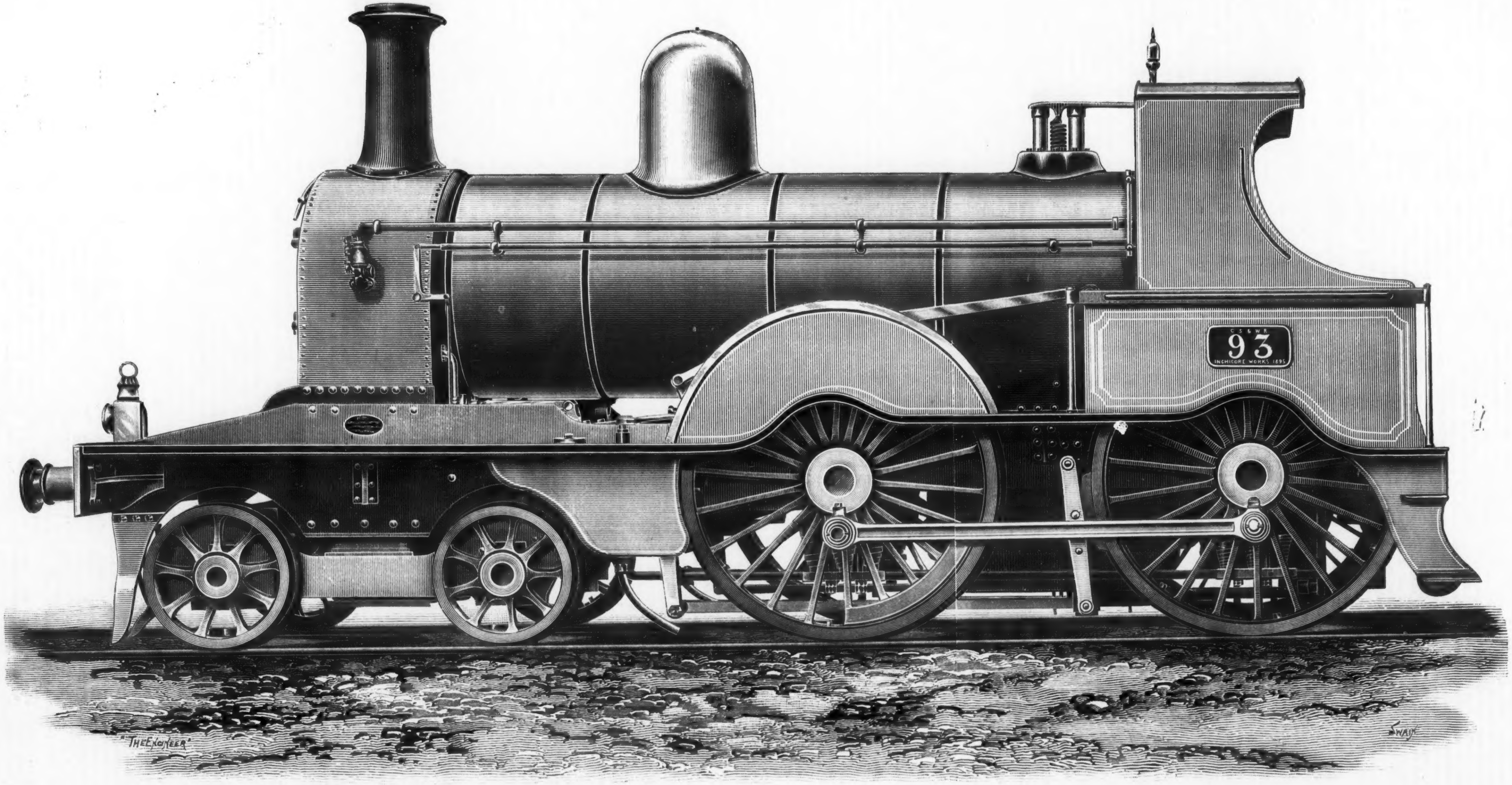
The Committee again adjourned until yesterday—Thursday.

STEPS have recently been taken to increase the water supply of Slough, for which purpose the engineer, Mr. Secker, has had a series of three 11½in. artesian tube wells bored by Messrs. Le Grand and Sutcliff, of London, to an average depth of 150ft., the chalk formation being reached at from 61ft. to 72ft. below surface. The boring operations occupied ten weeks, or an average of twenty days each, including pumping trials. The three wells are to be coupled to one receiving main, and their united yield is equal to a supply of nearly two million gallons per diem.

COMPOUND EXPRESS LOCOMOTIVE, GREAT SOUTHERN AND WESTERN RAILWAY

MR. H. A. IVATT, M. INST. C.E., INCHICORE, ENGINEER

(*For description see page* 417)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TO CORRESPONDENTS.

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*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and bearing a penny postage stamp, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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C. W. R.—*We stated a fact concerning water-tight doors. We did not express an opinion. The Admiralty will not adopt doors of the kind you suggest because they would take up too much room. Drawings and models of doors of the kind were shown and explained at the last meeting of the Institution of Naval Architects, and they were absolutely ignored by everyone present. We hold that the air lock idea is excellent, but we can also say at the same time that there are many objections to it. If, however, you can send a drawing properly worked out to show how your doors would be fitted, we will publish it.*

BOOKS ON RAILWAY SIGNALS.

(*To the Editor of The Engineer.*)

SIR,—Would any reader be kind enough to inform me if there is any work or works published which would give me full information of the working of railway signals in all countries, also of fog signals; also where I could get these works? J. B. P.

London, April 15th.

REVERSING PROPELLERS.

(*To the Editor of The Engineer.*)

SIR,—Will any reader kindly let me know the name and address of the makers of reversible propellers? J. W. B.

April 21st.

DR. ANGUS SMITH'S COMPOSITION FOR COATING WATER PIPES.

(*To the Editor of The Engineer.*)

SIR,—Will any reader tell what are the materials used in this composition, or where I can find a description of it? C. H. B.

London, April 21st.

SUPERHEATING STEAM.

(*To the Editor of The Engineer.*)

SIR,—I have a horizontal brick flue, 2ft. by 2ft. by 27ft., through which furnace gases are continuously passing, temperature 700 deg. to 1000 deg. I wish to utilise a portion of this heat, to superheat steam for boiling down waste liquors, &c. Would any of your readers advise me how best to do this? SUBSCRIBER.

April 21st.

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, April 30th, at 8 p.m. Paper: "On Railway Telegraphs, with Special Reference to Recent Improvements," by W. Langdon, member.

GEOLOGISTS' ASSOCIATION.—Friday, May 1st, at 8 p.m. Papers: "On the Physical Geology of Purbeck," by A. Strahan, F.G.S., illustrated by the lantern. "Notes on Mollusca from the Skiddaw Slates," by J. Postlethwaite, F.G.S.

SOCIETY OF ARTS.—Monday, April 27th, at 8 p.m. Cantor Lectures: "Applied Electro Chemistry," by James Swinburne. Four Lectures. Lecture I.—Introductory—Phenomena of Electrolysis. Wednesday, April 29th, at 8 p.m. Paper: "Fruit Drying or Evaporation," by Edward W. Badger.

ROYAL INSTITUTION OF GREAT BRITAIN.—Tuesday, April 28th. Afternoon Lectures, at 3 p.m.: "Child Study and Education," by Professor James Sully, M.A., LL.D. (Lecture III.) Thursday, April 30th. "Recent Chemical Progress," by Professor Dewar, M.A., LL.D., F.R.S., M.R.I. (Lecture III.) Friday, May 1st, at 9 p.m. Paper: "Chronographs and their Application to Gun Ballistics," by Colonel H. Watkin, C.B., R.A., M.R.I.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Saturday, April 25th, at 6 p.m. Discussion on "Some Structural Details of Modern Ships," by Mr. M. C. James, will be resumed. Discussion on "The Determination of the Forces which produce Vibration with Three-crank Engines at High Speeds," by Mr. R. M. Ferrier, and "Balancing High Speed Engines," by Mr. A. E. Doxford, will be opened by Mr. James Patterson.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—Saturday, April 25th, at 2 p.m. Papers for discussion: "Short History of the Jameson Coke Oven," by Mr. John Jameson. "Report of the Proceedings of the Flameless Explosives Committee," by Mr. A. C. Kayll, engineer. "Resistance of Air Currents in Mines," by Mr. T. L. Elwen. "Coal-cutting by Machinery," by Mr. William Blakemore. "A Compound Winding Engine," by Prof. W. Galloway. Paper: "Gas Producers and Gaseous Fuel Illuminants," by Mr. Robert Martin.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, April 28th, at 8 p.m. Papers to be discussed: "The Thirlmere Works for the Water Supply of Manchester," by Mr. G. H. Hill, M. Inst. C.E. "The Vyrnwy Works for the Water Supply of Liverpool," by Mr. G. F. Deacon, M. Inst. C.E. Papers to be read: "American and British Methods of Manufacturing Steel Plate," by Mr. Jeremiah Head, M. Inst. C.E. "Four American Rolling Mills, by Mr. Samuel T. Wellman. Friday, May 1st, at 8 p.m. Students' meeting—Paper: "Swing Bridge over the River Nene at Sutton Bridge," by Mr. Edward S. McDonald, Stud. Inst. C.E. Sir Douglas Fox, Vice-president, Inst. C.E., will preside.

THE ENGINEER.

APRIL 24, 1896.

HORSELESS CARRIAGES.

IT is absurd to doubt that a great and novel industry is springing up in this country. The self-propelled vehicle is with us, and its popularity will not be less than that of the bicycle. The history of the movement in favour of mechanical road carriages has yet to be written. History is being made daily. But our descendants will probably wonder not that the horseless carriage has caught the public fancy, satisfied an all but universal want, or gratified a ubiquitous desire, but that we, as a nation, consented for so many years to leave the finest highways in the world comparatively unutilised. No doubt the bicycle has done much to educate public opinion. We have learned that the roads of a country can be employed without the aid of horses and without walking on them. The fact was known to comparatively few until recently. Now it is understood by everyone. The step from the bicycle to the horseless carriage is as nothing to the leap between the horse drawn vehicle and the bicycle. It is impossible to forecast the results of the adoption of the new mode of locomotion with either certainty or profit. But it is not difficult to understand why the horseless carriage should be popular. The age is an age of movement. A little thought will serve to convince most men that the great difference between the world of to-day and the world at the beginning of the present century is that locomotion of every kind, and in all its endless forms, is infinitely more facile and more abundant now than then. Civilisation and locomotion go together. Not locomotion of the individual or the thing only, but locomotion of thought. It is because he has given the world roads and railways, and steamships and telegraphs, that the engineer has been the civiliser of the world. He has done more to promote material progress than the warrior, the statesman, or the philosopher. And the desire for locomotion has grown, and is growing. More people travel each day than travelled the day before. Our ships steam faster, our trains run more quickly, year after year. The horseless carriage will come to satisfy the wants of a humanity which finds the railway too unwieldy, the horse too expensive, and the cycle too trivial.

Very largely, no doubt, the advent of the oil engine has promoted the growth of the horseless carriage. Legislation has laid a heavy hand on steam, and has done infinite harm not only by prohibiting the use of steam-propelled pleasure carriages, but by stopping invention and the development of ideas. Inventors and engineers have been assured so strongly by legal enactments that a steam-propelled vehicle must be a nuisance that they have come to believe it. The petroleum motor has not yet earned or received a pestilent parliamentary reputation. The public are willing to believe in it, though they will not believe in steam, knowing the while not much, if anything, about either; and less in any case about steam than about petroleum. We are much mistaken, however, if it is not yet found that steam will hold its own against the petroleum motor. Its possibilities are far greater now than they ever have been hitherto. We can produce engines of a lightness undreamed of in the days of Hancock or Gurney, and boilers which, fired with petroleum, will realise the wildest dream of the inventor in the matter of small size and power. A copper coil which can be carried on a man's forearm will, as we have seen, make steam enough to propel a carriage carrying four persons on an indifferent road at a good pace. But it is indisputable, whatever steam may be or may do, that the notion of the petroleum motor has proved attractive; and our friends in France have not hesitated to push praise of the light oil engine to the extreme limits of veracity. The public has been promised a vehicle which will leave nothing to be desired, and the public has wondered how it has done without that vehicle so long. That is one reason why the present movement is so powerful, so widespread, and so rapid. But this is not all; the public needs to be educated, and we think we are justified in taking credit to ourselves for the part we have played in promoting the establishment of the new industry.

For years we have carefully placed before our readers particulars of every advance that was made in steam locomotion on common roads. We have persistently advocated the cause of the traction engine and the modification of legislative restriction. When in France, where the law of highways does not kill invention in the matter of locomotion, the new vehicle propelled by oil was brought before the public, we despatched a special commissioner to examine, investigate, and describe for the benefit of our readers; and we venture to say that THE ENGINEER was the first journal in England to tell the world what was being done in France. So impressed were we with the results of our investigation, that we decided to do all that lay in our power to promote the construction and use in Great Britain, and in British possessions, of the self-propelled vehicle. To that end we took two steps of prime importance. To stimulate invention we offered substantial money prizes, and we were successful in enlisting the warm co-operation of two eminent engineers and one equally eminent electrician. The names of Sir Frederick Bramwell, Mr. J. Audley Aspinall, and Dr. Hopkinson, are a sufficient guarantee, not only of the trustworthiness of the trials which will decide the awarding of our prizes, but of the real importance of the undertaking as a whole. We cannot but think that the possession of a first prize may be taken as a certificate of merit, possessing an unparalleled significance. The severe nature of the tests to which the competing vehicles will be submitted, and the absolute competence of the judges to estimate at their true value each phase of the performance of the vehicles, will impart maximum value to the awards, a value which we feel certain the public will not fail to appreciate.

But it was not enough to promote the construction or development of the horseless carriage. It was essential that our highways should be thrown open to its use. To this end we promoted a memorial to the Government, and the host of signatures we have obtained in every centre of industry in the kingdom could not fail to impress Government, and assist the good work. The mere demand for change in the law could effect little unless it was backed up by substantial evidence of the soundness of the demand and the extended range of the desire for a change. We have left nothing undone to supply this evidence, and our efforts have been, we are glad to say, completely successful. The passing of Lord Harris's Bill is, we venture to hope, now a mere question of time, and long before the date of our trials the highways will be thrown open to the use of the self-propelled carriage, under the same restrictions as those which now regulate the use of the horse-drawn vehicle. We ask for no more, and the country will be satisfied with no less. At every turn we hear of exhibitions, competitions, and prizes. They will all do good, no doubt. Far be it from us to say that they will not. But in the midst of the hurry and dust, and confusion of tongues, it is possible that the fact that to THE ENGINEER, the inception of the whole movement in this country is mainly, if not wholly, due may be forgotten; and we have been too much gratified by the success which has hitherto attended our efforts to suffer the truth to slip into oblivion. It is not every day that a journal can accomplish so much for the promotion of a new national industry as THE ENGINEER has done. That must be our sufficient excuse for insisting, as we do, on the fact.

ENGINEERS FOR THE ROYAL NAVY.

To state opinions as facts is a not unusual method of controversy. A notable example is supplied by a letter written by Mr. Albert Durston, Chief Engineer of the Navy, in reply to one addressed to him by Mr. Adamson, secretary of the Institute of Marine Engineers. In our last impression we referred at some length to a paper read by Mr. F. Cooper on "Engineers and the Royal Naval Reserve." We have not got a copy of Mr. Adamson's letter, which is of the less consequence that we can gather its tenour without difficulty from Mr. Durston's reply. That gentleman says:—"The paper on R. N. R. engineers is a most interesting one, and the matter is well put. Unfortunately, it is based on the erroneous statement published in THE ENGINEER, and it takes no account of our staff of chief engine-room artificers, and engine-room artificers who correspond to the junior engineer of the old navy or the mercantile marine. When these are taken into account our engine-room staffs compare favourably with the mercantile marine. As to points named in your letter (1) assistant-engineers for temporary service, as advertised for, the regulations will show we desire to get the pick of young mechanics whose parents have made some sacrifice for them. We do not, however, intend to increase them much more at present. (2) Engine-room artificers, as I have said, do junior engineers' duties, and I think their case well deserves consideration as to whether some of them could not have warrant officer's rank. (3) We should not, except in an emergency, draft engineers direct from the mercantile into the Royal Navy. (4) I think it would be a most desirable thing to put R. N. R. engineers on same footing as to training, &c., as the executive or deck officers."

The statement referred to as "erroneous" was published in our impression for March 7th last year. Whether it is erroneous or not is a matter of opinion, and not of fact, as Mr. Durston seems to think. Mr. Durston, it must be understood, speaks for the Admiralty, and what he has to say on the subject we may regard with strict propriety as an Admiralty utterance. We have stated, it will be remembered, that at least 1100 engineers and assistant-engineers are needed, and that a less number would not give the official complement to each warship that may be put in commission. We carefully eliminated all craft which no longer deserved the name of fighting ships; and we took for granted that if war on anything like a large scale broke out we should need all the ships we have. But the Admiralty, we have excellent reason to believe, do not contemplate the use of all our warships under any conceivable circumstances; and they have arrived at the conclusion that 850 engineer officers of all grades are sufficient to meet the needs of the Navy for the next twelve months. Now this may very well be true, and yet the statement which we have made, far from being erroneous, will remain strictly accurate. We assert, and we advance it as a fact, that there should be on the Admiralty lists a sufficient number of engineers to utilise every ship we possess, always and at all times. It appears to be useless to go on building more and more ships, while we cannot utilise what we have got. But it may very reasonably be argued, that this is a matter of opinion, and that none but experts can say how many ships of war we should need if war broke out. It happens that we have a very recent expression of opinion on this point from an expert, whose authority will scarcely be questioned. Lord Charles Beresford was the guest of the Sheffield and District Press Club on Saturday night, and among other interesting things he said:—"The First Lord of the Admiralty said we should not want all our ships. That he utterly denied. We were short of ships, and before we had been at sea a month we would wish we had more. *There ought to be a ship's company rating for every ship in the service, without touching the Reserves.* Between April, 1897, and 1899, we should have to get 22,000 men. Where was the First Lord going to get them? It was a very different matter getting men in these days, from what it was in former days. Now we require engine-room artificers, artificers, and stokers. These men were all skilled men. It took five years to make a seaman-gunner who could handle guns. In the Marlborough, the first ship in which he went to sea, 10 per cent. of those on board were non-combatants. In the Magnificent now there were 52 per cent. of non-combatants, so they could understand how the character of a ship's company had altered. The position of being short of actual requirements at the present moment, and not being ready for requirements three years ahead, was a dangerous position."

We direct attention to the words which we have italicised. As regards bluejackets, we do not express any opinion. We are content to take Lord Charles Beresford's word. But we do ourselves assert—and that as strongly as possible—that every ship in the service should have her full complement of engineers. Probably if Mr. Durston will look at the matter from this point of view he will see that far from The Engineer's statement being erroneous, it was perfectly accurate in the most minute particulars. The difference between ourselves and the Admiralty is not one concerning the number of engineers, but the number of ships. Provided all the ships in the Navy of the classes we particularised are to be available in war time, 1100 engineers must also be available to man them. Mr. Durston does not, we take it, dispute this. It cannot be disputed in the face of the Navy List. The contention of the Admiralty is that all the ships we possess would not be available in war time, whether we had engineers for them or not. This is a very remarkable and even startling proposition. We shall be surprised if we have heard the last of it.

It may be urged that this is not what the Admiralty really means. That they "back their luck" that there will be no war, and that, consequently, there are engineers in abundance. We fancy that very recent events must have excited some little doubt at Whitehall as to the prudence of this policy. It would in any case be interesting to know what percentage of our fleet our Admiralty contemplate putting in commission on emergency. We could then form some opinion as to whether there is or is not a delusion operating at Whitehall. But let us, for the sake of argument, conclude that only a percentage of our fleet would take part in a war, and go on to ask on what basis 850 officers are held to be sufficient. So far as we can gather, no provision whatever is made in this estimate for the "expenditure" of engineers. As we have already pointed out, they are, it appears, in Admiralty estimation endowed with charmed lives, which will carry them safe from violence, and with iron constitutions which will enable them to sustain the most tremendous bodily and mental exertions without breaking down. Our estimate of 1100 officers provides no reserve of any kind. There is nothing to draw on if a man is invalided; no one to take the place of a man killed or disabled. In a word, the error committed by The Engineer lies in under-estimating instead of over-estimating the number which should be available. We may knock off 30 per cent. of all the ships on our list, and then in war time 1100 would be all too few.

So much being said in defence of our accuracy, we may go on to consider the subject from another point of view. Lord Charles Beresford pointed out in the speech to which we have just referred, that the Admiralty are going to add forty-six ships to our fleet within the next two years. We shall be under rather than over the mark if we say that 100 engineers of various grades will be needed for these vessels. It is true that many of them are torpedo catchers with but one engineer each, but others ought not to carry less than six engineers each. Where, we ask, do the Admiralty propose to get these men? And we may ask further, why it is that the Admiralty is so persistent in its policy of under-manning the engine-rooms of our fleet? The money saved is such a small sum by comparison with other items of expenditure, that we cannot believe that parsimony or a desire to save has anything to do with the matter. Is it not a fact that we have not more naval engineers because the Admiralty cannot get them? On this point a little enlightenment is most desirable. The official statement that all the men wanted are to be had must be discounted. Everything depends on how many the Admiralty say are necessary. Instead of 850 officers, they may hold that 50 would suffice. They may think that all the men they can get, however few, are enough. On this point we want something more reassuring than a mere expression of Admiralty opinion. If we had an engineer as First Lord we fancy that matters would assume a somewhat different aspect.

We gather from Mr. Durston's letter that the Admiralty regard engine-room artificers as competent to discharge engineers' duties. Is it too much to suppose that the Admiralty rely on the artificers to supply the deficiency in officers? Mr. Durston's letter would appear to suggest that it is not. If so, the inconsistency of the policy of Whitehall becomes more than ever manifest. We are told that the naval engineer must have an exceptionally excellent technical education, and in the same breath we are informed that artificers are competent to discharge the duties that highly trained gentlemen are expected to perform. It really is time, we think, that the Admiralty should make some specific statement of the nature of its policy as regards engineer affairs; there is nothing more likely to lead to confusion and misapprehension than reticence. The First Lord of the Admiralty virtually ignores the engineering branch of the service in his speeches. Others are not more open. No good purpose is served by silence, and much would be gained by a definite explanation of the system to be adopted in future in manning the engine-rooms and stokeholds of our ships of war, and the reason why two engineers and half-a-dozen artificers can do the work in a man-of-war that cannot be performed by less than a dozen engineers, with their greasers, &c., in an Atlantic liner, and of the part which the artificer is intended to play in future. Several other matters suggest themselves as needing elucidation; we should be satisfied, however, with definite information on the points we have stated.

THE INCANDESCENT GAS LIGHT CASE.

Public interest has been aroused in no common degree by the actions which have lately been brought by the Incandescent Gas Light Company, Limited, against the De Mare Incandescent Gas Light System, Limited, and the Sunlight Incandescent Gas Lamp Company, Limited, for infringement of the former corporation's patent. Many technical cases of the greatest commercial importance, and directly affecting the convenience and pockets of thousands of the general public, are fought out in comparative obscurity, and receive brief paragraphic notice in the daily press. The only difference in the present instance consists in the fact that the matter in dispute is one coming immediately and literally before the eyes of the community. Throughout the country, in every little town boasting a small gas works, one or more enterprising tradesmen are certain to have adopted the novel light to dazzle their customers and display their goods, and both users and onlookers feel that they have some personal knowledge of the nature and qualities of the mode of illumination known succinctly but inexactly as the incandescent gas light. The state of general opinion is accurately indicated by the appearance in the *Times* of Monday last, not only of an account of the judgments given on Saturday, but also of a leading article recapitulating and commenting upon those judgments. A judicial delivery on a patented process for the production of synthetic indigo at a cost lower than that of the natural material might occur and pass almost unregarded, although its effect upon one of the great industries of the greatest of our dependencies might prove to be colossal. That the obvious is always to be met with is more than an etymological truism. But apart from its popular side, the recent contest possesses interest of a technical character sufficient to warrant its consideration in these columns.

For months it has been a matter of common knowledge that the Welsbach system of lighting, owned and worked by the Incandescent Gas Light Company, has, after a long period of probation, advanced to an assured industrial position. Difficulties and defects in the earlier forms of the light have been gradually overcome by the persevering research of the company's technical advisers, and a light has been produced which for economy and efficiency takes a high rank. With the remembrance of lean years the company, being a trading organisation, no doubt sought to recoup itself with all possible speed. The prices charged for burners and mantles bore but a distant relationship to their cost of production, and the public, legitimately enough, was made to pay pretty stiffly for a valuable idea. The natural result followed. Others were anxious to reap part of the rich harvest which it was evident could be gathered from the not wholly intelligible anxiety of civilised man for a superfluity of artificial light. The principle underlying all varieties of incandescent gas lighting has been dealt with in this journal within the last few weeks, and needs no re-statement now. It is enough to say that inventors seeking a method to rival the Welsbach light must devise a different form for the refractory material to be heated, or must employ a different refractory material, or must prove the Welsbach patent invalid. Attempts in all these directions have been made, but with indifferent success. In the defence offered by the De Mare Incandescent Gas Light System it was contended that the patent was not novel, as the production of light by heating certain refractory substances has long been known and practised. This was emphatically negatived by Mr. Justice Wills, who, in a judgment showing a remarkable grasp of a subject not without complexity, stated that, in his opinion, the patent covered perfectly new ground and had shown the road to success in a region where before was failure unrelieved. Further, it was argued for the defence that the specification did not give instructions sufficiently precise to allow of the manufacture of mantles by the prescription included therein; this was also overruled. Thus for the validity of the Welsbach patent there has been issued a weighty pronouncement. Beaten on this point, the defence resorted to the denial that their method of lighting infringed the Welsbach patent. The structure used by the De Mare Company is a "plume," described in the judgment as consisting "of a number of threads tied on to a platinium wire, and arranged so as to form a sort of fringe, all the threads of which are brought very closely together where they are strung on to the wire, but allowed to separate as they leave it, so that the apparatus looks like a housemaid's small brush, the cross-sections of which would take the shape of a fan." The refractory oxides used in the formation of this plume are zirconia, erbia, and magnesia, and in the opinion of the Court fall within the scope of the Welsbach specification. Differences in the mode of manufacture and in the design of the finished plume from those of the Welsbach mantle were held not to constitute a departure sufficiently great to exonerate the defendants from the charge of infringement. Judgment was accordingly given against the De Mare Company, and, should the decision be upheld on appeal, the manufacture of plumes of the refractory rare earths must be discontinued until the lapse of the Welsbach patent.

The second case—that against the Sunlight Company—took a somewhat different course, and led to a wholly different conclusion. The refractory structure manufactured by the Sunlight Company is a hood or mantle scarcely distinguishable in form from that made by the Incandescent Gas Light Company. The material of which it consists, however, is composed of 50-60 per cent. of alumina, about 30 per cent. of zirconia, and a top-dressing of chromic oxide. The last named is applied by spraying a solution of a chromium salt on to a mantle made of alumina and zirconia and igniting the composite product. Mr. Justice Wills considered that the large difference in the oxides used from those employed in the Welsbach mantle removed this hood from the domain of the Welsbach patent which specifically embraces rare earths, whereas none of the oxides adopted by the Sunlight Company can properly be described as belonging to this chemical category. Some stress was also laid in the judgment on the homogeneity of the Welsbach mantle, and the heterogeneity of the Sunlight hood, the latter quality being presumably brought about by the process of spraying the chromium salt on to a skeleton previously rendered coherent. It is difficult to agree with this view, for seeing that the chromium is applied in a soluble state to a porous material it will penetrate the latter to a considerable extent and may even saturate it, forming ultimately a mixture almost as intimate as that produced by the simultaneous application of all the constituent oxides. We are, therefore, inclined to believe, that the essential ground for allowing, as was ultimately done, the claim of the Sunlight Company's patent to be considered no infringement of the Welsbach patent, consists in the nature of the oxides used rather than in the particular mode by which they are formed into a mantle. Thus the Sunlight Company is in the present position of affairs, free to make and sell a mantle of shape substantially identical with that of the Welsbach device. Disregarding the possible result of an appeal, the ultimate success of the mantle depends on its efficiency as compared with that of the Welsbach, and on its prime cost.

The result of the two actions at law, which we have sketched above, goes a long way to confirm what we have said on the occasion of previous patent cases of a similar kind. There is a strong disposition—and on the whole it is a healthy one—on the part of the Courts to uphold, if possible, a patent which is new and useful in a given field, even if foreshadowings of it can be adduced as anticipations. At the same time, although a fairly liberal interpretation of the specification of a patent of this class may be expected, it not infrequently happens either that the specification claims more than can be shown to be practicable, or it omits some method which is afterwards proved to be practicable in a way peculiarly poignant, viz., by its successful exploitation at the hands of a rival in trade. The protection of modifications of a process by separate patents, instead of by numerous claims or an omnibus claim in a single specification, appears to be advisable where the interests to be guarded are large, and opposition is probable. With regard to that aspect of the case which has to do with the evidence of experts on both sides, we should be silent were we not thoroughly convinced of the necessity of iteration. It is not insignificant that the *Times*, not usually over-mobile in its views, has adopted the opinion which we have oftentimes expressed, and declares that picked technical assessors aiding the Court in matters of scientific fact, even as a judge aids a jury on points of law, would much facilitate the hearing of cases lying outside the knowledge of the Court. The attainment of these desirable ends would be a reasonable compensation for the regrettable loss of many a racy story.

THE GROWTH OF STEAMSHIPS.

The return of the vessels in course of construction at the end of the first quarter of the year has some features that are of special interest. There is first shown the fact that out of all the steamships building, steel was the material used except in a trivial quantity; and that is due to the fact that iron and wood are only used in the construction of a few steamers which average 120 tons each, and are thus shown not to be for ocean purposes; whilst, on the other hand, the average of the steel steamships building was about 2250 tons each; and in only a slightly minor degree, similar remarks apply to the sailing vessels that were in course of construction in the same quarter. Out of some 400 vessels building in the United Kingdom, the largest proportion—more than a seventh– is of vessels between 3000 and 4000 tons; and the next largest is for vessels between 2000 and 3000 tons; whilst even in the numerical contrast, the comparison is in favour of the large steamers. In Belfast, the average size of the vessels building is very noticeable, it being over 5300 tons for both sail and steam together, an average which does not seem to be attained by any other of the British districts tabulated by Lloyd's returns. At the same time, it is noticeable that on the Continent there are many vessels of large dimensions in course of construction. At Lubeck, Rostock, and Stettin, out of the vessels building there, seven were of an average of 5900 tons each, but this is the average of the large vessels only—the smallest vessels not being included in the tables. Apart from Germany, there does not appear to be any very large average attained by the builders, though in one of the French districts, the large vessels in course of construction were over 3000 tons each, subject, however, to the remark already made as to the exclusion of small vessels from the returns. The fact, however, may be looked on as settled, that the tendency towards the building of large steamers continues, and that there is now a determination on the part of some of the foreign builders to participate in the orders for the construction of these vessels of greater tonnage. How far it will go remains to be seen, but the large steamships will increase the share of the work of the world over the seas they have been doing.

LITERATURE.

Polyphase Electric Currents and Alternate Current Motors. By SILVANUS P. THOMPSON, D.Sc., &c. London: E. and F. N. Spon. 1895.

THE author delivered a course of four lectures at the Technical College, Finsbury, on the subject of "Polyphase Currents," and has now published the matter with many additions, in the form of the present volume. Little has so far been done in this country with polyphase currents, and the author offers his thanks to German and Swiss firms for many particulars of which he has made use. The addition at the end of the volume of a full bibliography of the subject, and also of a list of British patents, will be found of great use. The book opens with a sketch of the construction of the ordinary alternator, and diagrams show how the current curve is caused to lead or to lag behind the volt curve. In our opinion the graphic method is decidedly the most useful for dealing with this subject; and the Zeuner type of diagram, so familiar to all mechanical engineers, is referred to in the first chapter, and is very useful for showing the momentary pressure on each of the three wires of a linked system. It seems strange to be reminded that the original Gramme machine, built about 1877, was in reality a polyphase generator, but the circuits were kept separate, and there is no reason to suppose that Gramme realised the possibility of linking up the different monophase currents. The author gives, in his usual lucid style, a description of the elementary form of polyphase generator, and this is followed by a description of the now historical machines used for the Lauffen transmission work. The second chapter deals with the combination of polyphase currents. The author makes use of the clock diagram to show how the pressure varies between the line wires of the three-phase system when the coils of the generator are joined up in star fashion, proving that the pressure between two of the leads outside the machine would be 173 virtual volts, while that generated by one coil was 100 virtual volts, and diagrams make this somewhat difficult subject clear.

Economy in copper is most assuredly obtained by the use of the polyphase system, and the author proceeds to point out that the pressure is determined by the lamps, which are not practicable for voltages over 100 to 110. This statement we think requires some correction, in view of the fact that in Bradford and elsewhere lamps have been used with the greatest success for 215 volts; and, in fact, there is little doubt that the three-wire system for direct current will be used very largely with 400 to 480 volts between the outside wires.

The author discusses the somewhat intricate question of the relative costs of copper, and finds that the three-phase system with the lamps joined in mesh, only 75 per cent. of the copper is used which would be required for the single-phase system. Taking the single phase and two wires as 100, the relative costs of the other systems have been put very clearly by Mr. Goerges. It appears that the single-phase three-wire system, with the middle wire half the section of the others, stands at 31·35; while three-phase with four wires has no advantage over the ordinary three-wire system, when the extra cost of fixing the fourth wire is taken into account.

The author uses steam-engine analogies to show how the two-phase and three-phase currents are used to produce the rotary field, and then takes up the history of Arago's experiments on rotating magnetic fields, followed by those of Babbage and Herschel. Walter Baily exhibited the first polyphase motor in 1879, before the Physical Society of London; and this fact will surprise many, who considered that the type had its origin in Germany. Three years later, Deprez laid down an important theorem; and in 1885 Professor Galileo Ferraris, of Turin, arrived independently at the same fundamental ideas as Baily and Deprez. A history is then given of Tesla's work, and also of the work of other electricians, the Frankfort Exhibition naturally supplying the best examples. The author then describes Mr. C. E. L. Brown's machines, and uses the dreadful words "rotor" and "stator" respectively for the moving and stationary parts of the machine. The most important part of the work is probably that which deals with the structure of the polyphase motor, and Chapter VI. deals with the theory of its structure. The volume closes with reference to the work carried out by various firms at the present time; and we may say that it sums up, in a very compact form, information hitherto scattered through the pages of the "Proceedings" of scientific societies and technical journals.

Die Berechnung der Centrifugalregulatoren. Von W. LYNEN. Berlin: Julius Springer. 1895. (The Calculation of Centrifugal Governors.)

THIS work is written by the governmental architect and private tutor of the Royal Technical High School of Charlottenburg, near Berlin, and is the first work we have seen devoted solely to the consideration of the design of the various forms of speed governors for prime movers. The author has evidently made the subject his special study, and although a considerable knowledge of the higher mathematics is required to enable the reader to follow him throughout, yet the various curves and formulas given should be of use to the practical designer. The method used is synthetic, and the action of each single force is considered separately. The general conditions of equilibrium are not discovered by analysis of the forces, that is to say, by static methods, but by the dynamic method. Results are given in the form of a series of curves, and with the aid of curves 1 and 2 the author considers that all weight governors with normal action can be calculated.

One result is a new calculation of the double ball governor, and the author hopes that the efficiency of the cosine governor will be better understood. The subject of axis governors is thoroughly treated, and it is pointed out that spherical or disc weights are to be preferred, for constructional reasons, to the usual club-shaped swinging weights. Numerous examples of calculation are given, in order that the new method of calculation may be clearly understood. The author concludes that the numerous governors in use do not essentially differ from one another, and that the type invented by Watt must be reckoned among the best. The curve of centrifugal force for the three governors at the end of the tables shows a turning point. This type is especially suitable for engines running with great uniformity, such as are used for electric light work, for it is almost astatic at the speed generally used, and has great power at the extreme speeds.

The author considers that, in spite of the importance of governors to engine builders, there is yet a great lack of knowledge on the part of engineers; the reason of this, he suggests, is that governors are built to a large extent by firms who make a speciality of the work. Personally, we think, however, that the latter statement is more applicable to continental than to British practice. Alluding to the analytical method of calculation, the author points out that the weight is considered in conjunction with the gear for moving the sliding piece, and there is a mass of values which only a maker with long practice can understand. He also gives a sketch of the usual figure drawn, and quotes the resulting formula for angular velocity in which there are eight arbitrarily chosen values. The value of ω is less decisive than the change of angular velocity with change of the value, but on this point neither formula nor diagram give any information. The author's method is first to consider the centrifugal force of a rotating mass, then the centrifugal force of a centrifugal pendulum suitable for the governor, and afterwards the forces other than centrifugal forces acting on it. The action of the latter is independent of the rotation of the governor, and depends only upon the nature of the movement. Examination must begin with the most normal motion, and with the simplest changes, and afterwards other and more complex changes can be dealt with. The superiority of the graphic method over the arithmetical is well shown for obtaining rapidly a clear view as to which particular part of the governor must be dealt with to obtain a desired result. The volume should certainly be of value to governor designers who can read German and follow the calculations. A great many different types of governors are dealt with, and the whole of the illustrations are merely line diagrams showing the links and joints.

A Laboratory Course of Experimental Physics. By W. J. LOUDON, B.A., Demonstrator in Physics in the University of Toronto; and J. C. MCLENNAN, B.A., Assistant Demonstrator. London: Macmillan and Co. 1895. Demy 8vo. Pp. 302. Net 8s. 6d. Uncut.

THIS somewhat cosmopolitan production—devised in Toronto, printed in Norwood, Massachusetts, and published in London and New York—is intended to overcome the difficulty experienced by the authors in providing during a limited time ample instruction in the matter of details and methods to large classes engaged in experimental physics in laboratories, and they signify that the book contains a series of elementary experiments arranged as far as possible in order of difficulty. These are intended for students who have but little acquaintance with higher mathematical methods, and they are followed by an advanced course of experimental work in acoustics, heat, and electricity and magnetism intended for those who have taken the elementary course, and who have a more extensive acquaintance with mathematical methods.

The elementary course is arranged under the following headings:—The vernier, the calipers, the cathetometer, the spherometer, micrometer, screw gauge, dividing engine, specific gravity bottle, hydrostatic balance, hydrometers, Mohr's balance, Boyle's law, the volumenometer, determination of capillary constants, the sextant, the goniometer, curvature of mirrors, focal length of lenses, indices of refraction, magnification with lenses, photographic lenses, photometers, specific heat of solids and liquids, latent heat of fusion, and level testing.

The advanced course is divided into three sections:—(1) Acoustics, dealing with the sonometer, equal temperament, transverse vibration of strings, pitch, Lissajou's method of tuning, harmonic motion, overtones, the chronograph, the clock fork, Melde's experiments with strings, Helmholtz's apparatus for combining simple tones, Kœnig's analyser, the manometric flame, velocity of sound and Dœppler's principle; (2) heat, dealing with thermometers, coefficients of expansion of dry air, Favre and Silberman's calorimeter, latent heat of steam, weight of dry air, hygrometry, density of vapour, Dumas' method, coefficient of expansion of metals, specific heat of dry air, pressure of vapours for low temperatures, and Regnault's apparatus for the determination of the pressure at high temperatures; and (3) electricity and magnetism, treating magnetic lines of force, magnetic moments, the declination and inclination compass, intensity of earth's magnetic field, magnetic field of a current, tangent and sine galvanometers, hydrogen and copper voltameters, calibration of galvanometers, galvanic batteries, resistance, temperature, coefficient of resistance, galvanometer resistance, resistance of batteries, E.M.F. determination and absolute determination of resistance by use of calorimeter. Then the determination of gravity by the pendulum and the torsion pendulum furnish matter for two short appendices, and twenty-one tables of various data terminate the book.

From the above synopsis the scope and the arrangement of the matter may be gathered, and as regards the latter it must be admitted that it is by no means happy, especially in the elementary course, as the dodging about from subject to subject it necessitates could not but confuse the student; whilst as regards the former, when considered as a course of practical physics, it is inadequate and incomplete. It is true, on this point, the authors state that the important subject of "Physical Optics" has been omitted because they have not yet mapped out a suitable course of experiments. Then, as regards the treatment, in many instances it is concise and clear, in all it is brief, but in some it is unsatisfactory and cursory; for example, the student is suddenly introduced to the vernier, which is described but not defined; its construction is detailed, but the principles on which it is based are not clearly set forth; examples of its application are given, but the manner of applying it is not explained. Regnault's apparatus for the determination of the pressure of vapours at high temperatures is illustrated by an unworkable diagram with unexplained conventions, and the whole of the directions for working are, "compress the air in the large reservoir, determine pressure by means of the manometer and barometer, and finally take the temperature at the boiler." The object being essentially practical and instructive, the extreme brevity indulged in does not contribute to the utility of the articles. There are more or less copious tables of contents, distributed at irregular intervals, preceding each section in fact, which are far from readily accessible, and as there is neither a general table of contents nor an index, ready reference is impossible, a by no means useful feature in a book for students. The book, however, is well printed and well illustrated, and may serve a useful purpose as a note-book for the particular matters dealt with, and more especially as an adjunct to a more comprehensive course of lectures on practical work.

SHORT NOTICES.

The Volunteers and the National Defence. By Spencer Wilkinson. Westminster, London: Archibald Constable and Co. 1896. Price 2s. 6d.—This is an essay written with the object of giving a comprehensive account of the chief processes of modern war, and to show how the volunteer force may be fitted to do the work of defence with conditions of war what they are to-day. After an introduction and chapter on the scope and method of inquiry into the subject, the author deals with his subject in two main parts, and under the subheads mobilisation, transport, march, quarters, security and exploration, battle, actual conditions of volunteer service, attendances, ranges, principles of modern methods, discipline, and finance.

Lean's Royal Navy List, Containing Special Points of Interest. By Lieut-Colonel Francis Lean—Retired full pay—Royal Marine Light Infantry. No. 74. April, 1896. Published quarterly. London: Witherby and Co. Price 7s. 6d.—This excellent publication is now in its nineteenth year. It was started in January, 1878, and every year of its life has seen improvement in it. It is not too much to say that for fulness of information and careful editing it has no equal. As a book of reference it is invaluable.

The South-Eastern Railway: Its Passenger Services, Rolling Stock, Locomotives, Gradients, and Express Speeds. By the author of "British Railways." With three plates. London: Cassell and Co., Limited, 1895. Price 2s. 6d.—A very convenient little handbook of thirty-two pages, containing much information of interest and value to all who wish to know something of the working of railways. The South-Eastern has a somewhat bad reputation for unpunctuality and slowness. We gather from our author that this is not due to want of locomotive power—indeed it is not easily to find anything better than Mr. Stirling's latest engines—but to the severity of the gradients, the weight of the trains, and the crowded condition of the road. There are diagrams of speed and gradients, and very full particulars of the train service.

The London, Brighton, and South Coast Railway: Its passenger Services, Rolling Stock, Locomotives, Gradients, and Express Speeds. By the author of "British Railways." With two plates. London: Cassell and Co., Ld. 1896. Price 3s. 6d.—A capital little book of 56 pages. The author has more to say about the Brighton than about the South-Eastern Railway. The method of treatment is, however, the same. The particulars of locomotive work are very complete and interesting.

BOOKS RECEIVED.

The Cheque Bank Handbook, 1896. Second edition. List of principal banks and agents.

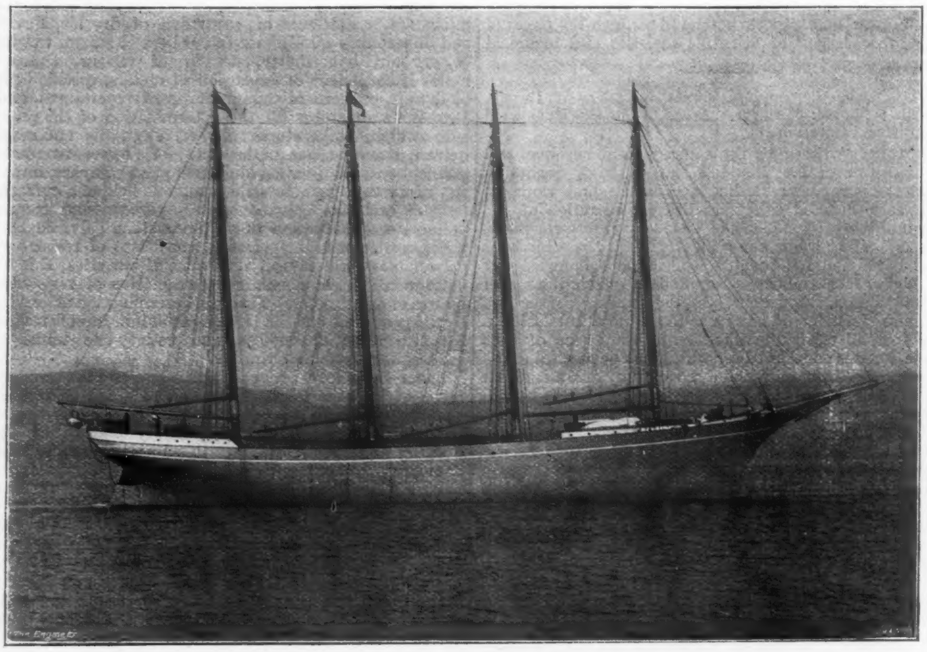
The Progress of Artillery. Naval Guns. By James Atkinson Longridge, M. Inst. C.E. London: E. and F. N. Spon. 1896.

An Elementary Treatise on the Calculus, for Engineering Students. With numerous Examples and Problems worked out. By John Graham, B.A., B.E. London: E. and F. N. Spon. 1896.

Les Rayons X et la Photographie à travers les Corps Opaques. Pat Ch. Ed. Guillaume, Adjoint au Bureau International des Poids e. Mesures, D.Sc. Paris: Gauthier-Villars et Fils. 1896. Paper 127 pp.

A REUTER telegram from Simla says heavy floods in the Panjkora Valley have damaged the bridges at Chutiatan, and have destroyed all the bridges on the river above Dir. It is hoped, however, that the forwarding of reliefs to Chitral will suffer no delay.

THE FOUR-MASTED SCHOONER HONOLULU



A NOTABLE CLYDE-BUILT SCHOONER.

The attention now being directed to the subject of the manning of ships, coupled with the constant aim of shipowners to avail themselves of any economy possible in that direction, while at the same time securing the needful efficiency, are considerations which should render some details of the new steel fore-and-aft schooner Honolulu of interest. This vessel—of which we give an illustration reproduced from a photograph kindly furnished to us by her builders, Messrs. Robert Duncan and Co., Port Glasgow—besides being the largest steel fore-and-aft schooner ever built in this country, is of a type very rarely met with in British waters, and altogether a novelty as emanating from the stocks of a Clyde shipyard. She has been built for the timber-carrying trade to the order of Mr. John Ena, merchant and shipowner, Honolulu, for whom Messrs. Duncan and Co. have before built sailing vessels of the ordinary kind. As will be seen from our illustration, the Honolulu, both in the matter of hull and of rig, has features distinguishing her from the ordinary sailing ships of modern times, at least so far as British practice is concerned. This was conspicuously made evident in the course of last month, when the Honolulu, while loading a general cargo prior to departing on her maiden voyage, lay alongside some of these full-rigged vessels in the Queen's Dock, Glasgow. Vessels of the type of the Honolulu, however, are no novelty on the Pacific, and along the west coast of America; many of these being double her tonnage, which is about 1000 tons gross.

Our illustration conveys a fair idea of the peculiarities of rig, of the vessel, and perhaps also of her hull. Features which at once attract notice are the great sheer, graceful clipper bow and bowsprit, the four lofty pole-masts of equal length, and the simplicity, not to say meagreness, of the rigging gear. The vessel's general proportions are somewhat extreme as compared with the proportions ordinarily adopted in modern sailing vessels, while the hull form is quite yacht-like in its fineness of lines. The vessel's dimensions are 225ft. length over all, or 210ft. between perpendiculars; 42ft. beam, and only five beams to the length; and 18ft. 6in. depth of hold. The rise of floor is of the unusual height of 6ft., giving a relatively small midship area, and, combined with the fineness of water-lines, giving a coefficient of form resembling that pertaining to those renowned tea clippers built in our midst in the "fifties," which made such marvellous passages to and from the Far East. The Honolulu has four huge steel pole-masts, each of them about 140ft. in height from keel to truck, and with an immense fore-and-aft sail, hooped to the mast and laced to gaff and boom. These four sails, and three jib sails which are carried forward, give a total spread of canvas considerably greater in proportion to displacement than the total sail area of any square-rigged vessel afloat.

The structure of the vessel is of the strongest description for the safe carrying of heavy timber cargoes, somewhere about 1¼ millions superficial feet of lumber being her complement. Save the collision bulkhead forward, the interior of the vessel is unobstructed from end to end, and there is no 'tween decks. The main deck from stem to stern is entirely of steel, with strong bulwarks supported by heavy bulb web stanchions every 4ft. apart, in order to secure safety in carrying the immense deck-loads common in the particular trade for which the vessel is intended. The forecastle deck is also of steel, while the poop deck is laid with specially selected Oregon pine. Besides having unusually large hatchways forward of each mast for timber cargoes, there are fitted in the bow and stern large ports capable of taking in the heaviest timber of almost any length, the timber being put on board by an ingenious arrangement of leads and pulley blocks worked from a special steam winch of extra power, situated in the large deckhouse abaft the forecastle. This steam winch, combined with a large multitubular boiler, is specially designed with warping drums, both horizontal and vertical, and every appliance and gearing, not only for loading and discharging deckloads of heavy timber, but for rapidly hoisting and working the vessel's immense fore-and-aft sails. This combination of boiler, winch, and gear has been supplied by Messrs. Murray Brothers, of San Francisco, who are familiar with the requirements in this installation of special machinery on board ships of this type. In case of need, steam can be raised in this boiler in about ten minutes to a pressure of 200 lb. per square incn—an immense advantage where all the spars, sails, and gear are of the heaviest description. Manual labour is saved to a very considerable extent, and a smaller number, or less experienced seamen, is capable of managing the sails, ropes, &c. The style of rig adopted, in fact, and the equipment of the vessel generally, admit of her being efficiently worked by about half the number of seamen which would be required under ordinary British regulations.

Steam from the boiler above-mentioned also drives a powerful capstan windlass of Emmerson and Walker's make, and also actuates one of Tangye's patent duplex steam pumps capable of throwing 2000 gallons of water per hour. This appliance will be invaluable in the event of fire or other accident to the vessel or cargo. A set of Mills' patent pumps is fitted amidships, which can also be worked from the steam winch through the medium of messenger chains. The entire outfit of blocks for the vessel is of a special and very expensive description made by Messrs. Laird and Sons, Irvine, from patterns and particulars supplied by its owner and adapted for the excessively hard work they have to accomplish. The rudder is of a design also furnished by the owner, and which is seldom seen in large sailing vessels in home waters, being abnormally broad at the bottom, tapering to nothing at the load water-line, for the purpose of manœuvring the ship quickly when going through narrow channels amongst the Sandwich Islands. The vessel, which is classed "British standard" with the British Corporation of Shipping, Glasgow, was built and equipped under the superintendence of Captain William Thonagel, of San Francisco, who has had great experience, and is well known in the Pacific trade.

THE RAILWAY ZONE TARIFF SYSTEM IN RUSSIA.

Since the introduction in February, 1879, of the special Government tax on railway passenger tickets, 25 per cent. on first and second-class, and 15 per cent. on third-class tickets, the passenger rate on Russian railways per mile has been 2·15d. per mile first-class, 1·61d. second-class, and 0·827d. third-class. From time to time attempts were made to reduce these rates, but all that was accomplished was a reduction in the three classes of 3 per cent. per mile in 1880, and 6·8 per cent. in 1891. The comparatively small use of the Russian railways showed conclusively that the rate was too high. While in 1891 the number of railway passengers in Great Britain was 817,000,000, in Germany over 315,000,000, in France 208,000,000, and in Belgium about 57,000,000, the number conveyed in Russia was only 43,500,000. Notwithstanding the enormous distances in Russia, more than one half of the passengers conveyed did not travel over 33·15 miles, and only 6 per cent. of the total travelled 199 miles. The number of coaches used is, therefore, very small. On the average for each first-class passenger five places were available, for each second-class passenger not less than four places, and on some lines twenty places, and for each third-class passenger more than two places.

The good results which followed the adoption of the zone tariff in Hungary led the Russian Government to pursue a similar course, and the new passenger tariff was introduced on 1st December, 1894. The zone tariff begins at 199·56 miles, between that point and 1011·3 miles there are 36 zones, viz., 199·56—331·5 miles, eight zones; 332·16—470·73 miles, seven zones; 471·39—656·37 miles, eight zones; 657·03—1011·3 miles, thirteen zones. After this distance every 33·15 miles is counted as a zone.

The cost of a third-class railway ticket for a distance of from 0·663 to 199·56 miles is: up to 106·08 miles, 0·824d.* per mile; from 106·74 to 198·9 miles, 0·516d. per mile. The charge for a second-class ticket is one-half, and for a first-class ticket two and a-half times higher than for a third-class. Children from five to ten years pay in each class half a full fare. Baggage to the amount of 36·112 lb. is allowed for each full ticket. The rate for transportation for each hundredweight of passenger's baggage is up to 215·48 miles, 0·369d. per mile; beyond that distance 9·64d. per zone is added. The new passenger tariff makes long-distance travelling by rail very much cheaper than under the former system. The following shows the comparative cost of a third-class ticket for distance up to 198 miles under the old and new systems:—

Distance.	Old tariff. £	s.	d.	New tariff. £	s.	d.
106·08 miles	0	7	8¼	0	7	8½
132·60 „	0	9	1¼	0	8	5
198·90 „	0	13	7¾	0	11	3¼
265·20 „	0	18	2¼	0	13	9¾
331·50 „	1	2	9¼	0	16	4
397·80 „	1	7	4	0	18	6¾
464·10 „	1	11	10¼	1	0	9¼
530·40 „	1	16	5	1	2	8
596·70 „	2	0	11¾	1	4	6¾
663·00 „	2	5	6¼	1	6	5¾
994·50 „	3	8	3¼	1	14	6¼
1326·00 „	4	11	0¼	2	0	10¼
1657·50 „	5	13	11¼	2	7	2¾
1989·00 „	6	16	7	2	13	6¾

The reductions vary from 7·76 per cent. at 132·6 miles to 60·8 per cent. at 1989 miles, and average 46·81 per cent. The reduction between certain known places is still more marked, viz.:—St. Petersburg to Moscow, old fare £1 7s. 5¾d., new fare 19s.; Riga, old fare £1 7s. 10½d., new fare 19s.; Verballen, old fare £1 18s. 2¾d., new fare £1 3s. 5¼d.; Nishni-Novgorod, old fare £2 6s. 2½d., new fare £1 6s. 7¼d.; Warsaw, old fare £2 7s. 9¾d., new fare £1 7s. 3¼d.; Kharkov, old fare £3 0s. 8d., new fare £1 11s. 8d.; Kiev, old fare £3 7s., new fare, £1 14s. 2½d.; Odessa, old fare £4 3s. 0½d., new fare £2 0s. 6½d.; Piatigorsk, old fare £5 2s. 3d., new fare £2 3s. 8¼d.; Vladikavkaz, old fare £5 9s. 6¾d., new fare £2 5s. 7¼d.; Cheliabinsk, old fare £5 17s. 3½d., new fare £2 8s. 1½d.

The difference in the rates of second-class travelling is still greater, the fare from St. Petersburg to Verballen having been reduced from £3 14s. 8¾d. to £1 15s. 1¾d.; that to Warsaw from £4 13s. 6½d. to £2 0s. 10¼d.; and that to Odessa from £8 2s. 5½d. to £2 17s. 11½d. The result is that people of small means, who had to travel long distances by third-class, can now go second-class for less money. How little the first and second-class have been used is shown by the following figures:—

Proportions of Passengers carried.

Years.	First-class. Per cent.	Second-class. Per cent.	Third-class. Per cent.	Fourth-class. Per cent.
1883	2·02	9·62	86·05	2·31
1889	1·49	7·54	88·80	2·17
1891	1·36	6·86	88·81	2·97

The following shows the difference between the old and new tariffs for every hundredweight of baggage:—Distances of 198·90 miles, old tariff, 6s. 7¾d.; new tariff, 6s. 2¼d. 397·80 miles, old tariff, 13s. 3½d.; new tariff, 11s. 10½d. 596·70 miles, old tariff, 19s. 11¼d.; new tariff, 16s. 8d.; 994·50 miles, old tariff, £1 13s. 2¾d.; new tariff, £1 4s. 7¾d. These reductions, ranging from 8 per cent. at 198·90 miles to 25·12 per cent. at 994·50 miles, and averaging 16·1 per cent., are much less for long distances than those for passengers.

It was expected that the Russian railways, through the introduction of the new tariff, would lose yearly £1,894,202, provided traffic remained the same. According to the former tariff the railways earned £8,061,754 from the passenger traffic, and according to the new tariff they could only expect to earn £6,665,885; but it is hardly possible that such a loss could occur, experience thus far showing the contrary. For instance, when in 1881-82, on the Warsaw-Vienna Railway, a lower rate was introduced on fourth-class tickets, the number of passengers increased from 1,600,000 to 2,000,000; but as soon as the rate advanced again the number of passengers returned to the former figures. The Griaze-Tsaritzine Railway had the same experience. It made a reduction of 0·43d. per mile, and not only did the number of passengers become greater, but the number of miles travelled also increased. In 1891, when the rates were reduced to the people of the needy districts, it was shown that, in comparison with 1890, the number of persons who used the lower rates increased by 44·3 per cent., and the number of miles travelled by 80 per cent. If the passenger traffic should increase on account of the great reductions under the new tariff in proportion to that mentioned in the foregoing cases, the prospects for the Russian railways are bright, and other countries may follow the Russian example. Later advices state that instead of the expected deficiency of £1,894,202, the receipts last year rose to £9,183,333, an increase of £1,121,579, or 13·92 per cent.

According to the United States Consul-General at St. Petersburg, it seems from the number of railway projects on foot as if Russia were about to enter upon a period of unusual railway activity. Last year, when the zone tariff had been working for some time, a syndicate of Berlin and Paris financiers was formed at Warsaw for the purpose of proposing to the Russian Government an extensive scheme of railway construction, comprising the construction of a railway from St. Petersburg to Kiev, the renting of the existing lines joining Kiev, Kazatin, and the Uman-Elisabetgrod branch, and the construction of a line from Uman through Volnesensk to Odessa, without a Government guarantee.

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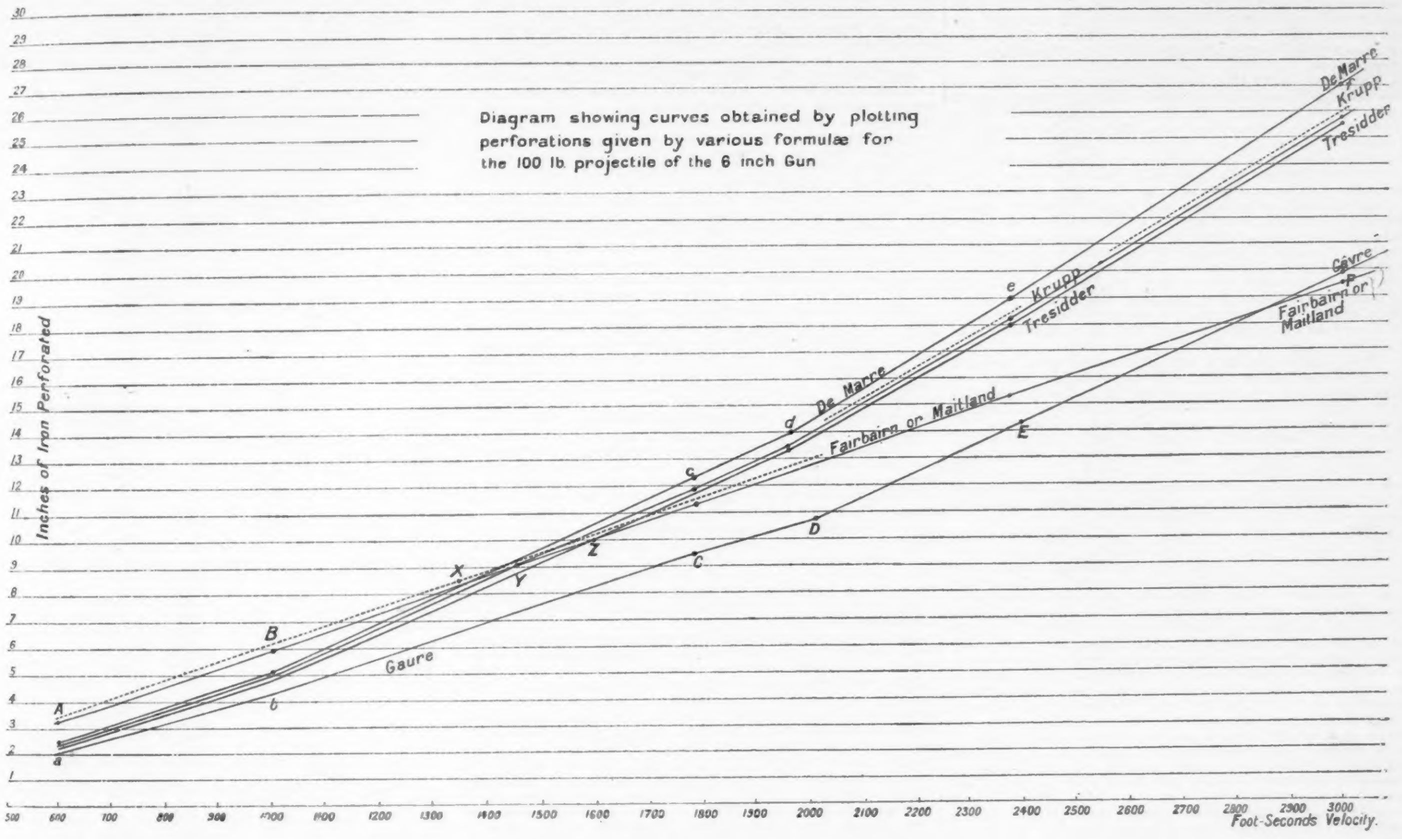
* As the value of the rouble has fluctuated from 3s. 2¼d. in 1874 to 1s. 5½d. in 1895, all rates in this paper are based on its gold value 3s. 2d.

New Walrand-Legenisel Plants.—Walrand and Legenisel, of Paris, have just completed and put in operation two of their special types of plant at the works of the Société Franco-Russe, and the Baltic Works, in St. Petersburg. At the first-named works there is only one 300 kilog. converter, while at the latter there are two of 800 kilog. As a result of the success attained at the last-named works, the authorities of the Obouchov State Foundry have decided to put down a plant of the same type.—*American Manufacturer.*

Gainsborough Waterworks.—At their meeting on the 13th inst. the Gainsborough Urban District Council, after passing a vote of condolence with the widow and family of their late engineer, Mr. Jabez Church, unanimously appointed Mr. Church's partner, Mr. Percy Griffith, as engineer to continue and complete the waterworks extensions now in progress. Since our last reference to these works, the first portion of the large boring has been successfully completed. This is 320ft. deep and 36in. diameter, and is lined with 30in. wrought iron tubes, the annular space around the tubes being filled with 3 parts fine sharp sand and iron borings to 1 part of Portland cement. The last lengths of the tubes were lowered on March 10th, and after carefully testing them for verticality, the cement was filled in behind them till it finished off level with the top of the last tube. As the boring was so much larger than the tubes, the whole weight of the 290ft. of tubes—upwards of 18 tons—had to be suspended on the overhead gear. Ample precautions were, however, taken by the contractors, Messrs. E. Timmins and Sons, and the whole of the operations were conducted without mishap or accident of any kind. The next section of the boring is now in progress, and is being bored 24in. in diameter. If it is found possible to continue this to the total depth required to be tubed—another 440ft.—without any difficulty from infall, &c., the whole of this section will have 18in. tubes lowered into it, and filled in with cement as in the first section. It will be remembered that this boring is to be carried down to a total depth of 1450ft., and is to finish not less than 18in. diameter at the bottom, so that the endeavour to avoid any driving of the tubes by the system described will be fully appreciated by anyone experienced in boring operations.

FORMULÆ FOR CALCULATING THE PERFORATION OF ARMOUR.

Captain Tresidder, the well-known member of Brown's Armour Plate and Steel Works, last year suggested a formula for perforation which might, he urged, be adopted with advantage internationally, on the following grounds: (1) Close agreement with actual results obtained at various velocities; (2) theoretical soundness; (3) simplicity. There is considerable support for the claims thus advanced—that is to say, this formula gives results for high velocities which are much more nearly correct, so far as we have evidence, than do the recognised British formulæ of Maitland or Fairbairn. For low velocities, we believe the last named formulæ, which are practically identical, give good results—better, we are inclined to think, than Tresidder's; but in the present day high velocities are much more important than low ones, because the former are more likely to be employed. Then, again, without question, Tresidder's formula is more simple than others. He has also embodied it in a slide rule which is an actual luxury for those who have to calculate perforations. With regard to theoretical soundness, authorities do not appear willing to admit that Captain Tresidder's claim is proved. He has not had much opportunity of advocating his views, and mathematicians are slow to be convinced on a question like this, so that at present the formula stands on its working merits, and the working merits of any formula now are difficult to determine fully, because firing ordinarily takes place against steel plates treated and hardened in such a variety of ways as to make comparison very difficult.



So far as we can speak with confidence, the whole question stands as follows:—We have in past years fired at comparatively low velocities at wrought iron until experience enabled us to arrive at a trustworthy formula for these conditions. Such a formula was obtained by a combination of such elements as are theoretically sound, with such empirical terms and corrections as caused a fairly correct result to be obtained over a certain range of conditions. As armour developed, difficulties increased. Steel, chilled iron, and steel-faced armour replaced wrought iron. If these always yielded in the same way as wrought iron, that is, by perforation, it would be easy to arrive at a relation between the resistance of any particular steel plate and that of wrought iron of the same thickness, but when plates yield by fracture the conditions are greatly changed. For example, in perforation, the smaller the diameter of a shot, the smaller is the hole it needs to make in order to pass through, and the less is the work required to make such a hole. If, on the other hand, the plate yields in preference by fracture, it is a question if the diameter of the shot enters into the calculation. It appears probable that the action is the splitting action of a pointed wedge struck with the plate, and both plate and shot generally break without a hole the size of the shot's transverse section being made at all. Chilled iron and wrought iron offer the extreme examples of what were then termed "hard" and "soft" armour, the former yielding wholly by fracture, the latter wholly by perforation. Probably the former action depends mainly on the total striking energy of the shot, affected, no doubt, also by its tenacity, on which depends the amount of work delivered before the shot breaks. The latter depends directly on the striking energy, and inversely on the diameter of the hole to be made, that is, the smaller the hole the greater the penetration. How widely the powers of perforation and of fracture differ may be seen from the fact that for many years there were on board the Nettle two guns available for testing plates, an old-fashioned 10in. gun and a new type 6in. piece. The perforation of the two was about equal, the smaller gun attaining to an equality with the heavy old-fashioned one, by having less work to do in making a 6in. hole than the heavy shot had to perform in making one of 10in.

For the work of fracture the small projectile had no such advantage, and it is probable that efficiency of the two shots might be nearly in proportion to their respective striking energies, and these were nearly in the proportion of two to one; so that while the 10in. and 6in. shot were able to perforate about the same thickness of soft armour, the former delivered about double the shock of the latter on hard armour. As armour developed further, it generally took an intermediate form, yielding partly by perforation and partly by fracture, and this may be said to be the case at the present time. Calculation also becomes more difficult from the liability of the shot to break against the hard face. As we have asked before now, who can calculate what a tool may do in the act of breaking? We may certainly understand how the effect may be greater under some conditions than others. For example, at a high velocity a shot may perform work before the line of least resistance is found, and thus cause surprise by behaving much better than at a lower velocity. On the other hand, at a still lower velocity, the shot may not break at all, and thus a worse result may be obtained at an intermediate velocity than at either a very low or very high one. These effects have been seen in experiments; we may conjecture why, but any approach to calculation is difficult. A question of this kind can only be dealt with systematically. The elements must be separated and investigated one by one. The first step needed is to ascertain the laws relating to perforation of wrought iron at the high velocities which have now come in. At present formulæ which have been empirically adjusted, so as to give good results over a certain range of velocities, are employed for those much higher with very little guidance as to their suitability. The little evidence we have is to the effect that the English official formulæ give perforations which are far too small; indeed, at Shoeburyness on one occasion a 6in. shot, fired even at the moderately high velocity of 2378 foot-seconds, passed clean through plates 17in. thick, and went on about 1600 yards, when by the old English formulæ it should have only perforated a 16in. plate, and should not have entered nearly 16in. into a 17in. plate. Krupp's formula, and that of De Marre, appear to be much more correct for high velocities; but we have very scanty data to support them. The relation borne by the respective formulæ to each other is best seen by tracing the curves showing the results they give. The diagram herewith exhibits the perforations given for the 6in. gun firing a 100 lb. projectile by the formulæ of Fairbairn, De Marre, Krupp, Tresidder, and a Gâvre formula.

The ordinates give the perforation in inches of wrought iron due to the velocity in feet-seconds registered along the abscissa. The figures and points of registry are those taken and worked out by Captain Tresidder in his pamphlet "Notes on Formulæ for Armour Piercing." These are as follows:—

Projectile.	Striking velocity f.s.	Perforation in inches by				
		Fairbairn.	De Marre.	Krupp.	Tresidder.	Gâvre.
6in. shot of 100 lb. ...	600	... 3·2	... 2·30	... 2·30	... 2·28	... 2·00
	1000	... 5·9	... 4·98	... 4·95	... 4·90	... 4·17
	1780	...11·2	...12·15	...11·80	...11·64	... 9·45
	1950	...12·4	...13·93	...13·48	...13·35	...10·78
	2380	...15·3	...19·00	...18·22	...18·00	...14·38
	3000	...19·5	...27·05	...25·80	...25·47	...19·98

On the diagram the curves pass through the points calculated and plotted at the different velocities, these points lying on or between A *a*, B *b* and C *c*.

Fairbairn's, it will be seen, gives the highest result at low velocities, but soon falls below most of the others, the curve crossing that of De Marre at X about 1350 foot-seconds, Krupp at Y at about 1460 foot-seconds, and Tresidder at Z at about 1600 foot-seconds.

From about 1200 to 1750 all the variations in the results fall within an inch, but at 3000 foot-seconds Fairbairn gives 6½in. less than De Marre, which, as has been repeatedly pointed out, is a monstrous discrepancy. The Gâvre formula gives also strangely low results throughout. We think, however, that this formula has been abandoned generally in favour of that of De Marre. Those then with which we are most concerned are the formulæ of Fairbairn or Maitland, De Marre, Krupp and Tresidder. The first has been long used officially, and is not yet actually discarded. Krupp appears to agree with our Shoebury trial better than De Marre's, and Tresidder gives practically very nearly the same results, the difference mainly being that in Krupp's the element of weight tells more, so that with a long projectile with great weight in proportion to its calibre, Krupp would give greater perforation. Tresidder's formula is commonly written thus, for working by logarithms:

$$t^2 = \frac{W v^3}{d} \times \frac{1}{\log^{-1} 8{\cdot}8410},$$

where t = the thickness in wrought iron in inches, w the shot's weight in pounds, v the striking velocity in foot-seconds, and d the diameter of shot or calibre of the gun in inches. Krupp's formula, using the same notation, is—

$$t^{\frac{4}{3}} = \frac{W v^2}{d^{\frac{5}{3}}} \times \frac{1}{\log^{-1} 5{\cdot}7770},$$

Raising all Krupp's terms to a power of $\frac{3}{2}$, we get

$$t^2 = \frac{W^{\frac{3}{2}} v^3}{d^{\frac{5}{2}}} \times \frac{1}{\log^{-1} 8{\cdot}6664}$$

This obviously approximates nearly to Tresidder's formula.

It is very desirable that the subject of perforation of wrought iron at high velocities should be investigated, not by firing on a large scale, when only a few rounds can be allowed on the score of economy, but with some small piece, when, at comparatively trifling expense, whole series might be obtained. A well planned series would, at all events, give sound data for the scale on which it was carried out, and furnish a formula which would be gradually tested by every round fired on a large scale, and those who have most experience in these matters believe that it would be found to hold good. It might be possible after that to devise something to teach laws of fracture, although this is difficult and far less important than perforation.

In the meantime, we can only act on what data we have before us. It is not to be expected that we should give up using formulæ for the low velocities for which they have been proved good. For high velocities, unfortunately, there is evidence that their use causes gross mistakes. The most natural course to take then would be to keep to our old Maitland or Fairbairn formula up to 1450 or 1600 foot-seconds, at which points it agrees with Krupp and Tresidder respectively. Here we might "shunt," as it were, on to one of these curves, and use the Krupp or Tresidder formula for the higher velocities.

There is, however, an objection to such a course—namely, that service tables exist which it is undesirable to alter unless we know that we are right in doing so. Now, in the present state of our knowledge, we have no certainty that we are correcting for the better until the difference becomes a large one, when it is necessary to act. On the whole, then, the best present course is to let our tables stand unaltered up to 2000 foot-seconds velocity. This covers all but the newest guns. For velocities over 2000 foot-seconds we may be confident that Krupp's or Tresidder's formula is much nearer the truth than the old ones, and we are inserting new velocities for new guns rather than making corrections in our existing tables. There remains the evil that a projectile striking at a velocity just below 2000 and one just above 2000 foot-seconds are calculated on different systems, and a wide gap exists between them. This is shown on the diagram by the dotted line which takes the course we suggest, and abruptly leaves the Fairbairn curve for that of Tresidder at 2000 foot-seconds; but perhaps it is a good thing that we should have an inconsistency made apparent like this, to remind us of our unsatisfactory condition of ignorance. At all events, we can suggest nothing better at the present time.

THE MOBILITY OF MOLECULES OF CAST IRON.*

By A. E. Outerbridge, jun., Philadelphia, Pa.

It has been generally accepted as a fact that cast iron, under the influence of repeated shocks, becomes brittle, and will finally break under a blow which otherwise it would have withstood. It will probably surprise metallurgists, therefore, to learn that experiment disproves the supposed fact, and establishes exactly its opposite.

The result of about a thousand tests of bars of cast iron of all grades, from the softest foundry mixtures to the strongest car wheel metal, enables me to assert with confidence that, within limits, cast iron is materially strengthened by subjection to repeated shocks or blows.

It is very well known that the usual process of annealing castings—such, for example, as car wheels—increases their strength by relieving cooling strains. But, it is not well known—if known at all prior to this announcement—that the molecules of cast iron are capable of movement—for they do not touch each other†—without the necessity of heating the casting, and that they can thus rearrange themselves in comfortable relation to their neighbours, and relieve the overcrowding near the surface of the casting. In more technical words, a molecular annealing may be accomplished at ordinary temperatures which will release the strains in the castings, precisely as does annealing by slow cooling in heated pits or ovens. A statement so surprising should not be made without sufficient data to establish its correctness beyond cavil, since it is contrary to former belief, certain to be questioned, and properly so. Before proceeding to give a record of the experiments which have been made, and which can be readily repeated by any one, a brief history of the origin of the first observation leading thereto may be interesting.

In 1883—being at that time engaged in metallurgical work at a large car wheel establishment—I noticed that chilled cast iron car wheels rarely cracked in ordinary service after having been used for any considerable time; if wheels did not crack when comparatively new, they usually lasted until worn out or condemned for other causes. No application was made of this observation at that time, further than to institute a careful investigation of the condition of the annealing ovens when some new wheels were returned cracked, under the supposition that the wheels were not well annealed, and an equally careful revision of the iron mixture to ascertain whether the fault lay therein.

In 1894, a large number of "transverse test bars," 1in. square and 15in. long, accumulated in the foundry of Wm. Sellers and Co., Incorporated; and, to expedite the cleaning of sand from their surfaces, they were all thrown into an ordinary "tumbling barrel" with other castings, and knocked about for several hours. When these test bars were broken upon the transverse testing machine, and the records were tabulated, I noticed with surprise that the average strength of the entire series was considerably higher than was usual with similar iron mixtures. This difference was fortunately so marked as to cause a careful inquiry—first, into the condition of the testing machine; then as to the chemical composition of the metal in the bars. The machine was found to be in good order, and the metal was normal. A card pattern was then made, upon which twelve test bars could be moulded side by side in one flask, and poured from one runner. Six of these bars were placed in the tumbling barrel, the other six were cleaned of adhering sand with an ordinary wire brush, and the twelve bars were broken upon the machine. All of the bars which had been subjected for about four hours to incessant blows in the tumbling barrel were stronger than their companion bars—the actual gain varying from 10 to 15 per cent. This metal was soft foundry iron.

These tests were repeated on several consecutive days with similar results, while various theories were suggested, and clues were followed, to detect the hidden cause of this strange fact.

One plausible explanation offered was, that the rubbing of the bars together in the tumbling machine slightly rounded the corners, and thus prevented a starting-point for a "check" or break of the bar under the strain in the testing machine.

This theory was soon overthrown by tests. The corners of six bars were rounded by filing—the companion bars not being filed; all of the bars were then cleaned with a wire brush and broken upon the transverse testing machine, and there was no apparent gain in strength in the bars with rounded edges. Round test bars—1⅛in. in diameter, 15in. long—were then poured from one ladle of iron. Some of these were cleaned in the tumbling barrel, and all that were so treated proved to be much stronger than the companion bars which had been merely cleaned with a wire brush.

This process of eliminating false theories was continued, until finally a new explanation occurred to me, and simultaneously a convincing test of its accuracy suggested itself. The explanation, as indicated in the title of this paper, is the mobility of the molecules of cast iron, at ordinary temperature, when subjected to repeated shocks.

The crucial test referred to consisted in subjecting six bars to 3000 taps each with a hand hammer upon one end only of the bar. All the bars so treated showed a gain in strength equivalent to the gain exhibited by bars which had been subjected to blows over the entire surface for several hours in the tumbling barrel. Here was a new revelation, of scientific interest to the metallurgist, and suggesting to the founder the possibility of annealing castings at ordinary temperatures by availing himself of this molecular mobility. It proves also that we have for many years been unconsciously accomplishing this beneficial result, at least partially and irregularly, by tumbling small castings in a revolving barrel, merely for the purpose of conveniently cleaning them from adhering sand.

Another interesting fact was incidentally brought out in this investigation, namely, that the strain caused by cooling, and the consequent weakening, exists even in the smallest castings, where we would naturally expect that the cooling would be practically uniform throughout the section; moreover, that even in bars of uniform section, such as 1in. test bars, the weakening by cooling strains sometimes amounts to more than 10 per cent. of the ultimate stress. Repeated tests show that ½in. bars, in which the fracture is comparatively uniform to the eye throughout the section, are subject to the same law. Other tests show that the comparative difference in transverse strength between bars which have been hammered on their ends, or otherwise subjected to the process of molecular annealing by vibration when cold, and companion bars cast in the same flask, not so improved, depends to a certain extent upon the number and force of the blows, and to a still greater degree upon the grade of cast iron tested. For example:—

(1) Greater relative difference is found in hard mixtures, or strong iron, than in soft mixtures, or weak iron.

(2) Greater relative difference is found in 1in. bars than in ½in. bars, and somewhat greater difference in 2in. bars than in 1in. bars.

Impact tests.—The foregoing experiments having been repeated sufficiently often to satisfy me of their absolute reliability—and really remarkable uniformity—a new series of tests was commenced for the purpose of ascertaining how many blows were required, and approximately what force was needed to accomplish the desired object of relieving cooling strains. A new machine was constructed for this purpose, and light was soon thrown upon these questions, while still other important questions were suggested and answered by the use of the same machine.

The impact machine first used was an old one, and consisted of a weight fastened to an arm swinging in a graduated arc. The friction of the pivot and the crude construction of the machine precluded even an approximately accurate measurement of the force of the blow delivered.

The new machine consisted of a frame or yoke, marked in inches, and a wedge-shaped weight, adapted to the size of the bars to be tested, which was raised vertically to any desired number of inches, and when released, fell by gravity in free space, striking the bars in the centre between the supports, which were 12in. apart. A 14 lb. weight was adopted for testing 1in. bars.

Impact testing machines have long been used, and car wheels are accepted or condemned according to tests made upon such machines. It has always been maintained that each blow of the "drop" weakened the casting, and that the final blow was only a record of the residual cohesion remaining in the metal after previous blows had proportionately weakened it. In the case of a thoroughly annealed car wheel, this reasoning may be sufficiently correct; but as applied to impact testing machines used for testing unannealed bars, the argument is absolutely fallacious. In such cases the impact machine is itself a means of molecularly annealing test bars, as I will now demonstrate.

Impact experiments.—Six of the 1in. square test bars, cleaned with the wire brush, were broken upon the impact machine by dropping the weight from a sufficient height to break each bar at the first blow. The six companion bars, also cleaned with the brush, were then in turn subjected to blows, numbering from ten to fifty each, of the same drop weight, falling one-half the former distance, these blows being insufficient to break the bars. The weight was then permitted to fall upon each of these bars in turn from the height at which the six bars previously tested had been broken at the first blow. Not one bar broke. Two, three, six, ten, and in one case fifteen blows of the same drop from the same extreme height were required to break these bars. In another similar case the weight was dropped once from the former height, then raised by inches until four more blows, each being 1in. higher than the last, had been delivered before breaking the piece. Subsequent tests showed still greater gain in strength.

The next experiment with the impact machine was designed to test molecularly-annealed bars from the tumbling-barrel, in comparison with untreated companion bars, under one heavy blow. It was found that a blow of sufficient force to break the unannealed bars with one fall of the weight must be repeated from five to twenty times—depending mainly upon the nature of the iron mixture—to break the molecularly-annealed companion bars. By careful experiment in the manner described, it was shown that the ultimate strength of the bars which had not been through the tumbling-barrel could be increased, by successive slight blows upon the impact machine, to an equality with their companions.

The experiments here related in a running conversational narrative form a part of the daily records of metallurgical work at the foundry of William Sellers and Company, Incorporated, Philadelphia; and the aggregate number tabulated is very large. All the tests corroborate fully the statements here made; and they are susceptible of repetition and confirmation by anyone interested in work of this character. They form a part of a long series of investigations—extending over a period of fifteen years—upon the relation between the physical nature and chemical composition of cast iron; they have served to throw light upon phenomena hitherto obscure connected with the design, construction, &c., of castings; and, as it is believed that they contain the germ of a new scientific discovery valuable in its principle to all workers in these fields, these brief notes are presented to the Institute in response to the invitation of its secretary, and through the courtesy of the firm of William Sellers and Company, Incorporated, for whose benefit and at whose cost they were primarily made.

In conclusion, it should, perhaps, be observed, to avoid the possibility of misunderstanding, that the molecular annealing of cold cast iron by successive slight shocks differs from annealing by heat in that it has no power to change the condition of carbon in the casting or to alter the chemical constitution in any way. All that is claimed is that every iron casting when first made is under a condition of strain due to difference in the rate of the cooling of the metal near the surface, as compared with that nearer the centre, and also to the difference of section; and, further, that it is practicable to relieve these strains by repeatedly tapping the casting, thus permitting the individual metallic particles to rearrange themselves and assume a new condition of molecular equilibrium. The large number of tests made and the remarkable uniformity of the results obtained warrant me in making these statements with full confidence that the repetition of such experiments, even under less favourable conditions for accurate observation than I have enjoyed, will convince others of the correctness of my conclusions, and will perhaps establish a new law of the physics of cast iron.

A few practical deductions of universal application may be drawn from these observations. (1) Castings, such as hammer frames, housings for rolls, cast iron mortars or guns, which are to be subjected to severe blows or strains in actual use, should never be suddenly tested to anything approaching the severity of intended service. Quantitative tests made upon the impact machine prove that the molecules of cast iron rearrange themselves under reasonably few shocks, so that it is perfectly practicable to molecularly anneal such castings when cold. Pulleys, and indeed all castings, are subjected in every-day service to this process of molecular annealing; and old castings are therefore more reliable than new ones, unless they have been misused. It is not impossible that the same law applies to steel castings and perhaps to all metal castings, and that in testing new guns, each preliminary small charge of explosive material, subjecting the casting to comparatively moderate shocks, enables the gun to relieve itself of internal strains, and eventually to withstand with safety shocks which would have destroyed it without this precautionary measure. This, however, is mere theory, and must not carry the weight of the arguments regarding cast iron, which are clinched by a thousand actual tests. (2) Strong iron castings, and castings of irregular section, have greater initial strains than soft iron castings or castings of comparatively uniform section; and it is, therefore, more important to subject the former to gradually increasing shocks until the strains are relieved by the movement and re-arrangement of the molecules.

Tables.—The tables here given show the results of tests for transverse strength of test bars, of different section and widely different grades of iron, which have been subjected to this process of molecular annealing, and also tests made upon the impact machine with test bars cast in the same moulds. To avoid the unnecessary duplication of figures, a few individual tests only are here tabulated, but they represent the average of probably a thousand records. The largest apparent gain shown in Table I. in the transverse strength of companion bars of 1in. section, is 525 lb.—see last line of the table—or very nearly 19 per cent. It is evident, even without plotting all the tests, that they would show a gradually ascending curve having direct relation, first, to the character of the alloy of iron; and second, to the number of blows given, up to the point when strain is relieved—beyond which an increased number of blows does not increase the strength of the bar. Furthermore, it may be noted that these tests with the impact machine indicate the existence of a similar law with relation to the ability of the metal to resist sudden and severe shocks. Similar observations apply to the tests recorded of ½in. and 2in. bars. All the 2in. bars were broken upon the testing machine of Messrs. A. Whitney and Sons, by their operator, who was at first ignorant of the object of the tests. Subsequently, similar tests were made by that firm with their car-wheel iron, and identical results were obtained by them. The tabulated tests have been selected from the daily records of experiments made at the machine tool works of William Sellers and Co., Incorporated, Philadelphia.

In Table I., the left-hand columns show the breaking strain and deflection of test bars of different kinds of cast iron, cleaned in the ordinary manner with a wire brush. The right-hand columns show the tests of companion bars, cast from the same runner, molecularly annealed by being subjected to shocks in the tumbling barrel, or by tapping on one end with a light hammer, as noted under "Remarks;" also a few tests made with round bars 1⅛in. in diameter, cast on end.

Table II. gives a few of the tests with 1in. bars, made upon the new impact testing machine, using a 14 lb. weight. The tests marked A represent bars cleaned with a brush, and those marked B companion bars, molecularly annealed in the manner described.

Table III. gives a few records of 2in. test bars, broken by A. Whitney and Sons upon their machine. The tests marked A were cleaned with the brush; those marked B were molecularly annealed in the tumbling barrel.

Other experiments have suggested themselves in the course of this investigation; and my paper, therefore, is not presented as an exhaustive, but as a tentative treatment of this interesting and, I believe, novel line of research, which is not incapable, even in its present stage, of some practical application.

Table I.

Unannealed. Breaking strain. Pounds.	Unannealed. Deflection. Inches.	Molecularly annealed. Breaking strain. Pounds.	Molecularly annealed. Deflection. Inches.	Remarks.
2350	·13	2850	14	Close grain.
2025	·12	2300	·14	Open "
2125	·13	2275	·14	" "
2275	·13	2400	·14	" "
2525	·14	2850	·15	Close "
2175	·13	2500	·15	Open "
2100	·13	2375	·14	" "
2025	·12	2300	·14	" "
2775	·14	2900	·15	Close "
2150	·13	2250	·13	Hammered on end of bar.
2550	·14	2925	·15	" " " "
3000	—	3200	—	Round bars 1⅛in. diam.
3000	—	3150	—	Hammered on end of bar.
2150	—	2450	—	Round bars 1⅛in. diam.
2100	·13	2425	·15	Open grain
2100	—	2400	—	Round bars 1⅛in. diam
2050	·12	2400	·14	Open grain.
2875	·14	3100	·15	Close "
2175	·13	2500	·15	Open "
2150	·13	2350	·13	" "
2675	·13	3000	·14	Close "
2775	·14	3300	·15	" "

Table II.

A.	1 blow of 14 lb. weight falling	13in.	broke the bar.	Open grain.
B.	8 blows " "	13in.	"	"
A.	2 " " "	14in.	"	"
B.	9 " " "	14in.	"	"
A.	2 " " "	14in.	"	"
B.	14 " " "	14in.	"	"
A.	2 " " "	15in.	"	"
B.	15 " " "	15in.	"	"
A.	3 " " "	15in.	"	"
B.	8 " " "	15in.	"	"
A.	2 " " "	15in.	"	"
B.	7 " " "	15in.	"	"
A.	3 " " "	13in.	"	Close grain
B.	4 " " "	15in.	"	"
A.	2 " " "	13in.	"	"
B.	10 blows at 13in., 5 at 15in., 5 at 17in., 3 at 18in., broke the bar. Close grain.			
A.	1 blow of 14 lb. weight falling	14in.	broke the bar.	Open grain.
B.	20 blows at 13in. and 3 blows at	14in.	"	"
A.	8 " of 14 lb. weight falling	13in.	"	"
B.	15 " " "	14in.	"	"
A.	8 " " "	12in.	"	"
B.	50 " at 12in. and 10 blows at 15in. failed to break the bar.			

Note.—The last bar, after withstanding these blows, was broken upon the transverse testing machine at a strain of 2975 lb.

Table III.

	Breaking strain in pounds.	Grade of iron.
A	20,400	Close grain.
B	21,600	"
A	13,600	Open grain.
B	15,800	"
A	14,000	"
B	14,800	"

I have suggested, and adopted throughout this paper, the hypothesis of the mobility of the molecules of cast iron, resulting in an effect similar or analogous to the effect of annealing by heat, because it seems to be warranted by the facts developed by the experiments described; it is of course possible, in our *à priori* ignorance of the laws governing atoms and molecules, that the theory may not be correct, but the tentative propounding of a probable hypothesis, by inciting to a more extended course of experiment, along different related lines of investigation, often leads to establishing or disproving the theory, and thus adds to our stock of positive knowledge.

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[*] Read at the Pittsburgh Meeting of the American Institute of Mining Engineers, February, 1896.

[†] In order to comprehend the modern idea of the nature of matter, we should try to realise that the molecules composing even the most dense solid substances with which we are familiar—such as gold, platinum, &c.—are not in contact, and are free to move within certain well defined limits. Lecture on "Matter," by the writer, *Journal Franklin Institute*, September, 1885, vol. xc., p. 184.

Guatemala: Central American Exhibition, 1897.—The Department of Science and Art has received, through the Foreign-office, a copy of a despatch from her Majesty's Acting Consul-General at Guatemala, respecting a "Central American Exhibition" of Science, Art, and Industry, which it is proposed to hold in that city next year, commencing on the 15th March, and closing on 15th July. Although primarily a Central American Exhibition, the Government of Guatemala are desirous that foreign nations should take part in it; a department will be assigned to them, and they will enjoy all the privileges possible, with the right of competing for the prizes.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—Chief engineers: Mark Blakeman, to the Daphne, to date February 2nd; William J. Anderson, to the Skipjack, to date March 7th; and Henry Percival Vining, to the Vernon for the Seagull, to date March 13th, all reappointed on promotion; George Ramsay, to the Blanche, to date May 5th. Engineers: Harry R. Batchelor to the Magpie, additional, for re-commission; and Richard Bryan to the Wildfire, additional, for the Sans Pareil, to date April 17th; W. J. Duffell, to the Repulse, to date May 5th. Assistant engineer: Arthur F. White, to the Blanche, to date May 5th.

HODGES' COMPOUND BLOWER.

The accompanying illustration—Fig. 1—shows, by a transverse section, a compound blower manufactured by Messrs. Hodges and Co., of Cazenove-road, Stoke Newington, the special feature of which is that the air is subjected to several successive compressions during its passage through the machine, the number of which in the one under notice is three. A blower of this type is most generally used for giving a working pressure of 1½ lb. per square inch, but they are also made to give as high an air pressure as 4 lb., involving the necessity of six compressions. It will be seen from the sectional view that the blower is constructed with five separate blast wheels mounted on a common shaft, and enclosed by suitable casings, so formed as to allow each wheel to work in its own chamber. The shaft revolves in bearings carried by the brackets shown, and is driven by the pulley situated between the bearings. A A are the two outer blast-wheels, made of steel discs, with blades of the same material fixed on one side only; B B are two intermediate wheels of similar construction, but with narrower blades and consequently smaller capacity than A A; C C, the centre blast-wheel, has blades fitted on both sides of the disc, forming a double blast wheel, having still smaller blades with a consequent further diminished capacity. In the spaces D D D D, between the backs of the wheels and the adjacent casing, are provided a number of fixed radial scoops E, the peculiar shape of which, it is claimed, constitutes an important factor in the efficiency of the machine.

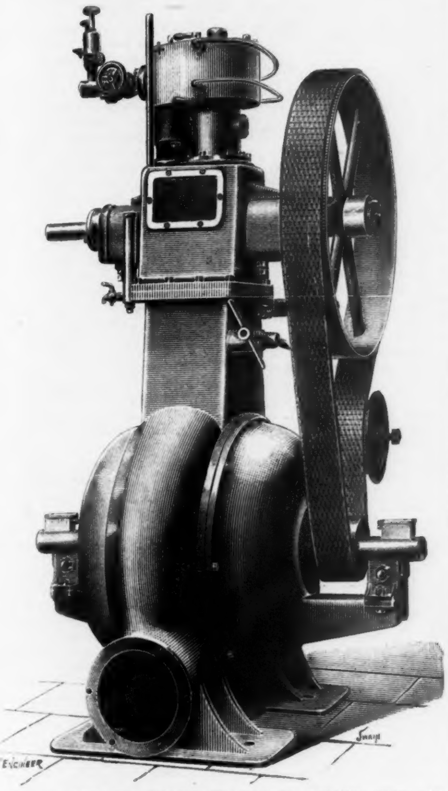


Fig. 3—HODGES' COMBINED ENGINE AND BLOWER

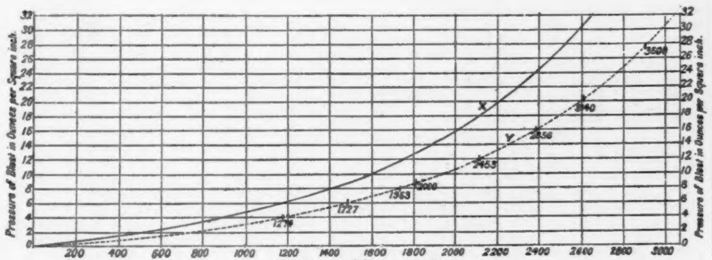


Fig. 2—DIAGRAM OF REVOLUTIONS AND AIR PRESSURE—HODGES' FAN

In operation, air entering the blower at either side, as shown by the arrows, is caused to rotate by the outer wheels A A, from the peripheries of which it is thrown off in a state of rapid rotary motion, the energy of which is utilised by impact upon the radial scoops E. This impact is said to transform the rotary movement of the air into a series of centripetal jets of high velocity, which, converging centrally, produces a blast at the inlets of the intermediate wheels of greater pressure than at the peripheries of the outer wheels, the increase in pressure being obtained without further expenditure of driving power. Upon the air leaving the outer wheels new conditions obtain, consequent upon its increased density and weight, and it may here be pointed out that a superabundance of air is always maintained under pressure at the inlets of the intermediate wheels, owing to the diminished area of the latter. A second compression now takes place by the agency of the wheels B, upon leaving which the air comes in contact with the second series of scoops and is finally compressed by the centre wheel and delivered into the annular receiving chamber F. Fig. 2 is a diagram giving the results of experiments made by Messrs. Hodges on the speeds and pressures of a compound blower of size No. 25, and shows clearly the pressure and volume of air delivered at any given speed. Referring to the diagram, each of the horizontal lines above O represents 2 oz. pressure per square inch, while each of the vertical lines from O to the right represents 200 revolutions per minute. The upper line X represents the curve of maximum pressures at the speeds given; thus at 1400 revolutions per minute the No. 25 size blower gives a maximum pressure of 8 oz. per inch, at 2600 revolutions 30½ oz. pressure. The most efficient working pressure is found to be about two-thirds the maximum, which is represented by the dotted line Y. On this line, at the pressures of 4 oz., 6 oz., 8 oz., 12 oz., 16 oz., 20 oz., and 28 oz., the figures under the intersections represent the cubic feet of air discharged per minute at the stated pressures.

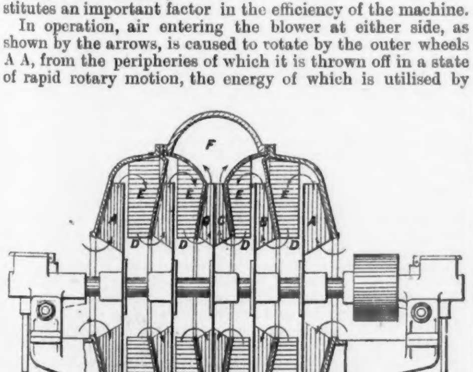


Fig. 1—HODGES' COMPOUND BLOWER—SECTION

We also illustrate in Fig. 3 one of these blowers combined with a high speed engine, the whole forming a compact and serviceable arrangement, obviating the use of counter-shafts and the loss of power incidental thereto. Being self-contained, the only fixing this machine requires is the bolting down and provision of steam and exhaust pipes for the engine. As the floor space required is limited, it can be placed in any suitable position, such as the corner of a smithy, close to the cupola, where the pressure of blast can be varied as required by the furnace attendant. When once the engine is started it requires little or no attention beyond the filling of the sight-feed lubricator, and a little oil being added to the crank chamber at weekly intervals. The connection between the blower and engine is made with an endless belt, a tightening drum or pulley being provided for keeping the belt taut. The engine, which is double-acting, is very carefully constructed, all the running parts being of steel, working in extra large phosphor bronze bearings. The crank chamber, it will be seen, together with the bearing brackets, is one solid casting, thus insuring perfect rigidity and alignment. The main bearings are adjustable upwards, by which means the shaft is retained square with the crosshead guide. The slide valve is of the balanced piston type, and the steam ports very short and straight. The cylinder, which is 8½in. in diameter, is fitted with relief valves and drain cocks, with pipes led into the exhaust and sight-feed lubricator. By extending the crank shaft, as shown, to receive a separate pulley, the engine can be used independently of the blower for driving any extraneous appliance or a line of shafting.

Although the engine is elevated it is remarkably free from vibration, even at very high speeds, a feature which is due to the careful method employed by the makers in balancing the moving parts. We have seen this engine running at a speed of over 500 revolutions per minute, driving the blower, and the engine running separately over 1200 revolutions without any holding-down bolts whatever, and with no perceptible vibration.

TESTING STEEL BOILER PLATES IN THE UNITED STATES.

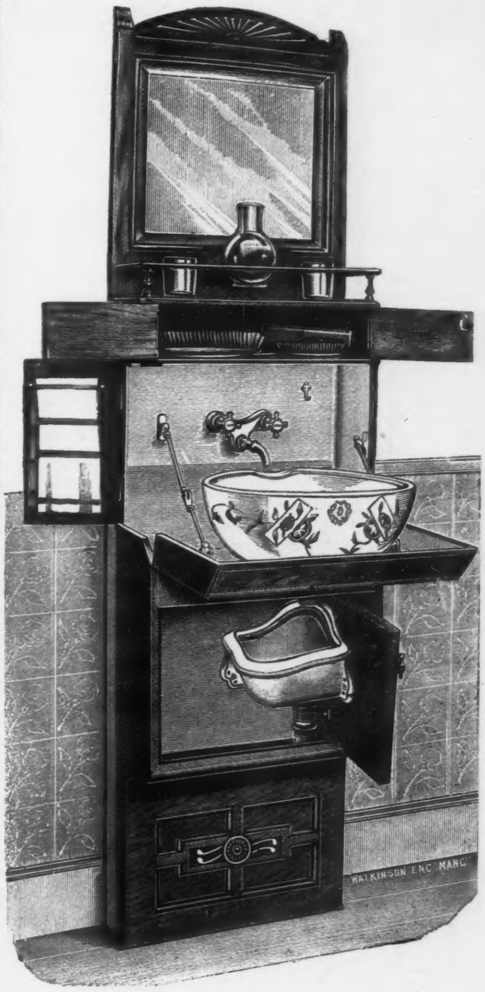
When the Board of Inspectors of Steam Vessels met at Washington, in annual session in January, the representatives of all the steel plate manufacturers in the country appeared, and urged a large number of changes in the regulations to ascertain the tensile strength. The Board, after considering the matter, acquiesced in some of the points urged, and adopted the following rule, which was made public at the Treasury Department on the 3rd inst.:—

"To ascertain the tensile strength and other qualities of steel plate, there shall be taken from each sheet to be used in shell or other parts of boiler which are subject to tensile strain, a test piece prepared in form according to a specified diagram. The straight part in the centre shall be 9in. in length and 1in. in width, marked with light prick punch marks at distances of 1in. apart, as shown, spaced so as to give 8in. in length. The sample must show, when tested, an elongation of at least 25 per cent. in a length of 2in., for thickness up to ¼in. inclusive; and in a length of 4in. for over ¼in. to 7-16in. inclusive; in a length of 8in. for 7-16in. to 1in. inclusive, and in a length of 6in. for all thickness over 1in. The reduction of area shall be the same as called for by the rule of the Board. No plate shall contain more than ·06 per cent. of phosphorus, and ·04 per cent. of sulphur, to be determined by analysis by the manufacturers, verified by them, and copy furnished the inspector for each order tested; which analysis shall, if deemed expedient by the supervising inspector-general, be verified by an outside test at the expense of the manufacturer of the plate.

"It being further provided that said manufacturer shall also furnish a certificate with each order of steel to be tested, stating the technical process by which said steel was manufactured. It being further provided, that steel manufactured by what is known as the Bessemer process shall not be allowed to be used in the construction of marine boilers. Plates over 1in. in thickness may be reduced to 1in. in the straight part for testing, in cases where the testing apparatus is not of sufficient capacity to test the full thickness of plate. The reduction of area and elongation must be equal to the requirement of full thickness of metal. Provided, however, that contracts for boilers for ocean-going steamers require a test of material in compliance with the British Board of Trade, British Lloyd's, or Bureau of Veritas rules for testing, the inspectors shall make the tests in compliance with the above rules. The samples shall also be capable of being bent to a curve of which the inner radius is not greater the 1½ times the thickness of the plates after having been heated uniformly to a low cherry red, and quenched in water of 82 deg. Fah."

RAILWAY CARRIAGE LAVATORIES.

The modern luxuries of railway travelling, and the extensive introduction during recent years of sumptuously equipped saloons on most of the leading lines, have necessitated special attention to matters of detail connected with the general fittings and accessories of these carriages. With regard to the sanitary fittings, Messrs. Morrison and Ingram, of Manchester, have recently designed several specially arranged lavatories and closets for railway carriages, of one of which we give an illustration showing a closing-up lavatory, which, whilst being commodious and replete with convenient accessories, is compressed into a remarkably small space, the lavatory, when closed, not projecting more than 9¾in. from the wall, whilst the width is only 19½in., and the height 6ft., including the over-mirror. The lavatory, every working part of which is readily accessible, is fitted with a hot and codl water supply to the basin, and a convenient arrangement is provided for hanging towels, whilst there is also a small cupboard suitable for various toilet requirements. The folding urinal in connection with the combined arrangement is automatically flushed, whilst the door is kept open.


WALKINSON ENG. MANC.

WEAR OF TIRES ON PASSENGER ENGINES OF THE NEW YORK CENTRAL RAILWAY FOR THE PAST TWENTY YEARS.

By P. H. Dudley.

Comparing the weights upon the drivers a few years ago with those in present use shows an increase in the static or dead load of some 65 per cent., while the increased speed of the trains now produces dynamic effects more than double the static loads, yet by increasing the width of the head of the rails as they were renewed and the higher standard of track maintained, the rate of the wear of tires for the heavier locomotives has not increased, but, on the contrary, decreased. In 1883, on the 65 lb. rails, deep and narrow type of heads, drivers carrying 13,360 lb. ran an average of 19,400 miles for a loss of $\frac{1}{16}$in. in thickness of the tires. This was the second type of 65 lb. rails, the first one having been rolled in England and had a wider head.

In 1884 the 5in. pioneer 80 lb. rail was put in service, the head being $2\frac{11}{16}$in. wide. Its use was yearly extended, and by 1889 locomotives on the Hudson division made nearly one-half their mileage on the 80 lb. rails. Engines then carrying 17,600 lb. per driver ran an average of 19,300 miles per loss of $\frac{1}{16}$in. in thickness of tire. In 1891 passenger engines on the Hudson division made their entire mileage on the 80 lb. rails, while those on the Mohawk and Western divisions made about three-quarters of theirs on the same class of rails; drivers carrying 20,000 lb. ran an average of 19,400 miles per loss of $\frac{1}{16}$in. in thickness of the tire. This refers to the loss by wear and returning for future service. In 1892 the 100 lb. rail, head 3in. wide, was laid on the Harlem line, which carries the combined passenger traffic of the three railroads entering and leaving Grand Central Station, New York City. The renewing of the entire line of the New York Central and Hudson River Railroad from Mott Haven Junction to Buffalo and return with 80 lb. rail was completed in 1892. In 1894 the 100 lb. rail was laid from Spuyten Duyvil to Peekskill, making about one-quarter of the Hudson division laid with 100 lb. rails.

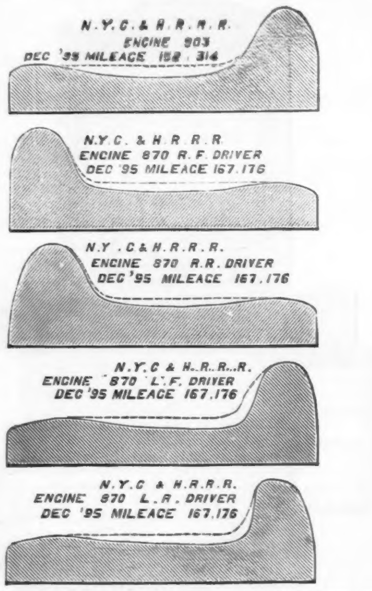
In June, 1895, I asked Mr. William Buchanan, general superintendent of motive power and rolling stock, for the mileage of some of the class "I" engines running over the 80 lb. and 100 lb. rails. When the class "I" engine was designed in 1889, the weight on each driver was 20,000 lb., but as the 80 lb. rails were put into the track the weights have been increased to 22,000 lb. The total weight of the locomotives in running service is 200,000 lb., or over 40,000 lb. being upon the truck. The mileage of the tires only includes one turning since October, 1892, and ends March, 1895.

Some of the engines, of which there were 43 in all, did not enter service until 1893, and others in 1894.

The list is so large, covering such a wide range of service, that it must show conclusively whether or not a broad flat-topped rail increases or decreases the rate of wear of tires running over them. The 43 engines ran 3,706,567 miles, and the total loss in thickness of tires in sixteenths of an inch was 160, or an average of 23,166 miles for a loss of each $\frac{1}{16}$in. of tire. Twenty-three of the engines which ran in part over the 100 lb. rails show an average mileage of 29,046 miles for each $\frac{1}{16}$in. loss in thickness of the tire. The mileage of 19,400 miles per loss of $\frac{1}{16}$in. in thickness shown by the light engines on the 65 lb. rails is now much exceeded by the heavier engines on the 80 lb. rails, the average mileage being 23,166 miles, and on the 100 lb. rails it will exceed the 29,046 miles, which over one-half the present engines now show by only making a part of their mileage on the wide rails.

The comparison between the wear of tires on the engines running the Empire State Express over the Hudson division, making one-fourth of the mileage on the 100 lb. rails, and the one running over the Western division exclusively on 80 lb. rails is very interesting.

The engravings show the approximate wear as obtained by plaster casts after the mileage indicated on them had been made by the engines.



Diagrams Showing Wear of Tires on Engines No. 903 and No. 870.

Engine 870 commenced the service for which the wear of the tires is shown May 25th, 1894, and completed it December 21st, 1895. The engines are double crewed, as is customary with all, and the mileage made per month fluctuated between 8576 and 9200. Out of the 575 days the engine was worked 571 days, the four idle days being occupied in boiler washing. The total mileage in that period was 167,176 miles. During all this time the fires were not drawn except on the four idle days.

The following table shows the wear of tires with different weights on them and running on various rail sections:—

No. of engine.	No. of miles run.	Circumference of drivers in feet.	Pounds of metal lost per 1000 miles, four-drivers.	Rail section on which engines ran.	Weight on each driver. lb.
870	167,176	20·41	0·801	80 lb. and 100 lb.	20,000 to 22,000.
903	152,314	22·00	1·332	80 lb. rails.	20,000 to 22,000.
84	56,219	18·06	1·234	English 65 lb. rail.	15,000 to 18,000.
86	73,647	18·06	1·887	,, ,, ,,	15,000 to 18,000.
4	78,864	17·28	1·379	,, ,, ,,	15,000 to 18,000.

NOTE.—The 100 lb. rail has a head 3in. wide, the 80 lb. rail a head $2\frac{11}{16}$in. wide, and the English 65 lb. rail had a head $2\frac{3}{8}$in. wide.

The loss per yard in circumference of tire, per 1,000,000 tons rolling contact on the rails was as follows:—

	lb.
No. 870	0·042
No. 903	0·070
No. 84	0·121
No. 86	0·136
No. 4	0·132

The general dimensions of the class "I" engines are given in the following table:—

Cylinder, diameter and stroke	19in. × 24in.
Steam port	18in. × $1\frac{1}{4}$in.
Exhaust port	18in. × $2\frac{3}{4}$in.
Bridges	$1\frac{3}{8}$in. wide
Valves:—	
Travel	$5\frac{1}{4}$in.
Outside lap	1in.
Inside lap	None
Boiler:—	
Diameter, smallest ring	58in.
Pressure per square inch	170 lb.
Fire-box:—	
Length, outside	$105\frac{1}{2}$in.
Width	$40\frac{3}{4}$in.
Area	27·3 square feet
Heating surface	150·8 square feet
Flues:—	
Number	268
Outside diameter	2in.
Length between sheets	11ft. 11in.
Heating surface	1670·7 square feet
Total heating surface	1821·5 ,, ,,
Weight of engine in working order	120,000 lb.
Weight on drivers	80,000 lb.
Weight on trucks	40,000 lb.
Weight, maximum tender loaded	80,000 lb.
Tractive force per pound M. E. P.	111·07
Adhesion to tractive force	0·20
Diameter of drivers	78in.
Driving wheel base	8ft. 6in.
Total wheel base of engine	22ft. 9in.

Engine No. 903 hauled the "Empire State Express" on the western division from April 3rd, 1894, to December 3rd, 1895, total mileage 152,314. Of the four tires of engine No. 870, the left front one was physically the softest and shows the most wear, as seen in the accompanying illustrations. Both front drivers show increased wear over the rear ones from crushing the sand when first applied to the rails, and is more noticeable than on the crucible steel tires of the lighter engines, of which I took plaster casts many years since. Ross Meehan shoes were applied to the drivers covering the full tread and flange of all drivers for both engines. On No. 870 considerable wear was produced on the outside of the flanges of the left side drivers, which is not included, as it was not produced by the rails.

The wear of tires per 1,000,000 tons rolling contact on the rails for the amount of metal lost, as shown by plaster casts, would be influenced by many conditions which need not be considered here; yet the results point to the same general fact that by widening the top of the rail, and giving it a larger top radius, the rate is decreased, notwithstanding an increased weight is carried upon the drivers. The top radius of the pioneer 80 lb. rail is 12in., with $\frac{5}{16}$in. corner radii, and for the 80 lb. and 100 lb. rails, laid in 1892 and since, it is 14in., and corner radii of $\frac{5}{16}$in. The important point is to secure as large an area of contact between the drivers and the rails as practicable, for the larger the area is the less are the wheel pressures per square inch of contact, and the greater width of metal of both rails and wheels to resist and distribute the tractive force exerted. The tractive force of both 870 and 903 on the rails drawing the same train would be practically alike, and the difference in wear of tires mainly due to the greater average area of contact of 870, running part of its distance on the 100 lb. rails, while 903 ran entirely on 80 lb. rails. The mileage of either engine is very large, nearly double what is obtained on the narrow-headed rails, as will be seen by a comparison with engines Nos. 84, 86, and 4, which ran on the 65 lb. rails. The practical results of introducing the broad-topped stiff rails show a decreased wear of tires, frogs, rails, ties, and expense of minimum maintenance, while the speed and train loads have been largely increased. The standard freight train load of the New York Central and Hudson River Railroad, on the 80 lb. rails, is 50 loaded 60,000 lb. capacity cars, making a gross load of 2250 tons, forming a train 2000ft. long, which runs 150 miles in six to eight hours. The train load has more than doubled from the old 65 lb. rails.

The broad thin type of head is making rapid progress abroad. Dr. Haarman, at his Osnabruck works, Germany, has introduced several sections, while many are being rolled in England for India and Australia. My 80 lb. section has recently been rolled in England for two Canadian lines. While the thin wide head and stiff type of rails is now generally recognised as the most economical form, the pioneer 5in. 80 lb. rail met with decided opposition, as being heavier and stiffer than was needed. Its introduction was largely due to the persistent efforts of Mr. J. M. Toucey, then general superintendent, but now general manager, of the New York Central and Hudson River Railroad. The rail once in the track made friends and had strong advocates, for the value of stiffness in a section was recognised, the principle being utilised by many railroads. It is not weight alone, but stiffness as well, which gives value to a section. It marked an epoch in railway progress, and while the advantages of a broad head and stiff 5in. rail have exceeded expectations, there are still greater values to be obtained by the use of the broader head and stiffer 100 lb. rail.—*American Engineer Car Builder.*

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

GOOD attendance on 'Change. Steam coal shipments are good, with fair inquiries for the future. Prices steady. The house coal trade continues good for the advancing season, and prices are without change. Tin-plates in better demand. The steel and iron works continue well employed.

Prices:—Coal: Best steam, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s.; house coal, best, 10s. to 10s. 3d.; dock screenings, 5s.; colliery small, 4s. 3d. to 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 46s.; hematite warrants, 47s. 9d., f.o.b. Cumberland; Middlesbrough No. 3, 37s. 10d. prompt; Middlesbrough hematite, 45s. 4d. Iron ore: Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel rails, heavy sections, £4 12s. 6d.; light ditto, £5 to £5 5s., f.o.b.; Bessemer steel tin-plate bars, £4; Siemens tin-plate bars, best, £4 2s. 6d., all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel coke, 9s.; Siemens coke finish, 9s. 3d.; ternes, per double box, 28 by 20 C., 18s. 6d. to 20s. Pitwood, 15s. 3d. to 15s. 6d. London Exchange telegram: Copper, £44 17s. 6d.; Straits tin, £59 10s. Freights: Homeward, firm.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

STEEL is steady this week at £5 for Siemens marked steel slabs at stations in the Midlands, £4 15s. for Bessemer blooms and billets, £6 to £6 10s. for Siemens bars, £5 7s. 6d. to £6 for Bessemer bars, £7 to £8 10s., according to tests and sizes, for Siemens best boiler-plates, and £5 15s. delivered for Bessemer ship-plates. Angles and girders of basic steel are £5 10s., and £6 5s. for boiler-plates. All the steel works are active, and the finished iron works and blast furnaces are also well engaged upon orders booked at the commencement of the new quarter.

Common bars are £5 5s. to £5 10s.; merchant bars, £6 to £6 5s.; and marked iron £7, with £7 12s. 6d. for the L.W.R.O. brand of the Earl of Dudley's make. Black sheets are £6 12s. 6d. to £7 for singles, £7 to £7 7s. 6d. for doubles, and £7 15s. for lattens. Angles are £5 15s., stamping sheets are £9 10s. and best thin sheets £11. Nail rod is £6 10s. Hoop and thin strip £6 7s. 6d. Tube strip for bedstead tube making is £6 5s., and for gas tube making £5 10s.

Staffordshire cinder pig is 36s. to 37s. for forge, with 2s. more for foundry; part mine, 39s. to 45s., according to quality; and all mine 55s. to 57s. 6d. Cold blast pig is 90s. Lincolnshire forge pig is 44s. 7d. net at stations. North Staffordshire and Derbyshire, 42s. to 43s., and Northamptonshire 41s.

The Tame and Rea District Drainage Board, at their quarterly meeting on Tuesday, had before them the estimates for the ensuing year, totalling £60,170. The Board approved a scheme submitted by their engineer, Mr. Till, for a large extension of the sewage farm. This scheme of extension will in all probability ultimately involve a capital expenditure of £244,500. When the Board was formed in 1877 the population in the drainage area was but 481,944. In 1884 the constituency had increased to a population of 605,594, and, without any extension of the area, it is estimated that by the year 1912 its population will amount to 900,000 persons, nearly the whole of whom will be resident on land draining to the sewage farm. A considerable extension of land and works is therefore absolutely necessary in the course of the next few years, in order to deal with the continually increasing quantity of sewage. Parliamentary powers will be necessary. The engineer of the Board is Mr. Till, and the services of Mr. Charles Hawksley have also been retained on a commission of 5 per cent. on the cost of construction, Mr. Hawksley undertaking to design the works, prepare all needful working drawings, and supervise the works during construction, as well as to give advice in relation to Local Government Boards and Parliamentary inquiries, and attend thereat. The new land which is to be acquired will raise the total area of the farm to be used for sewage disposal to 2320 acres, of which over 2000 acres will be available for irrigation. Mr. Till estimates the costs of the works only, including main conduit, outfalls, and stream diversions, new improvement, pipes and main drainage, laying out, machinery, and raising mains, extension of existing buildings, &c. &c., and stocking the land, at £124,500, exclusive of easements, compensation, or purchase of mill or water rights. He estimates, approximately, the cost of pumping expenses for lifting 5,000,000 gallons of sewage per day to the high level lands, exclusive of interest, sinking fund, or capital, at about £900 per annum.

Cycle engineers seem to be enjoying a good time. Easter week was one of the most remarkable in the history of the cycle engineering trade, and orders continue to pour into the Midland towns for machines from all parts of England and abroad, and factory accommodation at Coventry is extending in all directions. This remarkable activity in the cycle and cycle fittings trades is responsible for some extraordinary advances in the cycle share market of the Midlands, in which securities of this description have lately been sought after, to the neglect of nearly all other kinds of industrial shares. The extent of the upward movement may be best gauged, perhaps, by a comparison of the prices of a week ago with those realised on the first of the month, before the "boom" had set in. Beeston Pneumatic Tire at the earlier date were selling at from 18s. to 20s.; within the past ten days the price realised has been £6. W. Bown, Pref. 7 per cent., has risen in the same period from £3 15s. to £4 10s.; Cycle Components, from 20s. to 44s. 6d.; Humber and Co., from 26s. 3d. to 29s. 3d.; Pneumatic Tire, from £9 to £12 15s., ex dividend; Rudge-Whitworth, from 13s. 9d. sellers to 19s. 6d. buyers; St. George's Engineering, from 21s. to 35s.; Allday and Onions, from £4¼ to £5¼; and Self-sealing Air Chamber, from 15s. to 21s. The steel tube concerns which minister to the wants of cycle manufacturers have shared in the advance, Star Tube rising from £3 premium to £4 premium, or £5 for the £1 shares, and Rose Tube from about par to £1 premium; and during the week, in some of these cases, still further advances have been made. The newly-formed Cycle Manufacturers' Tube Company have arranged for the erection of a factory upon land purchased from the Coventry Corporation. The contract for the first portion of the work amounts to £21,000.

A conference of representatives from the County Councils of Montgomeryshire, Breconshire, Radnorshire, Cardiganshire, Merionethshire, and Carnarvonshire, with the local members of Parliament and gentlemen interested in agriculture, has taken place at Machynlleth. The object of the meeting, which was promoted by the directors of the Cambrian Railway Company, was to discuss methods for facilitating the carriage of agricultural produce over the district served by the Cambrian Railway. Sir Humphreys Owen, M.P., presided, and among other directors present were Lord Henry Vane Tempest and Mr. Edward Davies. After an interesting discussion of the conveyance of live stock, the chairman announced, amidst applause, that the company was prepared to revert to the rates of 1892 locally. Mr. Forrester Addie advocated the opening of a market in the Black Country by a reduction in the rates for produce, and the publication by the company of a list of customers and producers. Professor Parry, Aberystwith, spoke of unfavourable rates for home produce compared with foreign goods.

Three fatalities have unfortunately occurred at Himley Colliery, causing the death of William Marson (20), Gornalwood, who was killed whilst following his employment at No. 8 pit, Himley Colliery; and the death also of a man named Joseph Shaw (51), who resided at Pensnett; and of Wallace Kennell (22), of Wallheath, who was killed on the Earl of Dudley's private railway at Himley Colliery. The first two cases were caused by the fall of a roof whilst they were fixing up an iron girder across the roof. In the last-named case the deceased was engaged in shunting, when he was crushed against a truck and died almost immediately. Verdicts of accidental death have been returned.

The Public Works Committee of the Birmingham City Council have decided to report to the Council in favour of the scheme of reorganisation of the work of the City Surveyor's Department recently mentioned. It is proposed to continue the services of Mr. Till in connection with the City Council, but not in connection with the Drainage Board, and to pay him a reduced salary of £600 a year; while a deputy or assistant colleague shall receive £400 from the Corporation and £400 from the Drainage Board. This arrangement will involve no increase of costs, Mr. Till's salary hitherto having been £1000 from the City Council, and £400 from the Drainage Board.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—Although there is perhaps not quite so confident a tone in some quarters, owing to the persistent slackening off in the demand during the last month, with a consequent weakening of prices for raw material, there would seem to be nothing actually in the present position to occasion any real uneasiness as to the future. It was not to be expected that the heavy buying that went on two or three months back could be continued; and apart from the lull which was only natural to follow, trade, taking it all through, is satisfactory, and the principal iron-using branches of industry are not only kept fully employed, but in most departments new work comes forward rather in increasing than decreasing quantities. Of course there are nervous or needy holders of iron who are always, in a condition of the market like the present, anxious to realise even at a sacrifice in price. Generally, however, a strong tone is maintained; and apart from second-hand parcels or speculative transactions, prices have not, under the circumstances, given way more than might have been looked for.

A continued absence of animation is the report throughout the iron market here, and although there was an average attendance on Tuesday's Exchange, business all through was extremely slow. In pig iron especially there is a complete pause as regards further buying for the present. This absence of new business coming forward has, however, not hitherto been regarded as appreciably affecting the position of makers, and the report on 'Change of the altogether unexpected action of the associated Lincolnshire smelters at their meeting last Friday in deciding to reduce their list rates 1s. per ton occasioned considerable surprise. It was generally supposed that the Lincolnshire makers were so heavily sold that they were practically independent of new business for some time to come, and the explanation is that Northampton pigs have recently been offered at such extremely low figures that the important Staffordshire trade in Lincolnshire pig iron has been almost, if not altogether, lost, and that it is solely with a view to the recovery of this trade that the reduction has been made. With regard to other brands of pig iron, makers' prices remain without quotable change, but the position, taking it all through, is unquestionably weaker, and in the open market prices were very irregular, merchants, in fact, making their own quotations, according to circumstances. Lincolnshire iron, at the reduced rates, is now quoted 41s. for forge to 43s. for foundry, with Derbyshire remaining at 46s. to 47s. for foundry, net cash, delivered here, but with regard to Derbyshire iron the position of makers is not so strong as it has been recently. Local makers have made no change in their quoted prices, foundry qualities remaining at 46s. 6d., less 2½d., delivered here, and it is only where they come into competition with forge Lincolnshire at Warrington that they will be at all affected by the reduced rates. For delivery Warrington, 41s. 8d. net cash is now about the average price for Lincolnshire forge, and Lancashire makers, to secure business, will have to come in at something like the same figure. Makers' prices for outside brands are somewhat easier, but without quotable alteration. They are still quoting 47s. net cash for good foundry Middlesbrough, delivered by rail Manchester, but orders could be placed at 6d. to 9d. less, and delivered Dock Quays, Manchester, at about 44s. 9d. net cash. For Glengarnock makers' official quotations are 48s. 6d. delivered Lancashire ports, and 50s. 6d. delivered Manchester Docks, but sellers could be found at 6d. to 9d. under these figures, and Eglinton could be bought without difficulty at 47s. net prompt cash, delivered Lancashire ports, and 49s. 3d. delivered Dock Quays, Manchester.

New business comes forward steadily in the manufactured iron trade, and forges are kept fully going. For bars prices are firm at last week's quotations, £5 10s. to £5 12s. 6d. being the minimum for Lancashire, and £5 12s. 6d. to £5 15s. for North Staffordshire qualities, delivered here. Sheets, however, are weak and irregular, owing chiefly to the collapse of prices in Staffordshire; and £7 5s. to £7 10s. may perhaps be taken as about the average figures for delivery here. The Association list rates for hoops are steady at £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths, delivered Manchester district, and 2s. 6d. less for shipment.

In the steel trade a moderate business is reported, with a steady tone in prices at late quotations, makers being very firm at 58s. to 58s. 6d, less 2½, for good foundry hematites; with £4 7s. 6d. to £4 10s. net cash the average figures for steel billets; £6 to £6 2s. 6d. for local made steel bars; £6 7s. 6d. for boiler plates; and £5 10s. to £5 12s. 6d. for steel girders, delivered Manchester district.

A brisk tone prevails in the metal market, with prices well maintained at full list rates.

In the engineering trade general activity continues to be reported, and in some quarters a considerable amount of new work has been booked during the last few weeks. This remark applies particularly to machine tool makers, who have secured some large orders for delivery well into next year, whilst at many of the local establishments there is quite a pressure to get through the work already in hand. Stationary engine builders also continue fully engaged, both in the light and heavy departments; boiler makers are also kept extremely busy, having a larger weight of orders in hand than they have had for a considerable time past, and amongst locomotive builders a fair amount of new work has also been secured.

Messrs. Henry Wallwork and Co. have just completed for Messrs. A. C. Wells and Co., of Manchester and London, a specially designed painting machine to be used on the Liverpool Overhead Railway. This consists of a modification of their "Lightning" painter, which was some time back described and illustrated in THE ENGINEER, but in the present instance it is to be driven by an electric motor. The whole of the machinery, consisting of the electrically-driven air compressor, by which the paint is forced up to the painting nozzles, and then discharged in fine spray, the paint receptacle, and the electric motor, are fixed, in compact form, upon a travelling car constructed to run upon the tram rails below the overhead railway, and the machine can be operated at any point along the line by an electric current supplied from the company's own installation. Another improvement and modification of their painting machinery is also being introduced in the form of a portable self-contained painting machine weighing less than 1 cwt., and complete in itself, with air-pumps, paint receivers, and all the requisite apparatus carried on one small base-plate, fitted with wheels and a couple of handles, arranged in truck form, so that it can be readily wheeled from point to point. The mixing arrangement, which is automatic, is operated by the rotation of the crank actuating the air pump, which is worked by hand, and supplies the compressed air for forcing the paint to the nozzles. I may add that the method of painting by machinery, introduced by Messrs. A. C. Wells and Co., is making considerable headway, the machines they have already supplied having, I understand, given great satisfaction, and I hope, for a later issue, to be in possession of more complete details, with illustrations, of the newly designed and improved machines they are now introducing.

Throughout the coal trade the position remains unsatisfactory, with comparatively few collieries working above four days per week, and all descriptions of round coal hanging upon the market. With the present mild spring weather, requirements for house fire qualities are necessarily falling off, and although there is no actually quotable change in list rates, surplus supplies are pushed for sale, and in the open market prices are weaker. The lower descriptions do not move off any better for iron making, steam, and general manufacturing purposes, and the complaint generally is that they are extremely difficult to sell, with only excessively low prices obtainable, ordinary steam and forge coals not averaging above 5s. 9d. to 6s. 3d. at the pit mouth. For engine classes of fuel there is a fair demand, and with collieries in many cases rather short of supplies, the tendency as regards prices is, here and there, decidedly in an upward direction. The general average prices, however, remain unchanged at about 3s. and 3s. 6d. for common, to 4s. and 4s. 6d. for better qualities, and 5s. for special sorts, at the pit mouth, and although in a few cases advances of 3d. per ton are being got, these are altogether exceptional.

In the shipping trade business shows no improvement, and owing to the excessively low figures at which orders recently have only been obtainable, some of the collieries are declining to compete at all for business, preferring rather to leave this branch of trade alone than to accept orders at altogether unremunerative prices. Common steam coals, delivered Garston Docks or High Level, Liverpool, average about 7s. to 7s. 3d., and for delivery Partington tips, Manchester Ship Canal, about the same figures would be taken.

Some feeling of anxiety with regard to the possibility of another wages dispute in the coal trade is beginning to manifest itself as the period approaches when the present Conciliation Board agreement comes to an end. It is evident that the miners are as determined as ever upon the question of a minimum wage, and this part of their policy they have all along kept to the front with unshaken persistency. The coalowners, on the other hand, are as strongly adverse to binding themselves down to a fixed minimum rate of wages—at any rate on the basis proposed by the miners—and if the question is to be fought out on this issue, it is difficult to see how a renewal of the struggle can be avoided. By the agreement which comes to an end in July, the miners have already succeeded in getting in the thin end of the wedge with regard to the principle of a minimum wage, and it is probable they may endeavour to drive it still further home by suggesting that the existing arrangement — that is, that the present rate of wages remain undisturbed for a period of eighteen months, after which the colliers, if the state of trade warrants it, are to be in a position to ask for an advance—shall be carried over for another similar period. The contention of the coalowners, however, is that the present state of trade and the lower wages paid in other competing colliery districts does not warrant the rate of pay already received by the federated miners, and that the Board of Conciliation shall have power to regulate the rate of wages, which, of course, means that there must be some reduction. I scarcely think, however, that either the miners or the coalowners will care to enter upon another protracted contest, and in well-informed quarters it is thought probable that some means will be found to bridge over the difficulty by an arrangement which, whilst not actually binding the coalowners to a minimum wage, may for the time being satisfy the miners, who will no doubt be advised by their leaders that it is not their policy just at present to push the matter to the extremity of forcing on another struggle. It would seem, however, to be almost inevitable that the minimum wage question, which has taken so strong a hold upon the minds of the colliers, must sooner or later be fought out, but in all probability the miners' leaders will prefer to wait until the condition of the coal trade is more favourable than it is at present for carrying the struggle to a successful issue.

Barrow.—The demand for hematite qualities of pig iron is still brisk, and orders are offering freely to makers, who are already well sold forward. Business in Bessemer qualities of metal is not only strong by reason of the immediate large consumption on the part of steel makers, but because there is an all-round good demand for forward deliveries generally. The production of the 39 furnaces in blast is all going into consumption, and during the week 1102 tons have been cleared out of warrant stock, leaving 302,816 tons still in hand, or 13,641 tons increase since the beginning of the year. Makers quote their old rates of 50s. per ton for parcels of mixed Bessemer numbers, net f.o.b., and warrant iron is selling at 47s. 11d. net cash, while buyers are offering at 47s. 10½d.

There is still a good business in the iron ore trade, and smelters are using large supplies as well of native as of Spanish qualities. Last week's quotations are still maintained.

The steel trade is brisk, and the mills are busy in every department, including rails and plates, as well as billets, hoops, castings, and merchant steel. Orders are still numerous all round, and prices are firm, heavy rails being at £4 12s. 6d. per ton.

Shipbuilders are looking forward to some new orders, and during the week the Naval Construction and Armaments Company has booked an order from the Admiralty for two more torpedo boat destroyers. It has already in hand two of this class of boat, and it is quite on the cards that boats of a higher rate of speed will be ordered.

The coal and coke trades are very firm.

In shipping things are much brisker. During the week the exports from West Coast ports reached 9189 tons of pig iron and 14,694 tons of steel, as compared with 4098 tons of pig iron and 4559 tons of steel in the corresponding week of last year, an increase of 5091 tons of pig iron and 10,135 tons of steel. Since the beginning of the year the shipments have totalled up to 94,771 tons of pig iron and 131,222 tons of steel, as compared with 78,888 tons of pig iron and 110,169 tons of steel in the corresponding period of last year, an increase of 15,883 tons of pig iron and 21,053 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

BETTER time has been worked in most of the collieries in the South Yorkshire district. The week's output has been an average one. Very little change has taken place in the condition of trade. Values remain low, although the prices of steam and small fuel have an upward tendency. Slack and smudge are in increased request, owing mainly to the extra demand for coke-making purposes. Establishments making their own coke find it to their advantage to use their own slack and smudge. The supply of slack is very restricted owing to the short time worked at the pits. A limited tonnage of both Silkstone and Barnsley house coal is being forwarded to London, owing to the mild weather, and the large quantity of seaborne coal at present in the market. A similar remark applies to the eastern and other markets.

In house fuel the quotations, owing to the plentiful supplies, are low. Silkstone coal is at 8s. to 9s. for best hand-picked, while ordinary samples are obtainable at 7s. to 7s. 6d. per ton at the pits. Best qualities of Barnsley "softs" make from 7s. 3d. to 7s. 6d. per ton, inferior qualities 6d. to 9d. per ton less. Owing to the low prices asked for secondary sorts of thick seam coal, the thin seam pits are worked with considerable difficulty. The best qualities of this class will not fetch more than 5s. 9d. to 6s. per ton. There is an abundant supply of fuel in the market, and low values only can be obtained. It is expected in many quarters that the Baltic ports will shortly be opened. A large tonnage is being forwarded in connection with railway and other contracts. Steam coal prices range from 6s. 9d. to 7s. per ton. Good screened slack is obtainable at from 3s. 6d. to 4s.; ordinary pit slack, 2s. 6d. to 2s.; while smudge is as low as 1s. 6d. per ton at the pits. An improvement has taken place in the coke trade, and the majority of the district ovens are now well employed. North Lincolnshire has been taking a much larger tonnage of late, owing to more furnaces being put into blast. Derbyshire is requiring an average amount, and a similar remark applies to several of the other iron smelting districts. Values of best coke range from 9s. 6d. to 10s. per ton in owner's wagons at the works.

The heavy departments of the city continue in the same regular condition. The railway material branchs are well off for work. Some very good orders for springs, buffers, axles, tires, and similar goods, have recently been booked. These have been mainly for the Midland, and the Manchester, Sheffield, and Lincolnshire, for its London extension, as well as for other of the leading home railway companies. Several foreign railways, including South American, have also placed some large contracts. The increased activity in these branches has had a stimulating effect on the demand for steel, and three of the Bessemer works are working night and day. The Queensland Government have placed an order for half-a-dozen engines with the Yorkshire Engine Company. This company is also well employed on work in other departments. The armour-plate mills and forging presses are busily engaged on Government orders, and it is satisfactory to note that during the last week or two some further orders for shells of various patterns have been received by the Sheffield firms who make this class of work a speciality.

In the lighter industries a remarkable improvement has taken place since the quarter ended. A very brisk business is being done in files, the men working full time. Competition is still very keen, and it is stated that in some cases manufacturers are disposing of the files at cost prices, relying on the steel used for their profit. The skate business has been very poor this year, owing to the absence of any prolonged winter, and heavy stocks laid in last year have remained untouched. The mild weather has had the effect of stimulating the demand for building tools, and heavy tools for the engineering trades have been in good request. The saw business is only quiet. Since Easter an improvement has taken place in the cutlery trade. Some excellent orders have been received for cutlery. These have been mainly for the pen and pocket qualities. A very good business is also doing in the table knife branch. Manufacturers of the cheaper qualities of cutlery are well off for work, finding full employment for their men.

Lord Charles Beresford, who has been the guest of the Master Cutler—Mr. H. Herbert Andrew—during his visit to the Sheffield Press Club, visited the Toledo Steel Works, the Master Cutler's establishment, and the Cyclops Works, Messrs. Charles Cammell and Co., on Monday. At the first place he witnessed the process of manufacturing tool steel, cotton spindle steel, and steel for mining purposes; as well as the production of special steel for safes, the preparation of metal for projectiles, the Siemens-Martin process, the drawing of telegraph wire, &c. The Master Cutler and Mr. J. L. Potts, the manager, conducted Lord Charles Beresford and the party accompanying him over the departments. At the Cyclops Works, Mr. Alexander Wilson, J.P., the managing director, and Mr. T. W. Jeffcock, J.P., one of the directors, received the visitors, who were shown the rolling of a 25-ton armour plate for H.M.S. Illustrious, now being built at Chatham. Another plate for the Victorious was Harveyised, and his lordship was also able to see the machining of the plates to be used in one of the new warships, as well as several of the minor processes. At the Press Club, Lord Charles vigorously criticised the naval system at the Admiralty as theoretically excellent but practically rotten. He particularly objected to no provision being made for manning the new war vessels, pointing out that the First Lord of the Admiralty admitted that in April next he would be 11,000 men short, and that he intended to take them from the First Naval Reserve. His lordship contended that we had no Naval Reserve, and that 22,000 more men will be required a year hence. He wants to know where the First Lord is going to get them.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THOUGH the local iron market is very quiet, and both buyers and sellers show a disinclination to operate at present, yet the tone cannot by any means be described as depressed. On the contrary, business men are decidedly hopeful, for their belief is that this lull is simply one of those unaccountable pauses which occur from time to time in every upward movement, when buyers, after a brisk period of buying, take a rest. Makers have certainly well filled order books, and are quite indifferent about selling further at present, while buyers have ordered enough to satisfy their requirements for some little time to come, and they hold off just now. But there is nothing in the position and prospects of trade to favour an opinion that trade is falling off.

The activity in the pig iron industry is unprecedented, the production is the largest on record for the North of England, and it is regarded as certain that it is not now in excess of the requirements, though it has been so for the last half-year. But now the exports are very heavy, and local consumption has never been larger, for finished iron and steel works are in full swing—indeed, the present rate of production has never been surpassed. It is calculated that at the end of the month a decrease of 3000 tons in the stocks of Cleveland pig iron will be reported. Some apprehension is felt that the output of pig iron will be increased, and that too many furnaces will be put in blast. This has been partly caused by the report of the sale of the Coultham Ironworks, but it is not likely that they will enter upon the competition for at least six months, as the furnaces need to be relined. It is not probable that the new owners will restart them unless they can see their way to making a fair profit. At present the profit must be small, where a producer has to buy his materials in the open market, and has to give anything like the present prices for them.

The exports of pig iron from the Cleveland district have this month amounted to 76,982 tons, as compared with 68,858 tons last month, and 84,344 tons in April last year to 22nd. The exports have kept up very well indeed when it is taken into consideration that the navigation season commenced so early this year. Local consumption also is good, and a large quantity of hematite pig iron is being forwarded to the Sheffield district.

Makers generally maintain their quotations fairly well, as they are for the present independent of the market, but second hands have reduced their prices 3d. per ton for all kinds of pig iron; they, however, have only been selling small lots for delivery before the end of the month. Of No. 3 Cleveland pig iron sales have been made at 37s. 9d.; while No. 1 was 39s.; No. 4 foundry, 37s. 3d.; and grey forge, 36s. 9d. Cleveland white iron is practically unprocurable. In the absence of business and the desire to do it, reliable prices for forward delivery can hardly be given. Cleveland warrants have this week touched a lower price than has been known since January 14th, 37s. 8d. cash being all that the buyers would give on Monday. There has since been a slight recovery, and on Wednesday afternoon 37s. 10d. cash would be given, there being sellers at 37s. 11d. The stock of Cleveland pig iron in Connal's stores on Wednesday night was 190,256 tons, an increase for the month of 2782 tons. It might have been expected that with such excellent shipments and inland deliveries iron would rather be drawn out of than put into the public stores.

Finished iron and steel manufacturers have booked very few orders since before Easter, but they are well supplied with contracts, and can keep their establishments in full operation. There is, therefore, no easing of prices. The managing director of one of the leading bar-making establishments in the North of England states that never since their works were founded has business been so brisk as it is at present; indeed, orders have been coming in so rapidly that they were unable to keep pace with them, and there seems to be every prospect of a still more active trade. The question of a restart at the Darlington Steel Works, which have been idle since October, 1894, is much discussed. The directors had a meeting last Saturday, when the subject was considered, and a further meeting is to be held, so as to settle upon the proposal to be made to the shareholders at the forthcoming annual meeting. It is true that the selling prices of steel rails have gone up, but the cost of production has increased likewise, and the directors seem to be doubtful about the present activity being maintained. The inland situation of the works tells against them in their competition with the manufactories near the seaboard. Deliveries of rails and railway material, as well as bridge work, are very heavy from the Tees, and it is a long time since Middlesbrough Dock has been so crowded with large steamers as it is at present, most of them bound for India and Japan. Heavy steel rails are obtainable at £4 12s. 6d. per ton net at works.

The steel ship-plate trade is very brisk, as shipbuilders in the North of England and Scotland are so actively employed. On the Tyne especially is this the case, a considerable proportion of it being work for the British Government. This week orders have been placed with Palmers' Shipbuilding and Iron Company for two thirty-knot torpedo boat destroyers, and other two are to be built by Messrs. Hawthorn, Leslie, and Co. Palmers have now on hand for the British Government eight torpedo boat destroyers, and two third-class cruisers. Owing to the improved prospects, the value of Palmers' shares has considerably increased. A short time ago their £15 A shares could have been bought at 7½, now they are 9½ On the Tyne there are at present ordered eighteen war ships, including torpedo boat destroyers, and of these thirteen are for the British Government. The Tyne Iron Shipbuilding Co. will build a steel steamer of 3400 tons gross for the Stag Steamship Co., and Messrs. Ropner and Sons, Stockton, will build a steel steamer of 5400 tons deadweight, for a Cardiff firm, the price, it is stated, being £30,000. Owing to the activity in shipbuilding the price of steel plates is strongly upheld at £5 2s. 6d. per ton, and some firms will not sell under £5 3s., both less 2½ per cent. and f.o.t.

Wages questions continue to come to the front, the improvement in trade having led the men to endeavour to secure a larger share of the realised prices. At the foundries the men have commenced an agitation for increased wages, and those at the Anderston Foundry, Port Clarence, are the first to hand in a definite claim, which is for no less than 15 per cent. advance. The Northern United Enginemen's Association, which includes cranemen and firemen, have accepted the offer of the employers, an advance of 1s. per week in wages for those receiving 25s. per week and upwards, and 6d. for those under 25s. The pattern makers have agreed to accept an advance of 1s. per week. The joiners of the Tees, Hartlepools and the Tyne yards claimed 3s. per week advance, and the employers offer 1s. from May 6th; the men have this offer under consideration.

The death is announced of Mr. Thomas Walker, of Saltburn, a partner, since its formation in 1872, of the firm of Walker Maynard and Co., Redcar Ironworks.

The employés of the Cleveland Bridge and Engineering Co., Darlington, on Monday presented an illuminated address, a gold pendant, and a silver kettle to Mr. Edward Westby Jacob, who is retiring from the managership of the works, which he has held for the last ten years, during which time the works had been considerably extended.

A testimonial from the working men and others in South-East Durham was on Saturday presented to Alderman Joseph Richardson, D.L. Mr. Richardson is senior partner in the firm of Richardson, Duck and Co., shipbuilders, Thornaby-on-Tees. The University of Durham have conferred the honorary degree of D.C.L. upon Sir David Dale, Bart., who has for so many years been a leading member of the iron and coal trades in this district, and has done so much to popularise the principles of arbitration and conciliation in disputes between employers and their men. He took a prominent part in establishing the Board of Conciliation and Arbitration for the North of England Manufactured Iron Trade, which has successfully adjusted industrial difficulties in that industry since 1869.

The traders of Middlesbrough and district have commenced to agitate for an enlargement of and a new entrance to the Dock, which is the property of the North-Eastern Railway Company, as there is not accommodation for the very large vessels that are now employed in the trade between this country and India and the East, a trade in which Middlesbrough is very largely engaged, as so much railway material and bridgework is manufactured in the district for that part of the world. The trade up till within the last few years has been carried on with steamers of from 2000 to 4000 tons, and the dock and entrance were capacious enough for these. But of late the tendency has been to greatly enlarge the capacity of the vessels employed, as it is found that steamers of from 7000 tons upwards can be worked much more economically, and lower freights can be accepted without loss. But there is not adequate accommodation at Middlesbrough Dock for such vessels, and the consequence has been that they have frequently to take only a part of their cargo on board in the dock and fill up elsewhere. Some vessels are too wide to get into the dock at all, and some of the leading shipowners decline to risk sending their vessels. Not only is the entrance too small, but there is not room enough to swing the vessels if they were in. It has been decided to send a deputation to the directors of the North-Eastern Railway Company, to represent to them the necessity of making adequate provision for dealing with these large vessels. The dock at Middlesbrough was opened in 1842; in 1852 it passed into the hands of the railway company; in 1872 it had to construct a new entrance; and in 1883 it had to make a still larger entrance and to enlarge the dock considerably. If the trade is not to be hampered it will be necessary without delay to still further increase the accommodation. Some traders are of opinion that it would be well if the example of Antwerp could be followed, and quays erected with deep water berths in the lower reaches of the river. That would make the port a less expensive one. The suggestion that a new dock independent of the railway company should be constructed lower down the river does not find favour with the traders.

The steam coal trade is exhibiting improvement, and the collieries north of the Tyne are doing better than for six months past, while the price of best steam coal has been this week raised 3d. per ton, viz., to 8s. f.o.b. Blast furnace coke is scarce; the supply was not in excess of the requirements before the Brancepeth explosion, and now consumers cannot get all they need. Brancepeth Colliery was probably the largest coke making establishment in the country, and the stoppage of the business there could not but seriously affect the supply. This week fancy prices have had to be paid by those needing coke at once, but contracts over three or six months can be placed at 14s. delivered at the Tees-side furnaces.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The pig iron market has been comparatively quiet this week. Scotch warrants are only in moderate request, hematite being slow of sale, while Cleveland iron is much neglected. There is scarcely any speculative interest in Glasgow market at present. Prices are already such that an early rise could hardly be expected; and, on the other hand, the "bears" do not appear assured that the time has yet arrived for a very decided fall. Business has been done in Scotch warrants from 46s. 1½d. to 45s. 11d. cash, and 46s. 3½d. to 46s. 1d. one month. Cumberland hematite has sold from 48s. 1d. to 47s. 9d. cash. Cleveland warrants have changed hands at 37s. 10½d. one month.

There are 43 furnaces producing ordinary, 35 hematite, and 3 basic iron, the total of 81 comparing with 75 at this time last year. Only a small quantity of iron has been added to the stock in Connal and Co.'s Glasgow stores.

Prices of G.M.B. iron are 3d. to 6d. per ton lower, and the special brands are not quite so steady as of late. Govan and Monkland, f.o.b. at Glasgow, Nos. 1, are quoted at 47s. 3d.; Nos. 3, 45s. 9d.; Carnbroe, No. 1, 47s. 6d.; No. 3, 46s.; Gartsherrie, Calder, and Summerlee, Nos. 1, 50s. 6d.; No. 3, 48s.; Coltness, No. 1, 53s.; No. 3, 48s. 3d.; Glengarnock, at Ardrossan, No. 1, 50s. 6d.; No. 3, 46s.; Eglinton, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Dalmellington, at Ayr, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Shotts, at Leith, No. 1, 52s.; No. 3, 48s. 6d.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 49s.

Good shipments of Scotch pig iron are being made to Italy, but in other directions the export trade does not show any improvement. The past week's shipments have amounted to 7937 tons, compared with 8695 in the corresponding week of last year, and of the total there was sent to Italy, 2800 tons; Germany, 810; India, 145; United States, 25; Russia, 170; Australia, 245; France, 30; Holland, 394; Belgium, 35; China and Japan, 160; other countries, 86; the coastwise shipments being 3037, against 6032 in the same week of 1895.

The finished iron industry is fairly active, but competition is keen, and prices are thereby kept down. The steel works are very busy, with good prospects as to the future, orders coming in freely, both for shipbuilding and general engineering work. It is reported that the tender of a Clyde firm recently sent to the United States, for 3000 tons of railway bridge material, has been found to be the lowest—cost, freight, &c.—but it is considered doubtful whether the order will be sent here. Be this as it may, the incident is instructive as to the ability of our steel makers to cope with competition abroad, at least in this particular kind of material.

There are one or two somewhat more hopeful features in connection with the coal trade, which on the whole stands much in need of improvement. A brisk demand is experienced for small coal and dross for manufacturing purposes, and the shipments abroad are this week considerably larger, the quantities despatched from the East Coast to continental ports being heavier than for some time. The prices f.o.b. at Glasgow are: For main coal, 5s. 9d.; splint, 6s. 3d. to 6s. 6d.; ell, 6s. 3d. to 6s. 9d.; and steam, 7s. 6d. per ton. The tone of business in Ayrshire is steadier, although there does not appear to be any considerable increase in its volume.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

The coal trade is slightly brisker, and holiday influences are steadily wearing off. The coal shipments from the port of Cardiff for the past week were 305,000 tons. This is very satisfactory, and indications are that it was not a sudden boom but the prelude to a large export during the month. "Big steamers" have been again in evidence, the Pindari for Colombo with 7700 tons, the Samoa for Bombay with 8000 tons, and Oriscalli for the same port with 6000 tons. Swansea coal shipments last week were encouraging, 31,000 tons, though it was reported that the San Francisco trade is quiet. Newport has exported 47,270 tons foreign, and 21,919 tons coastwise.

The anthracite trade between Swansea and Germany is improving, and coal totals for that destination take second rank in importance with those for France. It is hoped that, as the season advances, and business with San Francisco improves, the weekly total of anthracite exports from Swansea will begin to take good distinctive form.

There has been some little trace of discontent noticed amongst the Plymouth colliers with regard to the settlement of the "test case," but I am glad to state that at a meeting of colliers on Monday the matter was satisfactorily explained, and a vote of confidence in Mr. David Morgan, the miners' agent, passed unnamimously.

The impartial notice of the "discharged note" question in The Engineer of last week reminds me that a short time ago I had an interview with an old miners' agent, and a long discussion of the subject took place, and though I knew that a good deal of feeling had been imported into the matter, it was a subject of surprise that so much intense excitement had been aroused. The men were stubbornly bent at all hazards, if refused, to throw down their tools, and the prompt action of the coalowners and of the Sliding Scale Committee, in frankly and even genially abandoning the situation, has done a good deal towards bringing about a better understanding. "Mabon's" action in the affair has been warmly commended, and there is but one opinion, and that a warm one, about the good services of Sir W. T. Lewis, Bart.

Colliers, like those "who go down to the deep in ships," seem to be perversely reckless. Two men from the Dowlais Collieries were fined this week for having tobacco pipes in their possession in Bedlinog colliery last week.

On 'Change mid-week, Cardiff, the mustering of members was gratifying, and business was regarded as healthy in coal, coke, and fuel. Best steam coal was in demand at 10s. 3d. to 10s. 6d.; seconds ranged from 9s. 9d. to 10s.; ordinary seconds, 9s. 3d. to 9s. 6d.; drys, 8s. 9d. to 9s. 3d.; best Monmouthshire, 8s. to 8s. 3d.; seconds, 7s. 9d. to 8s.; very best small, 4s. 9d. to 5s.; best, 4s. 3d. to 4s. 6d.; drys and inferior generally, 3s. 6d. to 3s. 9d. The house coal trade is now unmistakeably upon the down grade. The green winter has been followed by an early spring, and all hopes of a good house coal demand appear to have been abandoned. Quotations remain much about the same, but prices vary a good deal with the conditions. Best, 10s. to 10s. 3d.; No. 3 Rhondda, 9s. 6d.; brush, 7s. 9d. to 8s.; small, 6s. to 6s. 3d.; No. 2 Rhondda, 7s. to 7s. 6d.; through, 6s. to 6s. 3d.; small, 4s. to 4s. 3d. Pitwood continues weak.

Good trench on Saturday was offered in Cardiff from 14s. 9d. to 15s. Iron ore imports are becoming more noticeable, and prices are quoted in Cardiff firmly as follows:—Rubio, 11s. 9d.; Tafna, 11s. to 11s. 3d.; Garucha, 10s. 9d. to 11s. Large consignments came in this week. Cyfarthfa had several cargoes, Blaenavon three, Dowlais three; Mr. Howard, Ebbw Vale, and Briton Ferry, one each. I was pleased to see an abundant supply in all sorts of places around the Cyfarthfa furnaces this week, and a much better despatch of tin bar from the same quarter. Preparations are going on at Cyfarthfa for resuming the steel rail trade, which has been partially abandoned on account of the demand for steel bar for tin-plate destinations. It was reported on 'Change, Cardiff, this week, that the demand for steel bars is getting less, and that the highest price obtainable for Bessemer quality is £3 17s. 6d., while Siemens is quoted at £3 18s. Heavy steel rails are down from £4 10s. to £4 12s. 6d., light sections are at £4 17s. 6d. to £5 5s. The prices of ship plates are well maintained, and steel scrap, rail and bar ends, &c., are caught up.

A more varied list of quotations, iron and steel, was given this week at the Swansea Exchange, as follows:—Pig iron, Glasgow warrants slightly lower, 46s. cash buyers; Middlesbrough, No. 3, 37s. 9½d.; hematite, 45s. 6d.; Welsh bars, £5 10s. to £5 12s. 6d.; sheet iron, £6 15s. to £6 17s. 6d.; steel, £6 10s. to £6 12s. 6d.; steel rails, heavy, £4 10s. to £4 12s. 6d.; light, £4 17s. 6d. to £5 7s. 6d.; Bessemer steel, bars, £3 17s. 6d.; Siemens best, £3 18s.; tin-plates, Bessemer coke, 9s. to 9s. 1½d.; Siemens, 9s. 1½d. to 9s. 3d.; ternes, 16s. 6d. to 22s. 6d.; best charcoal, 12s. 6d. to 12s. 9d.; block tin, £59 12s. 6d. to £60 2s. 6d.; lead, £11 to £11 2s. 6d.; Spanish, £10 17s. 6d. to £11; copper, advancing £45 6s. 3d. to £45 8s. 9d.

Other Swansea quotations are:—Anthracite, best, 11s. to 11s. 6d.; seconds, 9s. to 10s.; ordinary, 8s. to 8s. 9d.; steam, 9s. to 10s.; bituminous, No. 3 Rhondda, 9s. 6d. to 10s.; No. 2, 8s. 6d. to 9s. 6d.

Coke continues to advance, implying increased activity in the iron trade. Last prices Cardiff, were, 12s. 9d. to 15s., furnace; foundry, 15s 6d. to 19s. 6d., according to brand.

Patent fuel in fair demand, Cardiff and Swansea.

There is still not much movement to record at the iron and steel works; Cyfarthfa is to have its resident London agent, though of course, from time immemorial, Cyfarthfa has had its representative in the city. All that can be stated about the trade is that prospects are more hopeful. Better news reaches me from the tin-plate districts. Last week there was a larger shipment than make, reducing stocks, and gratifying news is to hand that several works are going to restart. One notable case I am glad to announce is that of the Beaufort Works, Morristown, by concession of the men.

I regret to announce that the tin-plate trade is very depressed at Briton Ferry. The mills at the Vernon, Gwalia, and Villiers are still idle, and there is no prospect of a restart unless the men see the wisdom of following the steps of others, and make a reduction. This is what I have on various occasions pointed out as an imperative necessity, to take a leaf out of iron and steelworkers' books. If these had stubbornly contended for old wages, furnaces would now be as deplorably hard off as mills. The mills at Baglan Bay and Earlswood are fully occupied.

Production of tin bar at Albion and Briton Ferry is a fair average.

I note that Wales is importing freely pig from Ulverstone, and iron bars from Workington.

I referred lately to the possibility of a new industry at Swansea, and the likelihood that the waste sulphate of soda in the district would be utilised for the treatment of sulphide ores from Australia. This is now made tolerably sure by the arrival of the steamer Buluwayo from Port Pirie, South Australia, with a cargo of 3006 tons, and new works are planned to be adopted for the process forthwith.

Opponents of the movement in London for obtaining Welsh water, and who think that it has collapsed, may be interested to learn that a steady survey is still going on in certain localities, tending to indicate that if carried out Langorse Lake will figure conspicuously.

It is stated at Milford Haven that a subsidy has been granted to the Milford Dock Company by the Admiralty for the use of their large graving dock at Milford when required by them. This dock is 600ft. in length, and considered to be one of the finest dry docks in the kingdom.

It has been decided, adverse reports notwithstanding, to proceed with the Llanelly Harbour Bill. The Docks Committee have held several meetings of late, when all matters in reference were well discussed, and they now report that they expect the Bill will come before the House of Lords Committee next week, when all matters *pro* and *con.* will be dealt with in evidence.

I share with many a good deal of interest in the fate of our Welsh Bills, which, as I close my dispatch, are coming to the front. The first is the Great Western Additional Powers Bill for lines in Roath, and improvements in connection with the Bute Docks. Then comes the great struggle, the proposal to amalgamate the Bute Docks and Rhymney. Next, the proposal to form the Windsor Docks on the mud flats between the Taff and Ely rivers. This is expected to be strongly opposed. Then we have the proposal of the Barry Company to get into the Monmouthshire coalfield, and some minor Bills of less significance. These I have mentioned are certain to bring out the best powers of promoters and counsel.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

The trade in iron and steel is improving steadily all round; material changes, either in prices or demand have, however, not taken place, and there is, consequently, not much of interest to be related this week.

Business on the Silesian iron market continues strong. The favourable influence of the Russian commercial treaty is now being felt, especially in the steel and hardware trade, where a steady and altogether satisfactory employment prevails.

Exports in machines to Russia have also been pretty large for some weeks past, the prices realised being, as a rule, fairly remunerative.

Though heavy contracts are not being booked just at present, the activity on the Austro-Hungarian iron market continues, on the whole, satisfactory, owing to the numerous orders that were secured some weeks ago. During the first three months of the present year, the convention of the rolling mills sold about 75,000,000 kilos., which shows a plus of about 23,000,000 kilos. against the same period last year. There is an exceedingly brisk business done in girders and structural iron, and the railway and engineering department is also in fair employment.

On the French iron market raw as well as finished iron finds good markets, and prices are tolerably firm, but have not perceptibly changed since last week, merchant bars being offered at 150f. p.t., girders 160f. p.t., while steel rails were sold at 115f. p.t. free at works.

A lively tone prevails on the Belgian iron market, and prices have been rather more paying of late. Pig iron is in quiet but regular demand, while the various sorts of malleable iron continue to be very actively inquired for. Quotations are, as a rule, tending upwards. Luxemburg foundry pig is quoted 53f. p.t.; common forge, 52f. to 53f. p.t.; merchant bars, No. 2, f.o.b. Antwerp, 122·50f.; No. 3, 127f. p.t.; the same Belgian station, 132·50f. and 137·50f. p.t. Girders, f.o.b. Antwerp, 122·50f. p.t.; the same Belgian station, 130f. p.t. Heavy plates for export, No. 2, 138f. to 140f. p.t.; No. 3, 148f. p.t.; sheets, free Belgian station, 162f.; in some instances, 165ft. p.t.; steel plates, 143f. to 145f. p.t. Steel rails, 113f. to 115f. p.t.

During the first quarter of 1896 201,770 t. pig iron were produced in Belgium, against 222,800 t. for the same period the year before; 75,795 t. being forge pig, against 109,809 t. last year; 21,325 t. foundry pig, against 26,100 t.; and 104,650 t. basic, against 86,900 t. for the corresponding period the year before. On April 1st of present year there were 28 blast furnaces in blow in Belgium, out of 44 built.

On the Rhenish-Westphalian iron market a good number of orders have been coming in upon the week, and prospects for spring demand are most encouraging. Export trade has also perceptibly improved of late. The week's business in pig iron has been on rather a large scale, and quotations are beginning to be more remunerative. The same may be told of the manufactured iron department. In bars and girders quite an animated business is doing; hoops are, likewise, in good request, and as for plates and sheets, the mills have not been so well employed for months. The number of orders that come in at the foundries and machine factories increases from week to week. The situation of the tube foundries, on the other hand, appears to be but slowly improving; prices are fluctuating, and have, in a few instances, even been moving in a downward direction. This may chiefly be accounted for by the exceptionally large stocks, which have been increasing all through last winter, and now concessions have naturally to be made to clear the stocks. The occupation of the wagon factories continues a good one.

Total output of coal in the Saar district was, for the first quarter of 1896, 1,470,070 t. against 1,283,090 t. for the same period last year; output in Silesia amounted to 3,491,470 t., against 3,117,010 t.; in the Ruhr district 9,218,130 t., against 8,344,120 t.; and in the three districts together, 14,179,670 t., against 12,744,320 t. for the same period last year. This shows an increase of 14·6 per cent. for the Saar district, 12·0 per cent. for the Silesian districts, 10·5 per cent. for the Ruhr districts, and 11·2 per cent. for the three districts together, when compared to the production for the same period the year before.

Negotiations are reported to be carried on between the Russian Government and German locomotive factories concerning the supply of about 300 locomotives worth M. 19,000,000. One-third of this order is to be carried out before the end of present year, while the remaining two-thirds will be delivered in 1897.

In 1895 output of gold in Russia is stated to have been considerably lower than in previous years; while in 1893 no less than 2664 pud were washed, output in 1894 decreased on 2483 pud, and last year amounted to 2406 pud only. This decrease may partly be accounted for by the exceedingly dry summer in East Siberia, which, for a time, prevented the gold washing in the rivers, and partly because there was much difficulty in securing labourers, a great number of them being employed in the less fatiguing and much more remunerative work for the Siberian Railway.

The following shows foreign trade of the Low Countries in iron and metals for 1895. In import, the largest figures fall to Great Britain, Germany, and Belgium. There were imported, iron manufactured goods as well as raw iron, worth 90·4 million florins; copper and copper articles, worth 49·1 million florins; steel and steel manufactured goods, worth 49·7 million florins; lead and lead articles, 16 million florins; zinc, for 12·5 million florins; tin, worth 20·2 million florins. With regard to export in iron and iron manufactured goods, which was worth 75·4 million florins, England, Germany, and the Dutch Colonies in East India are the chief consumers. Copper and copper articles (48·4 milllion florins) chiefly go to Germany; steel and steel manufactured goods (17·4 million florins) are exported to different countries. In plates and bars export to Germany is most important. Rails (11·2 million florins) are chiefly sent to the East Coast of Africa and to the Dutch Colonies in East India, while for steel wire (5·6 million florins) Great Britain is the chief consumer.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, April 16th.

Weakening prices for iron and steel are among the probabilities of the next thirty days, unless something unusual happens. The reason is current requirements are not heavy. Pig iron production is 750,000 tons ahead in stocks. Current weekly production is close on to 200,000 tons. Consumption is 180,000 tons, or perhaps under. A break in the billet pool is a possibility, and besides we have always to reckon with the sudden and unexpected. Buyers have suddenly turned their backs on the market. They never recognised 2·00 dols. coke and 4·00 dols. Bessemer ore as fair, and with the hanging-back demand they now say they will wait and see. Political questions are pressing, and politicians are at sea. The semi-centenary of the Pennsylvania Railroad was celebrated this week. The capital stock is 129,301,600 dols.; lines owned and controlled, 9077; investment, 857,000,000 dols.; gross receipts last year, 132,720,000 dols.; operating expenses, 92,859,286 dols. for 1895; net earnings, 39,861,525 dols.; passengers carried, 75,052,479; tons of freight carried, 160,410,144. The recent rumours of enlarged railway construction are encouraging the iron trade. Much mileage is projected, and in several localities there is urgent need of construction of short lines. The gold craze is now on; large parties are going to Alaska. The inquiries and orders for machinery are increasing steadily. In the smaller industries conditions are improving. Projected enterprises in railway and manufacturing plant and mining developments involve enormous outlays, and if the general conditions warrant such expenditures, iron and steel capacity could be fully engaged.

Testing Armour for Russia.—Last week the first test of armour plate was made by the Carnegie Company for the Russian Government, by the courtesy of the United States officials, at the Indian Head proving grounds. The plates submitted represented a group of 350 tons of armour now ready for shipment to Russia. It was a 5in. double-forged plate, the first thin armour to be subjected to that process. The test was conducted under Russian requirements, which were that the plates should repel the projectiles. Two shots were fired, one of a 4in. and the other of a 5in. shell, with a velocity of 1700ft. a second. Both shells failed to penetrate the plate, and as the test was satisfactory, the group will be accepted. The value of the armour represented in the test was between 125,000 dols. and 150,000 dols.—*American Manufacturer.*

The Incorporated Association of Municipal and County Engineers.—The twenty-first voluntary pass examination of candidates for the offices of municipal engineers and surveyors to District Councils carried out by this Association was held at the Institution of Civil Engineers on Friday and Saturday, the 10th and 11th inst. Twenty-seven candidates entered, and twenty-three presented themselves for examination, the written portion of which was taken on the first day. The greater portion of the second day was occupied with the *vivâ voce* portion of the examination. The examiners were:—I. For Engineering, as applied to Municipal Work, W. Santo Crimp, M. Inst. C.E. II. Building Construction, J. Senior, M. Inst. C.E., past-president, superintending examiner. III. Sanitary Science, J. Lobley, M. Inst. C.E., past-president. IV. Public Health Law Work, J. T. Eayrs, M. Inst. C.E., past-president. The next examination will be held at Liverpool in October next.

LAUNCHES AND TRIAL TRIPS.

On the 14th there was launched from the shipbuilding yard of Messrs. Joseph L. Thompson and Sons, North Sands, Sunderland, a steel screw steamer built to the order of Messrs. Joseph Brown and Son, of Old Castle Buildings, Liverpool. The vessel is of about 4850 tons deadweight capacity, and is constructed in accordance with Lloyd's rules for highest classification. The engines are of the triple-expansion type, by Messrs. John Dickinson and Sons. On leaving the ways the vessel was named Netherfield by Miss Amina Brown, of Liverpool, daughter of Mr. Joseph Brown.

On Saturday, the 18th inst., the s.s. Clarence, which has been built to the order of Mr. F. le Boulanger, of Swansea, by Messrs. Craig, Taylor and Co., of Thornaby-on-Tees, proceeded to sea on her trial trip, which proved highly satisfactory. The engines, which have been constructed by Messrs. Westgarth, English and Co., Middlesbrough, worked without a hitch, and a speed of about 11 knots was maintained during a run of over three hours. The dimensions of the boat are as follows:—254ft. by 37ft. by 18ft., the engines being 19in., 31in., 51in., by 33in. stroke, with two large boilers working at 160 lb. pressure. The owner was represented by Mr. George Eldridge, of London, and Captain F. Dinan, the atter of whom will take command of the vessel.

During the current month Earle's Shipbuilding and Engineering Company, of Hull, have delivered to Messrs. Thos. Wilson, Sons, and Company, of the same town, a fine steel screw steamer named the Dido, 400ft. long, built for the Bombay trade, and capable of carrying 7200 tons deadweight; they have completed and handed over to the representatives of the Haytian Government, after successfully carrying through her speed and gun trials, a 16-knot steel gunboat, named the Crête-à-Pierrot, of 950 tons displacement, constructed under the superintendence of Sir E. J. Reed, K.C.B.; also the steam trawler Argo, owned by the Ocean Steam Fishing Company, of Grimsby; and they have in addition engined the trawler Prince, which has been built at Beverley for the Grimsby Anchor Steam Fishing Company. There is still a good share of Government and private work in hand at this yard.

Messrs. John Scott and Co. launched from their yard on the 16th the screw steamer Giang Seng, which they have built for a Chinese gentleman in Singapore. The dimensions are:—Length, 240ft.; breadth, 34ft.; and depth to main deck, 17ft. 6in. The builders have also supplied and fitted the triple-expansion engines of 160 nominal horsepower, with two large steel boilers having a working pressure of 170 lb. The vessel has been built for the coasting trade round Singapore. She will carry 1500 tons of cargo, and steam eleven to twelve knots per hour. She has a Board of Trade passenger certificate, and can accommodate twenty first-class passengers above awning deck, thirty second-class passengers in the poop, and she has also third-class accommodatfon abaft forecastle. The vessel has two teak decks, and has ample accommodation for the captain, officers, and crew. She has been fitted and finished under the superintendence of Captain Follet, who has had a long and successful experience in the trade for which the vessel is intended. The launching ceremony was performed by Miss Lily Follet, of Liverpool. The vessel, as usual, was launched with steam up, and, on leaving the ways, immediately left for Burntisland, where she will load a cargo of coals for Singapore.

On Friday, the 17th inst., Messrs. Wigham, Richardson, and Co., launched from their Neptune Shipyard, Newcastle-on-Tyne, a fine steel screw steamer, which they have in course of construction for the Chinesische Kustenfahrt Gesellschaft, of Hamburg, being intended for their service in the East. The steamer is 310ft. in length by 38½ft. beam. She will be rigged as a two-masted schooner, and is being built to attain the highest class in the registry of the Bureau Veritas and Germanischer Lloyd. She has a handsome clipper bow with a finely carved figure-head. The vessel has been specially constructed for the Chinese coasting trade, and contains handsome, well ventilated and convenient accommodation for a large number of native and European passengers. The engines and boilers are also being constructed by Messrs. Wigham, Richardson, and Co., the former being of the quadruple-expansion type, self-balanced on the well-known Yarrow, Schlick, and Tweedy system, and are intended to propel the steamer at a high speed. This type of machinery is being extensively applied to the better class of vessels, including the large mail steamers building for the Norddeutscher Lloyd. These vessels are to be larger and faster than the Majestic and Campania. A goodly company witnessed the launch, amongst whom were Mr. Drury, of Darlington, and Mr. Sutton, of Newcastle, and Captain Kohler and Engineer Blesing, representing the owners. As the vessel left the ways she was named the Loongmoon by Mrs. John Tweedy, of Newcastle-on-Tyne.

On Thursday, April 16th, Sir Raylton Dixon and Co. launched from the Cleveland Dockyards, Middlesbrough, the handsomely-modelled mail and passenger steamer Albertville, built to the order of Messrs. The African Steamship Company, London, for the Compagnie Belge Maritime du Congo, for the line between Antwerp and the West Coast of Africa. The dimensions of the vessel are:—Length, 365ft.; beam, 44ft.; depth moulded, 26ft. The cabin accommodation will be of very handsome description, fitted for 110 first-class and 60 second-class passengers, with very spacious state-rooms, specially ventilated and provided with every improvement which experience has suggested as suitable for the intended trade and the comfort of passengers in a hot climate. The first-class dining-room is in a large house on deck, panelled with marble and inlaid woods in the handsomest possible manner. The first-class smoking-room, second-class smoking-room, and cabin entrances, are all most elaborately fitted and decorated. The decks are all of teak, and over the mid-ship part of the vessel a teak shade-deck extends to the sides of the ship so as to give shelter from the sun and to form a promenade above for passengers. The second-class saloon is placed aft, handsomely panelled in teak, with tables, revolving chairs, &c. The ship will be lighted throughout with the electric light, and also provided with refrigerating machinery and a large cooling chamber for the conveyance of fresh meat, provisions, &c. Machinery of 2000 indicated horse-power will be supplied by Messrs. Thos. Richardson and Sons, of Hartlepool, consisting of triple-expansion engines, having cylinders 27in., 43in., and 72in. by 48in. stroke, with two large boilers, working at 180 lb. pressure, and fitted with Howden's forced draught. The vessel was launched in the presence of Mr. Frederick W. Bond, of London, the chairman of the African Steamship Company, and named by Mrs. Bond. The Albertville is a similar vessel to the Leopoldville, built last year for the same line, but of larger dimensions and higher speed.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

9th April, 1896.

7500. Securing Picking Bands to Pickers, J. and R. A. Hopkinson, Manchester.
7501. Pneumatic Tires, S. Bunting, Birmingham.
7502. Actuating Fret Saws, A. W. Nightingale, Glasgow.
7503. Velocipedes, J. Robson, Worcestershire.
7504. Cycle Saddles, E. Denman, Bristol.
7505. Blast Pipes of Locomotive Engines, R. Jenkins, Bristol.
7506. Cutting Tool, W. J. Brown, Stockton-on-Tees.
7507. Adjustable Lever-action Spanner, W. H. Williams, Bedford.
7508. Tailors' Measure and Drafting Tape, L. Jackson, Skipton.
7509. Cutters for Boot Heel Paring Machines, W. and E. Douglas, Kingswood.
7510. Waterproof Malt Sack, L. J. Meakin, Burton-on-Trent.
7511. Prismatic Curtain for Advertising Purposes, F. P. Cox, Liverpool.
7512. Taps, C. C. Linindoll, London.
7513. Tambourine, E. Howard, London.
7514. Pocket Knives, E. Stovold, London.
7515. Automatic Apparatus for Grinding Glass, G. E. Winkelmann, London.
7516. Centrifugal Oven for Oil Stoves, &c., G. E. Winkelmann, London.
7517. Multiple-throw Cams, J. Price, D. E. Radclyffe, A. H. Smith, T. Hann, and W. Bromley, London.
7518. Centrifugal Liquid Separators, R. A. Lister.—(*J. de L. Taché, Canada.*)
7519. Adjustable Tent Poles, T. H. Cothill.—(*P. Lewis, Canada.*)
7520. Folding Knives, &c., T. H. Cothill.—(*P. Lewis, Canada.*)
7521. Axles for Wheels of Vehicles, S. Pettit, London.
7522. Pipes for Smokers, D. Hampton, London.
7523. Picking Arms for Looms, A. Sykes and T. A. Audsley, London.
7524. Mitre Board, A. T. Southern, London.
7525. Water-closets, W. Cooper and T. Cooper, London.
7526. Construction of Walls, &c., J. Sheppard and F. Dashwood, London.
7527. Sealing Letters, G. F. Dewdney, Cardiff.
7528. Combined Cameras and Optical Lanterns, B. Doyle, London.
7529. Device for use in Cleaning Buttons, O. Watkins, London.
7530. Electrical Alarm Apparatus, G. H. Atkinson, London.
7531. Knife-cleaning Device, J. W. Ellis, London.
7532. Apparatus for Aerial Navigation, M. Henderson, London.
7533. Covered Wire for Millinery, &c., P. J. Baker, London.
7534. Bottles for Aerated Liquids, &c., W. Kilsby, London.
7535. Magazine Rifles, J. Fell, jun., London.
7536. Oil Presses, &c., M. Skull, London.
7537. Production of Pigments, P. Cannell-Bunn and W. Barrett, London.
7538. Production of Anthracene Compounds, H. E. Newton.—(*The Farbenfabriken vormals F. Bayer and Co., Germany.*)
7539. Supporting Hauling, &c., Ropes, J. Temperley, London.
7540. Apparatus for Raising, &c., Loads, J. Temperley, London.
7541. Apparatus for Raising, &c., Loads, J. Temperley, London.
7542. Cyclists' Riding Brace, A. Breese, London.
7543. Petroleum Engines, D. Best, London.
7544. Waterproof Garments, L. Frankenstein, Manchester.
7545. Cycle Wheels, W. Rodger and B. Southworth, Manchester.
7546. Railway Automatic Brakes, V. B. Beer, Manchester.
7547. Nut Lock, W. Hudson and C. E. Noren, London.
7548. Vaporisers, J. S. Judge, J. McKee, and G. Edmison, London.
7549. Starting Devices for Motors, E. J. Pennington, London.
7550. Steering Devices, E. J. Pennington and A. G. New, London.
7551. Propellers, E. J. Pennington and A. G. New, London.
7552. Gear Wheels, L. C. Papenfus and L. Loewenthal, London.
7553. Crimping Tongs, G. L. Thompson, London.
7554. Corsets, J. Stone, London.
7555. Duplex Tube, J. T. Thorpe, London.
7556. Electric Railways, H. C. Regan, jun., London.
7557. Commutator Brushes, R. Hirsch, M. R. Hirsch, and J. F. Trottman, London.
7558. Treadle Gearing, J. F. Green, London.
7559. Separating Fixed Gases, W. Hampson, London.
7560. Making Cardboard Boxes, H. C. Norman, London.
7561. Baking Pans, R. S. Mains, London.
7562. Eyelets, E. Kempshall, London.
7563. Coating Confectionery, W. B. Phinney, London.
7564. Nail-strip Cutting Machine, J. A. Horton, London.
7565. Manufacturing Cycle Frames, F. A. Ellis, London.
7566. Motor-driven Velocipedes, L. Rub, London.
7567. Ornamental Strips of Clay, W. C. Lawton, London.
7568. Preventing the Stealing of Bicycles, A. G. V. Petersen, London.
7569. Manufacturing Spinning Tops, C. W. McMinn, London.
7570. Small-arms, J. Hourat and J. Castadère, London.
7571. Knitting Machine Cylinders, L. N. D. Williams, London.
7572. Circular Knitting Machines, L. N. D. Williams, London.

10th April, 1896.

7573. Portable Safety Bicycle Stand, J. Mills, Gloucester.
7574. "Gnu" Trouser Guard, R. J. and W. R. Muckley, Cheshire.
7575. Hardening Steel Pens, &c., A. H. Howard, London.
7576. Fire-grates of Refuse Destroyers, C. Christmas, Birmingham.
7577. Bracket for Window-blind Rollers, J. Cook, St. Helens.
7578. Shoe Machine Awls, A. Austin, Stafford.
7579. Kilns, E. H. Davies, Hereford.
7580. Tip-carts, T. Rowan and H. Rowan, Glasgow.
7581. Rotary Motors, W. G. Potter, London.
7582. Printing from Stencils, &c., J. R. Turnock, Hereford.
7583. Root-harvesting Machines, A. S. Logan, Newcastle-on-Tyne.
7584. Preventing the Fraudulent Re-filling of Bottles, R. H. Thomas, Youghal.
7585. Gauge Glasses, J. F. McIntosh, D. M'Callum, and R. Watson, Dundee.
7586. Improved Dust Screen for Windows, E. Young, Glasgow.
7587. Shuttles of Looms for Weaving, H. Whittaker, Halifax.
7588. Electric Ram Lift, T. Meacock, Birmingham.
7589. Manure Drills, J. Hornsby and J. Innocent, Grantham.
7590. Equally Dividing off Spaces, G. Key, Birmingham.
7591. Cycle Gear Cases, W. H. Higgitt and W. Crowson, Birmingham.
7592. Switches for Tramway Lines, H. Schmalisch, Glasgow.
7593. Coiling Spiral Springs, C. A. V. Hallgren, Glasgow.
7594. Mangling Machines, H. C. Longsdon and F. Wilkinson, Keighley.
7595. Displaying Wines, E. A. Edwards and S. Willoughby, Manchester.
7596. New Colouring Matters, Levinstein, Ltd., and I. Levinstein, Manchester.
7597. New Colouring Matters, Levinstein, Ltd., and I. Levinstein, Manchester.
7598. Muffles, J. H. Robinson, Liverpool.
7599. The "Wharam" Screw, W. Wharam, Cheshire.
7600. Boot Finishing Machines, W. and E. Douglas, and C. J. Ward, Bristol.
7601. Machine for Line Shading, L. Bonnaud, Brussels.
7602. Packing Tobacco for Smokers' Use, S. Smith, Norwich.
7603. Motive-power Engine, F. W. Lanchester, London.
7604. Stirrup-irons, A. Hamilton, London.
7605. Metal-shearing Machines, W. B. Challen and Taylor and Challen, Ltd., London.
7606. Waste or Slop Water-closets, A. Hocking, London.
7607. Fire-lighter, S. Russell, London.
7608. Cycle Gearing, O. B. Whitney, London.
7609. Machine Working by Explosions, A. E. Tavernier, London.
7610. Dyeing Straw Plait, T. Lye and W. T. Lye, London.
7611. Pneumatic Tire Valves, J. May, London.
7612. Explosive Projectiles, E. Davies and H. M. H. Goodfellow, London.
7613. Machinery for Drying Tea Leaf, N. W. H. Sharpe, London.
7614. Cycle Plate for Name, &c., J. V. D. Jéquier, London.
7615. Making Steel Sheets, R. Farley and E. Tonks, London.
7616. Tobacco Pipes, H. Allcock, London.
7617. Turbines, S. C. Davidson, London.
7618. Steering Apparatus for Ships, J. Johannsen, London.
7619. Calling the Guard in Trains, J. Chomé, London.
7620. Stopping-up the Key-holes of Doors, J. Chomé, London.
7621. Connecting Electric Circuits, J. D. F. Andrews, London.
7622. Insulating Materials, &c., J. D. F. Andrews, London.
7623. Stoppers for Bottles and Jars, S. Broadhurst, London.
7624. Utilising the Gases from Combustion, A. Guasco, London.
7625. Collapsible &c., Boxes or Cases, E. H. Archer, London.
7626. Detachable Spur Fastening, G. Kühn, London.
7627. Packing of Hydraulic Rams, &c., C. Eastwood, Liverpool.
7628. Shovel for Malt, &c., J. K. C. Chesshire, Birmingham.
7629. Pneumatic Tires, J. R. McKie, Liverpool.
7630. Ventilating Arrangements of Ships, G. Walker, London.
7631. Washing Granular Substances, T. Parkinson, London.
7632. Heating Steam Engine Cylinders, W. I. Last, London.
7633. Ink Bottles, D. H. Jones, London.
7634. Pencils, G. W. Johnson.—(*The Eagle Pencil Company, United States.*)
7635. Gear Cases for Velocipedes, W. A. Landau, London.
7636. Shirts, F. G. Metcalf, London.
7637. Tube Scraper, E. Gravesen, London.
7638. Advertising, L. C. Moore, London.
7639. Buffers for Vessels, J. Ciocki, London.
7640. Car Door Fastener, E. A. Manchester, London.
7641. Puzzles, J. G. Gareis, London.
7642. Pulley Block Sheaves, &c., V. L. Regad, London.

11th April, 1896.

7643. Manufacture of Roofing Tiles, A. Weil, London.
7644. Saucers for Flowers and Plants, H. Kinsey, Swansea.
7645. Sleeve Links, A. J. Austin, Birmingham.
7646. Skating Cycle, J. M. Chambers, London.
7647. Tricycles, A. Wichard and G. A. J. Schott, Bradford.
7648. Apparatus for Use of Umpires, R. Gillett, London.
7649. Electric Cables or Conductors, H. Edmunds, London.
7650. Coverings for Electric Cables, H. Edmunds, London.
7651. Tubes for Steam Boilers, O. Meredith, Birkenhead.
7652. Welding Lap-weld Tubes, S. Y. Goddard, Wolverhampton.
7653. Lubricating Cap Washers, C. Brigg, Bradford.
7654. Automatically Weighing Coal, J. Taylor, Glasgow.
7655. Bottling Liquids, W. H. Courtenay, Birmingham.
7656. Ventilating Boots and Shoes, W. Bacon, Coventry.
7657. Cycles, M. Carswell, jun., Glasgow.
7658. Controlling Windows, &c., G. S. Robb, Glasgow.
7659. Drawing Pins, H. Marles, Brighton.
7660. Velocipedes, A. Shelmerdine, Liverpool.
7661. Looms for Weaving, C. Hahlo, C. E. Liebreich, and J. E. Thompson, Bradford.
7662. Beaters for Whisks, Mixers, &c., J. Morton, Wishaw.
7663. Beaters for Whisks, Mixers, &c., J. Morton, Wishaw.
7664. Connecting Metal Pipes, G. Chisholm, jun., Stirling.
7665. Vacuum Motors, A. Shiels, London.
7666. Valves for Beer Engines, A. Bruce, Glasgow.
7667. Treatment of Diseases of the Rectum, O. Schmidt, Cologne.
7668. Vehicles Propelled by Steam, &c., F. Lister, Keighley.
7669. Kitchen Ranges, G. F. Calderwood, J. Learmonth, and the Planet Foundry Company, Ltd., Manchester.
7670. Trilby Cycle Brake, A. F. Germain, Brighton.
7671. Ruling Lines, J. Joly, Dublin.
7672. Furnishing Needle Cases, R. Wheatley, sen., and R. Wheatley, jun., Birmingham.
7673. The "Haggard" Boatswains' Call, E. Emanuel Portsea.
7674. Bottle, G. M. Davies, Cardiff.
7675. Bottle-rinsing Machine, J. Hube, Berlin.
7676. Working Railway Signals, Hurst, Nelson, and Co., Ld., and G. T. Wheatley, Glasgow.
7677. Rein Holder, H. Green and J. Powell, Birmingham.
7678. Letter Boxes, T. Weir, Dublin.
7679. Silent Door Hook for Ships, W. Logan, Sunderland.
7680. Gate Latch, T. B. Heathorn, London.
7681. Direct-acting Pumps, C. G. Krakau, Kent.
7682. Anti-vibration Bicycle Handle, A. W. Murray, Dublin.
7683. Repairing Pneumatic Tires, F. Forrester and T. R. Hewlett, Manchester.
7684. Valves for Pneumatic Tires, J. Cartwright, Birmingham.
7685. Hydraulic Thrust Bearings, C. A. Sadler, Birmingham.
7686. Apparatus for Bending Wood, J. Polke, London.
7687. Apparatus for Making Barrels, J. Polke, London.
7688. Drying and Seasoning Wooden Articles, J. Polke, London.
7689. Egg-shaped Boxes, F. Ginzler, A. Garner, and W. Garner, London.
7690. Lasts for Boots and Shoes, W. Firman, London.
7691. Pneumatic Tires, E. Hale, Liverpool.
7692. Making Vanilline, O. Preu, London.
7693. Generation, &c., of Acetylene Gas, P. Woog, London.
7694. Electric Traction, F. C. Esmond, London.
7695. Detachable Waterproof Sleeves, C. W. Phillips, London.
7696. Neckties and Bows, E. G. Williams, London.
7697. Cigar and Cigarette Holders, J. H. Miall, London.
7698. Umbrellas and Walking Sticks, A. S. Woollett, London.
7699. Holders for Electric Street Lamps, J. Jakoubek, London.
7700. Globes or Glasses for Incandescent Gas Lamps, S. P. Catterson and Sons, Ld., and W. P. Catterson, London.
7701. Heads for Casks, &c., T. G. and A. Stevens, Greenhithe, Kent.
7702. Advertising on Hats, L. M. Engel and H. A. Marler, London.
7703. Levelling and Surveying Instrument, L. E. M. Viard, London.
7704. Apparatus for Tilting Beer Barrels, &c., H. Searle, J. Swallow, J. B. Swallow, and P. H. Searle, London.
7705. Carriage Wheels, A. Reichwald.—(*A. Rezow, Germany.*)
7706. Edge-setting Machines, M. T. Deune and P. Cave, London.
7707. Upholstering Ships' Cabins, J. Finch and J. H. Rider, London.
7708. Buckles, A. Richter.—(*W. Berg, Germany.*)
7709. Manufacture of New Derivatives of Amido- 1 alphyl- 2 alkyl- 5 Pyrazolones, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
7710. Construction of Submarine Bridges, O. Imray.—(*The Channel Bridge and Railway Company, Ld., France.*)
7711. Manufacture of Fuzes or Match Cords, M. Wagner, London.
7712. Compounds of Albumen and Protein Bodies, A. Classen, London.
7713. Sliding and Swinging Sashes of Windows, S. Naylor, London.
7714. Weaving Selvages, G. Browning, W. A. Joheson, and F. Maydwell, London.
7715. Photographic Washing Vessel, A. A. Bradburne, London.
7716. Connection for Electric Light Cables, R. J. Hatton and W. T. Henley's Telegraph Works Company, Ld., London.
7717. Flaying Knife, R. Graeme, London.
7718. Cloths for Filter Presses, A. J. Boult.—(*H. W. J. van O. Bastiaans, Germany.*)
7719. Revolving Receptacles, F. W. Schafer and A. E. Batson, London.
7720. Ornamentation on Palm Leaves, G. Walker, London.
7721. Testing and Disinfecting Drains, C. T. Kingzett, London.
7722. Envelope, G. A. Tydeman and E. Newton, Waltham Cross.
7723. Formation of Printed Designs upon Fabrics, A. Scheurer, London.
7724. Manufacture of Double Barrels for Firearms, P. L. O. de Gérente and Y. A. M. P. Goubaux, London.

13th April, 1896.

7725. Printing Designs upon Calico, I. Frankenburg, Manchester.
7726. Attaching Containers to Stands, T. J. Sturgeon, London.
7727. Sewing Machines, W. H. Dorman, Stafford.
7728. Packing for Taps, Cocks, &c., W. J. Simmons, Bristol.
7729. Show Cases, J. Gibbs, Bristol.
7730. Pasting Machines, J. J. Cramp, Coventry.
7731. Boots and Shoes, C. E. and W. T. Wright, Leicester.
7732. Driving Gear for Cycles, H. B. Webber, Dorking.
7733. Shoulder Pad for Coats, &c., W. H. Sladdin, Brighouse.
7734. Organ Stop, J. T. Hanson, London.
7735. Metallic Packings, J. Wood, Manchester.
7736. Pickle Fork, G. A. Brookes, Manchester.
7737. Marking Patterns, R. Greenhalgh, Manchester.
7738. Raising Nap on Fabrics, J. D. Tomlinson and J. Porter, Manchester.
7739. Machine Belting, J. Sharples, Birmingham.
7740. Attaching Blinds to Rollers, G. M. Davies, Cardiff.
7741. Railway Game, H. J. Tremellen, Newport, Mon.
7742. Colour Game, H. J. Tremellen, Newport, Mon.
7743. Swivels, W. Dipple, Birmingham.
7744. Match-boxes, W. J. Clapp and F. P. Robjent, Newport, Mon.
7745. Casting Partly Chilled Objects, W. H. Browning and J. G. Heywood, Manchester.
7746. Washer for Cleaning Clothing, E. W. Margetts, Stourbridge.
7747. Pneumatic Tires, W. G. Potter, London.
7748. Rotary Motors, W. G. Potter, London.
7749. Vessels for Warming Plates, T. F. Senior, Sheffield.
7750. Closing Gates, E. G. Herbert, Manchester.
7751. Boots, C. C. Hutchinson, London.
7752. Attachment Bosses of Saddles, J. B. Brooks, Birmingham.
7753. Umbrella Ring, F. Roberts, London.
7754. Swivel, E. Wade and W. Mindham, Barnsley.
7755. Swing-bar Balance, J. T. Bucknill, Thornfield Bitterne.
7756. Steam Traps, W. Donald, Glasgow.
7757. Packing for Piston-rods, J. O. Morgan, Newcastle-on-Tyne.
7758. Oil Stoves, A. H. Griffiths and T. B. Smith, Birmingham.
7759. Timing the Game of Billiards, J. Newman, Durham.
7760. Double Pole Switches, F. W. Heaton and H. Smith, Manchester.
7761. Shut-all Bolt for Doors, J. N. M. M. Brisc Dublin.

7762. Trussing Sections of Railways, G. V. de Luca, London.
7763. Stoppering of Bottles, &c., S. H. Baines, London.
7764. Means for Generating Steam, P. Pinckney, Portsmouth.
7765. Machinery for Trussing Straw, R. Maynard, London.
7766. Colouring Matter, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
7767. Driving Gear of Bicycles, P. M. Carter, London.
7768. Rests for Cycles, The Automatic Cycle Stand Ld., and J. J. Shedlock, London.
7769. Heaters, G. A. Watson, London.
7770. Game Apparatus, R. Booth, London.
7771. Prevention of Thefts from Pillar Boxes, D. Shawe, London.
7772. Spiral Spring Tire, H. L. Todd and W. Wright, London.
7773. Lighting of Lamps, R. Godfrey and J. P. Norrington, London.
7774. Machinery for Cleaning Boots, C. C. Eminson, London.
7775. Sewing Machines, M. T. Denne, London.
7776. Process for Hardening Iron, A. Tauxe, London.
7777. Stools, The Patent Stowaway Stool Co., and T. H. Lewis, London.
7778. Method of Closing Bungholes, C. E. Müller, London.
7779. Adjustable Cornice Pole Joints, E. Corbridge, London.
7780. Football and Cricket Boots, W. Barber, London.
7781. A New Cloth Pleater, &c., W. B. Mulligan, London.
7782. Extension Table, H. Grant, London.
7783. Obtaining Gold, W. P. Thompson.—(*E. Wohlwill, Germany.*)
7784. Looms, H. R. Ross, Manchester.
7785. Protecting Ships' Bottoms, &c., J. Sanders, London.
7786. Cravat Attachment, C. A. Jensen.—(*C. J. Schildhorn, Germany.*)
7787. Brakes for Cycles, A. Frampton, London.
7788. Colouring Matters, O. Imray.—(*G. H. Weiss, Germany.*)
7789. Electric Arc Lamps, J. Brockie, London.
7790. Butter Drying Apparatus, T. Bradford, London.
7791. Stop Motions for Engines, L. St. Peter, London.
7792. Corsets, E. and S. Kohnberger, and A. Neumann, London.
7793. Manufacture of a New Product, C. Stahlschmidt, London.
7794. Shade Holders, H. A. C. Hellyer, London.
7795. Shaft and Blast Furnaces, &c., F. Burgers, London.
7796. Obtaining Salt from Brine, W. Shedlock, London.
7797. Driving Mechanism for Funnels, G. R. Gaunt, Bradford.
7798. Letter File, A. Kojer, London.
7799. Inkpot, S. Coppen, London.
7800. Motive Power Engines, W. Clarke, London.
7801. Zoetropic Pictures, B. J. B. Mills.—(*A. and L. Lumière, France.*)
7802. Sterilising Milk, Cream, &c., A. T. Pfeiff, London.
7803. Root Cutting or Pulping Machines, S. B. Bamford, London.
7804. Dress Fasteners, B. A. Spaull, London.
7805. Corn and Seed Drills, J. Wilson, London.
7806. India-rubber Springs, &c., A. G. Spencer, London.
7807. Cycles, C. Hill, London.
7808. Navigable Battle Forts, J. F. Crease, London.
7809. Photographic Apparatus, G. R. Sanson, London.
7810. Wheels, F. W. Horridge, London.
7811. Gun Fitting, A. W. Swallow, London.

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7812. Drill Chucks, D. Weir, London.
7813. Cycles, W. G. MacIvy, London.
7814. Perambulator-mailcart Bodies, G. P. Taylor, Birmingham.
7815. Wheels of Cycles, R. Malkin and T. Bowyer, Manchester.
7816. Steel Re-heating Furnaces, W. Trewhitt, Middlesbrough.
7817. Taking Photographs, J. Oulton, W. Shaw, and R. H. Adams, Bradford.
7818. Metallic Sound-resisting Board, F. C. Steinmetz, London.
7819. Apparatus for Superheating Steam, G. Sinclair, Glasgow.
7820. Movable Partitions, &c., C. Strapps, Manchester.
7821. Lace-securing Attachment, J. G. Rollason, Birmingham.
7822. Oil Engines, H. N. Bickerton, Manchester.
7823. Trivets, T. le Poidevin, Guernsey.
7824. Cycle Tires, T. Guthrie, Newcastle-on-Tyne.
7825. Apparatus for Compressing Air, M. E. Clark, Manchester.
7826. Polishing Cloth, J. J. Ashworth, Manchester.
7827. Split Pin, J. Barker, Oldham.
7828. Mats for the Seats of Tramcars, H. Haley, Manchester.
7829. Match-boxes, F. Hutchins, London.
7830. Machine for Sowing Turnip Seeds, W. Doyle, Dublin.
7831. Speed of Vessels, J. Davis, Bradford-on-Avon.
7832. Automatic Tapping Attachments, F. A. Errington, London.
7833. Riveting Machines, J. Johnson.—(*C. B. Albree, United States.*)
7834. Electric Railways, A. S. Krotz, W. P. Allen, and O. S. Kelly, Manchester.
7835. Twin Peg and Ball Toy, H. J. Tremellin, Newport, Mon.
7836. Valve Motion of Beer, &c., Engines, A. Bruce, Glasgow.
7837. Linotype Printing Machines, R. H. H. Baird and I. Hall, Glasgow.
7838. Steam Boiler Furnaces, T. Hineson, Ashton-under-Lyne.
7839. Label and Ticket Holders, S. Learoyd, Huddersfield.
7840. Garden Rollers, F. Brangwin and H. F. Baly, London.
7841. Positive Drive for Spindles, T. Sowerbutts and J. Watson, Accrington.
7842. Tilt for Supporting Tarpaulins J. Tilley, North Shields.
7843. Oil Tank Wagons, A. S. Nelson, Glasgow.
7844. Flanging the Manholes in Boilers, W. Fairweather.—(*The Babcock and Wilcox Company, United States.*)
7845. Securing Spokes in Cycle Wheels, A. C. Tennant, Seacombe, Cheshire.
7846. Photographic Cameras, R. Dobson, Glasgow.
7847. Rubber Tires, J. D. Beebe, London.
7848. Car Movers, P. H. Jacobus, London.
7849. Disengaging Boats on Ships, R. Anderson and W. Prentice, London.
7850. Ships' Davits, R. Anderson and W. Prentice, London.
7851. Bottle Labelling Machine, H. S. Grace and A. D. Reynolds, Birmingham.
7852. Music Leaf Turner, H. B. Kirk, London.
7853. Devices for Elevators, Otis Elevator Company, Limited.—(*Otis Bros. and Co., United States.*)
7854. Regulating Electric Motors, Otis Elevator Company, Limited.—(*Otis Bros. and Co., United States.*)
7855. Railway Permanent Ways, J. Butterworth, London.
7856. Typewriting Machines, J. Y. Johnson.—(*The Philadelphia Typewriter Company, United States.*)
7857. Machine for Stoning Raisins, E. Sutherland, London.
7858. Vehicles Propelled by Oil, A. G. New, London.
7859. Retaining Railway Window Sashes, W. Shears, London.
7860. Printed Sheet Delivering Mechanism, W. Scott, London.
7861. Ladies' Improved Skirt for Cycling, W. Evans, London.
7862. Lead Presses, A. J. Boult.—(*H. B. Cobb, United States.*)
7863. Axle-boxes. F. A. Sürth, London.
7864. Hooks and Eyes, J. F. Schoeppl and W. Heeren, Leeds.
7865. Separating Laminated Packs, F. McCarty, London.
7866. Coping Bricks, &c., J. Hamblet and I. Parkes, London.
7867. Band Saw Guides, W. McBeth, Canada.
7868. Drying White Lead, T C. Sanderson, London.
7869. Generating Acetylene Gas, H. A. Kent, London.
7870. Pneumatic Tires, The Scottish Manufacturing Company, Ltd., and A. Macdonald, Glasgow.
7871. Pneumatic Tires, The Scottish Manufacturing Company, Ltd., and A. Macdonald, Glasgow.
7872. Hoisting Mechanism, P. Jensen.—(*P. Egan, United States.*)
7873. Power Transmitters, P. Jensen.—(*P. Egan, United States.*)
7874. Welt-seam Trimming Machines, Z. T. French and W. C. Meyer, London.
7875. Fire Buckets, W. R. Myers, London.
7876. Fire-escapes and Ladders, J. C. Merryweather, London.
7877. Making Carpets, A. H. Brinton and F. E. Tucker, London.
7878. Furnaces, W. R. Jones, London.
7879. Improved Blind Roller, J. W. Griffiths, London.
7880. Coffee Substitutes, R. Haddan.—(*Katreiners Malzkaffee Fabriken mit beschrankter Haftung, Germany.*)
7881. Electric Transformers, J. Devonshire.—(*W. S. Moody, United States.*)
7882. Electric Motors, J. Devonshire.—(*W. B. Potter, United States.*)
7883. Electric Motors, J. Devonshire.—(*C. P. Steinmetz and E. J. Berg, United States.*)
7884. Electric Power Systems, J. Devonshire.—(*E. J. Berg, United States.*)
7885. Incandescent Lamp Bases, J. Devonshire.—(*J. H. and A. Pe lerquist, United States.*)
7886. Tanning Hides, V. Gallien, London.
7887. Fire-grates and Stoves, W. H. Harvey, London.
7888. Producing Aerial Displacement of One or More Performers on the Stage of a Theatre, W. P. Thompson.—(*C. E. Pritchard and J. B. Brant, France.*)
7889. Actuating the Cut-off Gear of Corliss and other Engines, J. S., T. A., and E. R. Walker, Liverpool.
7890. Lamp or Stove Wicks, E. E. Joyce, Liverpool.
7891. Fastenings for Bags and Music Cases, A. D. Southgate, W. G. Southgate, and A. Scherzinger, London.
7892. Plastering Compounds, J. E. Summers and J. H. Ogburn, London.
7893. Radiant Heat Baths, J. H. Kellogg, London.
7894. Making an Alimentary Product, J. H. Kellogg, London.
7895. Ornamental Fabrics, A. H. Kursheedt, London.
7896. Electric Hair Cutters, F. M. Bell and J. L. Sloss, London.
7897. Military Intrenching Tools, &c., T. Rowe, London.
7898. Cultivating Bacteria, H. H. Lake.—(*L. von Lorentz, Germany.*)
7899. Ovens for Drying and Burning Tiles, R. Stanley, London.
7900. Band Brakes, C. R. Hutchings, London.
7901. Apparatus for Mixing Air and Gas, J. M. Mitchell, London.
7902. Carving Machines, S. Pitt.—(*F. Snow, United States.*)
7903. Cages for Fowls and other Animals, C. Hüsgen, London.

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7904. Coffee, H. Boisselier, Enfield.
7905. Fastening the Soles to Boots, H. W. Boswell, Dartford.
7906. Hemstitch Machines, J. Walker, Belfast.
7907. Breech-loading Guns, E. C. Green, Cheltenham.
7908. Tiles, F. J. D. Hüllinghorst and G. Ewart, London.
7909. Machine for Contracting Tires, W. G. Mullett, Bristol.
7910. Process to Obtain Ammonia, J. Plummer, Midlothian.
7911. Toy Guns, &c., R. Smith, Rishton, near Blackburn.
7912. Toasting Appliances, J. R. G. d'Almeida, London.
7913. Furnaces, E. Johnson and J. Thompson, Lemington-on-Tyne.
7914. Printing Presses, F. Waite and Waite and Saville, Ld., Bradford.
7915. Roller Blinds, J. Oulton, W. Shaw, and R. H. Adams, Bradford.
7916. Boots, R. G. Jones, Swansea.
7917. Combined Boiler, Bath, &c., W. Mould, Birmingham.
7918. Steam-boiler and other Furnaces, J. Murray, Glasgow.
7919. Transit Basket, A. E. Catchpole and Harrod's Store's, Ld., London.
7920. Draught Excluders for Doors, W. H. Kewer, London.
7921. Harrows, R. A. Dennett, London.
7922. Pulley Blocks, G. T. Winnard and J. Bedford, Sheffield.
7923. Supplying Acetylene Gas to Vehicles, T. Durnan, Sheffield.
7924 Axis Tractor, R. C. Macdonald, Glasgow.
7925. Preserving Stud Holes in Shirt Fronts, A. H. Binnie, Glasgow.
7926. Siphon Flushing Cisterns, H. E. Brice, Birmingham.
7927. Waist Belts, H. T. Ollard, Birmingham.
7928. Electric Signal Indicator, M. Mercier, Manchester.
7929. Outer Covers of Pneumatic Tires, A. Latimer, Birmingham.
7930. Rack for Holding Coats, &c., J. Penrose, London.
7931. Inhalatory Appliances, A. M. Hugill and J. Overton, Manchester.
7932. Cabinet-making, J. Schuler and M. Wuzel, Halifax.
7933. Gas Cooking Appliances, E. P. Greenwood, Manchester.
7934. Window Fastener, T. Howard and J. Hallan, Hendon.
7935. Spinning and Twisting Machines, J. Boyd, Lanarkshire.
7936. Firelighter, C. H. Silson and F. Robinson, Bradford.
7937. Harness for Horses, E. Garnier and S. J. Prescott, London.
7938. Loose Socketed Sewer Pipe Joint, C. Lee, London.
7939. Transmission of Power, F. R. Simms.—(*W. Maybach, Germany.*)
7940. Heating Apparatus, F. R. Simms.—(*W. Maybach, Germany.*)
7941. Hardening Steel Plates, J. A. Mays, London.
7942. Smoking Pipe, S. Comoy, Accrington.
7943. India-rubber Stamps, J. S. Elder, Glasgow.
7944. Bicycles, P. M. Staunton, Dublin.
7945. Upright Lever with Centre Spring, J. R. Knight, Blackrock.
7946. Sash Window Fastener, H. Stringer, Willenhall, Staffs.
7947. Sash-lift Bows, B. Drysdale and T. R. Voce, Birmingham.
7948. Combined Trousers and Knickerbockers, B. P. Hughes, London.
7949. Let-off Motions for Looms, J. Crabtree, J. Robinson, and J. W. Haworth, London.
7950. Selvedge Weaving Apparatus, E. T. Whitelow, Manchester.
7951. Compounds for the Inside of Barrels, G. Stacey, London.
7952. Horseshoes, W. H. Crawcour, London.
7953. Manufacture of Stockings and Socks, W. L. Hill, London.
7954. Detachable Buttons, A. E. Webb, London.
7955. Incandescent Gas Burner, &c., C. Howard, London.
7956. Construction of Unions, &c., G. S. Trafford, London.
7957. Boxes, H. and H. Inman, London.
7958. Roofing Tiles, G. Power, London.
7959. Vent Plug, S. H. Robinson, London.
7960. Device for Preserving the Eyesight, B. A. Dorst, London.
7961. Driving Gear for Bicycles, W. D. Scott-Moncrieff, London.
7962. Centrifugal Governors, J. N. and W. Paxman and J. C. Peache, London.
7963. Printing Machines, E. Graber and L. Hepworth, London.
7964. Lamp Chimney, G. Rowlands, London.
7965. Funnel, L. Kemp and J. E. Smurthwaite, London.
7966. Tires for Cycles, F. W. Randall, London.
7967. Lamps, W. Staveley, London.
7968. Bottle and Stopper, W. Youlten, London.

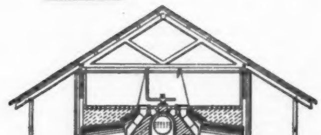
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

553,574. Incinerator, *C. Thackeray, Montreal, Canada.—Filed July 30th*, 1894.

Claim.—(1) An incinerator having a main flue for the products of combustion, auxiliary flues running parallel thereto, suitably controlled communicating passages between the main and auxiliary flues, series of furnaces and combustion chambers laterally adjoining the auxiliary flues, main transverse communicating passages, suitably controlled, between said combustion chambers and the main flue, and auxiliary transverse communicating passages, suitably controlled, between said combustion chambers and said auxiliary flues, for the purpose set forth. (2) An incinerator having a main flue for the products of combustion, a series of main furnaces and combustion chambers laterally adjoining said flue, suitably controlled transverse communicating passages between the combustion chambers and said flue, and a series of auxiliary cells arranged in alternate order with said main furnaces and communicating on each side with same, for the purpose set forth. (3) An incinerator having a main horizontal flue for the products of combustion, a chimney located at one end of same, a central auxiliary flue and outer auxiliary flues running parallel with the main flue, suitably controlled communicating passages between said central auxiliary flue and main flue, series of furnaces and combustion chambers laterally adjoining the outer auxiliary flues, main transverse communicating passages, suitably controlled, between said combustion chambers and the main flue, auxiliary transverse communicating passages, suitably controlled, between said combustion chambers and said auxiliary flues, series of auxiliary furnaces or cells arranged in alternate order with said main furnaces and communicating on each side with same, a steam boiler located in said main flue, and suitable conductors connected with said boiler, and serving to convey superheated steam to said furnaces or cells, for the purposes set forth.

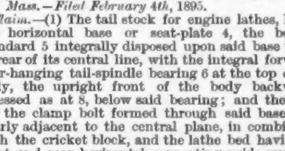
553,574.



553,594. Engine Lathe, *V. F. Prentice, Worcester, Mass.—Filed February 4th*, 1895.

Claim.—(1) The tail stock for engine lathes, having the horizontal base or seat-plate 4, the body or standard 5 integrally disposed upon said base wholly in rear of its central line, with the integral forwardly over-hanging tail-spindle bearing 6 at the top of said body, the upright front of the body backwardly recessed as at 8, below said bearing; and the hole 9 for the clamp bolt formed through said base at or nearly adjacent to the central plane, in combination with the cricket block, and the lathe bed having the front and rear horizontal supporting guide ways, the centrally disposed clamp bolt with its adjusting nut above the foot and beneath the spindle bearing, all substantially as shown and described. (2) The combination of the low cricket block having the top seating surface with transverse guide, the tail-spindle support composed of the base or seating plate adjustably mounted on said cricket block, the body standard integral with said base and standing thereon substantially in rear of the central vertical plane, the back of said body forwardly arched and carrying the integral forwardly overhanging bearing at the top thereof, the tail-spindle mounted in said bearing, the clamp bolt arranged through an opening in said base approximately adjacent to the centre plane, with its operating nut disposed above the top of the base and beneath the bearings, the binding shoe on said bolt, and the set over adjusting screw in said cricket, all substantially shown and described.

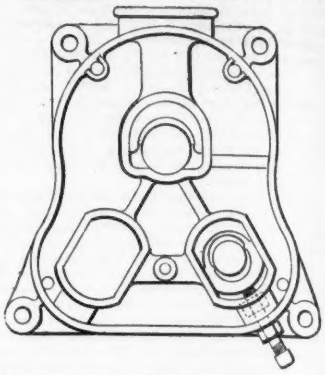
553,594.



553,607. Cane Mill, *C. A. Calvert, Buffalo, N.Y.—Filed July 2nd*, 1895.

Claim.—(1) In a cane mill, an imperforate bottom plate provided with a raised flange or rim forming a pan, and with journal pockets having their walls extended above the bottom of the pan and their bottoms on a level therewith, and provided in their inner walls with openings or passages arranged above the bottom of the pan, whereby the pockets communicate with the surrounding space of the pan, substantially as set forth. (2) In a cane mill, the combination with the bottom plate having a raised rim or flange forming a pan, and a pair of opposing journal pockets extending above the bottom plate, of a horizontal bridge piece connecting said pockets, having a bearing for the lower journal of a scraper and raised above the bottom plate, whereby a space is left between the bridge piece and the bottom plate for the removal of chips, substantially as set forth.

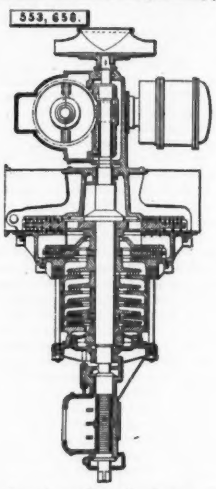
553,607.



553,658. Turbine Motor, *C. A. Parsons, Newcastle-upon-Tyne, England.—Filed February 21st*, 1895.

Claim.—In a steam turbine, a shaft, high-pressure discs thereon having lateral blades, fixed rings intermediate of the discs having lateral blades alternating with the blades of the discs, said rings extending inwardly toward the shaft, and providing passages to direct the steam inwardly and a low-pressure disc of larger diameter having blades on its opposite sides and rings with blades for said disc, said low-pressure disc having perforations at the central portion for the passage of the steam through to the opposite side of the disc, substantially as described.

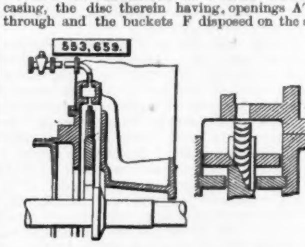
553,658.



553,659. Steam Turbine, *C. A. Parsons, Newcastle-upon-Tyne, England.—Filed February 21st*, 1895.

Claim.—In combination in a steam turbine, the casing, the disc therein having openings A′ therethrough and the buckets F disposed on the sides of the disc, the blades E fixed to the casing and the peripheral buckets B with means for directing the jet thereto, substantially as described.

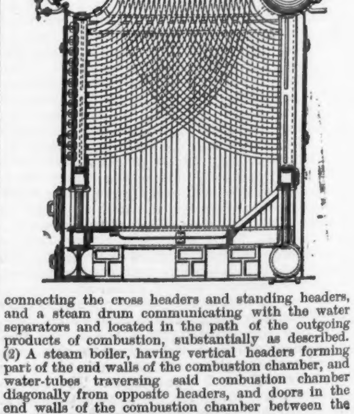
553,659.



553,700. Marine Boiler, *R. R. and H. L. Zell, Baltimore, Md.—Filed February 24th*, 1893.

Claim.—(1) A steam boiler, comprising side walls made up of series of water-tubes having top and bottom headers, front and rear walls made up of standing headers with intermediate doors, the doors of the one wall being opposite the headers of the other wall, a mud-drum communicating with the bottoms of the headers of the rear wall, water separators communicating with the standing headers at their upper ends and with the top headers of the side wall tubes, cross headers connecting the water separators, curved tubes connecting the cross headers and standing headers, and a steam drum communicating with the water separators and located in the path of the outgoing products of combustion, substantially as described. (2) A steam boiler, having vertical headers forming part of the end walls of the combustion chamber, and water-tubes traversing said combustion chamber diagonally from opposite headers, and doors in the end walls of the combustion chamber between the headers, substantially as described.

553,700



NAVAL ARCHITECTURE.—A FEW PRINCIPLES POPULARLY EXPLAINED.

No. VI.—TONNAGE AND FREEBOARD.

THE tonnage of a vessel is a measure of her internal capacity for the stowage of cargo, and must not be taken to represent the weight in tons of the cargo she is able to carry. It affords a rough basis of comparison between the cargo-carrying capabilities of vessels of the same type, but no more than that. The object of its determination is to fulfil an international agreement whereby vessels may be, as nearly as possible, equitably taxed for harbour, light, and other dues. Hence the mode of measuring it is fixed by Act of Parliament, and the measurement itself is performed by officials of the Board of Trade.

The origin of the term "tonnage" is said to have been the number of "tuns" of wine which the hold of a vessel would stow, and hence the word was at first written "tunnage." Be that as it may, the term "tonnage" has been used since the first Act of Parliament was passed in this country, just two centuries ago, to fix a method of determining its value, and insisting upon the tonnage so obtained being inserted upon the vessel's certificate of registry. This document, known as the ship's "register," contains three statements relating to her tonnage, in addition to what is known as her "registered dimensions."

It should, however, be premised that the legalised rules for the determination of a ship's tonnage have undergone many changes, and assumed many forms during these two hundred years. The method now adopted by international agreement was first embodied in the Merchant Shipping Act of 1854, and became law in that year.

We now find upon a ship's register, as already remarked, three expressions relating to her tonnage. These are:—(1) The under-deck tonnage; (2) the gross tonnage; (3) the net register tonnage. The under-deck tonnage represents the capacity for cargo below the upper deck, in all vessels with less than three decks; and below the second deck in all other vessels. The gross tonnage represents the total capacity for cargo to the upper deck in all vessels, and likewise in all covered-in houses and spaces above the upper deck. The net register tonnage is obtained by subtracting from the gross tonnage all legally-allowed deductions, as for crew space, propelling spaces, &c. Hence it is upon the net register tonnage that all dues are paid, and consequently the law requires that the figures representing it shall be deeply cut on the inside of the main hatchway, so as to be readily seen by all officials who seek to do so without having to disturb the cargo.

We have said that the tonnage is a measure of the vessel's capacity for the stowage of cargo. In point of fact, it represents an approximation to the number of cubic feet in the vessel which are appropriated to cargo stowing purposes. In some types of vessels the approximation is a close one, while in others it is not so. In most sailing ships, for instance, the register tonnage is as nearly as possible what its name would indicate, having regard to the ton-unit employed; while in some classes of steamers the deductions for propelling space are so great as to leave a net register bearing but a small proportion to the space actually available for stowing cargo.

Until the year 1854, the calculations for the tonnage of a vessel, as enacted by successive Acts of Parliament, took no account of her form. and consequently two vessels of the same principal dimensions, but with different coefficients of fineness, would have the same tonnage, and therefore pay the same dues. Indeed, between the years 1773 and 1835 the Rule enacted by Parliament for the measurement of merchant vessels did not even take any account of their depth, but simply of their length and breadth. The Rule for Tonnage by Builder's Old Measurement—or Tonnage B.O.M. as it was described—deducted three-fifths of the breadth from the length, and multiplied the difference by one-half the square of the breadth. The product was supposed to be the cubic capacity in the vessel suited for receiving cargo. Then, allowing 94 cubic feet for the stowage of a ton of merchandise, the product just obtained was divided by that number in order to find the tonnage.

If L be the length for tonnage, and B the breadth, then

$$\text{tonnage B O M} = \frac{(L - \frac{3}{5}B) \times B \times \frac{B}{2}}{94}$$

The operation of this rule resulted in vessels being made unduly deep, because depth was not paid for in dues, and hence it led to their instability and frequent loss.

The Act of 1854 represents an intelligent attempt to determine the actual cargo capacity of a vessel by applying the same method for measuring the internal capacity of her hold, as in our first paper was used to determine her immersed volume or "displacement;" so that allowing 100 cubic feet for the stowage of a ton of merchandise, we have the tonnage found on dividing the internal capacity by 100.

The mode of calculating the internal capacity in each case is laid down with great minuteness by the Act of Parliament, but it must be sufficient for our purpose to indicate what is done in general terms.

Let us suppose a vessel 200ft. long. In such a case the law requires the length to be divided into ten equal parts, and the area of the transverse section calculated at each of these divisions of her length. A curve of sectional areas is then formed with the values so obtained, and the area enclosed by this curve and its base is the total cubic capacity of the hold.

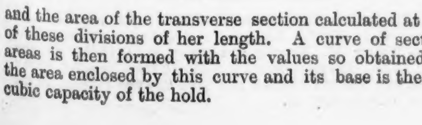


FIG 24

Consider this case in further detail.

Fig. 24 shows the longitudinal elevation of the supposed vessel 200ft. long. T T is the tonnage deck and S S are its extremities, so that the distance S S = 200ft. is the registered length. Now, as we have said, in this case the length is to be divided into ten equal divisions, giving nine sections of the vessel and two end positions of practically no area.

Let Fig. 25 represent a section of the vessel at one of these divisions. Suppose in this case the depth of hold is 16ft., we have then to divide that depth into four equal divisions of 4ft., the upper one commencing at one-third the round of beam below the deck. This gives us five ordinates, as shown on the figure. The lengths of these are carefully measured in the vessel to the inside of the ceiling, and the same is done at each of the other sections at which the vessel is divided. In the case of the ordinates of each section, the even numbered ones—*i.e.*, the second and fourth—are each multiplied by four, the end ordinates by unity, and the odd numbered ones by two. The sum of the products multiplied by one-third the common interval between the ordinates gives the area of the section. The areas at the other sections are found in a similar manner, and a curve of sectional areas constructed therefrom, as shown by Fig. 26. To obtain this curve we draw a base line representing the length of the vessel, which is in this case 200ft., and divide it into ten equal parts at the ordinates numbered on the figure. The area of the section corresponding to each ordinate is set off upon it to the same scale, and the curve drawn through the points so obtained is the curve of transverse sectional areas. The area of this curve gives us the internal cubic capacity of the vessel for cargo, and it is obtained by multiplying the end ordinates by unity, the even numbered ordinates by four, and the odd numbered ones by two. The sum of the products being multiplied by one-third the common interval between the sections, and divided by 100, gives the number of tons, of 100 cubic feet each, which the vessel can stow below her tonnage deck. This is the under deck tonnage as determined by the present tonnage law.

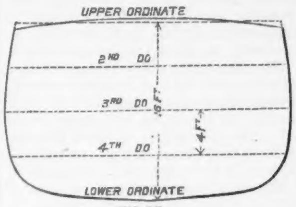


FIG 25

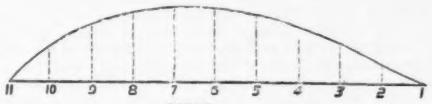


FIG 26

To obtain the gross tonnage we have to measure the cubic capacity of the bridge house, poop, and forecastle, and any other permanent closed-in spaces on the upper deck available for cargo or stores, or for the berthing or accommodation of passengers and crew, and having divided the same by 100, the result is added to the under deck tonnage, and produces the gross tonnage. To obtain the net register tonnage various deductions have to be made for propelling and crew spaces, and for some minor allowances permitted by an Act of Parliament passed in 1889. The rules for calculating propelling space deductions are of an arbitrary character, and their details are too lengthy and complicated to be quoted here.

Such, briefly, are the methods whereby the tonnage of a vessel are obtained. It will be evident that it affords very little information in regard to her cargo carrying capabilities, the latter being always greatly in excess of the register tonnage upon which dues are paid.

Passing from the legalised methods of measuring a ship for registry purposes, we now come to the commercial method as between the builder and purchaser. It is usual now-a-days for the shipowner when inviting tenders for a new vessel to stipulate that she shall have a certain "deadweight" carrying capability on a fixed freeboard or mean draught of water. In some trades it is further insisted that there shall be a certain number of cubic feet of space in the portions of the holds and 'tween decks available for cargo. The latter is the actual internal capacity as contrasted with the fictitious one which the arbitrary deductions of the tonnage laws result in. The former is a true criterion of the vessel's freight-earning capabilities. Deadweight cargoes are those of which the specific gravity is higher than that of water, but the term is usually applied to cargoes much more dense than water, such as pig iron, iron ore, &c. Whenever the cargo carried is of so high a specific gravity that the vessel is loaded down to her full immersion before the hold is full, then that cargo may be considered as deadweight.

Cargoes of such a low specific gravity that when the hold is full the vessel is not immersed to her proper load line, are termed "measurement cargoes;" because the rate of freight in such cases is based upon the cubic capacity occupied, rather than upon the actual weight carried.

The deadweight-carrying capability of a ship is the displacement between the light and load lines.

The measurement capacity is the actual cubic space in hold and 'tween decks available for cargo.

The tonnage laws allow 100 cubic feet of space to a ton; but as 35 cubic feet of sea water weigh a ton, it is evident that the density of a deadweight cargo is at least three times that assumed in the Act of Parliament.

Closely associated with the question of tonnage is that of freeboard, the details of which have been fixed by Parliament for British ships during the past seven years.

The freeboard of a vessel is the height of her upper deck above the load water-line amidships, and its amount is determined in every case by the application of certain clearly defined rules and regulations. The purpose of these regulations is:—(1) To ensure that when loaded a vessel shall have a certain volume of reserve buoyancy in relation to her volume of displacement. That is to say, that the volume of the vessel above the water-line shall have at least a certain ratio to the volume below the water-line. (2) To ensure that the weight of cargo shall not be such as to bring undue stresses upon the parts of the hull. (3) That provided the cargo is properly stowed there shall be enough free side left for purposes of stability. (4) To ensure as far as possible the safety of the sailors in navigating the vessel, against the risk of huge seas washing them from off the deck.

When the freeboard of a vessel is determined, her deadweight capability may easily be found; for, as already explained, it is the displacement between the light line and the water-line passing through the centre of the freeboard disc. The marks put upon the sides of vessels to represent the depths to which they may be legally loaded are very often a subject of mystery to the observer. Fig. 27 shows the freeboard marks on a sailing vessel, and Fig. 28 those on a steamer. We have first, in each case, a line to represent the deck of the vessel, or rather a bar, drawn at what is termed "the statutory deck line." The freeboard *a* is set off below the top of this bar, and it determines the centre of the circle or "freeboard disc." These particulars are common to the two figures, as also are the letters "L. R.," which stand for Lloyd's Register, and denote the society which has assigned the freeboard in the particular case under authority received from the Board of Trade. "B. T." on a freeboard disc means that it was assigned by the Board of Trade; "B. V." means the Bureau Veritas, a continental registry; while "B. C." means the British Corporation of Glasgow. The letters usually seen are, however, "L. R.," as in our illustration.

Turning to Fig. 27, we further see that alongside the disc are two bars, the lower of which, marked W N A, indicates the depth of loading allowed for a winter voyage in the North Atlantic; while the upper one, marked F W, shows the depth to which the vessel may be loaded in fresh water in order that when she gets down a river into the sea she will float with the centre of disc just awash. As we need scarcely remark, a vessel's draught of water always diminishes as she proceeds from fresh water into salt, and *vice versâ*.

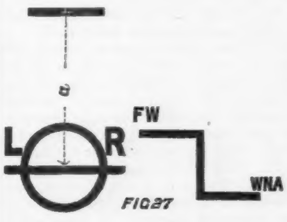


FIG27

As shown by Fig. 28, the marks alongside the freeboard disc of a sea-going steamer are more numerous than on a sailing vessel. Indeed, those shown on Fig. 28 are often spoken of as her gridiron. We find the W N A and F W bars as in a sailing vessel, but in addition thereto there are (1) I S, which means the depth to which the vessel may be loaded for a summer voyage in Indian seas; (2) S, which is the summer or ordinary load-line, and corresponds with the centre of the disc; (3) W. or winter line, for other regions than the North Atlantic.

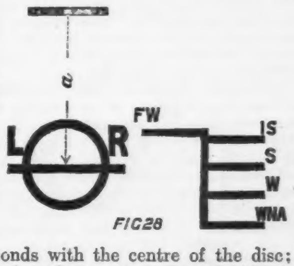


FIG28

Regarding the statutory deck line, it should be explained that the top of the bar is really above the level of the upper deck at the side to the extent of from about 1in. to 2in. In point of fact, the actual distance above the deck is about one-sixth the round in the deck beam. The reason for putting the deck bar above instead of at the deck is not easy to explain. In fact, there is no scientific reason for it whatever. In days gone by, when wooden ships had thick wooden waterways, it was claimed that the freeboard should be measured to the top of the waterway. And now that iron ships have no wooden waterways, but, on the contrary, gutter watercourses instead, the old statutory allowance is still permitted in setting off the deck bar. But since the distance of the bar above the deck is always added to the freeboard determined by calculation, it simply amounts to first adding an inch or two and then taking it off again. There are many such anomalies in all the Acts of Parliament relating to tonnage and freeboard.

HARBOURS AND WATERWAYS.

The Thames.—The report of the Commissioners appointed to inquire into the condition of the lower reaches of the river has been published. This report justifies the appointment of the Commission, if for no other reason than that it has brought to light the fact, that while the shipowners using the river were constantly complaining of the inadequacy of the depth of water to the present requirements of navigation, the channel buoyed out by the Trinity House was not the deepest or most direct, and that there existed, unknown to the officers of the Conservancy Commissioners and every other authority, a channel through the Leigh Middle shoal of 25ft. at low water, giving a foot more depth than is shown on the Admiralty chart or indicated by the Trinity House buoys. It hardly appears credible that on a river like the Thames, having the largest amount of navigation in the world, that there does not exist a regular system of surveying, and that there is not, as in the case of the Mersey, a department charged with this special duty. The last survey was made about sixteen years ago, and this is the only survey on which the pilots had to rely.

The Commissioners now recommend that a marine surveyor should at once be appointed, and be constantly employed to sound and chart the Thames from the Nore upwards. The powers of the Commissioners were unfortunately confined to a small portion of the river, and were too limited in scope to allow of a full and complete report on the navigation of the river. They have come to the conclusion that the channel demanded by the owners of deep draught ships—that is, one having 30ft. at low water up to Gravesend—is, in the face of what has been done in other rivers, and especially at Southampton, a reasonable demand, and that such a channel would be of great public advantage, and that there is no serious difficulty in obtaining such a depth. But such a channel would be useless unless the river were also deepened between the Leigh Middle and Gravesend, where there now exist shoals with only 23ft. over them; but this forms no part of the programme of the Thames Conservancy, although, as the Commissioners remark, "it is highly important that all homeward-bound vessels should be able to reach, and foreign-going vessels able to leave, Gravesend at any time of the tide." Under present conditions, an inward or outward-bound vessel drawing 25ft., with an allowance of 2ft. under her keel, can pass the Leigh Middle shoals without delay at any state of the tide on about 125 days in the year, but she may be detained for want of water on 240 days. Vessels drawing 28ft. may have to wait every day of the year for periods ranging from a few minutes to 5¼ hours. The present aim of the Thames Conservancy, which they are attempting to accomplish by dredging, is to give 24ft. between Yantlet and Crayford Ness, a distance of 20¼ miles; 22ft. up to the Albert Dock, 6½ miles; and 18ft. to the Thames Tunnel and London Bridge, 9 miles.

The investigations of the Commissioners as to the deposit of dredgings by the Thames Conservancy in Dead Man's Hole have a very important bearing in connection with the enormous amount of sludge which is daily being discharged into Barrow Deep from the London Sewage Works. Since 1878 the Conservancy have deposited, in a deep three miles above the Leigh Middle shoals, over an area of 200,000 square yards, more than 2,000,000 cubic yards of dredgings. Recent surveys show that while other portions of the river have become shallower, the depth in Dead Man's Hole has not been reduced, and it follows that the solid matter deposited there has found its way into other parts of the river. Generally the result of the recent survey shows that the channels of the river Thames have improved since 1883.

Belfast and Dublin.—From the annual reports issued by the Commissioners of these ports, there appears to be a marked difference in their prosperity. While the income for last year at Belfast is the largest ever received, that at Dublin shows a considerable falling off. At Belfast the total receipts from all sources for the year was £139,190, an increase of £8255 on the previous year. The expenditure was £128,342, leaving a surplus of £10,848. During the present century the tonnage has increased from 5500 tons to 2,150,232 tons, the increase of 1895 over the previous year being 64,279 tons. The Commissioners have expended £226,267 in reclaiming land, part of which is now profitably used for shipbuilding yards, and part is intended for future extensions of the quays. Upwards of £200,000 has also been spent on graving docks. At Dublin the tonnage for last year was 1,796,071 tons, or 62,398 tons less than in the previous year—almost the same quantity that Belfast has gained. The continental and oversea shipping shows a decline of 41,954 tons, and the coasting and general cross channel trade of 13,594 tons. Steam colliers decreased by 5967 tons, and sailing colliers 3127 tons. The receipts amounted to £54,644, being a decrease on the previous year of £2710. The dredging of the channel has been continued, 432,210 tons of material having been removed. One of the hoisting dredgers is to be converted into a suction dredger at a cost of £10,050.

Peterhead.—From the last report issued it appears that this harbour of refuge is progressing but slowly. It is now ten years since the Act sanctioning the work was passed, and it was then expected that the work would take from twenty to thirty years to complete. As it is intended that the convict labour shall be utilised in the construction of this harbour, a great number of preliminary arrangements had to be made before the actual work of construction could be commenced. A prison had to be erected for the reception of the convicts, and accommodation for the officials and warders; workshops and stores were required; and a line of railway for conveying the stone from the quarry at Stirling-hill. These works were not completed until 1888, when the first batch of convicts was received into the prison. Until recently the number of convicts has been limited, and the progress of the work slow. During last year the south breakwater has been extended 90ft., and the foundation of a further length of 66ft. prepared and levelled with concrete. The whole of this work under water has been done by divers. A barge harbour has also been made. The length of the breakwater, allowing for the opening, is to be 3600ft., and at the present rate of progress it will take thirty years to complete. The cost was estimated by Sir John Coode at £750,000. The annual grant is £25,000. The breakwater consists of a wall built of concrete blocks, weighing from 27 tons to 50 tons each, faced with granite, and resting on a rubble base of granite. The water area of the harbour will be about 400 acres, and the walls will extend into a depth of from 70ft. to 80ft.

Ipswich.—The Commissioners of this port having come to the conclusion that the present dredging plant is obsolete and not equal to the requirements for further deepening the river, have determined to spend £20,000 in the purchase of new plant. It is intended to obtain a stationary dredger, capable of raising 400 tons an hour and of dredging to a depth of 28ft.; also two steam hoppers each capable of conveying 400 tons to sea at a speed of nine knots, the distance being fourteen miles. The depth to which it is intended to dredge the channel is 24ft. at high water neap tides.

Yarmouth.—It is intended to improve the entrance to this harbour by an extension of the concrete works at the North Pier at Gorleston, and the creation of a "spending beach," in order to reduce the effect of the waves entering between the piers, which have proved to be very injurious to the fishing vessels during gales, especially to those which are moored at Gorleston. The estimated cost is £20,000, and the scheme has been adopted on the recommendation of Messrs. Coode, Son, and Matthews, the consulting engineers of the Commissioners.

Birmingham Canal navigations.—The annual report of the directors of these navigations shows that during last year there was a decrease in the receipts for tonnage and wharfage, chiefly attributable to the revision made by the Board of Trade under the Canal Tolls and Charges Act, and especially to the effect of that measure on the coal traffic through Birmingham, and partly to the severe frost of the winter of 1894-5. The balance available for dividend was £9725, the difference in amount required to make up the 4 per cent. guaranteed by the London and North-Western Railway being £39,065.

The scheme for improving the means of canal communication between Wolverhampton and Birmingham and London, which was brought forward two or three years ago, was revived at the recent meeting of the South Staffordshire Institute of Iron and Steelworkers by Mr. A. M. Punnett, as a means of enabling merchants to meet the competition of Germany and Belgium. The Committee who investigated this matter at the time, when the scheme was first brought forward, estimated the traffic between Wolverhampton and London as three times as much as that to Liverpool, and seven times as great as that to Bristol. They, therefore, advised the improvement of the Grand Junction Canal, the estimated cost being £1,250,000, and the benefit to be derived a reduction in carriage on iron of from 12s. 6d. to 6s. a ton, and on coal of from 6s. 9d. to 4s. It will be remembered by the readers of this journal that at the meeting of the Federated Institution of Mining Engineers held last year at Birmingham the question of a better water communication between this town and the seaports was discussed, and papers read by Mr. Wells, Mr. Wheeler, Mr. Vernon Harcourt, Mr. Marten, and others, from which it appeared that the opinion of these engineers was to the effect that the Severn is the natural seaport of Birmingham, and that the scheme of Mr. Keeling for improving the canals between Birmingham and the Severn offered the greatest advantages at the smallest cost. By this means a canal system affording accommodation to steamboats of 300 tons, and capable of coast navigation, would give to Birmingham sea communication with Bristol, Cardiff, Swansea, and the other Severn seaports; and also by the sea route with Liverpool, the Thames, and with Rouen, Paris, Antwerp, and other continental ports. The estimated cost of this scheme is £600,000, or about half that of improving the Grand Junction.

Sheffield and South Yorkshire Navigation.—The report of the directors of this company for the ten months to the end of last year shows a balance of revenue of £27,243, which, after paying debenture and preference interests at the rate of 4½ per cent., left £3569, sufficient to pay ½ per cent. on the ordinary shares. The tonnage for the ten months was 738,835, and tolls £43,639. The average for the same period between 1888-92 was—tonnage 704,776, tolls £43,240, showing a slight increase. The reason of the increase of the tolls not being proportionate to the increase in the tonnage is due to reduction imposed by the Board of Trade under the orders of the Canal Traffic Act. Beyond building a new warehouse at Sheffield and improving the accommodation there, the directors do not appear to have carried out any of the works contemplated when the Act was obtained for enlarging the locks and improving and deepening the canal so as to adapt it for a proper service of steam barges and coal-conveying compartments similar to those on the Aire and Calder. Until this is done, and a better sea communication made by the proposed junction with the Aire and Calder, so as to get an opening to Goole Docks, it cannot be expected that there will be much increase in the traffic. It is stated that Messrs. France and Co. intend to commence a service of steam barges between Sheffield and Goole, and that it is intended to dredge the river Don and Dutch river from Stainforth to Goole, for the purpose of providing a better waterway pending the construction of the new Junction Canal.

THE NORTH POLE BALLOON.

FROM the earliest classic times attempts have been made in the most persevering, if in a somewhat unpractical manner, to accomplish the transit from one point of the globe to another by an aërial instead of a terrestrial or a combined land and water route. So far as the two latter routes are concerned, the most recent desirable result, that of reaching the North Pole, has not hitherto been attained, and it is exceedingly doubtful whether it ever will be. Reverting for the moment to the old four elements, and omitting all consideration, for obvious reasons, of one of them, we are reduced to three, two of which, as already stated, have signally failed in their meritorious and heroic endeavours. There remains the third, which M. S. A. Andrée intends shortly to attempt, and for the expedition a North Pole balloon is at present being constructed in France, an expedition which is very naturally exciting a considerable amount of attention throughout the whole civilised world.

A brief description of the general features of this polar balloon will probably be interesting to our readers. It may be premised that the balloon will not be so large as several that have already made their appearance in public. For instance, a captive balloon the sole object of which is to transport people into the air for a very short period, and then to bring them safely back to *terra firma*, should be of as large a diameter as would be consistent with the financial proportions of outlay and receipts. The balloon of M. Andrée is intended for a very different purpose. Its object is to solve a problem, to make a discovery which has hitherto baffled, with lamentable results, the attempts of numerous able, skilful, and experienced navigators. It is not, therefore, intended to carry more people in it than are considered necessary to elucidate the great question at issue. Thus, the balloon will be of moderate size and the more easily managed. The unmanageableness of a balloon, as we have reason to know, increases enormously in proportion to its diameter.

The North Pole balloon has a diameter of 67ft. and a volume of 162,396 cubic feet. It has been decided, states our contemporary *L'Aérophile*, that the Chinese pongee silk—a material well known to Anglo-Indians—possesses superior claims to all other materials for the construction of the balloon. Two other descriptions of silk are to be employed in rotation, failing a sufficient supply of the pongee, which is classed as A1, and will stand a tensile stress of two tons to the square inch. If we divide the balloon horizontally by a great circle, we obtain its equator, and above this zone there will be three thicknesses of silk, and below it only two. In a word, north latitude and south latitude are in the proportion of three to two.

It may just be possible that when a balloon sets out in search of the South Pole these *pièces de resistance* may, so far as thickness is concerned, be reversed. From the northern or upper portion of the balloon to about 10ft. below its equator the skin will be in folds of triple silk, which is a very different substance from the Horatian "æs triplex." Below this parallel the silk will be only in double folds. All joints in the silken envelope will be first glued or sized, and then sewn together and covered with external and internal wrappers about 1¾ft. in width, very much after the fashion of iron bars and plates, with double-cover plates. Silken thread will be used for stitching the joints, and the skin moreover will be strengthened at the top and bottom rings and around all openings such as man-holes, port-holes, and wherever valves are located, and skylights. The weight of the balloon without fittings is almost exactly one ton, and before it is varnished, either inside or outside, it will be tested with an internal pressure equal to 3in. of water. Italian hemp of the best quality has been selected for the network, having a minimum breaking tensile strength of between seven and eight tons.

Accommodation for the intrepid *voyageurs* will be provided in the car, which has a diameter of 6½ft. and a depth of 4¼ft., and is constructed of wicker work. Hempen cords, six in number, 9ft. in length, and 1·2in. in diameter, will suspend the car from the body of the balloon. These suspension cords will be interlaced or braced together by horizontal and diagonal cords, so as to form a very efficient parapet or protection to the occupants of the car. A certain amount of ballast, although only so much deadweight, must be carried in all aërial excursions. The number of bags considered sufficient to suffice for the polar expedition of M. Andrée is estimated at 175. All are made up of hemp and filled with sand, and their total weight amounts to 2975 lb. It appears that the contract for the construction of the balloon has been placed in the hands of M. Henri Lachambre, an experienced aëronautical engineer, for the sum of £2100. It has been erroneously stated in several publications that the car of the balloon was pierced in the roof to allow of the passage of the guide ropes. Such an arrangement would be a serious infringement of the rules of aërial navigation. On the contrary, the guide ropes will be attached to the belt or zone of the balloon itself, while the car will be suspended in such a manner that the shocks or jerks occasioned by the trailing of the guide ropes will be nullified as much as possible. In the floor of the car there will be an aperture through which the light and heat of a lamp will pass, for the double purpose of warming the aëronauts and their food also. While alight the lamp will be, as a matter of precaution, suspended outside the car. There will be three guide ropes of the respective lengths of 1155ft., 1320ft., and 1485ft., and weighing in all one ton. They will be made of cocoanut fibre, in sections of alternate strength and weakness, in order that they should separate and give way if they fouled any obstruction which they could not clear. Experiments, conducted to determine the coefficient of friction for the guide ropes, give one-sixth for ordinary circumstances and conditions, but on ice the friction becomes reduced to one-half of this amount. It may be mentioned that a pigeon cot or pigeon house has been built at Hammerfest, the most northern village in Europe. Several pigeons "raised" in this house are to accompany M. Andrée and his intrepid friends in their polar expedition.

INSTITUTION OF NAVAL ARCHITECTS.

THE summer meetings of the Institution will be held this year in Hamburg on Monday, June 8th, and the following day.

On Wednesday, June 10th, the meetings will be transferred to Berlin, on the invitation of the Imperial German Government, and will continue there during the remainder of the week.

On Monday, June 15th, the Vulcan Company, of Stettin, will be happy to receive any members of the Institution who can spare the time to visit their works. Stettin is only two and a-half hours by rail from Berlin, and a special train will be arranged to convey the members there and back. Two Transatlantic liners of the largest size, a cargo steamer larger than any other at present in existence, and a first-class cruiser for the German Government, are under construction at the Vulcan Company's works.

The Hamburg-American Company has generously offered to take the members over in a body from Tilbury to Hamburg in the twin-screw Transatlantic liner Fürst Bismarck—length 502ft.—free of charge. The steamer will start either late on Saturday night, June 6th, or else early on Sunday morning, June 7th, and will arrive in Hamburg in about twenty hours after her departure. A special train, of which particulars will be given in the detailed programme, will convey the members from London to the port of embarkation on the Saturday evening.

Full particulars of the papers to be read, of the works and places of interest to be visited, and of the excursions and entertainments which are being organised, will be forwarded to the members on or about the 23rd of May.

In the meantime the members will be pleased to know that the meetings are receiving the warmest support from the Imperial Government, under whose direction the arrangements at Berlin are being prepared. A programme of exceptional interest for the instruction and entertainment of the members is already in course of preparation.

The meetings for the reading and discussion of papers will be held in Hamburg, in the Bürgerschafts-Saal in the building of the Patriotische Gesellschaft, and in Berlin in the large hall of the Technical High School, which is a very fine room, and admirably adapted for the purposes of the Institution.

Papers have already been promised by the following German members of the Institution:—Herr Dietrich—Privy Councillor—Constructor-in-Chief of the Imperial German Navy; Herr F. Laeisz, President of the Chamber of Commerce of Hamburg; and by the following, amongst other home members of the Institution:—Mr. B. Martell, "On various Descriptions of Doors applicable to Water-tight Bulkheads and their Fastenings," &c.; Mr. F. Elgar, LL.D.

At Hamburg the members and ladies will be entertained at a garden party on Monday, June 8th. An inaugural meeting for the reading and discussion of papers will be held on the morning of Tuesday, June 9th. A visit will be paid to the shipbuilding establishment of Messrs. Blohm and Voss in the afternoon of that day, and in the evening the Hamburg Reception Committee will entertain the members and ladies at dinner at the picturesque resort Blankenäse, on the Elbe.

At Berlin active preparations are in progress of completion, and every possible step is being taken to render the visit of the members to the German capital both instructive and agreeable.

The members of the Institution will dine together on one of the evenings at the Kaiserhof Hotel, Berlin, at 7 o'clock. The hosts of the Institution at Hamburg and Berlin will be the guests of the Institution on that occasion. Tickets will be £1 each, wine included. The exact date will be announced in the programme.

The railways on both sides have been approached with the view to giving special reductions in the fares to members on their return home, and also to those members who cannot avail themselves of the Hamburg-American liner Fürst Bismarck.

The Council trust that the members of the Institution will do all in their power to assist in doing honour to their most hospitable hosts by attending in large numbers.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Assistant-engineers (temporary)—Walter W. Newton and Percy F. Griffiths, to the Victory; Henry George Radford and Albert John Venning, to the Vivid; George Herbert Fletcher and Cecil Edward Vinning, to the Pembroke, to date May 1st.

TYPES OF LOCOMOTIVES ON BELGIAN LIGHT RAILWAYS

(*For description see page* 440)

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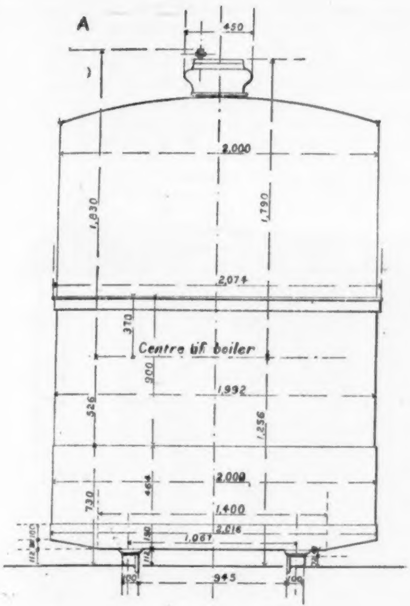
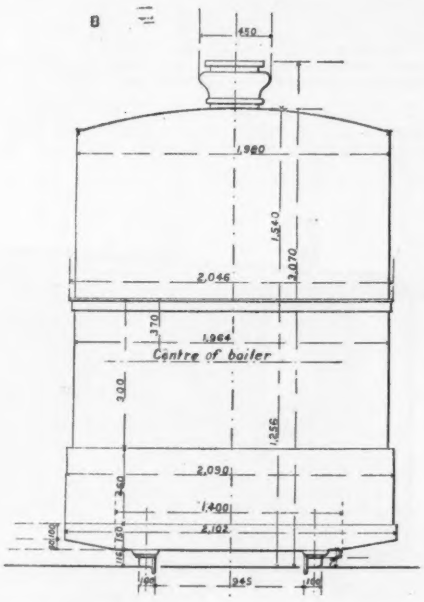
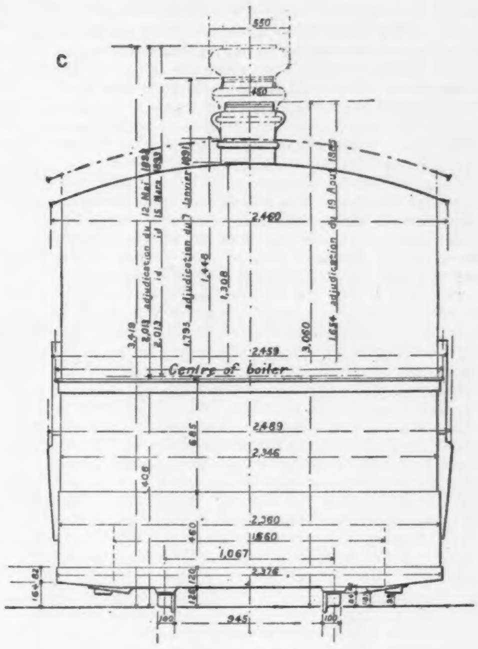

450
2,000
1,830
1,790
2,074
370
Centre of boiler
900
526
1,992
1,256
2,000
730
464
1,400
2,016
1,067
945

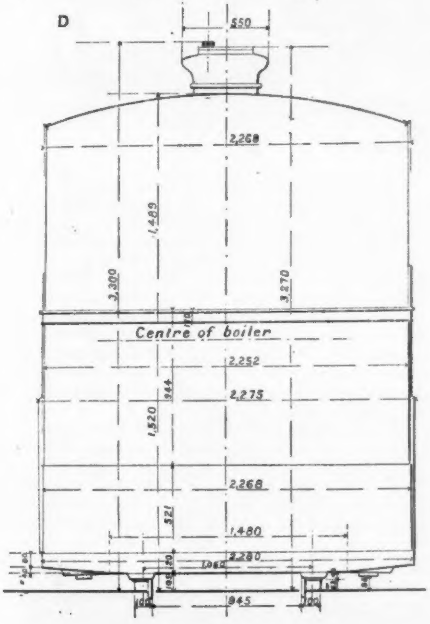
B


450
1,920
1,540
3,070
2,046
370
1,964
Centre of boiler
1,256
2,090
340
1,400
2,102
945

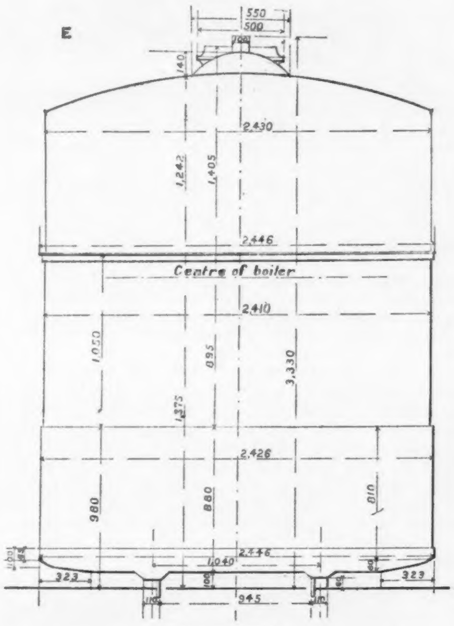
C


550
460
2,460
Centre of boiler
2,459
3,060
1,308
1,448
2,489
2,346
685
608
2,360
1,860
460
1,067
2,376
945

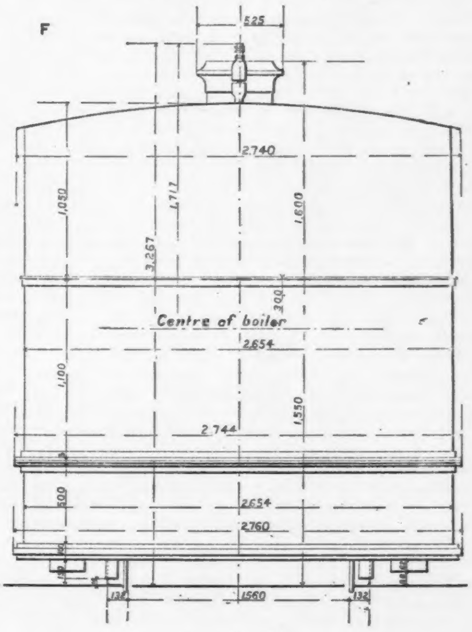
D


550
2,268
1,489
3,300
3,270
Centre of boiler
2,252
2,275
1,520
2,268
521
1,480
2,280
1,062
945

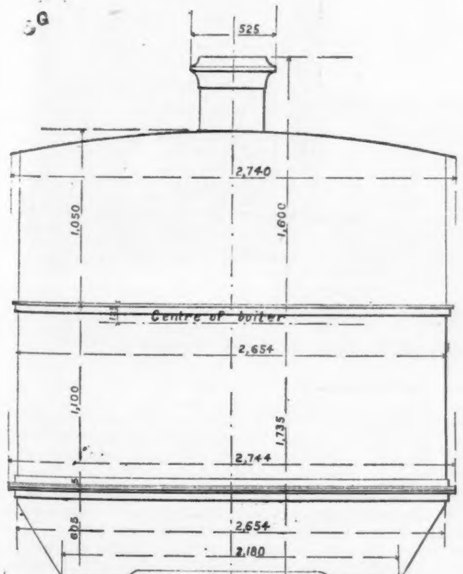
E


550
500
300
140
2,530
1,242
1,405
2,446
Centre of boiler
2,410
1,050
895
3,330
1,275
2,428
980
880
810
1,040
2,546
323
945
323

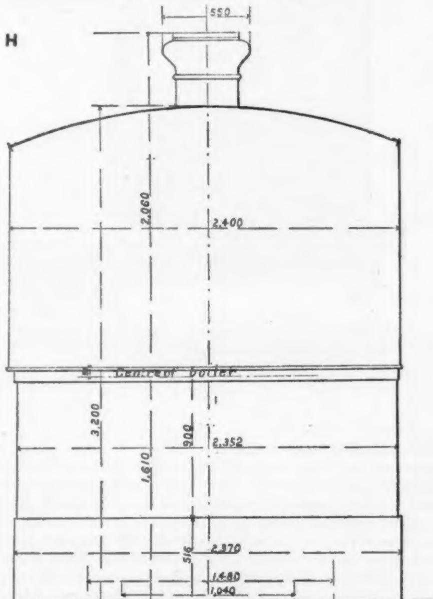
F


525
2,740
1,050
1,717
1,600
3,267
300
Centre of boiler
2,654
1,100
1,530
2,744
500
2,654
2,760
132
1,560
132

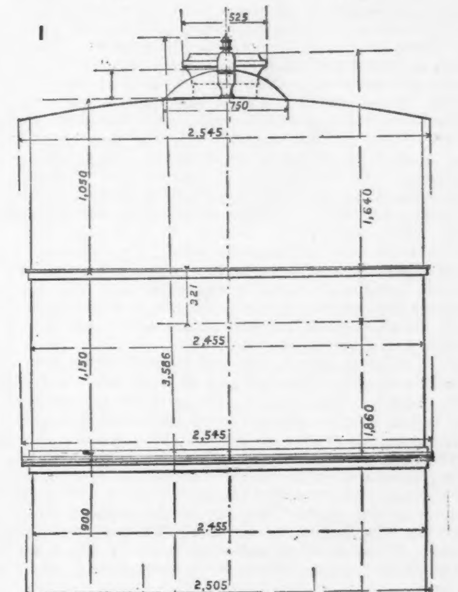
G


525
2,740
1,050
1,600
Centre of boiler
2,654
1,100
1,735
2,744
2,654
605
2,180
150
220
132
1,360
132

H


550
2,060
2,400
Centre of boiler
3,200
900
2,352
1,610
2,370
516
1,480
1,040
2,382
945

I


525
750
2,545
1,050
1,640
321
1,150
3,586
2,455
2,545
1,860
900
2,455
2,505
110
945
110

"THE ENGINEER." SWAIN ENG.

LIGHT RAILWAYS ABROAD.

No. II.

ROLLING STOCK.

SINCE the year 1885 the Société Nationale brought into use a number of different types of engines, as represented by Figs. A to I—page 439 and the supplement, and of which our tabular supplement gives the principal dimensions, in English measurements, corresponding with the dimensions on the engravings, which are given in the metric measures. The Société Nationale finds that, from all the different types in use, the engines weighing 15½ tons in full working order are those working most efficiently, and are strongly to be recommended for the ordinary general service; while for heavy freight trains, especially on hilly lines, the type of 27 tons in full working order are the best. The author had opportunity for travelling several times with these locomotives on the different lines, of which the engines of the Société Métallurgique of Brussels and of the Sociéte of St. Leonard of Liège well represent the above types—shown in Diagram A to I. In the first engines constructed by the Société Métallurgique some provision was made to condense the exhaust steam by leading it through condensing pipes fixed in one of the water tanks before passing it into the chimney, but, similar to the writer's experience with other engines, the water in the tank got rapidly very hot, and had, therefore, often to be changed, while the tank itself would have got exposed to injurious accumulation of grease from the waste steam, and if used again for feeding the boiler would have caused greasy deposits on the fire-box and boiler shell, and rapidly worked its destruction by burning the plates. This practice was, therefore, discontinued, and all that is done now in the engines of later construction is that a small cold water tank is placed between the two vessels, through which the exhaust steam passes before going into the chimney; there it is largely condensed, but the principal point of this arrangement is the reduction of the noise of the exhaust steam, and not for the purpose of condensation. The steam distribution in this engine is effected by the Walschaert system, so generally used on the Continent. The boiler is of iron; the tubes are of brass, without copper ends; while the fire-box, with its stays, are of copper, the crown stay bolts being of iron; the axles and the wheel flanges are of steel, while the nave and the spokes are of iron; the whole of the machinery is of fine grained or of Swedish iron; the axle bearings are of bronze, composed of 84 per cent. of copper and 16 per cent. of tin.

The engine is represented in fuller detail than in the diagrams, in Fig. 36, p. 441, which represents the elevation; Fig. 37, half sectional and half full view in plan; and Fig. 38, p. 445, half transverse section and half end view. Its principal dimensions will be seen from the diagram and table under Class A.

The engines shown by the type drawings in the supplemental engraving, marked A to I, and the outline dimension diagrams on page 439, correspondingly marked A to I, are illustrated in detail on pages 441 and 445.

The general type of engines as manufactured by the Société St. Leonard, at Liège, for 1 metre narrow-gauge lines is shown in Fig. 39, which is a side elevation; Fig. 40, a plan; and Fig. 41, half end view and half transverse section. Some modifications are, however, made in the general type of engines, as they are always particularly constructed according to the conditions of the line on which they have to work. They are outside-cylinder engines, and the frames are outside the wheels, to prevent as much as possible the side-sway of the engine. They have three axles, with the six wheels coupled. To preserve the requisite stability the centre of gravity is kept as low as possible, being lower than the height allowed for it on engines working on normal-gauge lines. The main connecting-rods—as shown in elevation and plan—are very long, as they are directly coupled to the crank pins of the hind axles by means of Hall's system. This system is greatly used in Austria and Bavaria. It seems to offer the advantage of reducing to a minimum the leverage of the overhang of the crank pins—measured in plan—by bringing the coupling rods closer to the wheels. The distribution of the weight over the axles is carefully made, so as to obtain the greatest adherence. To distribute the weight as regularly as possible over the coupled axles the wheel springs are connected with compensation levers or balanciers. The pistons are usually of Hadfield's cast steel, and the rods of Bessemer steel. The system of steam distribution in the cylinders is on the Walschaert principle, which, by variable expansion and with the reversing gear, offers the great advantage of giving the same lineal advance or lead of the slide valves for every degree of expansion.

Grate.—The grate is so arranged as to allow the burning of briquettes manufactured of coal dust—a fuel which, however, according to the author's experience, even in this type of engine, caused considerable smoke, to the great annoyance of the travelling public. The water tanks, from which the boiler is fed by means of Giffard injectors, are placed on both sides of the boiler. The engine is, however, also provided with an extra feed pump in case of need. The price of the engine is about 1·66f. per kilogramme, or about 11·32d. per pound of weight. Its principal dimensions, some of which are also marked on diagram Table A—I, under class C, are as follows:—

Diameter of cylinders	11in.
Stroke of pistons...	1ft. 2⅝in.
Diameter of wheels	2ft. 8¾in.
Wheel base	5ft. 10⅞in.
Length of fire-box	3ft. 4 7/16in.
Width of fire-box at top	3ft. 0¾in.
Width of fire-box at bottom	2ft. 3 11/16in.
Height of fire-box in front	3ft. 7 5/16in.
Height of fire-box at end...	3ft. 1in.
Diameter of barrel	3ft. 4 9/16in.
Total length of boiler	10ft. 4⅞in.
Length of tubes between tube-plates ...	5ft. 2¾in.
Diameter of tubes	1⅜in. to 1 9/16in.
Number of tubes	160
Grate surface	7·9 sq. ft.
Heating surface of fire-box	44·65 sq. ft.
Heating surface of tubes, inside	299·12 sq. ft.
Total heating surface	343·78 sq. ft.
Capacity of water tanks	444·4 gallons
Capacity of coal bunkers	1100 lb.
Weight of engine, empty...	15 tons, French
Weight of engine in full working order	18½ tons, French
Certified boiler pressure	10 atmospheres
Theoretical tractive power	7700 lb.
Effective tractive power at 60 per cent...	4620 lb.
Total length of engine to end of buffers	20ft. 2⅞in.
Outside width	8ft. 0¾in.
Height from rail surface to top of chimney	9ft. 11 7/16in.

It will also be remembered that the Société Nationale des Chemins de Fer Vicinaux recommended Class E for heavy work and hilly lines, of which class the St. Leonards works also supplied a great number of first-class engines, which gave great satisfaction, and which were specially recognised by the Société Nationale. This closes the record of the Belgian engines in this review, as used by the great and powerful Belgian Tramways Company, La Société Nationale, and of which the following general table A—I, in accordance with the corresponding diagrams, gives in full the practical and most important details of the series of engines in use on their lines.

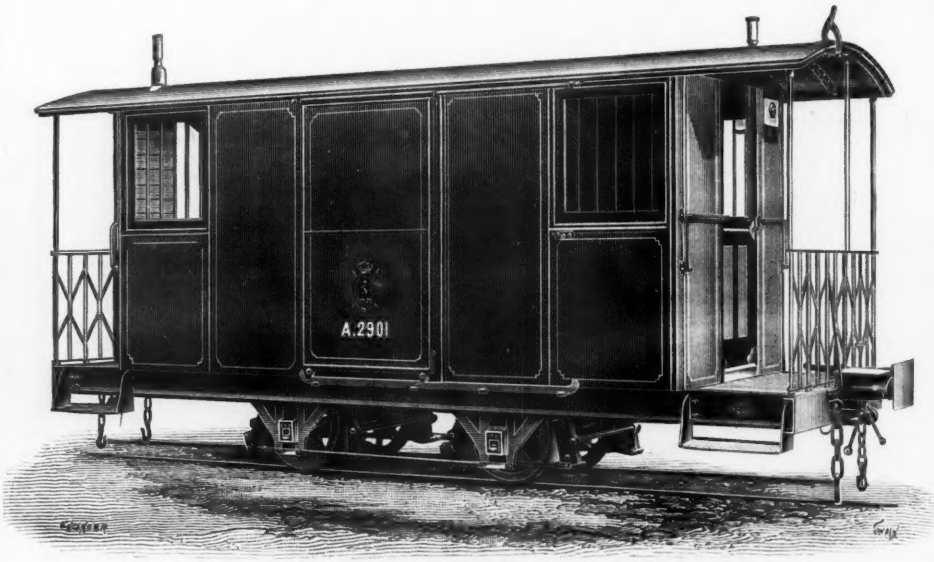


Fig. 53—LUGGAGE VAN

The locomotive works of Krauss and Company at Münich, in Bavaria—Germany—are amongst the most important manufacturing concerns on the Continent for tramway and narrow gauge railway locomotives. The writer thinks it will, therefore, be of great interest to bring before the reader for comparison a short description of the most recent of the types of engines manufactured by this company, the more so as this engine contains some very important and novel details which this company has patented. They consist in a new arrangement and disposition of the movable wheel or bogie frames, to allow locomotives of great or large wheel-base to pass through very sharp curves, without offering great resistance, nor to press too hard on the rails. The American bogies, or others already in use, are, as it is stated, very expensive arrangements, requiring frequent repairs, and the cost of maintenance is therefore very great. This is, of course, a very important point to consider in the present case of narrow gauge lines, where the cost of establishment is such a serious item, that on it depends whether the line can be made or not. Any economy in construction either of permanent way or rolling stock, which thus can be realised, without impairing the effectiveness of the service, is therefore of considerable advantage, and will have to be adopted on these lines. The engines actually used on narrow gauge lines have usually two or more coupled axles, with a movable bogie of two running axles fixed either in front or at the tail of the engine; these bogies pass the curves the easier the fewer the coupled axles there are on the engine. On light railways, however, it is not so much high speed but great tractive power which is wanted, consequently these engines often possess insufficient adhesion, as the bogie absorbs a large portion of the total weight of the engine somewhat out of proportion of the amount it should take; or, again, it occurs that, on the contrary, these engines have to be built far heavier than the tractive power to be obtained would require, and this because of the weight on the bogie. As stated, it has further to be considered that the locomotives which are provided with one radial axle, on whatever principle or system, do not answer the purpose sufficiently. Their adaptability to pass the curves well, and to return afterwards to their normal position in the axis of the permanent way, is not sufficiently secured to be always effected as completely as required. To avoid these defects, the present construction has been introduced. The adjoined table of diagrams—Figs. 42 to 50—represents the types of locomotives which were provided with the new arrangement and disposition of the movable frame of this construction. These engines were provided with free leading axles, but with a wheel base which did not correspond so well to the curves they had to pass. To remove these defects, and to avoid the use of the costly movable bogie with two free axles, the Krauss Company devised the new arrangement, namely, to form the bogie out of one of the coupled axles, and of one free axle only.

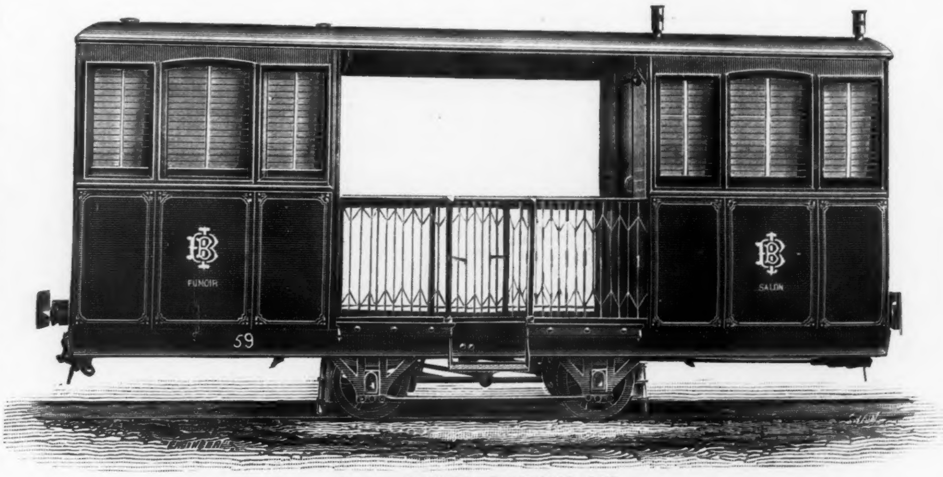


Fig. 59—CENTRAL PLATFORM CAR

To this effect a frame made of plate iron and the required angle irons, or made of cast steel, is fixed to the engine frame, on which it moves round a pivot, and connects the running axle with the next coupled axle of the engine, so that the latter turns in the curves in a direction at right angles to the longitudinal axis of the locomotive, while the free axle turns in the radial direction of the curve. The arrangement is indicated in the diagram. Both axle-boxes of the coupled axle are transversely connected together by the plate iron framing and to the bogie frame, by means of a ball-and-socket joint. The axle-boxes are also made so as to have some side way clearance in the horn plate guides; while at the same time the crank pins of the coupled axle are of ball-shaped form, to prevent any wedging of the connecting-rods. These pins do not show any unusual, but only a normal use in the joint. The axle-boxes of the free axle are independent of the main frame of the locomotive, and are fixed to the bogie frame. The transmission of the load upon the running axle takes place in the longitudinal axis of the locomotive by means of a transverse bearing spring and a corresponding vertical rod, which latter takes an inclined position during the passage of the free axle in the curve, and thus brings the bogie frame back to its normal position, after having left the curve. The engines represented on the diagram—Fig. 42 to Fig. 50—are used for main, secondary, and light railways, of normal or narrow gauge, and are in use on State and private lines, for express and ordinary trains, for passenger and goods traffic.

It is stated that these locomotives wherever they are used have satisfactorily answered all the requirements of the different railway companies. Their steadiness and stability on the straight line, as well as in passing the curves without slackening speed, in spite of their comparative lightness, has been well recognised. Comparing the arrangement of this movable bogie with engines provided with a radial axle, it will be found that this arrangement and disposition is simple, practical, and efficient for taking the curves and returning to the normal, and does not require any special construction to this effect. For light narrow gauge railways and with light permanent way, the tank engine, with three coupled and one trailing free axle, as represented in diagram, Fig. 42, and in detail in Figs. 51 and 52, is most suitable. This engine is built to different sizes, according to the local conditions of the line. The free axle and the third-coupled axle next to it, form the new movable bogie, turning round the point X. With this locomotive curves of the same minimum radius can be passed as with an ordinary locomotive of three-coupled axles of 1800 mm.—5ft. $10\frac{7}{8}$in.—wheel base. The running axle, however, permits the carriage of big water tanks and coal bunkers, as well as the use of a boiler with greater direct heating surface and fire-grate, without any overloading of the third-coupled axle. Besides there is another advantage, and that is of a large wheel base, producing a more steady run of the engine, and thus less wear and tear of the permanent way and the engine itself. The next important items, forming part of the rolling stock, are the vehicles for passenger and goods traffic, of which herewith follows the description.

CARS.

The vehicles for the Société Nationale des Chemins de Fer Vicinaux were mostly supplied, as far as the writer is informed, by the Société La Métallurgique mentioned before in reference to their supply of engines. The body of the cars with the framework is of teak, while the interior lining is of pitch pine. The outside of the car body is also covered with sheet iron of $1\frac{1}{4}$ mm., or about $\frac{3}{64}$in. thickness. The under frame carrying the body is of iron, the axles and wheel flanges are of steel, the naves and spokes of forged iron, worked under the steam hammer. The seats of the second-class carriages, which are the carriages mostly used by the travelling public, are alternately of laths of pitch pine and teak. The first-class carriages are mostly in all respects similar as to general construction, but are provided for seats and backs with velvet cushions stuffed with horsehair. The total length of the cars, as will be seen from Fig. 53, a longitudinal elevation of a second-class car, is 7·280 m. (23ft. $10\frac{9}{16}$in.), inclusive of buffers, while the outside width, as shown—plan, Fig. 54, and in the end elevation, Fig. 55—is 2·320 m. (7ft. $7\frac{1}{4}$in.), exclusive of roof. There are twenty-four seats inside, with standing room for sixteen passengers on the two platforms. The seats are cross benches, with a longitudinal passage in the centre of the car between them. In the first-class carriages there is, however, one compartment provided with a couch going lengthways, one each side, as shown in plan, Fig. 56. All the principal dimensions will be seen in the above mentioned figures. Besides the first and second-class carriages, there are also mixed carriages, with first and second-class compartments in one carriage, as represented in plan Fig. 57. The luggage van, as used on these vicinal lines, is shown in Fig. 58, from a photograph, which in case of need can also be used as a passenger car, being in its general dispositions of the same type. Its total length, inclusive of buffer, is 6·294 m. (20ft. $7\frac{3}{4}$in), and its total width 2·400 m. (7ft. $10\frac{7}{16}$in.).

According to the experience of the writer, who frequently travelled in the different classes of these cars in fine, as well as in rainy and stormy weather, they are very satisfactory, well adapted and thoroughly efficient for this kind of service. They are, on the whole, of elegant design, comfortable, for the comparatively short journeys, and neatly built. The platforms make the travelling in fine weather more pleasant, with the exception of the annoyance of smoke coming from the engine, especially as coal dust briquettes are used on the country lines, coke only being used in the towns. The centre passage of the cars is essentially for the guard, who collects fares, and, when need be, sells tickets; the latter only in exceptional cases. For his protection, a small foot-plate covers part of the buffers, hook and chain connection, as seen in Fig. 58, and thus gives him free passage through the whole train. The doors are mostly left open by the public, with the result that the smoke fills the cars, an annoyance which should, and the writer thinks could, easily be removed, by using coal briquettes and coke combined on the country road. Perhaps better stoking and closing some of the doors might be more effective.

As there is usually a heavy wind blowing over the country from the North Sea, and to better protect the traveller on the platform from rain and dust, the Société Métallurgique have introduced a new type of cars, with a central platform in the middle of the car, having the compartments at each end—as represented in engraving from a photograph, Fig. 59. Each of the compartments can be arranged for first or second class, or as saloon or smoking compartment. Each of the compartments contains six seats; the centre platform has standing room for twenty-four passengers. The total length of the car is 7·340 m. (24ft. 1in.), and the total width is 2·200 m. (7ft. $2\frac{3}{16}$in.), otherwise the car is of the same type as the other, constructed on the same principle, and the same material as for the other cars is used. The cars, on the whole, run steadily on the straight line, as well as on the curves. The writer did not observe any grinding in passing the latter; but, the material being comparatively light, some swaying of the cars occurs naturally when leaving the curves at ordinary, and not slackened, speed. The Société Nationale des Chemins de Fer Vicinaux finds, from its long experience with these cars, that the best types of passenger cars for their lines are the first-class carriages, the mixed carriages with first and second-class, and the second-class carriages, with two axles of 2·400 m. (7ft. $10\frac{7}{16}$in.) wheel base and of small capacity, as represented in Figs. 53 to 57. The luggage van, as shown in Fig. 58, is provided with a screw brake of eight brake-blocks.

As the construction of light railways is at present occupying such prominence, the few notes on the subject contained in these articles may be of some practical interest and value, and the writer thanks M. de Burlet, engineer-in-chief and managing director of the Société Nationale des Chemins de Fer Vicinaux, at Brussels, and the manufacturers herein named, who were kind enough to place the necessary information at his disposal.

As to the rolling stock of large capacity, the Société Nationale is waiting still more experience before pro-

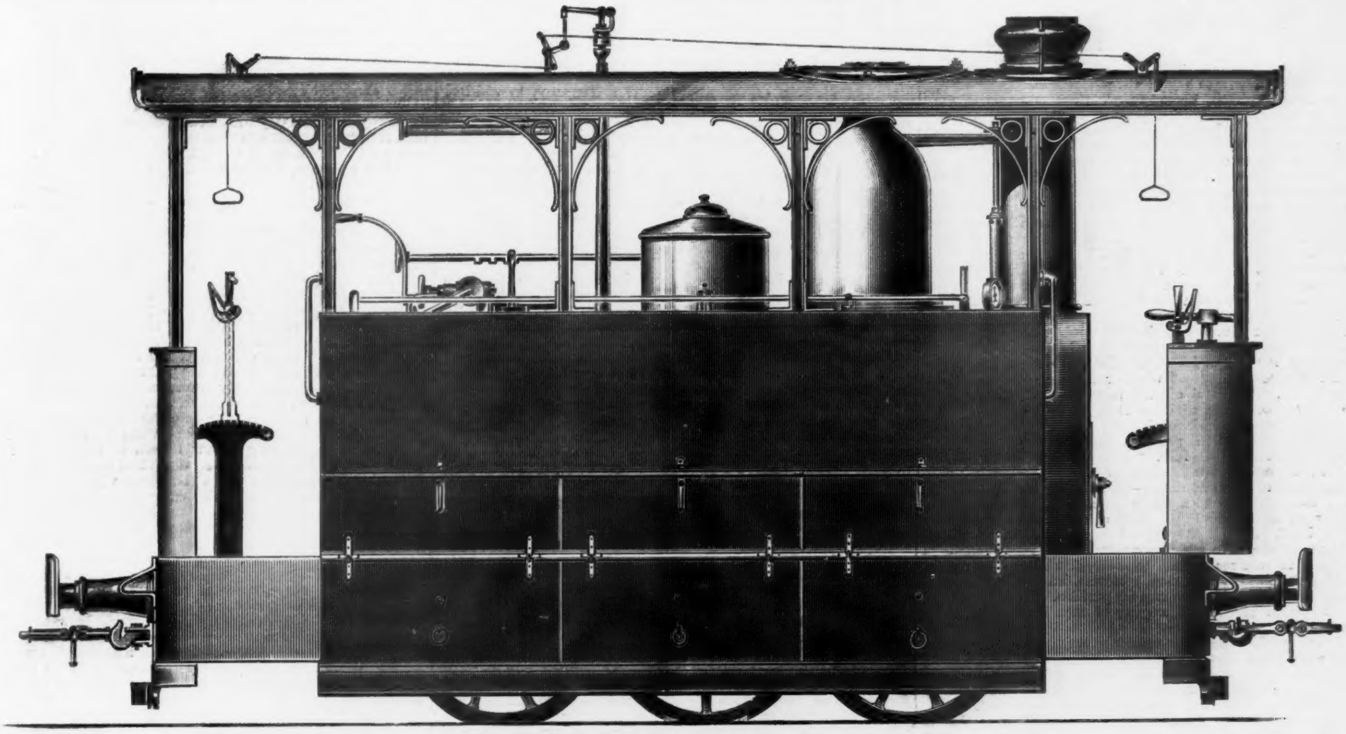


FIG 36. SIDE ELEVATION

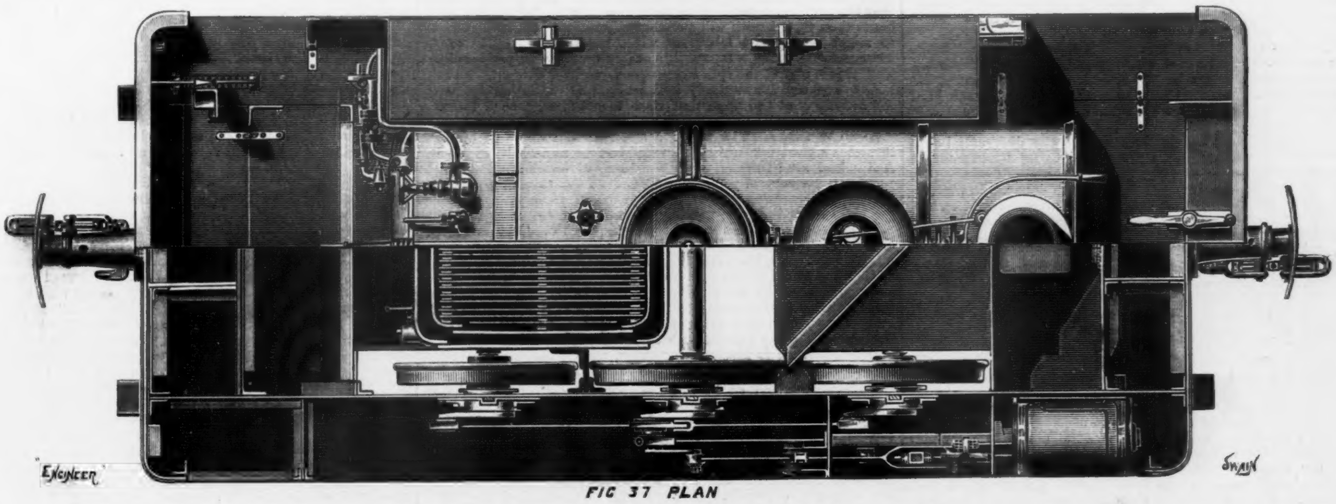


FIG 37 PLAN

LOCOMOTIVES, BELGIAN LIGHT RAILWAYS—THE SOCIETE METALLURGIQUE, BRUSSELS, ENGINEERS nouncing definitely as to the best. The principal dimensions of the above-named vehicles are as follows:—

	M.	Ft.	In.
Wheel base	2·400—	7	$10\frac{7}{16}$
Total length of frame—			
For cars	6·800—	22	$3\frac{11}{16}$
,, and...	6·340—	20	$9\frac{9}{16}$
Luggage van	6·340—	20	$9\frac{9}{16}$
From level of rail to centre of buffer ...	0·608—	1	$11\frac{15}{16}$
,, ,, ,, draw-bar	0·448—	1	$5\frac{5}{8}$
Diameter of wheels	0·600—	1	$11\frac{5}{8}$
Length of springs	1·200—	3	$11\frac{1}{4}$

Weight of Cars.

	Kilos.	Tons	cwt.
First-class and mixed class, empty	4600—	4	10
Second-class...	4500—	4	8
Luggage van	5000—	5	0

Price.

	F.	£
First-class and mixed	3800—	152
Second-class...	3250—	130
Luggage van	3000—	120

A PIECE-RATE SYSTEM.*

(*Concluded from page* 418.)

(58) THE exact percentage beyond the usual standard which must be paid to induce men to work to their maximum, varies with different trades and with different sections of the country. And there are places in the United States where the men, generally speaking, are so lazy and demoralised that no sufficient inducement can be offered to make them do a full day's work.

(59) It is not, however, sufficient that each workman's ambition should be aroused by the prospect of larger pay at the end of even a comparatively short period of time. The stimulus to maximum exertion should be a daily one. This involves such vigorous and rapid inspection and returns as to enable each workman in most cases to know each day the exact result of his previous day's work, *i.e.*, whether he has succeeded in earning his maximum pay, and exactly what his losses are for careless or defective work. Two-thirds of the moral effect, either of a reward or penalty, is lost by even a short postponement.

(60) It will again be noted that the differential rate system forces this condition both upon the management and the workmen, since the men, while working under it, are above all anxious to know at the earliest possible moment whether they have earned their high rate or not. And it is equally important for the management to know whether the work has been properly done.

(61) As far as possible each man's work should be inspected and measured separately, and his pay and losses should depend upon his individual efforts alone. It is, of course, a necessity that much of the work of manufacturing—such, for instance, as running roll-trains, hammers, or paper machines—should be done by gangs of men who co-operate to turn out a common product, and that each gang of men should be paid a definite price for the work turned out, just as if they were a single man. In the distribution of the earnings of a gang among its members, the percentage which each man receives should, however, depend not only upon the kind of work which each man performs, but upon the accuracy and energy with which he fills his position. In this way the personal ambition of each of a gang of men may be given its proper scope.

(62) Again, we find the differential rate acting as a most powerful lever to force each man in a gang of workmen to do his best; since if, through the carelessness or laziness of any one man, the gang fails to earn its high rate, the drone will surely be obliged by his companions to do his best the next time or else get out.

(63) A great advantage of the differential rate system is that it quickly drives away all inferior workmen, and attracts the men best suited to the class of work to which it is applied, since none but really good men can work fast enough and accurately enough to earn the high rate; and the low rate should be made so small as to be unattractive even to an inferior man.

(64) If for no other reason than that it secures to an establishment a quick and active set of workmen, the differential rate is a valuable aid, since men are largely creatures of habit; and if the piece-workers of a place are forced to move quickly and work hard the day-workers soon get into the same way, and the whole shop takes on a more rapid pace.

(65) The greatest advantage, however, of the differential rate piece-work, in connection with a proper rate-fixing department, is that together they produce the proper mental attitude on the part of the men and the management toward each other. In place of the indolence and indifference which characterise the workmen of many day-work establishments, and to a considerable extent also their employers; and in place of the constant watchfulness, suspicion, and even antagonism with which too frequently the men and the management regard each other under the ordinary piece-work plan, both sides soon appreciate the fact that with the differential rate it is their common interest to co-operate to the fullest extent, and to devote every energy to turning out daily the largest possible output. This common interest quickly replaces antagonism, and establishes a most friendly feeling.

(66) Of the two devices for increasing the output of a shop, the differential rate and the scientific rate-fixing department, the latter is by far the more important. The differential rate is invaluable at the start, as a means of convincing men that the management is in earnest in its intention of paying a premium for hard work; and it at all times furnishes the best means of maintaining the top notch of production; but when, through its application, the men and the management have come to appreciate the mutual benefit of harmonious co-operation and respect for each other's rights, it ceases to be an absolute necessity. On the other hand, the rate-fixing department, for an establishment doing a large variety of work, becomes absolutely indispensable. The longer it is in operation the more necessary it becomes.

(67) Practically the greatest need felt in an establishment wishing to start a rate-fixing department is the lack of data as to the proper rate of speed at which work should be done. There are hundreds of operations which are common to most large establishments; yet each concern studies the speed problem for itself, and days of labour are wasted in what should be settled once for all, and recorded in a form which is available to all manufacturers.

(68) What is needed is a handbook on the speed with which work can be done, similar to the elementary engineering handbooks. And the writer ventures to predict that such a book will before long be forthcoming. Such a book should describe the best method of making, recording, tabulating, and indexing time-observations, since much time and effort are wasted by the adoption of inferior methods.

(69) The term "rate-fixing department" has rather a formidable sound. In fact, however, that department should consist in most establishments of one man, who in many cases need give only a part of his time to the work.

(70) When the manufacturing operations are uniform in character, and repeat themselves day after day—as, for instance, in paper or pulp mills—the whole work of the place can be put upon piece-work in a comparatively short time; and when once proper rates are fixed, the rate-fixing department can be dispensed with, at any rate until some new line of manufacture is taken up.

(71) The system of differential rates was first applied by the writer to a part of the work in the machine shop of the Midvale Steel Company in 1884. Its effect in increasing and then maintaining the output of each machine to which it was applied was almost immediate, and so remarkable that it soon came into high favour with both the men and the management. It was gradually applied to a great part of the work of the establishment, with the result, in combination with the rate-fixing department, of doubling and in many cases of trebling the output, and at the same time increasing instead of diminishing the accuracy of the work.

(72) In some cases it was applied by the rate-fixing department without an elementary analysis of the time required to do the work; simply offering a higher price per piece providing the maximum output before attained was increased to a given extent. Even this system met with success, although it is by no means correct, since there is no certainty that the reward is in just proportion to the efforts of the workmen.

(73) In cases where large and expensive machines are used, such as paper machines, steam hammers, or rolling mills, in which a large output is dependent upon the severe manual labour as well as the skill of the workmen—while the chief cost of production lies in the expense of running the machines rather than in the wages paid—it has been found of great advantage to establish two or three differential rates, offering a higher and higher price per piece or per ton as the maximum possible output is approached.

(74) As before stated, not the least of the benefits of elementary rate-fixing are the indirect results. The careful study of the capabilities of the machines, and the analysis of the speeds at which they must run, before differential rates can be fixed, which will ensure their maximum output, almost invariably result in first indicating and then correcting the defects in their design and in the method of running and caring for them.

(75) In the case of the Midvale Steel Company, to which I have already referred, the machine shop was equipped with standard tools furnished by the best makers, and the study of these machines, such as lathes, planers, boring mills, &c., which was made in fixing rates, developed the fact that they were none of them designed and speeded so as to cut steel to the best advantage. As a result, this company has demanded alterations from the standard in almost every machine which they have bought during the past eight years. They have themselves been obliged to superintend the design of many special tools which would not have been thought of had it not been for elementary rate-fixing.

(76) But what is perhaps of more importance still, the rate-fixing department has shown the necessity of careful systematising all of the small details in the running of each shop; such as the care of belting, the proper shape for cutting tools, and the dressing, grinding, and issuing same, oiling machines, issuing orders for work, obtaining accurate labour and material returns, and a host of other minor methods and processes. These details, which are usually regarded as of comparatively small importance, and many of which are left to the individual judgment of the foreman and workmen, are shown by the rate-fixing department to be of paramount importance in obtaining the maximum output, and to require the most careful and systematic study and attention in order to ensure uniformity and a fair and equal chance for each workman. Without this preliminary study and systematising of details it is impossible to apply successfully the differential rate in most establishments.

(77) As before stated, the success of this system of piece-work depends fundamentally upon the possibility of materially increasing the output per man and per machine, providing the proper man be found for each job and the proper incentive be offered to him.

(78) As an illustration of the difference between what ought to be done by a workman well suited to his job, and what is generally done, I will mention a single class of work, performed in almost every establishment in the country. In shovelling coal from a car over the side on to a pile one man should unload forty tons per day, and keep it up, year in and year out, and thrive under it. With this knowledge of the possibilities I have never failed to find men who were glad to work at this speed for from four and a-half to five cents per ton. The average speed for unloading coal in most places, however, is nearer fifteen than forty tons per day. In securing the above rate of speed it must be clearly understood that the problem is not how to force men to work harder or longer hours than their health will permanently allow; but, rather, first, to select among the labourers which are to be found in every community the men who are physically able to work permanently at that job, and at the speed mentioned, without damage to their health, and who are mentally sufficiently inert to be satisfied with the monotony of the work, and then to offer them such inducements as will make them happy and contented in doing so.

(79) The first case in which a differential rate was applied furnishes a good illustration of what can be accomplished by it. A standard steel forging, many thousands of which are used each year, had for several years been turned at the rate of from four to five per day under the ordinary system of piece-work, 50 cents per piece being the price paid for the work. After analysing the job and determining the shortest time required to do each of the elementary operations of which it was composed, and then summing up the total, the writer became convinced that it was possible to turn ten pieces a day. To finish the forgings at this rate, however, the machinists were obliged to work at their maximum pace from morning to night, and the lathes were run as fast as the tools would allow, and under a heavy feed. It will be appreciated that this was a big day's work, both for men and machines, when it is understood that it involved removing, with a single 16in. lathe, having two saddles, an average of more than 800 lb. of steel chips in ten hours. In place of the 50-cent rate that they had been paid before, they were given 35 cents per piece when they turned them at the speed of ten per day, and when they produced less than ten, they received only 25 cents per piece.

(80) It took considerable trouble to induce the men to turn at this high speed, since they did not at first fully appreciate that it was the intention of the firm to allow them to earn permanently at the rate of 3·50 dols. per day. But from the day they first turned ten pieces to the present time, a period of more than ten years, the men who understood their work have scarcely failed a single day to turn at this rate. Throughout that time, until the beginning of the recent fall in the scale of wages throughout the country, the rate was not cut.

(81) During this whole period the competitors of the company never succeeded in averaging over half of this production per lathe, although they knew and even saw what was being done at Midvale. They, however, did not allow their men to earn over from 2 dols. to 2·50 dols. per day, and so never even approached the maximum output.

(82) The following table will show the economy of paying high wages under the differential rate in doing the above job:—

Cost of Production per Lathe per Day.

Ordinary system of piece-work.	Dols.	Differential rate system.	Dols.
Man's wages	2 50	Man's wages	3 50
Machine cost	3 37	Machine cost	3 37
Total cost per day	5 87	Total cost per day	6 87
Five pieces produced.		Ten pieces produced	
Cost per piece	1 17	Cost per piece	0 69

The above result was mostly, though not entirely, due to the differential rate. The superior system of managing all of the small details of the shop counted for considerable.

(83) There has never been a strike by men working under differential rates, although these rates have been applied at the Midvale Steel Works for the past ten years; and the steel business has proved during this period the most fruitful field for labour organisations and strikes. And this notwithstanding, the Midvale Company has never prevented its men from joining any labour organisation. All of the best men in the company saw clearly that the success of a labour organisation meant the lowering of their wages, in order that the inferior men might earn more, and, of course, could not be persuaded to join.

(84) I attribute a great part of this success in avoiding strikes to the high wages which the best men were able to earn with the differential rates, and to the pleasant feeling fostered by this system; but this is by no means the whole cause. It has for years been the policy of that company to stimulate the personal ambition of every man in their employ, by promoting them either in wages or position whenever they deserved it and the opportunity came. A careful record has been kept of each man's good points as well as his shortcomings, and one of the principal duties of each foreman was to make this careful study of his men, so that substantial justice could be done to each. When men throughout an establishment are paid varying rates of day-work wages, according to their individual worth, some being above and some below the average, it cannot be for the interest of those receiving high pay to join a union with the cheap men.

(85) No system of management, however good, should be applied in a wooden way. The proper personal relations should always be maintained between the employers and men; and even the prejudices of the workmen should be considered in dealing with them. The employer who goes through his works with kid gloves on, and is never known to dirty his hands or clothes, and who either talks to his men in a condescending or patronising way, or else not at all, has no chance whatever of ascertaining their real thoughts or feelings.

(86) Above all is it desirable that men should be talked to on their own level by those who are over them. Each man should be encouraged to discuss any trouble which he may have, either in the works or outside, with those over him. Men would far rather even be blamed by their bosses, especially if the "tearing out" has a touch of human nature and feeling in it, than to be passed by day after day without a word, and with no more notice than if they were part of the machinery. The opportunity which each man should have of airing his mind freely, and having it out with his employers, is a safety valve; and if the superintendents are reasonable men, and listen to and treat with respect what their men have to say, there is absolutely no reason for labour unions and strikes.

(87) It is not the large charities, however generous they may be, that are needed or appreciated by workmen, such as the founding of libraries and starting working men's clubs, so much as small acts of personal kindness and sympathy, which establish a bond of friendly feeling between them and their employers.

(88) The moral effect of the writer's system on the men is marked. The feeling that substantial justice is being done them renders them on the whole much more manly, straightforward, and truthful. They work more cheerfully, and are more obliging to one another and their employers. They are not soured, as under the old system, by brooding over the injustice done them, and their spare minutes are not spent to the same extent in criticising their employers. A noted French engineer and steel manufacturer, who recently spent several weeks in the works of the Midvale Company in introducing a new branch of manufacture, stated before leaving that the one thing which had impressed him as most unusual and remarkable about the place was the fact that not only the foremen, but the workmen, were expected to, and did in the main, tell the truth in case of any blunder or carelessness, even when they had to suffer from it themselves.

(89) From what the writer has said, he is afraid that many readers may gain the impression that he regards elementary rate-fixing and the differential rate as a sort of panacea for all human ills. This is, however, far from the case. While he regards the possibilities of these methods as great, he is of the opinion, on the contrary, that this system of management will be adopted by but few establishments, in the near future at least, since its really successful application not only involves a thorough organisation, but requires the machinery and tools throughout the place to be kept in such good repair that it will be possible for the workmen each day to produce their maximum output. But few manufacturers will care to go to this trouble until they are forced to.

(90) It is his opinion that the most successful manufacturers—those who are always ready to adopt the best machinery and methods when they see them—will gradually avail themselves of the benefits of scientific rate-fixing; and that competition will compel the others to follow slowly in the same direction.

(91) Even if all of the manufacturers in the country who are competing in the same line of business were to adopt these methods, they could still well afford to pay the high rate of wages demanded by the differential rate, and necessary to induce men to work fast, since it is a well recognised fact the world over that the highest-priced labour, providing it is proportionately productive, is the cheapest; and the low cost at which they could produce their goods would enable them to sell in foreign markets and still pay high wages.

(92) The writer is far from taking the view held by many manufacturers that labour unions are an almost unmitigated detriment to those who join them, as well as to employers and the general public. The labour unions—particularly the trades unions of England—have rendered a great service not only to their members, but to the world, in shortening the hours of labour, and in modifying the hardships and improving the conditions of wage-workers. In the writer's judgment the system of treating with labour unions would seem to occupy a middle position among the various methods of adjusting the relations between employers and men. When employers herd their men together in classes, pay all of each class the same wages, and offer none of them any inducements to work harder or do better than the average, the only remedy for the men lies in combination; and frequently the only possible answer to encroachments on the part of their employers is a strike. This state of affairs is far from satisfactory to either employers or men, and the writer believes the system of regulating the wages and conditions of employment of whole classes of men by conference and agreement between the leaders, unions, and manufacturers to be vastly inferior, both in its moral effect on the men, and on the material interests of both parties, to the plan of stimulating each workman's ambition by paying him according to his individual worth, and without limiting him to the rate of work or pay of the average of his class.

(93) The level of the great mass of the world's labour has been, and must continue to be, regulated by causes so many and so complex as to be at best but dimly recognised. The utmost effect of any system, whether of management, social combination, or legislation, can be but to raise a small ripple or wave of prosperity above the surrounding level, and the greatest hope of the writer is that, here and there, a few workmen, with their employers, may be helped, through this system, toward the crest of the wave.

THE Clyde shipbuilding industry is now fairly in the thick of a period of activity such as it has not experienced for a number of years. During the month just ended new shipping to the extent of approaching 40,000 tons has been launched, while during the same period no less than 52,000 tons have been ordered, including 2000 tons of Government work. This is some 9000 tons in excess of the tonnage booked during March, and quite 12,000 tons ahead of the bookings for February. Nor does the boom which this represents seem to have spent itself, as the flow of fresh orders continues, and quite a number of inquiries are in the market. The North German Lloyd Company is asking tenders for the construction of as many as five new steamers, each of 5000 tons, for the Brazil trade. As German yards have an abnormal quantity of tonnage on hand at present—of which 50,000 tons is to the order of this one company alone—it is very probable that several, if not all the five boats, will be built in this country, the Clyde, in all likelihood, coming in as usual for a big share of the work. Other three cargo vessels, ranging between 5000 and 6000 tons, are likely to be ordered within the next week or so from Clyde builders.

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* Presented at the Detroit meeting of the American Society of Mechanical Engineers.

ROYAL UNITED SERVICE INSTITUTION.

STEADY PLATFORMS AT SEA FOR SEARCH LIGHTS.

AT the Royal United Service Institution on Wednesday, April 29th, Admiral Henry Boys, R.N., in the chair, a paper was read by Mr. Beauchamp Tower, M.I.C.E., on "An Apparatus for Providing a Steady Platform at Sea for Search Lights, &c."

In this apparatus, which has already been very fully described in our columns, the platform or part to be kept steady, and to which the search light is attached, is hung in gimbals, so as to have angular freedom in every direction, in the same manner as the bowl of a mariner's compass. A gyroscope is provided, revolving in a horizontal plane and throwing a truly vertical jet out of the axial jet nozzle. The directing of this jet in the true vertical is the sole business of the gyroscope and the only object of its existence. Immediately above the axial jet, and about ¼in. from it, are four open-mouthed ports formed in a circle, divided by radial divisions into four equal sectors; their open mouths are directed downwards towards the axial jet. The passages, of which they form the terminations, communicate each to one of the four cylinders. If the platform is truly horizontal, the axis of the axial jet passes through the centre of the circle containing the four ports, and the jet is equally distributed between them, but should the platform be the least bit out of the horizontal plane, some of the ports receive more of the jet than others, and this causes an inequality of pressure in the cylinders which cants the platform into the horizontal plane. Thus the vertical axial jet playing on the four ports acts as a force tending to keep the ports and itself concentric, and consequently the platform horizontal. The reason for using the jet as a connection between the gyroscope and platform is that it enables the gyroscope to powerfully control the platform, and yet suffer no reaction on itself. A very small force would be sufficient to disturb the gyroscope from its horizontal plane of rotation, but no force can be communicated to it from the platform, as it makes no difference to the gyroscope what the axial jet strikes against after it has left the nozzle. The water from the jets, after expending its energy in the manner described, falls past the gyroscope through the open bottom of the cell into the tank below, and thence through a pipe returns to the sea.

The first practical machine was fitted up on a small steam yacht, 50ft. long and 11ft. beam, and subjected to a laborious course of experiment, extending over about two years. It was experimented with by the officers of H.M.S. Vernon as a means of mounting search lights, and by the officers of H.M.S. Excellent as a means of mounting machine-guns. In both cases their reports showed that the machine answered the purpose for which it was designed perfectly, and I believe, so far as I am permitted to know, that their opinions were favourable. After these experiments, a machine for mounting a 24in. search light projector was ordered by the Admiralty to be fitted to H.M. gunboat Bloodhound, tender to H.M.S. Vernon, for further experiment, which showed that the machine could be depended on to keep a search light ray absolutely steady on a small vessel in a heavy sea, and I believe that further favourable reports were sent to the Admiralty on the subject. Since then, Sir W. G. Armstrong, Mitchell, and Co., have taken up the manufacture of these machines, and are fitting it to the torpedo destroyers Swordfish and Spitfire, which they are constructing for the Navy. They are also supplying these machines to the order of the Chilian Government for a cruiser building at Elswick. There would be no difficulty in mounting the smaller class of quick-firing guns on these machines, of course specially designed for the purpose; and on a small vessel, in which the motion is very quick and the difficulties of accurate shooting great, it ought to be very effective. For larger guns, an automatic firing apparatus has been designed for attachment to this machine, so as to fire the gun electrically at the right moment in the roll.

The discussion was opened by Mr. J. I. Thornycroft. He said that he had had an opportunity of seeing and testing Mr. Tower's platform for himself. He had stood on the platform during rough weather in the Solent, and experienced the sensation of looking down and watching the vessel rolling under him while he himself was in comparative equilibrium. Such rolling as he could feel was exceedingly small. He had also seen from a distance the effect of a search-light mounted on the platform. Although the night was rough, the vertical motion of the light was almost nil, and resembled, when revolving on a vertical axis, nothing so much as a lighthouse beam. With regard to the structure, Mr. Tower had attacked a difficult problem and had arrived at a simple solution. He had successfully overcome the unavoidable difficulty of external force applied to the upper part of the structure. This, of course, could have been overcome by a change of the pressure of the water admitted to the cylinders, but the port arrangement, he thought, was better. With regard to gun-fire, Mr. Tower had to give a popular illustration, reduced the flight of a snipe to that of a partridge as the target would be moving uniformly instead of in a zig-zag fashion—anyhow. The former is difficult enough, but the latter well nigh impossible.

Mr. Brunel said he had also sat on Mr. Tower's apparatus, early in 1889, before the correcting cylinders had been added. The boat was rolling at an angle of from 20 deg. to 30 deg. They had a mock gun. The utmost error observable on this occasion was about ½ deg., and this did not arise suddenly but gradually, at a rate of less than ¼ deg. at each roll. Afterwards the machine was tried again at the Needles, and found to be a thoroughly practical machine, in that it stood the test of being in the hands of people who had previously never had anything to do with it. The correcting cylinders had then been added, and they corrected every error.

Mr. Tower, in replying, said he had first started with a small model, and, with regard to sensitiveness, had arranged that a very small angle would cause sufficient change at the ports to enable them to operate, and this arrangement was too good, too sensitive; the action was so quick and violent that he had to allow of there being some error, this to be corrected by means of the correcting cylinders. In the torpedo boat Bloodhound, on which experiments had been carried out, the captain of H.M.S. Vernon had worked an apparatus, entirely by himself, which had not been in use for three or four months. There used once to be a slight quiver in the platform, but that had now been overcome. In an experiment which had been conducted recently by Sir W. G. Armstrong, Mitchell, and Co., on a boat which was caused to rock by a number of men running to and fro athwartships, a spot of light thrown on a neighbouring ship was found to remain absolutely stationary. A vote of thanks was passed to Mr. Tower, and the proceedings terminated.

HORSELESS CARRIAGE NOTES.

THE Exhibition of Horseless Carriages at the Imperial Institute will contain a large number of motor-propelled vehicles of very various designs, and by French, German, and English makers. They will also include motor omnibuses, vans, and motor cycles. A private view of the exhibition will take place this afternoon for the reception of members of the House of Lords, and the opening of the exhibition will take place on the 9th inst., when the Prince of Wales will perform the ceremony. The exhibition has been organised by the Motor Car Club, which is affiliated with the Automobile Club of Paris, and with other similar organisations, supported by all the at present best-known makers of steam, oil, and electrically-propelled vehicles, and the exhibition will represent all these different interests and makers. There will, of course, be a considerable number of vehicles, by several different firms, driven by benzoline motors of the Benz and Daimler types, the latter predominating, just as they did in the Paris and Bordeaux races. This is a result of the early appearance in the field and the suitability of the Daimler motor for the requirements of the several carriage-builders in Paris and Switzerland who adopted these motors, and it appears now probable that the legal difficulties in the way of the use of the light oils will soon be removed or lessened in this country. The electrical and steam motors, appear, however, to be gaining more and more favour, and the Count De Dion and M. Serpollet, and others, are probable exhibitors.

IN moving the second reading of the Locomotives on Highways Bill in the House of Lords last week, Lord Harris and Viscount Clifden made some remarks which are in support of the observations we made last week as to the haulage of one vehicle by another. Lord Harris said the use of light locomotives, capable of going at a fair pace on the highway, had become common in some countries on the Continent and in America, and it was not unnatural that those who wished to use such locomotives should claim to have a chance of turning their attention to an industry and means of conveyance which was obviously very useful; but they found that they were obstructed in this country by impediments which were not in existence on the Continent. Parliament had been extremely jealous about the safety of the public, and had imposed a considerable number of rules, and passed a very considerable number of laws, regarding the use of locomotives. It was ludicrous that the same provisions should apply to a vehicle of a hundredweight or so as were applied to a locomotive of several tons. He was informed that there were at present persons who were prepared to put on the streets of London, provided the power were given by Bill, electric omnibuses, which they maintained would be as convenient in every respect as the present means of locomotion. The method adopted in the Bill was, first, to exclude light locomotives from most of the provisions of the existing Acts which applied to ordinary locomotives, and then to lay down a certain number of restrictions which should specially apply to the lighter vehicles. It was provided that their weight should be limited to two tons, but he was informed that this maximum would render the use of light locomotives impossible, and Mr. Chaplin was ready to listen to any evidence placed before him as to what would be the proper weight to fix as a maximum. Another provision was that a light locomotive should not draw any other vehicle after it. He thought this was a wise provision, as there would be danger to other vehicles from these light carriages suddenly coming round a corner, no limit being fixed as to the speed at which they should run. It was also provided that no smoke or vapour should be visible in the running of these vehicles; but he had been told by a gentleman who had been using these carriages on the Continent that, in certain states of the temperature, it was impossible to prevent a certain amount of vapour escaping so as to be visible. Probably, it would be necessary to introduce in the Bill some words which would remove this disability. There was special provision made in the Bill to safeguard the keeping and use of petroleum and other inflammables in connection with these light locomotives. It was further provided that any person driving a light locomotive negligently should be liable to a heavy penalty, and the Local Government Board reserved to itself power to make regulations with respect to the use of light locomotives on highways, while in the first clause it was provided that nothing in the section should affect the existing general powers with respect to the regulation of traffic on the highways. There was an earnest desire in the country that a Bill of this kind should be passed, and the Local Government Board had, perforce, to draft the Bill rather in the dark, having no experience of light locomotives in this country; but they would, of course, be ready to give their consideration to any proposal for amending it which might be thought necessary. Viscount Clifden welcomed the Bill, but took some exception to the provision which prevented a light locomotive from drawing any other vehicle after it. The Earl of Morley pointed out that, as at present drawn, the Bill would exclude these vehicles from the liability to pay the toll which, under the Act of 1861, still existed on certain roads and bridges. Lord Harris promised that full consideration should be given to the points raised.

THERE is obviously some misconception in the reasons urged against a locomotive vehicle drawing another. There would be no additional risk of danger to other vehicles when locomotive vehicles suddenly turned a corner, for it is the leading vehicle which, like any ordinary vehicle, would be the cause of danger to other vehicles crossing the corner. The addition of a carriage behind the leader would make no difference. There are many reasons for permitting the use of a mechanically-hauled vehicle, whether behind a motor carriage or behind something more truly of the nature of a locomotive.

ANXIOUS as Australians may be to adopt motor carriages when available, their import duties will be much against them. In reply to a letter from Messrs. Phillips, Ormonde, and Co., of the 12th of December, respecting duty on "horseless carriages," Mr. H. N. P. Wollaston, Secretary of Customs, stated that "duty will be charged on the vehicles under the heading of carriages, carts, and conveyances, according to their designation. A further charge will be made for the motors as machinery, which will be dutiable at the rate of 25 per cent. on and after January 1st next." Although duty is high, it appears that regulations are easy, for in reply to a letter on this subject, Mr. John Clayton, Town Clerk of Melbourne, writes that he is not aware of any bye-law prohibiting the use of such vehicles in the streets of Melbourne. "They will, however, of course, be subject to all bye-laws and regulations regarding street traffic."

SOME OF THE DIFFICULTIES IN DESIGNING RAIL SECTIONS.

MR. DUDLEY, writing to the editor of the *Railroad Gazette*, says:—

"The area of but few sections for the given weight per yard seems to be correctly determined on the drawings for the standard measures and weight before the dimensions are sent to the mills; the figures will not be corrected there. A part of this discrepancy in the area is due, in laying out the section, to the use of scales originally inaccurate, or that have become so since they were divided, the stamp of 'U.S. Standard' on them being no longer a guarantee of their correctness. A fine 12in. U.S. Standard scale divided in 1894, and used daily in August and September of that year, is now 0·012 of an inch shorter than when I obtained it, most of the error being in the six inches principally handled and used. An expensive English ivory scale I have used is $\frac{1}{32}$ of an inch short in 12in., and is only used when I wish to compute an English section from the dimensions given per yard. An English section laid out with our U.S. Standard I have always found to exceed the weight given per yard. My 80 lb. section, rolled in England, is lower than our standard measures, the weight being made up by a slight increase in thickness of web and head.

"At the mills the dimensions for the section go to the roll designer, who determines and lays out the passes for the rolls on paper, estimating the allowance to be made for draft, flow, speed, and shrinkage of the hot metal. Then the hot templates are made, from which to turn the rolls.

"The rolls are driven according to their pitch diameter, and those portions of the pass which are sunk deep into the body of the rolls, the bottom of the pass being so much less than the pitch diameter, describe a less distance; therefore the metal in some portions of the pass must slip. This becomes a very serious matter for the manufacturer with sections having wide flanges, as the extreme width must slip through the bottom of the pass faster than the bottom of the rollers is moving, and a great many seconds will be made unless the angle for the base is large, for good delivery. Outside of the mills little is known of the difficulties and intricacies of roll designing and turning and rolling the steel.

"The shrinkage of the steel in the different types of sections cannot be the same, nor is it the same in all portions of the section. The more massive portions of the section have more heat units to be dissipated than the thinner portions, recalescence occurs at different times and the shrinkage is unequal. Of course allowance is made for this, but it only can be a mere approximation. In the light and low sections it was not so important or difficult as it is in the heavier and higher sections now in use. A bar finishing 100 deg. lower than the usual run will not shrink as much and will be higher. For the same reason there is often a slight difference in height between the rail from the top of the ingot and the one from the bottom. When the rolls are first turned they are intended to be low, and as they wear and are dressed, the height increases. Most specifications allow a variation of $\frac{1}{32}$in. under and $\frac{1}{32}$in. over the standard height. This is too much for the standard of track now desired for the present speed and heavy rolling stock.

"When one looks at the rolls for a section and all the provisions which must be made for its rolling, one can readily see it is only by the great skill acquired by long experience, that as good work is produced as is generally turned out by the present system of rolling, being obliged to shape and form the section so largely by longitudinal flow of the metal."

DEAD WEIGHT POWER.

THERE are still persons extant who think that power can be got from weights, springs, and similar devices, and one of them recently wrote to the *American Machinist*, asking details of a machine for driving by weights. The reply is so well given and patiently worked out that we quote it for the benefit of persons who want similar information.

"A horse-power being 33,000 foot-pounds per minute, the total required for one horse-power for five hours would be 33,000 × 60 × 5 = 9,900,000 foot-pounds; and as this is the power to be realised, we must add, say, 10 per cent. to this for the friction of the apparatus; 9,900,000 + 990,000 = 10,890,000 foot-pounds, or, as more convenient, we will say 11,000,000 foot-pounds. If the weight is to be wound up to a height of 10ft., and to descend that distance when doing its driving, then, of course, only one-tenth of this weight will be required, or 1,000,000 lb., or 550 tons.

"For a weight for this purpose, there might be some discussion both as to shape and material. Our idea is that a spherical cast iron weight would be the neatest thing to use. It is like an obelisk for a cemetery; it requires no discussion except about the dimensions and cost. Now, as we must have 1,100,000 lb. of cast iron, and as one cubic inch of cast iron weighs, say, ·27 of a pound, our ball must contain 1,100,000 ÷ ·27 = 4,074,074 cubic inches. Then the diameter of the ball will be the cube root (4,074,074 × 0·5236) = 198in., or 16ft. 6in. This ball could be cast at any foundry where they do such work, and at two cents per pound it would cost 22,000 dols. We cannot say anything about the freight on the ball, as we do not know anything about how far it would require to be transported, and the railroad is not yet built that could carry it.

"Some persons might think that we might have allowed more vertical travel for the ball, and so have made it lighter; but we think not. Supposing the weight to stand on the ground, we would have, first the diameter of the ball 16ft. 6in., then about 2ft. of waste height for attaching the chain, 10ft. for the distance to rise and fall, and say, 5ft. to clear the circle of the drum, making 33ft. 6in. from the ground to the centre of the drum shaft.

"We could use a common link chain for suspending the weight, and it might be made by any blacksmith who would undertake the job. Twenty feet in length would probably be enough, and if we assume the iron to have a tensile strength of 40,000 lb. per square inch, this would call for 1,100,000 ÷ 40,000 = 27·5 square inches, which is about the area of a 6in. circle; so that we ought to use not less than 6in. round iron, the two sides to the link only giving a little factor of safety. The piece of chain would weigh about three tons, and, as blacksmithing goes, it probably could not be got for less than 5 c. per pound, which would be 300 dols. This is for the bare chain, and has nothing to do with the fastening of it either to the weight or to the drum, which would add considerable to the cost.

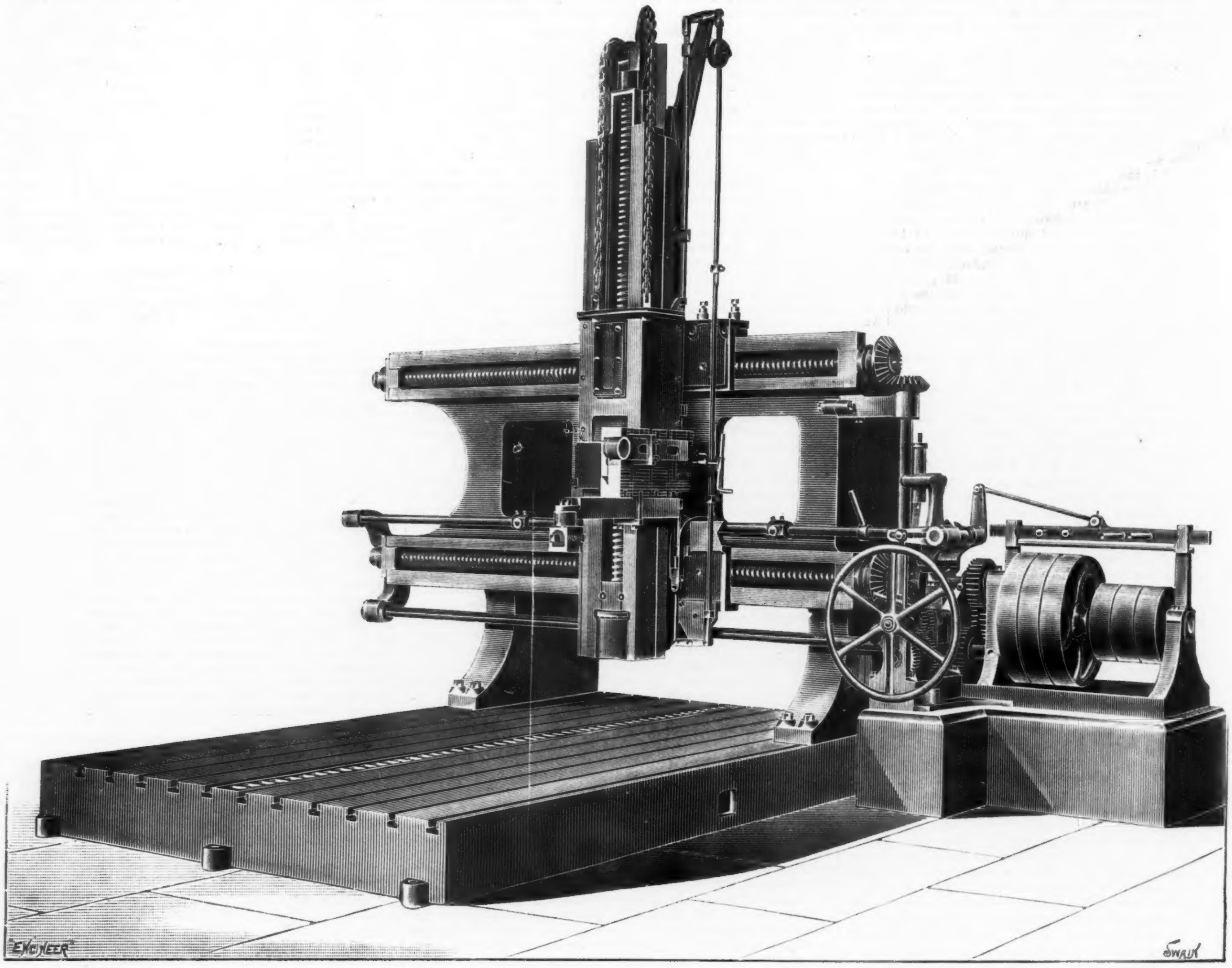
"We spoke of a drum, but there would, in fact, be no drum, but only a simple wheel of sufficient diameter to allow the necessary travel with a little less than one revolution, the end of the chain being fastened securely to the periphery. If the wheel were 4ft. in diameter it would be big enough.

"We would have, then, this wheel in the middle of a shaft, and two standards, say 17ft. apart, so that the weight would swing between them. The standards would, of course, be the bearings for the shaft, and the first driving gear would be on the end of the shaft, outside of one of the standards. The shaft journals should be about 30in. in diameter and 40in. long, the shaft, of course, being larger in the middle.

"Having brought the matter thus far along, we felt it our duty to leave it, as it is not proper for us to take the work from the competent mechanical engineer, who should be employed to complete the design and superintend the construction. Before going further with the case, it might be well to remember that three quarts of oil in an oil engine would furnish as much power as could be got from one descent of the weight which we have been figuring on. Possibly the oil arrangement might be the simpler and cheaper one."

HORIZONTAL AND VERTICAL PLANING MACHINE

MESSRS. THOMAS SHANKS AND CO., JOHNSTONE, N.B., ENGINEERS



HORIZONTAL AND VERTICAL PLANING MACHINE.

THE illustration above, from a photograph, shows a small horizontal and vertical planer of moderate dimensions, which has been designed and made for Messrs. W. H. Allen, Son, and Co., Bedford, to plane vertically 6ft., and horizontally 8ft. Although there is a clear space for work to pass under the slides, the tool is made to come down close to the base-plate, and this space is also utilised for a revolving table—not shown—to pass below, for obvious purposes.

By the use of a disengaging detail a quick return of 3 to 1 is secured. There are also other details for doing work quickly, which the illustration clearly shows, and which are the result of much experience in larger machines. The tool slide is prepared for Barrow's patent duplex tools. A similar machine to this is being made for the new firm of Messrs. McKie and Baxter, who are starting in Glasgow the manufacture of small marine engines, and another is in hand for a Greenock firm.

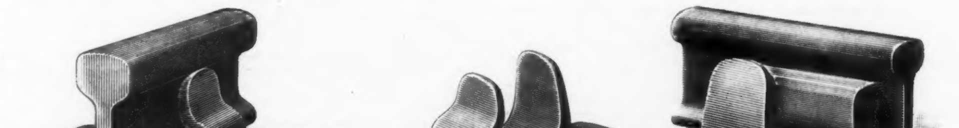
TRACTION ENGINES ON ROADS.

THE witnesses examined by the House of Commons Committee on Thursday, the 23rd ult., were Sir Charles Lennard, the chairman of the Kent County Council, Mr. Ruck, surveyor to the county of Kent, and Mr. W. B. Prosser, clerk to the same County Council. The first-named witness spoke of certain damage done in Kent to house property by vibrations set up by passing traction engines, and said he would not like to see the maximum limits of speed increased. He thought it desirable for the safety of the public that the drivers of road locomotives should be certificated. Mr. Ruck, in the course of his evidence, gave some interesting figures relating to the maintenance of roads in Kent, showing that when once the roads had been brought up to traction engine standard by strengthening the foundations, the expenditure in their upkeep was no larger, but rather less than when made to the lower standard necessary for ordinary traffic. The "extraordinary traffic" clause was the chief subject upon which Mr. Prosser was examined. He suggested to the Committee that cases of litigation under this clause should be heard by the county courts instead of by the justices, as at present, and that this clause ought to be amended to read "for whose benefit the traffic is conducted," instead of "to whose order the traffic is conducted."

On Monday last the first witness to give evidence was Mr. Wilmot, county surveyor to the Warwick County Council. This county has 465 miles of rural district roads, maintained at an annual expenditure of £60 per mile, and the bye-laws of the Council prohibit engines from travelling during "the early hours of the night." In granting licences in this county the licensee is required to undertake to make good all damage done to roads by his engines. Although it is open to question whether the above body has the power to make a condition of this kind, the witness considered that it had been the means of preventing damage to the roads by heavy locomotive traffic. It may be pointed out that in Warwickshire the net load carried by any one truck is restricted to 12 tons, but as much as 20 tons is sanctioned in the case of boiler haulage. Mr. Wilmot does not see any objection to the maximum limits of speed being increased to six and three miles instead of four and two miles as now.

Mr. Platt, A.M. Inst. C.E., Borough Surveyor of Rochdale, complained chiefly of the damage done to the roads in his district by the legalised wheels with cross-bars, and advocated the abolition of this restriction, so as to allow any approved form of wheel to be used. He would not consent to the power for making bye-laws being taken from local authorities and placed in the hands of a central authority, even though such a body were prepared to receive suggestions from the districts interested. Mr. Gadsby, Surveyor to the county borough of Derby, informed the Committee that their bye-laws prohibited the use of traction engines between the hours of 5 p.m. and 12 p.m., and in addition, between 9 a.m. and 5 p.m. upon certain busy streets. The licence fee per engine in Derby is £10, with a rebate of £5 in cases where engines have previously been licensed in neighbouring counties. He would resist the handing over of the power to make bye-laws to a central authority.

After hearing the evidence of Mr. Crear, City Surveyor of York, who appeared generally satisfied with the working of the laws governing the use of traction engines on roads, the Committee again adjourned until yesterday—Thursday—the proceedings of which will be reported in our next week's issue.



MUIRHEAD'S WROUGHT STEEL CHAIR

MUIRHEAD'S WROUGHT STEEL RAILWAY CHAIR.

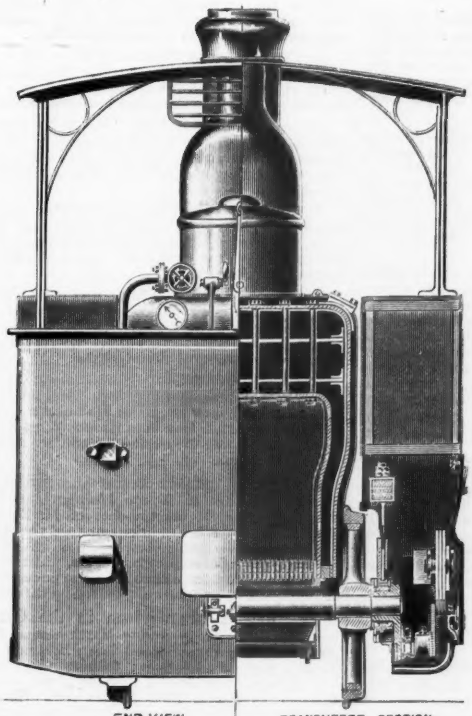
THE engraving above illustrates a forged steel railway chair, which is remarkable in its process of manufacture, and in the fact that the advantages of forged steel are secured at the price, it is claimed, of cast iron chairs. A rolled billet is by a special process split up from either end, the piece sheared, forged, and bent up at either end, one to form the straight, and the other the bent horn. The central part between the horns is forged to shape, the holes punched, and the chair is completed and has only about three-sevenths to half of the weight of the cast chair. They are not only stronger, but have the same or greater bearing surface than the cast iron chairs they replace, and, being identical in type, they take the same key and spike, and are thus interchangeable. Under very severe tests they have proved of remarkable strength, and, in fact, no tests were sufficient to break the chair even in the gullet, where ordinary chairs so readily give way. They are made in Glasgow under Muirhead's patents, and are shown in London by the agents, Messrs. John H. Austin and Co., 61, Gracechurch-street. Several miles have been in use for some time now on our leading railways.

LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—The forty-third anniversary festival of this Association was held on Saturday last at the Cannon-street Hotel, and was largely attended. Mr. John Wolfe Barry, C.B., F.R.S., Vice-President Inst. C.E., presided, and amongst the other gentlemen present were Mr. H. M. Stanley, M.P., Vice-Admiral the Hon. Sir E. R. Fremantle, the Hon. and Very Rev. Dean Fremantle, M.A., Mr. A. R. Binnie, M. Inst. C.E., Mr. A. T. Simpson, M. Inst. C.E., Mr. Jeremiah Head, M. Inst. C.E., Mr. E. W. Moir, M. Inst. C.E., and Mr. William Royal, the president. This society was formed in 1852 by a few foremen engineers, with the object of fostering congenial fellowship. With the gradual displacement of "rule of thumb" by scientific knowledge, however, the usefulness of the society was increased by the reading and discussion of papers on mechanical and other scientific subjects. Moreover, the Association is largely a philanthropic one, and has considerable funds accumulated for the assistance of unemployed members, the partial maintenance of members suffering from permanent infirmities, and widows and orphans. Considering the advantages to be derived from such an institution, therefore, it is not surprising that the London Association can lay claim to a membership exceeding 250. The festival on Saturday comprised a dinner and an excellent musical programme, and was much enjoyed, but the toast list was a very heavy one, and might with advantage have been curtailed. The remarks of one of the proposers of toasts, too, were not of a kind calculated either to further the original good object of the society or to bring credit upon such a time-honoured institution.

LOCOMOTIVES, BELGIAN LIGHT RAILWAYS

THE SOCIETE ST. LEONARD, LIEGE, ENGINEERS

(For description see page 440)



END VIEW TRANSVERSE SECTION

FIG. 38

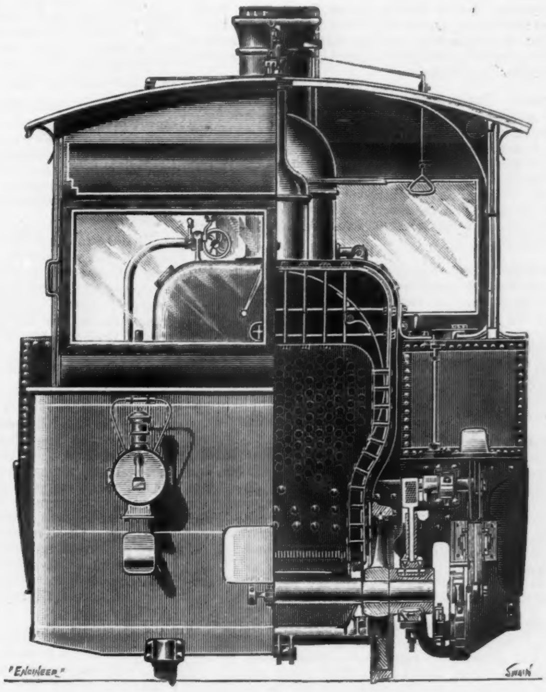

"ENGINEER"
SWAIN

FIG. 41

FIG 39.

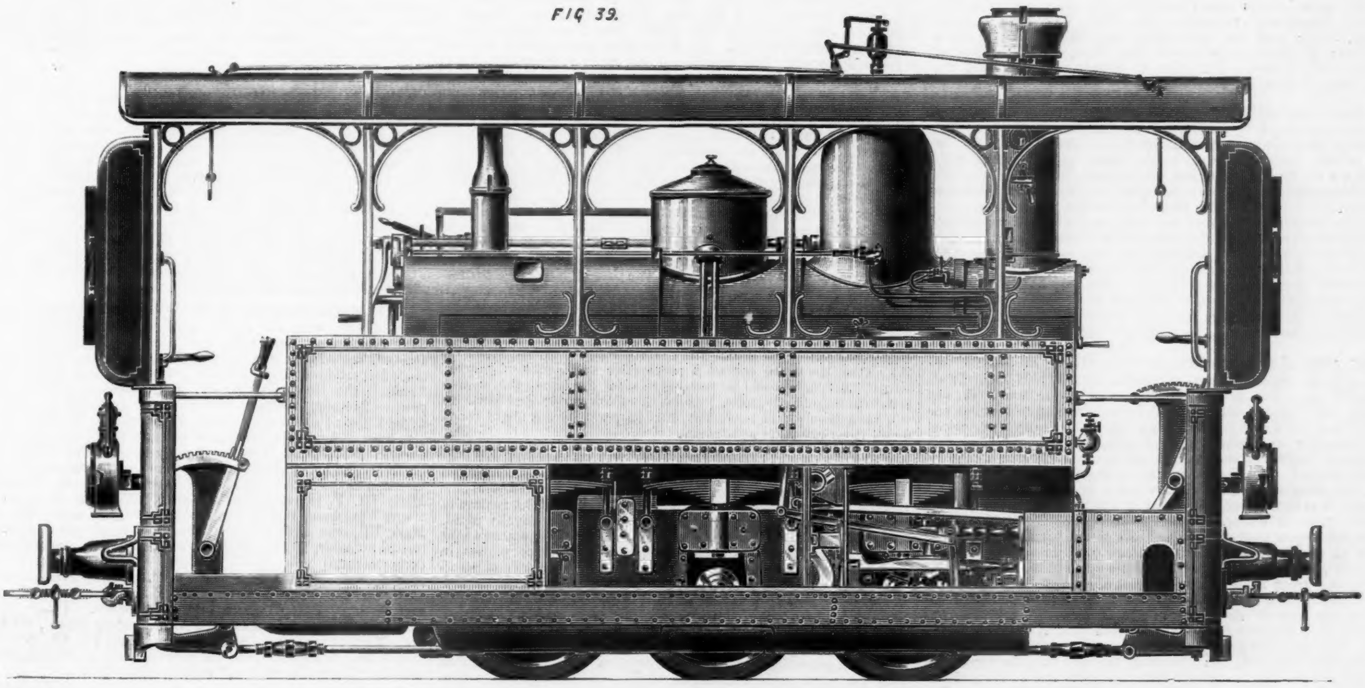
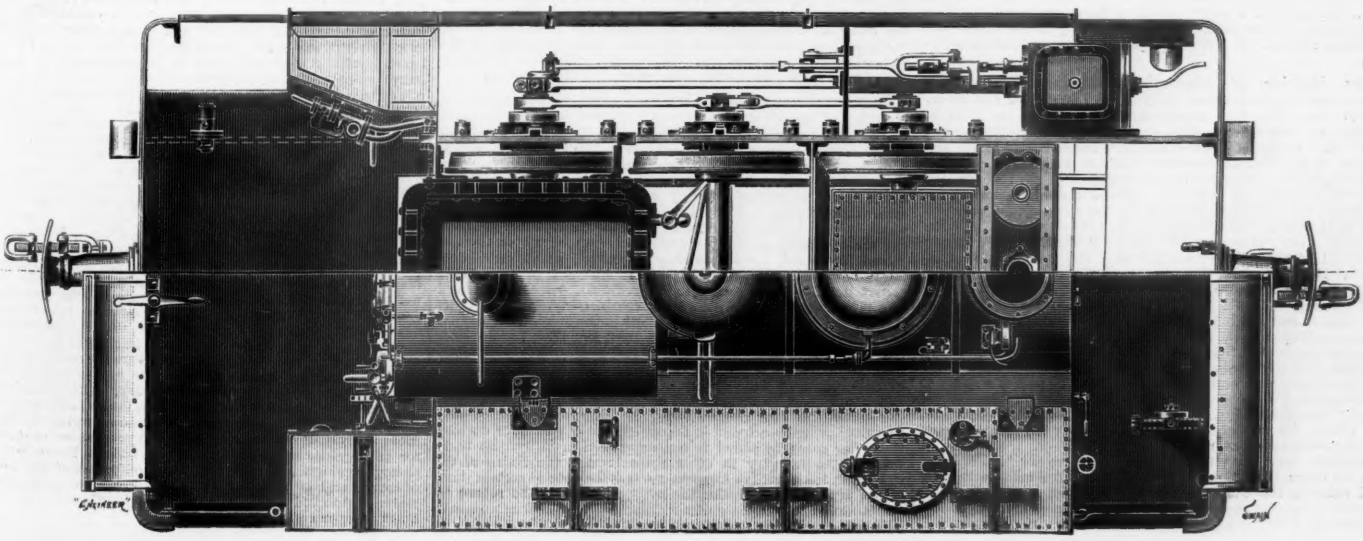


FIG. 40.


"ENGINEER"
SWAIN

RAILWAY MATTERS.

At the beginning of this year, 58 per cent of the Russian freight cars had had their capacity increased to 27,000 lb. Until recently, according to the *Railroad Gazette*, the standard was about 22,000.

The London, Chatham, and Dover Railway Company announces that it has arranged with the Hungarian State Railways for the issue of through return tickets from London to Budapest, at reduced fares, for visitors to the Exhibition at Budapest. The return tickets will be issued by express train services *viâ* Dover and Calais, Dover and Ostend, and Queenboro' and Flushing. The same Company also announce special arrangements for the conveyance of passengers to Berlin, for the Industrial Exhibition about to be opened there.

Recent reports state that the number of miles of new line opened in Russia in 1895—excluding the Siberian Railway—is 550 miles, and the total Russian mileage at the end of the year—excluding Asiatic Russia and Finland—was 21,366 miles, of which 4924 miles is double-track railroad. More than 2000 miles were taken into the State system in 1895, which has now 63½ per cent. of the whole. A great deal of railroad work was done last year on lines not yet open, and these and the lines whose construction was resolved upon that year amount to about 8230 miles—including the Siberian line.

A Brussels newspaper says that the Government has determined to unite the two great terminal stations in that city by six underground tracks, and to construct a central station and a girdle line around the city. Two of the underground lines are to to be worked by electricity, and the fare from all points on the girdle line and the underground roads to the Central on any other station is to be at the uniform rate of two cents. The cost is estimated at £2,800,000, and the capacity at 300,000 passengers daily. The actual traffic is estimated at 40,000,000 passengers yearly, the gross earnings at £160,000.

The gauges adopted by the Colonies of Australia can be seen at a glance by the following figures:—New South Wales, 4ft. 8½in.; Queensland, 3ft. 6in.; South Australia, 5ft. 3in. and 3ft. 6in.; Victoria, 5ft. 3in.; Western Australia, 3ft. 6in. The lines have been constructed generally by private firms, under the supervision of the Government engineers. In New South Wales and Victoria the lines are fenced throughout, but in the other Colonies they are only partially fenced. The "Pioneer Lines," Narrabri to Moree, 63 miles; Parkes to Condobolin, 60½ miles; and Jerilderie to Berrigan, 23 miles, which are now under construction in New South Wales, will not be fenced.

The following figures show the estimated populations in June, 1895, of the various Colonies of Australia, the miles of railway open, and the population per mile:—New South Wales: Population, December 31st, 1894, 1,250,450; miles of railway, 2615, inclusive of 84 miles of private railways; and the population per mile, 479. Queensland: Population, December 31st, 1894, 445,155; miles of railway, 2379; and the population per mile, 187. South Australia: Population, December 31st, 1894, 352,402; miles of railway, 1738½, inclusive of Palmerston line, 145½ miles (N.T), and 16½ miles private lines; and the population per mile, 203. Victoria: Population, December 31st, 1894, 1,179,109; miles of railway, 3120; and the population per mile, 378. Western Australia: Population, December 31st, 1894, 82,072; miles of railway, 1145, inclusive 572 miles of private railways; and the population per mile, 73.

A law compelling railways to carry bicycles in baggage cars free was passed by the New York Legislature on April 8th. Section 37 of the railway law, fixing the maximum limits for the rates of fare on the railways of the State, says that the rates named are for "a passenger and his baggage," and sec. 44, c. 565, prescribing the regulations for checking baggage when taken for transportation, now has the following paragraph added to it:—"Bicycles are hereby declared to be and shall be deemed baggage for the purpose of this article, and shall be transported as baggage for passengers by railway corporations, and subject to the same liabilities; and no such passenger shall be required to crate, cover, or otherwise protect any such bicycle; provided, however, that a railway corporation shall not be required to transport, under the provisions of this Act, more than one bicycle for a single person." The Bill was passed in the Assembly by a vote of 127 to 1.

The cost of construction per mile of line in Japan, according to the report for the year ending March, 1894, varied considerably according to the circumstances under which it was carried out. That of the Tokyo-Yokohama section of 18 miles was 162,741 yen per mile; but this being the first railway undertaken in the country was necessarily expensive, as it was superintended by foreign engineers and carried out to a considerable extent by foreign labour. The same was true, although to a less degree, of the Koke Otsa section, which was begun in November, 1870, and completed in September, 1879, and of which the cost per mile was 142,659 yen—or dollar. Probably the Yokohama Oguki section, which was began August, 1885, and completed April, 1889, may be taken as representing the best average conditions. Its length is 258 miles, and its average cost per mile was 52,156 yen. As indicating the great reduction in the cost of construction, the report shows that before the nineteenth fiscal year the amount of fixed capital per mile of line open in the Government railways was 104,697 yen, whereas in the twenty-sixth year it was only 64,671 yen. The decrease arose not only from the cheaper method of construction adopted, but also from the fact that the services of foreigners were almost entirely dispensed with, and native material and manufacturers employed as much as possible. The proportion of working expenses to the revenue is 36 per cent., and when compared with that of the previous year shows a decrease of 11 per cent., obtained from a large increase in the earnings, and decrease in the expenses incurred in operation, especially in the locomotive expenses, and the low price of coal which prevailed during the year.

The interior of Australia is without important river courses, the rivers that do exist are too shallow and uncertain to allow of perfect dependence being placed on them at all times, and the railways must come in to give a continuous and trustworthy means of communication between inland plains and the sea coast. This explains the continual demand for new lines of railway as the only means of internal development; and though it would be distinctly unwise to attempt to diminish any of the safeguards that have been adopted for the prevention of expenditure upon commercially hopeless lines, a too close scrutiny of the immediate ability of new routes to be made remunerative—bearing in mind that the railways are not only the main arteries of industrial communication, but the real pioneers of settlement, developing the immense resources of inland Australia wherever they trend—should not be allowed to weigh too heavily against their construction. A reliable, ready, and not too expensive means of communication with the seaboard is as necessary to the settler and producer as even the land itself. It can be seen by a reference to maps that the needs of the population in respect of railway accommodation have been, on the whole, as well met as a policy of encouragement to the development of the natural resources of the country, coupled with a due regard to economical considerations, will allow. By way of showing comparatively the progress made by the railways—Government and private—in the whole of Australasia, it may be remarked that here there are 31·5 miles of line for every 10,000 inhabitants, as against 3·9 miles in Europe, 26·7 miles in the United States, and 31 miles in Canada. The number of miles open for each 100 square miles of territory are:—Australasia, 0·40; Europe, 3·8; United States, 5·9; Canada, 0·5.

NOTES AND MEMORANDA.

In a paper in the *Comptes Rendus* on "Fallow Ground," by M. P. P. Dehérain, the ancient practice of allowing land to lie a year fallow after three years' cultivation is shown to have rested upon a sound basis, the land increasing considerably in nitric nitrogen during the fallow year. With modern manures the necessity for this no longer exists, although the practice still survives in many parts of Europe.

At a recent meeting of the Berlin Physical Society, Dr. Lindau, of Munich, spoke on the cooling of gases during their adiabatic expansion, and showed that from this the specific heat of the gases may be determined. In opposition to this view Professor Planck pointed out that the cooling does not depend solely on specific heat, but also on the extent to which the gas differs from the condition of a perfect gas.

According to a recent paper in the *Comptus Rendus* on the products of combustion of an acetylene burner, and explosive mixtures of acetylene and air, by M. N. Gréhant, the combustion of acetylene in an ordinary fish-tail burner is complete, the products not comprising the least trace of a combustible gas containing carbon. With mixtures of acetylene and air the most violent explosion was produced when the volume of air was nine times that of the acetylene.

The tendency in America, where boilers are so much used of the water-tube type, is to use water separators of large size, which serve as reserves of steam close to the engine. The *Electrical Review* says, the United Electric Light and Power Company, of New York City, have recently applied four Stratton separators to their 1200-horse power of Westinghouse engines, and report that the pressure variation as between the engine and boilers scarcely varies, and the pulsation in the steam pipes is practically stopped, as proved by the practical abolition of all vibration.

The annual report to the City Corporation by Mr. A. J. Street, the chief inspector of weights and measures, shows that last year the inspectors visited 5371 places of business and examined 24,646 weights, 29,436 measures, and 6689 weighing instruments, as against 4074 places of business, 25,635 weights, 37,591 measures, and 5754 weighing instruments in 1894. The seizures last year were 23 weights, two measures, and three instruments, while some others in each category required adjustment or stamping. Of 30 cases reported to the City Solicitor, 19 persons were proceeded against, of whom 16 were convicted. The indoor work of the department included the verification of 293,785 weights, measures, and instruments, of which 257,308 were certified and stamped and 36,477 rejected. The fees for stamping amounted to £1312.

It has occurred to many people that perhaps celluloid might be useful as an insulator for electric cables, and in a letter to *Nature* on buried celluloid Professor George Forbes says:—"I feared it might deteriorate. I have made an experiment of 4½ years' duration which may be of use in connection with the subject. On August 15th, 1891, I took four photographic quarter-plate celluloid plates, with the gelatine removed, and treated them as follows: No. 1 was nailed to an outhouse, and became rotten in a year; No. 2 was 1ft. deep in garden soil; No. 3, 1ft. deep in gravel; No. 4, 1ft. deep in a rubbish heap. The last three were dug up on April 6th, 1896. Nos. 2 and 4 were in as perfect a condition as ever. No. 3 has some sand rubbed in, but is perfectly sound. The experiment was made at Pitlochry, N.B. The specimens can be seen at my office."

The rock salt mine at Friedrichshall, Würtemberg, which has been actively worked for the last thirty-five years, and where an inburst of water lately occurred, would soon have required a new shaft for ventilation and ensuring safety to the hands. The water burst in at the roof of the oldest part of the mine, to the north of the shaft, adjoining a rock wall for protecting that portion; and there is little doubt—observed Dr. Von Baur to the Verein Deutscher Ingénieure—that some of the older pillars that had become weakened in course of time gave way, which caused the falling in of the roof. Thereupon the water from the strata above, which had given great trouble while the shaft was being sunk, poured into the mine at the rate of 1000 cubic metres—220,096 gallons per hour. The accident happened on a Sunday at ten minutes past six in the morning, when there was no one in the mine, but the neighbouring inhabitants were startled by a heavy shock like that of an earthquake that was felt in Mannheim, Wimpffen, and a whole series of more distant localities, while on the surface the shock caused a perceptible subsidence of hopper form. Though it would be possible to clear the mine, this course is not considered advisable, because the fresh water that burst in will have dissolved so much salt, that its pumping out might cause a still more extensive subsidence.

Some results of recent investigations on earthquake pulsations are described by Prof. G. Vicentini. The instrument employed is the microseismograph designed by himself (*Nature*, vol. li.) and now erected in the Universities of Siena and Padua. The motion of the paper on which the pulsations are recorded is unusually rapid, and this has allowed a detailed examination of their nature to be made. Prof. Vicentini distinguishes, as a rule, three phases in each disturbance. The first consists of rapid vibrations and small oscillations; the second of large, and more or less irregular oscillations, with several maxima which begin and end abruptly; in the third phase the pulsations become more regular, and are longer in period. Throughout nearly the whole movement, but especially during the last two phases, the mean position of the pendulum generally undergoes a continuous change, showing that with the more rapid oscillations there coexist long, slow waves with a period of at least twenty seconds, which result in a gentle tilting of the surface of the ground. If the earthquake is a severe one, and the origin at a great distance from the place of observation, the three phases are separated from one another. But, as the distance of the epicentre diminishes, the first two phases partly coalesce, and the rapid vibrations are superposed on the earlier long-period oscillations. When the earthquakes are weak and of local origin, the tilting of the ground is still observed.

The measures proposed by the Italian Government for the relief of the sulphur industry of Sicily lend interest to a report by the United States Consul at Catania on the present condition of the Sicilian sulphur mines and miners. The industry is now in a deplorable state owing to over-production and low prices. The Consul does not see how the production can be reduced; for the mines must be worked, if only to keep out the water, which accumulates rapidly and would soon ruin them. The proposition which appears to have found favour with the Government has been the establishment at the ports of warehouses, where certificates should be issued for the sulphur deposited, which certificates might be discounted by the banks. In addition, a reduction of export duty, which amounts to about 8s. 6d. per ton, is asked. The price of sulphur has fluctuated considerably, that for "best thirds unmixed" having been as follows in the respective years per ton:—1876, 120 lire; 1879, 97·41; 1884, 89; 1886, 76·20; 1891, 115·59; 1895, 55 lire. The wages of the miners have necessarily gone down with the prices, so that now they have fallen to 3½d., 4d., and at most 5d. per day. For many years the quantities mined have largely exceeded those exported, and in 1894 and 1895 the excess was over 300,000 tons. The report of great sulphur deposits having been found in Louisiana, and of plants for working them, has naturally added to the depression in Sicily. So backward is the industry in other respects that the fusing of the sulphur in the primitive furnaces can only be done at certain times of the year, after harvesting the crops, which would be ruined by the fumes. The modern works at Catania can, of course, remain in operation all the year round.

MISCELLANEA.

The Bath and West and Southern Counties Society's St. Albans show at St. Albans, will commence on Wednesday, May 27.

Messrs. Thornycroft and Co. have received orders from the Admiralty for three 30-knot and one 32-knot torpedo catchers.

Large petroleum deposits have been discovered near Conil in the province of Cadiz. The territory was recently inspected by the chief engineer of the province, and English engineers were engaged to commence drilling.

A further series of trials is to be made with the automatic boiler feed, recently fitted to the torpedo-boat destroyer Lynx, at Devonport. The *Naval and Military Record* says that the new gear fitted in this vessel has not so far proved satisfactory.

An interesting article on "English Coins," by Mr. G. F. Hill, M.A., the first of a series, appears in the May number of *Knowledge*, accompanied by photographic reproductions of about forty coins, dating from 180 B.C. Other articles fill a very interesting number.

The model of the twin-screw armoured barbette battleship Fuji, built by the Thames Ironworks and Shipbuilding Company, the latest addition to the Imperial Japanese Navy, has been lent for a short time to the museum of the Royal United Service Institution, Whitehall.

The Blackwall tunnelling operations have now reached the No. 1 shaft, and in the course of a few weeks the shield will be got on to the last lap. On Whitsun Monday the public will be admitted to the tunnel at a small charge, and the receipts are to be handed over to some of the hospitals.

Stability in warship construction is apparently now receiving more consideration from the French naval authorities than it has in the past, as we read that the trials of the cruiser Descartes at Brest have been postponed, on the ground that the hull does not attain the requisite conditions of stability, therefore cannot yet be accepted.

A new blast furnace on the American system, designed for a daily out-turn of 200 tons, has been blown in at the Cockerill Works, Seraing, in the presence of M. Nyssens, the Belgian Minister of Works. This brings up to six the number of furnaces owned by the Cockerill Company, the blast for each of which is supplied by a separate blowing engine, while the pumps for all the furnaces require a force of 25,000-horse power, steam being raised in twenty-six water-tube boilers, fired by the furnace gases.

The output of pig iron in the German Empire—including Luxemburg—during March was as follows:—Puddling pigs and spiegel iron, 159,002 tons; Bessemer pigs, 46,013 tons; Thomas pigs, 281,465 tons; foundry pigs, 64,677 tons; total, 551,157 tons. The total in February, 1896, was 496,170 tons, and the total in March, 1895, 481,144 tons. The total during the quarter ended March 31st was 1,560,355 tons, against 1,405,423 tons, representing an increase as compared with last year of 70,013 tons, or 14·55 per cent. on the month, and of 154,932 tons or 11·02 per cent. on the quarter.

The Russian Government have just accepted a group of armour plates from the Carnegie Company, after a very satisfactory trial at the Indian Head Proving Ground. According to the *Army and Navy Gazette*, the armour was manufactured under a contract for 1100 tons made some months ago. Of the total bulk 350 tons are of 5in. thickness, 350 tons of 10in. and 400 tons of 14in. The trial plate, which was attached to a 36in. oak backing, was manufactured under the double forging process. Squares of twelve square feet were marked off on it, and six shots, five of 4in. diameter, weighing 33 lb. each, and one of 5in., weighing 600 lb., were delivered, each in one of these squares. The first shot struck the plate with a velocity of 1740ft. per second, the second with 1660ft., the third with 1690ft., and the fourth with 1760ft. All of the shells smashed on the face of the plate, after making a penetration of only a couple of inches. The fourth shot produced a crack in one corner, which was widened by the fifth shot, delivered at a velocity of 1760ft. per second. The sixth shot, of 5in. diameter, fired with a velocity of 1705ft. per second, although delivered some distance from the crack, produced a vibration which caused a fragment to break off.

The annual accounts of the Ordnance Factories for the year 1894-95, with the report of the Comptroller and Auditor-General thereon, have just been issued as a Blue Book. The accounts include those of the Ordnance Factories, the Royal Carriage Department, Royal Arsenal; the Royal Gun Factory, Royal Arsenal; the Royal Laboratory, Royal Arsenal; the Royal Gunpowder Factory, Waltham Abbey; the Royal Small Arms Factory, Enfield Lock; the Royal Small Arms Factory, Birmingham, &c. The total cost of work performed was £2,231,421 10s. 5½d. Of this amount £937,423 6s. 11½d. was for the army, £1,153,840 1s. 4d. for the Navy, and £140,158 2s. 2d. for India. The cost of guns manufactured in the Royal Gun Factory is set out in detail. One 13·5in., Mark III. F. (without sights) cost £10,255 18s. 7d.; two 12in. "wire" (without sights) cost £14,348 19s. 2d. each; three 6in., Mark VI., cost £999 18s. 9d.; one 6in. jointed cost £1637 4s. 2d.; one 30-pounder, 20 cwt., Mark I., cost £460 14s.; one 8in. howitzer (experimental) cost £1365 5s. 7d.; one 6in. howitzer (experimental) cost £761 16s. 9d.; one 5·4in. howitzer (experimental) cost £687 5s. 4d. The foregoing are B.L., complete with sights and fittings, except where otherwise stated. Under heading, "Ordnance, Q.F., complete," appear, among others, thirty-nine 6in., Mark II. (without sights), costing £1431 16s. 6d. each; sixty-two 4·7in., Mark IV. (without sights), costing £656 6s. 9d.; and one 4in. 25-pounder "wire," costing £1417 6s. 9d.

The Babcock and Wilcox Company have recently received an order for six of their marine type of water-tube boilers from owners who have already had experience of the boiler in actual working on board their ships over a considerable period. Boilers of the Babcock type have now been in use on board ship for over six years, and there are indications that their adoption on board merchant ships will soon be largely extended. The company's present business premises, forming a portion of the great pile of buildings of the Singer Manufacturing Company at Kilbowie, near Clydebank, having proved too small for its operations in turning out boilers for land and marine purposes with the despatch required, the Babcock Company is about to transfer its works to greatly enlarged premises on the other side of the Clyde, at Porterfield, near Renfrew. These are on the site of, and to some extent the same premises erected several years ago for the purpose of steel manufacture by the Renfrewshire Steel Company, but never properly set agoing in that capacity. The Babcock Company having some time ago purchased them, have since been busily adding to and re-arranging the works for the purposes of boiler manufacture. Entirely new plant has been laid down, and the company hope to have operations fully set agoing in the new works by the end of the present summer. One branch of the manufacture, which has hitherto been done by sub-contract, will now be overtaken at the enlarged works, viz., the manufacture of the drums, which form so important a feature in the make-up of water-tube boilers. For a number of years the company have had to requisition the services of some four or five firms in Glasgow and neighbourhood to undertake this work. The vertical connecting boxes or "headers," and other items in the building up of complete boilers, will be manufactured by new forging machinery of great interest, as also the machining and preparation of these items for taking their several places in the boiler. The tubing, which so largely enters into the construction of boilers of this type, will, of course, still be supplied by outside firms, the quantity of such material absorbed by the company being little short of a million lineal feet per annum.

PARTICULARS OF THE LOCOMOTIVES ON BELGIAN LIGHT RAILWAYS

LOCOMOTIVES.	A.	B.	C.	D.	E.	F.	G.	H.	I.	CA.
Principal dimensions and weights	12$\frac{1}{2}$ tons	14 tons	15$\frac{1}{2}$ tons	18 tons	22 tons	23 tons	23 tons	24 tons	24 tons	15$\frac{1}{2}$ tons
Boiler—										
Inside diameter of barrel	2ft. 11$\frac{1}{4}$in.	2ft. 11$\frac{1}{2}$in.	3ft. 4$\frac{9}{16}$in.	3ft. 4$\frac{9}{16}$in.	3ft. 4$\frac{9}{16}$in.	3ft. 9$\frac{1}{4}$in.—3ft. 8$\frac{5}{16}$in.	3ft. 7$\frac{3}{8}$in.—3ft. 8$\frac{5}{16}$in.	3ft. 11$\frac{1}{4}$in.	3ft. 9$\frac{1}{4}$in.	3ft. 5$\frac{5}{16}$in.
Length of barrel	4ft. 4$\frac{9}{16}$in.	4ft. 4$\frac{3}{8}$in.	5ft. 3$\frac{1}{2}$in.	5ft. 8$\frac{11}{16}$in.	5ft. 8$\frac{3}{4}$in.	8ft. $\frac{3}{4}$in.	8ft. $\frac{3}{4}$in.	6ft. 1$\frac{3}{8}$in.	6ft. 6$\frac{23}{32}$in.	5ft. 3$\frac{5}{8}$in.
Thickness of plates	$\frac{1}{2}$in.	$\frac{1}{2}$in.	$\frac{1}{2}$in.	$\frac{1}{2}$in.	$\frac{1}{2}$in.	$\frac{7}{16}$in.	$\frac{7}{16}$in.	$\frac{5}{8}$in.	$\frac{9}{16}$in.	$\frac{15}{32}$in.
Height of centre line of boiler from top of rail	4ft. 1$\frac{3}{8}$in.	4ft. 1$\frac{7}{16}$in.	4ft. 7$\frac{5}{16}$in.	4ft. 11$\frac{13}{16}$in.	6ft. 1$\frac{13}{16}$in.	6ft. 1in.	5ft. 8$\frac{5}{16}$in.	5ft. 3$\frac{3}{8}$in.	6ft. 1$\frac{3}{16}$in.	4ft. 7$\frac{5}{16}$in.
Total boiler capacity	53 cu. ft.	42·38 cu. ft.	63·57 cu. ft.	67·10 cu. ft.	69·93 cu. ft.	102·42 cu. ft.	102·42 cu. ft.	109·48 cu. ft.	93·59 cu. ft.	63·57 cu. ft.
Water volume, with 4in. above crown of fire-box	33·55 cu. ft.	24·45 cu. ft.	35·32 cu. ft.	38·85 cu. ft.	40·97 cu. ft.	65·33 cu. ft.	65·33 cu. ft.	59·51 cu. ft.	60·04 cu. ft.	35·32 cu. ft.
Volume of steam space	19·42 cu. ft.	19·42 cu. ft.	28·25 cu. ft.	28·25 cu. ft.	28·96 cu. ft.	37·08 cu. ft.	37·08 cu. ft.	49·97 cu. ft.	33·55 cu. ft.	28·25 cu. ft.
Total length of boiler	9ft. 5in.	9ft. 5in.	10ft. 4$\frac{7}{8}$in.	11ft. 6$\frac{3}{8}$in.	12ft. $\frac{13}{16}$in.	14ft. 3$\frac{3}{16}$in.	14ft. 3$\frac{3}{16}$in.	13ft. 3$\frac{1}{8}$in.	12ft. 11$\frac{7}{16}$in.	10ft. 4$\frac{15}{16}$in.
Certified pressure, in atmospheres	12	12	10	12	12	10	10	12	12	10
Grate—										
Length of grate	3ft. $\frac{3}{16}$in.	3ft. $\frac{1}{4}$in.	3ft. 4$\frac{7}{16}$in.	3ft. 7$\frac{7}{8}$in.	3ft. 9$\frac{5}{8}$in.	3ft. 8$\frac{1}{2}$in.	3ft. 8$\frac{1}{2}$in.	4ft. 5$\frac{7}{16}$in.	3ft. 10$\frac{11}{16}$in.	3ft. 4$\frac{7}{16}$in.
Width of grate	2ft. 3$\frac{9}{16}$in.	2ft. 3$\frac{9}{16}$in.	2ft. 3$\frac{5}{8}$in.	2ft. 3$\frac{5}{8}$in.	3ft. $\frac{7}{8}$in.	3ft. 4$\frac{5}{8}$in.	3ft. 4$\frac{5}{8}$in.	2ft. 3$\frac{9}{16}$in.	3ft. 6$\frac{1}{2}$in.	2ft. 3$\frac{11}{16}$in.
Surface of grate	6·92 sq. ft.	6·87 sq. ft.	7·78 sq. ft.	8·42 sq. ft.	11·70 sq. ft.	12·55 sq. ft.	12·55 sq. ft.	10·19 sq. ft.	13·73 sq. ft.	7·78 sq. ft.
Fire-box—										
Height of crown above grate	2ft. 8$\frac{5}{8}$in.	2ft. 9$\frac{7}{16}$in.	3ft. 3$\frac{3}{8}$in.	3ft. 10$\frac{1}{16}$in.	3ft. 2in.	3ft. 3in.	3ft. 3in.	3ft. 6in.	3ft. 2$\frac{9}{16}$in.	3ft. 3$\frac{3}{8}$in.
Thickness of side plates of fire-box	$\frac{1}{2}$in.	$\frac{1}{2}$in.	$\frac{1}{2}$in.	$\frac{9}{16}$in.	$\frac{9}{16}$in.	$\frac{7}{16}$in.	$\frac{7}{16}$in.	$\frac{9}{16}$in.	$\frac{9}{16}$in.	$\frac{1}{2}$in.
Thickness of back plates of fire-box	$\frac{1}{2}$in.	$\frac{1}{2}$in.	$\frac{1}{2}$in.	$\frac{9}{16}$in.	$\frac{9}{16}$in.	$\frac{7}{16}$in.	$\frac{7}{16}$in.	$\frac{9}{16}$in.	$\frac{9}{16}$in.	$\frac{1}{2}$in.
Thickness of tube plate of fire-box	$\frac{15}{16}$in.	$\frac{15}{16}$in.	$\frac{7}{8}$in.	$\frac{13}{16}$in.	$\frac{15}{16}$in.	$\frac{13}{16}$in.	$\frac{13}{16}$in.	$\frac{15}{16}$in.	1$\frac{1}{16}$in.	$\frac{5}{8}$in.
Tubes—										
Number, inclined	103	103	160	160	162	141	141	191	194	inclined 160
Interior diameter	1$\frac{3}{8}$in.	1$\frac{3}{8}$in.	1$\frac{3}{8}$in.	1$\frac{3}{8}$in.	1$\frac{3}{8}$in.	1$\frac{9}{16}$in.	1$\frac{9}{16}$in.	1$\frac{3}{8}$in.	1$\frac{3}{8}$in.	1$\frac{3}{8}$in.
Thickness	$\frac{5}{64}$in.	$\frac{5}{64}$in.	$\frac{5}{64}$in.	$\frac{5}{64}$in.	$\frac{5}{64}$in.	$\frac{5}{64}$in.	$\frac{5}{64}$in.	$\frac{5}{64}$in.	$\frac{5}{64}$in.	$\frac{5}{64}$in.
Length between tube plates	4ft. 6$\frac{11}{16}$in.	4ft. 6$\frac{11}{16}$in.	5ft. 2$\frac{3}{16}$in.	5ft. 7$\frac{5}{16}$in.	5ft. 10$\frac{7}{8}$in.	8ft. $\frac{3}{8}$in.	8ft. $\frac{3}{8}$in.	6ft. 6$\frac{11}{16}$in.	6ft. 6$\frac{11}{16}$in.	4ft. 6$\frac{11}{16}$in.
Total length	4ft. 8$\frac{3}{4}$in.	4ft. 8$\frac{3}{4}$in.	5ft. 4$\frac{3}{16}$in.	5ft. 9$\frac{1}{2}$in.	6ft. 1in.	8ft. 2$\frac{1}{4}$in.	8ft. 2$\frac{1}{4}$in.	6ft. 8$\frac{13}{16}$in.	6ft. 9in.	4ft. 8$\frac{11}{16}$in.
Thickness of front tube plate, iron	$\frac{3}{4}$in.	$\frac{3}{4}$in.	$\frac{3}{4}$in.	$\frac{7}{8}$in.	$\frac{13}{16}$in.	$\frac{11}{16}$in.	$\frac{11}{16}$in.	$\frac{7}{8}$in.	$\frac{15}{16}$in.	$\frac{3}{4}$in.
Safety valves—										
Diameter	2$\frac{5}{16}$in.	2$\frac{5}{16}$in.	2$\frac{29}{64}$in.	2$\frac{29}{64}$in.	2$\frac{29}{64}$in.	3$\frac{1}{8}$in.	2$\frac{9}{16}$in.	2$\frac{13}{16}$in.	2$\frac{9}{16}$in.	2$\frac{5}{16}$in.
Number, on top of dome	2	2	2	2	2	2	2	2	2	2
System	Lever with balance	Lever with balance	Wilson	Wilson	Wilson	With balance on dome	Wilson	With balance and direct-action	Wilson	With balance and direct-action
Chimney—										
Internal diameter	11$\frac{3}{16}$in.	11$\frac{3}{16}$in.	11$\frac{3}{16}$in.	13in.	13in.—15in.	13$\frac{3}{4}$in.—16$\frac{1}{8}$in.	13$\frac{3}{4}$in.—16$\frac{1}{8}$in.	13in.	13$\frac{3}{8}$in.—16$\frac{1}{8}$in.	11$\frac{3}{16}$in.
Height from level of rail	9ft. 11$\frac{7}{8}$in.	10ft. $\frac{13}{16}$in.	10ft. 6in.	10ft. 8$\frac{3}{4}$in.	10ft. 9in.	10ft. 4in.	10ft. 11$\frac{1}{4}$in.	12ft.	11ft. 5$\frac{3}{4}$in.	10ft. $\frac{3}{8}$in.
Heating surface—										
Fire-box	33·35 sq. ft.	32·71 sq. ft.	43·04 sq. ft.	46·91 sq. ft.	49·17 sq. ft.	52·72 sq. ft.	52·72 sq. ft.	60·47 sq. ft.	56·49 sq. ft.	43·04 sq. ft.
Tubes	169·15 sq. ft.	167·42 sq. ft.	300 sq. ft.	322·80 sq. ft.	345·08 sq. ft.	467·52 sq. ft.	467·52 sq. ft.	452·13 sq. ft.	471·82 sq. ft.	263·19 sq. ft.
Total	202·50 sq. ft.	200·13 sq. ft.	342·16 sq. ft.	369·71 sq. ft.	394·25 sq. ft.	520·24 sq. ft.	520·24 sq. ft.	512·60 sq. ft.	528·31 sq. ft.	306·23 sq. ft.
Frames—										
Distance from side frame to side frame	4ft. 1$\frac{11}{16}$in.	4ft. 1$\frac{11}{16}$in.	4ft. 1$\frac{3}{16}$in.	3ft. 10$\frac{5}{8}$in.	3ft. 11$\frac{5}{8}$in.	5ft. 4$\frac{5}{8}$in.	4ft. 1$\frac{3}{8}$in.	3ft. 10$\frac{7}{8}$in.	4ft. 2in.	4ft. 1$\frac{3}{8}$in.
Thickness of side frame	$\frac{5}{8}$in.	$\frac{5}{8}$in.	$\frac{3}{4}$in.	$\frac{13}{16}$in.	$\frac{13}{16}$in.	$\frac{13}{16}$in.	1$\frac{1}{16}$in.	1in.	[illegible]	[illegible]
Length from end to end of frame	15ft. 3in.	15ft. 3$\frac{1}{16}$in.	17ft. 2$\frac{5}{8}$in.	17ft. 8$\frac{9}{16}$in.	17ft. 10$\frac{1}{2}$in.	20ft. 8in.	20ft. 8in.	20ft. $\frac{1}{8}$in.	18ft. 8$\frac{3}{8}$in.	17ft. 2$\frac{5}{8}$in.

Frames—										
Distance from side frame to side frame	4ft. 1$\frac{1}{4}$in.	4ft. 1$\frac{1}{4}$in.	4ft. 1$\frac{3}{4}$in.	3ft. 10$\frac{3}{4}$in.	3ft. 11$\frac{3}{4}$in.	5ft. 4$\frac{3}{4}$in.	4ft. 1$\frac{3}{4}$in.	3ft. 10$\frac{3}{4}$in.	4ft. 2in.	4ft. 1$\frac{3}{4}$in.
Thickness of side frame	$\frac{5}{8}$in.	$\frac{5}{8}$in.	$\frac{3}{4}$in.	$\frac{11}{16}$in.	$\frac{13}{16}$in.	$\frac{13}{16}$in.	1$\frac{3}{16}$in.	$\frac{3}{4}$in.	$\frac{13}{16}$in.	[illegible]
Length from end to end of frame	15ft. 3in.	15ft. 3$\frac{1}{16}$in.	17ft. 2$\frac{5}{8}$in.	17ft. 8$\frac{9}{16}$in.	17ft. 10$\frac{1}{2}$in.	20ft. 8in.	20ft. 8in.	20ft. $\frac{1}{8}$in.	18ft. 8$\frac{3}{8}$in.	17ft. 2$\frac{5}{8}$in.
Length from end to end of buffer	18ft. 3$\frac{15}{16}$in.	18ft. 3$\frac{15}{16}$in.	20ft. 4$\frac{1}{8}$in.	20ft. 11$\frac{9}{16}$in.	20ft. 11$\frac{3}{4}$in.	23ft. 10$\frac{9}{16}$in.	23ft. 10$\frac{9}{16}$in.	23ft. 1$\frac{1}{2}$in.	20ft. 11$\frac{13}{16}$in—21ft. 6in.	20ft. 3$\frac{1}{2}$in.
Total width	6ft. 9$\frac{9}{16}$in.	6ft. 9$\frac{9}{16}$in.	8ft. 1$\frac{15}{16}$in.	7ft. 5$\frac{1}{2}$in.	8ft. $\frac{1}{4}$in.	9ft. $\frac{9}{16}$in.	9ft.	7ft. 9$\frac{3}{4}$in.	8ft. 4$\frac{1}{8}$in.	8ft. 2in.
Springs—										
Number	6	6	6	6	6	6	4	6	8	6
Balance beam	0	0	0	0	Centre and trailing shaft	Centre and trailing shaft	0	0	2	0
Span	2ft. 3$\frac{9}{16}$in.	2ft. 3$\frac{9}{16}$in.	2ft. 3$\frac{9}{16}$in.	2ft. 3$\frac{9}{16}$in.	2ft. 3$\frac{9}{16}$in.	2ft. 3$\frac{9}{16}$in.	2ft. 2$\frac{3}{4}$in.	2ft. 3$\frac{9}{16}$in.	2ft. 11$\frac{7}{16}$in.	2ft. 3$\frac{9}{16}$in.
Number of leaves	8	9	11	12	11	12	10 to 14	11	12—11	11
Section of leaves	3$\frac{11}{16}$/$\frac{3}{8}$in.	3$\frac{11}{16}$/$\frac{3}{8}$in.	2$\frac{1}{8}$/$\frac{3}{8}$in.	3$\frac{1}{2}$/$\frac{3}{8}$in.	2$\frac{13}{16}$/$\frac{3}{8}$in.	2$\frac{15}{16}$/$\frac{7}{16}$in.	3$\frac{5}{16}$/$\frac{3}{8}$in.	3$\frac{1}{8}$/$\frac{3}{8}$in.	2$\frac{15}{16}$/$\frac{3}{8}$in.	2$\frac{1}{8}$/$\frac{3}{8}$in.
Working deflection	0	0	0	0	1$\frac{15}{16}$	1$\frac{15}{16}$	1$\frac{3}{4}$ to 2$\frac{1}{8}$	0	1$\frac{15}{16}$	0
Wheels—										
Diameter at tread	2ft. 8$\frac{3}{4}$in.	2ft. 8$\frac{3}{4}$in.	2ft. 8$\frac{3}{4}$in.	2ft. 9$\frac{1}{16}$in.	2ft. 11$\frac{7}{16}$in.	2ft. 11$\frac{7}{16}$in.	2ft. 11$\frac{7}{16}$in.	2ft. 9$\frac{7}{16}$in.	2ft. 8$\frac{3}{4}$in.—2ft. 3$\frac{9}{16}$in.	2ft. 8$\frac{3}{4}$in.
Diameter at tire	2ft. 4$\frac{13}{16}$in.	2ft. 4$\frac{13}{16}$in.	2ft. 4$\frac{13}{16}$in.	2ft. 4$\frac{11}{16}$in.	2ft. 6$\frac{1}{2}$in.	2ft. 7$\frac{1}{2}$in.	2ft. 7$\frac{1}{16}$in.	2ft. 4$\frac{11}{16}$in.	2ft. 4in.—1ft. 10$\frac{13}{16}$in.	2ft. 4$\frac{13}{16}$in.
Distance between wheel flanges	3ft. 1$\frac{3}{16}$in.	3ft. 1$\frac{3}{16}$in.	3ft. 1$\frac{3}{16}$in.	3ft. 1$\frac{3}{16}$in.	3ft. 1$\frac{3}{16}$in.	4ft. 5$\frac{1}{2}$in.	4ft. 5$\frac{1}{2}$in.	3ft. 1$\frac{3}{16}$in.	3ft. $\frac{3}{8}$in.	3ft. 1$\frac{3}{16}$in.
Thickness of wheel flanges	3$\frac{15}{16}$in.	3$\frac{15}{16}$in.	3$\frac{15}{16}$in.	3$\frac{15}{16}$in.	4$\frac{5}{16}$in.	5$\frac{3}{16}$in.	5$\frac{3}{16}$in.	3$\frac{15}{16}$in.	4$\frac{11}{16}$in.	3$\frac{15}{16}$in.
Centres—										
Diameter	5$\frac{1}{8}$in.	5$\frac{1}{2}$in.	5$\frac{7}{8}$in.	6$\frac{11}{16}$in.	5$\frac{5}{16}$in.	7$\frac{1}{16}$in.	5$\frac{7}{8}$in.	6$\frac{11}{16}$in.	7$\frac{1}{16}$in.—4$\frac{11}{16}$in.	5$\frac{7}{8}$in.
Length	3$\frac{15}{16}$in.	4$\frac{3}{8}$in.	5$\frac{3}{16}$in.	5$\frac{3}{16}$in.	6$\frac{11}{16}$in.	6$\frac{1}{4}$in.	7$\frac{7}{8}$in.	5$\frac{3}{16}$in.	7$\frac{1}{4}$in.—8$\frac{5}{8}$in.	5$\frac{3}{16}$in.
Distance, centre to centre	4ft. 3$\frac{1}{4}$in.	4ft. 3$\frac{1}{4}$in.	4ft. 3$\frac{1}{2}$in.	4ft. 2$\frac{1}{8}$in.	4ft. 5$\frac{1}{8}$in.	5ft. 10$\frac{3}{8}$in.	3ft. 8$\frac{7}{8}$in.	4ft. 2$\frac{1}{8}$in.	4ft. 7$\frac{3}{4}$in.—4ft. 11$\frac{11}{16}$in.	4ft. 3$\frac{1}{2}$in.
Wheel base—										
Trailing axle to...	—	—	—	—	—	—	—	—	—	—
Centre axle	2ft. 11$\frac{7}{16}$in.	2ft. 11$\frac{7}{16}$in.	2ft. 11$\frac{7}{16}$in.	2ft. 11$\frac{7}{16}$in.	3ft. 3$\frac{3}{8}$in.	4ft. 1$\frac{3}{16}$in.	4ft. 1$\frac{3}{16}$in.	3ft. 3$\frac{3}{8}$in.	2ft. 11$\frac{7}{16}$in.	2ft. 11$\frac{7}{16}$in.
Leading axle	2ft. 11$\frac{7}{16}$in.	2ft. 11$\frac{7}{16}$in.	2ft. 11$\frac{7}{16}$in.	2ft. 11$\frac{7}{16}$in.	3ft. 3$\frac{3}{8}$in.	4ft. 1$\frac{3}{16}$in.	4ft. 1$\frac{3}{16}$in.	3ft. 3$\frac{3}{8}$in.	2ft. 11$\frac{7}{16}$in.	2ft. 11$\frac{7}{16}$in.
Total of wheel-base	5ft. 10$\frac{7}{8}$in.	5ft. 10$\frac{7}{8}$in.	5ft. 10$\frac{7}{8}$in.	5ft. 10$\frac{7}{8}$in.	6ft. 6$\frac{3}{4}$in.	8ft. 2$\frac{3}{8}$in.	8ft. 2$\frac{3}{8}$in.	6ft. 6$\frac{3}{4}$in.	5ft. 10$\frac{7}{8}$in.	5ft. 10$\frac{7}{8}$in.
Motion—										
Diameter of cylinders	9$\frac{1}{16}$in.	10$\frac{3}{16}$in.	11in.	1ft. 1$\frac{3}{4}$in.	1ft. $\frac{9}{16}$in.	1ft. 1$\frac{3}{4}$in.	1ft. 1$\frac{3}{4}$in.	1ft. 1$\frac{3}{4}$in.	1ft. 1$\frac{3}{4}$in.	11in.
Stroke of piston	1ft. 2$\frac{1}{8}$in.	1ft. 2$\frac{1}{8}$in.	1ft. 2$\frac{1}{8}$in.	1ft. 2$\frac{1}{8}$in.	1ft. 3$\frac{3}{4}$in.	1ft. 3$\frac{3}{4}$in.	1ft. 3$\frac{3}{4}$in.	1ft. 2$\frac{1}{8}$in.	1ft. 2$\frac{1}{8}$in.	1ft. 2$\frac{1}{8}$in.
Number of coupled wheels	6	6	6	6	6	6	6	6	6	6
Distance from centre to centre of cylinders ...	5ft. 5$\frac{3}{4}$in.	5ft. 7$\frac{7}{8}$in.	5ft. 10$\frac{5}{16}$in.	5ft. 9$\frac{9}{16}$in.	6ft. 6$\frac{1}{8}$in.	7ft. 7in.	6ft. 4$\frac{3}{8}$in.	5ft. 9$\frac{9}{16}$in.	6ft. 7$\frac{9}{16}$in.	5ft. 10$\frac{5}{16}$in.
Distance from centre to centre of slide valves ...	5ft. 6$\frac{3}{4}$in.	5ft. 8$\frac{7}{8}$in.	5ft. 11$\frac{3}{8}$in.	6ft. $\frac{5}{16}$in.	6ft. 4$\frac{9}{16}$in.	—	7ft. $\frac{3}{16}$in.	6ft. $\frac{5}{16}$in.	6ft. 6$\frac{1}{16}$in.	5ft. 11$\frac{3}{8}$in.
Distance from centre to centre of link motion ...	5ft. 11$\frac{9}{16}$in.	6ft. $\frac{9}{16}$in.	6ft. 4$\frac{13}{16}$in.	6ft. 6$\frac{3}{16}$in.	7ft. 2$\frac{3}{4}$in.	8ft. 3$\frac{11}{16}$in.	7ft. 1$\frac{3}{8}$in.	6ft. 6$\frac{3}{16}$in.	7ft. 3$\frac{1}{16}$in.	6ft. 4$\frac{13}{16}$in.
Radius of excentrics...	2$\frac{7}{16}$in.	2$\frac{7}{16}$in.	2$\frac{9}{16}$in.	3in.	3$\frac{5}{8}$in.	3$\frac{7}{16}$in.	3$\frac{11}{16}$in.	3$\frac{3}{8}$in.	3$\frac{5}{8}$in.	2$\frac{9}{16}$in.
Outside lap of slide valves	$\frac{9}{16}$in.	$\frac{9}{16}$in.	$\frac{9}{16}$in.	$\frac{29}{32}$in.	$\frac{15}{16}$in.	$\frac{15}{16}$in.	$\frac{15}{16}$in.	$\frac{7}{8}$in.	$\frac{15}{16}$in.	$\frac{9}{16}$in.
Inside lap of slide valves	$\frac{1}{32}$in.	$\frac{1}{32}$in.	$\frac{1}{32}$in.	$\frac{1}{64}$in.	$\frac{1}{32}$in.	$\frac{1}{32}$in.	$\frac{1}{32}$in.	$\frac{1}{64}$in.	$\frac{1}{32}$in.	$\frac{1}{32}$in.
Width of slide valve openings	$\frac{11}{16}$in.	$\frac{11}{16}$in.	$\frac{3}{4}$in.	$\frac{7}{8}$in.	1$\frac{3}{16}$in.	1$\frac{3}{16}$in.	1$\frac{3}{16}$in.	$\frac{7}{8}$in.	1$\frac{3}{16}$in.	$\frac{3}{4}$in.
Length of slide valve openings	5$\frac{1}{2}$in.	5$\frac{1}{2}$in.	7$\frac{7}{16}$in.	7$\frac{7}{16}$in.	9$\frac{13}{16}$in.	9$\frac{13}{16}$in.	9$\frac{13}{16}$in.	7$\frac{7}{16}$in.	9$\frac{13}{16}$in.	7$\frac{7}{16}$in.
Length of main connecting-rod	3ft. 2$\frac{9}{16}$in.	3ft. 1$\frac{3}{8}$in.	6ft. 1$\frac{3}{16}$in.—3ft. 1$\frac{3}{4}$in.	3ft. 11$\frac{1}{4}$in.	6ft. $\frac{7}{16}$in.	3ft. 7$\frac{5}{16}$in.	3ft. 11$\frac{1}{4}$in.	6ft. 3$\frac{15}{16}$in.	5ft. 4$\frac{15}{16}$in.	3ft. 1$\frac{3}{4}$in.
Capacity of water tank	52·98 cu. ft.	52·98 cu. ft.	70·634 cu. ft.	84·06 cu. ft.	86·53 cu. ft.	104·19 cu. ft.	104·19 cu. ft.	91·83 cu. ft.	102·43 cu. ft.	70·64 cu. ft.
Capacity of coal bunker	17·65 cu. ft.	17·65 cu. ft.	23·0 cu. ft.	28·26 cu. ft.	35·32 cu. ft.	35·32 cu. ft.	35·32 cu. ft.	34·08 cu. ft.	31·79 cu. ft.	22·96 cu. ft.
Total weight in full working order	15 tons	16$\frac{1}{2}$ tons	18$\frac{1}{2}$ tons	22 tons	27 tons	28$\frac{1}{2}$ tons	28$\frac{1}{2}$ tons	29 tons	30 tons	18 tons
Tractive power $F = 0{\cdot}65\,\frac{p\,d^2\,l}{D}$...	3927 lb.	4631 lb.	4851 lb.	9009 lb.	7808 lb.	7784 lb.	7784 lb,	8899 lb.	9095 lb.	4851 lb.

TYPES OF THE ROLLING STOCK OF

Fig. 53 Elevation.

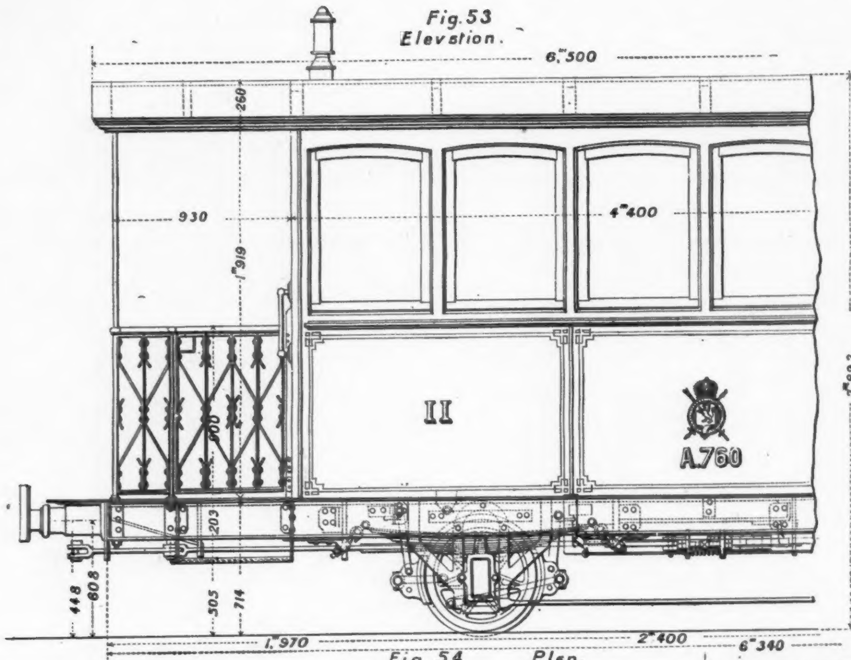

6"500
260
930
1"919
4"400
II
A.760
203
400
448
608
505
714
1,970
2"400
6"340

Fig. 55. End View.

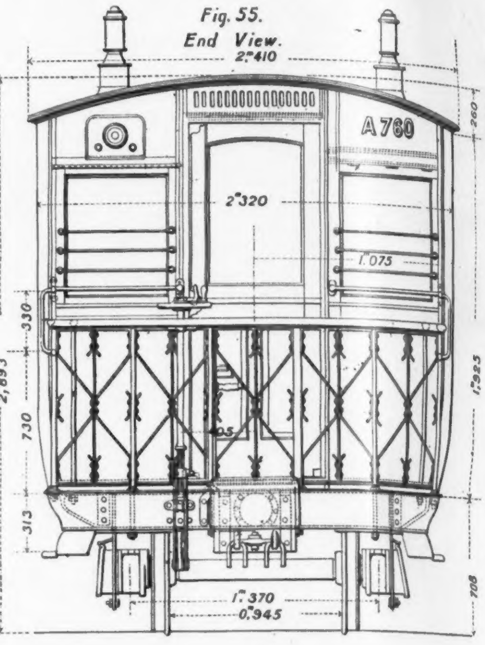

2"410
A760
260
2"320
1,075
330
2"893
730
313
1,925
705
1"370
0,345

Fig. 54. Plan.

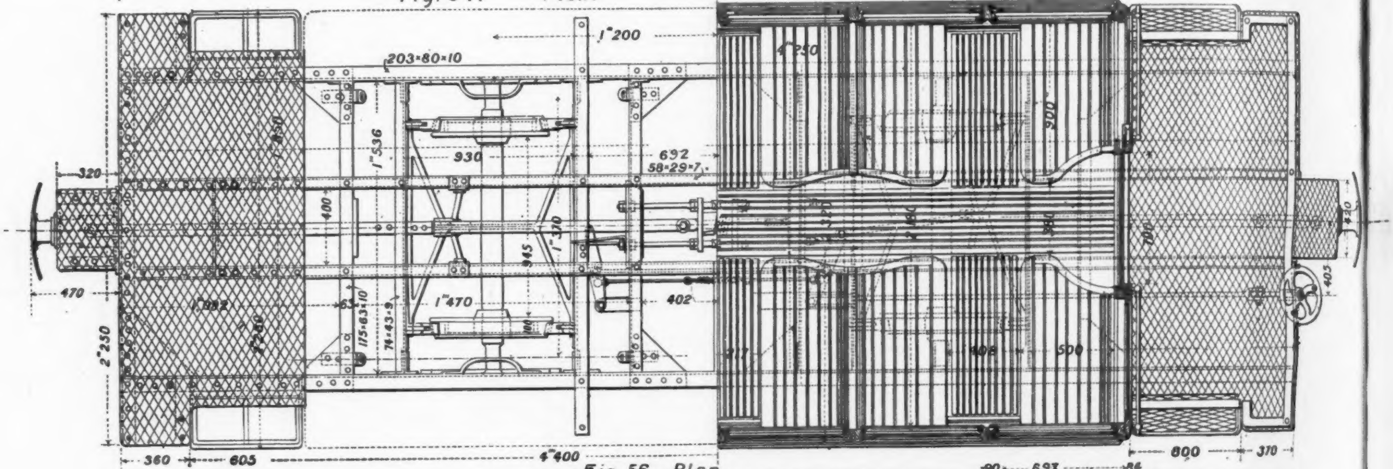

1"200
203×80×10
1"536
930
692
58×29×7
320
400
945
1"370
470
402
2"250
1"470
115×63×10
74×43×9
360
605
4"400
600
370
900
500
408
405
430

Fig. 56. Plan.

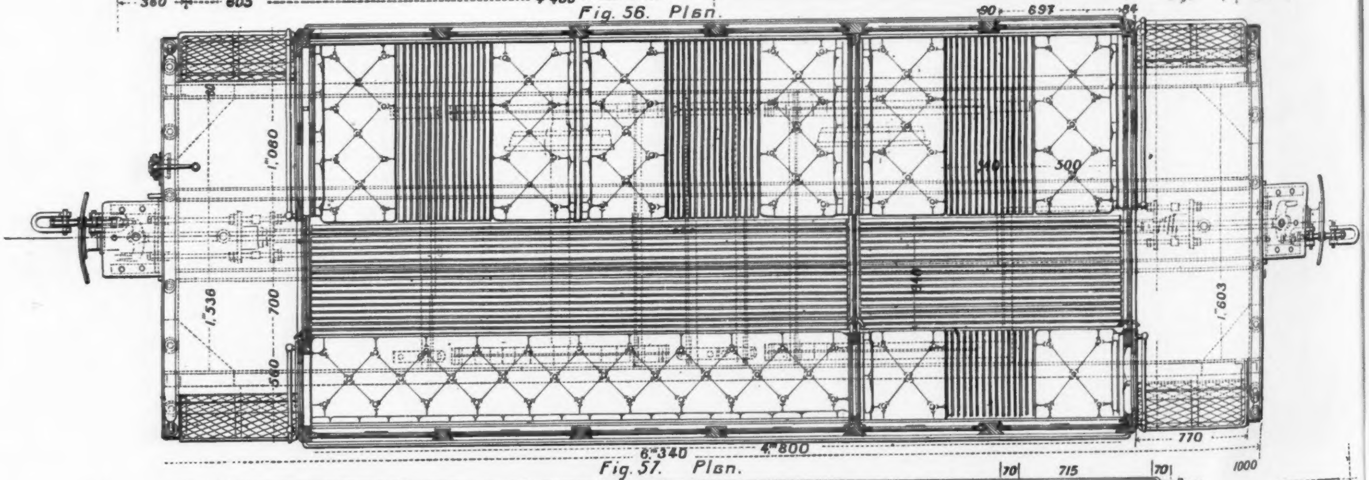
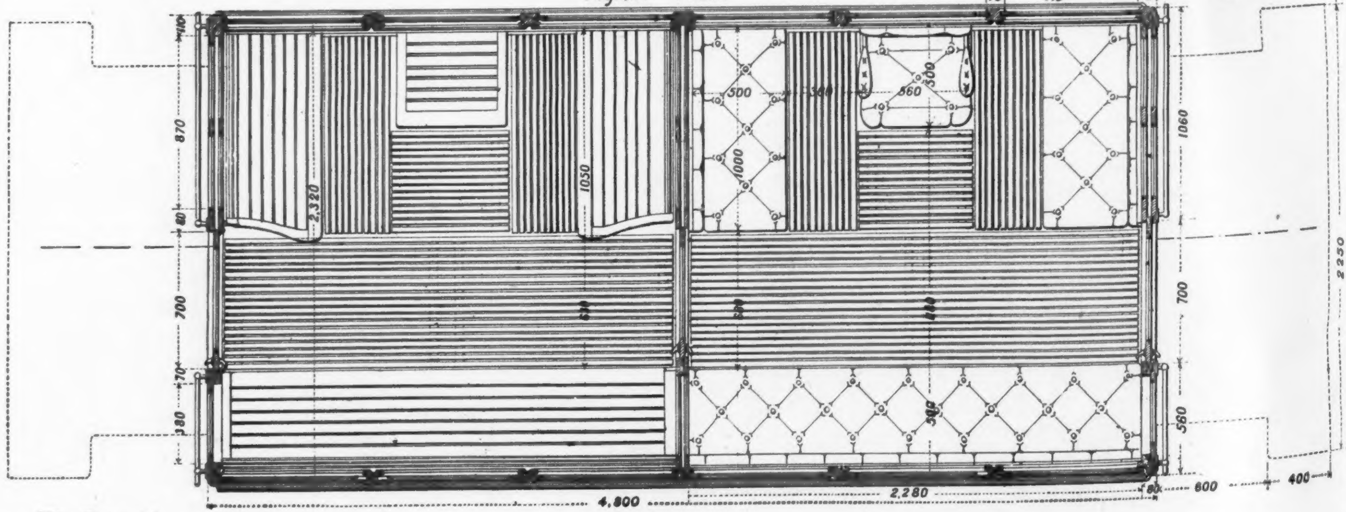

90
697
84
1,080
500
1,536
700
560
1,603
6"340
4"800
770
1000

Fig. 57. Plan.


70
715
70
500
560
1000
1050
2,320
870
80
700
70
380
1060
2250
700
560
4,800
2,280
80
600
400

"THE ENGINEER"

OCK OF THE BELGIAN LIGHT RAILWAYS

260
1.925
708
1.930
405
2230

Fig. 33.

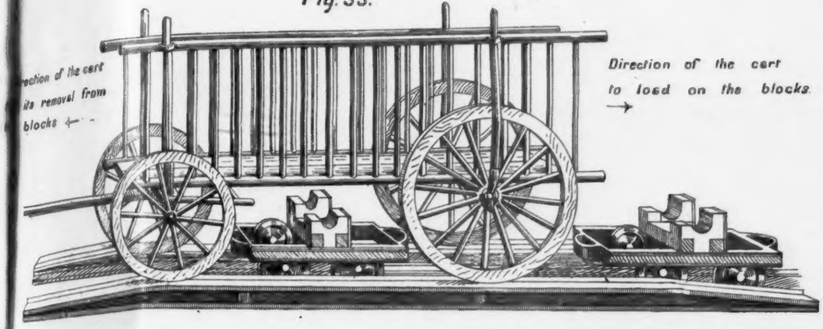
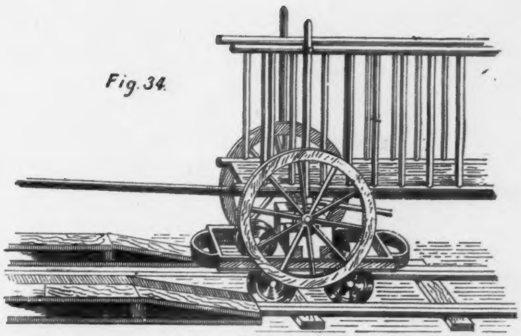
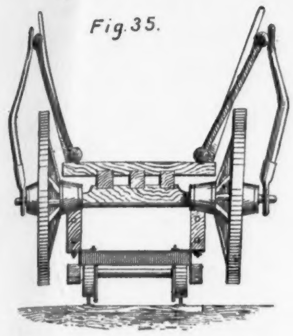

rection of the cart
its removal from
blocks
Direction of the cart
to load on the blocks

Fig. 34.



Side View.

Fig. 35.



End View

Fig. 48.

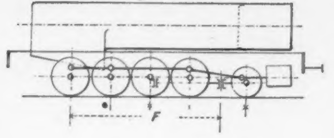


Fig. 42.

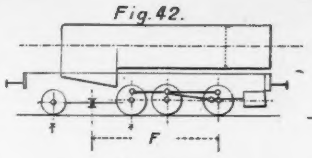


Fig. 45.

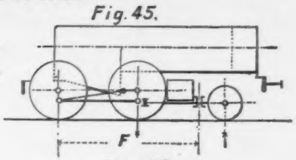


Fig. 49.

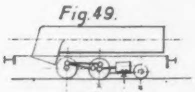


Fig. 43.

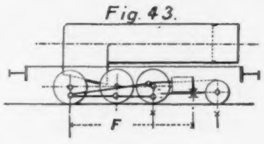


Fig. 46.

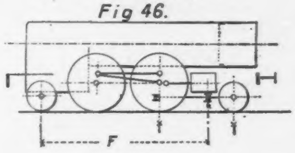


Fig. 50

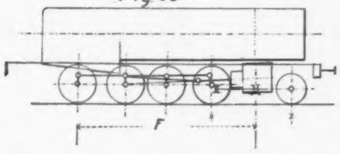


Fig. 44

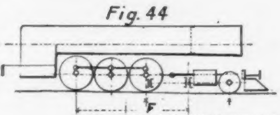


Fig. 47.

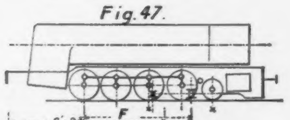


Fig. 51.

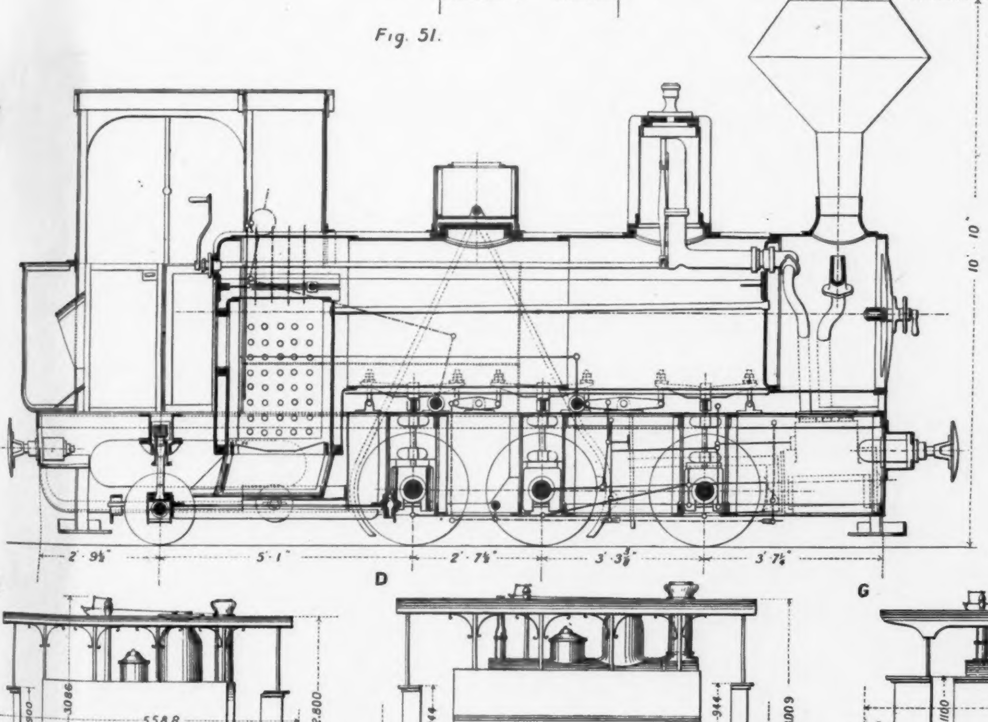
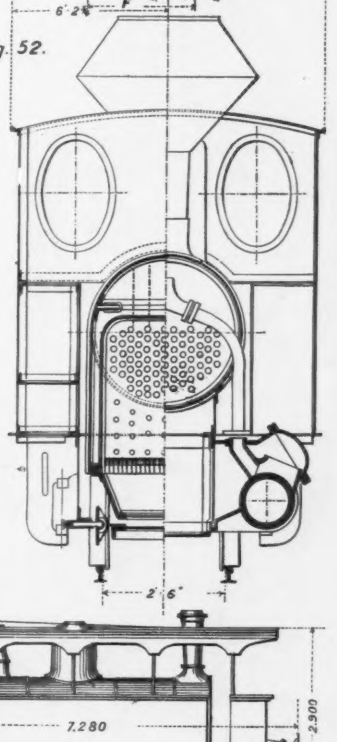
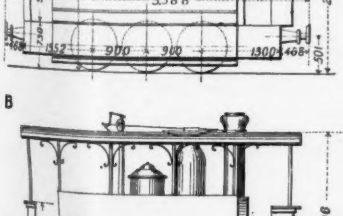

10' 10"
2' 9½"
5' 1"
2' 7½"
3' 3⅜"
3' 7½"

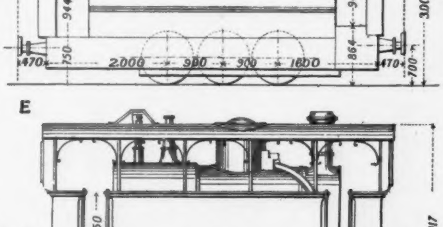
Fig. 52.



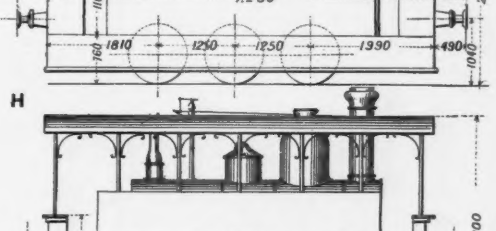
A


3086
900
5.588
2.800
900
900
1300
468
501

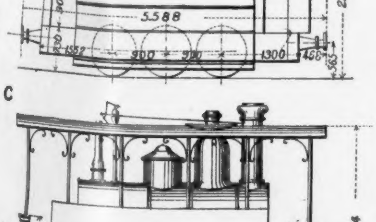
D


944
944
3.009
470
750
2.000
900
900
1600
864
470
700

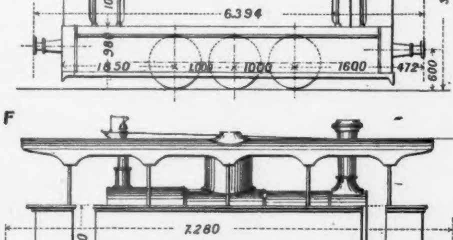
G


1100
7.280
2.900
760
1810
1250
1250
1990
490
1040

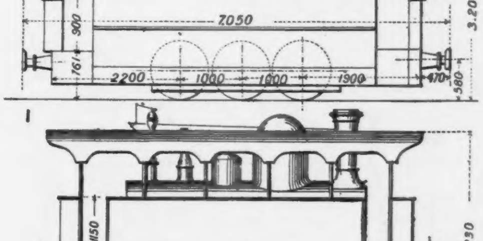
B


900
5.588
2.798
900
900
1300
468

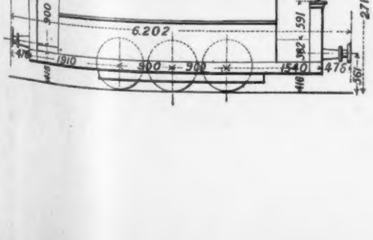
E


1050
6.394
3.117
980
1850
1000
1000
1600
472
600

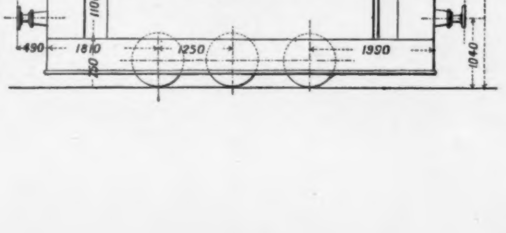
H


900
7.050
3.200
761
2200
1000
1000
1900
470
580

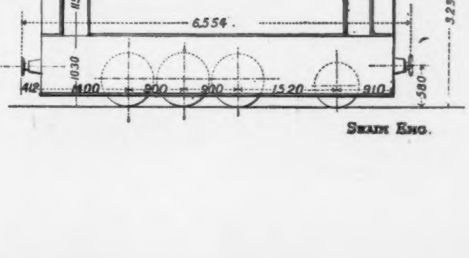
C


900
6.202
2.714
591
1910
900
900
1540
476

F


1100
7.280
2.900
490
1810
1250
1990
1040

I


1150
6.554
3.230
1030
418
1400
900
900
1520
910
580

Swain Eng.

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*** *With this week's number is issued as a Supplement a Two-page Engraving of Types of the Rolling Stock of the Belgian Light Railways, and a Supplementary Table of Dimensions of the various Types of Locomotives. Every copy as issued by the Publisher includes a copy of these Supplements, and subscribers are requested to notify the fact should they not receive them. Price 6d.*

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TO CORRESPONDENTS.

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*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

ALPHA (West Hartlepool.).—*You can obtain a list of several from Messrs. Spon, 125, Strand, or Phillips, 32, Fleet-street, London.*

IGNORAMUS.—*It may be taken for granted that under all circumstances a strict mathematical investigation will give more accurate results than a graphic investigation. But the mathematician must understand his business.*

J. C. M.—*On inquiry we find that there was a clerical error in the manuscript. The sentence on page 272 should read: "The present capacity of output is about equal to 50 tons of 60 per cent. white caustic soda, and about 100 tons of 35 per cent. bleaching powder from 60 tons of common salt weekly." At the time of our representative's visit the dynamos were working at about 700 ampères, but this is not necessarily a permanent current. They are sometimes run up 920 ampères or a little over.*

ONE WHO INTENDS TO COMPETE.—*If you will read the regulations with care you will find that they answer all your questions. The minimum run will be 100 miles out and 100 miles home. But there is no reason why it should not be twice as long if the judges should so decide. The competitors may go as they please, running at night or stopping at night as they think fit, so long as they complete the distance in the time to be fixed in the manner provided by the conditions. Every competitor must take care of himself; one of the objects of the competition is to ascertain how a horseless carriage will get on in a strange district.*

BALL BEARINGS FOR CENTRIFUGAL MACHINERY.

(*To the Editor of The Engineer.*)

SIR,—Could a centrifugal machine, weighing when loaded about 7 cwt., revolving from 1000 to 1200 revolutions per minute on a vertical shaft, be made to run on ball bearings—say three sets—if so, what would be a practical diameter for same? J. S.

Leicester, April 29th.

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF JUNIOR ENGINEERS.—Friday, May 8th, at 8 p.m. Paper: "Notes on Belgian Electrical Engineering Practice," by Mr. A. Anstruther-Thomson and Mr. G. C. Allingham, members.

INSTITUTION OF CIVIL ENGINEERS.—Tuesday, May 5th, at 8 p.m. Papers to be discussed: "American and English Methods of Manufacturing Steel Plates," by Mr. Jeremiah Head, M. Inst. C.E. "Four American Rolling Mills," by Mr. Samuel T. Wellman. Thursday, May 7th, at 8 p.m. "James Forrest" Lecture: "Physical Experiment in Relation to Engineering," by Dr. Alexr. B. W. Kennedy, F.R.S., M. Inst. C.E.

SOCIETY OF ARTS.—Monday, May 4th, at 8 p.m. Cantor Lectures: "Applied Electro Chemistry," by James Swinburne. Tuesday, May 5th, at 8 p.m. Paper: "Australia's Prospects in British Markets," by James F. Dowling. Sir Saul Samuel, K.C.M.G., Vice-president of the Society, will preside. Wednesday, May 6th, at 8 p.m. Paper: "High Explosives and Smokeless Powders," by Hudson Maxim.

ROYAL INSTITUTION OF GREAT BRITAIN.—Tuesday, May 5th, at 3 p.m. Lectures: "Ripples in Air and on Water," by C. V. Boys, F.R.S. A.R.S.M., M.R.I. Thursday, May 7th: "The Art of Working Metals in Japan," by W. Gowland, F.C.S., F.S.A. Friday, May 8th, at 9 p.m. Discourse: "Electric Shadows and Luminescence," by Professor Silvanus P. Thompson, D.Sc., F.R.S., M.R.I. Saturday, May 9th, at 3 p.m. Lecture: "Three Emotional Composers," by F. Corder, Curator, Royal Academy of Music.

SOCIETY OF ENGINEERS.—Monday, May 4th, at 7.30 p.m. Paper: "Hydraulic Rotative Engines," by Mr. Arthur Rigg, Past President. Synopsis:—New Rivals to Hydraulic Engines—Gas, Oil, and Electricity—Great literary attention given to Turbines, and practically none to Hydraulic Engines—Care bestowed upon improvements in economical working of Steam Engines, but comparatively none upon Hydraulic Engines—Water Power remains in a state of primitive simplicity, although it is far more costly than Steam—Cost of pressure water produced artificially—Uncontrolled supply to Hydraulic Engines. General History of Hydraulic Rotative Engines—Bramah—Armstrong—Westmacott, Knowlden, and Edwards—Brown—Schmidt, of Zurich—Hoppe, of Berlin—Walker and Carey—Duckham—Ramsbottom—Brotherhood—Hastie—Greathead—Williams—Walker. Comparison between Hydraulic Engines with two and three cylinders—Diagrams showing rotative effort on crank pin of several types—General Constructive Principles—Revolving Cylinder Types—Variable Power—Governing Hydraulic Engines to uniform speed—Regulating the stroke in accordance with load—Conclusion.

DEATHS.

On the 22nd April, at 13, Newbattle-terrace, Edinburgh, THOMAS MEIK, M. Inst. C.E., in his 85th year.

On the 28th April, at Monkton House, Penarth, HENRY JOHN VOSE, Superintending Engineer Postal Telegraphs, South Wales District, in his 46th year.

THE ENGINEER.

MAY 1, 1896.

THE OUTLOOK IN THE COAL TRADE.

TWO meetings, fraught with issues of vital consequence to the industrial interests of the kingdom, were fixed for April 29th and 30th. The first is that of the Conciliation Board, and the second the Conference of the Miners' Federation. The subject before both is the same—the continuance or non-continuance of the Rosebery Agreement. The Council of the Yorkshire Miners' Association met at Barnsley on the 20th inst.—last Monday week—when the proposals of the coalowners and of the Miners' Federation were considered. Mr. Hewlett, on behalf of the coalowners, proposes that the Conciliation Board be continued "to determine from time to time the rate of wages, on and from August 1st, 1896." Mr. B. Pickard, on behalf of the Miners' Federation, proposes "That the agreement now in existence be continued until the 1st August, 1898." The Council have agreed to recommend the latter proposal and to reject Mr. Hewlett's. This news will be no surprise to those who have followed the narrative of events given from time to time in THE ENGINEER. Of late a large number of miners' meetings have been held in the largest of the colliery districts, and it becomes increasingly evident that the policy prescribed by the Union leaders will be faithfully followed. At one of the most important collieries in the Yorkshire district, the proposal of the Associated Coalowners, relative to the future of the Conciliation Board, was unanimously rejected. This may be taken as typical of the resolutions which are being passed in all the districts. The men have been asked by their leaders to stand by the principle of a minimum wage, with a right to the producers to have a voice in the selling price of coal. These two points form the essence of the proposal put forward by the Miners' Executive, and so far as the decisions of the miners themselves have yet been given, they have been adopted without a single dissenting voice. A noteworthy feature of the meetings has been an equally harmonious compliance with a recommendation from the Yorkshire Executive to advance the rate of contributions to the Union. In the Sheffield district it has been unanimously decided, at one large gathering of colliers, to double the present contribution for the next four months, in order to meet any emergency which may arise when the present arrangement in the coal trade expires. This is the clearest of war notes. It is intended as such, and will be taken in its interest. The general public are paying singularly little attention to the trouble ahead; and with no inconsiderable section the belligerent utterances now so freely heard are discounted as not half so terrible as they read. There is no general expectation of a coal war, whether the Conciliation Board comes to an end or not. The remark is frequently heard, "Oh, the large coalowners will not stop in any case. Their newly-opened and modernly-equipped pits can be made to pay at present prices, and the more of the older ones that go to the wall the better for the others." Neither is there any expectation amongst miners that a demand for lower wages, if seriously made, will be resolutely insisted upon. The probability is that the Conciliation Board will come to an end, that business will go on as it did prior to the Rosebery conference, that the minor collieries, which cannot produce at a profit, will be crushed out in the conflict for contracts, and that the colliers will win the fight for a living wage, as they interpret it, without respect to the values of the mineral out of which the living wage is to come. It is an anomalous and a purely selfish position. It is anomalous, because it sets at defiance all the well-established laws upon which commerce is conducted; it is selfish, because it takes no account of the living dividend, which is as essential to the existence of thousands of investing people as the living wage is for the working collier. It is not clear that this policy will have any other than the usual outcome of its kind. The men make more money per hour during the time they are at work, but they work so much less that they are absolutely poorer at the week end than they would be under moderate concessions. Nor does the evil end there. The British coalowners, handicapped in the cost of production, are being beaten in certain foreign markets; the French Government have decreed that henceforth nothing but French coal must be used in French State establishments—this order has reduced the value of coal sent to France from £231,798 in March of 1895, to £167,969 in March of 1896—and in other directions the trade is being alarmingly attenuated. But the collier looks to his leader, and follows him. There is perfect cohesion in the ranks of the mine workers. Although it would be unjust to speak of the Associated Coalowners as a rope of sand, for they proved themselves strong enough to fight a stern battle, they can never hope to possess the astounding docility of the Miners' Unions. Coalowners have many interests, and their circumstances vary with their seams and the situations in which they are fixed. The colliers have but one interest, and it is the same all round—to resist all reductions. Short hours of labour, and long wages while at it, form the theory of their position; and it must be taken for granted that when the district lodges, on a mere hint from the Miners' Executive, at once decide to double their contribution to the war fund, the men and their leaders may mean a game of "bluff," but it is bluff which means business. And the business is for the men to keep the existing rate of wages for the present, and look for more as soon as they can. The essence of the position for the coalworkers is this, "Let us make the most of the present; get all we can for what we do, and, as for the future, well, let the future take care of itself."

COMPOUND LOCOMOTIVES.

IN another page will be found a letter from an American engineeer, Mr. F. W. Dean, whose name will no doubt be familiar to many of our readers. Mr. Dean asks us why it is that we hold that the advantages possessed by the compound locomotive over the simple engine are best displayed on long runs with heavy trains. We shall answer this question presently. But it is advisable, in the first place, to consider certain arguments and statements advanced by Mr. Dean in a paper read by him last year before a monthly meeting of the American Society of Mechanical Engineers. In that paper Mr. Dean attempts to explain why so much diversity of opinion exists among engineers as to the relative merits of compound and non-compound engines. In effect, he blames not the principle, but the method of applying it. There are, he tells us, certain very good compound locomotives at work in the United States. Probably, he thinks, about one-half of all the compound locomotives in use are bad; and he not unnaturally proceeds to argue that an engine which he has designed is among the best. He tells us in a little explanatory introduction to his paper that "the gains and losses of the compound type of locomotive with reference to the simple type have here been publicly explained and discussed. These features of the compound have been realised by the author, and his designs have been so made as to reduce the losses to a minimum, or to annihilate them, and to make the gains the greatest. Such results are brought about by placing the intercepting valve close to the high-pressure cylinder, by making two oval receivers having large volume and re-heating surface, providing two large openings into the low-pressure steam chest, using a light and efficient double-ported balanced slide valve for the low-pressure cylinder, and having no restricted passages, obstructions, or abrupt turns in passages between the cylinders." As a result he claims a saving in steam of about 20 per cent. We may observe parenthentically that this is the percentage usually claimed by all inventors of compound locomotives, and we venture to add that Vauclain and V. Borries, to say nothing of inventors in Great Britain, will be slow to admit that they have failed to appreciate the value of excellence of detail in working out their designs.

It is not our intention to dispute the accuracy of Mr. Dean's claims; that we shall leave to the ingenuity of our readers. It will be more useful perhaps to give the opinions of most British locomotive superintendents on compound locomotives in general. We naturally hold views identical in all respects. They have often been set forth in our columns. It can do no harm to state them once more, in response to Mr. Dean's request for information. In very few words, then, we say, that whether a compound locomotive will or will not be more economical than a simple engine depends entirely on the conditions under which it is used and on the way in which it is used; and that in this country, so far, the conditions favourable to the compound engine either do not exist at all or only in a modified degree. It would take up far more space than we can devote to the subject to give precise explanations of our meaning, or a sufficient number of examples to demonstrate the truth of our propositions. Putting the facts as concisely as is consistent with lucidity, we may say that the running expenses of a locomotive are not all concentrated in the coal bill. But, leaving this point on one side, we may point out that, other things being equal, the engine which exhausts its steam at the highest pressure will use the greatest quantity of steam in hauling a train. The whole object and purpose of compounding is to reduce the exhaust pressure in a locomotive. It may be said that its object is to work more expansively, and we may write in a learned fashion about heat units and thermal efficiency. All this is very well in its own place. The practical, penetrating truth is that an engine exhausting steam of 100 lb. pressure is wasting more energy than one exhausting at 50 lb. How much more is quite a distinct story, with which we need not just now concern ourselves. The range of temperature theory has been played out as regards the compound engine. Mr. Dean very truly says indeed, "As cylinder condensation is the greatest of all enemies of economy, by using multiple cylinders we invite our greatest enemy to be always with us. It is at least approximately true that cylinder condensation is proportional to surface, other things being equal." It is easy to see that by augmenting the diameter of the cylinders of a simple engine we can cut off earlier in the stroke, and so reduce the pressure at which exhaust takes place. It is a suggestive fact, however, that all attempts — and they have been numerous — that have been made in this country to use cylinders large in proportion to the boiler have ended in failure. The engines have wasted coal. They have not kept time. They have been unsatisfactory in various ways. No doubt this was due in many cases to the drivers availing themselves of the big cylinders, and "running their engines out of breath." But there is more than this. The link motion is a very excellent expansion gear up to a certain point. Beyond that it entails so much compression that mischief is done. The beauty of the compound system is that it dispenses with a very early cut-off in any one cylinder. But the use of special valve gear which has been tried with success at once places the simple engine on a level with the compound engine in this respect.

We may now proceed to reply to Mr. Dean's questions. The benefits of the compound system will be most apparent when an engine is heavily loaded and runs long distances without a stop, simply because these are the most favourable conditions under which it can be used. For let us suppose that we have an engine hauling a heavy train with an initial cylinder pressure of 150 lb. on the square inch, and that the load is such that the pressure has only dropped to 75 lb. on the square inch when the exhaust port opens. If, now, an engine similar in all respects, save that it was compound instead of simple, hauled the train, its greater cylinder capacity would permit us to reduce the terminal or exhaust pressure to, say, 40 lb. But if the load was so light that the terminal pressure in the simple engine was 40 lb., the cylinder capacity of the compound engine would be too great. The exhaust pressure might not be enough to supply draught for the furnace. A contracted blast pipe would have to be used, and the other sources of waste named by Mr. Dean would come into play. We thus find that, according to the conditions, a compound locomotive may be either more or less economical than a simple engine; and, of course, it follows that conditions may obtain under which neither engine would display any advantage over the other. So far, then, it is clear that the more heavily loaded a locomotive is, the more likely is it to be improved in economy by compounding. In the United States loads are usually much heavier in proportion to the size of the engine than they are here, and the exhaust pressures are much higher. Therefore we should expect to find the compound system showing to far better advantage on American than on English railways; and this is precisely what does happen. The late Mr. W. Stroudley would have nothing to do with the compound engine, because he held that the conditions under which his traffic was carried on were not suitable. He always maintained that if the compound locomotive was to be used at all, it ought to be used with very heavy mineral or goods trains on long leads, and up steep inclines. Any one, indeed, who has heard a big goods engine hauling a heavy train up such inclines as Shap, or those numerous enough in Derbyshire, will readily understand that more cylinder capacity would reduce the weight of steam needed per mile. Concerning fast and heavy passenger traffic we have said nothing. Space fails us. But here, again, whether the compound locomotive is or is not better than the simple is purely a question of conditions. Mr. Webb finds that the conditions obtaining on the London and North-Western Railway are favourable to the compound engine. On the other hand, we see that Mr. Holden, on the Great Eastern, says that the conditions on his line are not favourable. The chances are a thousand to one that both gentlemen are right, in spite of the difference in their practice.

On one remaining point we find it impossible to agree with Mr. Dean. He speaks, no doubt, according to his experience; we, according to the experience of British railway men. The compound system is not suited for working stopping trains. Mr. Webb gave a compound engine a thorough trial on the Metropolitan system. His experience was not such as to induce him to build more compound locomotives for such service. In all two-cylinder compounds it is essential that the engine shall work non-compound at starting; and when the distance between the stations is small, the engine is working much of its time non-compound under the worst possible conditions. Mr. Dean holds a different opinion. But he evidently bases his arguments on a type of engine of which we have no experience at this side of the Atlantic. It is, we gather, in experimental use on the New York Elevated Railway. Possibly Mr. Dean will see his way to supply some particulars of its construction at an early date. He says, referring to the question we have just dealt with, "The point here considered is of the greatest importance in suburban and elevated work, for here the compound is peculiarly economical if it is a compound from the beginning. If it is a simple engine for some little time after starting, the greatest part of its peculiar adaptation to the work which requires frequent starting is lost." We confess that we do not see how it is possible to get away with a two-cylinder compound engine without the use of an intercepting or driver's valve; and it appears that so long as this valve is used, so long does Mr. Dean agree with us. It seems then, after all, that there is no wide diversity of opinion between ourselves and Mr. Dean, for such time as we deal with normal compound locomotives. Mr. Dean has, however, a locomotive concerning which we know nothing. That being the case, it is, of course, impossible for us to dispute the accuracy of claims based on its performances. When, for instance, we are told that his engine will always work compound, and yet start a heavy train with much promptitude up an incline of 1 in 55, and that a similar engine—or is it the same? —works with despatch, and certainty, heavy fast suburban traffic with eleven stops in nine miles, we have nothing to say except that we should like to have further particulars of what must be a very remarkable locomotive; and we have no doubt that in this expression of desire many of our readers will unite with us.

PERMANENT WAY.

THE report by Major Marindin, on the accident at Little Bytham, on the Great Northern Railway, lends point to the correspondence which has been proceeding in our columns on the construction of permanent way. The accident in question occurred on the 7th of March, when part of an express train from the North left the rails. Major Marindin attributes the accident to the roughness of the road, which had been renewed. The ballast had not settled, and the rails being out of level, the engine lurched and twisted the track to such an extent that the rear coaches left the rails. It is argued that if the ballast had been good the line would not have sunk, but there is no reason to conclude that the ballast was either worse or better than that on miles of line which carry their loads with perfect safety. "There is no reason," says the report "to doubt that the relaying gang had done their work well, that the rails were properly laid and secured, and were true to gauge and in good line, or that the sleepers were properly packed, but the inspector admits that there was still some work to be done by the ballasting gang in filling up with new ballast, and especially at the sleeper ends outside the outer rail, and it was apparent from an examination of the line that the top ballast was not of first-class quality, being somewhat light and dirty, and that, while in the 4ft. way between the rails it was filled only half way up the sleepers at most, there was a great deficiency of it outside the sleeper ends, which in most places were not boxed in at all. Between 11.40 a.m. and the time that the accident happened, viz., 7.38 p.m., thirty trains, exclusive of the Leeds express which left the rails, had passed over this piece of line, and of these fifteen were passenger trains."

After all has been said, we do not think that this accident goes far to show that permanent way in England is bad. We do not suppose that any railway engineer could be found who would maintain that railway track, even on his own road, is quite perfect; but then absolute perfection is not to be found in our universe, and the wonderful absence of accidents from derailment which attends the working of railway traffic in this country bears splendid testimony to the general excellence of our railroads. The arguments of our correspondents are mainly twofold. One party insists on the necessity for better ballasting, the other appears to care little for ballast and a great deal for track. It is noteworthy, however, that while these last criticise existing roads pretty sharply, they are far from being agreed among themselves as to the substitute. Several advocate longitudinal sleepers and flat-footed rails, others flat-footed rails and cross sleepers. Others, again, hold that if only a good steel chair is substituted for the existing cast iron chair, all will be well.

As there is not the least likelihood that railway companies will make any change whatever in the methods of construction, it is perhaps almost a waste of time to discuss permanent way at all; yet questions connected with it are certainly not devoid of interest. We know that the flat-footed rail on a longitudinal sleeper is entirely out of the question. It has had a very extended trial, and has not succeeded. Our correspondents forget the relations between the rail and the sleeper. The flat-footed rail sank into the sleeper, and could only be kept out of it by interposing packing pieces with the grain across the rail. This was nothing but a makeshift. The difficulties and delays of repair and replacement were intolerable on crowded lines. The defects of the flat-footed rail on the cross sleeper road are well known, although they appear to have been equally forgotten by our correspondents. For the same weights the flanged rail is much less stiff than the bull-head, for reasons which we have recently fully explained, and the rail is more difficult to roll sound and true. But beyond all this there is the difficulty of securing it to the cross sleepers in an efficient way. We have not the least hesitation in saying that a first-class road cannot be made with flanged rails spiked to cross sleepers. The chair road in use in this country is a survival of the fittest. It has been reached after a prolonged history of trial and error. Its sharpest critics are unable to prove in the light of daily practice that it is a bad road. Indeed, their great difficulty is that it is so excellent that it is not easy to see how anything better on the whole can be produced.

We confess that we have some sympathy with the advocates of steel chairs. The normal chair is very cheap, and can be produced with facility by the million in moulding machinery by boys. Chairs at £3 2s. 6d. a ton, or about 1s. 6d. each, do not represent a large outlay even when the percentage of breakages is considerable. The advocates of the steel chair will have to show that money can be saved by adopting it instead of the cast iron chair. It is mainly a question of expense. It cannot be denied that the permanent way on British railways is in the main admirable. We do not say that better might not be produced; but how, and at what cost? This last is the crucial question, and yet it is that on which our correspondents have least to say.

BRITISH-BUILT STEAM YACHTS FOR AMERICAN OWNERS.

FOR individual owners—and all without the United Kingdom—four of the largest steam yachts ever constructed in this country are at present under way in Clyde yards. Three of the new vessels are for American owners, each being about 1700 tons measurement; an advance of 500 tons on the size of Captain H. McCalmont's palatial yacht Giralda, hitherto the most notable craft for size, speed, and sumptuousness, in Britain's pleasure fleet. The three are from the designs of Mr. G. L. Watson, Glasgow, who may well regard the important commissions to design and place the boats as some compensating return for his disappointment over the American Cup contests. The fourth is for Commendatore Ignozes Floris, of Palermo, and will be 1200 tons yacht measurement, and 2300 indicated horse-power, the builders and engineers being Messrs. Scott and Co., Greenock. Her engines will be of the triple-expansion type, and the speed guaranteed is 16 knots. Electric light will be fitted throughout, and the saloons and fittings, of course, will be on a corresponding scale of luxuriance. Perhaps the most noteworthy of the trio of yachts for American owners is the one under way in the yard of Messrs. J. and G. Thomson, Clydebank. This vessel is for the American millionaire, Mr. Ogden Goelett, and will be at once the fastest and most luxuriously appointed pleasure vessel that has ever taken form in Britain. She will measure from the figurehead to taffrail 311ft., while the beam will be about 40ft., and depth 36ft. She will be propelled by twin-screws, driven by triple-expansion engines, supplied with steam from water-tube boilers of the "Almy" type. Her coal-carrying capacity will approach 1000 tons, and under forced draught she will steam 18 knots at sea; her "measured mile" performance, however, being expected to approach 20 knots. In connection with the acquisition of these large steam yachts by American owners—directly, indeed, on account of their being designed and built in this country—it is of interest to learn that a Bill is now before the United States Congress whose object is to shut out foreign-built yachts from the privilege of flying the American flag. It was found in the cases of the British-built yachts Valiant, Conqueror, and others that, though they must be admitted to ordinary yachting privileges as members of foreign yacht clubs, they could not be prevented from flying the "the Stars and Stripes," because there was no penalty against it. In this way they rank to all intents and purposes as American yachts, and American builders and designers are consequently aggrieved. Should the Bill referred to receive sanction from Congress, its effect on the further acquisition of British-built steam yachts may be prohibitive.

SUBMARINE TELEGRAPHIC WORKS.

THE submarine telegraph industry benefits largely by political unrest, as well as by some of the victories of peace, so that it is no wonder that in its past half-year the Eastern Extension Telegraph Company has had a record income. Its total receipts were £311,582, or about 20 per cent. above those for the same period of the preceding year. The gold mining industry of Western Australia gave a heavy traffic to the cables, and thus largely contributed to the enlargement of the receipts. That enlargement enabled a dividend and bonus to be paid of 7 per cent. for the year; and it also allowed of very substantial sums to be paid to reserves. In the half-year 340 knots of the New Zealand cable and 109 knots of the Tasmanian cable have been renewed; and further heavy renewals are intended to be carried out this year. Finally, a payment was made out of reserves which, with previous payments, reserves the sum of £286,043 for the alternative Singapore-Hong Kong cable; and this, added to duplicate and triplicate and other cables that have been similarly provided, brings up to £1,485,000, the sum that has been from time to time paid from reserves built up out of revenue to strengthen the cable system of the company. It is certain that the renewals will be needed for some little time yet, but it may be not unfairly hoped that there will be with the recovery of trade in Australia and in the East, a revenue that will be increased, and that will give the ability to more than maintain even to further extend the great system, which springs from the primal eastern telegraphs, and has carried the nerves of communication to the remotest portions of the empire. It cannot be said that the return over the life of the company has been an inordinate one, though the investment has been increasingly remunerative of late, and that increase may be expected to continue with revival in the trades of the Far East and of Australasia. As yet it has been an industry that has been dependent on a limited number of messages, because of the heavy cost; but by the combination of the Governments and of the companies, it has been possible to cheapen the cost, and probably this may be done yet more in the future, and that there will be a dependence more on the extent of the work than on high charges to cover the interest on the heavy cost of construction.

LITERATURE.

Light Railways for the United Kingdom, India, and the Colonies. By JOHN CHARLES MACKAY, F.G.S., A.M.I.C.E. Crosby Lockwood and Co. London: 1896.

THE author of this portly volume tells us on the title page that it is a practical handbook setting forth the principles on which light railways should be constructed, worked, and financed, and detailing the cost of construction, equipment, revenue, and working expenses of local railways already established in the United Kingdom, the Colonies, Belgium, France, Switzerland, &c. As there has never yet been a time when a good treatise on light railways was more wanted, promises such as those made by Mr. Mackay should ensure the popularity of his book, always provided, of course, that the promises are fairly well kept. The first thing we ask ourselves is what kind of book is most likely to be of service; and the reply is, of course, that one dealing with the various questions which present themselves the moment a light railway in England is mentioned, is that most likely to prove of service at this moment. Now unfortunately, it is just in this class of information that the volume before us is most deficient. Mr. Mackay has collected a great mass of statistics concerning existing light railways. To some extent he has classified his information, but it is all presented to the reader in such a way that it is next to impossible to utilise it for any particular case. Abundant examples of what we mean present themselves on almost every page. Let us take, for instance, the eighth chapter on "Working Expenses." We are told at the outset that "the working expenses of railways depend on several conditions, which vary on different railways." Most people, we believe, will admit the truth of this as a species of self-evident proposition. We want, however, some detailed information as to what the working expenses of a narrow gauge British line ought to be, and we get none. We are told that the Corris Railway in the Isle of Man is worked at 2s. 2d. per train mile; the Easingwold Railway at 1s. 10d.; and the Glyn Valley at 1s. 7d.; but it is obvious that such meagre statements are of no value whatever to a man who wishes to prepare an estimate of the working expenses for a line ten miles long, say, in Cheshire. He will want to know the cost of rolling stock, its depreciation, wages, the quantity of coal used, its cost, the cost of water, and many other things. If Mr. Mackay had obtained and published detailed information of this kind about, say for example, the Corris line, he would have done good service. We are told, again, that "the main results of working the light railways of Belgium is 10d. per train mile, or £204 per mile per annum," and that the expenses are 71·31 per cent. of the gross earnings. Figures of this kind may be of national importance perhaps; but they are not of the least use to the promoter of a line, nor can they be regarded as being in any sense or way aids to the investor. When we attempt to get information on details, we have to hunt all over the book; thus, on page 95 we are told that the cost of working a locomotive on the Glyn Valley Tramway is £13 per week, including all charges. If the price of coal per ton and the driver and fireman's wages had also been stated, little more would have been required to make the information tolerably complete, and therefore useful. Numerous tables are given, but they are very deceptive; the information they supply being far too general to be of much service to promoters or engineers. It is next to impossible, indeed, to arrive, from our author's figures, at any conclusion drawn from analogy as to the chances of profit from any intended line.

Much space is given up to the consideration of light railways abroad—that is to say, in India, Ceylon, Australia, &c.—with tables of prices, &c. But again we are compelled to say that these figures are not, and cannot be, in any way a guide to the engineer in this country. Our author cites for special praise the Moroi line in India, 2ft. 4in. gauge, laid with 30 lb. rails. For twenty-five miles it runs along, and on a good road. It is fairly level. The cost was £1709 per mile. But how is it possible to deduce anything concerning a home line from the results of this? It will be seen that we base our criticisms on our author's title-page. The book does not in any adequate fashion deal with the principles on which light railways should be constructed, or worked, or financed. It does not detail the cost of construction or working. It is not in any proper sense of the word a handbook of light railways; but, on the other hand, if we disregard the title-page altogether, we may say that Mr. Mackay has produced a very interesting volume, of a somewhat popular character, which contains a great deal of general information about light railways, set forth in a very readable way and moderately well illustrated.

One fact comes out very clearly in Mr. Mackay's pages, namely, that it is only under very exceptional circumstances that the light railway really earns dividends for its owners.

The book may be utilised in various ways, its indefiniteness lending it freely to the purposes alike of the promoters and the opponents of any proposed line. Those, however, who desire to have within reach general information concerning almost all the light railway systems in the world will do well to buy Mr. Mackay's book. It may be regarded as the first instalment, perhaps, of a considerable body of literature dealing with the subject. We would advise Mr. Mackay to write a second book, in which he will deal with one or two or even three lines, and supply not only detailed information concerning cost of construction and working, but the reason why the lines do or do not pay. That is the kind of information most wanted at the present moment.

SHORT NOTICES.

Know Your Own Ship: A Simple Explanation of the Stability, Construction, Tonnage, and Freeboard of Ships. Specially arranged for the Use of Ships' Officers, Superintendents, Draughtsmen, and Others. By Thomas Walton. With numerous illustrations. London: Charles Griffin and Co., Ltd., 1896. Price 5s.—Many would like to know something of the construction of ships and the principles upon which their construction, loading, and sailing depend, but the books available are almost all written for those who are, or intend to be, technically instructed for professional occupation. They are either for the shipbuilder, the engineer, or the technical instructor. There is no book for the layman who wishes to gain an intelligent knowledge of the construction, buoyancy, displacement, measurements, stresses, strength, and chief details of construction of hull. This book of Mr. Walton's will remove a want in this direction, and will be found very useful by many who are not quite laymen on ship construction matters.

Handy General Earthwork Tables. By J. H. Watson Buck, M. Inst. C.E. London: Crosby Lockwood and Son. Price 3s. 6d. —This is a pair of tables for easily finding the contents of cuttings or embankments, measured by the 66ft. or the 100ft. chain. The two tables are clearly printed, and are mounted on the inside of a stout pair of covers, or rather a folding cover, like that of a book.

BOOKS RECEIVED.

Willing's British and Irish Press Guide, and Advertisers' Directory and Handbook, 1896. Twenty-third year. A concise and comprehensive index to press of the United Kingdom, &c. &c. London: James Willing. Price 1s.

Commission des Etudes du Port de Montevideo. Présentation de l'Avant-Projet. Rapport de la Sous-Commission. Montevideo: Imprenta y Litografia *La Razon*, Cerro, 57. 1896.

Report of the Results Obtained with Experimental Filters at the Pettaconset Pumping Station of the Providence Waterworks. By Edmund B. Weston. Providence, R.I.: E. L. Freeman and Sons. 1896.

Torpedoes and Torpedo Vessels. By Lieut. G. E. Armstrong, late R.N. Illustrated with a frontispiece by Chevalier E. De Martino, and numerous photographs and diagrams. London: George Bel and Son. 1896. Price 5s.

THE CRYSTAL PALACE EXHIBITION.

THE exhibition which opens on Saturday at the Crystal Palace is full of promise of excellence and interest. The English people have always taken the lead in everything connected with travel, or locomotion from place to place, by land or by sea. At a comparatively early period we possessed the best highways in the world; and probably the same thing may be said with strict truth of our modern roads. On these highways ran vehicles of superlative excellence just before the advent of railways; and the horses which drew them were as good as the coaches and curricles. All this excellence was not attained in a moment; and the Crystal Palace authorities propose to show the world how progress was effected and what shape it has taken from an early period to the present moment, when mechanical power proposes to supplement, if not supplant, the horse. Not only will a representative display of mechanically-propelled vehicles, old and new, be found at the Palace, but a collection such as has never before been got together under one roof of examples of the coach-builder's art, ancient and modern; and besides, an extremely interesting collection of pictures and engravings of the life of the highway. These possess considerable historical importance, as illustrating the dress, customs, and mode of life of our ancestors. Not a few of the exhibits are curious. Napoleon's carriage taken after Waterloo has been seen by countless thousands, but few are perhaps aware that the Duke of Wellington also had a carriage at Waterloo. This has been sent to the Palace by Col. Lionel Tufnell-Tyrell. It was presented by the second Duke of Wellington to Sir John Tyrell. It can be taken to pieces, and then forms three distinct carriages. Another curiosity is the original brougham, or at least of all that is left of it, namely, the body. Lord Brougham used it at his seat, Brougham Hall, near Penrith, Cumberland. It appears in a very dilapidated state, although the timber is still sound. The coat of arms and coronet on one of the panels are still visible. It was built about 1840. Another relic is the Queen's first carriage, built by the predecessor of William Cole in 1828, and driven by her Majesty at the age of twelve and onwards, in the gardens of Kensington Palace. This carriage was drawn by a donkey, and her Majesty at the present day still uses a similar carriage which is drawn by a donkey.

In the present day we are prone to forget the work done by our predecessors in facilitating transport and intercommunication. Those, however, who are familiar with the works of the earlier engineers understand how great was the interest displayed by such men as Telford in the construction of our magnificent coach roads. The engineering difficulties overcome were very considerable, and the perfection attained has never been impugned. The mail coach was a remarkable vehicle—a vehicle in all respects constituting a survival of the fittest, and an exquisite adaptation of means to an end. It was made the subject of most elaborate experiment in draught; and the excellence of its material and workmanship, combined with lightness, rendered it ultimately a real marvel of constructive skill. It is doubtful if at this moment an old Royal Mail, say, of 1825, is in existence, but Messrs. Holland and Holland exhibit a coach which is very nearly as old, and may be taken to represent, perhaps, the ultimatum of the art of building mail coaches. It was built about 1830 by Wright, or Waud, who were then considered the chief builders of mail coaches, and it has been in Messrs. Holland and Holland's possession for nearly thirty years. Only two years ago it went to Ascot; but now it is past work.

Messrs. Holland and Holland tell us that when this coach became their property, it was a regular Royal Mail, having only the seats behind the box seat and one seat for the guard at the back; and the latter had a blunderbuss, &c., in a box before him, where the back roof seat is now placed. This coach, before being altered, had gold stars painted on the quarters and doors, and "V.R." in big letters, this having been the fashion with all Royal Mail coaches. The hind boot opened at the top, under the guard's feet, so that the mail bags as they were thrown up could be easily dropped into the depths below. In order to accommodate the letter-bags, which, as the postage was gradually lessened, became more and more numerous, the hind boot of the carriage was made deeper than usual, and differing from the general plan, as our readers will notice on looking at this coach, the boot was brought out flush with the body of the coach. In order to allow of the extra depth of boot referred to above, the hind axle was bent downwards. As it stands to-day, with the exception of the wheels having been renewed from time to time, and the addition of the two hind seats, this interesting coach is precisely as it was sixty years ago.

Besides complete vehicles there will be a large collection of models and examples of various inventions applicable to locomotion, such as spring wheels, india-rubber tires, and a multitude of appurtenances far too numerous even to mention in detail. From H.M. War Department comes a very interesting collection of models from the Rotunda Museum at Woolwich, including such things as models of two Irish cars fitted for conveyance of ammunition, an ancient sling wagon upon curious springs, a carriage and two pontoons complete—Blanshaw's—a travelling forge wagon and limber, a gun carriage for a 33-pounder siege gun, a 12-pounder ammunition wagon, dated 1732, a crane constructed on a gun carriage—French—and a store cart dated 1732.

For our readers probably the most interesting feature will be the exhibition of self-propelled carriages in the building and the grounds. It is impossible that these carriages should be numerous, because they do not as yet exist, and of those shown the major part have already been fully described in our pages.

Nearly every method of mechanical propulsion will be shown, from the handsome little traction engine with wood tires, shown by Messrs. Burrell, of Thetford, to the small self-propelling vehicle, built in 1887, and called the Petrol cycle, shown by Mr. C. T. Crowden, and supposed to have been the first oil-driven motor vehicle ever constructed. The Randolf steam omnibus has been brought from the Patent Museum at South Kensington, and we regret to have to add that neglect and corrosion have been suffered to play havock with it. Among others who have sent or promised to send horseless carriages are Mr. Ward, who will exhibit four electrical omnibuses or vans; the Universal Electric Carriage Syndicate, Arnold Motor Carriage Co., Decauville et Cie., Emile Delahage, Louis Delmar, Gerhadt and Ochme, A. F. Hammer, F. Leitzmann, Lepape, Sir David Salomons, Bateman, Des Vignes and Terry, L'Hollier, Gascoine and Co., the Steam Carriage and Wagon Co., the Britannia Co., &c. &c.

What remains to be said about them we shall say in succeeding impressions. The exhibition, like all exhibitions, will not be complete on the opening day, and that has certainly not been the fault of the Crystal Palace Company, or Mr. Gillman, or Mr. Sennett. It is, of course, impossible to do more now than speak of it in general terms, and to add that it will be opened by the Lord Mayor on Saturday, at 2 p.m.

THE LONDON, CHATHAM, AND DOVER RAILWAY COMPANY, in conjunction with the Northern of France Railway, announce that an important new service from London to Cologne, Berlin, and St. Petersburgh, will be brought into operation once a week from May 9th. Passengers will leave Victoria at 11.0 a.m. on Saturdays, and travel *viâ* Dover and Calais, Brussels, and Berlin, reaching Cologne at 11.30 the same night, Berlin at 8.40 the following morning, and St. Petersburg on Monday afternoon at 3.50 p.m. The trains will be composed of sleeping cars and one dining car. This service will effect a saving of nine hours, compared with the ordinary through trains, and will give an excellent and rapid means of reaching Berlin by the Calais route. There will also be a special service on the same day *viâ* Ostend, and passengers leave Victoria one hour earlier, viz., 10.0 a.m. A similar service will leave St. Petersburg on Tuesdays for the return journey, by both routes.

BRICKPAVING.—The specification for brick paving adopted by the city of Peoria, Ill., for the coming year's work, includes the following:—The foundation is to be 6in. of concrete, composed of one part natural cement, 1½ parts sharp sand, and four parts broken stone concrete, covered with a 2in. cushion of sand. The size of the bricks is to be 2½in. by 4in. by 8in., or 3in. by 4in. by 9in., and they are required to withstand the following tests:—(1) A transverse test flatwise, in which they shall show a modulus of rupture of 2200 lb. per square inch; (2) an absorption test, in which, after forty-eight hours' immersion, they shall show an absorption of not more than 2 per cent. of their own weight; (3) an abrasion test, in which twelve bricks are placed in a cylindrical rattler, 24in. by 3ft., with 300 lb. of smoothly-worn scrap iron, in pieces varying from ¼ lb. to 5 lb. weight, and revolved one hour at fifteen revolutions per minute, after which the loss by weight for the smaller brick is to be not more than 9 per cent., and of the larger brick not more than 7 per cent. The cement is to be tested for fineness, time of setting, soundness, and tensile strength. In the pavement the bricks are to be set on edge in rows running transversely across the street, except at street intersections, where the rows shall make an angle of 45 deg. with the curb lines. After laying, the bricks are to be settled by a roller weighing not less than 250 lb. per lineal inch, or by tamping by a 60 lb. rammer on a 2in. by 12in. by 12ft. plank. The joints are to be filled with sand.

MIDLAND INSTITUTE OF MINING ENGINEERS.—A meeting of the members of this Institute was held on Saturday, 18th April, in the Chemical Lecture Room, Firth College. Mr. John Nevin, president, occupied the chair, and amongst the gentlemen present were:—Mr. A. M. Chambers, J.P., Mr. G. B. Walker, J.P., Mr. T. W. Jeffcock, J.P., Mr. H. Bonser, Mr. E. W. Thirkell, Mr. A. A. Atkinson, Mr. H. Nash, Mr. T. W. H. Mitchell, Mr. A. W. Bennett, Mr. R. Kennedy, Mr. W. Washington, &c. A discussion on Mr. G. Blake Walker's paper on "The Roth Method of Firing Shots" was opened by Mr. Shea, with a series of experiments, showing the means by which explosion of the cartridge is caused in Dr. Roth's system. He said it seemed to him to be a very good and serious attempt to avoid the use of fuse in mines, but he could not see that it possessed any great advantage over the electrical method of firing shots. A practical objection appeared to him to be the danger of the leaden tube getting closed up. The leaden tube connecting the bottle outside with the detonator in the shot hole was of very small diameter, and in stemming the shot a slight shot might cause the hole to be closed up so that the chlorine gas could not get to the detonator, and there was also the possibility of some chemical change taking place in the mixture which might involve danger when it came to be used in the mine. In replying to a vote of thanks, Mr. Shea said that chlorine monoxide, though a dangerous gas, was perfectly harmless and safe used in the way Dr. Roth suggested. Replying to Mr. Bennett, Mr. G. B. Walker said it was usual to carry the tube only just through the shot hole; two minutes elapsed before the shot was fired, so that there was plenty of time to get away. The system, he understood, had been used in Westphalia with very satisfactory results. After some remarks from the chairman on the Acton Hall sinkings, a short discussion arose on Professor Lewes' paper on "Mining Explosives." Mr. H. Bonser, in reviewing the position, said a perfectly safe explosive had yet to be manufactured, and it followed that mechanical methods must be resorted to in this direction. Nothing safer than the water cartridge and the gelatinous cartridge had yet been employed, and the committee charged with the subject might extend their observations by firing explosives surrounded by water in future experiments, and he had little doubt the problem of complete safety would be solved. Professor Lewes said a small quantity of carbon monoxide would make a mixture of coal dust and air very explosive, and that by igniting carbonite in a small bomb and sprinkling coal dust into it the whole was readily ignited by a lighted match. The experiments carried out by the committee of the North of England Institute did not bear out this contention, and actual experiments outweighed all theories. With any high explosive the quantity of carbon monoxide produced by a shot was perfectly inappreciable in a working place. Mr. G. B. Walker and Mr. Shea spoke briefly, pointing out that in given circumstances carbon monoxide might cause an explosion in coal dust, Mr. Bonser holding it was not a practical question. A discussion on Mr. Rankin Kennedy's paper on "Electrical Machinery for Mines," was adjourned.

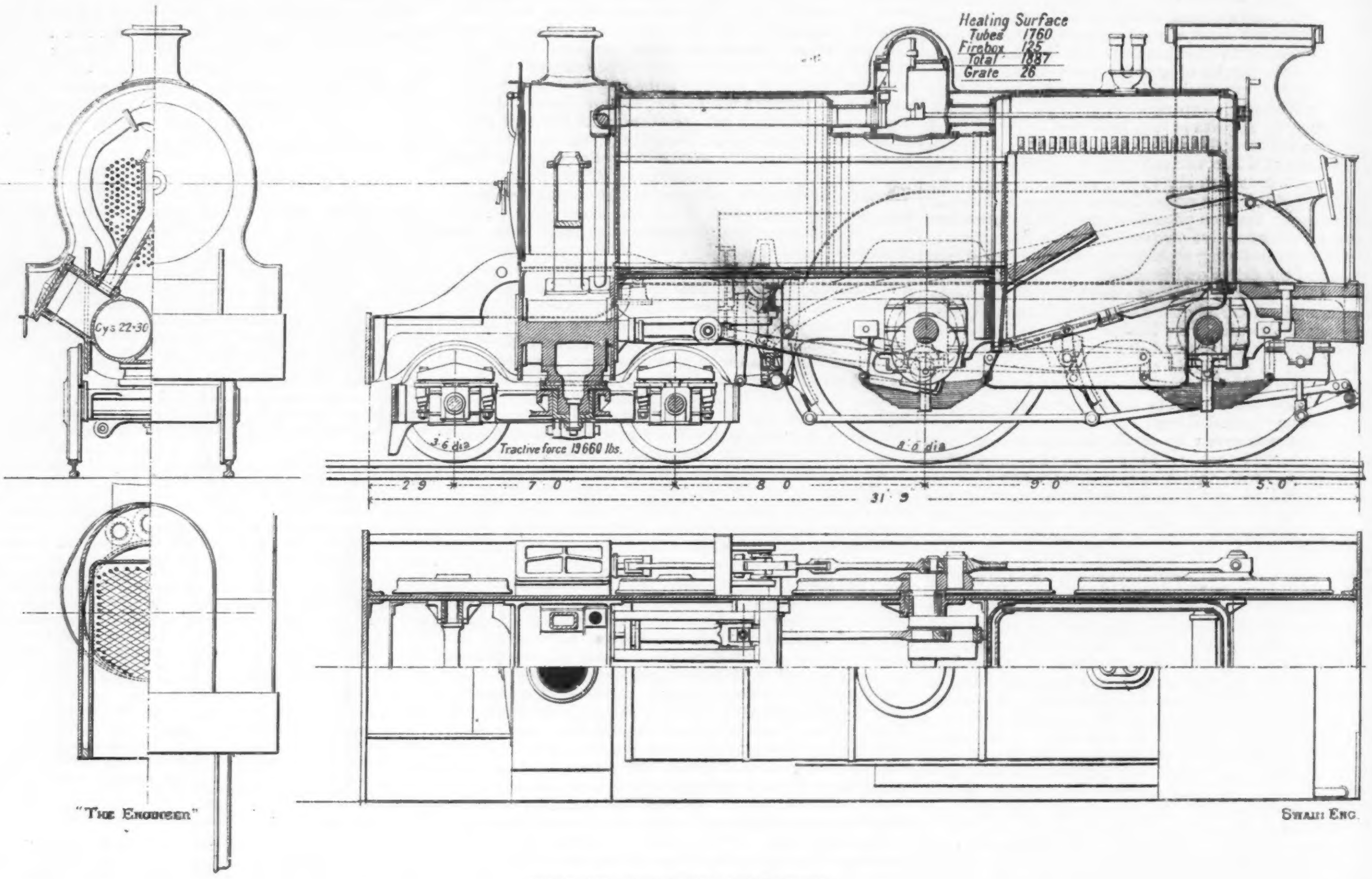
LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

COMPOUND LOCOMOTIVES.

SIR,—In furtherance of my letter published in THE ENGINEER March 20th, I now enclose print of the large locomotive. You will see that it is designed on the lines aid down in your article of March 13th. Having made some of the preliminary drawings of Winby's patent locomotive when with Messrs. Hawthorn, Leslie and Co., I concluded that it was not an engine that would commend itself to railway engineers, also that an engine could be designed of equal or more power without the complication and cost. The greatest difficulty was the boiler, but, as will be seen from the drawing, this was overcome in a very simple manner.

The fire-box is of the ordinary raised locomotive type, the bridge stays being arranged transversely on account of the length. From the fire-box shell the barrel is of ordinary diameter, to go between the driving wheels, it is then increased in diameter and joined to the smaller part by a circular flanged plate, the flat surface of which is supported by the diagonal stays which support the smoke-box tube plate. On the smallest diameter of barrel the dome is placed, which is connected to the fire-box shell by a steam-pipe, through which the regulator rod passes. The regulator steam-pipe is connected to the dome and flange plate of the barrel, and there are two steam-pipes—one on each side of regulator pipe—connecting the dome with the front part of the barrel. The large diameter of barrel and increased height of fire-box shell give ample steam space, and the smallest part of the barrel is filled with tubes, and the dome, being above, takes the steam. The fire-grate, being sloped, can be carried over the trailing axle, and this gives the necessary grate area. The height of boiler is greater than usual, but there are engines running in this country within a few inches of it, but in America there are many locomotives running at high speed with much higher boiler centres on the same gauge.



BAGULEY'S COMPOUND LOCOMOTIVE

The inside cylinders are cast, together with the valve chests outside the frames, at an angle of 30 deg. This allows ample room for the steam and exhaust pipes, and is necessary for the valve gear, which is Baguley's patent, and in the engine illustrated is worked from the coupling-rod pin or driving axle. It consists of a valve connecting-rod, the driven end of which works a pendulum lever, the end of which carries the radius link, and gives the lap and lead movement by lifting the radius link from side to side. The radius link has an arm which is connected to the valve connecting rod, and the horizontal vibration of the latter rocks the link or its centres, and gives the port opening and cut off. The gear has been fitted on over thirty locomotives—tank engines—and gives excellent results in practice, the wear and tear being reduced to a minimum.

The engine frames are parallel from end to end, and the whole of the motion, &c., is on straight lines throughout, without overhanging parts or cranks. The bogie is of the cradle type, and with its wheels swings completely under the frame, so that the engine may pass round sharp curves with safety.

The whole idea being to design a locomotive that could be constructed for about the same price per ton as existing engines, and to follow, as far as possible, ordinary main line practice, keeping the outside appearance similar; the total width, height, and running weight per wheel are such that it could be run on any of the leading English lines, the weight per pair of coupled wheels not being greater than what is daily run by single expresses.

Stafford, April 14th. ERNEST E. BAGULEY.

SIR,—Your recent article on triple cylinder locomotives I have read with interest, but must take exception to your statement that the compound locomotive will do best on a long straight run, and presumably at high speed. I take the view that this is the kind of service in which the compound will do the poorest and the simple engine the best. Quick work enables the simple locomotive to work its steam most expansively, and with minimum losses, while with compounds this service increases the loss of work between the cylinders, and gives less opportunity for re-heating in the receiver. This loss of work has often been in poorly-designed compounds sufficient to neutralise the gains from compounding, so much so that the compounds referred to have saved no water, although they have saved coal by better evaporation.

In suburban work and heavy freight work the compound saves most over the simple engine, because it expands its steam more than the simple, and exhausts at a lower pressure. When a simple engine starts it is necessarily for some time very wasteful, while the compound engine is fairly economical from the start, and much more so soon after.

I should be very glad to have you state at length what your reasons are for thinking that the compound locomotive has its greatest advantage over simple locomotives in long fast runs.

I enclose a copy of a paper of mine upon compound locomotives, read before one of the irregular meetings of the American Society of Mechanical Engineers. F. W. DEAN.

53, State-street, Boston, Mass., U.S., April 17th.

BOILERS FOR ELECTRIC LIGHT STATIONS.

SIR,—From a perusal of your recent columns, your readers will have concluded that only two types of boilers—the water-tube and Lancashire—are in actual use for electric light stations and suitable for such. This must be our excuse for troubling you with this letter.

The marine boiler of the single-ended Scotch type, with Serve tubes and the Ellis and Eaves suction draught, possesses all the features specially desirable for this purpose. It is giving complete satisfaction, and a repeat order is now being executed for the extensions in one installation. It is being fitted in three others. At our own works, where the demand for steam is also unequal and intermittent, similar boilers have been at work for nearly five years, day and night, with the exception only of Sundays and holidays. The total plant on this system in our own works represents an evaporation of over 150,000 lb. of cold water per hour.

This combination occupies much less ground space for a given horse-power than the water-tube boiler of the types in use or the Lancashire boiler, even when no economisers are used. At the same time the efficiency of the installation is very high, no less than 72½ to 75 per cent., even when burning at the rate—familiar enough to us, though strikingly high to those unacquainted with it—of 45 lb. of coal per square foot of grate, 5ft. 8in. long, exclusive of dead plate. The rate of draught is varied instantaneously at will from the lowest to any intermediate or the highest rate, without damage to the boiler, as proved by the experience named. Thus one boiler, 10ft. 6in. diameter by 10ft. 6in. long, occupying, with suction fan and engine—placed usually behind it on the ground—a space of 19ft. by 12ft., will easily give at this rate of efficiency an evaporation of 12,000 lb. of cold water per hour for the period of the maximum load, or even 15,000 lb. with special coal, whilst pressure can be maintained with a few pounds of gas coke per hour when no service is required. At the intermediate rates of combustion the efficiency is naturally still higher, but the other types of boilers named are not equal in efficiency, at any rate, of combustion, to the efficiency at our highest rate. Incidentally, any kind of coal can be burnt without smoke. High chimneys are not required, but only such as are insisted upon by local authorities to carry the smokeless gases away at sufficient height to be no nuisance to the immediate neighbourhood. There is no brickwork. The boilers are above ground and accessible all the time.

Thus from a given ground area this system enables a greater total evaporation to be obtained, with a higher rate of efficiency than with any other system at present in use, whilst the control of power is absolute. We have removed over fifty of the large number of Lancashire boilers we had, partly for the sake of the space, partly for the economy. Pea-nuts are very convenient fuel, and the boilers will burn anything which can be burnt in any boiler.

(JOHN BROWN AND CO.)

Sheffield, April 22nd. F. GROSS.

CIRCULATION IN WATER-TUBE BOILERS.

SIR,—I regret that through absence from home I did not see, till last week, the leading article in your issue of April 3rd, in which you honoured me with so much attention in connection with the discussion, at the late meeting of the Institution of Naval Architects, on the theory of circulation as set forth in Professor Watkinson's paper on water-tube boilers.

I have now carefully read that article, and I find so great divergence between the views I entertain as to the causes of circulation and those which you have ascribed to me, that I cannot help thinking that the discussion alluded to, or at least the part which I was permitted to take in it, must have been very imperfectly reported to you. I am the more led to this conclusion because, in your report of the discussion, the summary of my remarks is limited to two sentences, the first of which is misleading, and the second refers to a matter to which I certainly did not allude at all.

Under these circumstances, and as you kindly invite a reply from me, you will, I hope, allow me to state briefly the substance of what I really did say on the occasion, my memory being refreshed by a copy of the shorthand notes now before me.

Professor Watkinson had considered three stages of circulation:—(1) Before steam was formed in the up-tubes. (2) When bubbles of steam were being formed, but not in sufficient quantity to break the continuity of the water. (3) When very rapid generation of steam caused steam or foam to interfere with the continuity of the water. He stated that in the two extreme cases—(1) and (3)—the cause of circulation was the difference of the density of the risers and down-comers.

With this I entirely agreed, but I differed from him in that I ascribed the same cause to the intermediate case (2); also, whereas Professor Watkinson assigned a different cause to this case, viz., the "entraining action" of the bubbles rising through the water in the up tube. It is this "entraining action" or "frictional drag" of the bubbles as they rose, or rather, were forced, through the water which I took exception to as a cause of circulation. I pointed out that the upward drag of the bubbles on the water is necessarily accompanied by an equal and opposite drag on the bubbles by the water through which they are moving. Now the observed effect is that the whole contents of the up tube—water and bubbles together—are being lifted bodily. The action and reaction between the two parts, the bubbles and the water, which neutralise each other when the motion of the whole mass is considered, are powerless to lift the whole mass bodily. Surely Newton's Third Law of Motion teaches us that no internal actions between parts of a body, simple or complex, can move that body as a whole. Were it otherwise, there would be some hope of success for the boy who tried to lift himself over the fence by tugging at his boot laces.

Professor Watkinson did not improve matters by appealing to an experiment wherein he produced circulation by dragging a row of beads on a string up and down a tube of water. Here he introduced an *outside* force, the pull on the string, and the experiment, I submit, has no bearing whatever on the results of the mutual action of steam bubbles and the water round them.

It certainly seems to me that the superior pressure in the down-comers, due to the greater mean density of their contents, is a sufficient cause of circulation, not only in Professor Watkinson's extreme cases (1) and (3), but also in the intermediate case, and, indeed, in every case of natural circulation in water-tube boilers.

Allow me now, Sir, to allude to an argument which you advance in your own article, with the object of disproving the above simple contention. You imagine a diaphragm across a vertical U tube, and at the lowest point of it, dividing the water in one leg from that in the other, and you say that "So long as there is a column of water, no matter how thin or how light, extending from the top of the riser to the diaphragm, no movement can take place, the hydrostatic pressure being the same on both sides of the diaphragm."

This is certainly true as a hydrostatic problem, or as long as everything is at rest, but permit me to point out that the motion of water, and, therefore, circulation in water-tubes, is governed, not by hydrostatic laws, but by the laws of hydraulics.

Let me put the matter differently. We will suppose our vertical U tubes, connected with a water-receiver at the tops, to contain solid water in the right leg and some immersed bubbles in the left leg, which bubbles are by mechanical means in some way held down and prevented from rising. We have the same pressure near any one of the bubbles in the left leg as at the same level in the right leg, and everything is at rest. But now let the bubbles go, and instantly the water around them acquires velocity, and, in so doing, loses pressure, the "pressure head" being partly transformed into "velocity head," according to the well-known hydraulic law. The pressure is now less in the left leg than at the same level in the right leg, and a flow is at once set up from high-pressure to low-pressure, or from the right leg downwards towards the left. I hope this is clear, and that it may appear to you, Sir, as it does to me, to be a sufficient theory of circulation, consistent with the one previously discussed, but from a different point of view.

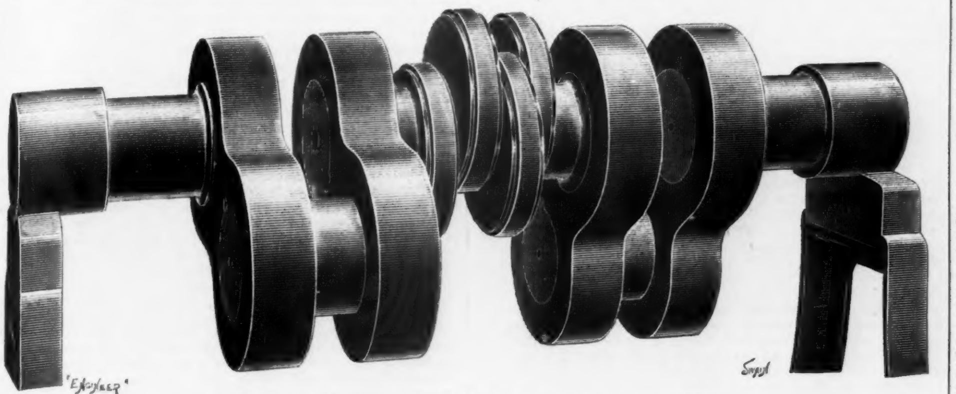
I have written this letter, Sir, in response to the invitation conveyed in the last clause of your article, and I venture to hope that you may find space for it in your next issue of THE ENGINEER.

Royal Naval College, Greenwich. CARLTON J. LAMBERT.
April 28th.

[We hasten to express our regret that we have misunderstood Professor Lambert's words. The point, however, is of very small importance as regards the phenomena. The difference of opinion on the main fact remains. As to entraining action, if Professor Lambert is right, no body moving through water draws any after it; and a ship, for example, has no following wake; a boiler never primes, and steam is always dry. We must ask Professor Lambert to reconcile his denial of all entraining action with his hydraulic theory. We gather that he holds that the bubble-containing column rises, because the bubbles when rising cause a loss of pressure at the base of the column, although they would not if they were at rest. Professor Lambert overlooks the fact that the bubbles are pushed up from below, and that this pushing results in a reaction at the place of the diaphragm. "The pressure is now less in the left leg than at the same level in the right leg," says our correspondent. Why is it less? We strongly suspect that our correspondent uses the word entraining in a somewhat different sense from ours. We shall be glad to hear further from Professor Lambert on this subject.—ED. E.]

A BUILT-UP LOCOMOTIVE CRANK SHAFT.

SIR,—You may think the enclosed photograph of a built-up locomotive crank axle of sufficient interest to your readers to illustrate in your journal. With proper tools it is not costly to produce, and enables us to get more effective surface for the big ends than in the solid crank, owing to there being no radii at each end of the crank pin. The pin and also the axle-box bearings are case-hardened, which gives a more durable surface. The excentrics and the middle are turned out of the solid.



BUILT UP LOCOMOTIVE CRANK AXLE, L. & N. W. RAILWAY

The crank from which the photograph is taken was for one of our engines with 17in. cylinders by 24in. stroke.

Crewe, April 22nd. F. W. WEBB.

THE LIQUEFACTION OF GASES.

SIR,—If your correspondent "Cryos" will first make himself acquainted minutely with what has been done, and will then ask me any question that puzzles him, I shall be happy to give him any information I can. At present, however, it is quite clear that he has failed to understand the Hampson process. Indeed, if "Cryos" is right, Dr. Hampson has never liquefied a gas at all, and my eyes have deceived me.

"Cryos" cannot understand how great cold can be produced in an apparatus which has lost no heat. The explanation is simply that two different temperatures not only may, but do constantly exist in the same body of gas. Take, for example, the temperature, say 4000 deg. Fah., of the gas entering a flue of a locomotive, and 600 deg. Fah. the temperature of the same gas at the other end of a tube 10ft. long. In the Hampson process we have a tube more than 10ft. long. At one end the temperature is some 250 deg. or 300 deg.; at the other it is – 180 deg. or – 200 deg. The difference is probably less than 500 deg. in this case. It is probably at least 3000 deg. in the case of the locomotive flue. There is surely no matter for wonder in the difference in the Hampson apparatus?

It is a simple matter of calculation how much the Joule effect can accomplish, and for air or oxygen it is too little to take practical account of. With carbonic anhydride it is about five times as much as with air.

"Cryos" is under the mark when he says that the expanding air does work against the atmosphere. It does very much more. Expanding in the Linde apparatus from 300 atmospheres, or 4500 lb. on the square inch, into 100 atmospheres, or 1500 lb. on the square inch, it helps the compressing pump during the suction stage in a way which "Cryos" will readily understand; but then all this work reappears as heat at the compression side. It represents so much less fuel burned, but it does not represent any loss of heat outside the apparatus.

The regenerative cold aspect of the question is really too simple, I think, to need further elucidation.

Finally, I may call "Cryos's" attention to the circumstance that he has not given a scrap of evidence that any energy in any form escapes from the apparatus. All the efforts, indeed, of the user are expended in preventing, with indifferent success, energy from getting into it from the external surroundings in the shape of heat. Even if the Joule effect was applicable—which it is not—that would not determine the escape of energy from within to the external world.

I have no desire to inflict a long mathematical disquisition on your readers, when nothing of the kind is really necessary. But it may not be out of place to refer "Cryos" to Hirn's treatise on thermodynamics for a fuller handling of the porous plug experiment than is to be found in Clerk Maxwell, and to page 114 *et seq.* of "Thermodynamics, Heat Motors, and Refrigerating Machines," by De Volson Wood, published by John Wiley and Sons, New York, in 1889. ZERO.

April 27th.

PERMANENT WAY.

SIR,—I trust you will afford me the opportunity of saying another word upon the subject of "Permanent Way," especially as Major Marindin, in his report on the Little Bytham accident, corroborates my views in more than one direction. I agree with the Major that no fault is to be found with the "individual in the matter of inspection, and I consider it lies at the door of those only, who, by their attainments and position, are quite capable of investigating the effects produced on the so-called permanent way, by the introduction of a very heavy rolling stock, with the disposition of the weight and the high speed at which it is run."

It seems to have been forgotten that the only effective connection between the rail and sleeper and the "formation" of the road is due almost entirely to the weight applied as the load rolls over it, producing besides a lot of effects evidently not yet challenged, even if suspected. The weight of the rails and sleepers themselves, including the few barrow loads of ballast cast upon them, may be taken as *une quantité négligible;* but not quite so the ballast, which might be put between the sleepers and at their ends.

Where the lives of her Majesty's subjects are concerned, and considering that I myself might unfortunately have been a traveller with the train that came to grief at Little Bytham, I feel that I have a right to make myself heard by the greatest number on a matter that I know something about; and I attempt this, too, because I think the last word has not yet been said upon it, and that in the interest of all the subject cannot be considered as closed.

I have no idea of criticising the report of Major Marindin, but I do ask why any one should suggest—the realisation of which only adds greatly to the inferred shortcomings of the "practice" condemned—that a lighter train, certainly not going at half the speed of the train which followed it, should have the effect of "distorting a road," and preparing it for the derailment of a following train, far more capable in itself of producing the necessary distortion? Why suppose the lurching felt by the locomotive of the latter train, not to have been the direct result of the very much heavier blow inflicted by a much greater weight, multiplied into a greatly increased velocity? If the previous train did perform the sinister work, then the possibility of the succeeding train doing it was doubly imminent.

There are numerous items of possible improvement of the permanent way of a railway, beside the very good one of the steel chair—if only engineers will think so, there's the rub—which in time will doubtless be adopted, and the sooner the better—I say for all concerned. J. W. WILKINS.

15, Lilford-road, S.E., April 28th.

SIR,—I see a correspondence is beginning on this subject, and especially *re* steel *versus* iron chairs.

Is not the proper solution of the matter the abolition of chairs altogether? Our use of railway chairs seems contrary to the general practice of other countries, and it must lie with those who support the chair system to show us its advantages. Your readers who were brought into contact with the leading representatives of the United States and other countries at the International Railway Congress will bear me out in saying that while they admired the excellence of our permanent way they were unanimous in condemning our chairs as making the road too rigid and hard. The only result of using chairs—beyond extra expenditure—would seem to be to make the rails a continuous bridge supported on a hard surface, with a very small bearing surface; instead of placing the rails on the sleepers which gives the whole width of the sleeper as a bearing surface, and this surface one which is slightly elastic, and which therefore mitigates the blows and noise inseparable from wheels running at speed on metal.

But, as I have said, perhaps someone will start a discussion by telling us the advantages of chairs; the disadvantages are manifest. NORMAN D. MACDONALD.

SIR,—Your correspondents of last week make some strong statements. I have seen the chair referred to—Muirhead's, of Glasgow—and although not prepared to endorse the claims of your correspondents, I am sure the new chair will get a fair trial. It has several points in its favour. (1) It is said to be cheaper, that is, a mile of road can be laid at less cost with this than cast iron. (2) It is of the same pattern as the old chair, taking the same key and spikes, so that no special arrangements have to be made for its adoption. (3) Being half the weight, the platelayers will be all in its favour. If, as is stated, it is found to be cheaper than cast iron, that will be its greatest claim, as, unless it can meet its old opponent in price, it will have no chance, as, however willing railway engineers may be to introduce improvements, they must satisfy the treasury of the railways. Every former attempt in producing a steel chair has failed in this particular. Therefore, it remains to be seen if the distribution of metal adopted in this new one can make it a commercial as well as a mechanical competitor with the old chair. INSPECTOR.

Leeds, April 28th.

SIR,—Major Marindin's report on the Little Bytham accident, which has just been issued, states that "owing to the deficiency of ballast the road was unfit for trains to run over at full speed."

I think it should be generally known that in America and some of our colonies a system of ballasting is adopted by means of specially designed hopper wagons and ploughs, whereby the process is greatly simplified, and a train load of ballast can be deposited, spread, and trimmed in less than ten minutes, with the attendance of only one or two men. This system has been adopted in this country by the Great Western Railway Company, where its advantages are recognised and appreciated, and also by the Glasgow and South-Western and Great North of Scotland Railways; but the majority of our English railway companies hold aloof, and, with true conservative feeling, prefer to adhere to their antiquated and costly practice.

It can hardly be doubted that if such a method of ballasting had been in vogue where this accident occurred there would have been no occasion or inducement to defer the operation of ballasting until the necessary time and men could be found to do it, the catastrophe would have been averted, and a lamentable loss of life have been prevented. JAMES FFORDE, M. Inst. C.E.

17, Victoria-street, Westminster, 24th April.

SIR,—Two correspondents have, in your issue of 24th inst., advocated the use of steel chairs, although it is not quite clear whether cast or rolled steel is recommended. In either case the question of cost should not be disregarded; and it is scarcely likely that the cast iron chairs now used will be replaced by steel ones, unless some distinct advantage on the score of economy can be shown.

No doubt the excessive weight is objectionable in more respects than one, and it arises—(1) from the great bearing area necessary to prevent crushing into the wooden sleepers; and (2) from the great thickness of metal required under the rail to resist cross strain in the chair.

By using the system described and illustrated in my letter, published in THE ENGINEER of 25th October last, the weight of cast iron necessary for the support of an 85 lb. rail can be reduced to 32 lb., without any sacrifice of strength or alteration in the present method of keying; and I do not think it would be easy to improve this in either efficiency or cost. I should be glad to furnish either of your correspondents with further particulars if desired. JAMES WHITESTONE.

113, Queen Victoria-street, E.C.,
April 28th.

SIR,—Your correspondent, "For the Platelayers," in his suggestion for the use of steel chairs instead of the present heavy cast iron ones, is partly answered by Mr. James Andrew, but these gentlemen do not seem to be aware that there are some steel chairs on the Glasgow and South-Western Railway, outside St. Enoch Station, which were laid there eighteen months ago, and are as good as ever to-day. From inquiries in Glasgow, I find these chairs are made under Mr. R. M. Harrison's patent, weigh 18 lb. each, and are pressed out of a piece of tin-plate bar. I am also informed that the Great Northern Railway, North-Eastern Railway and Caledonian Railway are using these chairs on parts of their lines, and as they seem to me to be practically unbreakable, and have the merit of elasticity, which cast iron has not, I think they would be just the things for the platelayers, your correspondent included. S. E.

Birmingham, April 27th.

HORSELESS CARRIAGES.

SIR,—It seems to me a mistake to allow one carriage to draw another at a high speed. You cannot get power out of the driving wheels unless you have great weight on them, and it would practically allow the present traction engines with their heavy trains behind them to occupy the roads and run at a dangerous speed. If two vehicles were hinged together and their length did not exceed 20ft. it might be reasonably safe, but the utility of it is questionable. As to a breakdown, one vehicle could be sent to bring home the broken carriage, if it observed the rules of a red flag and four mile speed. If Parliament allows a total weight of four tons for the carriage and its load, and a maximum speed of ten or at most twelve miles an hour, it is all we want with a maximum length of, say, 20ft. or 22ft. A landau and its pole is about 20ft. long. G. A. HAIG.

SIR,—In reading over the conditions of the road carriage competition I observe that you have omitted to stipulate that the vehicles shall be sufficiently powerful to ascend the steeper gradients, and I venture to think that this should be in some way incorporated in these conditions. The gradients on most roads are admittedly seldom above 1 in 14-15, but any one acquainted with the country, and venturing into the hilly districts, will be faced with grades up to 1 in 8. It may be news to you, but in Scotland in the northern parts and on the main lines of highway in the highlands 1 in 10 is not infrequent. If you will consult the map you will find that on the Inverness and Wick road there are big hills—that at Berriedale being, I think, 1 in 9, with a nasty turn on it. The Perth and Braemar road, with the "Devil's Elbow," a fearful double turn, shaped so Z, is on the slope of 1 in 9, and on account of its altitude the surface is abominable. The Glencoe road is 1 in 10 at its steepest point, and has also very rough surface. Were these side roads it would not matter much, but seeing they are high-roads, and the gradients being necessities, mostly from the physical features, it is scarcely likely that a remedy is possible or can be expected. Off the main lines of traffic there are, of course, any number of other hills of equal steepness leading to the more out-of-the-way districts, but they nearly all lead to the prettier parts of country, so that for a tourist travelling through this country, at least to see the scenery, a vehicle would need to be sufficiently powerful to overtake a long grade of 1 in 9, with a pretty rough surface.

One of the circulars of an oil motor company states that it will ascend a grade of 1 in 10, but it seems to me this is scarcely sufficient, for Scotland at least, and I should be inclined to say that the English lake district, Devonshire, Derbyshire, Wales, and many parts of Ireland matters will be on a very similar footing. I venture to propose that in the trials some rough ascent of the grade I state should be incorporated as a supplement, with a view to satisfaction as to the universal utility of the better class vehicles. By doing so I think you would save annoying experiences to those unacquainted with exact steepness of the "dangerous" hills. HARRY R. G. INGLIS.

20, Bernard-terrace, Edinburgh, April 27th.

[We have no doubt that competitors will be fully prepared for the ascent of very steep hills. Whether it would be wise under any circumstances to attempt to work mountainous districts with horseless carriages is a question on which we express no opinion.—ED. E.]

SIR,—It is with great interest that your articles and paragraphs on the horseless carriage are read in Australia. For there is but little doubt that in a country where water is frequently very scarce, and horse feed occasionally dear, the demand for such vehicles must naturally grew apace. Though in Victoria as yet no one has ventured to import one of these machines, yet I would like to inform all English manufacturers that before they can with safety dispatch a carriage to this part of the world they must look to it that the motor can use an oil which is safe with the thermometer at 120 deg. in the shade. It frequently happens that that temperature is reached and occasionally exceeded, and if it approaches that in the shade the sun reading can be easily imagined. We have frequently had inquiries for these vehicles, but have not conscientiously been able to recommend them for the simple reason that we had doubts as to the safety of the oil used. If any maker of horseless carriages can provide a conveyance which will be unaffected by the most powerful sun's rays, and which will also be able to endure the rough usage which always falls to the lot of machinery that is handled by farm labourers, we shall be glad to be put into communication with them.

Melbourne, March 20th. PHILLIPS, ORMONDE AND CO.

THE NAVIGATION OF THE THAMES.

SIR,—The report to the Board of Trade by the Lower Thames Navigation Commission recalls attention to this matter. I have awaited its issue with great interest. The recommendations of the Commissioners are good, but I think it is to be regretted that the reference to the Commission was so limited, and did not include the Upper Thames—in fact, the whole river from the Nore to London.

It has long been a matter of surprise to me that the Thames Conservators should not have done more towards the deepening of the river. It is amazing that they should so lag behind the needs and demands of the time, and fail to provide for the requirements of the largest vessels, especially in view of what has been done by smaller ports and navigations. Why should London not be a "non-tidal" port right up to London Bridge? Would any spirited minor navigation allow such an obstruction to remain as the Thames Tunnel, with only 12ft. at low water? Probably the tunnel in time will have to go, and it seems to me that neither it nor the enormous values of riverside properties should be allowed to stand in the way of the provision of such a low-water channel as shall meet the needs of the largest vessels. The scheme of dredging proposed by the Conservancy Board will not do this. They should not hesitate to provide 30ft. from the sea to London Bridge.

A. SCOTT, Assoc. Mem. Inst. C.E.

Newcastle-on-Tyne, April 29th.

THE CRYSTAL PALACE.

SIR,—Will you kindly allow me a little space in your next issue to inform "M. E."—who writes to you from Dulwich, April 20th that the difference in level between the Low Level Station and the floor of the Crystal Palace is not "50ft.," but 157ft. If he will look on the 6in. Ordnance map of the district he will find the figures printed thereon. I venture to suggest that the best and, I believe, the cheapest method of conveying passengers from the Low Level Station into the Palace would be by means of a cable tramway simiiar to that now successfully in work between Kennington and Streatham Hill. I am sure no one would grudge the extra 1d. to be landed in the Palace, instead of having to tramp up the flights of stairs and along the almost interminable rising corridors, which is the only method in use at present. MEM. INST. C.E.

Westminster, S.W., April 27th.

TUBE WELLS AT GAINSBOROUGH.

SIR,—We notice in your issue of the 24th inst. a paragraph in reference to the boring at Gainsborough for the Urban District Council. The weight of tubes is mis-stated; it should be 28 tons instead of 18 tons. The boring, when plumbed at 310ft., was found to be 2¼in. out of perpendicular, 6in. having been allowed in the specification.

We are now about completing the borehole for the Goole District Council, which is 1000ft. deep, 18in. diameter, and are lowering in one complete length 835ft. of 15½in. perforated tubes weighing 18 tons. (For EBENEZER TIMMINS AND SONS, Ltd.),

Runcorn, April 27th. A. TIMMINS, Director.

RE ELECTRICAL COLONISATION.

SIR,—The scheme proposed by Mr. Meacock, of electrical colonisation, is not novel; it is almost identical with that formulated by Earl Russell and B. H. Thwaite, in the *National Review* some three years ago.

The proposal for rural districts is really very admirable, and would enable electric lighting to be cheaply obtained.

April 28th. RURAL.

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

Concrete and iron arch bridge.—A highway bridge having two spans of 97½ft., two of 110ft., and one of 125ft., is to be built across the Kansas River at Topeka, and is to be on the Melan concrete and and iron system. It will have a 27ft. roadway, and two side walks 7ft. wide. The four piers and two abutments will be of monolithic concrete, one part Portland cement, three parts sand, and six parts 2½in. broken stone. Towards the surface this is to be one cement, two sand, and four parts ½in. stone, while the surface is to be faced with 1in. of one cement to two sand. There are to be twelve steel arch ribs, 3ft. centre to centre, each rib being a lattice girder 18in. deep over the angle iron chords—or booms—these ribs being connected longitudinally at the piers. There is no lateral metallic bracing. The concreting will be carried on in longitudinal ribs between the steel ribs, and this arch concrete will be composed of one part Portland cement, two parts sand, and four parts of ½in. to 1in. broken stone. The exposed faces and soffits will be faced with 1in. of mortar composed of one part cement to two of sand, thoroughly bonded to the main body of the concrete. Between the spandril walls will be earth filling, rammed hard, covered with a concrete pavement foundation of one part natural cement, two parts sand, and three parts broken stone. On this will be a 2in. cushion bed of sand, and one layer of paving brick set on edge. Expansion joints—filled with pine strips—are provided in the concrete walk. The side walk paving is of one part cement, two sand, and four stone, covered with 1in. of mortar, of two cement to one sand. The ribs are to be of open-hearth steel, with not more than 0·08 per cent. phosphorus, having an ultimate strength of 60,000 lb. to 68,000 lb., an elastic limit of not less than half the ultimate strength, an elongation of 28 per cent. in 8in., and a reduction in area of 40 per cent.

A 16in. gun lathe.—An immense lathe for boring and turning 16in. guns has been built by the Pond Tool Company, to the designs of the engineers of the United States Ordnance Department, and is to be erected at the Watervliet Arsenal. This great tool is 138ft. long over all, and its total weight is 280 tons. The carriages weigh 18 tons each, and the headstock weighs 52 tons. The 16in. rifled guns for which it is designed are about 50ft. long, and weigh 142 tons. The bed of the lathe is in six sections, each weighing 20 tons, and the sections carrying the boring bar are narrower than those carrying the carriages, rests, and headstocks. The main spindle of the headstock is of cast iron, 24in. diameter, with a bearing 31⅞in. long in an adjustable split cast iron shell. To the spindle is bolted the cast iron face plate, 18ft. diameter, weighing 13 tons, and to this is bolted the cast steel ring gear, 10½in. face, 8ft. 9in. outside diameter, the teeth being machine-cut, as in all the gearing of the lathe. The cone pulley has five steps for a 10in. belt, and by means of two sets of gearing and two speeds of countershaft, the spindle can be given twenty different speeds, ranging from 0·22 to nine revolutions per minute. The head screw is 5⅞in. diameter, 63ft. long, with a left-hand thread of four threads to 5in. The feed motion for the boring bar is transmitted from the head gearing to the foot of the lathe by a 4½in. steel shaft 137ft. long, made in two sections for convenience of transportation, and carried on drop bearings within the bed. The boring bar is of forged gun steel, 11in. diameter, 61ft. 3½in. long, and weighs six tons; it has a 4in. hole through it. The feeds for the boring bar range from 0·008in. to 0·17in. per revolution of the gun, while the clutch pulleys give it a motion of 28ft. per minute, independent of the motion of the gear. The gun is carried by two ring rests and a bent rest, forged steel rollers being placed in the sides of the rests. This lathe cost about £10,000.

Boring out heavy guns.—The 12in. steel breech-loading rifles, which are the largest guns as yet made at the Watervliet Arsenal, comprise eleven parts, all of forged steel, having an ultimate strength of 95,000 lb., and an elastic limit of 45,000 lb. The tube and jacket, 32,000 lb. each, are the heaviest parts, and the trunnion hoop, 5000 lb., is the lightest. The aggregate weight of the parts is 137,000 lb., while the finished gun weighs 116,500 lb., so that 15 per cent. of the rough weight, or 20,500 lb., is removed during the construction of the gun. The new 16in. guns will weigh 284,480 lb. finished. The ingots are usually forged hollow on mandrils, having previously been bored out in a lathe, and after being forged by steam hammers and hydraulic presses, the parts are annealed and oil-tempered. The tube is straightened on the lathe bearings, and counterbored to 11½in. diameter, for 6in. inside, this counterbore serving as a guide for the first boring tool. This is a "hog-nose" bit, of self-hardening steel, keyed upon a cast iron boring head. It cuts almost entirely forward, only a small portion of the cutting edge being carried around the corner to the side, this facilitating the boring of a straight hole. The cutting speed is 6ft. per minute, and the tool advances 0·04in. for each revolution of the tube. Work has been done at 9ft. per minute, with a feed of 0·08in. per revolution, but this is too rapid for good work. Lard oil is used for lubricating the cutter, and is carried off by flexible metallic tubing. For withdrawing the boring bar to inspect the cutter, a traverse motion of 15ft. per minute is provided. After this boring is made a second cut is taken with a wood rammer, consisting of a maple wood head—soaked in oil—carrying two cutters which cut only on the side. The cutting speed is 6ft. per minute, and the feed is 0·1in. per revolution of the tube. The jackets are bored in practically the same way.

River steamer.—A new steamer, the Adirondack, is to be put in service by the People's Line this summer on the Hudson River, and will run between New York and Albany, 140 miles, making the trip in about eight hours. The hull is 400ft. long over all, 378ft. long on the water-line, 50ft. beam, and has a loaded draught of 8½ft. The deck width over the guards will be about 75ft. The superstructure will carry four decks, each having a 10ft. promenade outside the state rooms, while the upper deck will form a wide space, covered by awnings and obstructed only by the pilot house, officers' quarters, and machinery space. There will be 328 state rooms, smoking room, main and ladies' saloons, a large dining room on the main deck, and all the conveniences provided on these steamers in the way of toilet rooms, news-stands, bar, barber's shop, &c. The hold will have a capacity for 1500 tons of freight. The interior will be finished in white and gold, and handsomely carpeted, upholstered, and furnished. The electric light plant will include 2000 incandescent lamps and a powerful search-light. The engine is of the old-fashioned vertical type, with walking beam above the upper deck. It is a single-cylinder surface condensing engine, with cylinder 7ft. diameter and 12ft. stroke, developing 4000-horse power, and designed to give a speed of eighteen miles per hour. Steam will be supplied by four double-end marine boilers, 11ft. diameter and 33ft. long, carrying about 150 lb. steam pressure. The walking beam's connecting-rod drives direct the main crank shaft. The side wheels or paddles are 30ft. diameter and 12ft. wide, fitted with feathering buckets.

Sewage disposal.—This is a subject which is becoming of the utmost importance in a number of cities, towns, and suburban districts, and the various methods of effecting the disposal are attracting considerable popular, medical, and engineering attention. Boston probably affords the best example of main drainage for the disposal of sewage. Formerly there were about forty-three separate outlets directly into the harbour and near the ends of the docks, where there was little wave action. Now it is carried by means of interceptors into a main sewer, and after passing through a depositing main and an inverted syphon, is carried by means of an embankment to a storage reservoir on Moon Island. The storage reservoir on the island is so arranged as to discharge its contents in half-an-hour if necessary, although it usually takes about eleven hours for the reservoir to fill. About an hour and a-half after discharge, at a distance of two miles, no contamination is noticeable. This is one of the most successful exhibits of disposal by dilution to be found in this country. The sewage farm at Berlin, Ontario, is generally classified as an instance of broad irrigation, but as the field was constructed by excavating trenches about 17ft. apart, with tile drains and back filled with gravel, it acts rather as a filter for the sewage. The amount of sewage disposed of is about 15,000 gallons per acre per day. The field of eight acres cost 800 dols., and the cost of preparation was 3000 dols., making the total 3800 dols. The broad irrigation field at Pullman, Illinois, does not seem to be so great a success as has been claimed, and a reliable authority stated that upon the occasion of a visit he found that a 140 acre field for broad irrigation had not been used for three years, and was being otherwise fertilised, while a supplementary filtering area of fifteen acres had not been used for a month. The total sewage from the town of 10,000 inhabitants was being carried in an open ditch to Lake Calumet, and the plant seemed to be operated not to purify sewage but to make money. The soil at this place was not at all suitable for sewage filtration or for broad irrigation. In the experiments made at Lawrence with one filter that had been operated for two years under 86,000 gallons per acre per day, the purification was effected to the extent of removing 94 per cent. of the organic matter and 98 per cent. of the bacteria. Another filter run for the same length of time under 49,000 gallons removed 97 per cent. of the organic matter and 99 per cent. of the bacteria. In the chemical process the sludge which comes from the compressors is little valued as a fertiliser; the farmers will hardly take the trouble to cart it away. At Canton, Ohio, there is a plant for the chemical disposal of sewage. It is first treated to 8 grains of lime and $1\frac{6}{10}$ grains of sulphate of alumina per gallon. It is then passed into a channel, where it is agitated by boards sticking out at the sides, from there through a series of tanks, where most of the solid matter is precipitated, and flows out over a series of steps, by which it is aërated. The sludge is forced into a filter press at a pressure of 100 lb. per square inch, which reduces the precipitated matter to the sludge cake. The cost of this process is a little over 11 dols. per million gallons of sewage purified. At Long Branch, New Jersey, the sewage is treated chemically by alum and lime. In the plant erected at the Chicago Exhibition, the solids in the sewage from the grounds were chemically precipitated by the use of copperas and lime, and were then compressed and burnt in the garbage crematory. It seemed to be a complete success.

THE CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—At the ordinary meeting held on April 23rd a paper was read before this society by Mr. W. Cooper Penn, A.M.I.M.E., on "Anchors." The author traced their development from the days of the Romans down to the present time, and gave particulars of interesting trials of various forms and patterns of anchors made by the Admiralty at various times. He also entered into the details of construction of many of the modern anchors, particular attention being drawn to the stockless anchors now so much in vogue. A discussion ensued, and a vote of thanks to the author of the paper terminated the meeting.

THE ELECTRIC LIGHTING QUESTION AT BATTERSEA.—The result of a competition for the best method of dealing with a public supply of electricity in Battersea has been announced. In September instructions to electrical engineers were prepared, and premiums of £50, £30, and £15 were offered for the best three schemes submitted, the schemes finally selected to become the property of the Vestry, and the premium of the successful competitor, in the event of his scheme being carried out, to merge into and form part of the commission or remuneration for the supply of detailed plans and specifications, and for general superintendence of the work. Each competitor was required to submit with his scheme a report as to the best method of utilising the waste heat from the destructor at the Vestry Dust Depôt, and to provide in his report for the following:—1. For lighting a small area. (*a*) The lighting of the main and side roads, and (*b*) the lighting of public and private property. 2. For extending the lighting (*a*) to all main roads, and (*b*) to public and private property abutting thereon. 3. For extending the lighting (*a*) to all side roads, and (*b*) to public and private property abutting thereon. Full sets of plans had to be submitted with each scheme, and detailed estimates given of the capital outlay involved and of the cost of working, showing what advantage would be likely to accrue by its adoption. The "instructions" were duly issued to twenty-eight applicants, and in response thereto twenty-one sets of schemes were submitted by December 12th. The Electric Lighting Committee appointed Mr. Robert Hammond, M.I.E.E., as expert to advise the committee and report on each of the schemes submitted. Mr. Hammond's report as to the relative merits of these schemes was fully considered by the committee, and in accordance with his recommendation, the premiums last week were allotted by the Vestry as under:—

Mark of scheme.	Amount of prize.	Name of winner.
1st.—J.	£50	The Brush Electrical Engineering Company, Ld.
2nd.—M.	£30	Mr. W. Best
3rd.—F.	£15	Mr. J. Hardie McLean.

The above-named schemes were referred back to the committee, who have instructions to prepare a scheme for dealing with the electric lighting of the parish and to submit same to the Vestry at an early date. The Vestry at their meeting also adopted the recommendation of the Electric Lighting Committee in respect to the lighting of the Town Hall by electricity, and have decided to put the work in hand at once. Mr. Hammond has been appointed as the consulting engineer to carry out the work, at a fee representing 5 per cent. upon the capital outlay. It is estimated that the cost of the scheme will be about £3000, for a loan for which application will be made to the London County Council. The generating works for the Town Hall lighting will be erected on the vacant land at the rear of the present buildings.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

PIG iron is quoted this week:—Cold blast, 90s.; Staffordshire all-mine, 55s.; part-mine, 40s. to 42s. 6d.; and cinder pig, 35s. 6d. to 36s. Northampton forge pig is 40s.; North Staffordshire and Derbyshire, 41s. to 42s.; and Lincolnshire, 42s.

In finished iron marked bars remain at £7, with the usual 12s. 6d. for Lord Dudley's L.W.R.O. make; merchant bars are £6 to £6 5s., and common bars are £5 5s. to £5 10s. The depression in the sheet trade, arising from over-production, continues. Black sheets are £6 10s. to £6 15s. for doubles, and £7 15s. lattens. Galvanised sheets are about £10 for 24-gauge at Liverpool. Stamping sheets are £9 10s., and best thin sheets £11. Angles are £5 15s.

There is a brisk demand for steel at £4 15s. to £5 for Siemens slabs, £4 10s. for Bessemer blooms and billets, £5 15s. to £6 for bars, £7 5s. to £7 10s. for sheets, and £5 12s. 6d. to £5 17s. 6d. for angles and boiler plates. Basic steel girders and angles are £5 10s., and boiler plates £6 5s.

Large quantities of steel are now being used by the weldless steel tube makers who supply the cycle manufacturers, and there is every reason to believe that the demand for this material will continue to grow, since the cycle tube industry in South Staffordshire is rapidly extending, and promises in time to become as important locally as it is in Birmingham. There is no lack of capital for new steel tube undertakings, and several new companies which have recently been put forward have had their capital considerably over-subscribed. The growing scope of this particular class of market for steel is further indicated by the circumstance that the cycle engineering trade itself is at the present time experiencing a perfect "boom," and orders have had to be refused in this district to an extent unparalleled in any previous year. A good deal of Swedish steel has up to now been used for drawing weldless steel tubes for cycle frames, for which purpose the material has, of course, to be of extra quality, but although the purchases of Swedish steel still continue large, yet steel tube makers are finding, much to their satisfaction, that they can now get supplies of sufficiently good material near at home.

The Executive Council of the County Councils Association recently invited an expression of opinion by county councils upon two points, viz.:—(*a*) As to the desirability of imposing a tax upon cycles, the proceeds of which should be paid to the county authority in aid of the highway rate; and (*b*) as to the expediency of numbering and registering annually all cycles, in order to render identification more easy, and of charging a licensing fee sufficient to cover the expenses of such registration. Replies have been received from twenty-four counties. Four only are in favour of taxation. Fourteen counties, including Staffordshire, are opposed to taxation, and six counties, including Warwickshire, are not prepared to express an opinion. Six counties are unreservedly in favour of registration, and five are unreservedly opposed to it. Lancashire is prepared to consider a scheme of registration when devised; Somerset and Surrey think registration desirable, but practically impossible; while Staffordshire and Warwickshire are in favour of representing to the Home Secretary the need of conferring on police authorities the means of identifying cyclists who have broken the law. Before, however, either taxing or registration of cycles are carried into effect, not only the counties but the towns will have something to say on the matter; and Wolverhampton, Coventry, and Birmingham, in which towns the manufacture of cycles is a very important industry, will certainly strenuously oppose any action tending to hamper the freedom of their customers, and to thus retard the popularity of cycling.

At a meeting of the Council of the Walsall Chamber of Commerce on Monday, the president, Mr. E. J. Shaw, adverted to the Select Committee on Lamps, and, as showing the importance of the lamp trade in that particular locality, said there were from 10,000 to 15,000 persons engaged directly or indirectly in the Midlands in the manufacture of lamps. The Committee were having witnesses from different parts of the kingdom in reference to the storage of petroleum oils and the making of lamps; but those who had been called so far were mainly professional gentlemen not closely identified with the manufacture of lamps, and to much of the evidence given lamp manufacturers were taking strong exception. The evidence was unreliable in a great measure, and it afforded an instance how large an industry might be injuriously affected by a wrong kind of evidence being laid before the Committee, and a Bill being drafted on the recommendations of the Committee. He suggested that a representative of the Chamber should be sent to give evidence before the Committee. Mr. T. A. Hill proposed that the president be asked to attend, and the motion was seconded by Mr. T. A. Smith, and unanimously agreed to.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The possibility of another conflict between the federated coalowners and miners, to which I referred in my notes last week, is necessarily causing increasing concern, but scarcely any really serious apprehension as to the probability of a protracted stoppage. The attitude taken up by the miners at their conference this week has been very much what I indicated in my previous notes; they seem to be thoroughly determined on the question of establishing a minimum wage, and the issue will, in all probability, turn upon whether, by some mutual concession, a satisfactory arrangement can be come to which will enable the Conciliation Board to be renewed. So far as the coalowners are concerned, I know for a fact that several of the principal leaders in the last conflict with the men are thoroughly determined not again to be made what they term the "cat's paw" for other collieries, who early broke away from the combination, and reaped a very substantial advantage from the high prices, at the expense of the colliery concerns who remained firm, and in any case there is certainly no probability of another such strong combination of coalowners to carry on a protracted struggle with the Miners' Federation. On the other hand, the Miners' Federation is not in any strong financial position, and during the period of depressed trade for the last two years has suffered considerable loss in membership, so that neither side will be in a position to fight out anything like a general or protracted conflict, and this will no doubt considerably favour the disposition for compromise. The absence of any serious apprehension of renewed strife is evidenced by the continued inactive condition of the demand for nearly all descriptions of fuel; so far there has been no pressure whatever to get in extra supplies in anticipation of a possible stoppage of the pits, nor has there been even any special anxiety with regard to forward contracts, which would certainly be the case if there were any real fears of another long suspension of work at the collieries.

If anything a rather more active inquiry was reported on Tuesday's Manchester Iron Exchange, and here and there a moderate business was being put through. Generally, however, the tone of the market continues dull, and there has been some further easing down in makers' prices for pig iron, whilst on the other hand low sellers of iron held in second hands have, in some cases, been slightly hardening up in their quotations. With regard to district brands, moderate orders have been booked by Lincolnshire makers at the reduced rates, chiefly in forge qualities for shipment, and prices are very firm on the basis of 41s. for forge to 43s. for foundry, net cash, delivered Manchester; Derbyshire iron, which has recently been showing a lack of firmness, has, following the reduction in Lincolnshire, given way to the extent of about 6d. per ton, 46s. to 46s. 6d. net cash being now the full average figures for foundry qualities delivered here. Lancashire pig iron makers, who are well booked for the present, are fully maintaining late quotations, No. 3 foundry remaining firm at 46s. 6d., less 2½, delivered Manchester. In outside brands offering here prices continue irregular; makers would now, in some cases take 46s. 10d. net cash for good foundry Middlesbrough, delivered by rail Manchester, whilst as regards iron in second hands there is a slight stiffening tendency, 44s. 9d. being quoted for delivered at the Manchester docks. Scotch iron offering through second hands also shows rather more firmness, Eglinton being quoted 46s. 9d. to 47s., delivered Lancashire ports, and 49s. 3d. delivered Dock Quays, Manchester, with Glengarnock at 48s. at the ports and 50s. 3d. delivered Dock Quays, Manchester.

In the manufactured iron trade a fair weight of business continues to be reported, and prices for bars are firm at recent quotations, local makers not taking anything under £5 10s., but shipping orders have been booked at 2s. 6d. below this figure. North Staffordshire bars are without change, £5 12s. 6d. to £5 15s. being the average figures for delivery here. As regards sheets, a weak tone prevails, and orders could now be placed at still lower prices, £6 17s. 6d. to £7 being about the average for singles, delivered in this district. For hoops the Association list rates remain without quotable change, and are firm at £6 2s. 6d. for random to £6 7s. 6d. for special cut lengths, delivered Manchester district, with 2s. 6d. less for shipment.

A moderate demand comes forward in the steel trade, and a steady tone is maintained as regards prices, makers showing no disposition to give way upon late quotations, although there are low sellers amongst merchants. Good foundry hematites are still quoted by makers 58s., less 2½, but merchants would take about 57s. For steel billets, £4 7s. 6d. net cash represents about the average figure, with local steel bars quoted £6, and boiler plates obtainable at from £6 5s. to £6 7s. 6d. per ton, delivered in this district.

In the metal market the demand generally continues brisk, and prices are exceedingly firm at the full list rates, attempts being made, in some cases, to secure some advance upon these on small sales.

The position throughout the engineering trades continues generally satisfactory, establishments being mostly kept full going upon work in hand, with new orders in most branches coming forward freely, and there is every prospect of steadily increasing activity through the remainder of the year.

The other day I was shown a new design in pumps, Mose's patent, which is being introduced by the Patents Company, 35, Market-street, Manchester. This pump can be used either as an ordinary or as a force pump, according to requirements, the alteration from the one to the other being effected by simply moving an india-rubber ball—which, under ordinary conditions, rests at the end of the discharge pipe—over the orifice of the pump, when the water will be forced to flow through a contracted pipe outlet at the top, to which a hose length can be connected, and the water is discharged in a strong jet. Another special feature of this pump is the introduction of an internal lining of non-freezing material, which renders the pump impervious to frost during the winter months. The pump is also made with an inside brass liner, with a special bucket, designed to reduce the wear and tear.

Messrs. Leech Brothers and Co., of Old Millgate, Manchester, have brought out an improved form of radiator, suitable for large or small buildings, which can be heated either by steam or hot water. The radiator consists of a series of loops, ranging from three to any number up to a hundred, as required, which are connected by face joints, and amongst the advantages claimed for the arrangement are the exceptionally large heating surface presented, in proportion to the height of the loops, which ranges from 30in. to 36in., whilst it is impossible for any steam or hot water to escape from the radiator, and no india-rubber packing is used for making the joints.

In the coal trade the condition remains without material change. The demand all through, except for engine fuel, is extremely slow, and pits continue on not more than four days per week. For the best qualities of round coal, suitable for house fire consumption, requirements are of necessity slackening off with the advance of summer, and although quoted rates are unchanged, prices show a weakening tendency, buyers who could place orders for anything like quantities being able to obtain concessions. The lower qualities of round coal continue difficult of sale, and prices are so excessively low that many of the collieries are either ceasing to work their common mines, or lessening their output as much as possible by putting them on short time. Perhaps no more conclusive evidence of the unsatisfactory outlook in this branch of the coal trade could be afforded than the low prices at which the important railway contracts for forge coals are being renewed. Last year they were taken at what was considered the low figure of 6s. 3d. per ton; this year 5s. 9d., or a reduction of 6d. per ton upon last season's contracts, is being taken, one colliery having placed about 50,000 tons at that price. I hear that even this is considered to be a good figure compared with the prices which some of the collieries have been taking for the same class of coal for shipment, and that it would not have been difficult to place contracts at 5s. 6d. per ton. The ordinary pit mouth prices for steam and forge coals for inland sale still average about 6s. per ton. Engine classes of fuel move off readily, and with supplies not over-plentiful, prices show a hardening tendency, slight advances of about 3d. per ton being obtainable in some instances, but generally quoted rates, although very firm, are unchanged, 3s. 6d. to 3s. 9d. being about the average figures for common slack, with best sorts ranging from 4s. 6d. to 5s. at the pit mouth.

No improvement is noticeable in the shipping trade, and common steam coals can still be readily bought at 6s. 9d. to 7s., delivered ports on Mersey or Partington tips, Manchester Ship Canal.

Barrow.—The business doing in hematite qualities of pig iron is steady and brisk, and makers find that they have plenty of orders to engage their attention for some time. Indeed, generally speaking, they are booked forward for fully six months ahead, while those smelters who have also steel works can book ahead for fully a twelvemonth. Prices are firmer on the week and although makers have not changed from their quotation of 50s. per ton for mixed Bessemer Nos. net f.o.b., warrant holders are asking more money. Sellers are at 48s. 1½d. per ton net cash, and buyers at 48s. 1d. Stocks have not been increased or decreased during the week. They still represent slightly over 300,000 tons.

Iron ore is in considerable demand on native as well as on Spanish account. Spanish, indeed, are being more largely imported, as their use in the blast furnaces with native ores has been found to be a distinct advantage. Average qualities of iron ore are quoted at 10s. per ton net at mines, and best descriptions find a good market at from 12s. 6d. to 14s. 6d. per ton. Spanish descriptions are still quoted at about 13s. per ton for 60 per cent. qualities delivered at West Coast ports. There are from three to six steamers in Barry docks every week with cargoes of ore for the various smelters in the district.

Steel makers report an active condition of things all round. The rail trade is very busy. Orders for heavy sections are plentiful, and are already well held. Home, colonial, and foreign buyers generally are in the market. Heavy sections are firm at £4 15s. per ton net, f.o.b. The demand for all classes of shipbuilding material is well maintained, and the plate mills are busy, and likely to remain so. Ship plates are still firm at £5 2s. 6d. per ton net. There is still a good trade in billets and hoops, and merchant qualities of steel generally are in good demand. Tin bars are quiet, but some good orders for steel sleepers have fallen to the lot of West Cumberland steel makers for the Colonial Governments.

Shipbuilders and marine engineers are getting short of orders. The works at Barrow are so large that they require a big tonnage of work to keep them briskly employed. Much new work has recently been tendered for on commercial account, and there is also some large Admiralty work to give out during the year, but in the meantime builders and engineers are short of work to go on with, although a large amount of Admiralty work is at present receiving attention.

The coal and coke trades are brisk, but there is no alteration to note in prices, coal, indeed, being weak, while coke is strong in values.

The shipping trade is slightly depressed this week, especially in regard to shipments of pig iron, which show a falling off.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

GENERALLY the iron market has this week been more favourable to sellers than for some time past, and business certainly shows a distinct improvement upon last week, the demand being brisker, and higher prices are realised. This is rather contrary to the experience, for when near the end of the month in the pig iron market prices become easier, as there are usually cheap lots offering by speculators who have iron over, and these forced sales weaken the market. However, there does not in April appear to have been much of this, the speculators having generally oversold accounts, and they have had to buy to cover. Advantage of this has been taken by the sellers, who have advanced their prices at least 3d. per ton all round for pig iron, and some even more. This has brought into the market a considerable number of buyers who were hesitating to purchase, and there seems to be more disposition to do business. Last week 37s. 9d. per ton was the figure for early deliveries of No. 3 Cleveland G.M.B. pig iron, but early this week 37s. 10½d. was readily paid for deliveries to be made before the end of the week, and 38s. has been the regular figure for May deliveries, both makers and merchants holding out for and realising this, while the leading firms would not let their iron go under 38s. 3d., as they are of opinion that a continued active trade will be done.

Cleveland warrants, which on Tuesday last week were down to 37s. 8d. cash, the lowest figure which has been known since the middle of January, have taken a turn upwards, and this week they have been as high as 38s. 4½d., but on Wednesday there was business at 38s. 2d. cash. The stock of Cleveland pig iron in Connal's warrant stores on Wednesday night was 193,357 tons, an increase of 5883 tons for the month, this having chiefly accumulated during the past week, for little iron was sent in during the first fortnight. Nevertheless, it is expected that the aggregate stock of Cleveland pig iron in the district will for April show a decrease of about 3000 tons, and that will be the first time since October last that the consumption has exceeded the production. The price of No. 4 Cleveland pig iron is firm at 37s. 6d. and grey forge 37s. for early delivery. Cleveland hematite pig iron hardly holds its own so well as Cleveland ordinary iron, as it is thought that the output is too large, though that is a question which cannot readily be answered, for, while the extent of the production is made known, no particulars are given of the stocks. The general belief, however, is that more hematite pig iron is made than is required, and so consumers are backward about buying anything more than satisfies current needs. Shipments of hematite pig during April have shown considerable improvement. Mixed numbers are quoted 46s. 3d. for May deliveries, and this is paid by consumers who would not pay more than 46s. 3d. early in the week.

Exports of pig iron from the Cleveland district during April have been very good, up to Wednesday evening they reached 98,561 tons, against 89,147 tons in March and 106,929 tons in April, 1895. The exports for April have been much above the average of that month in recent years, that average being 85,000 tons. The year's shipments so far have been greatly in advance of those of any previous year.

Messrs. Bolckow, Vaughan and Co., at their pig iron works in the Eston district are spending a large amount of money in improving the plant; they are erecting new kilns, laying down new boilers, and having new blowing engines constructed. At the Southbank fourteen calcining kilns are being renewed, and are being so arranged as to save a good deal in labour. At the Cleveland Works eleven old boilers are to be replaced by Lancashire boilers. These old boilers are of the long cylindrical egg-ended and externally-fired type, which was so strongly condemned by the Board of Trade Commissioners when last July they inquired into the disastrous boiler explosion at the Redcar Ironworks, by which twelve lives were lost. Since this decision, almost all who had these boilers have been altering them or putting in new boilers. Messrs. Bolckow, Vaughan and Co. have already replaced twelve of such boilers by eight Lancashire boilers. The firm have for some time been of opinion that they were not getting out of their Cleveland furnaces as large a quantity of iron as they were capable of producing, in consequence of the lack of blowing power. They have, therefore, decided to erect new and independent blowing engines for their hematite furnaces there, and new engines, engine house, and boilers will be erected, £15,000 being applied out of revenue in part payment for the new blowing plant. All the alterations are to be paid for out of revenue, none being charged to capital.

Shipyards generally are actively employed, and the improvement has been so marked that the yard of Messrs. Osborne, Graham and Co., at North Hylton, on the Wear, has been reopened after a stoppage for a considerable period. The British Admiralty have furnished a large amount of work in the yards of this district by their orders for torpedo boat destroyers and cruisers, these orders all going to the Tyne and Wear. The yards on the Tyne receiving such contracts were enumerated last week but it also appears that Messrs. Doxford and Sons, of Pallion, on the Wear, have secured the contracts for two torpedo boat destroyers similar to those which they constructed last year for the British Government. The demand for merchant steamers is good, and builders have no difficulty in filling up the berths of the vessels they launch.

At a meeting of the North-East Coast Institution of Engineers and Shipbuilders, held at West Hartlepool on Saturday, the chairman—Mr. Robert Thompson, of Sunderland—when speaking of the question of foreign competition in shipbuilding, in the course of a discussion, made the remark that British shipbuilders had got this "beastly climate of ours" to thank for a good deal, yet much as it was complained of, there was not a country on the Continent where the men could work so many days per year as they could in England.

When the Redcar Ironworks boiler explosion occurred last June, Messrs. Walker, Maynard, and Co., the owners, were insured in an Employers' Liability and Accident Insurance Company against claims under the Employers' Liability Act. It being decided by the Board of Trade Commissioners that the explosion occurred through the negligence of their servant, the firm were liable to pay compensation to those who suffered by the accident, and they have since agreed with the representatives of the men as to the legal compensation to be paid. They have paid this over, and now require the Insurance Company to refund the money to them. As to their liability after the decision of the Commissioners, the Insurance Company are at any rate doubtful, and the whole question is be submitted to arbitration.

The Board of Trade Commissioners have this week held inquiries at Newcastle into two boiler explosions. As to the first of these—the explosion of a boiler at the Barrington Brickworks, belonging to the Bedlington Coal Company—they gave an important decision as to the testing and supervision of boilers. They held that the Bedlington Coal Company was responsible because its inspector had not applied the hydraulic test to the boiler after certain repairs, and they blamed the Scottish Boiler Insurance Company also, because its agent had not properly examined the boiler, especially in December, 1895. A proper test, they held, would in all probability have discovered the seam rip, and prevented the explosion. The Bedlington Coal Company was also to blame for omission to inform the insurance company of the repairs to the boiler. The two companies were, therefore, each ordered to pay £40 towards the cost of the inquiry. The counsel for the insurance company entered his protest against the decision, which he said would revolutionise boiler insurance and inspection throughout the kingdom. The boiler was a very old one, was 30ft. long by 6ft. diameter, and was constructed of iron. It was of the cylindrical egg-ended type, externally fired. The explosion occurred on March 12th, and the engineman lost his life.

Ironfounders are more actively employed on the whole, as are also the bridge builders and engineers. Part of the cast iron segments that are required in the construction of the City of London subway are to be furnished by Messrs. Head, Wrightson, and Co., Teesdale Ironworks, Thornaby-on-Tees; part by Messrs. Smith, Patterson, and Co., of Blayden-on-Tyne; and part by Scotch founders. Messrs. John Abbot and Co., of the Park Works, Gateshead, are to supply the steel roofing girders for the electricity station of the Harrogate Corporation. A rumour is in circulation that a new engineering company is to be established on Tees-side, but no particulars are yet available.

In the finished iron and steel trade no change can be reported, works are well employed, and orders booked are numerous, but new orders are scarce. Prices are unaltered.

In the Northumberland steam coal trade there is now considerable activity, as was looked for as soon as the navigation season was fully open, and large shipments are being made to the Baltic. Good exports are also reported to South America. The improvement has led to a rise of about 6d. per ton in the prices recently. In the early part of the month 7s. 9d. per ton f.o.b. was all that would be paid for best steam coals, now 8s. 3d. is being quoted and paid, and steam smalls were from 3s. 6d. to 4s. Heavy shipments have been made this week to Cronstadt, navigation to which has only just been opened. The home consumption of gas coal is quieter, but there is a fair export. The wages of Northumberland colliery enginemen have been reduced 2d. per day, and of firemen 3 per cent., deputies also being reduced to a like extent. Coke is firm at from 13s. 6d. to 14s. delivered at furnaces on Tees-side, or 15s. f.o.b.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

IN the Yorkshire colliery districts stocks continue to be large, and the most discouraging feature is that they are still growing. In some directions an improving tendency is reported, but taking the fuel industry all round there is really no change to report on the week. Steam coal is now getting into more active demand, both Hull and Grimsby having larger supplies sent from the local collieries, the former being still the favourite port to which the collieries with the largest output send their produce. Although prices are still low they are pretty steady, Barnsley hards are quoted at from 6s. 6d. to 7s. per ton; secondary qualities from 6s. per ton. Household fuel, as might have been expected in consequence of the continued mild weather, gets weaker every day. The tonnage going from the district is about the smallest that has been known for years, and the rule is the smaller the tonnage the keener the competition. What trade there is in the metropolitan market mainly falls to the coal sent from the North by water. This enables agents to exact fresh concessions from inland coalowners, and those of their number who cannot hold their stocks are obliged to offer special terms to effect a clearance. The easier rates which have ruled during the present month are still inadequate to let inland pit owners compete successfully with Northumberland and Durham fuel. The best demand is for the higher qualities of Silkstone, which make from 8s. to 8s. 9d. per ton; ordinary from 6s. 9d. per ton. Barnsley house ranges from 7s. 3d. to 8s. 3d per ton; other qualities, from 6s. 6d. to 7s. 3d. and 7s. 6d. per ton. There is again a falling off in the request for gas coal, which does not make more than from 6s. to 7s. per ton, with falling values. A continued improvement in trade is favourably affecting manufacturing fuel, and a slight upward tendency is noticed in the lower-priced sorts, which have long been at a most absurdly low price. On the other hand, nuts of good quality are bad to sell even with declining prices, which almost counterbalances a better demand for small stuff, caused by the revival in the coke business with Lincolnshire, Northamptonshire, and the West. Small nuts may be quoted at 4s. 3d. to 5s. 3d.; screened slack, from 3s. 3d.; pit slack, from 2s. 6d.; smudge, from 1s. to 1s. 6d. per ton. Coke is in good demand at from 8s. 6d. to 10s. per ton.

In nearly all the departments of the heavy industries trade is satisfactory. Some foreign orders are now coming in for war goods, which added to the heavy requirements of the Government, promise good work during the year. The armour plates required under the new Admiralty scheme are being rapidly pushed forward. There never has been a time when the large armour plate rolling and planing mills and shops have presented a more active scene of industry than at this moment. It is expected that some further good work will soon be booked on foreign account. Railway and marine material continues to be freely placed, and the local firms who have specialities in Atlantic-going steamers are exceedingly busy.

In the lighter industries the reports are considerably varied. In some firms complaint is heard that the business is more of a parcel post description than they like. Merchants at a distance order goods as they require, and the speed with which they can now, thanks to postal facilities, get their orders fulfilled militates against accumulations of work, which enable employers to guarantee their men any length of engagement. It is particularly disappointing to know that the principal cutlery houses, whose chief market is America, describe business as altogether unsatisfactory. The revival which began at the end of last year, and from which so much was expected, seems quite to have passed away, leaving trade as depressed as at any period of United States stagnation. This is all the more unsatisfactory, as the American houses ought now to be in the full swing of the spring season and exceptionally busy. On the other hand, the improvement in the Australian trade, to which attention has already been directed in THE ENGINEER, is a most gratifying feature. Good orders for cutlery, tools, and general hardware, have been received during the last month by the leading Sheffield houses, whose representatives travelling throughout Australia sent home most encouraging accounts. Australia has evidently been rapidly recovering from recent embarrassments, as travellers have little difficulty in collecting what is due, and find merchants more disposed to place work. There is also a better state of things prevailing in the Brazilian and general South American markets, although the competition of United States and continental agents is increasingly severe.

India, China, Japan, and Mexico are all yielding better work, although the orders placed are not so heavy as could be desired. The Government contracts for ivory-handled table cutlery, which comprises from 1000 to 1200 dozens, will soon be placed. It does not excite much enthusiasm, as all the Government work is "cut" very low, and the conditions of acceptance are so onerous that there is not much to be had out of it. But Government orders are regarded from different points from ordinary work. They are useful as advertisements with foreign countries; they are in large quantities, keep the men employed betwixt seasons, and the deliveries are at periods from three to twelve months. The depression in the cutlery branches will seriously affect ivory cutters if it is continued. The London ivory sales now proceeding are expected to result in high values, owing to the smaller weight and the increasing demands for other purposes.

The pearl cutters report that their business has drooped, particularly in the higher grades. German cutlery manufacturers, a year ago, competed keenly for the better classes of pearl handles, but this year they are confining their requirements to the commoner goods—a feature which confirms the popular impression that the Germans, like the Americans, are most successful when they devote themselves to a vast output in the lower grade goods at a very lean price.

The decision come to by the Miners' Federation of Great Britain at Nottingham has excited no surprise here. It was known in this district that the miners' ballot was precisely as the miners' leaders wanted. It declares firmly for "the living wage," that is, for a minimum rate, below which wages shall not fall. That minimum they find in the present amount, which is 30 per cent. above the standard of 1887. In return, they are willing to concede to the masters a maximum wage, which they fix at 45 per cent. above the 1887 rates. The employers are not willing to have the Conciliation Board continued on these terms. They prefer that the Conciliation Board should have power to determine the rate of wages from time to time as the state of trade demands. That conceded, the coalowners would be glad to have the Board continued for an indefinite term. The miners' leaders specifically state the period of continuance as two years. A compromise has been suggested, with the minimum wages fixed at 20 per cent. instead of 30 per cent., and the maximum left at 45 per cent. The miners' leaders point out that this practically means a reduction of 10 per cent. in wages, and they do not see their way to consent to that. Mr. A. M. Chambers, President of the Coalowners' Federation, speaking at Thorncliffe on Tuesday, declared that "times were difficult, and the issues at stake very great. All they could do was to hold their hands, to keep their powder dry, and try to bear the ills they had, rather than fly to others, some of which they knew a great deal too much about."

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE was a marked improvement in the pig iron warrant market in the early part of the week. Scotch pig iron, which was down last week as low as 45s. 11d. per ton, advanced to 46s. 9½d. cash, and 46s. 11½d. one month; a very considerable business having been done. For Cleveland warrants there has been little inquiry, the cash price being about 38s. 4d. A moderate business was done in Cumberland hematite warrants at 48s. 2d. to 48s. 5d. cash, and 48s. 5d. to 48s. 7d. one month. The rise in prices was in some measure sympathetic, the tone of the market being favourably influenced by an improvement in the prices of stocks and shares. At the same time the business in pig iron between sellers and consumers outside of the speculation market is large, probably as great as it has ever been at any former time, the great bulk of the iron going into use at home.

Stocks of pig iron in Glasgow warrant stores show little variation. No additions are being made; indeed, in the past week, a slight decrease was noted in the stock. Connal's stores now contain 283,675 tons, which shows an increase since the beginning of the year of 10,000 tons. Taking into account the amount of the production, which is somewhere about 28,000 tons per week, this addition to stock will be sure to be of comparatively small importance. There are at present 43 furnaces producing ordinary, 35 hematite, and three basic pigs, the total of 81 comparing with 75 at this time last year. A large demand exists for hematite pig iron. It is understood that the whole of the output of the 35 Scotch furnaces is going into consumption, besides large quantities of Cumberland and Middlesbrough hematite.

The prices of Scotch makers' pig iron are as follows:—Govan and Monkland, f.o.b. at Glasgow, Nos. 1, 47s. 6d.; Nos. 3, 46s. 3d.; Wishaw and Carnbroe, Nos. 1, 47s. 9d.; Nos. 3, 46s. 6d.; Clyde, No. 1, 50s. 6d.; No. 3, 47s. 6d.; Gartsherrie, No. 1, 50s. 6d.; No. 3, 48s.; Calder and Summerlee, Nos. 1, 51s.; Nos. 3, 48s.; Coltness, No. 1, 53s. 6d.; No. 3, 49s.; Glengarnock, at Ardrossan, No. 1, 51s.; No. 3, 47s.; Eglinton, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Dalmellington, at Ayr, No. 1, 47s.; No. 3, 45s.; Carron, at Grangemouth, No. 1, 52s.; No. 3, 48s. 6d.; Shotts, at Leith, No. 1, 53s.; Nos. 3, 49s.

The shipments of pig iron from Scottish ports in the past week have been 7203 tons, compared with 5427 in the corresponding week of last year. The foreign demand is still unsatisfactory.

In the finished iron and steel branches there is no change of importance. The activity already noted in these departments is fully maintained. Prices of both iron and steel are steady and it is not easy to obtain any advance on prices. A very animated business is being done in sheets, the makers of which are working day and night. Tube makers are likewise very busy. Locomotive and marine engineers and the producers of bridge and railway materials report brisk trade.

The only department of the coal trade that is at all active is that for the supply of manufacturing fuel. The various kinds of furnace coal, including nuts and dross, are in good request at firm prices. Steam coals are difficult to sell; and splint, being in very full supply, is easy. The prices f.o.b. at Glasgow are, for main coal, 5s. 9d.; splint, 6s. 3d. to 6s. 6d.; ell, 6s. 3d. to 6s. 9d.; and steam, 7d. 6d. per ton. The shipments of coal from the various Scottish ports in the past week aggregated 152,227 tons, compared with 142,345 tons in the preceding week, and 151,004 tons in the same week of 1895. The total coal shipments since the beginning of the year amount to 2,041,993 tons, being 137,255 tons more than in the corresponding period of last year.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

LAST week Cardiff shipped 340,000 tons of coal—50,000 tons above the average There is not much change in the situation of the coal trade. Business still continues brisk, and large cargoes to coaling ports and foreign destinations have been very marked, especially from Cardiff, the Knight of St. George taking 6000 tons to Bombay, and the Avondale 5000 tons to the same destination. Mid-week three large cargoes of 5000, 4000, and 2400 tons were dispatched to Colombo, and consignments of between 3000 and 3500 tons were common to Rio, Aden, and elsewhere. A strong opinion prevails in coal circles that naval and military events of importance are looming.

Attendance on 'Change, Cardiff, has been well maintained, and prices continue satisfactory. Mid-week best steam coal was in good demand at 10s. to 10s. 3d., and the inquiry for good seconds looked well, best being quoted at 9s. 9d. to 10s., and even ordinary from 9s. 3d. to 9s. 6d. For dry coal there was little demand. Prices:—8s. 9d. to 9s., and for small steam coal only slight inquiry, prices ranging from 3s. 3d. to 4s. 9d., according to quality. In house coal little improvement was shown, and prices remain practically the same as last week:—Best households, 10s. to 10s. 3d.; No. 3 Rhondda, 9s. 6d. to 9s. 7½d., brush, 7s. 9d. to 8s.; small, 6s. 3d. to 6s. 6d.; No. 2 Rhondda, 7s. to 7s. 6d.; through, 6s. to 6s. 3d.; small, 4s. to 4s. 3d. Swansea prices:—Anthracite, 8s. to 11s. 6d., according to quality; steam, 9s. to 10s.; bituminous, 9s. 6d. to 10s.; No. 2 Rhondda, 8s. 6d. to 9s. 6d.; small, 5s. to 5s. 3d.

Patent fuel is in moderate demand. Cardiff prices, 10s. to 10s. 3d. Swansea, 9s. 9d. to 10s. 3d. Coke maintains a firm tone. Cardiff prices: Furnace, 13s. to 15s.; foundry, 15s. 6d. to 16s. 6d.; special, 19s. to 19s. 6d. Pitwood continues the same, 14s. 9d. to 15s., ex-ship. Merchants in Cardiff are complaining of the scarcity of berths to discharge pitwood in, and also of the length of time it takes wagons to be transferred alongside steamers. I hear that the leading men in the trade are about to petition the dock authorities upon the matter.

The iron ore market is steady as regards prices, and a fair inquiry exists. Cargoes have again been numerous this week; Dowlais receives six, Cyfarthfa one, Blaenavon two, Ebbw Vale, one, and the Patent Nut and Bolt Company one.

This week most of the Cardiff notables are in London, taking part as speculators in the great railroad schemes.

The first of the important Welsh Bills came before the House of Lords Committee this week. This was the Great Western Additional Powers Bill. Mr. Pope put this very concisely as consisting of two objects, the making of a branch line on the Great Western Railway, near Pengan station, to the new Bute Docks at Cardiff; and the other the amalgamation of the Marlborough line with the Great Western. The claim of the Great Western was to have an independent connection with the Bute Docks. The Bill was only opposed by the Taff Vale Railway. Mr. Wilkinson, assistant manager of the Great Western, was the first witness called, and stated that his company carried about a million tons a year of coal to the Bute Docks, the Taff Vale Railway four and a-half millions, and the Rhymney Railway Company about two and a-half million tons. The traffic from the Monmouthshire Valley had greatly increased of late, because, probably, of a better price being obtained at Cardiff. Ten new sinkings in the Monmouthshire coal field are projected.

After a good deal of pertinent evidence by supporting witnesses, and oppositional by Taff Vale witnesses, the room was cleared, and on readmittance of the public, the chairman stated that the committee approved of the preamble of the Bill, as far as it applied to No. 1 Railway, on condition of certain concessions to the Taff. This gives the Great Western Railway all it desired, an independent line from Pengan to the Bute Docks.

On Tuesday the Barry Railway Bill was brought forward, opposed by the Rhymney, Taff Vale, Bute Docks, and others.

This may be briefly described as an attempt on the part of the Barry to reach the Monmouthshire coalfields. For two years this has been attempted by means of a new railway through East Glamorgan. The tactics are now changed, and if successful, all the company then required will be obtained at a less cost. The proposal now is to make a railway from St. Fagans to Walnut Tree Junction, and thus join up the Rhymney system with their own, and, to complete their requirements, running powers over the Rhymney at the junction, over the Great Western at Llanbradach, and over the Taff Bargoed Railway, and a line from Walnut Tree into the Aber, where new collieries are being sunk. This promises to be a severe and an interesting struggle, and will bring out on all sides very marked ability.

I notice that Sir William Lewis, Bart., is in his usual place, and that in addition to Mr. D. Morgan, of the Docks, a strong addition to his staff is present in Mr. James Hurman, formerly of the Taff Vale Railway, and notable for his ability in parliamentary conflicts.

The Cardiff Exhibition is to open on May 2nd, and promises to be of interest to the engineering world. The principal railways will be represented by useful models, the electric world by a great number of the latest inventions, light and power, some of which are making their way in pit work. I am informed, and have been favoured with an inspection of an interesting list of special value to the maritime world, canals, bridges, piers, &c., and propose, as the exhibition progresses, and goes through its course of evolution, to notice the most striking contributions. Art, as well as industry, is to be represented, and amusement will form a special attraction.

It is stated by Mr. Dalziel, secretary for the metal trades section of the Cardiff Exhibition, that the Dowlais Company will be represented, amongst other notable productions, by a steel plate, which has been sent in, weighing 8600 lb., and measuring 70ft. in length. The plate was rolled at the company's Cardiff branch, and is the longest ever manufactured. Some very large steel ingots are promised by the same firm, so it is evident that the metal trades section will be an interesting one.

The Hannibal, the largest vessel ever built at Pembroke Dockyard, was successfully launched on Tuesday. The ship has been built from designs by Sir William White, under the supervision of Mr. H. Cock, chief constructor, &c., and at a cost, it is stated, of £1,000,000. Tonnage, 14,900 tons; extreme length, 420ft.; breadth, 76ft. 6in.; depth, 46ft.

There is moderate animation in iron and steel.

The rail dispatches of the week include 960 tons from Newport, Mon., to Hobart, a small consignment to Dublin, and 200 tons to Southampton.

I note that figures are slightly easier. Swansea quotations this week are:—Steel rails, heavy, £4 7s. 6d. to £4 12s. 6d.; light, £4 15s. to £5 5s. Pig iron has fluctuated a good deal, but the latest report is that prices are 6d. better. In copper a slight improvement; block tin unaltered.

Other Swansea quotations are as follows:—Middlesbrough pig, No. 3, 38s. 3½d.; hematite, 45s. 8d.; Welsh bars, £5 10s. to £5 12s. 6d.; sheet iron, £6 15s. to £6 17s. 6d. at works; steel sheets, £6 10s. to £6 12s. 6d.; Bessemer steel bars, £3 17s. 6d.; Siemens, £3 18s. Tin plates: Steel coke, 9s. to 9s. 1½d.; Siemens, 9s. 1½d. to 9s. 3d.; ternes, 16s. 6d., 17s. 6d. to 22s. 6d.; best charcoal, 12s. 6d. to 12s. 9d.; wasters, 6d. to 1s. less.

I regret having no improvement to record in tin-plate. There is a slightly better inquiry for tin bars, I am informed, and hopes are held out in good quarters that the "corner is being turned," though slowly. I see that Llanelly is sending black plates to Ghent, and tin-plates coastwise to Cardiff. The latest Swansea report is that shipments have been small, and stocks had increased. The output has been curtailed a good deal by the stoppage of mills, so that demand and make are getting fairly equal. Some Morristown men are emigrating. A little better tone prevails at Briton Ferry. The Gwalia has restarted on a reduction of 15 per cent., and three mills at the Villiers will start on the same terms. The main shaft of the engine driving the other three has broken, and this will entail delay and a cost, I hear, of £1000.

A movement is on foot to make Cardiff a first-class port.

With reference to my paragraph in THE ENGINEER last week concerning Cyfarthfa Works and its representation in London, I find on making inquiries that the London office of the Messrs. Crawshay Brothers, Cyfarthfa, will remain at the same address as heretofore, and that no change in this direction is contemplated.

"Old" Dowlais Works are going in for additional electric light and power.

I regret to announce the death of Mr. H. J. Vose, superintendent engineer—telegraphs—for South Wales. In the coal world, Mr. E. Beddoe figures in the obituary, son of one of the pioneers in the well-known Mynyddyslwyn seam in Monmouthshire.

Early in May the compact engineering works at Ystalyfera are to be brought to the hammer.

The vacant position of secretary to the Taff Vale Railway has not yet been filled. One name discussed is that of Mr. George Robertson, who had the appointment some years ago, but retired in order to join a steamboat company. I remember that his retirement was much regretted. He had worked up from the juniors.

The consignment of 3000 tons of sulphide ores from South Australia is to be treated by a new process at Llansamlet, where works are being fitted up by a new company. The place will be in direct contact with the Midland Railway.

Swansea dispatched 2400 tons of anthracite to California last week.

Some degree of friction continues amongst the Plymouth colliers. I hope it will disappear with the month.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

BOTH on home and foreign account a good demand has been experienced upon the week, and the brisk activity that has for some time past characterised the various departments of the iron trade has been well maintained.

With regard to the position of the iron market in Silesia, only the most favourable accounts are given. The firm tendency in prices continues, although for some articles demand has perhaps been a trifle less lively than last month. Export in nearly all articles of iron and steel has undeniably improved, and a confident tone is generally to be perceived among producers as well as consumers. Local demand for malleable iron and steel has also been pretty good; both the bar and the girder mills have booked orders that reach far into the third quarter, and there is much firmness shown with regard to quotations.

The Austro-Hungarian iron trade is in about the same condition as before, the various departments of the iron and steel trade being satisfactorily employed. Foreign competition is less keen than formerly, and as there is a decided increase in consumption, both on home and on foreign account, the tone of the iron market is naturally pretty strong. The hardware business, which was somewhat weak hitherto, has perceptibly improved just lately. The convention of the Austro-Hungarian rail works are stated to have produced in 1895, 55,700,000 kilos. rails, against 51,400,000 kilos. in 1894, 46,500,000 kilos. in 1893, 44,000,000 kilos. in 1892, 58,000,000 kilos. in 1889, 94,200,000 kilos. in 1883, 44,800,000 kilos. in 1879. The said convention was formed in 1879.

Every branch of the French iron trade seems busy, orders coming to hand freely. There is no alteration to be noted in prices, which remain firm all round, with a slight inclination to advance where orders for immediate delivery are concerned.

The reports from the Belgian iron market are exceedingly gratifying, raw as well as manufactured iron and steel selling briskly. Some rather heavy orders have been booked during the past week. There is not much of interest to be related in connection with the Belgian coal market. Prices are firm, best steam coal fetching 11f. p.t., while house coal is sold at 12·50f. to 14f., and in some instances even 15f. p.t., small coal is quoted 6·75f. to 8f. p.t. according to quality. Regarding the Belgian business in coal and coke during the first two months of present year, import was 269,435 t., against 204,918 t. for the same period the year before; of which, 158,170 t. came from Germany, against 96,724 t. last year; import in coke amounted to 34,417 t., against 60,640 t.; 31,715 t. coming from Germany, against 59,578 t. for the same period the year before. Belgian export in coal amounted to 735,041 t., against 784,434 t. for the same months in previous year; 33,913 t. were sent to Germany, against 44,272 t. last year; 559,473 t. were exported to France, against 622,885 t. last year. In coke, export amounted to 140,639 t., against 142,018 t.; 16,720 t. going to Germany, against 26,270 t. for the same period the year before. Export in coke to France amounted to 83,768 t., against 61,218 t. for the same months in previous year.

Throughout the iron and steel trades of Rheinland-Westphalia new work continues to come forward freely; all the leading establishments are not only fully engaged, but there is work in hand to keep them going for many months ahead. A very firm tone prevails, consequently, in all departments. Brisk activity is going on at the iron ore mines of the Siegerland and Nassau; in the first-named district output is, on an average, 8000 t. higher than at the end of last year; here and there inquiries have already been coming in for the fourth quarter. In spite of the healthy business that has of late been doing in inland ore, large quantities of foreign ore continue to be thrown on the market, and generally meet with ready demand. The prices quoted last week for Siegerland ore were as follows:—Spathose iron ore, M. 9 to 9·60 p.t.; roasted ditto, M. 12 to 13·70 p.t.; calcined iron ore, M. 12 to 14 p.t.; Nassau red iron ore, 50 p.c. contents, fetches M. 9·30 p.t. net at mines; for the third quarter, M. 9·50 p.t. is asked. Minette of Lorraine is quoted M. 2·60 to 2·80 p.t.; the 40 p.c. quality realising M. 3·40 p.t. net at mines. The business in pig iron has been exceedingly brisk upon the week, and the blast furnace works are consequently very busy; a further increase in demand is expected. Prices, which may now be considered in just proportion to those of the raw material, are firmly maintained, and generally exhibit a rising tendency. Spiegeleisen, 10 to 12 p.c. grade, notes M. 58 to 59 p.t.; forge pig, No. 1, M. 53 to 55 p.t.; No. 3, M. 42 p.t.; hematite, M. 65 p.t.; foundry pig, No. 1, M. 65; No. 3, M. 57 p.t. Basic is generally sold at M. 56 p.t.

German Bessemer steel stands on M. 60 p.t.; while Luxemburg forge pig is quoted 56f. p.t. free Luxemburg. A very satisfactory state of things can be reported in the malleable iron industry. Bars and girders are specially brisk, and makers are well sold forward. In spite of a very keen competition from foreign markets, girders have been raised M. 3 p.t. last week. The position of the plate business has further improved, heavy plates realising M. 5 p.t. more than previous week. Sheets continue in very good call generally, and there is also little more life stirring in the hoop trade. Wire and wire nails are still in languid demand, and this tends to give a certain weakness to prices. In rivets, on the other hand, there has been a slightly better tone noticeable of late, and prices are stiffening. Machine and construction shops are pretty fully engaged, and so are the foundries.

Last week's list quotations per ton at works were as under:—

Good merchant bars, M. 118; angles, M. 128; girders, M. 94 to 97; billets in basic and Bessemer, M. 84 to 85; hoops, M. 123 to 125; heavy plates, for boiler-making purposes, M. 160 to 165; tank ditto, M. 135 to 140; steel plates, M. 130 to 135; tank ditto, M. 120 to 125; sheets, M. 137 to 150; iron wire rods, common quality, M. 125; drawn wire in iron or steel, M. 118 to 138; rivet iron, M. 138 to 142; rivets, M. 175 to 180; wire nails, M. 127 to 130; complete sets of wheels and axles, M. 280 to 290; axles, M. 220; steel tires, M. 200; Bessemer rails, M. 118; steel sleepers, M. 110; fish-plates, M. 120 to 130; light section rails, M. 100.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

GOOD attendance on 'Change. The demand for steam coal is fairly good, and prices for best quality firm. House coal shipments continue good with prices unchanged. Tin-plates in fair inquiry. The demand for manufactured iron and steel continues good.

Coal: Best steam, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s.; house coal, best, 10s. to 10s. 3d.; dock screenings, 5s. to 5s. 3d.; colliery small, 4s. 6d. to 4s. 9d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 46s. 5d.; hematite warrants, 48s. f.o.b. Cumberland; Middlesbrough No. 3, 38s. 1d. prompt; Middlesbrough hematite, 45s. 7d. Iron ore: Rubio, 12s.; Tafna, 11s. 3d. Steel: Rails, heavy sections, £4 12s. 6d.; light ditto, £5 f.o.b.; Bessemer steel tin-plate bars, £4; Siemens tin-plate bars, best, £4 2s. 6d.; all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel, coke, 9s.; Siemens, coke finish, 9s. 3d.; ternes, per double box, 28 by 20 C, 18s. 6d. to 20s. Pitwood, 15s. 3d. to 15s. 6d. London Exchange telegram: Copper, £45 5s.; Straits tin, £59 13s. 9d. Freights, firm.

BERLIN EXHIBITION.—For the convenience of visitors to the Berlin Exhibition the South-Eastern Railway Company have arranged to issue first and second-class return tickets from London to Berlin by the 8.15 p.m. service *viâ* Ostend and *viâ* Calais on Tuesdays and Fridays only, at practically the single fare for the double journey. The special return tickets, which will be available fifteen days, will be ready early in May and issued during the period of the exhibition.

MOVEMENT OF THE GOUFFRE MOUNTAIN.—Owing to the movement towards the river Gardon of the Gouffre Mountain, near the Grand' Combe Colliery, in the French Department of the Gard, which has completely interrupted railway communication, the Bessèges Municipal Council passed a resolution calling on the P.L.M. Company to make a new railway between Bessèges and Chamborigaud. Inasmuch, however, as that company imposed full kilometric rates for carrying coal by a circuitous route from the Kescol and Champclauson collieries, the Grand' Combe Company decided to construct a new line on the right bank of the Gardon. Although the additional railway rates have been suspended, the Grand' Combe Company announces that its new line will be pushed on as fast as possible.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, April 23rd.

SYMPTOMS of increasing confidence in the commercial situation are appearing. There are greater investments of both home and foreign capital in securities, railroad and industrial, and a healthy activity in mining circles. The political whirlpool is getting into shape, so that the business interests are beginning to discount probabilities. A Protection President will be elected. A party split will occur in both conventions, three presidential candidates will fight for the White House, and the Republicans will win. Quick remedial legislation will follow, and decreased imports will soon tell the tale that the American people have wakened out of their nap. The iron trade is not very active. Coke and ore makers are prancing around with their high prices, and consumers are distrustful. Billets are not bought freely at Pittsburgh just now, but requirements are large, and an enormous demand must soon set in if prospects are real and not illusory. Pig iron production is still in excess of consumptive requirements, but for all that prices have ruled firm. Southern freights have advanced a trifle, and a spirit of combination is cropping out to keep prices up by restricting production. In finished products there is only moderate activity. Prices are firm, especially in all Western markets, where general business is better. Plates and structural material are particularly active. Railway equipment sells slowly, and rolling stock, though badly needed, is not ordered. Steel rails in heavy sections are dull, though light sections and girder rails have been selling quite freely. Ship and boat yards are all crowded, and machine shop work is improving.

LAUNCHES AND TRIAL TRIPS.

The s.s. Imperialist was launched from the yard of Messrs. William Doxford and Sons, of Sunderland, on the 25th April, having been built to the order of Messrs. Angier Brothers, London, under the superintendence of Mr. F. J. Pilcher, Liverpool.

The steam yacht Latona, of 265 tons, yacht measurement, designed and built by Day, Summers and Co., of the Northam Ironworks, Southampton, for Baron A. W. von Knoop, was launched on the 29th April. Length, perpendiculars, 136ft.; length on load water line, 135ft.; breadth, 20ft. 3in.; depth, 13ft. The engines are of the compound inverted surface condensing type, of 60-horse power nominal, the cylinders being 18in. and 35in. diameter by 24in. stroke, and boiler 10ft. 6in. diameter by 9ft. long, working pressure 90 lb.

On April the 27th Messrs. Ropner and Son, of Stockton-on-Tees, launched a steel screw steamer of the following dimensions, viz:—Length between perpendiculars, 314ft.; breadth, extreme, 44ft.; moulded depth, 23ft. 3in., which they have built to the order of Messrs. George Pyman and Company, West Hartlepool. The vessel is built on the single-decked rule, "with freeboard," having half poop, bridge, and topgallant forecastle, her deadweight carrying capacity being 4100 tons on 19ft. The saloon and cabins for captain and officers are fitted in the poop, the engineers' accommodation being under the bridge amidships. She is built on the web frame principle, leaving the holds entirely clear for cargo, and carries her water ballast in a cellular bottom and in the after peak. All labour-saving appliances are fitted for the economical working of the steamer, and also for the expeditious loading and unloading of cargoes. She has steam steering gear amidship and screw gear aft, four powerful steam winches, two large donkey boilers, direct steam windlass, stockless anchors, &c. The engines will work up to about 1000 effective horse-power, and are by Messrs. Blair and Co., having cylinders 23in., 37½in., and 61½in. by 39in. stroke, steam being supplied by two large steel boilers working at 160 lb. pressure. The name of Veva was given to her as she left the ways, the naming ceremony being performed by Miss Eva Pyman.

On Saturday morning last the s.s. Ebani left the port of Hartlepool for her trial trip. The vessel has been built by Messrs. Wm. Gray and Co. to the order of the African Association, of Liverpool, for their line of steamers between that port, the Continent, and the West Coast of Africa. She is a handsomely-modelled steamer of the following dimensions:—Length over all, 270ft.; breadth, 36ft. 2in.; and depth, 22ft. 8in. The vessel takes Lloyd's highest class, is built of Siemens-Martin mild steel, with poop for passengers, having well-lighted berths and saloon most tastefully fitted up, smoking-room above, and a luxurious chart-room. The engineers' and officers' rooms are amidships in the long bridge, and the crew's berths in the topgallant forecastle. An ice-room is fitted under the deck, and electric bells in the cabin. An electric light installation has been provided for lighting the vessel throughout. A cellular double bottom is fitted throughout for water ballast. The engines have been supplied by the Central Marine Engine Works of Wm. Gray and Co., and they are of the triple-expansion type, of 1200-horse power, having two large steel boilers working at a pressure of 160 lb. per square inch. There is also in the engine-room electric light machinery, Mudd's patent evaporator, triple automatic telegraph, and other specialities for the economical and convenient working of the machinery. After adjusting compasses the engines were put full speed ahead, and the vessel ran to the south almost as far as Whitby, and back again to Hartlepool, when the speed was found to be 11½ knots per hour. The engines ran in a most excellent manner, there being no heating of bearings, and the boilers kept a steady head of steam with easy firing. Before leaving the harbour the vessel had been carefully inspected by Mr. Holt, chairman of the African Association, and there were present at the trial Mr. Tunnicliffe, one of the directors of the African Association, and Mr. E. H. Bushell, the superintendent engineer, under whose supervision the vessel and her machinery have been constructed. Captain Murrell represented the builders of the ship, and Mr. T. Mudd the engine builders. On the conclusion of her trial the vessel proceeded round to Liverpool, where she loads her first cargo for the African Coast.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

15th April, 1896.

7969. Manufacturing Anhydride, J. Enright, London.
7970. Attachment for Ladies' Skirts, C. E. Green, London.
7971. Utilising Grains, S. Pratt, London.
7972. Instrument for Measuring Angles, L. K. Bell, London.
7973. Electrical Accumulators, A. Heil, London.
7074. Hot Water Heating Apparatus, G. L. Berry, London.
7975. Attaching Articles, W. P. Thompson.—(*F. Loos, Germany.*)
7976. Drive Chain, A. Appleby, Birmingham.
7977. Coating Paper, H. W. V. Wilson and W. Brown, Liverpool.
7978. Signalling on Steamers, J. H. Latham, Liverpool.
7979. Fastening Ladies' Veils, J. Mansergh, Liverpool.
7980. Fastenings for Slip-hooks for Traces, A. Wood, London.
7981. Safety Corking of Bottles, &c., L. Vézac, London.
7982. Pneumatic Tires, T. J. Watson, London.
7983. Typewriting Machines, M. A. Wier, London.
7984. Mangles, R. Lentzkow, London.
7985. Ladles and Forks, J. Ashmall and E. Alford, London.
7986. Steam Pipes, J. D. H. Reimer, London.
7987. Fastening Cycle Tire Covers, E. J. J. Ranger, Farnham.
7988. Hair Fastener, B. J. Swan, London.
7989. Dumpling Shaper, M. M. E. Müller, London.
7990. Automatic Toy, J. R. Christy and J. N. Strong, London.
7991. Operating Water Supply Valves, J. C. Busby, London.
7992. Bottles, M. J. Nolan, London.
7993. Can Openers, W. Millen, London.
7994. Meat Broilers, G. W. Aldrich, London.
7995. Music Leaf Turners and Holders, W. Stevenson, London.
7996. Inkstands, W. G. Lamb, London.
7997. Brine Evaporating Apparatus, W. Shedlock, London.
7998. Wires for Hanging Pictures, F. T. Jenkins, London.
7999. Screwing and Boring Machines, W. W. Hulse, London.

16th April, 1896.

8000. Pressing Irons, P. Wallis, Kettering.
8001. Cycle Saddle, J. Barber, M. Dear, and H. W. Daws, Shanklin.
8002. Cycle Brake, J. Webster and J. T. Woodhouse, Sheffield.
8003. Ploughs, W. A. Wood, Derby.
8004. Thermometer Case, N. J. Butler, Brighton.
8005. Extraction of Cyanides, W. Irwin, Manchester.
8006. Indicating Lock, L. Fletcher, Wigan.
8007. Cycle Tires, G. Roberts, Grimsby.
8008. Propelling Cycles, F. B. Harper, Wolverhampton.
8009. New Game, H. O. and J. O. Roberts, Gloucester.
8010. Lock for Cycles, J. G. Curtis, Cork.
8011. Feed Heaters, T. Mudd, West Hartlepool.
8012. Steam Boilers, T. Mudd, West Hartlepool.
8013. Axle Boxes, G. Ashton, Leigh.
8014. Boxes, J. McDade and J. Paterson, Glasgow.
8015. Watch Key, F. C. Wilkins, Malvern.
8016. Water Service Pipes, A. E. Wright, Cardiff.
8017. Spring Mattresses, F. G. Gale, Birmingham.
8018. Marking Cloth, F. Lehmann and A. van Kempen, Manchester.
8019. Candle Grip, D. Evans, Merthyr Tydfil.
8020. Tires of Cycles, H. James, J. W. Oliver, and J. Malcolm, Sheffield.
8021. Drying Bottles, T. R. Shercliff, Birmingham.
8022. Fuzes of Projectiles, W. B. Ballantine, jun., Glasgow.
8023. Lamps, J. Collinge, Preston.
8024. Umbrellas, E. Briggs, Bradford.
8025. Hair Pins, A. Donald, Dundee.
8026. Cycle Coupling, H. L. Peters, London.
8027. Chain Wheels for Cycles, H. J., A. S., and G. A. Spratt, London.
8028. Dress Skirts, C. Crowther, Manchester.
8029. Ball Castors, E. H. Rowley, Manchester.
8030. Pin Clip, T. Franks, London.
8031. Spinning Cotton, J. Seed, Preston.
8032. Cycles, Cottereau, Brussels.
8033. Felloes of Wheels, A. and A. Gamette, Brussels.
8034. Fire Escape, E. and T. Jason, Brussels.
8035. Spokes for Wheels, H. de Laspée, London.
8036. The General Press, F. C. Clayton, Leeds.
8037. Collapsible Tubes, J. M. Smith, London.
8038. Alarum Clock with Variable Indicator, A. J. Priestley, Leeds.
8039 Hot-water Plates, R. L. Acland London.
8040. Ice-cream Freezer and Churn, J Shackleton, London.
8041. Attachments for Indentures, H. J. Pickering, London.
8042. Treating Gold and other Ores, J. B. Torres, London.
8043. Medical Inhaler and Thermometer, E. Rowland, London.
8044. Furnaces of Steam Boilers, S. A. Johnson, London.
8045. Tire Inflators, B. R. Adkins and C. Windsor, London.
8046. Cheques, &c., A. J. Boult.—(*C. M. Higgins, United States.*)
8047. Vehicle Brakes, I. N. Keeling, London.
8048. Smoke Consuming Apparatus, C. W. Stauss, London.
8049. Valves of Steam Engines, C. W. Thompson, London.
8050. Ruling Machines, E. Graber and L. Hepworth, London.
8051. Writing Desks or Tables, S. Berger, London.
8052. Ring Spring Tire for Cycles, J. W. Graydon, London.
8053. Fire-grates for Domestic Purposes, O. D. Black, London.
8054. Locks, Latches, and the like, T. W. Bedford, London.
8055. Wheel Tires for Cycles, E. G. Brewer.—(*H. W. J. Wilkinson, United States, and F. K. von Oosterwyk, Holland.*)
8056. Handle-bars for Velocipedes, A. Wrench, London.
8057. Brooms, S. W. Ray, London.
8058. Railway Carriage Couplings, E. Schwirkus, London.
8059. Tires, T. B. Gibbs, London.
8060. Pipes used for Smoking, H. Sanford-Burton, London.
8061. Dies for Making Gas Retorts, W. P. and G. B. A. Gibbons, Birmingham.
8062. Electric Railways, P. W. T. Davies, London.
8063. Mud Guards, R. Bowes, Liverpool.
8064. Treating Sulphide Ores, T. Huntingdon and F. Heberlein, London.
8065. Regenerative Furnaces, S. Pitt.—(*H. L. Gantt, United States.*)
8066. Looms, R. L. Hattersley, S. Jackson, and B. Walker, Bradford.
8067. Magneto-electric Governing Appliance, R. P. Wilson, London.
8068. Magneto-electric Regulating Appliance, R. P. Wilson, London.
8069. Treating Fibrous or Pulpy Materials, J. B. Ker, London.
8070. Pocket Scissors, S. and F. Jones, F. S. Howard, and W. A. Higginson, London.
8071. Wheel or Roller Skates, J. du P. Sworder, London.
8072. Treating Ores, W. T. Whiteman.—(*The Compagnie Générale l'Alumine Exploitation des Brevets F. Raynaud (Société Anonyme), Belgium.*)
8073. Covering Roadways, &c., S. O. Cowper-Coles, London.
8074. Bicycles, C. F. A. H. Bagot, London.
8075. Explosives, M. I. E. Morris, London.
8076. Automatic Guns, H. S. Maxim and L. Silverman, London.
8077. Hose Pipe Couplings, H. H. Lake.—(*I. P. Doolittle, United States.*)
8078. Asbestos Fabric, J. Germain and L. and H. Boisne, London.
8079. Foot Scrapers and Cleaners, R. J. Trumbull, London.
8080. Accumulator, E. Commelin and R. Viau, London.
8081. Torpedoes, L. H. Moulun, London.
8082. Stamping Apparatus, J. Bohensky, London.
8083. Holding a Looking-glass Inclined, E. M. A. Fraser, London.
8084. Pinion Teeth, C. D. Abel.—(*R. Abt, Switzerland.*)
8085. Operating Bulkhead Doors, D. Munro, London.

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8086. Skirts, J. Westaway, London.
8087. Vessels for Cooking Liquids, J. Westaway, London.
8088. Cooking Vessels, J. Westaway, London.
8089. Outlet Valve Motion, W. Seck, Frankfort-on-the-Main.
8090. Ice Cream Cart, B. Twigg and C. H. Bennett, Sheffield.
8091. Serving Ice Cream, B. Twigg and C. H. Bennett, Sheffield.
8092. Utilising Tires of Wheels, J. C. H. Pierson, London.
8093. Filter, &c., H. E. Fry and N. G. Hackney, London.
8094. Brackets, W. Thomson, Huntingdonshire.
8095. Spindles of Yarn-twisting Frames, R. Fischer, Manchester.
8096. Automatic Air-escape Valves, T. C. Olney, Manchester.
8097. Hopper-feeding Machines, D. Armstrong and J. Ashton, Manchester.
8098. Treating Furnace Gases, W. H. Hill-Hartland, Sheffield.
8099. Coin-freed Machine for Stamps, F. J. Shapley, Bristol.
8100. Bedstead Loose Fitting, J. and F. S. Turner, Dudley.
8101. Boot Stretchers, T. Morton and F. R. Baker, Birmingham.
8102. Locking Corks in Bottles, W. W. Cashmore, Birmingham.
8103. Preventing Noise from Gas Engines, O. Y. Rhodes, Leeds.
8104. Looms, A. Johnstone and J. W. Parker, Bradford.
8105. Automatic Receiver of Mails, T. Knowles, jun., Sunderland.
8106. Twyer Stone, C. A. Brackelsberg, Brussels.
8107. Appliances for Circulating Water, J. Laird, Glasgow.
8108. Furnaces for Steam Boilers, O. Meredith, Birkenhead.
8109. Band for Cycle Tires, D. W. Andrews, Manchester.
8110. Shaking-barrel, A. J. Leaver, London.
8111. Apparatus for Shaping Bread, J. P. Killeen, Dublin.
8112. Grinding Spectacle Lenses, G. Prescott, Dublin.
8113. Portable Rotary Blower Pump, E. Samuelson, Banbury.
8114. Reservoir for Supplying Ink, J. Joly, Dublin.
8115. Apparatus for Water-heating, W. Mycock, Rochdale.
8116. Facilitating the Opening of Boxes, P. W. Watts, Manchester.
8117. Winding Regulator, W. Whittaker and J. H. Fanton, Manchester.
8118. Punches for Tickets, J. Macrae and W. Clark, Glasgow.
8119. Vacuum Milking Machines, A. Shiels, Glasgow.
8120. Apparatus for Sweeping Chimneys, T. Flynn, Glasgow.
8121. Border for Garden Walks, J. C. Meyers, Dublin.
8122. Process for Clarifying Beer, E. and C. Müller, Berlin.
8123. Letter-boxes, D. and S. Cristol, London.
8124. Measuring Appliance, C. V. du Toit, London.
8125. Driving Gear for Cycles, F. Peters, London.
8126. Clearing Ships of Water, E. E. Middleton, Essex.
8127. Cycle Brakes, F. P. Craven, London.
8128. Cycle and other Lamps, J. A. Hay, Birmingham.
8129. Seats, S. D. V. Meter, Birmingham.
8130. Weather Guard for Cyclists, G. J. D. Coleridge, London.
8131. Incandescent Gas Lamps, A. H. Catherwood, London.
8132. Roughing Screws for Horseshoes, E. Dejean, London.
8133. Penholders for Ruling Purposes, G. Thompson, London.
8134. Electrical Welding Process, L. W. Breuer, London.
8135. Pneumatic Tires, J. T. Trench, London.
8136. Pneumatic Tires, J. T. Trench, London.
8137. Mudguards for Velocipedes, I. W. Boothroyd, London.
8138. Attachments to Cycles, &c., R. Corsham, London.
8139. Seed and Manure Drills, W. Brenton, London.
8140. Cultivators, E. Mote, London.
8141. Switch Apparatus, Siemens Bros. and Co.—(*Siemens and Halske, Germany.*)
8142. Apparatus for Superheating Steam, B. Jaffé, London.
8143. Mounting of Photographs, S. Delépine, London.
8144. Auto-harps, J. A. Taylor, London.
8145. Speed Gears, S. H. Crocker, London.
8146. Curve Tracers and Rulers, E. B. Noyes, London.
8147. Can Openers, J. A. Haskett, London.
8148. Decoration of China, The Coalport China Co., and T. J. Bott, London.
8149. Burner for Incandescent Lighting, E. Ernst, London.
8150. Combined Billiard Marker, R. B. Pearson, London.
8151. Burners for Liquid Combustibles, L. Runge, Liverpool.
8152. Process for Preserving Eggs, A. Huber, London.
8153. Closing Devices for Bottles, G. Labuthie, London.
8154. New Acid, J. C. Mewburn.—(*The Chemische Fabrik von Heyden, Gesellschaft mit beschraenkter Haftung, Germany.*)
8155. Utilising Space under Seats in Churches, H. Anderson, London.
8156. The T Curtain Hook, J. E. Doughty, London.
8157. Duplicate Keys for Locks, &c., E. R. Darling, London.
8158. Lathes, W. V. Pittler, London.
8159. Stoppering Bottles, &c., G. Elsley and R. Hill, London.
8160. Cycles, F.-H. R. B. Liebenrood, London.
8161. Combustion of Fuel, W. Tyree, London.
8162. Rat Traps, W. Tyree, London.
8163. Operating Electric Signals, L. Mesmer-Weber, London.
8164. Buttons, J. H. Nancarrow, London.
8165. Cycles, W. S. Simpson, London.
8166. Linotype Machines, The Linotype Company.—(*The National Typographic Company, United States.*)

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8167. Tramway Track or Rail Cleaner, J. T. Warren, Bristol.
8168. Securing Elastic Tires to Wheels, J. Adair Waterford.
8169. Incandescent Gas Lamps, P. Meyer, London.
8170. Trawling Gear, G. A. Smith and W. J. Baker, Scarborough.
8171. Sanitary Closet Seat Pad, L. W. Caulfield, Brighton.
8172. Weaving Wire, D. S. Birrell and A. Rathbone, Liverpool.
8173. A New Game, H. O. and J. O. Roberts, Gloucester.
8174. Articles of Dress, W. F. Quinn and J. Taylor, Leicester.
8175. A Unicycle, J. Pledger, London.
8176. Furniture Castors, C. E. Dunn, Birmingham.
8177. Cleaning Out Tubular Bends, J. W. Banks, Belfast.
8178. A Collapsible Boat, A. H. K. Smith, Portsmouth.
8179. Tobacco Pipes, A. H. Gorsuch, J. Crowther, and G. H. Richmond, Manchester.
8180. Manufacture of Mats, F. Armitage and W. Hirst, Huddersfield.
8181. Opening Closed Vessels, H. Austin, Wolverhampton.
8182. Fire-arms, E. T. Whitelow.—(*A. W. Schwarzlose Germany.*)
8183. Swimming Appliances, W. Snaydon, Dorsetshire.
8184. Cloths for Cleaning Purposes, S. O'Neill, Lancashire.
8185. Lowering Gas Fittings, P. G. Ebbutt, Birmingham.
8186. Cycles, J. W. Smallman, Nuneaton.
8187. Sewing Machines, W. H. Inslee.—(*The Singer Manufacturing Company, Germany.*)
8188. Stone Cutters' Chisels, J. Mellon, Glasgow.
8189. Tires of Cycles, J. McConechy, Glasgow.
8190. Manufacture of Driving Belts, J. K. Tullis, Glasgow.
8191. Outside Blinds for Shop Windows, J. R. Malcolm, Dundee.
8192. Furnaces, A. Hope and W. Arnold, Manchester.
8193. Woven Wire Mattresses, F. G. Gale, Birmingham.
8194. Manufacture of Margarine, J. C. Uhlenbrock, Manchester.
8195. Wearing Apparel, J. Tenebaum, Liverpool.
8196. Ready-made Seal for Deeds, J. L. Phillips, Llanelly.
8197. Ramming of Ships, R. J. Plunkett, Bristol.
8198. Hydraulic Apparatus, A. S. Bryce, jun., Glasgow.
8199. Four-wheeled Road Vehicles, J. H. Kelly, Glasgow.
8200. Window Tickets, A. Macdonald, Glasgow.
8201. Two-speed Gearing for Cycles, A. Dicksee, London.
8202. Flexible Transmission Shafts, E. L. Doyen, London.
8203. Steering Gear, J. Brown, Glasgow.
8204. Wrapper for Paste Blacking, A. E. Pinfold, Bradford.
8205. A Puzzle, W. Percival and A. E. Pinfold, Bradford.
8206. Cycle Gear Cases, H. Fearncombe and Co., Ltd., and A. Evans, London.
8207. Braces, H. H. Leigh.—(*Plener and Co., Germany.*)
8208. Troughing for Electric Wires, J. Row, Manchester.
8209. Hooks for Securing Veils, H. Broughton, London.
8210. Controlling the Feed in Arc Lamps, H. J. Fisher, London.
8211. Flower Holder, H. G. Perring, London.
8212. Tobacco Pouch and Pipe Case, P. E. Ward, London.
8213. Combined Washstand and Bed, J. J. Huygens, London.
8214. Preventing Liquids in Pipes Freezing, G. Stevens, London.
8215. Refrigerators for Eggs, &c., J. H. Bowley, London.
8216. Electric Motors and Dynamos, W. E. Gray, London.
8217. Jacquard Apparatus, J. Szczepanik and L. Kleinberg, London.
8218. Boots and Shoes, G. A. Royce and F. Knight, London.
8219. Trees for Boots, &c., G. A. Royce and F. Knight, London.
8220. Tape Lines, S. H. Rodick, London.
8221. Knitting-machine Lock Mechanism, H. Verges, London.
8222. Coupling Railway Vehicles, H. S. Frampton, London.
8223. Dolly for Laundry Purposes, W. Cree, London.
8224. Improved Laundry Washing Board, W. J. Jones, London.
8225. Golf Clubs, F. A. Ayers and G. Buckoke, London.
8226. Hardening Metal Articles, W. S. Simpson, London.
8227. Treating Sewage, W. D. Scott-Moncrieff, London.
8228. Electric Generators, Siemens Bros. and Co., Ltd., and E. F. H. H. Lauckert, London.
8229. Railway Carriage Couplings, J. L. J. Linou, London.
8230. Pneumatic Tires, A. J. Boult.—(*F. H. Snow, Australia.*)
8231. Weighing Apparatus, F. Williams, London.
8232. Preservation of Perishable Goods, H. Higgins, London.
8233. Hermetic Sealing of Vessels, H. Higgins, London.
8234. Prepayment Gas Meters, L. S. Burchard.—(*W. Webber, United States.*)
8235. Producing Designs on Linen, &c., J. Weiss, London.
8236. Material for Destroying Insects, C. H. Higbee, London.
8237. Recording Variations in Rotating Bodies, J. S. Raworth, London.
8238. Waistbands for Knickerbockers, J. Royle, London.
8239. Producing Illuminating Gas, C. Gautzsch, London.
8240. Incandescent Gas Stoves, S. H. Crocker, London.

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8241. Gas Globes and Shades, W. H. Prestwich, London.
8242. Spinning Frames, W. P. Thompson.—(*Christiania Seildugsfabrik and A. Pein, Norway.*)
8243. Steel Tube Tire for Cycles, W. G. Brightling, London.
8244. School Slates, E. Burke, Dublin.
8245. Governor Meter, W. G. Potter, London.
8246. Collar Studs and Solitaires, M. Bennett Swansea.
8247. The Bunsen Retort Superheating Gas Burner, M. F. Solon and Marquis Bibbero, Cobridge, Staffordshire.
8248. Pegs for Loom Shuttles, B. Garlick and J. Ellis, Huddersfield.

8249. Governing Marine Engines, D. Johnston and W. McAdam, Glasgow.
8250. Valves, T. O'Hara and J. R. and T. Ashmore, Liverpool.
8251. Decorating Tiles and Plaques, R. Lunn, Derby.
8252. Combination of Easel Show Cards, T. Morton, Birmingham.
8253. Cycles, W. A. D. Hipperling, C. P. T. Engels, G. C. W. Hipperling, and F. C. H. Klare, Berlin.
8254. Ladies' Cycling Dresses, J. W. Boyce, Cheltenham.
8255. Mechanical Motors, J. O. Dale, Birmingham.
8256. Cork Armoured Pneumatic Tire, V. de H. Dowler, Plaistow.
8257. Hose Pipe Couplings, H. G. Fraser, Dundee.
8258. Cop Shuttles, J. Ireland, Dundee.
8259. Ventilation of Coal Mines, W. G. Thomas, Liverpool.
8260. Driving Motor Vehicles, J. Fielding, Gloucester.
8261. Mechanical Toys, G. Royle and W. R. Wynne, London.
8262. Tightening Wires, M. Commichau, Zwickau, Saxony.
8263. Springs for Wheels, H. W. McWm. Bourke, London.
8264. Socket for Handle Bar of Cycles, J. Loftos, London.
8265. Flushing Closets, T. G. Rhodes, R. Gaunt, and J. B. Ledgard, London.
8266. Trussing Knives, Hay Knives, &c., T. A. Linacre, Sheffield.
8267. Manufacturing Varnish, E. W. Barnsley, Birmingham.
8268. Increasing Speed of Screw Propellers, W. White, London.
8269. Electrical Conductors, &c., G. Wilkinson, London.
8270. Hollow Rubber Tires for Wheels, I. E. Clifford, London.
8271. Electric Traction, W. S. Boult, London.
8272. Word-making Game, A. Walker, London.
8273. Boilers, J. G. Nash and J. M. Borrow, London.
8274. Grading Machines, W. Johnson and H. Walker, London.
8275. Closing Puncture Holes, &c., J. G. Horsey, London.
8276. Order Pads, R. J. Cook and W. H. C. Hammond, London.
8277. Tubes, J. Hudson, London.
8278. Cutting Tools, G. Cubbon, London.
8279. Registering Amount of Liquids, J. D. Hannah, London.
8280. Drawing-off Liquids under Pressure, N. Caro, London.
8281. Insulating Bricks, S. Pollak and N. Zwillinger, London.
8282. Waste Preventing Spout, W. E. C. Pinchbeck and J. Griffin, London.
8283. Ball Cleaner, C. J. Jacobs, St. Helen's, I.W.
8284. Producing Compressed Air, J. Joetten, Cologne.
8285. Washing and Cleaning Machines, E. J. Lane, London.
8286. Packing Tea, T. Howard, London.
8287. Grinding China, J. Macintyre and Co., Ld., and A. H. Ryles, London.
8288. Producing Ammonia, O. Imray.—(*La Société Christiania Minekompani, Norway.*)
8289. Charcoal for Filtering Oils, G. E. G. Terouanne, London.
8290. Motor Carriage for Railways, W. Hildebrand, London.
8291. Feeding Bottles, A. Haworth, Liverpool.
8292. Milk Cans for Transit Purposes, W. J. H. Buckler, Birmingham.
8293. Billiard Tables and the like, J. S. Burroughes, London.
8294. Automatic Friction Coupling, R. Dahlander, London.
8295. Lifeboats, C. Hibberd, London.
8296. Attaching Spikes to Boots, A. J. Aitkens, London.
8297. Bleaching Paper Pulp, W. H. Caldwell, London.
8298. Manufacture of Tabloids, K. G. Georgi, London.
8299. Propelling Vehicles, &c., J. Wills, Isle of Wright.
8300. Letter Boxes, Money Boxes, &c., J. W. Simmonds, London.
8301. Cycle Adjustable Throw Cranks, W. F. Goreham, London.
8302. Linotype Machines, The Linotype Company, Ltd.—(*The National Typographic Company, United States.*)
8303. Blotter and Calendar, F. J. Measures and F. Adams, London.
8304. Briquette Fuel, C. Bourquin, J. Besson, and P. H. P. C. de Renéville, London.
8305. Fastening Broom Handles, W. Geneger and R. Sanders, London.
8306. Self-propelled Vehicles, L. Bollée, London.
8307. Chicken Rearing Apparatus, A. Bayldon, London.
8308. Electrical Resistances, V. A. Fynn, London.
8309. Manufacturing Hollow Pulp Ware, A. Thame, London.
8310. Improved Prongless Buckle, W. Pritchard, London.
8311. Apparatus for Colour Printing, L. C. G. Lesage, London.
8312. Machines for Chopping Meat, E. Graddon, London.
8313. Protection against Genital Infection, A. Scheuer, London.
8314. Producing Artificial Stone, L. Preussner, London.
8315. Compressing Tobacco, T. Cole and W. L. Cole, London.

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8316. Electric Switches, E. H. Wright, J. J. Heckman, A. H. Graves, C. C. Carnahan, and W. H. Carnahan, London.
8317. Navigable Vessels, L. O. Smith, London.
8318. Fixing Dyes in Fabrics, C. M. White.—(*The Electro Waterproofing and Dye-fixing Company, United States.*)
8319. Advertising Clocks, V. I. Feeny.—(*W. F. Mills and L. A. Robertson, United States.*)
8320. Electrical Accumulators, &c., C. Fabbro, London.
8321. Locking Cycle Steering Gear, C. S. Madan, Didsbury.
8322. Cellular Double Bottoms in Ships, G. Gallilee, Hull.
8323. Treating Fabrics, C. M. White.—(*The Electro Waterproofing and Dye-fixing Company, United States.*)
8324. Artificial Decoy Bird, R. M. Presland, sen., London.
8325. Sewing Machines, D. J. MacDonald, Glasgow.
8326. Depositing Copper on Printing Rollers, H. Wylie and J. Grant, Glasgow.
8327. Machines for Cutting Bacon, F. J. Burrell, Thetford.
8328. Artificial Horizons, E. Beecher, Cardiff.
8329. Apparatus for Drying Bottles, T. R. Shercliff, Birmingham.
8330. Animal Shoes, E. R. Rogers and J. Walker, Birmingham.
8331. Metal, F. W. Popp, Birmingham.
8332. Pneumatic Tires for Cycles, W. C. Lister, Wolverhampton.
8333. Wheels, W. H. Caldwell, Dublin.
8334. Wheels, J. Watson, London.
8335. Table Utensils, F. Hadida, Liverpool.
8336. Electric Tramways or Railways, A. G. Adamson, Glasgow.
8337. Castors, E. Smallwood, Birmingham.
8338. Connecting Cars with Wires, W. E. Kenway, Birmingham.
8339. Kitchen Fenders, W. P. Eglin, Halifax.
8340. Automatic Lubricators, F. and J. Thiel and C. Geier, Glasgow.
8341. Velocipedes, J. B. Fondu, Brussels.
8342. Tires, W., W. H., G., and S. E. Lawson, and G. S. Blackburn, Manchester.
8343. Making Wire Fencing, W. Edenborn, Glasgow.
8344. Sorting Minerals, G. Dowson and R. Blakeborough, Stockton-on-Tees.
8345. Appliance for Ladies' Dresses, E. A. Gee, Stockton-on-Tees.
8346. Gas Lamps, A. O. Brown, London.
8347. Bottle Stoppers, V. Reiser and T. Sutcliffe, Bradford.
8348. Refining Oils, J. Y. Johnson.—(*The Ohio Oil Improvement Co., United States.*)
8349. Lath and Venetian Blinds, V. Bennett, Swansea.
8350. Apparatus for Cleaning Windows, J. Sherriff, Glasgow.
8351. Hats, C. L. Lamotte, London.
8352. Treatment of Sewerage, W. H. Higgin, Little Lever, near Bolton.
8353. "Bridgewater" Attachment for Bicycles, B. B. Bridgewater, Hereford.
8354. Engines, A. H. Williams, Glasgow.
8355. Paper-making Machines, J. P. Cornett and F. A. Lindley, Glasgow.
8356. Tools for Drilling Holes, H. Alexander, Glasgow.
8357. Explosive Gas Engines, M. C. Dunsmore, Glasgow.
8358. Riveting Machines, G. W. Parker, Glasgow.
8359. Motor Power Apparatus, J. M. MacDonald, London.
8360 Decorticating Fibrous Plants, J. M. MacDonald, London.
8361. Bottles, G. P. Clark, London.
8362. Electric Signalling Devices, E. J. Devine, London.
8363. Stone Working Appliance, W. Thomas, London.
8364. Claw and Peen Ended Hammer, A. Porter, Bolton.
8365. Fire Iron, H. Carter, Bolton-le-Moors.
8366. Fastener for Boots, A. T. M. Johnson and S. L. Lion, London.
8367. Diamond Polishing Stool, E. and R. Loesser, London.
8368. Melting Iron, T. Doherty and P. D. Crerar, London.
8369. Handling of Steel Balls, &c., A. L. Jenner, London.
8370. Wrenches, R. O. R. Russell, London.
8371. Card Setting Machines, J. Thornton, London.
8372. Syphon Bottles, H. W. Handcock, London.
8373. Oil Engines, J. E. W. Chadborne, Cheltenham.
8374. Hypodermic Syringe, J. Coleman, London.
8375. Cutting Bar Soap, H. E. Downs, London.
8376. Printing, F. C. Taylor and J. Cooke, London.
8377. Relays, F. E Chapman, London.
8378. Brake Mechanism, H. H. Lake.—(*C. O. Baird, United States.*)
8379. Sewing Machines, F. H. Richards, London.
8380. Telegraph Instruments, B. F. Merritt and J. M. Joy, London.
8381. Rotary Web Printing Machines, F. Meisel, London.
8382. Electric Tramcars, J. Devonshire.—(*W. B. Potter, United States.*)
8383. Boot Cleaning Appliances, &c., T. G. Benton, London.
8384. Combustible Gases, B. H. Thwaite, London.
8385. Metallic Bedsteads, S. J. Hoadly, London.
8386. Reducing Hard Substances, &c., A. Jordan, London.
8387. Stop Valves, D. B. Morison, London.
8388. Cycles, A. H. Mackmurdo, London.
8389. Packing Goods, H. A. T. Sandon, London.
8390. Photography, C. L. A. Brasseur and S. P. Sampolo, London.
8391. Pianofortes, R. M. Squire, London.
8392. Washing Clothes, J. R. Orrell, Liverpool.
8393. Casks, G. R. Lund, Liverpool.
8394. Photography, J. M. Davidson, London.
8395. Mats for Vehicles, T. Nurse, London.
8396. Clamp for Manuscripts, &c., R. Toepper, London.
8397. Electrical Resistances, H. Edmunds, London.
8398. Electrical Resistances, H. Edmunds, London.
8399. Electrical Circuits, H. Edmunds, London.
8400. Door Closing Devices, J. Cuggia, London.
8401. Knitting Machines, W. Moore, London.
8402. Preparation of Peat for Fuel, C. D. Jenkins, London,
8403. Cycles, P. S. Phillips, London.
8404. Skirt Dancing, M. M. Dessau, London.
8405. Shutters, Sheaths, Slides, &c., M. M. Dessau, London.
8406. Mechanisms for Transmitting Power, C. C. Leclaire, London.
8407. Fumigators, W. Leigh, London.
8408. Rifle, T. R. R. Ashton, London.
8409. Pumps for Pneumatic Tires, A. Clarkson, London.
8410. Electro-deposition of Metals, J. C. Graham, London.
8411. Umbrellas or Sunshades, &c., S. D. S. Ross, London.
8412. Adjusting Gearing Chains, W. C. Barns and C. O. Hillsdon, London.
8413. Construction of Boats, H. A. House and R. R. Symon, London.
8414. Necktie Holder, T. H. Biggs, London.
8415. Ties for Fastening the Ends of Bands, J. H. Huntington, London.
8416. Presses, C. T. Packer and G. W. Swift, jun., London.
8417. Machines for Polishing Tubes, P. Medart, London.
8418. Projection of Photographs of Subjects, J. Bonn, London.
8419. Hot Air and Oil Engines, R. J. Eke, London.
8420. Plush Fabrics, H. Müllers and A. Spindler, London.
8421. Means for Inflating Pneumatic Tires, O. Jones, London.
8422. Umbrellas, R. Waples, jun., London.
8423. Artificial Limbs, S. M. Kellum, London.
8424. Baskets for Transporting Fruit, T. R. Ogier, London.
8425. Tip Holders for Umbrellas, &c., H. Scudder London.
8426. Stopping Engines or Machines, T. W. R. McCallum, London.

22nd April, 1896.

8427. Coverings for Roofs, &c., H. Piquet and A. H. Griffith, Port Talbot, Glam.
8428. Electric Switch, J. B. Verity, Birmingham.
8429. Attaching Ornaments to the Hair, J. Carlu, London.
8430. Knife Cleaners, W. T. Kirkman and H. Doughty, Liverpool.
8431. Construction of Safes, J. Green, Stockport.
8432. Removing Bark from Willows, W. Bridgewater, Leicester.
8433. The "Ouse" Pike Gag, B. R. Bambridge, Eton.
8434. Ring Spinning Machines, W. Lee, Manchester.
8435. Apparatus for Cutting Fustians, J. Wilkinson, Manchester.
8436. Flat Whitewash Brush, T. J. Pickford, Bradford.
8437. Tires for Cycles, G. P. Appleyard, Halifax.
8438. Mechanical Toys, R. Bradshaw, R. Cort, and J. Whewell, Halifax.
8439. Dress Holders, H. P. Lavender, Walsall.
8440. Fraud Protection Cheque, F. Dunsford, Leeds.
8441. Mounting Pens for Ruling Machines, J. Joly, Dublin.
8442. Carpet Fastenings, W. T. Mealley, Dublin.
8443. Inking Ribbons for Typewriters, J. E. Booth, Bradford.
8444. Grilling and Boiling Apparatus, W. E. Jaques, Ironbridge.
8445. Bogie Frame, G. R. Goughins, Virginia, United States.
8446. Potato Planters, J. Tweedle, Liverpool.
8447. Steam Engines, A. Blechynden, Liverpool.
8448. Condensing Steam, Sir W. H. Bailey, A. J. Bailey, and T. Westerby, Manchester.
8449. Cycles, W. Walton, Bradford.
8450. Wind Organs, J. B. Howard.—(*L. Müller, Germany.*)
8451. Shirts, A. E. Price, Manchester.
8452. Skates, A. H. Boultbee, Sheffield.
8453. Paper Knife, A. Mahn, Glasgow.
8454. Ocean Coaling Apparatus, T. Knowles, jun., Sunderland.
8455. Jointing Drain and Sewer Pipes, W. Pilkington, Cromer.
8456. Cycle Handles, H. B. Chapman, London.
8457. Optical Toy, C. E. Gyngell, London.
8458. Electrical Recording Instruments, W. Turvey, London.
8459. Sleeve Link, M. A. Young, London.
8460. Transmitting Power or Motion, G. Greaves, London.
8461. Cycle Pedals, H. S. Halford, London.
8462. Roasting Jill, L. E. Jones, London.
8463. Time-checking Apparatus, L. T. Darnault, L. Calderon, and R. Zevallos, London.
8464. Treating Paper, H. J. Rogers and W. M. Mordey, Watford.
8465. Fog Signal Apparatus, L. T. Darnault, L. Calderon, and R. Zevallos, London.
8466. Tires, A. J. Henderson, London.
8467. Tires for Cycles, F. W. Golby.—(*B. Fröhlich, Germany.*)
8468. Locomotive Advertising Devices, F. J. Measures, London.
8469. Accumulators, W. Wilkinson, H. Alexander, and G. P. Wallis, London.
8470. Game to be Played on Lawns, M. C. N. Vowler, London.
8471. Hydrometers, A. E. Dean, London.
8472. Screw Nail, H. H. Jay, London.
8473. Fastenings for Postal Envelopes, G. Bell, London.
8474. Fire Alarm, W. Cooke, London.
8475. Keys, A. W. Lugg, London.
8476. Overshoes, S. Allsop, London.
8477. Covers for Pneumatic Tires, H. W. Stannard, London.
8478. Reducing Valves, E. Morton and G. Edwards, London.
8479. Boot Lace Fasteners, J. J. Rayner, London.
8480. Shirt Studs, H. A. Davis, Bromley.
8481. Tube Ventilator for Shops, J. Burt, Roath, Cardiff.
8482. Machine for Straining Paper-stuff, H. Schaaf, London.
8483. Electric Cable Joints, Siemens Brothers and Co. and W. Dieselhorst, London.
8484. Bending and Shaping Lead Pipes, J. W. Wilson, London.
8485. Mounting Side or Wing Mirrors, J. Porter, London.
8486. Vessel or Receptacle for Cooking, J. Westaway, London.
8487. Cooking and Grilling Meat, &c., J. Westaway, London.
8488. Supporting a Cooking Vessel over Lamps, J. Westaway, London.
8489. Filters, J. Westaway, London.
8490. Securing Watches to Cycles, E. G. Tuteur, London.
8491. Washing, &c., Spun Fibres and Stuffs, B. Thies, Cologne.
8492. Raising Door Portiere Rod Curtains, J. Lilly, Birmingham.
8493. Baby Corral, A. Wood, London.
8494. Pipes, P. F. Campbell, London.
8495. Puzzles, G. J. C. Adami, London.
8496. Supports for Scaffolds, H. Schubert, London.
8497. Construction of Buildings, J. T. Wilson, London.
8498. Money Holder, E. Rein, London.
8499. Engine Glands, J. Appleton and W. Cundliffe, Liverpool.
8500. Frame or Holder for Placards, T. H. J. Pryce, London.
8501. Circular Cutters, Sir C. H. A. F. L. Ross, Bart., London.
8502. Gasholders, &c., F. Livesey and W. T. Sugg, London.
8503. Furnace Injectors, F. Pauwels, London.
8504. Transferring Barges, &c., B. J. Thomas, J. J. Taylor, and G. C. Thomas, London.

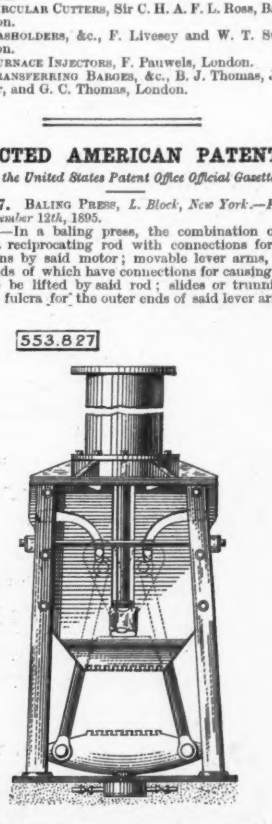
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

553,827. Baling Press, *L. Block, New York.—Filed September 12th*, 1895.

Claim.—In a baling press, the combination of a motor, a reciprocating rod with connections for its actuations by said motor; movable lever arms, the inner ends of which have connections for causing the same to be lifted by said rod; slides or trunnions forming fulcra for the outer ends of said lever arms; rising stationary ways or cam surfaces over which said fulcra may be moved as said lever arms are lifted; pitmen the upper ends of which are pivoted to said lever arms inside of the fulcra, a movable platen to which the lower ends of said pitmen are pivoted, and a stationary platen, whereby a bale may be compressed between the platens, the lifting movement of said lever arms continued beyond their horizontal position, and the strain upon the stationary parts of the press transferred on different points thereof as the fulcra are moved.

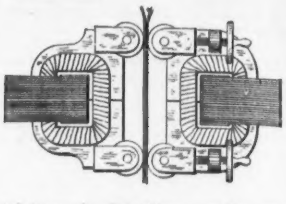
553.827



553,923. Apparatus for Electric Welding, *H. Lemp, Lynn, Mass.—Filed June 17th*, 1891.

aim.—In an electric metal working apparatus, the bination substantially as described with two transformers supplying heating currents to the same work, of alternating current sources connected respectively to the primaries of said transformers, and adapted to supply alternating currents of different frequency.

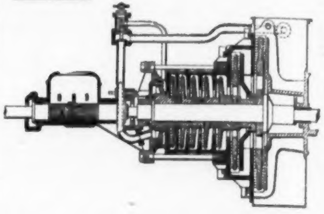
553.923



553,932. Steam Turbine, *C. A. Parsons, Newcastle-upon-Tyne, England.—Filed February 21st*, 1895.

Claim.—(1) In combination, the propeller shaft, the dummy piston thereon, the turbine wheels or discs, the steam supply pipe leading to the dummy piston to resist the end thrust, and a valve controlling said steam supply automatically, and means for controlling said valve in proportion to the end thrust, substantially as described. (2) In combination, the propeller shaft, a bearing therefor to allow end thrust of the same, a dummy piston on the shaft, a steam supply leading to the dummy piston, a valve controlling said supply, and means controlling said valve in proportion to the end thrust, substantially as described. (3) In combination, the shaft, the turbine thereon having the dummy piston, and the fluid supply leading thereto, whereby said dummy piston will balance the end thrust, substantially as described. (4) In combination, the shaft, and turbine thereon arranged to take up the end thrust, the inlet for the steam to the turbine, a second inlet for the balancing fluid, a valve controlling the said inlet, a piston controlling the operation of the valve, and a connection from the piston chamber to the first steam inlet leading to the turbine, whereby the balancing power of the fluid will be proportional to the fluid pressure from which the rotation is derived.

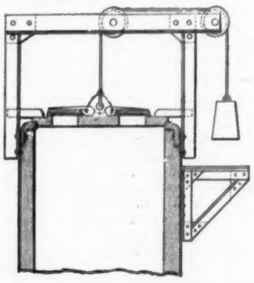
553.932



553,956. Explosive Valve for Blast Furnaces, *T. Coultas, Pittsburg, Pa.—Filed April 4th*, 1895.

Claim.—In explosion valves for blast furnaces, the combination with the down-take pipe, of a vertical pipe leading from the upper end of said downtake, a valve at the upper end of said pipe, rods passing through said valve and through projections on said pipe, springs interposed between said projections and shoulders on said rods, a frame supported by said pipe, a rope secured to said valve and passing up over a pulley in said frame, a second pulley over which said rope passes, a weight at the end of said rope, and a shelf secured to said pipe and adapted to support said weight when lowered, substantially as set forth.

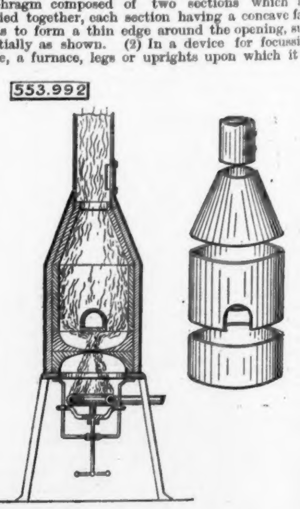
553.956



553,992. Apparatus for Focussing Flame, *C. H. Land, Detroit, Mich.—Filed January 15th*, 1894.

Claim.—(1) In an apparatus for focussing flame, a diaphragm composed of two sections which are applied together, each section having a concave face so as to form a thin edge around the opening, substantially as shown. (2) In a device for focussing flame, a furnace, legs or uprights upon which it is supported, U-shaped supporting arms, having a threaded opening through its lower end, an adjusting screw which passes up through the arms, and a spider which is vertically adjustable upon the arms and forms a support for the burner, combined with a Bunsen burner, and a thin-edged diaphragm at the bottom of the furnace, substantially as specified.

553.992



WAGES IN THE ENGINEERING TRADE.

By J. STAFFORD RANSOME.

II.—TRADE UNION INFLUENCES.

MY first article of this series dealt with the great inequality of wages in different districts, and two schedules were used for the purpose of showing that the standard of wages in a given town was by no means necessarily proportionate either to the size of the town, or to the strength of the local trade union element in it. With regard to the first of the above points, no argument or amplification is necessary; as, by means of the local census returns on the one hand, and, on the other, the statistics as to the wages paid, anyone interested in the question can satisfy himself without difficulty as to how far the wages standard has to do with the population of a town.

A comparison, however, between local standards of wages and the amount of local trade union influence is a more complicated matter, for the following reasons:—(1) The number of men returned as belonging to trade unions is invariably exaggerated. (2) An accurate return, giving the total number of men in a trade—that is to say, the men who might be qualified to join the unions—does not exist in most localities. (3) The strength of the trade union influence cannot always be gauged by the number of trade union members; as it frequently happens that, when there are several unions in one trade, their tactics are so diametrically opposed that, instead of strengthening each other, they very materially weaken the influence of trade unionism generally.

I think it well to repeat here a portion of one of the schedules given in my last article for the purpose of comparing local trade union influence with local rates of wages in some of our large engineering centres.

Table showing Towns in their order of Wages and Trade Union Influence.

Rate of wages.	Position.	Trade Union influence.
London	Highest ...	Belfast
Sheffield	2nd	Sunderland
Manchester	3rd	Bolton
Birmingham	4th	Newcastle-on-Tyne
Liverpool (with Birkenhead)...	5th	Leeds
Bolton	6th	Glasgow
Belfast	7th	Dundee
Bradford	8th	Bradford
Newcastle on-Tyne ...	9th	Manchester
Sunderland	10th	Liverpool (with Birkenhead)
Glasgow	11th	Sheffield
Leeds	12th	Birmingham
Dundee	Lowest... ...	London

From this table it is clear that, as far as the engineering trade is concerned, local trade union influence has but little to do with the wages paid locally. This may come as a surprise and even as a shock to those people who habitually credit the trade unions with having forced wages up to their present height, but unprejudiced students of trade union principles have long since known that these societies, as at present worked, cannot have any solid influence of a permanent character in forcing up the rates of wages. One may go beyond this, and state that to force up wages is dead against the interests of present-day trade unionism, and its policy is merely to maintain a rate of pay below which scale the most inferior hands in the trade must not accept work, and for more than which the best and most skilled men are not allowed to ask. To put it in other words, it should be distinctly understood that the line adopted by trade unionism is not to raise the pay of men in accordance with their merits, but to force up the price of the inferior men as high as possible, and then drag down the better men to that level. People generally ignore the fact that the trade unions resent masters paying a higher wage than that prescribed by the union rate, and that over and over again the unions have done their best to pull down the wages in shops working under these conditions.

This is quite a rational policy from the point of view of the men who run these societies, and make their living out of them. For in order to make trade unionism pay them, the first thing to do is to establish a hold on the men, so that they may be able to force them to pay their subscriptions. This, of course, they are unable to do unless they can oblige the good workmen to accept the same wages as the dregs of the trade.

Two of the chief influences which tend to weaken trade union power are brought about, firstly, by the existence of *bonâ fide* benefit clubs, either organised by the men themselves, or between masters and men, and which give benefits four or five times as great as those promised by the unions for a similar expenditure. The effect of such institutions is to make the men to a great extent independent of the trade societies. The second weakening influence comes into force when the better men realise that they can do more for themselves in the way of wages outside the union than in it.

Apropos of this question, it is as well to remark that ignorant people still imagine that workmen in non-unionist factories are paid less than those in "society shops." A greater fallacy never existed, at all events in the engineering trade. In a general way the non-unionist is at least as well paid as the unionist, and often his wages are higher. In any case, when the pay is equal, the net amount of weekly money accruing to the non-unionist is higher than that of the unionist, as his wages are not "sweated" by any trade society. No doubt the trade unionist rejoinder to the above will be, that the unionists have fought the battles and raised wages to their present standard, and that then the non-unionists have sneaked in, and, without paying anything to the societies, are now able on their own account to insist on the union rate. This is all plausible enough, and would be a very strong argument in favour of trade unionism were it true, but it is not; for, although the trade unions are continually fighting battles, ostensibly for the benefit of labour, the particulars in the schedules I have given prove, at all events, that if trade union influence has made wages what they are, they have signally failed to run up the rates of pay in their strong centres. In fact, when the *modus operandi* of trade unionism is understood, it is no difficult matter to appreciate that its influence cannot possibly materially affect the pay sheet in the long run.

What trade unionism can do, and what it very frequently does, is to force wages up in a certain locality by dint of bringing to bear on that one spot, for the time being, all its machinery and organisation. But if the wages thus forced up reach an unduly high figure, one of two things must happen; either the wages sink back to their natural level directly the undue pressure is withdrawn, in which case the rise of wages is not of a permanent character, or the unduly high rate is maintained; but the work leaves the locality, and goes to another where the wages are lower, or other conditions more favourable. Thus, in a given locality, wages may be forced up by a trade society to an entirely unjustifiable extent; and, by dint of great expenditure of trade union funds, they may be maintained at that level. But the work cannot be retained, and naturally goes elsewhere. Consequently it matters little how high the rate of pay is fixed when no work is forthcoming at the price.

There are innumerable instances of the above, and London has been more often attacked in this way than any other centre. Two striking cases in point are afforded by the Coopers' Union and the Compositors' Union. The former, by dint of squandering large sums of money, has managed to maintain so high a rate of wages that the manufacture of tight casks by hand has practically been stamped out in the metropolis. The Compositors' Union has, by similar methods, driven all the printing that can possibly be done elsewhere, out of London, and much of it out of the country. On the strength of these facts, it might be argued that, after all, if the unions can bring about such a state of things, they must be capable of raising wages on their own initiative. But, as a matter of fact, they do not effect a general rise all round; for while they are using undue pressure to bring about an abnormal rate in one locality, they have to neglect all the others; and, without doubt, it is usually the districts so neglected which profit in the long run by getting the extra work.

Speaking generally, the most serious effect of trade unionism on the wages question is a disastrous one, for the unions can and do use their influence to lower the quality and quantity of the work done for a given rate of wage in a given time; for the trade union standard is based on the capacity of the inferior workmen, whom it is the business of the union to protect from competition by not allowing the better men to receive higher wages. Thus the unions, while not able unduly to lift wages all round, can, by the methods of their organisation, give an employer a minimum of quality and quantity of work for a certain fixed wage. This is very accentuated in the engineering trade, and goes far to account for the preference which masters often have for a non-unionist, even at a higher price.

It is not a very long time since masters in the engineering trade were under the impression that practically all their skilled hands belonged to one or another of the trade societies. That such, however, is not the case, is clear from the fact that in the most union-ridden town in the trade, Belfast, at least 20 per cent. are non-unionists. In Glasgow the non-unionists number at least 60 per cent., and in London about 75 per cent. I do not pretend to have anything but a vague idea as to the proportion of unionists to non-unionists throughout the engineering trade, but, taking the unskilled element into consideration, I have no reason to suppose that the unionist element is greatly stronger in engineering works than the union average in all the trades of the country, viz., about one-seventh of the men employed. A return of engineering unionist members would probably show on paper a considerably higher proportion than this, but as certainly half the number enrolled do not pay their subscriptions with any regularity, they cannot be said to really belong to the unions, as they have forfeited all rights to any of their "benefits."

Wages in the engineering trade are "sweated" by a considerable number of trade societies, of which the largest is the Amalgamated Society of Engineers, which professes to have over 75,000 members, of which somewhat less than 65,000 are supposed to be "paying" members, the balance presumably being made up of paid officials. This society, though, financially speaking, thoroughly rotten, has always been considered the most powerful trade society in the world. This is mainly due to the fact that its politics have all along been of the aggressive order, and no doubt it has spent more money on strikes than any other trade union, though its big strikes have nearly always resulted in disaster to its members.

The society which is second in importance in the trade is that of the boilermakers and iron shipbuilders, familiarly known as the "black squad." The membership of this society is said to be considerably more than half that of the Amalgamated Society of Engineers, but, in that it covers only a section of the trade, it is a far more representative union of that particular section than the other is of the whole trade. It is also much more financially sound, and less aggressive in its policy. Then, again, it usually does a great deal better for its men than does the Amalgamated Society of Engineers. This is due to the fact that its policy is always to settle its differences without resorting to strikes if possible. The Amalgamated Society, however, whose paying members really have no voice whatever in its management, is credited with bringing about labour disputes on frivolous pretexts, and it is no secret that some of its biggest strikes have been organised for the purpose of advertising a certain agitator, or of drawing attention away from unpleasant matters connected with the internal working of its organisation.

A forcible instance of the slight effect of trade unionism on the wages question was afforded in the engineering trade by the recent Clyde and Belfast disputes. The papers persisted in referring to these strikes as a "Shipbuilding dispute." But, as a matter of fact, the shipbuilding element, as represented by the "Black Squad," came to terms with the masters in both localities before the strike began. For personal motives, however, the Amalgamated Society of Engineers found it policy to make their men strike, ostensibly to get better terms than those obtained by the shipbuilders. But after a protracted struggle, and expending vast sums of money on a futile dispute, the engineers accepted practically the same terms as those accorded to the shipbuilders, and originally offered to them. This points strongly to the fact that aggressive trade unionism cannot do more than reasonable trade unionism in the way of lifting wages.

Then comes the question as to what reasonable trade unionism can effect. As a matter of fact, the reasonable element is nearly always swamped by the aggressive element at the present day, and so the public are unaware that there are still a few trade societies which conscientiously study the interests of their men. Such societies can, by carefully watching the ups and downs of trade, determine the best moment at which to demand a rise; they can then firmly put their demand before the masters; not in an exaggerated form, but merely asking for what they consider they are entitled to. Then, if their demand is a reasonable one, and the masters are made aware that they are prepared to bring the whole of their strength to enforce it, they may perhaps get their rise a few months, or even a year earlier than it would come in the ordinary course, or at all events with less trouble. This is the utmost an ideal trade union can be expected to do in the way of permanently raising wages. In a similar manner a reduction of wages may be successfully resisted for a time.

I do not believe that an ideal trade union, worked on impossibly conscientious and intelligent lines, could generally and permanently influence the rate of wages to any great extent—to an extent, let us say, which would cover the ordinary weekly subscription paid per man to keep the union going. The usual argument about wages having gone up since trade unionism became the order of the day is, of course, fostered by trade union leaders for obvious reasons. But wages have risen since the Salvation Army was started, and since the Tay Bridge was blown down; though no one in his senses attributes this increase to either of these causes. Nor is it due to the influences, good or bad, of trade unionism; for wages have risen in localities where there is no trade unionism, and they had begun to rise long before there was such a thing as a trade society, and will go on rising as long as civilisation advances, even if the trade unions were to be swept off the face of the earth. Money does not go as far now as it did years ago. It is all very well to say that in some cases the necessaries of life are cheaper than formerly, and others quite as cheap; but at the present day a man's necessities are vastly more numerous than they were, and as civilisation and education increase, so will the wants of the working man increase, and his wages will in the natural course of things follow his wants. Bad times will no doubt, as in the past, check an increase in his wages from time to time, whether trade unions endeavour to force matters or not. But it is reasonable to suppose that in the long run wages must be in the ascendant.

People generally have got into the habit of considering that the trade unions have been instrumental in raising wages, because they hear every now and then that such and such a trade society has called its men out on strike for more money, and sometimes it appears to have been successful in getting it. But what does a successful strike as carried out by a trade union mean? Take the two great "labour victories" of modern times, the Dock Strike of 1889, and the Coal War of a couple of years ago. In the first, which had for object the raising of the pay of the "casual docker" from 5d. to 6d. per hour, the extra money was enforced, but the casual docker was ousted from his trade by a better class of man who came to compete with him, and by the labour-saving appliances which the dock company has found it advisable to lay down now that the price of labour has risen.

The effect of the "successful" Coal War was to break up innumerable homes, permanently to ruin property which habitually found work for thousands of men, and to allow the masters to dispose of their stocks, and pit-mouth rubbish, at famine prices; after which, owing to the temporary increase in the price of coal, they were well able to afford for a time to pay the higher wages demanded. At the present date the wages in that industry are regulated by a committee, and follow the ups and downs of the state of trade.

Trade unions are bound to appear to make a great fuss about the wages question, as one of their most popular war cries is "more money," which naturally catches on with the men. Trade union influence can distort and temporarily modify the rates of wages, but it cannot of itself effect a real all-round increase, nor can I find any perceptible trace of its being responsible for the want of equalisation in engineeering wages which exists in different parts of the country.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE spring meeting of the Institution of Mechanical Engineers commenced on Wednesday, the 29th ult., and was held at the premises of the Institution of Civil Engineers, Great George-street, Westminster. After the customary formal business had been disposed of, the President, Mr. E. Windsor Richards, read his address, in which he gave an outline of the conditions governing the production of raw materials for engineers in a cheap and effective manner. As this is given *in extenso* on another page, we shall not attempt to deal with it any further here.

Mr. Laird, in proposing a vote of thanks to the President, congratulated him, and enumerated instances in which English inventions, such as the rolling mill, the Bessemer processes, &c., had been adopted by continental firms, which showed that we were not alone in the race of industrial progress as regards the production of iron and steel, and that English manufacturers must look to their laurels. The vote of thanks was seconded by Mr. Jeremiah Head, who, in the course of his remarks, said that he thought English firms would be well advised if they followed the example of Mr. Carnegie, who sends two of his managers annually on a visit to Europe, with salaries and expenses paid, in order to see what was going on and take note of valuable developments. Mr. Head also pointed out that two very important industries, those of watch-making and sewing machine making, had almost entirely left our shores for those of America, which had outstripped us in the matter of cheap production.

The discussion of the paper on "Notes on Steam Superheating," read by Mr. W. H. Patchell before this Institution on January 31st last, and which was reproduced in full in The Engineer of February 21st—see page 196—was then proceeded with. Mr. Patchell, however, first made a few additional remarks. He said that Messrs. J. Musgrave and Sons, Bolton, had written to him stating that the superheater—Figs. 4 and 4A—attributed in the paper to Messrs. Hick, Hargreaves, and Co., had been made by them, and a patent had been taken out in the names of Musgrave and Dickson. Speaking of the evaporative efficiency of the Babcock and Wilcox boilers, mentioned in the paper, the author said there was nothing remarkable in this performance, which was only about the average obtainable from other boilers.

Mr. Edward Perrett next described an arrangement of engine and boiler for utilising superheated steam, which he had experimented with for a long period some years ago. The entire plant comprised a boiler, a regenerative furnace, and two separate steam cylinders, high and low-pressure. The steam, after having done duty on one side of the high-pressure piston, was returned into the regenerative fire-brick furnace, where it was superheated and then admitted to the other side of the said piston, from which again it was exhausted into a low-pressure cylinder. It is rather difficult to describe the arrangement without a diagram, and we hope to be able to place an illustration of this interesting early attempt at superheating before our readers in a future impression.

Professor W. C. Unwin said that the reason superheated steam had not become more generally used in this country was, that engineers did not understand its *rationale*. There were three ways of using steam in an engine—First, the ordinary wet boiler steam; secondly, the moderately superheated steam, which was wet in the cylinder; and thirdly, there was the highly superheated steam, which was superheated as used in the cylinder. As far as he knew, Herr Schmidt was the only person at present using the last named, but he was not yet in a position to state whether it would prove a success commercially. He wished to emphasise the fact that the addition of a superheater to an installation was an engine gain, and not a boiler gain, being of the same nature as the steam jacket. Professor Unwin then went into the history of superheating, and said it was not taken up in this country till 1859, but the practical value of superheated steam was really first discovered by Hirn in 1855. Going on to criticise the paper, the speaker said that the boiler and engine economies were mixed up, and there was not enough information to show which advantages were and which were not due to superheating. Referring to the McPhail and Simpson apparatus, Professor Unwin said that if it were a superheater at all it was so by accident and not design, and was of opinion that it would disappear in favour of the arrangement used by Hirn, in Alsace. He had tested a 500-horse power engine working with this arrangement for two years, and did not find the necessity of a special device for regulating the temperature of the steam. The great secret was in putting the superheater in the proper place. With superheaters placed near the furnace a smaller area is required. Speaking generally, a gain of 15 to 20 per cent. with ordinary engines would be effected by adding a superheater to a boiler, with a proportionate gain in the consumption of fuel.

Mr. Phillips, the next speaker, said he had been engineer on a steamship in 1851, on which a superheater was provided, though not used, but steam superheating had been employed in the Navy before this date. He thought the credit for its introduction should be given to the American, Wetherhed.

Mr. Bryan Donkin confirmed Prof. Unwin's remarks regarding the regulation of the degree of superheating. He said the answer to the question, Why is superheated steam more economical than saturated steam? was obviously that cylinder condensation is reduced owing to the temperature of the cylinder walls being raised; but he had found that the temperature of the cylinder might be raised by superheated steam, and the steam be saturated prior to the movement of the piston.

The proceedings were resumed on Friday evening last, when the further discussion of Mr. Patchell's paper was continued. Mr. M'Phail was the first speaker, and read what was practically a paper expounding the advantages of the M'Phail and Simpson's superheaters, which is too long for reproduction in our columns. Mr. Lavington E. Fletcher next gave a few figures from tables relating to tests made by the Manchester Steam Users' Association of superheaters. These tables were handed in to the secretary for insertion in the statistics of the society. Mr. Jeremiah Head gave some further particulars of the superheating engine with regenerative furnace, which Mr. Perrett alluded to in Wednesday's proceedings.

After a vote of thanks had been accorded to the author, the President called upon the secretary to read a paper on

Steel Steam Pipes and Fittings and Benardo's Arc Welding in connection therewith,

by Mr. Samuel MacCarthy, of which the following is an abstract:—

Cast iron and copper pipes.—Cast iron, which has the advantage of being seamless, and which can be moulded into any desired shape, is heavy, cumbrous, frequently porous, and always liable to fracture by a blow. The necessarily great thickness of cast iron steam pipes, and the rigidity of the bends, also add greatly to the difficulties of arranging for expansion. Hence the use of this material, for pressures over 50 lb. or 60 lb. per square inch, is becoming more and more rare. Copper, which for so long a period was almost exclusively adopted in the Navy, and also to a great extent in the mercantile marine, for steam and feed pipes, has, in consequence of numerous disastrous failures, become of late years greatly discredited. The causes of its failure need not be entered into here, inasmuch as the subject was fully dealt with in the paper on steam pipes, which was read by Mr. J. T. Milton before the Institution of Naval Architects in April, 1895—"Transactions," vol. xxxvi., page 191.

Wrought iron and steel pipes.—Cast iron and copper having failed to afford the necessary security and confidence in connection with steam at high pressures, there arose a great demand for welded wrought iron or steel pipes, which was promptly met by the leading tube makers, who lost no time in procuring the requisite machinery for their manufacture. With regard to the respective merits of iron and steel for this purpose, as for many others, there has always been a difference of opinion among engineers; and the controversy is not yet at an end, but invites renewed experiment and useful discussion.

Corrosion.—One of the principal objections raised by the opponents of steel has been that it is more subject to corrosion than iron; and doubtless this would be a grave defect if shown by experience to prevail. This matter was dealt with at great length in the paper on the comparative endurance of iron and mild steel when exposed to corrosive influences, which was read by Mr. David Phillips before the Institution of Civil Engineers in March, 1881—"Proceedings," vol. lxv., page 73. As the result of numerous experiments, he came to the conclusion that steel, in the form either of boiler tubes or of plates, was greatly inferior to iron in power to resist corrosion; but in the lengthened discussion which followed, the speakers were almost unanimous in their dissent from this conclusion. At all events, whatever may be the result as regards boiler tubes, there is every reason to believe that welded steel steam pipes are free from any risk in this respect. Recently the author has had an opportunity of examining several lengths of 7in. steam pipes and bends, made of steel, at the City of London electric lighting station at Bankside, which have been constantly at work at a pressure of 160 lb. for over three years, and which exhibit not the slightest appearance of pitting, scoring, or corrosion in any form. In erecting ranges of steam pipes great care should be taken to ensure efficient drainage; for should there be any point in the range where the condensed water is allowed to lodge, corrosion will no doubt take place sooner or later at that part, whether the pipes are made of wrought iron or of steel.

Thickness of metal.—As to the comparative thickness of steel and iron pipes, it might naturally be expected that the former would be made lighter in proportion to the greater tensile strength of steel. Theoretically this should be so; but in practice it is carried out to only a limited extent. Not only is a large margin required for safety, but the exigencies of manufacture necessitate a certain thickness of plate to ensure making a sound weld; and this thickness cannot be reduced without risk. For instance, a common size of steam pipe, 10in. bore, is most conveniently made of ¼in. plate, which would be amply strong enough for iron, and is consequently excessive for steel; but the reduction of $\frac{1}{16}$in. in the thickness would affect the cost and the weight so slightly that it is thought best to err on the safe side. For larger sizes, of 12in to 18in. bore, it is found practicable to make steel pipes somewhat lighter in proportion to iron. In this connection it is interesting to note that the Admiralty are now using steel for all sizes of steam pipes over 2in. bore. Above 9in. bore they still adhere to the practice of having a butt strap or cover strip riveted along the line of weld, which the author believes to be worse than useless, as the numerous rivet holes necessarily tend to weaken the pipe. It is also probable that the presence of the cover strip, in connection with the expansion of the pipe both circumferentially and longitudinally, has the effect of setting up a tearing strain, which may result in leakage at the rivets. The addition of the butt strap also adds greatly to the cost of the pipes. In a recent specification for steam pipes the Admiralty fix three-eighths of an inch as the uniform thickness for all pipes from 6in. to 14in. diameter of bore, the tensile strength of the steel not to exceed 25 tons, and not to be less than 23 tons per square inch. In the following Table I. are given the thicknesses which are usually specified for steam pipes from 6in. up to 18in. bore, for pressures varying from 100 lb. to 180 lb. per square inch; also the corresponding hydraulic test pressures. In addition to the hydraulic test, the pipes are also tested with high-pressure steam. This is important, because they are thus tested under actual working conditions as regards temperature and consequent expansion; and any minute pin hole which has not been revealed by the cold water test is certain to be detected under steam.

Table I.

Thicknesses of Steel Steam Pipes for Varying Pressures.

Diameter of bore. Inches.	Steam pressure per square inch			
	100 lb. Inch.	120 lb. Inch.	150 lb. Inch.	180 lb. Inch.
6	1-4	1-4	1-4	1-4
7	—	—	—	—
8	—	—	—	—
9	—	—	—	5-16
10	—	—	—	—
11	—	—	5-16	—
12	—	5-16	—	—
13	5-16	—	—	—
14	—	—	—	3-8
15	—	—	—	—
16	—	—	3-8	—
17	—	—	—	—
18	—	—	—	—
Hydraulic test pressure per square inch.	200 lb.	240 lb.	300 lb.	360 lb.

Methods of manufacture.—It is frequently supposed that the electric arc is brought into operation for welding the longitudinal seam of the barrel of the pipe. As a matter of fact this is not the case. It can of course be done, and has been done successfully in many instances; but as it was found from experience that no saving in cost was effected, and that nothing was gained either in speed or in efficiency by the use of electricity for this purpose, the straight seams are still welded in the ordinary manner: namely, either in the rolls, or by gas and power.

Roll welding.—In this process the iron or steel in the shape of strip is first scarfed along both edges in a planing machine, on the outer face along one edge and on the inner face along the other; it is then heated in a muffle, and by being drawn through skelping dies is bent into tubular form or skelp, and is ready for the welding furnace. When the welding heat is reached, the skelp is withdrawn from the furnace with tongs, and the end is placed upon the head of a horizontal mandril fixed to a long rod, which is held between a pair of revolving rolls that are turned to suit the particular size of tube being made. The skelp being seized by the rolls is rapidly welded by the pressure exerted upon it between the two rolls on the outside and the mandril on the inside of the tube. In all cases the tube is drawn twice through the rolls at a welding heat, the process being the same each time. On finally leaving the welding rolls, the tube passes through a mangle or reeling machine, which straightens it; the ends are then cut off square, and it is ready for testing.

Gas welding.—The strips, after being scarfed along their edges, are heated only cherry red in a muffle, and are then bent to the required diameter in the rolls. The pipe is next placed on a "beak," and a jet of gas is brought to bear along the seam, whereby in a short time a length of about 6in. to 8in. is brought to a welding heat. A small quick-speed steam hammer fixed above the work then rapidly closes the seam, and completes the weld. The operation is repeated on the next length, until the longitudinal seam is completed. The use of gas renders the process clean, and absolutely free from dust and other impurities; and the edges of the pipes having been carefully freed from scale after leaving the heating furnace and rolls, a perfectly sound weld is obtained.

Benardos arc welding.—It is in the manufacture and attachment of flanges, branches, bends, and tee pieces, that the Benardos system of welding by means of the electric arc plays such an important part. This process has now been in constant operation for over five years at Messrs. Lloyd and Lloyd's Coombs Wood Works, near Halesowen, with which the author is connected, where during this period it has been employed chiefly on large steel pipes and connections, suitable for high-pressure steam. The method of working is simple. Ordinary low-tension continuous-current lighting dynamos are used; to the terminals of these a battery of Benardos accumulators is connected, into which the current flows continuously. When the welding circuit is closed, the current flows from the dynamos and accumulators; and large resistances are used when necessary. In this way a large discharge is obtained, equal to about twice the capacity of the dynamos, and the load factor of the apparatus is high. For some purposes it is possible to work without the accumulators; but when this is done the efficiency of the apparatus is not so high, because during part of the working period no current whatever is passing, and the machinery is running light. As illustrated by the diagram—Fig. 1—the plant is run on the parallel system, and between the terminals of the dynamos or battery as many welding arcs can be connected as may be desired; and every welder is able, independently of the others, to vary his own current to suit the work in hand at the moment. One terminal of the circuit is connected by means of a flexible cable to a carbon pencil in an insulated holder, which is held by the workmen; the other terminal is connected to the table on which the work lies, or to the work itself. When iron or steel is under treatment, it is usual to make the carbon the negative pole, and the iron or steel the positive pole; but for other metals the poles are sometimes reversed. [In an appendix is given a summary of the results of experiments made by Messrs. David Kirkaldy and Sons for Messrs. Lloyd and Lloyd, to ascertain the tensile strength of electric-welded bars of various brands and sizes; and also a comparison of these with fire-welded bars.]

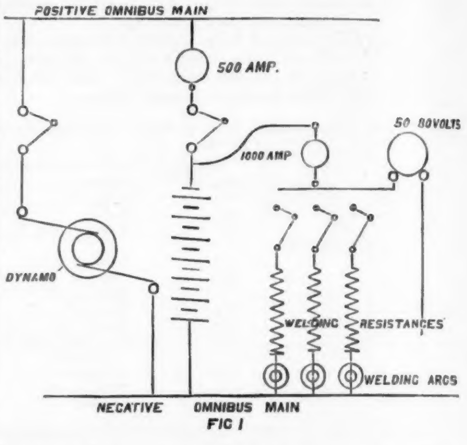


FIG I

Flanges.—The method usually adopted for welding flanges to steam pipes is as follows:—The flange is stamped out under the steam hammer in such a way that a V-shaped groove is left on the inside edge, extending about three-fourths through the thickness of the metal. The flange is next shrunk upon the tube, with its flat face outwards or at the end of the tube, and is carefully set in the exact position required. The welding consists in laying small pieces of steel in the V-shaped groove, and welding them in one by one by means of the electric arc, the welds being freely hammered between each heat. The welder makes a complete circuit of the back of the flange, and fills it up sufficiently to make a fillet of about 1½in. radius. In this way the flange is solidly welded to the tube at the back, and about three-fourths of the way through its thickness; but the front or outer side is not yet welded. The tube is then up-ended, and the outer side of the flange is welded to the tube, the only difference being that the heat of the arc is used to burn out a cavity all round the junction of the pipe and the flange, until the depth is reached at which the two have already been united; this cavity is then welded up in the same way as the back of the flange, thus ensuring that the flange is welded solid to the pipe right through.

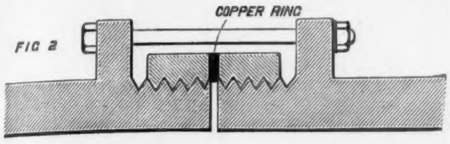
Outlets, branches, and tee pieces.—The welding of outlets and branches into steam tubes is done by much the same method as already described in the case of the flanges. The outlet, which consists of a piece of ordinary lap-welded tube, is cut off to the required length, and a hole is burnt by the arc in the tube, large enough for the outlet just to fit into. When fixed in the right position the outlet is welded in, as in the case of the flange, by laying on small pieces of steel about 1in. long by ¾in. wide and ¼in. thick, and welding them in one by one, continuing the process all round the outlet, until a fillet is formed of about 1½in. radius, but this varies slightly with the position of the outlet on the tube. A tee piece is made in a precisely similar way, a short piece of tube being welded into a longer piece; and a cross is made by welding two similar short pieces, one on either side of the main tube.

Length and size of arc.—One point in connection with electric-welded work, to which the author would call special attention, is the length and size of the arc which is used in the welding of various kinds of work. With a short arc, the carbon point is brought down too close to the steel; and the result is inferior work, not only from the presence of the carbon, but also because the heat is concentrated upon so small a surface that the strains set up in cooling are considerable. The longer the arc, the softer and more diffused is the heat; and any slight strain which may be set up can be got rid of by careful annealing. A long arc is therefore indispensable to the proper working of the system.

Strength of electric-welded flanges.—An 8in. iron pipe ¼in. thick, with flanges electrically welded on, when tested to destruction at Lloyd's Proving House, Netherton, broke in the body of the pipe at over 88 tons, the welded part remaining intact; and a similar pipe of steel broke in the welded part of the flange at over 101 tons. These tests were tensile only, and were carried out with the view of proving the absolute soundness and consequent strength of the flanges electrically welded on. For this purpose special tackle was made. A blank flange with an eye-bolt attached was secured to each flange of the pipe, and the chain of the testing machine was connected with the eye-bolts at each end, with the result given above.

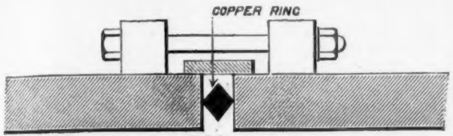
Other applications of arc welding.—All kinds of work of the above description can be readily and satisfactorily done by this process; but its utility in large works does not stop here. Small flanges can be heated and welded upon tubes by spinning them in a lathe at a high speed and allowing the arc to play on them, the weld being made by the pressure of two rollers, one inside and the other outside the tube. Defects in steel castings and in finished forgings can be repaired with the greatest ease; and the fact that, when such repaired articles are faced or turned in the lathe, the turnings come away sound and whole, is a proof that the welding has been perfect, and that the metal has not been burnt or rendered brittle by the process.

Joints.—In connection with the cognate subject of joints, the author is enabled, by the kindness of Mr. Frank Bailey, to describe a simple form of joint in use at the City of London and the Metropolitan electric lighting stations, which, in conjunction with the solid electrically welded flanges, has given excellent results. As shown in Fig. 2, the joint is made simply with a copper ring, one-eighth of an inch thick. These rings are cut of the required thickness from a copper cylinder of the necessary size, and are carefully annealed. The great thickness of the solid welded flanges admits of their being screwed tightly together, without any possibility of springing; and an absolutely steam-tight and durable joint is thereby made, which gives no trouble whatever.


FIC 2

Bolt holes.—Another great advantage of the solid welded flange is that it obviates any difficulty with the bolt holes. The frequent trouble and annoyance experienced with screwed flanges from the bolt holes not coming fair opposite each other are well known; and the objections to flanges riveted on steam pipes are too obvious to need any comment.

In the short discussion which ensued, Mr. Druitt Halpin criticised the form of steam joint shown in Fig. 2 as being open to objection on account of the screw threads being exposed to the action of the steam, and sketched on the board a form of joint shown in Fig 3.


FIC 3

In this the joint-making material is a copper ring of diamond-shaped section which is held in position by a metal ring surrounding the two ends of the piping. In fact it is the Perkins joint.

Mr. Howell, of Sheffield, objected to the Benardos method of welding, which he called soldering, owing to the effect it produced in the steel of making the metal "short." He had found that gas was better suited for welding purposes. Speaking of the corrosion of steel sometimes complained of, he said this must be due to inferior qualities of steel used, and suggested that if buyers of steel piping would leave themselves more in the hands of makers, instead of submitting ill-constructed specifications, they would be much better served,

Mr. Mark Robinson gave the results of some experiments recently made with lap-welded steel pipes to withstand endwise compression, and he had found them to behave excellently across the weld. He had compressed them to a concertina shape without fracture.

Mr. Platt said he preferred solid drawn steel pipes, which could now be obtained 12in. diameter in 12ft. lengths.

Mr. Carter considered that it was a mistaken idea to liken the electric welding process to soldering. He said that the electric current had a sort of infusive action, as proved by their being able to weld copper with steel. He asked the author if he could supply figures giving the relative cost of electric and gas welding.

Mr. MacCarthy having briefly replied, the meeting was closed with the usual votes of thanks. The report of the Research Committee experiments "On the value of the Steam Jacket: Experiments on a Locomotive Engine," by Professor T. Hudson Beare and Mr. Bryan Donkin, which was also down for reading, was adjourned till the Belfast summer meeting.

The dinner of the Institution was held at the Freemasons' Tavern, Great Queen-street, W.C., on Thursday, the 30th ult., and was largely attended. Amongst those present were the Hon. Thomas F. Bayard, Ambassador of the United States of America; Sir William Arrol, LL.D., M.P.; Sir Frederick Abel; Sir Edward Leader Williams; Sir Edward H. Carbutt; Mr. Thomas Richardson, M.P., and numerous other prominent gentlemen. The President, Mr. E. Windsor Richards, in proposing the toast of "Our Guests," coupled with it the name of the American Ambassador. In replying to the toast Mr. Bayard remarked that Archimedes, some hundred years before the Christian era, advanced the celebrated proposition that a solid body projected into liquids displaced its own equivalent weight. But even that celebrated member of the Institution of Mechanical Engineers did not tell them whether liquid projected into a solid body displaced its own weight. He was inclined to think that Archimedes had never dined with that society, and that even he would have had something to learn from modern civilisation. One of the great lessons, and perhaps the greatest, of science, as expounded by Archimedes, was the Archimedean screw, and he believed that this was nothing but a corkscrew. This, he said, was called the age of invention; London was only made possible by invention, discovery, and the application of mechanical engineering. Mechanical genius could not be circumscribed, for mankind must be the beneficiaries of the inventor and the discoverer. Mechanical engineers were the best ambassadors that could go forth into the world, for what was an ambassador if he were not the introducer and inducer of peace and goodwill, and of fair understanding between men?

Sir William Arrol, replying to the toast of the "Houses of Parliament," spoke of the unusually large number of mechanical engineers now in the Commons, but said the progress made in the business of Parliament was such as would not be tolerated in commercial undertakings. In proposing the toast of the "Institution of Mechanical Engineers," Prof. Roberts-Austen eulogised the excellent work done by this Institution in providing the means for conducting research. In acknowledging the toast, the President remarked that as the Institution was about to provide premises of its own at a cost of £23,000, they would have to economise somewhat for the next few years in the matter of research.

RESERVOIR DAMS WITH IRON SHEETING.

By Mr. Thomas Thomson.

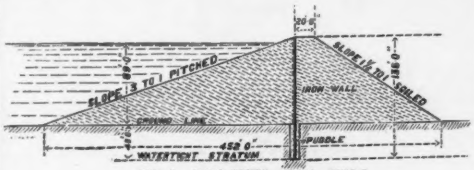
A small paragraph some weeks ago mentioned that a dam was being constructed somewhere in the States, in rather a novel manner. A wall of iron was to be employed, backed up by rock filling on either side. No further details were given, but it is evident that no strutting was to be employed, the iron simply fulfilling the duties of a water-tight sheet, and being kept in place by the filling, which supplies the necessary weight. It may be considered to all intents as an ordinary earthen dam, in which a continuous sheet of iron has been substituted for the ordinary puddle wall.

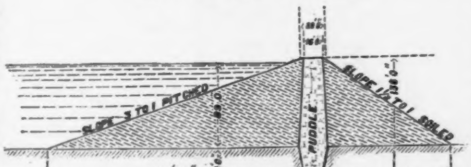
The writer has long been of opinion that a dam constructed in this way is superior in many respects to either an earthen dam with a puddle wall or one constructed of masonry. As an iron dam is now actually being built, it may be interesting to investigate the points in its favour.

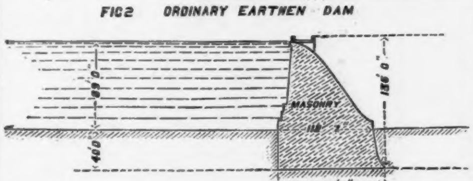
Let us see first the conditions which must be satisfied in a dam of any construction.

(1) It must have sufficient mass in each unit of its length to prevent rupture, overturning, or sliding on its base. *Per se*, mass, and mass only, is required, and the cheaper the material and the less workmanship employed in putting them together, the greater the factor of safety that can economically be employed.

In the ordinary earthen dam there is always sufficient weight to prevent failure from either of these causes. Flat slopes are required to prevent failure from slips or deformation, and the amount of weight necessitated by these slopes is much in excess of that required for stability. In masonry dams, on the contrary, there is no outside requirement to interfere, and the section of the dam is designed simply to sustain the pressure. The exact sections required have been closely investigated, and there is not much chance of an error being made in this direction, but owing to the enormous cost of masonry dams, the tendency is to run the margin of safety very close. This applies more especially to large dams of great height.


FIC 1 DAM WITH IRON WALL


FIC2 ORDINARY EARTHEN DAM


FIC 3 MASONRY DAM (VWRNY-DEEFEST SECTION)

(2) It must either have sufficient bye-washes to carry off the maximum floods of the catchment area, or else the crest and outer face of the dam must be so constructed that the water may overflow without producing damage. This is really more a requirement of the reservoir than of the dam itself. In the case of the iron dam, the bye-washes would have to be provided.

(3) The dam must be water-tight, and must remain so under any conditions which may occur either during or after construction. Of all the requirements of a dam this is the most difficult to fulfil in practice.

Water-tightness may be secured in either of two ways—by the insertion of a continuous sheet of water-tight material, such as the puddle wall in an earthen embankment, or by constructing the whole dam of water-tight material, as in a masonry dam. Of the two the sheet of water-tight material is much the more direct and workmanlike method, but as nothing but puddle has hitherto been proposed or used, it is not looked upon with much favour. The method adopted in masonry dams of making the whole mass water-tight is a necessity of the construction from other considerations. A certain amount of tension has to be provided for in the water face of an economical section, and in any case it is better, in view of settlement, to make the whole mass homogeneous. If there were a certainty of equal settlement it would probably be found more economical to adopt a larger section and build the outer half of the dam in dry work.

To satisfy the conditions thus laid down, the water-tight material, whether a sheet or the whole structure, must be of such a nature that the workmanship and material can be thoroughly tested and inspected during construction; that no movement of the dam, from settlement either in its foundations or itself, ought to affect it; and that its efficiency should not be impaired by deterioration or corrosion.

It is on the first two of these points that the present methods of construction most signally fail. There can be no absolute certainty of the imperviousness of puddle or masonry, even with the best workmanship and greatest care, still less with cheap contract work and inferior superintendence. And, if executed with the greatest care, the slightest settlement after completion may result in failure. As regards immunity from unsound workmanship, or materials and ability to retain its imperviousness under all sorts of settlement, the iron sheet stands a long way in front of either of the existing methods. Corrosion, on the other hand, would only affect the iron dam. In practice it would not be found a fatal objection.

(4) There must be a water-tight bond between the dam proper and an impervious stratum underneath—in other words, the water-tight sheet must be carried down to it. The same remarks apply to this as to the dam itself, except that the danger from settlement is much less.

Another requirement might be added—the necessity of a water-tight stratum on which to commence operations. The want of this has probably caused as many failures in reservoir construction as anything else, but correctly it is a requirement of the reservoir, not of the dam itself. Putting this and the question of bye-washes aside for the same reason, and treating the dam and its foundation on the impervious stratum as one, we have practically two main requirements—sufficient mass, and water-tightness under all conditions. The first is very much a matter of cost, the second is a practical difficulty which has not yet been satisfactorily met.

The method now being tried in the United States evidently substitutes for the puddle wall a continuous sheet of iron, say riveted plates. The thickness of the iron might vary from ¼in. or ⅜in. in small dams where economy was an object, to, say, 1¼in. in large dams of importance, where it might be considered necessary to provide for centuries of corrosion. The plates might be either lap or butt jointed, and the joints might be either caulked or rusted up. The iron should be well tarred or painted, or coated with Dr. Angus Smith's composition. On each side of the iron a layer of asphalte from ¾in. to 1½in. thick should be carried up, and on the water side a wall of puddle 1ft. or 2ft. thick might be provided to prevent the water reaching even the asphalte. The plating would, of course, be carried right down to the impervious stratum, a trench being sunk as usual, the plating built *in situ*, and the spaces at each side filled with puddle or concrete. The wings of the dam would be carried into the sides of the valley in the same way.

The erection of the iron wall would be carried on in advance of the dam, and it would be at all times fully open to inspection. The chance of a leak hole being left would be practically nil.

Having provided the water-tight sheet, and being able to place absolute dependence on it, there is nothing else required in the dam but sufficient weight to keep it in place, and there is no reason why that should not be provided with the cheapest materials to be had on the spot, and the minimum amount of labour in putting them together. The materials must, of course, be such as would not disintegrate under water, and must be so put together that slips or settlement to any great extent would not occur under the action of water; but further than this no special care would be required. Even this limitation would apply only to the side of the dam next the water. For the outer side almost any material might be employed.

The method would be especially suitable for cases such as often occur in large water supplies in England. To secure pure water a gathering ground is selected in a clay slate, or other geologically old rock formation, where puddle suitable for an earthen dam is expensive to obtain, and the rock, if used for masonry, is of a class that produces costly work. In such a case the part of the dam next the water would be built of earth and rock, built to form a solid bank which would not settle under water, but need not be absolutely water-tight.

Theoretically, the part of the dam between the iron sheet and the water is only required to keep the iron sheet in place when the water is not there, and if the reservoir were allowed to fill as the iron sheet is carried up, the whole weight of the dam might be placed behind it, and it might be constructed of any material. This would not be possible in practice; but if good material were scarce, a compromise might be made by inclining the iron sheet, so that the greater bulk of the dam was on the side farthest from the water.

The two great advantages of the method are the absolute certainty of water-tightness to begin with, and the assurance that no amount of settlement will interfere with it. The only disadvantage is the fear of corrosion. There is no doubt that a thin plate of iron, unprotected in any way, would corrode to a dangerous extent after some years; but there is no reason why a thin plate should be employed, as the cost of the iron and its protection is small compared with th other items. If an inch plate were used, protected by asphalte on each side, the probabilities are that corrosion would not impair the efficiency of the plate for many centuries.

As regards cost, the iron dam would work out slightly higher than the ordinary earthen dam where puddle was cheap, and lower if puddle was dear. The following would be the cost per lineal yard for sections similar to the deepest part of the Vyrnwy dam, viz., depth of water, 89ft.; depth of foundation, 40ft.; total height, 136ft.:—

Fig. 1.—*Proposed Dam with Iron Wall, 1¼in. thick.*

	£	s.	d.
54 cubic yards excavation in foundations, 3s. 6d. ..	9	9	0
2486 cubic yards embankment, 1s. 8d.	207	3	4
72 cubic yards puddle, 6s.	21	12	0
95 square yards pitching, 7s.	33	5	0
57 square yards soiling, 6d..	1	8	6
1 square yard roadway	2	0	0
208 cwt. wrought iron, 1¼in. thick rivetted, 16s. ..	166	8	0
90 square yards asphalte	22	10	0
	463	15	10

Fig. 2.—*Ordinary Earthen Dam.*

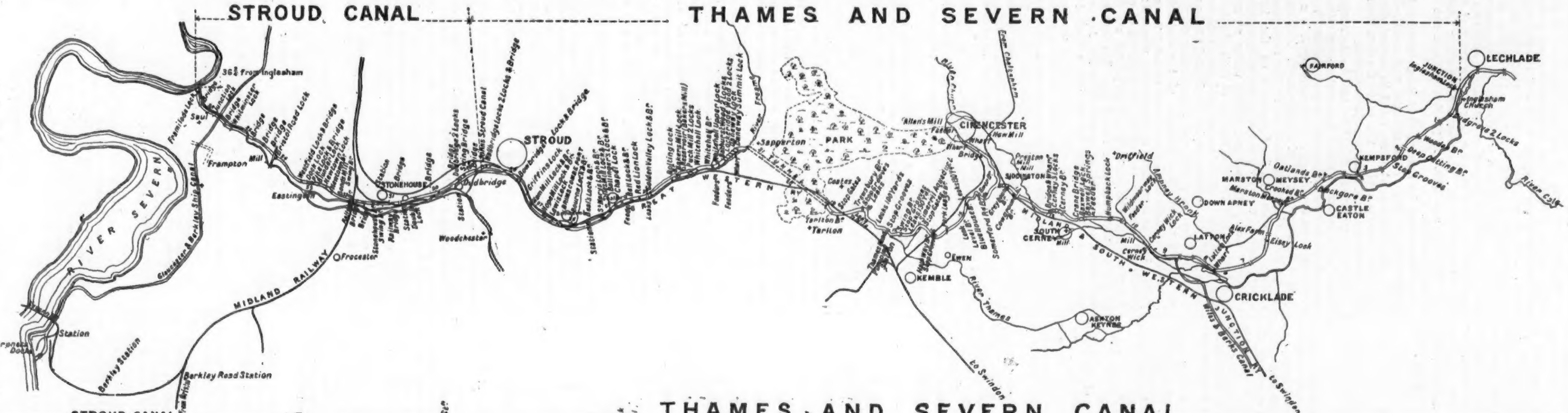
	£	s.	d.
107 cubic yards excavation, 3s. 6d.	18	14	6
2240 cubic yards embankment, 1s. 8d.	186	13	4
363 cubic yards puddle, 6s.	108	18	0
95 square yards pitching, 7s.	33	5	0
57 square yards soiling, 6d..	1	8	6
1 lineal yard roadway	2	0	0
	350	19	4

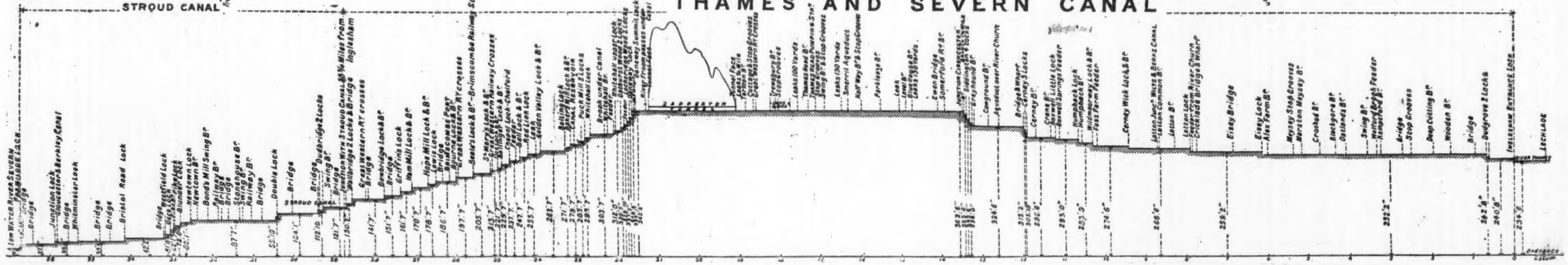
Fig. 3.—*Masonry Dam.*

	£	s.	d.
524 cubic yards excavation, 3s. 6d.	91	14	0
1050 cubic yards masonry, 30s.	1575	0	0
	1666	14	0

These are all taken at ordinary prices; the actual cost of the

CANALS CONNECTING LONDON, BRISTOL, WORCESTER, AND STAFFORDSHIRE


STROUD CANAL
THAMES AND SEVERN CANAL
LECHLADE
FAIRFORD
KEMPSFORD
CASTLE EATON
MARSTON MEYSEY
DOWN AMPNEY
LATTON
CRICKLADE
ASHTON KEYNES
SOUTH CERNEY
SIDDINGTON
CIRENCESTER
KEMBLE
EWEN
PARK
Sapperton
Tarlton
STROUD
STONEHOUSE
Dudbridge
Woodchester
Frocester
Eastington
Frampton
Saul
RIVER SEVERN
MIDLAND RAILWAY
Berkley Road Station
Sharpness Docks
Station
River Thames
River Coln
to Swindon
From Cheltenham
Wilts & Berks Canal
JUNCTION
WESTERN


STROUD CANAL
THAMES AND SEVERN CANAL
Low Water River Severn
Framilode Lock
Junction Lock
Bristol Road Lock
Double Lock
Sapperton Tunnel
Siddington Locks
Cerney Locks
Latton Junc. Wilts & Berks Canal
Cricklade Bridge Wharf
Eisey Bridge
Eisey Lock
Dudgrove 2 Locks
Inglesham Entrance Lock
LECHLADE
Ordnance Datum

Vyrnwy masonry was about 44s., but that is too high for comparison.

The ordinary earthen dam for this height may be almost left out of count, as few engineers would care to risk it. Comparing the iron dam with the masonry, it comes out about one-third the cost, and considering the dangers from bad construction and settlement inherent in the latter, it is undeniably the better job.

THE THAMES AND SEVERN CANAL.

The Thames and Severn Canal, which for some years has been much out of repair, and latterly impassable owing to leakages in the summit level, passes for some miles over some very bad and rocky ground, and having thus fallen into a useless condition, was last year acquired by the newly formed Thames and Severn Canal Trust to be restored, and again opened for traffic. This work is expected to he completed in about two years.

This canal is of historic and commercial interest, and forms an important link in the first line of inland navigation connecting London with Bristol, and with the counties of Gloucester, Worcester, and Staffordshire, the Forest of Dean, and the north.

It commences by a junction with the Thames at Inglesham, near Lechlade—33 miles above Oxford, and proceeds to Latton Junction, a distance of 8¾ miles, with a rise of five locks, where it is joined by the North Wilts branch of the Wilts and Berks Canal; thus forming a connection with Swindon, and thence eastwards to the Thames at Abingdon, and westwards to the Kennet and Avon navigation at Semington, and on to Bath and Bristol; it then proceeds a distance of 4¾ miles, rising by eleven locks to the summit ground at Siddington; here there is a short branch to Cirencester one mile in length.

A further distance of 3½ miles from Siddington brings us to the Thames head pumping engine, which, together with a feeder from the river Churn at Cirencester, supplies the summit level with water. The present pumping engine, 376ft. 3in. above sea level, was placed there in 1852, and pumps from a well 63ft. deep about two locks, or 120,000 gallons per hour. Two miles farther on Sapperton Tunnel, 3808 yards long, is reached; 2372 yards are lined with brick arching, and the remaining 1436 yards are in rock. This is the longest canal tunnel in England, with the exception of the Standedge tunnel on the Huddersfield Canal, which has a length of just over three miles. Sapperton Tunnel has a minimum height of 12ft. above water level, and a minimum width of 11ft. 6in. at water level. There is no towing path. A little more than a quarter of a mile from the west end of the tunnel is the end of the summit level at Daneway, and from here the canal descends by twenty-eight locks, passing Chalford and Brinscombe, to Wallbridge, where it joins the Stroudwater Navigation, making a total distance of thirty miles with forty-four locks, rising 130ft. 6in. from Inglesham to the summit, and falling 241ft. from the summit to Wallbridge. The dimensions of the locks are:—Between Inglesham and Siddington, varying 91ft. to 93ft. by 13ft.; between Siddington and Brinscombe, varying 90ft. to 91ft. by 12ft. 9in.; and between Brinscombe and Wallbridge, 68ft. by 16ft.

The first Act for the Thames and Severn Canal was obtained in 1780, and the works were at once proceeded with under Mr. R. Whitworth. The Sapperton Tunnel was esteemed one of the greatest engineering works of the day, and was visited by King George III. on July 19th, 1788, when in course of construction. The canal was opened in 1789, in which year, November 19th, the first vessel of 30 tons burden from the Severn passed into the Thames at Inglesham. Having got fairly into working order, the canal steadily improved its financial position until 1841, when it reached the height of its prosperity, and since then has declined. The last dividend was paid in 1864, and for 1871 the accounts show a loss on the year's working. In 1875 the company became carriers. In 1883 the Great Western Railway Co. acquired about four-fifths of the total shares in the undertaking, but the condition of the works on the canal showed no improvement, and the whole continued to deteriorate. On December 30th, 1893, a notice was issued announcing the closing of the canal from between Bell and Chapel locks near Chalford to Inglesham, thus leaving only 4¼ miles open.

In 1895 the Thames and Severn Canal Trust, consisting of representatives of the Stroudwater Navigation, the Sharpness New Docks and Gloucester and Birmingham Navigation Company, the Severn Commissioners, the Staffordshire and Worcestershire Canal, the Wilts and Berks Canal Company, the County Councils of Berkshire, Gloucestershire, and Wiltshire, the Town Council of Gloucester, and the Urban District Councils of Stroud and Cirencester, obtained an Act of Parliament, and took over the canal from the old company. The work of restoration is now being proceeded with, according to estimates prepared by Messrs. G. W. Keeling, M.I.C.E., and F. A. Jones, C.E., of the Sharpness Docks and Gloucester and Birmingham Navigation Company; Mr. W. J. Ainsworth, of the Wilts and Berks Canal Company; and Mr. W. J. Snape, of the Stroudwater Navigation; Mr. E. J. Cullis, A.M.I.C.E., being the resident engineer. The joint office of the Stroudwater Navigation and the Thames and Severn Canal Trust is at Wallbridge, Stroud. Mr. W. J. Snape, manager of the Stroudwater Navigation, has been appointed secretary and surveyor of the newly-formed trust, and now manages the traffic on the short open section—4¼ miles—of the Thames and Severn Canal between Wallbridge and Chalford.

The views of the canal, which we publish on pages 461 and 468, contain many features of interest, and well illustrate some of the points in its history to which we have referred. They are from photographs taken by Mr. H. R. de Salis, A.M.I.C.E., when making an inspection of the canal in January last. No. 1 shows the entrance lock of the canal from the Thames at Inglesham, and the Inglesham Round House. No. 2 shows a Pound above the three Cerney Locks, where the ruin of the canal has laid it dry. The view includes an imprisoned monkey boat, unable to proceed on account of the water having failed. No. 3 is a view of a Pound between Siddington first and second locks. No. 4 shows the east end of summit level, Siddington top lock on the right, branch to Cirencester on the left. The results of some of the work of restoration are shown in No. 5—Cirencester basin restored, wharf walls re-built, and mud

OLD THAMES AND SEVERN CANALS

For description see page 460)

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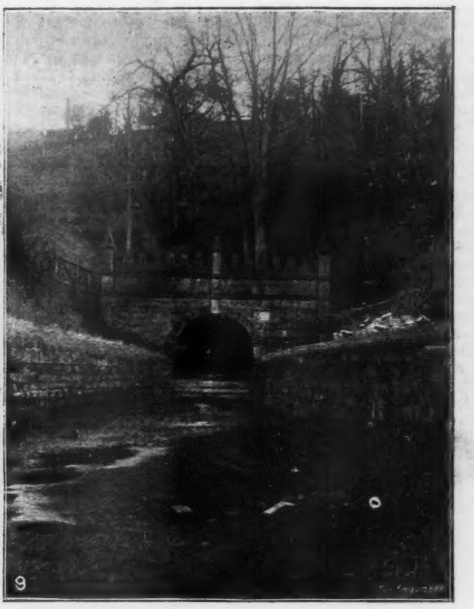

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removed. In No. 6, which is a view of Smerrill Aqueduct, there are some remains of a stop gate, taken from the bed of the canal. No. 7 shows Thames Head pumping engine; and No. 8 is the east end of Sapperton Tunnel. No. 9 shows the west end of Sapperton Tunnel already referred to. It was taken from the bed of the canal. No. 10, the Daneway summit lock, west end of summit level. No. 11 shows another imprisoned boat, the canal having become dry between Bathurst Meadow upper and lower locks. No. 12 is a view taken from upper sill of Tuck Mill lower lock. No. 13 is a view at Brinscombe. A view from Griffin's Lock looking towards Stroud is shown by No. 14; and No. 15 is a view at Wallbridge, where there is the junction of the Thames and Severn Canal with Stroudwater Navigation.

The Stroudwater Navigation, which connects the Thames and Severn Canal with the river Severn, is eight miles long, and descends from Wallbridge, Stroud, to the Severn at Framilode, by thirteen locks, passing Dudbridge, Stonehouse, Eastington, and Whitminster; one mile from Framilode it crosses on a level the Berkeley Ship Canal which runs from Sharpness to Gloucester. This navigation has a depth of water of 5ft. 6in., and can pass barges with cargoes of 75 tons.

The first Act of Parliament relating to the undertaking was passed in 1730, but owing to the opposition of the mill owners, which arose from the fear they entertained of losing their water, and from other causes, the provisions of the statute were not carried out. In 1759 a second Act was obtained, whereby certain persons were appointed to carry out the provisions of the former Act; these persons undertook to complete the navigation without locks, and consequently without any possibility of depriving the mill owners of water. To effect this object their intention was to shift the cargoes into boxes, and at every mill to remove them by means of cranes into other boats. Such a laborious undertaking could not succeed, though it was persevered in nearly to the ruin of the projectors. The first meeting of the Commissioners for making the Stroudwater Canal was held on 29th December, 1774; there was a delay occasioned by the company having to get two Acts of Parliament, and the canal was consequently not fully opened until 24th July, 1779, although part was in working order and opened for traffic, and the first tolls received on 3rd April, 1777.

The Upper Thames from Oxford to Inglesham, the remaining link in this through route, has not been for some years past navigable for more than rowing boats above Newbridge. It is now, however, being improved by the Thames Conservancy so as to render it navigable for vessels of 4ft. draught. The first of the new locks built under this improvement scheme at Radcot was opened in 1892, and last year the second new lock at Northmoor was completed; work is about to be commenced on a third lock at Grafton, to be followed by another near Duxford.

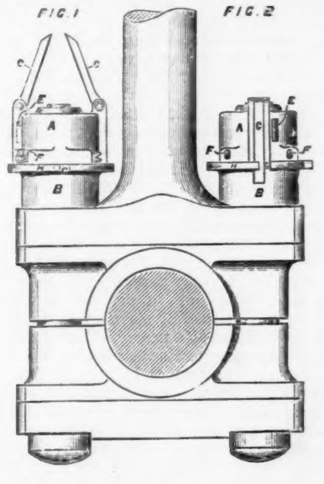
The improvements to the Upper Thames, together with the restoration of the Thames and Severn Canal, will once more restore to practical working one of the most important through routes of water communication in the country.

As a nation we at last appear to be realising to some extent that our inland waterways have been but too long neglected, and that, adapted to modern requirements, they have their sphere of utility in the carriage of heavy traffic at rates with which a railway cannot afford to compete.

DRYSDALE AND STODDART'S COMPENSATING NUTS.

We illustrate a novel arrangement brought out by Messrs. Drysdale and Co., Bon-Accord Engine Works, Glasgow, for automatically taking up the wear in crank pin or other bearings. It consists of a round nut B, having a collar H, and a separate brass cap A, inside of which is a coiled spring, one end E coming through the cap and the other end made suitable for going through a saw draught in the reduced end of the bolt inside A. Part of the nut B projects inside the cap, and has a groove all round it. Through the grooves are passed the split pins F, which thus keep the nut and cap together, while allowing them to revolve independently of one another. These nuts can be screwed on or off the bolts the same as ordinary nuts, the mode of operation in putting them on being as follows:—Hold the cap so that the end of the spring inside comes fair with the saw draught in the bolt, the pawls C being up clear, as in Fig. 1, then screw on the nut B. Meantime the cap A will not turn round, but will follow up with the nut. After the nut is up, the cap is given a turn in the opposite direction to that in which the nut was screwed, thus putting tension on the spring. The pawls C are now dropped into the notches G in the collar of the nut, as in Fig. 2, and this completes the operation. The compensating nuts will now take up, without further attention, the wear of the brasses until they are close together.

The advantages claimed for these nuts are:—(1) Saving the time spent in stripping worn brasses; (2) silent running of the parts fitted with these nuts; (3) the brasses will wear longer; (4) there is practically no initial pressure on the crank pin.



THE CRYSTAL PALACE EXHIBITION.—RANDOLPH'S STEAM COACH.

We illustrate this week on page 465 one of the most interesting exhibits at the Crystal Palace. It is a steam coach built for Mr. Randolph, one of the partners in the celebrated firm of Randolph and Elder, of Glasgow. The coach is in a very dilapidated condition, unfortunately. For this, however, the South Kensington authorities are not to blame. The truth is that the coach is not old enough to possess value as a relic. It was in a sense a white elephant, as will be seen presently. It is very difficult to obtain any information concerning its career—probably because it had none. We are enabled through the courtesy of General Festing and Mr. Last, to reproduce the following extract from the *Glasgow Herald*, of Wednesday, November 13th, 1872, which will give an excellent idea of its construction. Our drawings have been made in the Palace by our special artist.

"We had yesterday an opportunity of inspecting a new steam carriage which appears to reduce the chances of accident to the lowest point, and entirely to remove the objection of disturbance to the general traffic of the street. The carriage to which we refer has been introduced by Mr. Charles Randolph, of this city, whose eminence as an engineer is a guarantee for the soundness of the principles which it embodies. Mr. Randolph has for a considerable time given careful attention to the subject of steam as applied to street locomotion, and his plans having been matured towards the close of last year, a carriage has since been constructed, and is now ready for use—the machinery having been made by Messrs. Dübs and Co., of the Glasgow Locomotive Works, and the carriage portion by Messrs. James Henderson and Co., of North-street, Anderston.

"The carriage is 15ft. in length, and is externally a handsome specimen of the coachbuilder's handicraft. It consists of three divisions or compartments, which are harmoniously united—the driver's box in front, the boiler and engine-house in rear, with a compartment for passengers in the centre—and is carried on four wheels, two at each end. Taking these compartments in the order thus indicated, we have first the driver's box, which is roofed and closed in with side and front windows, and is set on a higher elevation than the rest of the carriage. It is comfortably cushioned, and will accommodate two passengers besides the driver. Below this box is a "boot" in which luggage may be placed, or fuel stored for long journeys. Behind the driver's box, and on a lower level, so as to be easily entered from the street, is the central compartment, which will comfortably accommodate six passengers. It is lofty enough in the roof to admit of a person of average height standing with his hat on, and is fitted with spring cushions, an umbrella or parcel rail, and hat belts in the roof, while passengers may communicate with the driver by means of a bell which is conspicuously shown. In the engine-house, which, as we have said, occupies the rear of the carriage, a seat is provided for the fireman, who takes his fuel from a coal bunk close at hand. The whole construction of the carriage is so designed as to secure order and neatness, together with the utmost possible economy of space in the working parts. When filled with passengers, and provided with water, &c., for a journey, its entire weight will be about 4½ tons.

"Passing from general details, we may now indicate the special engineering features of the carriage, in so far as these are capable of being explained to non-practical readers. Entering the driver's box, it will be seen that a lever is conveniently brought down on each side of the seat occupied by the driver from the roof. By drawing towards him the lever on the right hand, he applies brake power to both the sets of engines which drive the hind wheels, and may thus use it to stop the carriage on level ground, or regulate the restraining force of the drag, according to the steepness of the declivity down which the machine is travelling. With reference to the lever on the left hand, its purpose is to make the carriage run in either direction by acting upon the ordinary link motions, and its action is so adjusted that its relative movements are the same as those which it wished the carriage should perform—*i.e.*, pushing forward for the carriage to go forward, and pulling backward for backing. This harmony of action renders thought on the part of the driver unnecessary, and obviates chances of error; and it will be apparent to those who understand the operation, that the greater the distance the handle is made to pass through the greater will be the power of steam applied for propulsion. Rising through the centre of the compartment is a pillar surmounted by a steering wheel placed in a horizontal position. This steering apparatus is, of course, directly connected with the wheels, but by an ingenious piece of mechanism, which need not be described, it does not partake of the jolting motion imparted to the wheels by the stones and other impedimenta of the streets. The carriage, too, is protected from the unpleasantness usually experienced in travelling along rough roads, but this we shall refer to in its proper connection. We have thus noticed the principal mechanical peculiarities of the driver's box, but there are also minuter, although hardly less important, details to which we must advert. Thus, in front of the steering apparatus is placed a pointer, which unerringly indicates the position of the wheels relatively to the motion of the carriage. An important use of the pointer consists in the driver knowing before starting again the exact position of the wheels. A steam gauge is also provided, whereby the steersman may at a glance ascertain the pressure of steam in the boiler; a mercury gauge exhibiting the precise acclivity or declivity of the ground being passed over; and a mirror in front, showing the condition of the road or the traffic which may be coming on behind. The driver, again, is able to communicate with the stoker by pulling a bell, and the stoker may similarly arrest the attention of the steersman. For facility in steering, the two front wheels, which are 3ft. 4in. in diameter and 2½in. in breadth, are only 2ft. apart, while the hind wheels, which are 4ft. 6in. in diameter, and 4in. in breadth, are 5ft. 4in. apart, being the ordinary gauge of an omnibus. The latter are each provided with a spur wheel, bolted on the side next the carriage, which is driven by a pinion upon the crank shaft of each of the pair of engines. The carriage is set upon springs of improved construction. In the case of ordinary vehicles, progress through uneven streets results in more or less jolting, even where all the latest improvements have been adopted, but the springs of Mr. Randolph's carriage are so nicely adjusted, and the weight of the machine itself is so great, that the jerking motion of the wheels is not communicated in any appreciable degree to the body of the vehicle.

"It now only remains for us briefly to notice the engines and boiler. There are two pairs of vertical engines, one on each side of the carriage, with 3in. cylinders. The engines are quite apart from each other, so that, when a curve is being passed over, the engine and wheels on one side of the carriage accommodate themselves to the situation by acquiring increased velocity in proportion to the extent of the curve which is described. The carriage, we may add, can be readily turned in a street of ordinary width. As to the boiler, we notice that it is of the vertical type, and is fitted with Field's patent tubes, as also with a couple of safety valves, a water gauge, gauge cocks, and a pressure gauge. The area of the fire grate is two square feet, and the heating surface is about 80ft. The stoker is enabled to control the fire by means of a damper attached to the furnace, besides the ordinary method of working the furnace doors. The bursting strain of the boiler, assuming the material employed to be of only moderate quality, is 720 lb. on the square inch, but the metal used is of the very best description, and the boiler has been tested by the makers with 250 lb. of water pressure and 120 lb. of steam. It is not intended in practical working to exceed the 120 lb. With regard to the rate of travel, we may explain that when the pistons are running at the rate of 300ft. per minute, the carriage will go eight miles an hour. Of course this is by no means a maximum velocity; downhill, and even on level ground, it may be exceeded, but in a general way eight miles an hour is the rate aimed at. The water necessary for supplying the boiler is contained in a tank capable of holding about eight hours' supply, and is conveyed from the tank by means of two of Freidman's patent injectors. Besides serving this essential purpose, the water cistern, being interposed between the central compartment of the carriage and the boiler, tends to keep the former cool, and thus promotes the comfort of the passengers. The waste steam from the safety valves, together with the eduction from the engines, pass into a single pipe, and are carried into a chamber surrounding the funnel on the top of the boiler. This chamber is so large in proportion to the quantity of escaping steam that pulsation is entirely avoided, and the pressure is reduced to equability. The steam is discharged from the chamber into the funnel in a thin annular stream, which surrounds the effluent gases rising from the fire beneath, thus acting as a blast, and obviating the sudden screech and snort which would otherwise prove an annoyance. No steam is allowed to escape in the boiler house, and almost none is seen to be emitted from the funnel. We may add that the first trial of the carriage took place a few mornings since, when it was under the guidance of Mr. Charles R. Harvey, who has throughout attended to the details of construction. The carriage was taken from North-street, Anderston, out to Parkhead, the result of this first run being in all respects satisfactory. Mr. Randolph, we understand, anticipates that the mode in which he applies steam power to his carriage may be adapted to tramway cars, omnibuses, lorries, and even to ordinary carts."

After the coach had made a few trips, there is reason to believe that the authorities prohibited its use in the streets, and we hear nothing more of it until 1878, when it was sent to the Paris Exhibition. We believe that its owner wished to sell it, or at all events to get orders for similar carriages for use in France or Germany. Failing in this, the coach was brought back to England, and presented as a gift to the Patent Commissioners. These gentlemen did not want it, and for some years it was stored under protest by the Patent-office authorities, who had no proper accommodation for it in the Brompton boilers. They told Mr. Randolph's representatives, we understand, that it must be broken up if not removed, and the reply was, "Break it up." This was not done, and more room became available when the museum crossed the road. The revival of locomotion by power on common roads lends the coach an importance which it never before possessed. It is a very ingenious vehicle, and contains not a little that is worthy of imitation. Notwithstanding its size, it was very light, weighing, we are told, only 2½ tons empty, but its cost—£1800—was very high.

Our artist has, as far as possible, given detail drawings which explain themselves. The crank pins are set in discs, and the brake referred to in the description above consists of straps round these discs. The whole machine was very well made.

THE IRON AND STEEL INSTITUTE.

THE annual meeting of the Iron and Steel Institute was held on Thursday and to-day (Friday), May 7th and 8th, at the Institution of Civil Engineers; a fairly representative, although somewhat scanty, gathering of the members from all parts of the country being in attendance. Unfortunately the President, Sir David Dale, was unable to be present, as he has been obliged, under peremptory medical orders, to abstain from work of all kinds for a month, an abstention which must be extremely irksome to one of his well-known activity; but which, we sincerely hope, may bring him back to his accustomed strength and activity, at the end of his compulsory close time. In his absence the chair was taken by Sir Lowthian Bell, who, we are glad to see, has entirely recovered from his severe illness of last year.

From the report of the Council, it appears that the Institute continues to flourish, the number of members now on the list being 93 in excess of those of last year, while the funds show a surplus of income over expenditure of more than £1000. Considerable improvements have been made in the arrangement of the library, under the care of the secretary, Mr. Brough, and many works of special technical value have been added to the collection during the year. A powerful feature of interest in the report was afforded by the account of the arrangements for the autumn meeting of the Institute, which has been arranged to be held at Bilbao in the course of the first week of September next, an arrangement which, considering the long and tedious land journey and the want of accommodation on shore, could scarcely have been carried out without the assistance of the co-operative yachting system which has been so largely developed of late years by the Orient and other steam navigation companies. The idea has proved so popular with the members that it has been found necessary to detail one of the largest steamers in the Australian line of the Orient Company—the Ormuz—which will give facilities for visiting many interesting localities in Biscay and Guipuzcoa, besides the district immediately surrounding the meeting place. It was also announced that at the request of the Board of Trade Mr. Windsor Richards and Mr. E. P. Martin had been nominated by the Council as members of a committee which that Department has formed to investigate the question of the loss of strength in steel rails by time.

The Bessemer medal for the year has been awarded to Dr. Herman Wedding, of Berlin, an award which, judging by the applause with which the announcement was received, has been entirely approved by the members. In making the presentation, Sir Lowthian Bell dwelt upon Dr. Wedding's long connection with scientific metallurgy—a connection that may well be said to be hereditary—his family having been long and honourably associated with the development of the iron trade in Prussia; the first coke blast furnace on the Continent of Europe having been erected by his grandfather at Glenvitch, in Silesia, in 1796, which was followed by the larger works at Königshutte, built by Mr. Wedding and Mr. J. Baildon, a Scotch smelter, in 1798. Dr. Wedding is, in many respects, an old familiar friend in this country, as he was a principal representative of the German iron trade in the Exhibition of 1862, and has occupied a similar position at most of the large international exhibitions since that date down to the Chicago Exhibition of 1893, where his activity and kindness when acting as a judge in the metallurgical section will always be held in pleasant remembrance by those who were associated with him in the same work. These, however, are but small matters as compared with his literary and scientific activity, both as a teacher of metallurgy, Berlin School of Mines, and his monumental treatise on the metallurgy of iron, which originally begun as a translation of Dr. Percy's work, has in successive editions become the largest storehouse of scientific knowledge upon its subject in any language, and fully deserves the recognition made by the award of the Council. These qualifications were fully noticed by Sir Lowthian Bell in making the presentation, which was acknowledged by Dr. Wedding in a short but telling speech, in which he dwelt more particularly on his long connection with the English iron trade, including in that term both this country and America.

The first and most important communication in the list as announced, that by Mr. J. H. Darby on Dr. Mond's producer gas as applied to steel melting, was displaced from the original order, it not being quite ready for distribution, so that the proceedings began with the reading of the paper by Mr. B. J. Hall on the "Ford and Moncur Hot Blast Stove." This is the first detailed account of this apparatus that has been published, which is a somewhat remarkable omission, as it has been doing most excellent work for many years past, especially in West Coast hematite districts. The essential feature in its construction is the use of the regenerative brickwork in parallel walls 2¼in. thick, built dry and held in position by slag bricks of spindle shape section, with sharp edges in the vertical plane, spaced in zig-zig portion at small intervals. The combustion chamber is rectangular and central, traversing the full width of the stove, leaving a circular segmental space for the regenerative work on either side. These circular spaces are further divided by by a 14in. cross wall, giving four separate compartments, each one of which is provided with valves connecting it with the blast and chimney passages, so that it may be worked independently or in connection with one or more of the other three. This allows the heat of the blast to be maintained at a nearly constant temperature, one or more compartments being shut off when fully heated and held in reserve, to be brought into action as the temperature falls. In Cumberland the blast furnaces are usually worked with blast at 1350 deg. to 1400 deg. Fah., and the stoves at 1500 deg. A further valuable practice due to the arrangement of the separate valves is the power of cleaning out the bulk of the dust by suddenly changing the direction of the current from one compartment to another at the change of the stove, then the volume of air contained is driven through into the chimney, carrying the deposited material with it. This method of cleaning by discharge of the whole of the air under pressure in the stove through the limited area of one compartment has proved very effectual, and in some cases they have been at work continuously for five years without once having been laid off for cleaning.

The first stoves erected at Distington Ironworks have been in use for twelve years, without requiring any outlay for internal repairs.

The paper is accompanied by an interesting appendix, giving the statistics of the stove plant in use in British ironworks at the present time, which, though presented as incomplete, is probably only so in minor particulars. The relative proportions of the different forms of apparatus are seen in the following figures :—

Types of stoves.				
Cowper	318	and	3	building
Whitwell	120	,,	3	,,
Ford and Moncur	142	,,	13	,,
Massicks and Crooke...	64	,,	2	,,

From the details contained in the table, it appears that where Cowper stoves are used exclusively, 241 are provided for 128 furnaces, or an average of 1·88 per furnace, or in more recent cases 1·4 per furnace. With Whitwell's the figures are 91 stoves for 31 furnaces, or 2·9 per furnace, the same ratio obtaining with the Massicks and Crooke form—35 stoves for 12 furnaces. In eight cases where Ford and Moncur stoves are used exclusively, 48 serve 45 furnaces, an average of 1·08 per furnace. These figures are not in all cases quite comparable, as most of the examples of the latter class are modern and of large dimensions, but for these the proportion of three for two furnaces, or same as for Cowper stoves, is generally sufficient. The cleansing arrangement, however, gives a marked advantage to the Ford and Moncur form when the gas is dirty, and owing to the regular distribution of the gases over the chequer work it is more easily kept clean. The stove illustrated in the paper is estimated to contain 7320 square feet of heating surface in the combustion chamber and auxiliary regenerator, and 58,600 square feet in the four chequer filled compartments and passages, or 66,000 square feet in all. The height is 72ft. and the diameter 26ft., the whole being enclosed in an air-tight casing of mild steel or iron plates, a minimum space of ½in. being allowed for expansion between the casing and the brick lining. The cost of such a stove erected complete, with all mountings, but exclusive of foundations and connections, is about £1600.

In the discussion of this paper much old ground was traversed, in the matter of the history and development of the Cowper and Whitwell stoves, and some exception was taken to the author's statistics, but there was little of interest brought out. The users of the new pattern being largely confined to Cumberland and Lancashire, most of the information concerning its use came from those districts. One noticeable peculiarity not mentioned in the paper was announced by Mr. Crawford, of Moss Bay, namely, its very sparing use of gas, a point of great importance now that the power requirements for blowing are constantly increasing.

The second paper taken was that by Mr. Nursey on Mr. Dicks' "Method of Producing Metal Sections by Extrusion," which we print *in extenso* in another page. This gave rise to no discussion, other than a suggestion from Mr. Snelus that a similar method of production might be applied, at a future time, to the production of steel tubes from molten metal, following the Whitworth plan of liquid compression.

Mr. E. Metcalf Smith's paper on the "Treatment of New Zealand Magnetic Iron-sand," described the results of some experiments on the reduction of the well-known Taranaki sand. This mineral occurs as a beach deposit along a line of about thirteen miles of coast resulting from the waste of quartz and sand cliffs which are being perpetually re-arranged by the wash of the sea; a depth of 14ft. of the clean mineral having been found by digging on the shore. According to the incomplete analysis given, it contains 82 per cent. of magnetic oxide of iron, and 8 per cent. of titanic acid. For smelting it was compacted to a coherent mass by mixing it with about 30 per cent. of its weight of siliceous clay, which was then passed through a small blast furnace with a fluxing mixture of about equal parts of the same clays and limestone in the proportion of two of prepared ore to one of flux, which appears to bring the iron in the charge down to about 26 per cent. Forty-five tons of pig iron of the following composition were obtained in experimental trials in 1892 :—

	Pig iron.	Bar iron.
Iron...	94·09	98·94
Manganese	traces	traces
Titanium	1·00	0·21
Silicon	2·12	—
Sulphur	0·02	traces
Carbon	2·33	0·46
Loss and substance not determined...	0·44	0·39
	100·00	100·00

The pig iron is fairly granular, and a fragment flattens out when struck on the anvil. The bar iron is very fine grained and malleable, and is of excellent quality. The following method of treating the fluid metal will, the author thinks, commend itself. Having smelted the iron-sand, tap it into a ladle containing tarred iron-sand in the proportion of 4 cwt. to each ton of crude metal. The liquid metal will melt and absorb the iron-sand, and the tar will give sufficient carbon to retain the metallic iron in a fluid state. The metal so treated retains its greyness and fluidity, and if used for direct castings, there is a result of a gain in weight of 3 cwt. per ton, instead of a loss of 3 cwt. per ton, as is the case when re-melting pig iron for castings. In making wrought or bar iron, the tarred iron-sand compound can be added in the puddling furnace in the proportion of 50 per cent., and in making steel by the Siemens open-hearth furnace, 50 per cent. of tarred iron-sand compound may be used, yielding, together with what was placed in the ladle, a clear gain of 10 cwt. per ton. The cost of manufacture of pig iron, superior in quality to the best Scotch, is £2 7s. 3d. per ton, made up as follows :—

	£	s.	d.
Cost of fuel	1	4	0
Carriage, pugging, pressing, drying of compound iron-sand clays	0	10	3
Fluxes...	0	4	0
Labour	0	8	0
Sundries	0	1	0
	2	7	3

By the special treatment described, bar iron equal in quality to the B B H can be produced for £7 per ton. The manufactured wrought iron, when reduced with charcoal, stood the extraordinary tensile stress of fifty-two tons to the square inch.

Mr. Bernard Dawson having experienced difficulties in smelting New Zealand iron-sands in a blast furnace, asked for particulars as to dimensions of the furnace used by the author. The author, in reply, pointed out that by the use of the briquettes and the tarred sand, no difficulty was experienced in New Zealand in smelting the ore.

The last paper read on Thursday was a short note by Mr. E. A. Walford on the "Origin of Middle-Lias Iron Stone in North Oxfordshire," which he traced to the alteration of blue and green fossiliferous limestone by the infiltration of ferrous carbonate which has largely effaced the original fossils, and subsequently become changed to a rusty ferric hydrate by air and water acting through a long period. Owing to the late hour very little discussion followed, except that Mr. Snelus, while concurring with the mode of formation pointed out by the author, recognised another mode passing through the stages of calcite, ferrous, and finally ferric compounds. The meeting then adjourned till this (Friday) morning.

RAILWAY MATTERS.

Long street car rides for a 5 cent. fare are now given by the Nassau Electric Railway Co., of Brooklyn. The Brooklyn City R.R. carries passengers fifteen miles for a 5 cent. fare.

On the 13th ult. a train consisting of a locomotive and two gravel cars broke through a trestle near Bedford, Ind., on the Bedford Belt Railway. The conductor, fireman, and three others were instantly killed, and the engineer and another man injured beyond recovery. The trestle is about 75ft. high.

The North-Eastern Railway Company has announced its intention of making some reduction in their rates for the benefit of the agriculturists. The rates on town manure, farmyard and stable manure, and gas lime are to be generally reduced, and the rates for this traffic will in future be based on a very low scale. The rates under this scale are in many cases as much as 30 per cent. below the existing rates applicable over the greater portion of the railway.

The Lima (Peru) correspondent of the Panama *Star and Herald* says that the Senate has authorised the Government to make a contract for the construction of a railroad from Oroya to Chanchamayo, with a grant to the contractors of 70,000 acres of land. This road, when built, will be a most important one, opening communication between the coast and the great timber region. Propositions have been made by European capitalists for the construction of the road.

The Unopposed Bill Committee of the House of Commons passed a Bill last week sanctioning an extension of the authorised Baker-street and Waterloo Railway, in order to effect a communication with the terminal station of the Manchester, Sheffield, and Lincolnshire Railway Company's new line into London. The Bill also authorises the construction of this railway in three separate sections, each section having a distinct capital. An extension of time is also granted until March, 1901, within which to construct this railway.

The survey of the volcano Popocatepetl for the purpose of determining the best location for an aërial cable railway to the summit has just been completed. It has been determined to start the line from the ranch of Tlamacus, and it will be connected with the Interoceanic Railroad at the base, so that the business of shipping sulphur can be cheaply accomplished. This new railway will be a great attraction to tourists, who will now be able to make the ascent to the summit, 18,000ft. above the sea, and also descend to the crater, where the process of extracting sulphur is being carried out.

Japan has in operation lines aggregating 193·375 miles, of which 557·29 miles are owned by the Government. According to the latest statistics, the lines under construction make up a grand total of 719·61 miles. The *London and China Telegraph* states that a railway project of considerable importance is reported from Kyoto, by which Tsruga on the Japan Sea will be connected with Kyoto by a line along the western shore of Lake Biwa, that route being shorter than the existing Government road, which makes a detour along the eastern shore. The whole distance is 65 miles, and the estimated capital of the company, 3,200,000 yen.

The northernmost railway in the world, which extends to about latitude 64 deg., inside of the Arctic circle, is in Sweden, and serves for carrying iron ore from Gellivara south-east to the Gulf of Bothnia, at Lulea. Originally it was isolated, but in the summer of 1894, a Swedish main line, which extends nearly parallel with the west coast of the Gulf of Bothnia, was extended to a junction with it, so that now one may travel by rail from Stockholm into the Arctic zone. The main line is now to be extended around the head of the Gulf of Bothnia to the border of Finland at Haparanda, and the *Railroad Gazette* says a Finnish railroad on the east side of the gulf is also to be extended to Tornea, opposite Haparanda, when it will be possible to go by rail from Stockholm to St. Petersburg, going completely around the gulf.

The construction of the electric tramway subway through Tremont-street, Boston, Mass., has necessitated many changes in the water and gas mains previously laid in the street. On Monday, March 30th, Supt. H. C. Richardson succeeded in shifting as one piece 300ft. of 30in. cast iron water main to a line 18in. from its original position. A trench 6ft. deep and 8ft. wide was first necessary. The pipe was then cut at both ends and cross beams and jackscrews placed at 15ft. intervals, and the mains swung to these with heavy chains. When all was ready for the shift the jackscrews were turned in unison until the main had been elevated from 1ft. to 3ft., when it was shifted along timbers set on rolls to its new position and re-connected. Beginning work shortly after 10.0 a.m. Monday with sixty men, the whole operation was completed at 2.0 a.m. on Tuesday.

Comparative figures of the coal consumed per car-mile run on French tramways, employing different methods of propulsion, are contained in an article on electric lines by E. Cadiat in the *Portefeuille Economique des Machines*. As regards storage battery traction, on the lines from St. Denis to the Madeleine and from the Opera to Neuilly, the car mileage aggregated, in 1893, 502,060, or 1376 car-miles per day. The steam engines at St. Denis furnished for this service a total of 6500-horse-power hours, or 4·72-horse-power hours per car-mile. M. Badois, who reported these figures, gives 2·75 lb. of coal as the consumption per horse-power hour, and arrives at 12·98 lb. of coal per car-mile. At Marseilles, during the first two weeks of operation of the trolley system, 150,348 lb. of coal were consumed to run 19,970 car-miles, and during the second two weeks 150,975 lb. for 18,983 car-miles. The average is 7·73 lb., which, however, includes the coal used in connection with the lighting of the cars and the power station.

Mr. C. L. St. John, British Consul at New Orleans, in his report to the Foreign-office, says:—"The question of electric street cars is so important that it would not be out of place to enter on the subject. I believe no town anywhere has made more progress, and is more perfect in this respect, than New Orleans. A year or two ago the mule car system was in force, by which much time was lost, as only five miles per hour could be made; now that the transit is by electric car a speed of twelve miles an hour is obtained. In New Orleans, with an average saving to each passenger of twelve minutes, there is an economy of 10,000,000 hours a year, equivalent to 1,250,000 days' labour of eight hours. If time is money, and one day's labour is worth 4s., which it certainly is at New Orleans, the electric cars are saving the city £250,000 a year in time. In 1880 New Orleans boasted of 140 miles of tramways, 373 cars, 671 employés, and of carrying 23,716,327 passengers during the year. To-day she has 180 miles of lines carrying 47,250,000 passengers, at a uniform rate of 5 c.—2½d.—some of the distances being four to five miles. There is a project before the town council for 79 additional miles, bringing the total up to 260 miles. A quick transit not only saves time but also reduces rent, as less expensive districts can be reached by the working classes. It is only a question of time when such a system will be adopted in London and other European capitals, where at the present moment the streets are so encumbered by carriages as to convey the impression that there is no room for electric tramways; whereas it must be borne in mind that the introduction of such a system would relieve traffic by very much reducing the number of vehicles drawn by horses. At New Orleans, where in one street, the principal thoroughfare, there are no less than five lines, and the safety of the walking public is in no way protected by the police, there are few accidents. In London, where police protection is so admirably carried out, there would be far less danger than at present from innumerable vehicles driving in all directions and when least expected."

NOTES AND MEMORANDA.

In a recent paper before the Paris Academy of Sciences on "The Principal Results of the Last Ascent to a Great Height of the Balloon Aerophile—March 22nd, 1895," by MM. G. Hermite and G. Besançon, it is mentioned that at a height of eight and a-half miles the minimum temperature recorded was 63 deg. C., or a fall of 1 deg. per ·597ft.

The number of miles of streets containing water-pipes constantly charged in each water company's district within the Metropolis is as follows:—Chelsea, 96; East London, 185; Grand Junction, 135¼; Kent, 192; Lambeth, 236¾; New River, 364; Southwark and Vauxhall, 160; West Middlesex, 176¼; total, 1545¼ miles. Throughout this extent of streets hydrants for fire purposes can be fixed.

The history of the remarkable spring at the dropping well at Knaresborough, in Yorkshire, is noticed by B. A. Burrell at some length in a recent Chemical Society paper, from which it appears that its petrifying qualities were known in 1534. A complete analysis has now been made. The total solids amount to 162·435 grains per gallon, of which 114·37 grains are calcium sulphate, 25·48 calcium carbonate, and 17 magnesium sulphate. Traces of manganese and strontium were found.

In making tests of rods by the magnetometer method, it is usual to assume that as far as the self-demagnetising forces are concerned, the cylinder is equivalent to a very long ellipsoid. That this assumption, the *Electrical Review* says, is not quite true is well known, and the question has been gone into by several observers. The latest research on the question is by Mr. C. R. Mann. He finds that up to a certain value of the intensity of magnetisation, at about the point where the linear relation between I and H ceases in the reversal curve, the cylinder is very nearly represented by an ellipsoid, but after that the ellipsoid takes up a much greater magnetisation for the same magnetising force than does the cylinder. For a length ratio of 20 to 30 the deviation from the corresponding ellipsoids is a maximum.

Retort carbon is proposed as a material for the manufacture of resistances on the principle covered by a patent in Austria of Sirius Fabrik. A metre length of carbon of one square millimetre cross section would give a resistance of about 75 ohms at 0 deg. C., with a temperature coefficient of ·00052, its specific resistance being nearly 80 times greater than that of manganese copper. An adjustable resistance for arc lamps consists essentially of a quantity of the best round lamp carbons of the customary length arranged between two slate plates in such a manner as to permit of expansion, and with the necessary connections. The whole is covered with a perforated metal screen. The *Electrical Engineer* considers that there should be a place for apparatus of this class in alternating current work, since, owing to the short length required and the avoidance of the coil form, self-induction is obviated.

Concerning defective belt tighteners a writer in the Chicago paper *Milling* says:—"For a vertical belt the hinge frame is preferable and works admirably, by hinging it on trunnions at the bottom of the frame, and setting at such an angle up to the belt as will give just enough weight to hold the belt to its work. The advantage of this plan is that it gives the belt increased weight just when it is needed, and lightens up when running light. I am much in favour of tighteners on belts that have heavy power to transmit, as it is easier on both belt and bearings. By long experience I find the belt—especially rubber—retains its elasticity, and holds out much longer with the tightener properly used, than when the belt is kept strained up to its working tension all the time. Another advantage of the tightener is, that it makes possible the use of endless belts in many places, where without it they could not be conveniently used, and I think all will admit that they—endless belts—are one of the few 'comforts' of the miller. The tightener pulley should be as large as the room it has to work in will admit; not, however, to make it heavy."

At a recent meeting of the Cambridge Philosophical Society, a paper was read on "Some Scratched Stones from the Permo-Carboniferous Rocks of South-East Australia, and the bearing of the Evidence on the Question of Recurring Ice Ages," by Professor Hughes. Professor Hughes exhibited some specimens and photographs given to him by Professor David, of the University of Sydney, pointing out that the glaciation of South Australia as generally understood had been entirely disproved; that there had been no glaciers in the district in question, but that the traces of glaciation were due to ice floating from the south over a subsiding area, with, as he inferred, a compensating elevation elsewhere. He gave a *résumé* of the new evidence which he had collected in favour of the view that the recurrence of local glacial conditions was always connected with movements of elevation and depression, and appealed to physicists to explain the overthrusts and contortions of the surface of the earth, not solely by shrinkage of the nucleus nor by deformation of the whole mass, but by some conditions affecting regions limited in extent and depth, with perhaps a certain amount of periodicity determined by some more general cosmical causes

In a recent Chemical Society paper on "The Temperature of Certain Flames," by W. N. Hartley, F.R.S., the author mentions that he found no practicable means of measuring their temperature, owing to the disproportionate size of the measuring instrument—a thermo-electric couple, for instance—compared with the effective volume of the flame. He measured the temperature of flames by means of gold-leaf and with fine wires of platinum 1/3000in. diameter, such as were drawn by Wollaston and used by Faraday, also with pure platinum wire 1/1000in. thick. He furnishes evidence of the high temperature of a candle flame, not only from the melting of gold and of platinum in the flame, but by an examination of the spectrum to be seen in the mantle. Experiments made with platinum wires heated in a bats-wing gas flame are described, which proved that the carbon does not lower the melting point of the platinum, at any rate in any appreciable degree. A small carbon monoxide flame melts platinum wire 1/1000in. in thickness, and a cyanogen flame was shown to be intensely hot, for it melted such wire with extreme ease. The author believes that his experiments have dissipated the doubt that was cast on Professor Smithells' statement of the high temperature of the mantle of the Bunsen flame, and confirm his own estimate of the high temperature of the Bessemer flame.

A new method for utilising the power of a water-fall is attracting some attention in Canada, and, it is stated, a company has been formed to install an experimental plant of 175-horse power. Those who are to experiment will not get far if they have no more to go upon than the following from the *Mining and Scientific Press*:—"The essential principle involved is the compression of air by the force of the falling water, and the compressed air used to drive motors at the falls or be transmitted to a distance for the same purpose. From a tank or a standpipe, in which the water stands at the same level as above the dam, the water is permitted to pour down a pipe, around whose base are a number of holes, admitting air from tubes running up to the surface of the water. The air is sucked in and compressed by the water, and the two are automatically separated by gravitation, the air passing into a storage or supply chamber. The incredible statement is made that from 70 to 80 per cent. of the latent energy in the falling water can be rendered available in this manner. This is no more than a turbine yields, but the latter cannot transmit its energy to a distance without the interpolation of dynamos and motors, in which some loss of power occurs. It is said a plant operating on this principle is to be installed at the Dominion Cotton Mills in Magog, near Montreal."

MISCELLANEA.

The Exhibition of Horseless Carriages at the Imperial Institute will be opened to the public to-morrow.

The Japanese appreciate the value of naval power, and the necessity for ample dry dock accommodation if such power is not to be seriously hampered in time of war. Their new dry dock at the naval port of Kure is to be 464ft. long, 69ft. wide, and 42ft. deep—dimensions which would admit the docking of a 15,000-ton battleship.

Advices from Lisbon state that the Technical Commission appointed by the Portuguese Government has definitely reported to the Minister of Marine in favour of the tender of the Thames Ironworks and Shipbuilding Company, Blackwall, to build one fast cruiser, two gunboats, and one sea-going tug. Among the unsuccessful competing firms were two Italian and one American.

Concerning the stamping of patent and other forms at Inland Revenue offices in the provinces, Mr. Jackson, who has been in correspondence with Sir H. Reader Lack, the Controller of the Patent-office, has received a letter informing him that the Board of Inland Revenue have authorised their officers at Leeds to stamp in future any patent, design, and trade-mark forms which may be presented to them by the public for that purpose.

The Egyptian Government has determined to commence a geological survey. The work will be begun this year, and will take about three years for its completion, the estimated cost being £25,000. To carry out the proposed plans, Capt. H. G. Lyons, R.E., who is at present engaged under the Public Works Department of the Egyptian Government in superintending the excavation of the ruined temples of Philæ, will be employed.

Chicago has a complete telephone and signal system, consisting of 887 public and 370 private boxes, operating on 81 circuits, connected with the 37 precinct stations of this department, in which they are located. The system includes public sentry boxes placed at street intersections, equipped with a signal box to transmit the number of the station; a telephone for patrolmen to report and receive orders over; a chemical register at the station which records the calls, and the necessary switches for operating the telephone and testing for electrical disturbances.

At the last meeting of the Council of the Royal Agricultural Society, Mr. Frankish, from the Implement Committee, reported that the total number of implement stands at the Leicester meeting would be 445, and that, exclusive of open ground space, a total of 13,930ft. had been allotted in the Implement Department. At the trials of potato planters, held at Leicester on April 21st last, the judges had awarded the prizes as follows:—First prize of £20 to Messrs. Ransomes, Sims, and Jefferies, of Ipswich, for their double-row potato planter; and the second prize of £10 to the same firm for their three-row potato planter.

According to the United States press reports, the Japanese Government has made arrangements with the firm of Sir W. G. Armstrong and Co., Newcastle, England, for the erection of a steel foundry in Japan. The terms are as follows:—(1) The material shall for the present be imported from England; (2) of the workmen to be employed, 20 per cent. shall be brought from England and 80 per cent. shall be Japanese; (3) when a new arm is invented in England, it shall be manufactured at the works in Japan; (4) for a stated number of years the Japanese Government shall give a fixed subsidy to the company; (5) on the expiration of the period during which the company receives a subsidy the works shall be sold to the Japanese Government.

At the eighth annual general meeting of the Tarapaca Waterworks Company held on Monday at Winchester House, Mr. R. Harvey, who presided, said the net profit for the period under review, amounting to £52,020, was upwards of £3000 in excess of that of the preceding year, and was equal to 13 per cent. on their capital. The Board had, however, decided to pay a dividend of only 7½ per cent. By doing this they were enabled to carry forward the substantial sum of £20,000, after placing £10,000 to the reserve fund for the redemption of debentures. When the company was formed Iquique had only 20,000 inhabitants, whereas the population to-day was 33,000, so that the question of providing for a growing demand was one that could not be neglected.

It is stated that the parties to the proposed transfer in the Durham coal trade are the Earl of Durham and Messrs. James Joicey and Co. The output of Lord Durham's collieries, which are fourteen in number, is 12,000 tons per day. The purchase money is put down at from £800,000 to £1,000,000 sterling, and it is understood that the transfer will become an actual fact on June 1st. Messrs. Joicey have at present under their control about thirteen collieries, employing 4000 men, and the number employed in Lord Durham's pits is over 8000, so that when the transfer is effected Messrs. Joicey, of which firm the leading partner is Sir James Joicey, M.P., will have control over nearly thirty collieries and 12,000 men. The Lambton steamers, which carry most of the coal won from Lord Durham's pits at Sunderland, are twenty in number.

Some interesting facts concerning the competition of the Continent and America in the iron trade were given at a conference, held under the auspices of the British Iron Trade Association, at the Westminster Palace Hotel, London, on Wednesday, Sir Alfred Hickman, M.P., in the chair. Previous to the conference the annual meeting of the British Iron Trade Association was held, at which the report of the board, presented by Mr. J. Stephen Jeans, the secretary, set forth that the trade of 1895 had not recovered the ground lost since 1892, but that it was interesting and encouraging to note that, if the export trade of the rest of the year had been as good as that of December last, the value of exports would have been nearly 2,000,000 tons more than reported. The principal features of the export trade of 1895 were:—(1) The large increase in the shipment of plates and sheets, which reached the unprecedented total of 707,000 tons; (2) a slight improvement in the export of tin-plates; and (3) an increase of 44,000 tons in the export of rails. Our imports of iron and steel had shown an increase in 1895 over the preceding year under all heads except tires and axles.

For many years shipowners have declined to carry petroleum as cargo unless it has been guaranteed by the shippers as complying with the conditions imposed by the Petroleum Acts—namely, that it would not give off an inflammable vapour at a temperature of less than 73 deg. Fah. The inquiry proceeding by a Select Committee of the House of Commons has, however, suggested the necessity of some declaration making it clear that, when petroleum is about to be shipped as part of a general cargo, responsibility for compliance with this condition of the Act of Parliament rests solely with the shipper. The committee of the London Direct Short Sea Traders' Association, under the presidency of Mr. R. Cattarns, have therefore formulated the following petroleum clause, which will henceforth form part of their authorised bill of lading for oversea purposes, and also be inserted in the way bills used in the coasting trade:—"The shipowners refuse to carry petroleum which gives off an inflammable vapour at a temperature of less than 73 deg. of Fahrenheit's thermometer. Shippers will be held to guarantee the petroleum they ship will not give off an inflammable vapour under any circumstances at a temperature of less than 73 deg. of Fahrenheit's thermometer, and the consignees of the goods will be held responsible for all the consequences and legal penalties attaching under the Petroleum Act of Great Britain or elsewhere in the event of their shipping petroleum of a nature such as that above specified. Clause 12 of the authorised form of Continental Bill of Lading shall apply to this shipment."

THE PRODUCTION OF METALLIC BARS OF ANY SECTION BY EXTRUSION AT HIGH TEMPERATURES.*

By Perry F. Nursey.

So comprehensive are the developments of inventive genius in the present day, and so rapid and far-seeing are the strides made by invention, that they not unfrequently overtake, or rather overreach, the means at disposal for giving practicable form to otherwise practical ideas. Thus it sometimes happens that the introduction of an invention based upon common sense lines is temporarily retarded, or the invention itself permanently lost to the world, and industrial progress in a given direction thereby checked, by reason of there being no adequate means or suitable materials at hand for bringing it to a successful issue.

A case in point is afforded by the carrying out in practice of the ingenious metallurgical process which I now have the privilege of bringing before the Institute. The invention, which is that of Mr. Alexander Dick, deals with the production of all kinds of metallic sections, from a simple round wire to complex designs which it would be impossible to roll, by forcing metal heated to plasticity through a die under hydraulic pressure. The principle is simple enough, being nothing more than that employed in the manufacture of bricks, drain pipes, and similar articles. It is, however, the application of that principle to the purpose under notice that constitutes the ingenuity and originality of the invention, and which marks it as a substantial advance in metallurgical practice.

I do not forget that the principle of extrusion has been applied in the production of continuous lengths of leaden pipes and wire, and also of leaden rod for the manufacture of projectiles for small-arms, and for other purposes. In those cases, however, the lead is pressed at a comparatively low temperature, whilst in the present instance the metal is operated upon at a very high temperature, namely, that of plasticity, or about 1000 deg. Fah., and which varies considerably with different metals and alloys. It was this necessary condition of high temperature that led to the difficulties encountered by Mr. Dick in putting his invention in practical shape, and which difficulties present features of interest to steel makers.

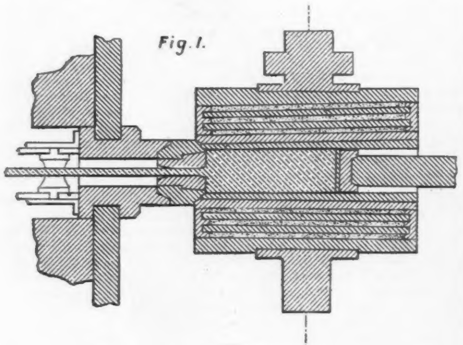


Fig. 1.

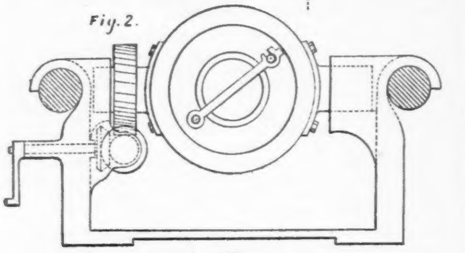


Fig. 2.

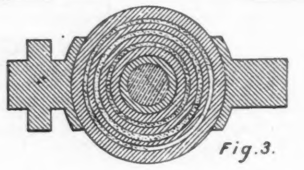


Fig. 3.

The process of manufacture consists in placing the heated metal in a cylindrical chamber, at one end of which is a die. Upon pressure being applied at the opposite end, the plastic metal is forced through the die, issuing therefrom as rods or bars of the required section and of a length governed by the quantity of metal placed in the receiver. This pressure chamber has not only to withstand the high temperature of the contained metal, but has likewise, whilst under the influence of that temperature, to meet the severe strain brought upon the interior by the resistance of the metal to the pressure of the hydraulic ram in forcing it out through the contracted area of the die. Hence the first and most important point to be settled was the design of the cylinder and the material of which it should be constructed. Other difficult problems presented themselves for solution as the work of construction progressed, but they were of a less anxious and perplexing character than that of the pressure cylinder, which is the main feature of the invention.

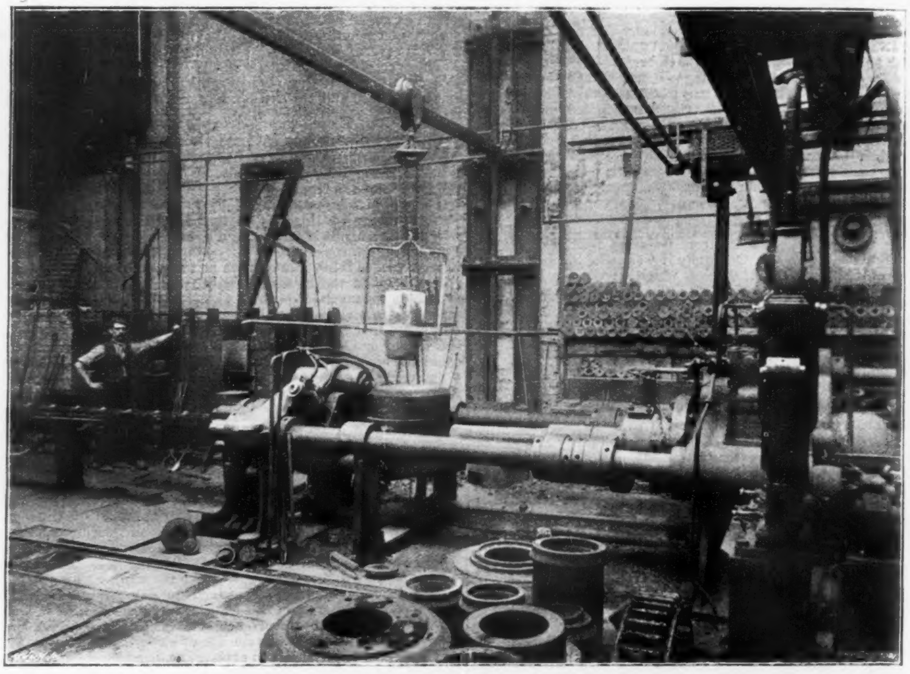
At starting several cylinders were made, some of cast and some of wrought steel, in order to ascertain which material was best suited for the purpose. The chamber was 24in. long and 6in. diameter internally, the walls varying in thickness from 3in. to 6in. Surrounding the cylinder was an annular chamber heated by a coke fire, the object of which was to maintain the plasticity of the metal during the operation of pressing. In practice, however, it was found that the strains set up by the unequal expansion and contraction of the walls of the cylinder, added to the internal working pressure, soon developed cracks, thereby rendering the cylinder useless.

A series of experiments was therefore carried out by Mr. Dick, with the object of finding a steel capable of standing the temperature and pressure to which the container was subject in working. To this end he obtained cylinders of various steels from several leading steel makers, which he tested under working conditions both of temperature and pressure. In the result, however, he found that not one of the cylinders would stand more than three tons per square inch at the working temperature, Delta metal being the material operated with. In all cases the cylinders bulged and developed longitudinal cracks, through which the metal was forced. Thus for a time the progress of a promising invention was retarded, and the accomplishment of an important object rendered extremely doubtful.

Nothing daunted by failure, Mr. Dick set to work to devise other means whereby he hoped to accomplish his end. In due course, and after the expenditure of a considerable amount of both time and money, he succeeded in producing the machine which I am about to describe, and which admirably fulfils its intended purpose. The difficulty respecting the pressure chamber, or container, was eventually overcome by dividing up the container into sections composed of concentric steel tubes alternating with annular spaces packed with a dense non-conducting material. This arrangement is based upon the principle that whilst steel, when heated to a high temperature, loses its integral strength, as proved by Mr. Dick's experiments, yet at lower temperatures it will retain its full power to resist pressure; so that a cylindrical chamber formed of several comparatively thin walls, and protected from extreme heat, will resist pressure better than a chamber having a thick solid wall heated to a higher temperature. A chamber surrounded by comparatively thin walls heated to a comparatively high temperature is not so injuriously affected by variations of temperature as a similarly heated chamber having a solid wall of greater substance.

By this compound system of construction, the liner, which is exposed to the extreme heat of the metal, may be made with a comparatively thin wall, and will not be liable to be fractured by unequal heating and cooling, and consequent expansion and contraction. Further, in order that it may be capable of successfully resisting pressure, it is reinforced by means of the surrounding steel tubes, which, although of themselves thin, are insulated and supported by a dense packing of non-conducting material, and are therefore kept at a comparatively low temperature and in a condition to offer the greatest resistance, which condition is further mechanically influenced by a stout steel outer casing.

Another problem which took some time to solve was the selection of an efficient non-conducting material. The main conditions here were, that the particles of the material employed should be capable of being densely consolidated, should not injuriously affect either the liner or the outer cylinders, nor melt nor become decomposed at a high temperature. After experimenting with a variety of substances, Mr. Dick found that the best results were obtained from crushed granite mixed with a small proportion of borax. This compound satisfactorily fulfilled all the necessary conditions, and was therefore adopted as a non-conductor.


DICK'S APPARATUS FOR MAKING BAR

The apparatus as now constructed and in daily operation is illustrated in perspective below. It is 16ft. in length, 6ft. wide, and 5ft. high over all. It consists mainly of the compressing cylinder or container and the hydraulic ram. A longitudinal section of the container is shown at Fig. 1, and a transverse section at Fig. 2. The container, which is 2ft. long and 2ft. diameter externally, has an inner liner of cast steel. The internal diameter of the liner varies in different containers from 5in. to 8in., according as to whether it is wanted for pressing a small or a large charge, the container being changed as required. The liner is enclosed within a series of cylinders of ordinary mild steel spaced about ⅜in apart, the annular spaces being filled in with non-conducting material. The container is mounted on trunnions and fitted with worm-gearing for bringing it to a vertical position for being charged with metal and restoring it to the horizontal for the operation of pressing.

Great care has to be exercised in making the die plates, the material of which is tungsten steel. They are formed with either one or several openings, each opening being of the section required to be given to the article to be produced. The edges of the openings in the dies are bevelled, so as to give free access to the metal under pressure, and to more perfectly condense it. The die plate is mounted in a holder, in which it is easily fixed, or from which it is readily removed, as different sections are required to be pressed. As it is necessary to heat the die and its holder previously to each pressing operation, the die is fitted into a shouldered recess in the holder, which is coned to seat into a hollow metal block. This block is firmly held in position during the operation of pressing by a pair of gripping jaws actuated by hydraulic power. The die-holder and the gripping jaws are carried in a strong crosshead. The die-holder and its adjuncts, together with a number of dies, as well as a container, and some of the steel cylinders used in its construction, are seen in the perspective view of the machine.

The metal is forced out of the container and through the die by a hydraulic ram 18in. in diameter, and working under a pressure of two tons per square inch. The ram has a prolongation or extension, of reduced diameter, which forms the plunger of the container, entering it at the opposite end to the die. A different plunger is used with each container, the diameter varying to suit the internal diameter of the container. On starting to work each day, the container is first heated up by gas with a Bunsen burner, which quickly brings the liner to the temperature necessary to prevent the first charge of metal getting a chill. The container does not require re-heating, as the liner remains red-hot after each run.

The working of this ingenious system of production will be best described from my own observations during a recent visit to the Delta Metal Works, Pomeroy-street, New Cross, London, where it has been in regular commercial operation for some time. Upon that occasion the machine was running on an order for Delta metal rods 12ft. long by 1in. diameter. Of course much greater lengths and much heavier sections are turned out as required. The great variety of sections produced, some of very intricate character, is shown by the specimens on the table. The specimens are samples of work ranging from light sections, such as wire weighing about $\frac{1}{100}$ lb. per foot run, to heavy rounds, hexagons, and squares weighing 40 lb. and over per foot run. The die in use on the occasion of my inspection had four openings, thus producing four lengths, or an aggregate of 48ft. of rod at the same time.

A charge having just been put through, the opening at the front end of the container—that next the die—was closed by a removable plate or stopper, as shown at Fig. 3, and the container was turned into a vertical position. A charge of 1½ cwt. of molten metal was then poured from a ladle into the container, and was allowed to stand for about six minutes, so as to acquire a plastic condition. The diameter of the plunger and that of a loose block which is placed between it and the charge—for a purpose which I will shortly explain—being less than the diameter of the steel liner, the plastic metal when under pressure would be forced backwards between the block and the liner were it not restrained. In order to prevent this back-flow taking place, a dished steel check disc, which is less plastic and more rigid than the heated metal at the working temperature, is first placed on the top of the charge, and when the pressure is brought on the disc is expanded, and completely fills the bore of the liner, thus effectually preventing the back-flow of the metal.

Upon this check disc was then placed the loose steel block just referred to, which, having been previously heated, prevents the cold end of the plunger chilling the charge of metal. The plunger being of smaller diameter than the liner, there is no fear of the latter becoming chilled by the former. To preclude the possibility of such an occurrence, the back of the loose block is recessed to receive a corresponding projection on the front end of the plunger, which is thus kept horizontal in its forward travel, and prevented from coming in contact with the liner.

The loose block having been inserted, the container was brought into a horizontal position, the stop plate removed, and the container run up to the die block, which, with the die, had been previously heated. The hydraulic pumps were then started, and in four minutes the charge was expelled and had become converted into four 1in. rods, each measuring over 12ft. in length. The clips were then released, and the ram continued its forward travel, pushing out the remaining metal or stump, together with the die and its holder, as well as the check disc and the loose block, leaving the container perfectly clear for a fresh charge. The rods were at once cut off from the stump or fag end of the charge to the exact length required and removed. The die and holder were then replaced by others, the container turned over into a vertical position, the stopper fixed in place, a fresh charge of metal teemed in, and as soon as it had become plastic the operation of pressing was again proceeded with. I may mention that the rate of travel of the ram can be varied to suit the size of the charge or the special nature of the output.

With regard to the physical characteristics of the bars thus produced, it is obvious that, owing to the great pressure put upon the metal, its quality must necessarily be greatly improved, in the same way that Whitworth steel is improved by compression. In the first place, it is found to be perfectly homogeneous. The actual increase of strength in extruded bars over that of hot rolled bars of the same metal varies with the nature and composition of the metal or alloy. Taking ordinary yellow metal, the increase in tensile strength is 24 per cent., with a proportionate increase in elongation. Some tests made at Woolwich Arsenal with Delta metal bars produced by extrusion show a tensile strength of 48 tons per square inch, with 32·5 per cent. elongation on 2in., against 38 tons per square inch tensile strength, and 20 per cent. elongation of rolled bars of the same metal. The samples exhibited have not been touched since they left the dies, and it will be seen that the surfaces are perfectly smooth, and that the various specimens require no further finish.

I have stated that at the time of my visit the mode of procedure was to charge the container with molten metal. The objection to this method of working is the delay occasioned at the press in waiting for the molten charge to set or become plastic, besides which there is the time occupied in various detail operations attending the charging of the container with molten metal. The result is that the average rate of working is only twenty-five charges per day of ten hours. This method of working has since been improved upon by Mr. Dick, and the container is now charged with billets after they have been heated to the point of plasticity in the furnace seen on the left in the view. With this method of working the output is doubled, easily reaching fifty charges and more per day, the labour cost per ton on the finished work is very small, being only the wages of two men and a boy per machine.

A larger press is also in course of construction which will have a 20in. ram, and will be capable of turning out heavier work than any yet produced. Besides being in operation at the works already mentioned, the system is being worked under licence in the Midlands, and it has also been adopted in the Delta Metal Works at Düsseldorf.

It will thus be seen that we have, if not a new industry, at any rate a new industrial process, and one, moreover, which is of far-reaching importance. Having accomplished so much, it is not outside the bounds of possibility that, given an improved

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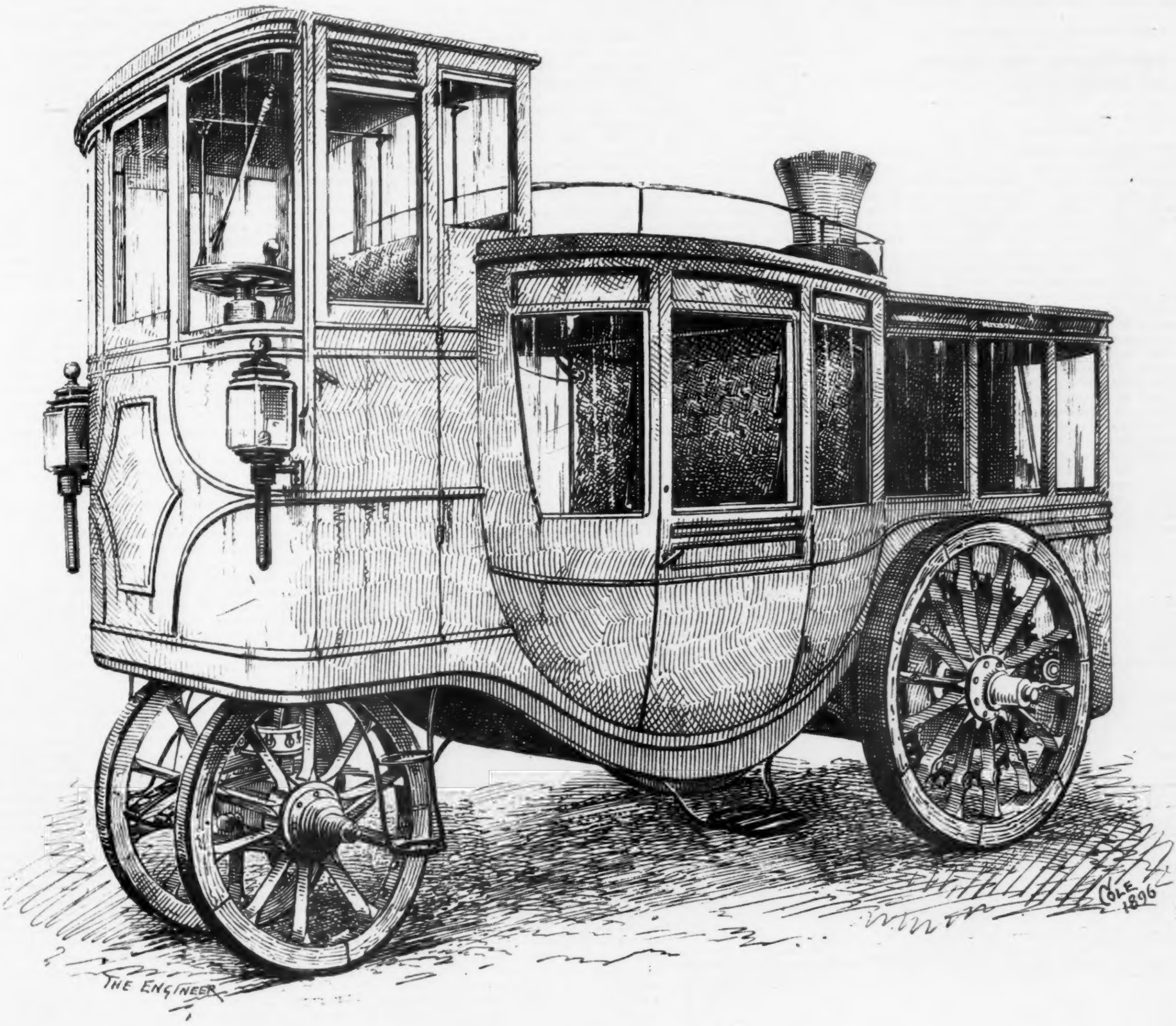
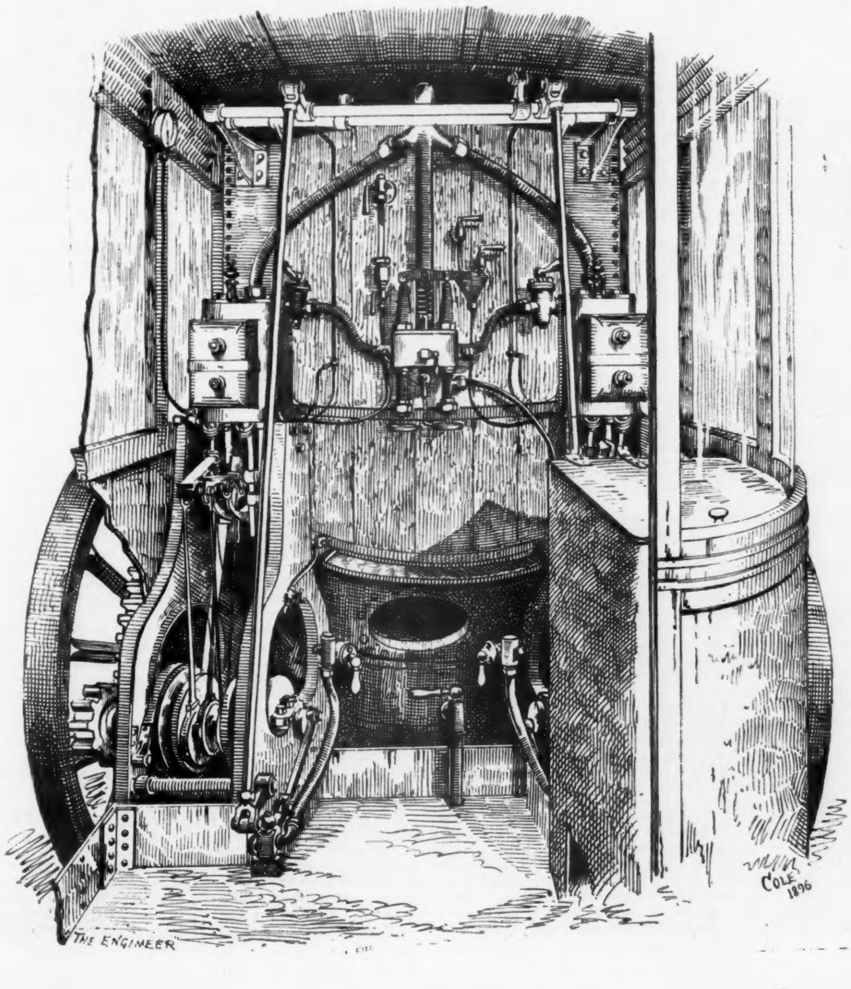
* Paper read before the Iron and Steel Institute, May 7th.

THE CRYSTAL PALACE EXHIBITION—THE RANDOLPH STEAM COACH, 1872

(*For description see page* 461)


COLE 1896
THE ENGINEER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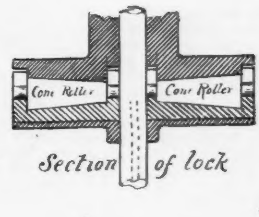
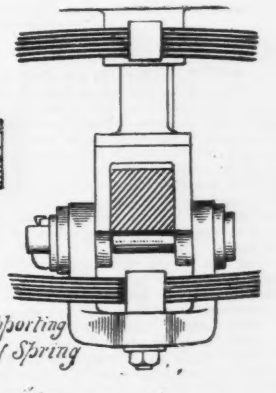
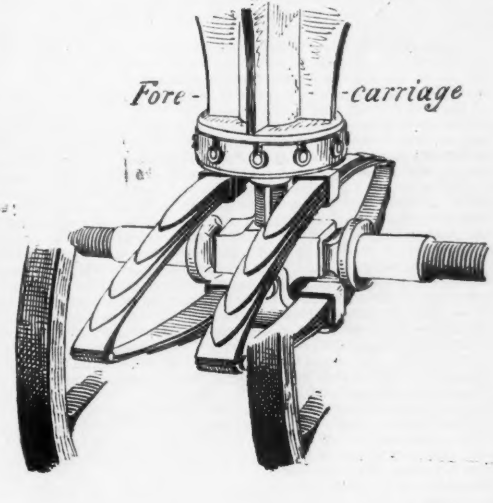

Cone Roller
Cone Roller
Section of lock


Stirrup, supporting lower arm of Spring


Fore-carriage

description of steel or other metal for the dies, other metals, such as iron and steel, which are less ductile and less expensive than those to which the system is at present applicable, may be used for the production of a still wider range of articles by extrusion. As a matter of fact, Mr. Dick is at the present time engaged upon experiments with the view of producing sections in iron and steel similar to those exhibited. Should he prove successful, I shall hope to have the pleasure of placing the results before the Institute.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

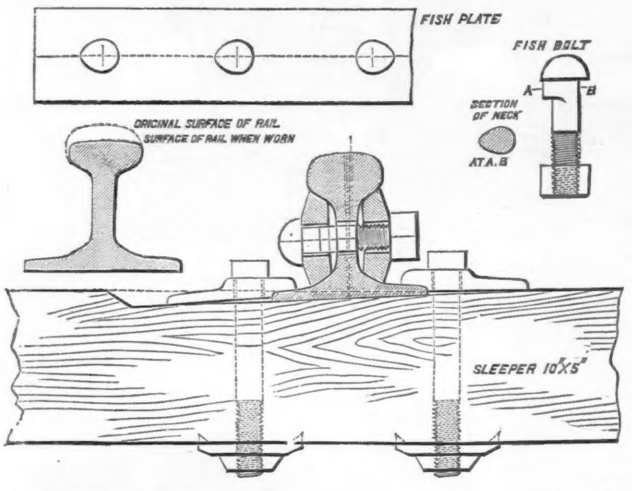
PERMANENT WAY.

SIR,—To the many communications which have been appearing of late in THE ENGINEER perhaps the addition of the following may not be found uninteresting. In the year 1870 the construction of a short branch, called the Taff Bargoed Railway, was committed to the late Mr. Edward Wilson and myself by the Great Western and the Rhymney Railway Companies, as joint owners of the line. At that time iron was very dear, and it was thought desirable by the committee to economise as much as possible in the use of that material. At that time the double-headed rail with cast iron chair was the prevailing form, although the bull-head was already coming into favour. To carry out the wishes of the committee, we decided to recommend the use of the Vignoles rail, whereof I enclose a full sized section, showing also the method adopted of placing it upon the sleeper. The rails were of Bessemer steel, but at that time the steel produced by the manufacturers was not considered so trustworthy as it is now found to be; in fact, it was thought liable to break off short in very unaccountable ways, particularly at places where the grain might have been interfered with by bolt holes or otherwise. It was, therefore, determined to have no holes or notches in the bottom flange of the rail, but to fix it on the sleeper by means of clips as shown on the drawing. The bolts, ⅞in. in diameter, were made to pass through the sleepers close to the edge of the rail, so that the clip has the greatest possible leverage on the rail to prevent canting.

The bolt heads were made square to enable them to be screwed by a key from the upper side of the sleeper, and the nut on the under side was made 3½in. square and perfectly flat so as to have a good bearing upon the sleeper, with the corners turned up sharp so as to go into the wood and prevent turning.

The sleepers were of Baltic redwood, creosoted, measuring 10in. by 5in.

The foot of the rail was 5in. wide, so that the bearing surface upon each sleeper was 10in. by 5in. = 50 square inches. The seat of the rail was slightly bevelled by adzing the sleeper so that the inside edge of the rail lay about ⅜in. below the level of the top surface of the sleeper, while the other edge lay upon the surface. By this means a slight cant inwards was given to the rail. This cant was on both rails alike and independent of the super-elevation usually given to the outside rail on a curve. The joints were protected by fish-plates of the most ordinary form and size, fastened by bolts 1in. in diameter of the form shown on the drawing. It will be seen that when first laid the under side of the clip is about ½in. clear of the upper surface of the wood of the sleeper. In the course of using the rail sinks into the sleeper, and the clip is made to follow it by screwing down the fang bolt that holds it, and when the sinking has gone so far as to bring the clip down to the wood it is removed and the seat adzed down so as to restore the original clearance.



Upon the branch railway where this arrangement is used the traffic, mostly coal and ore, is worked by tank locomotive engines weighing with coal and water 56 tons, and about forty trains per day run over each line of rails at a speed of from ten to forty miles per hour, though possibly a forty-mile speed may not often be attained. In practice it has been found necessary to re-seat the clip after eight or ten years' use of the way, after which it has hardly been found necessary to re-seat again during the life of the sleeper. The average life of the sleepers in the main way may be taken to be about fifteen years, though some are still in work after twenty-one years.

On straight roads, one fang bolt in each sleeper on each side of the rail is used; but in order to prevent spreading, a second bolt is introduced on the outside flange of the outside rail in all curves under 15 chains radius, although, in truth, very little tendency to spread has been noticed, possibly on account of the rail very soon embedding itself in the sleeper. And it is not found, in taking up an old road, that the fang bolts have in any way widened the hole in the sleeper; but a slight indent is sometimes found on the flange of the rail, and a corresponding indentation on the side of the bolt, say $\frac{1}{16}$in. deep. The weight of the rail is 80 lb. per yard, of the fish-plates 22 lb. per pair, of the fish bolts about 1¼ lb. each, and of the fang bolts with clips 4⅜ lb. each. On account of the strength of the bottom flange of the rail, or, rather, because of the inequality between the bottom flange and the head, it is found difficult to bend these rails cold, and care has always been taken to get a due proportion of rails bent to various curvatures while hot from the rolls, at the same time one-half of each lot of bent rails is cut a little shorter—say, an inch more or less, according to circumstances—to account for the difference between the lengths of the inside and the outside rails on curves. The average length of the rails is 30ft., and eleven sleepers are used in that length; the sleepers on each side of each joint being placed 2ft. apart centre to centre, and the intermediate sleepers 2ft. 9½in.

The road thus made has been found quite strong enough for the work it has to bear, though it is possible that if greater speeds and heavier locomotives were required for the traffic it might be thought necessary to add to the weight of the rail, and perhaps to the size or number of the sleepers.

Upon the road here described the trains are found to run very smoothly, and possibly all the better for the absence of hard cast iron chairs. Given the same weight of rail, of course the way is cheaper than a chair road by the cost of chairs with keys and cushions, which saving may amount to 3s. 6d. per yard. Also the way is found to be cheaper to maintain by about £25 per mile of single way per annum. I give a section of the rail when worn, showing by a dotted line the original form of the top. It is found that when the rail is thus worn, and removed from the main way—though fit to last for many years in station and standage sidings—the rail has lost about 12 lb. per yard of its original weight; yet when worn to that extent, though still in work, I have no recollection of any cases of breakage or other symptoms of weakness, unless that a little more packing may be required under the sleepers. Viewed as a girder the great strength of the bottom flange will probably account for this. Upon the whole, this form of permanent way proved so satisfactory on the branch where it was first used that it has been adopted as the standard system on the whole Rhymney Railway, upon which none of the original double-head rails now remain.

In laying the way the road bed was carefully made, the formation well drained, and the carefully selected ballast was clean and hard, contributing no doubt to the success of the way; but in truth no form of road can give satisfaction unless due attention be given to these points.

I have always here used wooden sleepers, and for them I have a preference on account of the easy running of the trains on them. Also, as long as good creosoted sleepers can be bought for 3s. 6d. to 4s. each, I think they will in the long run be found to be cheaper than those of steel at, say, 7s. 6d. each, while the outlay of capital in the first laying is to the extent of the difference reduced, which is often an important point in the early history of a railway. Thus, supposing the average life of the wooden sleeper to be fifteen years and of steel thirty, which is very doubtful, the difference in first cost added to compound interest on the same for fifteen years will give an amount sufficient to restore the road at the end of fifteen years. Beyond this, however, I have nothing to say against the use of steel sleepers, which no doubt are invaluable where timber may be scarce, or in many situations, as in India, where wood—except teak, perhaps—is quickly destroyed by the white ant and sundry grubs.

Cardiff, May 1st. CORN. LUNDIE, Engineer.

SIR,—Mr. J. Whitestone, in his letter in THE ENGINEER of the 17th, still harps on his pet theory of the rigid and uniform road, but he does not explain the reason why this kind of road proved such a terrible failure on the Manchester and Leeds Railway. He only refers to it as the "lathe bed."

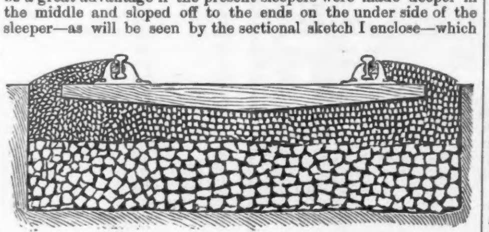
Mr. Jessie Hartley made parallel walls of granite quite uniform, straight, even, and rigid. The rails were bolted direct to the granite. It was a daily occurrence to have springs and tires broken owing to the excellent rigidity of the road.

The main point with Mr. J. Whitestone seems to be, firstly, to have a perfectly uniform line; secondly, to have it rigid. Now, I fail to see how a road could be more uniform than when the rock was dressed to a surface and more rigid than when the rails were spiked direct to the rock. This road, and also Mr. Hartley's parallel walls, seem to fulfil all that Mr. J. Whitestone requires, yet both these roads have proved—as all rigid roads must prove—a miserable failure.

He talks a good deal about the sleepers not being rigid enough, and then goes on to assume that the ballast has not sufficient stability, and recommends that stone ballast should be used instead; and says, in his opinion, steel sleepers should be used. I have used these steel sleepers myself in the Argentine Republic, and have seen the practical results with them. Mr. J. Whitestone seems to have had exceptionally good luck in his steel sleeper trials. I wish I could say the same. Steel sleepers will answer all very well where earth only is used, but where stone or any hard ballast is used they will not answer, as the difficulty of packing up these steel sleepers is very great, owing to their being hollow, and if they are not uniformly packed they are apt to buckle and break off the jaw which holds the key, and if only one jaw is broken the whole sleeper is useless until it is taken to the permanent way shop to have a new jaw put on. Not so with the wooden sleeper, which can have a new chair put on on the spot. I have tried these sleepers with broken brick, as stone is so expensive and brick is so cheap in the Argentine, and have found that the great amount of vibration caused by them works out the keys; this is not the case where earth only is used.

With regard to the springing of the sleepers, this is very slight as compared to the depression of the sleepers in the ballast. I should recommend that the sleepers should not be increased in thickness, but increased in width, so as to give more bearing surface to withstand the sudden pressure brought to bear on the sleepers under the rails.

Whilst on the subject of sleepers, I would propose that it would be a great advantage if the present sleepers were made deeper in the middle and sloped off to the ends on the under side of the sleeper—as will be seen by the sectional sketch I enclose—which would give it less bending tendency and would retard a good deal of lateral movement, and would act like an invert would to a culvert.



The hard wood sleepers that they use in the Argentine Republic, without any creosote or tar, and which is as hard as boxwood, and some harder, is used for the points and crossings, and by some railways entirely. With sleepers made with this kind of wood there is very little deflection, and a plain spike holds very firmly in this wood and does not get loose by time. I have seen a good deal of trouble experienced in taking out spikes to replace a broken chair. With sleepers made of this hard wood, as I suggest, and 12in. of good stone bottom ballast, and 7in. of stone top ballast, brought up over the ends of the sleepers to cover the keys, which keeps them from working out and protects the ends of the sleepers from the sun, and prevents a good deal of lateral play, with a 50 lb. chair for four spikes and a 90 lb. bull-headed steel 30ft. rail, properly packed and boxed, I feel sure we should have a road where there would be little need of complaint.

Stone ballast is the best; it has given the best results, and is largely used by the Great Western Railway. But there are some kinds of stone utterly unfit for railway ballast—for instance, a stone of a soft crumbling nature, which powders much, is very bad, as, in the first place, it binds too much and forms into too compact a mass, and then it is very bad for drainage, and in wet weather becomes very soft and absorbs a large quantity of water. Broken trap rock, however durable in itself, would pack to such an extent as to form into the condition of a solid ledge, which the rails would soon batter out. Limestone rock is quite durable, but it is of so binding a character as to pack too readily when used as ballast. Another class of stone which is unsuitable for ballast is slate rock; it is the poorest kind of stone, being rapidly decomposed in wet weather. A very suitable rock for ballast is gneiss rock; it is not hard, and breaks easily, thereby making it cheaper than hard rock, as rock for top ballast should never be larger than two cubic inches. On the Eastern Counties Railway they use broken sandstone, which, although soft, is preferred as affording an easy road.

A casual observer, passing by sleepers packed with a ballast which does not drain properly after rain, would not see much amiss with the road, but should a train pass by whilst he is there, he will see that each sleeper will go up and down with a hammering noise as the wheels pass over them, squirting out liquid muddy water, which after a time washes away the ballast from under the sleeper; the rail brings the chair and sleeper up to the level again after the wheels have passed. When the road gets into this state, if not discovered, it often remains like this for some time, and obliges one to open up the road until it is dry. Nothing is more fatal to a good road than a ballast which will not drain the road properly. A good ballast to a road is like a good foundation to a house, and no matter however good our superstructure is, we shall never obtain a good foundation with ballast which does not drain properly, and which has not sufficient elasticity. To my mind there is not sufficient attention paid to this serious question by the head engineers of railways, and the ship is often spoiled for a halfpenny worth of tar.

I think there can be little doubt that single driving wheel express engines try the road much more than four-wheel coupled engines, as the weight in the latter is more equally distributed than in the former, which have on some lines as much as 18 tons on the driving wheels only; and as there is more demand for increased speed—and these engines seem to be favourites for this—there is likelihood of this trouble increasing, as more speed means more power, and in the single wheel it is no good to increase the power without increasing the adhesion, which means more weight on the drivers.

Mr. Rose in his letter suggests what he calls an altered form of permanent way, but which is a mixture of the old longitudinal road of the G.W.R., which they have condemned and are doing away with, and the present sleeper road. Mr. Rose says that the rail is to be a Vignoles rail, and is to be fastened to the longitudinal by coach screws, which are not so firm as the old bridge rail of the G.W.R., which was held down to the timber by a fang bolt, which did not hold it at the edge as the coach screw would, but passed through a hole in the rail. He then says that there are to be ten sleepers in a 30ft. length, which will bring the sleepers 3ft. centre to centre, and give a clearance of 2ft. 2in. between the sleepers—that is to say, with 10in. sleepers. Additional sleepers are then to be driven in, which, with a sleeper of 10in. wide, will reduce the clearance of 2ft. 2in. to 8in., which would make it impossible for a navvy to beat up the road properly, as there would not be room enough horizontally for his beater to work. The lateral pressure brought to bear on the rail, especially on curves, breaks the jaws off the chairs, which breakage is very much on the increase on lines which key on the inside. The system of inside keying is too rigid for the class of cast iron chair we frequently have to use now, which is often made of mixed scrap, and is a very poor sample of cast iron. Where the road is keyed on the outside, a yielding substance receives the blow. This is why Mr. Barlow's wrought iron key did not answer, being too rigid. I wish we had cast steel chairs; then the large amount of broken chairs would be considerably reduced, and we should have made then one good step in the right direction.

The material of a permanent way does not go through the severe tests that material does for locomotives. And why should it not? How are we to tell what kind of material we are using unless? I have seen a 5in. bull-headed steel rail break clean through, not more in any place than $\frac{3}{16}$in. out of square. Then, again, look at the amount of fish bolts that break off in screwing up, all due to inferior material. Grover's washers for fish joints is a capital invention. If they were used more universally, we should run less risk from nuts working loose. I saw an experiment tried on a West of England line with Grover's washers, with bolts which had loose nuts on them. They were put to a joint on the main line, and heavy and fast express trains passed over the joint, and the nuts never worked loose. The joint was carefully watched during the trial.

Mr. Samuel and Mr. Adams invented a special chair for the rail joint, and I had fish-plates with a flange at right angles to the web of the rail, with holes in it intended to spike down on top of an extra large sleeper; but they have all proved a failure on account of the want of elasticity. The best kind of joint is the suspended joint, with Grover's washers and fish-plates, which nearly meet under the rail, and, where the sleeper is put as close as possible, each side of the joint, without interfering with the driving home of the keys. The Barlow saddle-back wrought iron rail, and the iron longitudinal system tried on the G.W.R., have proved a failure because of their rigidity.

I could bring forward a great many instances of failures of rigid roads, as I have tried a great many patent metal contrivances for permanent way, but have already taken up too much valuable space. F. J. P.

SIR,—Although "there is not the least likelihood that railway companies will make any change whatever in the methods of construction"—as stated in your leading article of the 1st inst.—I take it that this implies, not an absolute bar to all future progress, but only that the type of track consisting of bull-headed rails in chairs supported by transverse sleepers is now firmly established.

From the time when the correspondence in your columns commenced with my letter, published in THE ENGINEER of October 11th last, I have consistently maintained that this type is the best, not only for the heavy lines of this country, but for railways both heavy and light in all parts of the world; and further, that modern English practice, excepting the matter of sleepers and ballast, leaves little to be desired.

I suppose that a sense of proportion is especially necessary in engineering; but when it is remembered that, whilst the weight and stiffness of rails have been greatly increased within the last thirty years, we are still using sleepers of identically the same pattern as was common before the beginning of the period, some want of due proportion may be inferred. It is true that some railways have adopted a 14in. by 7in. sleeper; but other railways, with faster traffic, retain the 10in. by 5in. section with about one quarter the stiffness, and it is difficult to believe that both are right.

Then, as to the material itself, the elasticity of sleepers of the same size, and the same kind of wood, varies more than 50 per cent., as shown by direct experiment; and as the rails and sleepers have to work together, it seems hard on the former to have such unreliable partners. One of your correspondents has asked what we should think of cast iron rails now. Some time hence a similar question will be asked concerning wooden sleepers.

I suggest that the whole of the parts and materials comprised in a railway track ought to have some rational correlation to each other, both in quality and design, and that this is not the case at present. Moreover, the tendency is still to aggravate the disproportion by further increasing the stiffness of the rail without reference to the sleepers, which ought to be improved, *pari passu*, with the rails.

The early fathers of railway engineering used wood for sleepers, as well as bridges, because they had no knowledge of steel as it is known now, with its almost infinite adaptability to different requirements, and its low cost. The arguments I have advanced in your columns in favour of steel sleepers, regarding both efficiency and economy, have not been refuted, and steel sleepers have not yet received a fair trial in this country. Those used have been made of uniform section throughout, thus imitating the wood sleeper in one of its essential disadvantages; they have been laid in the most unsuitable ballast; and last, but not least, the means of attachment of the bull-headed rails to the steel sleepers have been far from perfect.

The admitted excellence of English track is only secured by an extravagant outlay on maintenance, and a constant vigilance, the least relaxation of which may, as we know, lead to disaster. It is to improvements in sleepers and ballast that attention should now be directed, and I hope that the discussion in your columns may result in more consideration being granted to the substructure of the track, with advantage to both the railway companies and their clients.

JAMES WHITESTONE.

113, Queen Victoria-street, E.C., May 5th.

THE ORIGIN OF THE BESSEMER PROCESS: HOW FACTS ARE MANIPULATED.

SIR,—It will be within the recollection of your readers that in my reply to the statement made by Mr. J. D. Weeks to the American Institute of Mining Engineers—in which he claims for a Mr. Wm. Kelly the originality of the Bessemer process—that I pointed out the fact that one of his witnesses, Mr. John E. Fry, gave us very minute details of the preliminary stages of Kelly's process, even to describing the kind of trolley on which the ladle of metal was conveyed to the apparatus, and how the metal was "dumped" into the open furnace, across the top of which pieces of sheet iron were laid to prevent the sparks flying too freely. I then went on to say, "And here the evidence stops short, for it is clearly not worth their while to pursue the subject any further, it would be dangerous to do so—it would, in fact, 'let the cat out of the bag.' These discreet witnesses have given all the very interesting details as to the 'dumping' in of the molten iron, even to the kind of 'little hauling car' which conveyed the metal to the apparatus; but it would have been infinitely more to the purpose if they had told us something about the way in which this metal was taken out, in what state of partial or complete solidity was it obtained, and whether it was soft malleable iron or hard and brittle 'plate metal.' They have told us nothing of the use of ingot moulds, in which the malleable iron must be made into ingots; they have told us nothing of the treatment of the metal after it was blown. Was it taken to the puddling furnace to be there converted into wrought iron, or was it rolled into bars or sheets from ingots formed while in a fluid state? Without all these essential facts, all their testimony and affidavits are worse than waste paper, as they directly prove nothing; but the absence of these facts affords very strong circumstantial evidence that Kelly never had produced homogeneous malleable iron, and had never made an ingot by his process."

Now it appears that Mr. Fry was not guilty of this suppression of facts, for in a two hours' conversation with Mr. Weeks, Mr. Fry states that he gave him vivid personal recollections antagonistic to his views, and the drawing he supplied proved that as late as the year 1858—two years after Bessemer's patent—"Mr. Kelly's experiments and ideas had not progressed beyond the operations of the finery fire."

The letter accompanying these remarks shows that Mr. Fry was not guilty of this suppression of important facts, which went to show that up to 1858—two years after my patent—Kelly's experiments had not progressed beyond the operations of the "finery fire." Mr. Fry also gave Mr. Weeks an article published in the year 1894, in the *Johnstown Daily Democrat*, written by Mr. Fry, and which he says, "gave what I believe to be the very first public announcement of Mr. Kelly's absolute failure to accomplish anything that could give ground to his claim of being the inventor of the pneumatic process of converting cast iron into its malleable products."

It is, then, not Mr. Fry who was guilty of this wholesale suppression of the truth, of which he says Mr. Weeks had full knowledge, and which he had derived from sources chosen by himself.

The honourable and disinterested love of truth and fair play which has prompted Mr. Fry to send me the following account of his long interview with Mr. Weeks, shows how worthily Mr. Fry has risen from the ranks to the honourable position of manager of the great Cambrian Steel Works.

HENRY BESSEMER.

5417, Penn Avenue, Pittsburg, Pa., U.S.A.,
April 20th, 1896.

Sir Henry Bessemer, London, England.

Esteemed Sir,—Your letter to the technical press of England, in reply to Joseph D. Weeks' address to the Am. Inst. Mining Engineers in session at this city in February last, has been read by me as published in the London ENGINEER of 20th ult. I have no desire to take part in the controversy which naturally follows a resurrection of this long buried question of priority of invention of the Bessemer process, but only share the desire of all fair-minded persons that facts, rather than personal prejudices and interests, may be made matters of history.

In your letter referred to above, you re-quote a quotation by Mr. Weeks, which he credits to an interview he had with me a few days prior to the delivery of his address to the Institute. Your reference to the quotation indicates that it ended abruptly because I, one of Mr. Weeks' witnesses, had something to suppress as to the outcome of the experiment, which would not be favourable to the views of Mr. Weeks as to the late William Kelly's claims to the invention in discussion. It is to advise you that the suppression was by Mr. Weeks, and not by me, that I now recite to you the facts of the interview referred to, and others germane to the discussion.

While Mr. Weeks was preparing his address he sought data by application to Mr. John Fritz, who was General Superintendent of the Cambria Works, at Johnstown, Pa., at the time Mr. Kelly went there to conduct his experiments. Mr. Fritz had no recollection of the events relative thereto, beyond having detailed me to assist Mr. Kelly in every way by assembling such materials as he required and to collaborate with him in his experimental work. Mr. Fritz therefore referred Mr. Weeks to me for data of Mr. Kelly's experiments. At Mr. Weeks' request I called at his publication office in this city, and the interview lasted two hours. During this time I gave him my quite clear recollection of what Mr. Kelly tried to do, what he did, and what he failed to accomplish which he hoped to do. Also I gave him a drawing, made by one of our shop hands at the time, of Mr. Kelly's apparatus of year 1858, which drawing Mr. Weeks designs having engraved for future publication, if it can be made to fit his side of the discussion, which I believe it will not. Moreover, I gave him a copy of a publication issued in Johnstown, Pa., in the autumn of 1894, in which was printed an article written at that time by me under caption of "The Bessemer Industry, Johnstown's Contribution to it."

My interview with Mr. Weeks gave him vivid personal recollections antagonistic to his views. The drawing proved that as late as the year 1858 Mr. Kelly's experiments and ideas had not progressed beyond the operations of the "finery fire," and the printed article gave what I believe to be the very first public announcement of Mr. Kelly's absolute failure to accomplish anything that would give ground to his claim of being the inventor of the pneumatic process of converting cast iron into its malleable products, or in substantiation of the rather vague claim allowed him in his first patent, issued subsequent to the issue of yours in this country.

Now, with this presumably trustworthy testimony at his disposal, Mr Weeks suppressed all except the insignificant extract he quoted relative to Kelly's first apparatus at the Cambria Works, and which you very properly characterised as incomplete reference to the first Kelly experiments there.

On October 24th, 1894, I mailed to you a copy of the Johnstown publication above referred to containing my article which must have miscarried in the post or you would have known that my views were diametrically opposed to those of Mr. Weeks, for in it I made as plain as circumstances would warrant that Mr. Kelly was copying your methods as fully as his limited sources of information enabled him to do, and that he was doing only that. I herewith enclose the folio of the Johnstown publication referred to containing my article, and it should convince you that I am not "one of Mr. Weeks' discreet witnesses" your letter to the press assumes me to be in the sense that I wilfully suppressed the fact of Mr. Kelly's absolute failure in his experimentation at Cambria Works.

In justice to myself I beg to inform you upon what grounds I presume to be considered a competent commentator in reference to the matter in question. I worked with Mr. Kelly, first and last, at the Cambria experiments. I am the chief living witness of his work, and the person to whom he freely confided his hopes of success and fears of failure. Later, beginning in 1871, I worked and studied assiduously for the development of the process, then practically in its infancy in this country. The Cambria Works made such progress in those days as astonished the world. In 1877 A. L. Holley, R. W. Hunt, of the Troy, N.Y., Works, and R. W. Jones, of the—Carnegie—Edgar Thomson Works, united their efforts to induce me to limit the output of the Cambria Works to the product of that time, on the ground that "further quantitative progress would congest the market for steel and ruin the business." Needless to say the proposition was declined, nor that they all experienced a change of view of the market later on. I was manager of the Cambria Steel Works at this time and during the years prior to 1882, when they were producing more Bessemer steel than any plant of similar converter capacity in the world. I have been a leading exponent of the process here in its encroachment upon the field of the open-hearth in the manufacture of special steels, and especially in sustaining it against the assertion of many notable authorities that "its irregularity of physical behaviour unfitted it for structural work." The steel in the superstructure of the Brooklyn Bridge—East River, N.Y.—made at Cambria was a sufficient answer to such. I have been in close touch with the process up to to-day in its most advanced development, and these experiences, with a keen recollection of events, should qualify me as a fairly trustworthy witness. All my friends know me as such and as a frank one.

Mr. Weeks took advantage of me in his misuse of the short quotation referred to. This was misleading to you, as to others, hence your intimation of my holding opinions prejudicial to the facts and consistent with Mr. Weeks' argument adulatory of Mr. Kelly. Naturally I feel that your reference to me as a biassed witness is an unmerited reproach. If almost a lifetime of service to employers faithfully performed, does not entitle me to a reputation for honesty and integrity of expression, then I have lived and laboured in vain.

Respectful consideration for the memory of those who have passed away demands as considerate reference to their achievements as words at command will give expression. It is beautiful and dutiful to only speak kindly of the dead. In the accompanying article I have kept these considerations in view.

The question as to whom the credit of the invention of the pneumatic process is due has, in my opinion as in yours, been settled in your favour beyond controversy. It seems ghoulish work to resurrect it now, after its forty years of sepulture, in any effort to advance undeserving interest. In my humble opinion, Mr. Weeks, as the President of the Am. Inst. Mining Engineers, made an impolitic choice of subject for his address, especially considering the material at his command represented in this city by manufacturing establishments in sight and hearing of his distinguished audience.

I know that it is one of the careless ways of a selfish world that credit is not only not given when due, but is too frequently withheld, and misconferred. A consciousness of duty well done to our fellow men must be the compensation in such instances. But only pure selfishness prompts the theft of others' achievement. Needless to add that pure selfishness is not a rarity, and few live to maturity who do not experience its adverse influences.—Respectfully yours, JOHN E. FRY.

HORSELESS CARRIAGES.

SIR,—As to my mind the purpose of mechanically-propelled vehicles is more or less to supersede the use of horses on common roads, it seems to me absurd that one locomotive vehicle is to be prohibited from drawing another.

It is almost a necessity in every country establishment to have half a dozen different carriages for the various requirements of every-day life, but it would be absurd to have a different pair of horses set apart for each, though this is apparently what will be required of persons employing mechanical instead of animal traction, if the Locomotives on Highways Bill now before Parliament is passed in an unamended form.

The locomotives must necessarily be expensive, and half a dozen will be quite beyond the means of the average private individual, in which case it will be necessary for him to keep up the usual stable of horses, in addition to whatever type of "autocar" he might choose to select.

My idea would be to keep one, or at most two, light locomotives capable of being attached to the present form of carriage. The most simple way of doing so would, to my mind, be to remove the forewheels and lock of an ordinary four-wheeled carriage and drop the pivot socket on to a hook in rear of the locomotive, in the same way that the trail of a field-gun is attached to its limber. In this way the whole length of carriage and locomotive would certainly not exceed that of a carriage and its pair of horses.

It would, I think, be much more reasonable to limit the length of the locomotive and its charge—or locomotive alone — to, say, 20ft. than to make it a hard-and-fast rule that no two vehicles are to be attached together, which prohibition would inevitably lead to much inconvenience. There may be difficulties in my suggestion which I have not foreseen; still, I feel certain that the clause referred to ought to be amended in some way or other, as otherwise the benefits of your enterprise in assisting the promotion of the Bill will be very much impaired.

May 3rd. A COUNTRY GENTLEMAN.

ELECTRICAL COLONISATION.

SIR,—I am indebted to "Rural" for bringing the proposal of Earl Russell and Mr. B. H. Thwaite, C.E., under notice. I find that the article referred to by "Rural" is in volume xx., 189-23, of the *National Review*, under the title of "Electricity in Country Houses." After very carefully perusing the article, and I may add with much interest, I fail to discover how the proposal contained therein affects the novelty of my scheme of electrical colonisation; in fact, although the object aimed at in both proposals is analogous, yet the proposed schemes are of an opposite character.

The proposal of Earl Russell and Mr. Thwaite is explained by the following extracts from the above article:—"The Lauffen-Frankfort demonstration proves that, by co-operation, residents in the country within an area comprised in a circle of from ten to fifteen miles may have in each house the modern resources of electricity at their service. It has been shown that electrical energy can be transmitted over a distance of 110 miles with a loss of only some 28 per cent. For the longest distance in a fifteen miles area, there would be only about one-seventh of the loss. Our proposal is that the owners of country houses should combine for the purpose of establishing at some fixed place—say near a railway station—a station at which to generate the force. At the station a steam engine, or a fuel gas engine, would drive two alternating dynamo machines. The pressure of the current would be reduced at each house to the measure appropriate to the character of the work to be done."

My electrical colonisation proposal is to group, say, a dozen residences adjacent to a central tower; the latter to contain three tanks or reservoirs, which may be designated the storage, distribution, and discharge tanks; the storage tank to be elevated a considerable height above the top of the residences, and may be charged from public domestic supply main, or from natural head, or the water may be pumped into it. The head of water from this tank is available for working water motors driving dynamos for the generation of electricity for lighting, heating, and motive power purposes in the residences, the motor dynamos to be fixed above the top of the discharge tank, the exhaust water flowing into same. The discharge tank to be elevated a few feet above the level of the ground floor, for supplying the lower portion of the residences with water for domestic purposes.

The distribution tank to be at an elevation about level with the top of the residences; this tank can be charged with water from the discharge tank with an electrically driven centrifugal pump, and is available for supplying the upper portion of the residences with water. The storage tank is available for extinguishing fires in the residences. The residences are to be specially designed for electrical equipment; not only is it intended for the lighting and cooking to be effected electrically, but fire grates and chimneys will be substituted with radiators, and the main staircase would be superseded with a simple screwed electric ram lift; a light line shaft, motor driven, to be provided for operating the washing and cleaning appliances for reducing physical exertion.

In suburban districts of most cities and towns the public supply main has a pressure of from 15 lb. to 40 lb. per square inch, and this source of energy is mostly wasted, excepting in the case of high buildings and elevated districts. Now with my scheme the storage tank can be charged direct through the meter, and the head of water is then available for generating electricity at an efficiency of at least 70 per cent., and the water is still available for domestic use. The storage tank dispenses with the need of storage batteries, and is available for giving a large quantity of power as required at intervals, the charging going on continuously. This system requires the minimum of attention, is noiseless in working, and has no waste products. Of course in districts where supply mains do not exist, a pumping plant could be adopted to charge the storage tank, and even then the arrangement would be comparatively economical and convenient.

From a public supply main, with an average meter charge of 8d. per 1000 gallons, electricity could be generated for less than 2d. per unit, and the water still be available for domestic purposes. My proposal is for one ownership to possess the colony, and to let the residences upon defined terms; the tenants would pay rent and electricity charges in lieu of rent, coal, gas, and water rates in ordinary residences. This system would facilitate the use of horseless carriages electrically propelled, which could be charged at periods when the demand for electricity is low for domestic purposes.

Now I should like to ask "Rural" where does the idea of colonisation come in the proposal he refers to? To colonise is to create, plant, or establish, and that is the essential feature of my scheme of electrical colonisation, whereas the proposal he refers to is one of provision only, having for its object the providing of electricity to country houses, and the scheme if worked out would resolve itself into a public supply scheme as established in many cities and towns, and many would be the difficulties to surmount in obtaining provisional orders for the distribution cables, and in getting the majority of property owners to share the responsibility of the undertaking. My proposal removes all these difficulties, and narrows the scheme to simply a matter of tenancy under defined conditions of a fixed rent and minimum charge for electricity, with meter registration for maximum quantity of current used.

The statement of "Rural" in questioning the novelty of my proposal of electrical colonisation cannot be substantiated from the source to which he has referred.

THOMAS MEACOCK.

Birmingham, May 5th.

ROLLED STEEL v. CAST IRON CHAIRS FOR RAILWAYS.

SIR,—It does not often fall to the lot of a correspondent to evoke such unanimous expression of opinion regarding the merit of a question as to give birth to a leaderette, for which I feel highly flattered, and so are the platelayers.

This emboldens me to again address you. You, Sir, hold that "It is mainly a question of expense." I have made inquiries which enable me to assert, positively, that the first cost of the new patent rolled steel chair for main line will effect a saving of 3d. per chair, which on a mile of railway means 8000 chairs and represents £100. It is not too much to expect that the life of the steel chair will be more than double that of the cast iron one. Those in authority who have gone into the question will be able to say whether my assertions are well founded. Many other advantages are apparent to your readers in favour of the steel chair, which I need not further refer to.

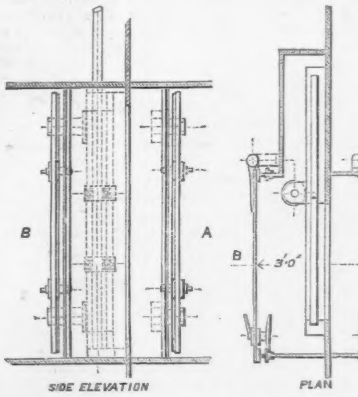
FOR THE PLATELAYERS.

Langside, Glasgow, May 4th.

WATER-TIGHT DOORS IN THE NAVY.

SIR,—As an outcome of the recent discussion on water-tight doors by the Institution of Naval Architects, and as water-tight doors often do not answer the purpose for which they are designed the accompanying sketch will illustrate what I would propose to fit below the water-line to more surely effect the keeping afloat a ship after one compartment has filled from collision, or otherwise.

Supposing the compartment on the right-hand side of sketch were full of water, door A would act, the pressure of water tending to keep the door shut and tight; if the compartment on the left, and supposing it to be the fore compartment of a ship, door B would act in the same way. It might be objected that the proposal involves the absorption of too much of the ship's space, but considering the number of lives at stake, it is worth the sacrifice. All the doors might be left open when there was comparatively little danger, but at night, when manœvering, or in fog, the hinged doors might be closed without fastening, being hung slightly inclined from the vertical so as to keep closed, but still allowing free passage for the ship's company, then in case of collision there would be plenty of time to close the main horizontal sliding doors.



Devonport. CHAS. W. ROWE.

CIRCULATION IN WATER-TUBE BOILERS.

SIR,—As I notice that the correspondence on the "Circulation in Water-tube Boilers" still continues, will you allow me to point out that the form of the ends or orifices of the water-tubes has a material influence on the circulation. To this fact attention has, I believe, not yet been drawn in the recent letters which have appeared. With the Yarrow boiler it has been the invariable practice to bell-mouth the upper and lower ends of the tubes. This is no doubt desirable in this type of boiler for purposes of strength; but experiments have shown conclusively that this bell-mouthing has a very marked effect in increasing the circulation, as all who are conversant with the laws governing the flow of water through pipes would expect.

F. W. CROHN.

14, Burney-street, Greenwich, May 4th.

LIQUEFACTION OF GASES.

SIR,—"Zero" kindly offers to give "Cryos" any information he can. Perhaps he will kindly tell us (1) how soon after starting the apparatus the gases begin to liquefy. (2) How much of the gas that is compressed, say per stroke, is liquefied during the time occupied by the same stroke. (3) At what temperature is the gas when it returns from the apparatus to the compressing cylinder say, the temperature on leaving the apparatus, and the temperature just before re-entering the compressing cylinder.

FRANK DOWLING.

CANALS CONNECTING THE THAMES, SEVERN, AND BRISTOL CHANNEL

(*For description see page 460*)

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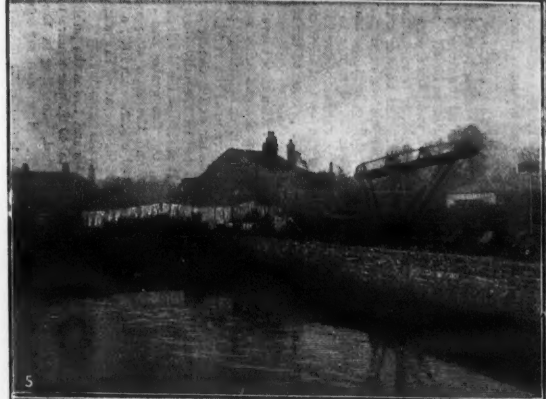
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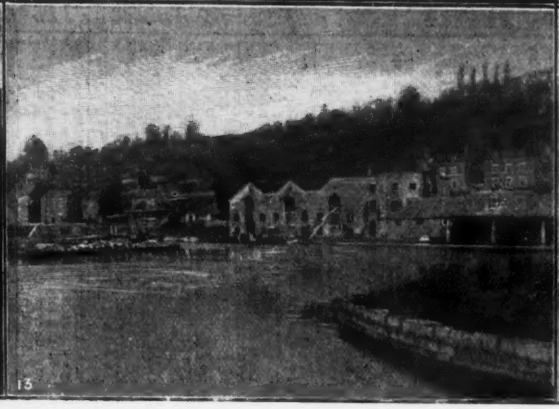
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FOREIGN AGENTS FOR SALE OF THE ENGINEER.

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TO CORRESPONDENTS.

Registered Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and bearing a penny postage stamp, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

A. A. W. (Norwood).—*It would be illegal to run a steam omnibus as you suggest between Anerley Station and the Crystal Palace. Inside the grounds the Palace Company may do as it pleases, but not outside.*

STUDENT.—*The stresses remain of the same size when the tie beam carries a floor, but the beam will be subject also to stresses as a beam between each of the supports and the vertical ties and queen posts. You will find your questions answered in any of the elementary books on roof trusses and girders, as, for instance, in Adams' handy book on stresses. See Molesworth's Pocket-book.*

DR. ANGUS SMITH'S COATING FOR PIPES.—*According to Mr. B. H. Thwaite, Dr. Angus Smith's method of protecting iron is most successful if effected as follows:—The ingredients consist of coal tar and pitch oil in the proportions of one part tar to three of oil. The mixture being heated to the boiling temperature of the oil, the castings are then immersed in the mixture, and allowed to remain in it until the same temperature is diffused throughout the mass. The castings are then gently withdrawn, the naphtha and other volatile oils evaporating and drawing off the castings, so that whilst still very hot, a firm, hard coating of pitch is left, which firmly adheres to the casting. Care should be taken to heat the mixture to a proper degree, viz., 350 deg. to 450 deg. Fah. If it is too hot the pitch will be overheated, and afterwards scale off. The castings should be newly from the sand, clean, and not rusty, or if rusty must be well scraped, and completely cleared of any rust coating. For description of the method see "Pipe Founding," by J. W. Macfarlane. London: E. and F. N. Spon.*

MACHINERY FOR MAKING UMBRELLA PARTS, HORN, IVORY, AND METAL BUTTONS, AND STEEL PENS.

(*To the Editor of The Engineer.*)

SIR,—We shall esteem it a favour if any of your readers can give us the names of manufacturers of machinery for the manufacture of (1) umbrella parts; (2) horn, ivory, and metal buttons; (2) steel pens.

London, April 30th. J. H. H.

BOOKS ON RAILWAY SIGNALS.

(*To the Editor of The Engineer.*)

SIR,—With reference to the letter from "J. V. P.," appearing in your issue of the 24th ult., I beg leave to say that I have now in the press a work on "Railway Signalling." The book deals with every branch of signalling, contains nearly 500 illustrations, and will, I think, be considered complete. It will be issued during the present summer.

L. and Y. Ry., Manchester, May 5th. H. RAYNAR WILSON.

METAL PLATES COVERED WITH LINOLEUM OR THE LIKE, AND FURNITURE WITHOUT WOOD.

(*To the Editor of The Engineer.*)

SIR,—I understand that plates or sheets can now be obtained suitable for panels or other such purposes covered with linoleum, Lincrusta Walton, or other such material; and also that some furniture suitable for use on board ship is now made without wood. Can any reader give me the names of the manufacturers of either of these and oblige? C. D. G. S.

May, 1896.

BAGULEY'S LOCOMOTIVE ENGINE.

(*To the Editor of The Engineer.*)

SIR,—Referring to my letter in last week's issue, the locomotive is described as a compound. Such is not the case, it having two inside cylinders 22in. diameter by 30in. stroke, not a 22in. and a 30in. cylinder.

ERNEST E. BAGULEY.

Castle Engine Works, Stafford, May 5th.

SUBSCRIPTIONS.

he ENGINEER *can be had, by order, from any newsagent in town or country at the various railway stations; or it can, if preferred, be supplied direct from the office on the following terms (paid in advance):—*

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Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Three o'clock on Wednesday afternoon in each week.

Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, May 14th, at 8 p.m. Paper: "The Influence of the Shape of the applied Potential Difference Wave on the Iron Losses in Transformers," by Stanley Beeton, C. Perry Taylor, and J. M. Barr, students.

THE INSTITUTION OF CIVIL ENGINEERS. — Tuesday, May 12th, at 8 p.m. Papers to be discussed: "American and English Methods of Manufacturing Steel Plates," by Mr. Jeremiah Head, M. Inst. C.E. "Four American Rolling Mills," by Mr. Samuel T. Wellman.

ROYAL INSTITUTION OF GREAT BRITAIN.—Tuesday, May 12th, at 3 p.m. Lectures: "Ripples in Air and on Water," by C. V. Boys, F.R.S A.R.S.M., M.R.I. Thursday, May 14th.—"The Art of Working Metals in Japan," by W. Gowland, F.C.S., F.S.A. Friday, May 15th. Discourse: "Cable Laying on the Amazon River," by Alexander Siemens, M. Inst. C.E., M.R.I. Saturday, May 16th, at 3 p.m.—Lecture: "Three Emotional Composers," by F. Corder, Curator, Royal Academy of Music.

DEATHS.

On the 29th April, at Montague Mansions, Great Russell-street, London' PETER JOHN MARGARY, M.I.C.E., aged seventy-five.

"THE ENGINEER"
ROAD CARRIAGE COMPETITION.

FOR the protection of intending competitors at our trials of Horseless Carriages, we have made application to the Board of Trade for its certificate under the Patents, &c., Act, 1883. Our request has been granted, and the following certificate and extracts from the Statute speak for themselves:—

PATENTS, DESIGNS, AND TRADE MARKS ACT, 1883.

Upon the application of Mr. Sydney White, Publisher of THE ENGINEER, 33, Norfolk-street, Strand, W.C., made to the Board of Trade on the 22nd day of April, 1896, the Board of Trade do hereby certify that the Exhibition proposed to be held in the year 1896 at the Crystal Palace, Sydenham, in connection with THE ENGINEER Road Carriage Competition, is an Industrial Exhibition.

Signed by order of the Board of Trade this 29th day of April, 1896.

FRANCIS J. S. HOPWOOD,
Assistant Secretary Board of Trade.

The following are the sections of the Act referred to:—

PART II.—PATENTS: *Exhibition at industrial or international exhibition not to prejudice patent rights.*

Section 39.—The exhibition of an invention at an industrial or international exhibition, certified as such by the Board of Trade, or the publication of any description of the invention during the period of the holding of the exhibition, or the use of the invention for the purpose of the exhibition in the place where the exhibition is held, or the use of the invention during the period of the holding of the exhibition by any person elsewhere, without the privity or consent of the inventor, shall not prejudice the right of the inventor or his legal personal representative to apply for and obtain provisional protection and a patent in respect of the invention or the validity of any patent granted on the application, provided that both the following conditions are complied with, viz.:—

(*a*) The exhibitor must, before exhibiting the invention, give the Comptroller the prescribed notice of his intention to do so; and

(*b*) The application for a patent must be made before or within six months from the date of the opening of the exhibition.

PART III.—DESIGNS: *Exhibition at industrial or international exhibition not to prevent or invalidate registration.*

Section 57.—The exhibition at an industrial or international exhibition, certified as such by the Board of Trade, or the exhibition elsewhere during the period of the holding of the exhibition, without the privity or consent of the proprietor of a design, or of any article to which a design is applied, or the publication during the holding of any such exhibition, of a description of a design, shall not prevent the design from being registered, or invalidate the registration thereof, provided that both the following conditions are complied with, viz.:—

(*a*) The exhibitor must, before exhibiting the design or article, or publishing a description of the design, give the Comptroller the prescribed notice of his intention to do so; and

(*b*) The application for registration must be made before or within six months from the date of the opening of the exhibition.

THE ENGINEER.

MAY 8, 1896.

THE FIRE-BOXES OF LOCOMOTIVE ENGINES.

THE adoption of the Belpaire fire-box by Mr. Harry Pollitt in the engine we illustrated on the 20th of March and some thirty similar locomotives, has excited some attention and drawn forth some comment. The Belpaire box is extensively used on the Continent, and very little anywhere else. The M. S. and L. engine does not furnish the first instance of its use in Great Britain; but it has found scant favour in this country. The title is, however, used in a somewhat loose way. Any flat-topped external fire-box is called by the name; but the original Belpaire box was used with a special fire grate, and had its origin in the necessity for burning small, or slack, coal. Belgian locomotives have the largest grates in the world. Grates 10ft. long and 7ft. wide are not unknown, and grates 8ft. by 6ft. are almost common. The difficulty of supporting the enormous crown plate is apparent, although the precise figures are seldom stated, or the magnitude of the strains realised. The total load on a fire-box crown, with an area of 70 square feet and a pressure of 150 lb., is 675 tons. The crown of the fire-box of an English locomotive will have to carry only about one-third of this amount. To support the crown of the Belgian fire-box with bridge stays is out of the question, and even if it could be done, the top of the outer fire-box bent to a cylindrical curve being about 8ft. in diameter, would rise to a point higher than the tops of the coaches in the train. To meet the conditions nothing remained but to make the tops of the inner and outer fire-boxes flat, and to tie them together. The locomotive boilers in torpedo boats are always made in this way in order to save at least two tons in crownbars, and to keep the top of the boiler low.

Locomotive superintendents know by bitter experience that the boiler is *the* weak part in their rolling stock. The engines do not wear out; the wear and tear of tires is comparatively trifling; frames seldom break; when the permanent way is reasonably good the outlay on the renewal of springs is small. But from the moment the boiler is first used to the moment when it is relegated to the scrap heap it costs money for repairs and renewals. It is a never failing source of worry and expense, and the worst part of it all is the internal fire-box. If that gives way in no other place, then the mere friction of the fuel against the side plates cuts the heads off the screwed stays and wears the metal thin. All the rest of a locomotive may remain excellent for twenty years. That must be a good boiler, or one very lightly worked, that does not need careful overhauling and considerable repairs after being in use three years and making some 55,000 or 60,000 miles. We have, of course, all met with exceptional boilers, but that must not be taken to represent the rank and file of a great railway system. It is in no way remarkable that engineers should examine every method of construction and criticise its weak points with care. Now, one of the worst points about the ordinary fire-box is the tendency to break side stays. The inside box being of copper, and hotter than the outside box of steel a less expansive metal, rises and falls with each change of temperature, and bends the side stays up and down, so at last they break. To combat this tendency to break, attempts have been made to give a certain amount of elasticity. In some cases the stay bolt has a hole drilled through it to reduce its sectional area. The inner end of the hole is plugged. If the stay breaks water will rush out through the hole and tell the tale, so that drilling is useful in two ways. Another plan consists in turning down the middle of the length of the stay. This sometimes causes trouble in putting the stay into its place. On one English line will be found a very ingenious machine which reduces the middle of the stay for a couple of inches of its length, but not to such an extent as quite to obliterate the thread. The stay can, therefore, be put in place without trouble, while there is sufficient reduction of area provided greatly to prolong its life. When we come to the method of carrying the crown of the box, we find that in this country almost invariably bridge stays are used. These stays ought to go across the box, because when they are bedded on the top edge of the tube plate they tend to force it down and make the tube holes oval. We have seen a copper plate distorted in this way to a surprising extent. It is the old story of the flow of solids. When the bridges are put on longitudinally, as they often are for structural convenience in fitting longitudinal stays, the regulator gear, &c., sling stays are used to support and help the bridge stays, and save the tube plate. These sling stays require to be fitted with very great care, and we confess that we do not regard them with any favour. The external box being curved to a circular arc, cannot rise and fall in the least, and no matter how tightly the slings are screwed or keyed up when the boiler is cold, they must be slack when it is hot, because of the rise of the fire-box. We have heard engineers admit this, and yet use the slings, as they said, as a measure of precaution, less a bridge should break. On the other hand, it must be admitted that a bridge stay is not free from serious objections. No matter how carefully bedding at the ends is effected, there is a tendency to squeeze down and injure the side plate. Besides, the whole load and stress are thrown on the foundation ring and its rivets, and we would willingly spare the ring a burthen of 200 tons or so if we could. The weight of a set of bridge stays is by no means insignificant, but as it serves in many cases to help in distributing the load on the wheels, this is of small importance. We need only mention, in passing, that the presence of bridge stays does not facilitate the cleaning of the fire-box crown. But they are not, perhaps, worse in this respect than other methods of staying.

In the Belpaire box there are no bridge stays, the flat tops of the two boxes being secured to each other by screwed stays ⅞in. or ¾in. in diameter, just the same in all respects as the side stays, save that they are four or five times as long. The objection brought to bear against this method of construction is that the rise of the internal fire-box slacks the stays, or, more strictly, tends to slack them, and that the crown plate is in consequence bent down and distorted. We hold that this objection is quite untenable. The flat crown plate of the outside fire-box is much larger than the inside plate, and is therefore more flexible. Obviously both plates are so flexible that, under pressure, the stays are fully loaded. The rise due to the greater expansion of the inner box is in great measure compensated for by greater depth of the outer box, and this is especially true of the Belpaire boxes, which are very shallow, although the steam space remains about the same, no matter what the depth of the box. It may be urged, of course, that the sling stays expand down as much in proportion as the outer sides rise. Taken altogether, however, we believe that in practice it will be found that the flat top of the outer box rises a little when the engine is under steam, and that the inner box does not drop, or undergo any distortion. The danger of distortion is, of course, that it may bring about the cracking of the crown plate, especially near the sides. The risk is, of course, transferred to the outer plate, but we believe that it exists much more in theory than in fact. We have not heard that the crown plates of Belpaire boxes are more liable to crack than are the side plates of normal fire-boxes.

Having said so much in favour of the Belpaire box, we may go on to add that we have no intention of urging that it is better than the usual English box with bridge crown stays. Either makes a fairly good job; which will be found the better depends on many circumstances, and above all on the size of the grate. The bigger the grate the stronger are the arguments in favour of the Belpaire box. The test of merit is very narrow. The first cost seems to be about the same, or perhaps a little in favour of Belpaire. For the rest, failure will take place, if at all, by the breaking of the stays and the cracking of either the inside or outside crown plate or both. We see no reason to think that either method of construction is distinctly and prominently better than the other in this respect. Probably some of our readers can supply information on this point derived from experience with both methods of construction used under similar or nearly similar conditions.

EDUCATION AND INVENTION.

WE commend to the attention of our readers the final paragraphs in the admirable address of the newly-elected President of the Institution of Mechanical Engineers. No man is in a better position to say what technical education can and can not do for this nation than is Mr. Windsor Richards. Those who see in education a panacea for all commercial ills, never stop to ask themselves whether there is any other side to the glowing picture they delight in drawing. Is it not possible to have just too much education and yet not enough? Not long since a correspondent advanced in our pages a sufficiently remarkable proposition. Writing about Dr. Hampson's process for the production of liquid gases, he said that apparatus of the kind could not be invented by men of strict scientific training. These were not "Zero's" precise words, but his longer statement only developes a little the same idea. At first sight the proposition appears to involve a paradox, but only at first sight; and although we cannot go so far as "Zero," we have little difficulty in admitting that there is a large substratum of truth in his assertion. The Hampson or Linde process is apparently thermodynamically wrong. No one rigidly trained in the thermodynamics of the text-books would think in the particular way necessary for the evolution of the Hampson apparatus. That is "Zero's" argument, and it would not be easy, even were we disposed to make the effort—which we are not—to refute it.

It is a noteworthy fact that the most important inventions have sprung from the brains of men who possessed very little precise scientific education; and it is almost equally true that such an education has never done much to develope, or aid the development, of any invention. It is, of course, an old story, that professors never invent anything worth having. It is not quite true. We may, however, leave the professors alone; they have work enough to do without inventing. There are multitudes of well-trained scientists and engineers who are not professors, and we may confine our attention to these, and ask how it is that accurate training seems to rob a man of all power of inventing; and how it is that the best things in the world have been produced by men comparatively ignorant. To explain the phenomenon, we must first settle what invention really is; what the word means; what its use involves. Now, we hold that nearly every invention is, in a sense, a discovery. In courts of law, hundreds of thousands of pounds have been expended in deciding what does and does not constitute an invention, what does and does not constitute a discovery. An invention can be patented, a discovery cannot, although the apparatus by which the discovery is made useful in the arts can be patented. Let it be conceded, for the sake of argument for the moment, that the difference between an invention and a discovery is one of degree and not of essence, and we shall be able at once to understand why a rigid and excellent scientific training may stifle invention. Such a training may be, and in mechanics at all events always is, fatal to discovery. It teaches that there is nothing left to discover. Everything is known that can be known for example, about heat, and the steam engine, and so on. If a carefully trained student proposes to himself to accomplish a certain thing in a particular way, his training may tell him that the thing he proposes to do cannot possibly be done, because the doing of it would break one of nature's laws. The result is, of course, that he sits still and does nothing. He bows to the inevitable. Another man, possessing far less knowledge, does not know enough about the subject to prevent him from trying a particular experiment. He tries it and succeeds. Then the learned man finds that he knew too much and yet not enough. The invention is a success; and yet its success involves no infraction of nature's laws. The ignorant man tried an experiment because he was ignorant; the learned man did not because he held that it would be useless to try it. It cannot be disputed that under the circumstances learning did more harm than good. Many illustrations of our meaning will suggest themselves to our readers. For example, let us take the modern bicycle. Any one carefully trained in the principles of equilibrium, and attaching due weight to the proposition that if a line joining the centre of gravity of a body with the earth falls outside the base of the body that body must upset, would say that it was quite ridiculous to suppose that a machine supported on two wheels only in the same plane could possess sufficient stability. We have heard it argued that the old high bicycle could not be mounted without the aid of a bystander, because its instability at slow speed was too great. Again, anyone who was carefully trained in mechanics would reject as preposterous the notion that a wheel could be made with thin wire spokes which would carry a heavy man. Furthermore, there is not a portion of the framing of a bicycle that is not, in the eyes of any one carefully educated in the strength of materials, utterly wrong. If any one of our readers will take the trouble to work out the stresses in a bicycle weighing 28 lb., and carrying at ten miles an hour a man weighing 12 stone, he will see that from first to last the whole machine is so completely impossible that nothing of the kind exists outside the land of dreams. Let us suppose that a law was passed under which no one was permitted to use a bicycle that was not pronounced to be quite safe by the Boardof Trade; and let the surveyors of the Board deal with the cycle precisely on the same lines as they deal with marine boilers, and see then what the Board of Trade machines would be like. Is it too much to say that, twenty years ago, any and every thoroughly trained engineer would have pronounced the modern "light roadster" a mechanical impossibility. Such men would know too much to attempt to produce anything of the kind. Let us take the injector again. To all intents and purposes its action was discovered, not invented; and it was discovered by a man who was in search of what was apparently thermodynamically impossible. The announcement that Giffard was forcing water into a boiler by means of a jet of steam drawn from the same boiler was received by every trained mind with shouts of derision; and months, if not years, elapsed before a theory of the action was formulated or accepted. Again, no trained electrician believed that it was possible to send a number of messages over the same wire at the same time. Edison, the telegraph clerk, did not know it was impossible; he tried and succeeded, and now as many as six messages can be sent at the same time without interference.

There are, however, certain inventions which are not in their nature discoveries at all, they are inventions by courtesy. They involve little more than the combination in a more or less novel form of old and often well-worn thoughts and things. It does not appear to us that any amount of training could hamper useful progress along this line. On the contrary, it may prove of the utmost service. It may prevent the commission of very serious mistakes, and much waste of time and money; and this brings us back to the starting point, and the proposition that a high scientific training is often and in many ways fatal to the exercise or development of inventive genius. Our readers who have followed us so far will see that the reason why lies in a nutshell; it can be stated in very few words. It is simply that knowledge is too often assumed to have reached finality when it has done nothing of the kind, and the belief is fostered and inculcated by those who write books and treatises and teach, in various ways. We are not now speaking of professors only, but of teachers at large, whether in the college or the workshop. Each man is prone to say, "There, read that, or listen to this. There is nothing more to be written or said; I have exhausted the subject, covered the whole ground." A noticeable example is supplied by a very simple device, the "hurdy-gurdy," or Pelton wheel. We have only to take down from our shelves any book on hydraulics published more than ten years ago to learn that an impulse wheel driven by the impinging of a jet of water on its vanes must be extravagantly wasteful of water, yet recent investigations have shown not only that the Pelton wheel is very economical, but that it ought to be so in the nature of things. The man of high science produces the turbine, a very admirable invention; but the Californian miner with practically no training and plenty of water under pressure, proceeding on quite different lines, turns out a machine very much cheaper and simpler, particularly in the matter of installation, and one not less economical in the use of water.

Lastly, we would point out that it is not the possession of knowledge that stops progress; the mischief is done by the assumption that the knowledge is final. In other words, the training becomes too dogmatic—too monkish, if we may use the word. The young man finds it very difficult to believe or to understand that his teacher in the college, or his head in the office, does not know all that is to be known; and it is only human nature that he should subsequently take to himself the belief that he himself knows all about everything, and that if he thinks nothing can be achieved in a certain direction nothing can be achieved. Yet it cannot, we think, be disputed that most of our leading scientific men know a great deal too much to invent anything; and so the world gets its steam, gas, and oil engines; its railways; its high speed ships; its power looms; its spinning jennies; its horseless carriages; its telegraphs, not from the man of science, not from the teacher, but from the hard worker; who is continually trying new things, because he has never learnt that there is a law or a limit beyond which he cannot go. No doubt much time and labour and money are wasted; but in the long run the world owes more to the man who does not believe in the impossible than it does to the man who sees it everywhere.

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THE GERMAN GOVERNMENT AND ENGLISH STEEL FOR SHIPBUILDING.

IT is a complete reversal of the condition of affairs to which attention in this country has lately been so continuously directed to find German steelmasters complaining of competition from England; and it shows that there is a bright side to the foreign competition shield as well as the duller face, to which alone we have been accustomed to gaze for so long a time past. The Association of German Iron and Steel Manufacturers has sent a petition to the German Minister of Public Works, in which that official is urgently requested to reduce the freight rates on shipbuilding material. They say that under existing conditions they are no longer able to compete with the English, and they declare it to have become an absolute fact that most of the vessels built on German soil are produced from English material. This is due to cheaper transporting facilities from England to the German seaports, where most of the shipyards are located, and to the great and consequently cheap production of Great Britain, which still builds 70 per cent. of all the ships in the world. As much as 133,834 tons of iron and steel for ship construction were imported from Great Britain during the period from 1890 to 1895. The German manufacturers announce their intention of establishing a "central bureau" to be entirely devoted to this line of the trade, which is to watch the British prices and to place orders from shipyards with German works that are able to fill such orders in the shortest time possible. We assume this means a ring of shipbuilders who will only accept German tenders. The memorial also contains a table showing some of the lowest offers of German and English work f.o.b. dock at Hamburg so far during 1896. The German average price for the different kinds of iron and steel used in shipbuilding was 117·67 marks, while the English bids averaged only 96·28 marks. For boiler plate, for instance, the lowest German offer was 174·05 marks, while two English works offered them for 119·23 and 138·90 marks respectively. British competition is felt still more severely along the Baltic coast, which is twice as far from the Westphalian iron district as Hamburg. Here it is where the question of railroad rates plays a specially important part. The Vulcan shipyard at Stettin called in 1895 for bids for the supply of material for a fast ocean steamer, and these were the lowest average prices asked:—German works, 136·77 marks; English works, 113·90 marks. In addition to this, the English works conceded 2½ per cent. cash discount, while the Germans would grant only 1½ per cent. The German manufacturers declare their willingness to reduce their price to the lowest figure possible, but say that a little pressure ought to be brought to bear by the German Government on the shipyard owners to induce them gently, but effectively, to use none but German material in the construction of vessels. They believe that they would be able to drive the English from this market if a law could be passed providing that only vessels constructed of German material shall be used in the Imperial service, and if the lowest freight tariff which now applies to coal only would also be granted to material destined for the construction of vessels. As yet, so far as we are aware, the memorial has not produced any practical effect, and we trust it will be a long time before the German Government passes such a law as that petitioned for.

LITERATURE.

Pumps and Pump Motors. By P. R. BJÖRLING. 2 vols. London: E. and F. N. Spon. 1895.

THIS is a large book. The first volume contains 280 quarto pages of text and eighty pages of tables, besides an index; the other volume contains 1006 figures of illustration upon 261 large plates. There is, therefore, a great quantity of matter in this work. It is well classified into divisions. Thus the first part, containing 107 pages, deals with the general forms of pumps, and is illustrated by 388 diagrams. The second part, of forty-six pages and 266 illustrations, is descriptive of the detailed construction of valves; while the third is similarly devoted to buckets, pistons, and plungers, illustrated by 122 diagrams. Air vessels and pump leathers are next dealt with at shorter length, and with the help of forty-three drawings; and next, fifty-nine pages contain descriptions of pump motors, with seventy-one illustrations. This part seems less bulky, in comparison with the others, than the importance of its subject demands. The chapter on steam, gas, and oil pumping engines occupies thirty-four pages, and that on electric driving of pumps thirteen pages. The other parts are entitled, "Charging and Testing Pumps," "Rules and Formulas," and "Tables." In the latter there are thirty-five tables, most of them of an extended arithmetical character.

A comprehensive and thoroughgoing work of sound character upon pumps and their driving engines was greatly needed, this branch of mechanical engineering, perhaps the oldest established in practice, and certainly one of the most important, having been neglected in technical literature to a surprising extent. To a slightly less degree the same is the case as regards hydraulic motors. The appearance of Mr. Björling's large work must, therefore, have been welcomed with sanguine expectations. But it may be at once confessed that its quality is by no means commensurate with its magnitude; so much so that it still leaves the field open for a sounder work, which may be, perhaps, half the size of this and yet contain much more practically useful matter. The descriptions of the constructions shown in the plates are very needlessly prolix and wordy. Often the text corresponding with a drawing is half taken up in statements of the reference numbers of plate and diagram, and the rest in mention by letter name of parts which are seen at the first glance at the drawing by the merest tyro in the knowledge of machinery. This cataloguing of ordinary elementary parts is repeated *ad* *nauseam* through hundreds of examples, and is in the bulk of the cases unrelieved by any criticism, favourable or the reverse, of the specialities peculiar to the design. Too often, beyond the mere letter A B C cataloguing of parts, the only remark made is such as "a very useful little pump," "another very neat type of pump," "a badly, although neat-looking, designed double-acting piston pump." The last quotation is a sample of the sort of grammar found throughout the book; it sometimes gets down to a very hopeless level. It is good to direct attention to details of construction, but to succeed in doing this with any ordinary reader it must be done in an interesting and enlightening fashion. "A is the working barrel, fitted with a piston packed with hemp and tallow, and secured to the piston-rod C by means of double nuts." This sample of description rises above the average, because it indicates the kind of packing used, and also the method of fastening the rod; but after similar statements have been already made regarding fifty other pumps, it cannot be regarded as attractive.

With regard to these details, there are scattered throughout the book very many intelligent and highly useful hints—in fact, it is in suggestions as to small detail points of construction that the greatest merit of the book lies. But to get hold of these, one has to wade through a woeful amount of mere word padding that makes one dizzy by its unusual degree of uninstructiveness.

Again, in a work having this aim, it is an unexceptionally good feature to have abundance and large variety of illustration of practical design, both in general arrangement and in detail. But no useful purpose is served by multiplying illustrations of unimportant and ineffective minute differences of detail, and of fantastic designs which, if they ever saw the light outside the Patent-office, must certainly have suffered immediate extinction as abortions. No doubt the wild excentricity of ignorant and untrained genius—to give it its most generous possible title—has revelled in a freer fashion in the design of pumps than in most other mechanical regions; but the kindest thing to do with the products of these errant imaginations is to let them sleep the slumber that is natural to irregular conceptions. We welcome, however, quite unreservedly the 267 illustrations of pump valves, because this subject of valves is of overwhelming importance in pumping efficiency, and because the diversity of design found in actual construction shows how little and imperfectly the subject is understood in the drawing office. These 267 drawings necessarily contain many proposals that are eminently ridiculous; but in this one direction under present circumstances the observation of all the varieties that have been conceived can hardly be otherwise than instructive to him who is prepared to learn.

As for the style of printing adopted for these drawings, we cannot honestly praise it. Many of the same drawings appear in Mr. Björling's small book on "Pump Construction," published by the same firm, printed in a much clearer and more intelligible manner. We here find special parts of the sections printed in continuous blocks of jet black. These masses of black surface are displeasing, and even painful, to the eye of a trained draughtsman; and as the sections of different parts so treated run into each other without any distinction to show change from one to another metal, or from one to a separate part—without even a dividing line between the parts—the result is distinctly and technically bad drawing.

There remain the more theoretical portions of the work to criticise, those portions dealing with principles, dynamic and other. Here, again, it ought to be mentioned that there lurk in odd corners throughout the pages useful reminders of subsidiary actions that are apt to be overlooked, and which, nevertheless, are important as affecting efficiency. But as regards the main dynamic principles that govern the working of pumps, the teaching of this book is of an order that is more justly characterised as low than as modest; it might also be termed comic if it were not the reverse of amusing and were not evidently intended to be taken seriously. The art of putting rider before horse, and of leaving the horse riderless, and of driving both rider and horse in aimless mazy circles, is cultivated to an extreme extent. The author seems so impressed with the discovery that it is the pressure of the external air that drives the water up and along the suction pipe into the pump barrel, that in one passage he goes the length of saying that the whole work of pumping is done by the atmosphere. He is also under the impression that if all joints in a suction pipe and barrel were perfectly air-tight the water would follow the piston, bucket, or plunger up to a height of 34ft. above the well level. He thus shows himself magnificently indifferent to frictional resistances as dependent on length and size of pipe and on the velocity of flow; to inertia resistances as dependent upon acceleration of velocity, and to evaporation at low pressure. Indeed, towards the end of the volume he explains the action of an air vessel upon the suction to be that the suction pipe delivers into the air vessel the whole of the water required for one delivery stroke of the pump during the delivery stroke; during the suction stroke it runs from the air vessel into the pump barrel, the water in the suction pipe presumably standing stationary meanwhile in an obliging manner to let the other pass. The problem of proportioning a suction air vessel so as to obtain half the pump-full flowing into it during the delivery stroke and flowing again out of it into the barrel during the suction stroke, so as to maintain a constant average velocity throughout both strokes in the suction main is not even suggested anywhere. As it involves calculations of accelerations of momentum and some other things, it may have been beyond the power of the author to solve it; but a suggestion of the existence of such an evidently useful problem might have stimulated the intelligent pump maker to solve it for himself, either by calculation or by experiment. In explaining "pressure" or delivery air vessels, it is said the object is "to prevent concussion," and "to economise the power of the motive force by keeping the liquid in constant motion, thereby decreasing the speed of the liquid when the pump pipes are smaller than the pump barrel." The first part of this statement is unexceptionable, but its effect is quite spoilt by the succeeding explanation. Certainly the maximum, as compared with the average velocity, is decreased by the action of the air vessel, and for frictional reasons it is a good thing to diminish the variation from the average velocity. But this has no relation of any kind to the ratio between pipe and barrel section. Of course the bad effects of variation of velocity in the delivery main are aggravated by relatively small sections of this main; but the air vessel does not diminish the average velocity in any case, and it reduces the ratio of maximum to average just as much if the main be large or small. Most of the remarks in Chapter XXXIV. on the placing of air vessels are well founded; but what can one think of the recommendation to fashion the volume of the air vessel in high and narrow shape, "because there will be a greater thickness or layer of air, hence it will be more elastic." A better reason also given, namely, that the absorption of air on the less surface of water has more force; but when this is followed by the direction to make the "throat of the air vessel long and narrow to prevent the water in the vessel from being disturbed by the action of the pump," one can only read on in astonished perplexity. Why not cut off the air vessel altogether if it is desired that the action of the pump should not disturb the water in it? That would be the surest way to effect this object. It would be difficult to surpass in point of vagueness and wrongness of principle the calculations anent the opening and holding open of valves given on pages 120 and 121. Firstly, it is said here that the difference of water pressure needed below and above a valve in order to lift it is reduced by the amount of buoyancy possessed by the valve when floating in water. This buoyancy is the weight of displaced water, and it is produced by that part of the difference of pressures above and below which is due to the weight of water between the two levels. Although no pump pressure is required for this, it is still evident that the difference of pressure exists in the water. The weight of the valve, in other words, is not altered by its immersion in water. Again, it is assumed that this difference of water pressure needed to open the valve is maintained after it has opened and the flow through it established; and from this assumption extravagant calculations are made of percentages of pump power spent in holding the valves open. These are wholly misleading. The valves may be, and mostly are, held open by the dynamic action of the water flow—that is, by the extra pressures due to curvature of the streams along the under face of the valve and the vacuum on the upper face due to the flow of the streams past its edges. Neither of these + and − pressures affect in the least the work done in the pump, as they are exerted perpendicularly to the direction of flow at the points where they are developed. The loss in horse-power due to the obstruction offered by valves, &c., is wholly caused by friction against the sides, by viscosity between the partial currents, and by eddy-making.

These are samples of the crudities which disfigure a book which, with their elimination, and with energetic condensation, might be converted into the best English treatise on the subject. The arithmetic would need to be revised throughout, both as to rationality and as to accuracy. For example, on page 268, the "duty" per indicated horse-power of a pump "using 5 lb. coal per horse-power per hour" is found thus:—

$$\frac{5 \times 1,980,000}{112} = 88,214{\cdot}28.$$

Now, as the "5 lb. per horse-power per hour" is an approximate figure, subject to a variation or error of, say, not less than 5 per cent., the final figures 14·28 in this calculation are irrational, absurd, and misleading, as declaring a degree of accuracy which does not really exist in the result. The beauty of this minute calculation is further appreciated when it is observed that with correct arithmetic the result is 88,400, or nearly 200 more than stated, in consequence of mistakes in multiplication. In passing it may be noted that the factor $\frac{1,980,000}{112}$ may be conveniently used in the form $18,000 \times (1 - {\cdot}02 + {\cdot}002)$.

Another example of similarly amusing arithmetic is taken at random from page 270, thus:—

"Total pressure = 78·54in. area of pump
× 500 lb. pressure per square inch
= 39,270 + 50 per cent. for friction,
= 58,905 lb. pressure."

The comparison of the 50 per cent. allowance for friction with the nice adjustment of the calculation of pressure to "5 lb." ought to be amusing even to the writer of this book. Similar entertainment may be had from the statement on page 278 of the horse-power of horses, namely:—

23,412 foot-pounds per min. for 8 hours; or
27,056 „ „ „ „ „ 4½ „ ; or
32,943 „ „ „ „ „ 3 „

These figures are not given as deduced from any special tests, but as standards. The final 12, 56, 43 foot-pounds are delightful. They are standards for all the world over; not for English or French or Russian horses; not for those fed on oats or on any other fodder in greater or less quantity; they are standards for *all* horses.

SHORT NOTICES.

The Factory and Workshop Acts Explained and Simplified. By E. M. Roe, her Majesty's Inspector of Factories. London: Simpkin, Marshall, Hamilton, Kemt and Co. Manchester and Birmingham: Cornish.—Major Roe has written a useful little book with the hope of assisting all to whom the Factory and Workshop Acts apply to find with ease their obligations and privileges. The book first of all explains the "definitions" given in the Acts. Then follow particulars as to the duties of employers, owners, workpeople, and parents; sanitary provisions; the safety of machinery by fencing, and precautions against fire; the periods of employment with meal hours, overtime, and night work, with special exceptions and restrictions; special rules in dangerous trades; arbitration; and references to penalties incurred on infringement of the Acts; together with the powers of various public officers. It has a complete index.

A Directory of the Chief Industries of India, with which is Incorporated a List of Tea Companies and Gardens, Indigo and Coffee Estates, with their Factory Marks, and a Directory of Tea, Coffee, Cinchona, and Cardamon Estates in Ceylon. With two maps. Calcutta: Thacker, Spink, and Co. London: W. Thacker and Co. 1896. Price 6s.—The title to this book sufficiently indicates its nature. The maps show the tea districts and the coal and iron centres respectively, and they are probably as clear as their size will permit.

COLONEL J. T. NORTH.

COLONEL NORTH died on Tuesday suddenly whilst he was presiding at his office in Gracechurch-street over a meeting of a company in which he was concerned, when he was taken ill and died almost immediately of failure of the action of the heart.

Born in the early forties, a solid, sturdy Yorkshireman, shrewd, honest, and quick, with no book-learning or accidental advantages of fortune, patronage, or friends, but with indomitable courage and energy, North was at an early age, whilst yet an apprentice in Messrs. Fowler's workshops at Leeds, selected from his fellows to go out to Peru to superintend the erection and working of certain machinery. He at once set to work to make the most of his knowledge and the best of his time and wits in a strange land, of which to the end of his days he never learned the language. The stories he was wont to tell of his early struggles showed of what stuff he was made. He spied out the nakedness, not of the land, but of the natives, and he set to work to clothe them to his profit. One of his earliest enterprises was the condensing of sea-water for domestic purposes at a place on the coast north of Valparaiso, where rain never falls. Patching up an old iron steamer that had been wrecked on a reef, he converted her into a floating water-tank, and made a good profit by her. Other enterprises succeeded quite as well, notably the working of large guano deposits, and eventually the Leeds apprentice, who had landed in Peru with a salary of £1 a week, went back to England the possessor of great wealth. It is said that just before the war between Chile and Peru he satisfied himself that the Peruvians would be defeated and that they would lose the province of Tarapaca—that singular region on which the beds of nitrate of soda are all that are left to tell of the existence of the great salt fjords and lakes which have been lifted up by volcanic action and desiccated by the sun, never to be melted by any rain, for the whole stretch of coast nearly 300 miles long. Some of these *oficinas* he acquired by purchase, and when the conquering Chilians came to seize upon the lands they found the British flag flying over many square miles of nitrate beds, of which the owner was J. T. North. On his return to this country after an absence of about twenty years, Colonel North—he was honorary colonel of the Tower Hamlets Volunteer Engineers—soon became a familiar figure in the City, built himself a very fine house at Eltham, in Kent, started a racing stable on a large scale, and became a prominent member of all the associations connected with sport. In 1889, the *Times* says, he paid a visit to Chile to strengthen his companies by agreements with the Chilian Government.

Colonel North married a daughter of the late Mr. John Woodhead, a leading Conservative in Leeds—and a representative of that party both in the Corporation and on the Board of Guardians. He leaves one daughter and two sons.

HORSELESS CARRIAGE NOTE.

IT has just been pointed out by a correspondent, writing to a Glasgow daily paper, that the Locomotives on Highways Bill which has now passed the second reading in the House of Lords to legalise the running of horseless carriages, while satisfactory in every way as concerning its provisions for England, is far otherwise in regard to Scotland and Ireland. To many it will come as a surprise to be told that these countries are being treated differently from England in this highly important connection, and the question will naturally arise why one set of uniform regulations should not be made to apply to the whole of the United Kingdom. So far as England is concerned the Bill provides that vehicles propelled by mechanical power, under two tons weight unladen, not drawing any other vehicle, and so constructed that no smoke or visible vapour is emitted, shall be treated as if they were carriages drawn by horses, and shall be subject only to the general regulations of traffic on highways, while the Local Government Board is given power to subsequently make such regulations as it may see fit with respect to the use of horseless carriages. This virtually gives to manufacturers and users in England an entirely free hand in the meantime, while any regulations which may subsequently be made by the Local Government Board will apply to the whole of England equally. As regards Scotland and Ireland, under Clause *C* of the Bill it is enacted that so much of Section 6 of the "Locomotives Amendment (Scotland) Act, 1878," and Section 6 of the "Public Health (Ireland) Amendment Act, 1879," as gives power to regulate the use of locomotives shall apply to horseless carriages. The sections referred to give power to the road authorities in Scotland, and to the urban sanitary authorities in Ireland, to make bye-laws regulating the use of locomotives to sixteen hours out of the twenty-four on such highways as they may fix, situated within their respective areas, and to make general bye-laws for regulating the use of locomotives upon any highway. It is significant as a foreshadow of what may be the result of this mixed legislation to be reminded that in Scotland it was under this Section 6 that the only conviction for running these carriages was obtained. The result of the passing of this measure in its present form will be that so far as Scotland and Ireland are concerned the law will stand exactly as it did before, since every petty local authority will still have power to pass such bye-laws as they may see fit for the regulation of horseless carriages, and restriction of the hours during which they may be run. When it is remembered that these vehicles are capable of covering 200 miles in a day, it can readily be estimated that they may pass through the territory of many local authorities in that time, each having, perhaps, a different set of bye-laws. This cannot but lead to endless confusion and trouble, and tend seriously to hinder in Scotland and Ireland the introduction of this new form of locomotion with its promised advantages.

THE IMPERIAL INSTITUTE EXHIBITION OF HORSELESS CARRIAGES.

THE largest number of motor carriages yet brought together in this country was exhibited at the Imperial Institute on Friday last, when a preliminary inauguration of the exhibition organised by the Motor Car Club took place, the occasion being a private view largely attended by members of the House of Lords and others interested in the Light Locomotives Bill introduced into the Upper House by Lord Harris.

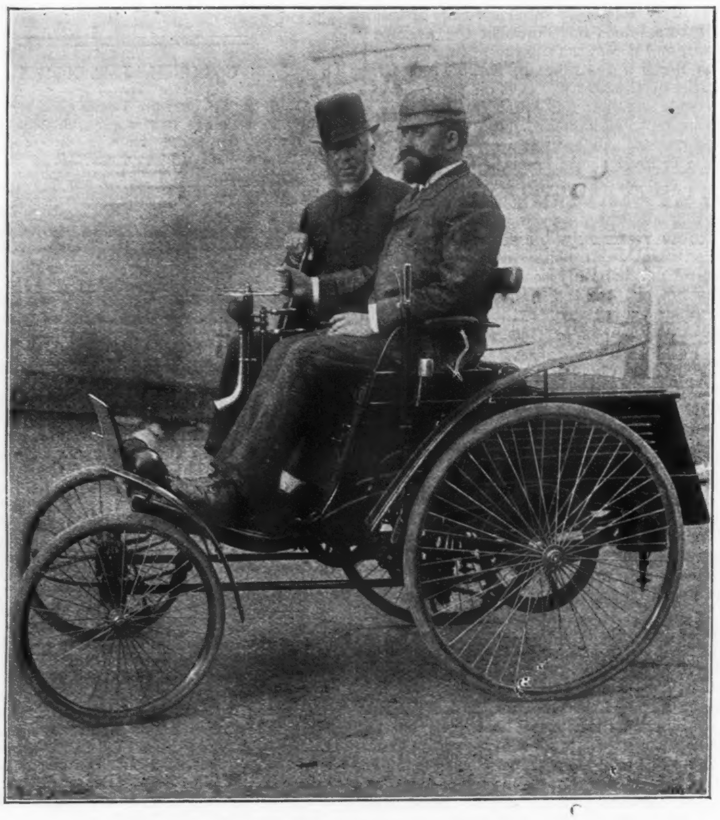

Fig. 1—ARNOLD'S MOTOR CARRIAGE, WITH BENZ MOTOR

In the evening a banquet was given in celebration of the event, and this was most influentially attended, and was made the more interesting by a subsequent display in the Imperial Institute grounds of the travelling and manœuvring powers of a number of the motor carriages and cycles forming part of the exhibition, the grounds being very prettily illuminated for the purpose.

Amongst those present were the Duke of Abercorn, the Marquess of Breadalbane, the Earl of Clanwilliam, Earl of Clarendon, Earl Denbigh, Earl of Dunmore, Earl Galloway, Earl of Kintore, Earl Poulett, Earl of Romney, Earl Waldegrave, Viscount Galway, Earl Russell, Viscount Knutsford, and Lords Ampthill, Derwent, Abinger, Digby, Exmouth, Harris, Fingall, Hillingdon, Howard de Walden, Hyde, North, Roberts, Thring, and Llandaff, most of whom were accompanied by their ladies.

Ample evidence was afforded in proof of the widespread interest now felt in the construction and use of horseless carriages for various purposes, and considerable surprise was displayed at the speed and complete control which the vehicles as now made place at the disposal of the users, and at the satisfactory signs of development towards thoroughly practical vehicles for various purposes. Several of those shown in operation have been briefly described and illustrated in our pages[1], but several new forms were present. The three kinds of motors, namely, steam, benzoline oil motor, and electrical motor, were represented. Vehicles by MM. Panhard and Levassor, by MM. Peugeot Frères, by Mr. Lutzmann, by Messrs. Arnold and Sons, of East Peckham, Tonbridge, Kent, by the Daimler Motor Company, London, by MM. De Dion and Bouton, and by M. Bollée were shown, all of which were operated by benzoline motors. An electric carriage of the Universal Electric Carriage Company, seating four persons, and operated by secondary batteries and a Serpollet steam carriage, were also shown in motion.

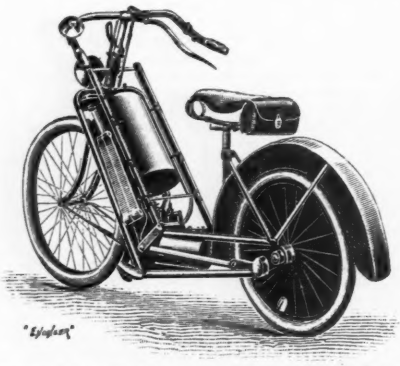

Fig. 6—THE DUNCAN AND SUPERBIE MOTOR BICYCLE

One of the Arnold carriages is illustrated by the accompanying engraving—Fig. 1—and by the sketch plan of the arrangement of its machinery—Fig. 2. These are vehicles for carrying two persons, and they are fitted with benzoline motors made by the Benz Company, of Mannheim. These motors are horizontal, and the ignition is effected by electrical means. Power is taken from the motion shaft by means of leather belts driving a second motion shaft, the belts running on pulleys of different sizes for two different speeds. The second motion shaft communicates motion to the driving wheels by means of a driving chain. The general arrangement is clearly shown by Fig. 2, which does not, however, show the position of the jacket water cooling tanks on either side of the inside of the rear of the vehicle, or of the oil supply reservoir, which carries enough benzoline for about seventy miles run on good roads. One of the vehicles of this build, called a Motor Sociable, to carry two persons, is fitted with a motor of about 1½-horse power, and with cycle wheels having india-rubber tires and ball bearings. Its weight is said to be under 6 cwt., and its price £130. A much larger vehicle by this maker, known as a Motor Victoria, fitted with a large leather hood and with a motor of 3-horse power, costs £230, and is a nice looking vehicle. Several carriages of this make competed in the Paris Bordeaux trial last year, under the name M. Roger, the Paris agent for the Benz manufactures. The steering wheels are carried upon a cross axle with short pivoted ends of the Ackermann type, the main part of the axle having a fore-and-aft pivot, so that the axle is free to accommodate itself to the differential rise and fall of the four wheels. The vehicle illustrated was shown in operation by Mr. Hewetson.

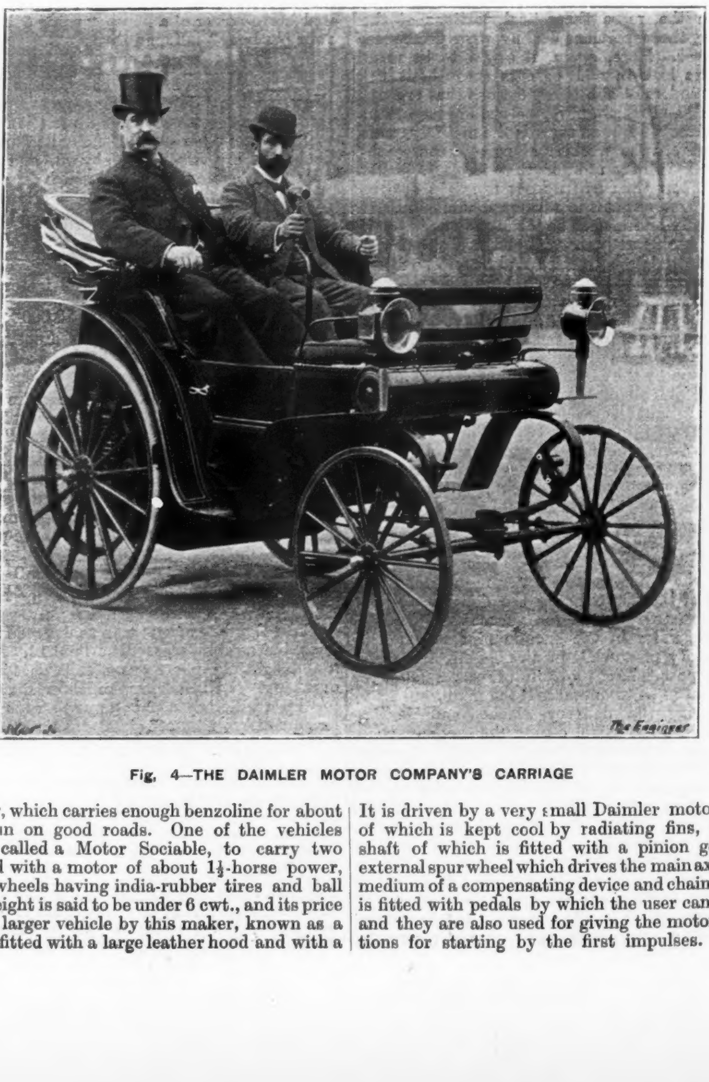

Fig. 4—THE DAIMLER MOTOR COMPANY'S CARRIAGE

The Lutzmann carriage is a high-mounted vehicle of the Victoria type, driven by a horizontal benzoline motor; it was shown in operation, moving in a stately slow-speed manner, by Mr. Koosen, of Southsea. The carriages built by MM. Panhard and Levassor and Peugeot Frères were illustrated by us, as above mentioned; and that owned by the Hon, Mr. Eveline Ellis is shown by the accompanying engraving—Fig. 3. It is propelled by a Daimler motor, operating a fore-and-aft shaft, which by bevel and compensating gear drives the second-motion shaft, provided with spur gear for three different speeds, the motion being communicated to the driving wheels by chain gear. This vehicle is exhibited by the Daimler Motor Company, and was shown in operation by Mr. Ellis.

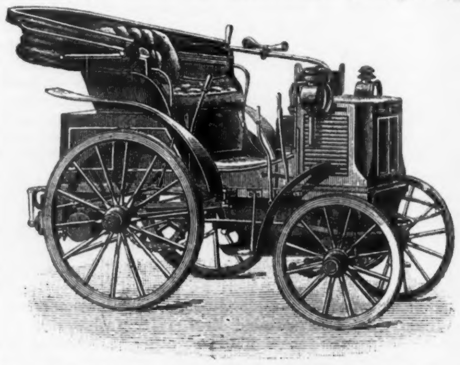

Fig. 3 — PANHARD AND LEVASSOR MOTOR CARRIAGE — DAIMLER MOTOR

Another type of vehicle, namely, the most recent form of Daimler motor carriage, is shown by the engraving —Fig. 4—above, and was illustrated in plan and section in THE ENGINEER of December 20th last.

The illustrations show the arrangement of the vehicle for four persons, with a vertical Daimler motor driving a second-motion shaft by means of belts and pulleys, the belts being tightened or loosened by means of jockey pulleys. The second-motion shaft is fitted with pinions which gear into spur gear rings attached to the road wheel spokes. This vehicle was shown in motion by Mr. Simms, and like that of Mr. Ellis, it attracted attention because of the ease with which it ran and mounted the ramp erected in the grounds, and the facility with which it was steered amongst other vehicles, and round various objects, in a somewhat confined space of the grounds at disposal.

The tricycle shown by Fig. 5, shown in use by the Comte De Dion, is that made by MM. De Dion et Bouton. It is driven by a very small Daimler motor, the cylinder of which is kept cool by radiating fins, and the crank shaft of which is fitted with a pinion gearing into an external spur wheel which drives the main axle, through the medium of a compensating device and chain. This tricycle is fitted with pedals by which the user can assist up hill, and they are also used for giving the motor a few revolutions for starting by the first impulses. This vehicle worked extremely well, and an oil motor bicycle was also shown in operation.

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[1] See THE ENGINEER, July 20th and 27th, 1894, June 21st, 1895, July 12th, 1895, January 3rd 1896.

The bicycle by MM. Duncan et Superbie is shown by Fig. 6, and is a very nicely finished machine. It is worked by a pair of benzoline motor cylinders, the return stroke of the pistons in which is effected by powerful india-rubber bands stretched on the outgoing stroke. To this vehicle as well as others we have mentioned we must refer in more detail in another impression.

The most remarkable of the smaller vehicles was the tricycle of M. Bollée, previously well known in connection with the steam carriages he has made. This is a tandem tricycle with a low seat between the two wheels in front for the passenger, and a seat to the rear for the operator, who sits nearly over the rear single driving wheel. A small horizontal benzoline motor, designed we believe by M. Bollée, is on one side of the tricycle frame, and drives the rear wheel by means of an endless cotton and rubber belt running over a pulley about 20in. in diameter. Attached to the rear wheel, the latter is so mounted that by a lever in the operator's left hand it can be pushed forward or pulled rearwards, thus slackening or tightening the driving belt. The driving pulley on the rear wheel also acts as the brake pulley, and when the hand lever is pushed forward and the strap loosened the pulley is simultaneously brought into contact with the brake block with more or less pressure as required, the driving-wheel is thus at the same time deprived of driving power and stopped by the brake.

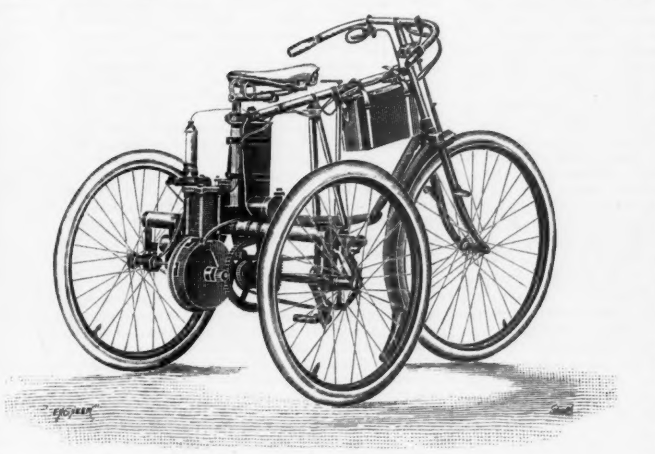


Fig. 5—THE DION AND BOUTON MOTOR TRICYCLE

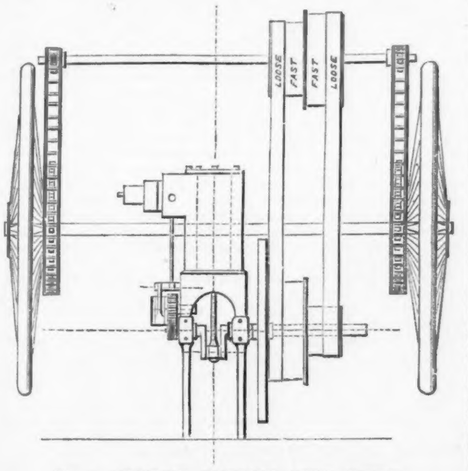


Fig. 2—ARNOLD'S CARRIAGE-BENZ MOTOR

At present we are unable to illustrate or give many particulars of this tricycle, but the very high speed it attained, not only on the straight but round sharp curves, and when dodging at this speed amongst other vehicles, drew the attention of everyone present to it as not only being remarkable in itself, but as having a very daring and skilled rider. It is only about four months since Monsieur Bollée commenced making this tricycle, yet he has already orders for fifty or sixty of them. For the present the one exhibited has been taken to Coventry with a view to its manufacture here, the rights having been bought by the Daimler Motor Company.

To the electric carriage shown in operation by Mr. W. C. Bersey, of the Universal Electric Carriage Company, we must refer in another impression when we have illustrations.

The Serpollet carriage was not of recent construction, and although of interest, does not represent the Serpollet carriage as illustrated by us last year. It is a powerful, but heavy, vehicle as compared with anything that would be looked for as a carriage. Indeed, the steam carriage, though there is little doubt that it will in the future play a most important part among horseless vehicles, cannot be yet said to be at all represented at Kensington. At present the oil or benzoline motor holds the field, and no doubt some of the objections at present urged against it as causing considerable vibration, particularly when the carriage is standing, and as being less easily variable in its speed or power than is desirable, and as having to be kept running when the vehicle is standing, will in some measure be removed; but to the satisfactory steam engine none of these objections apply, and when English engineers, seeing that light horseless carriages are really in demand, give their attention to the subject, there is little doubt that we shall see steam in this, as in every other requirement for motive power, playing a most prominent part.

THE CARDIFF EXHIBITION.

On Saturday this was formally opened by the Mayor of Cardiff—Lord Windsor—and is unquestionably one of the greatest successes of the principality. The attractions are of the most varied character, from a reproduction of old Cardiff to a model of Shakspere's house at Stratford, and from switchback and cycle-race courses to a large gathering of works of art.

For the mechanical and engineering world there is a great deal deserving of very close attention, and it is anticipated that large excursions of practical minds will journey to the Welsh gathering from all parts of South and North Wales, and from the opposite coasts of Somersetshire, Devonshire, and Gloucestershire, since a collection of models of interest to the electric, maritime, and engineering industries of the country has not, in Wales certainly, ever been brought together.

The machinery section is one of the most interesting in the Exhibition. There are over 200 exhibitors, and much of the success of this part is due to Mr. Riches. The electric light plant is in the centre of the building, and comprises four pairs of compound engines, a pair of vertical engines, a large horizontal main engine, and two pairs of smaller engines for the standbys, and supplemental work. These not only form an interesting exhibit, but do the electric work of the Exhibition. Then there are dynamos and exciters in close proximity. There is a countershaft between the dynamos and engines. The machinery supplies the power for the 200 arc and 600 incandescent lights. The engines are supplied with steam from two batteries and two boilers, each of Babcock and Wilcox's multitubular type—1000-horse power, if required. In addition to these four boilers there is a small battery of boilers erected by Messrs. Hornsby, of Grantham, of a somewhat similar type. The steam pipes, after serving the electrical plant, supply a pair of Braithwaite's high-speed engines about 400 revolutions per minute, and calculated to give off 200-horse power. The steam is then carried into the running section, and to the model coal mine, which will be noticed again, with other features of the Exhibition, which is to continue until October.

Another of the most prominent features of the Cardiff Exhibition is the maritime section. The leading shipbuilders, shipowners, and dock contractors of the country have sent exhibits, and as 8400 square feet are allowed, it follows that the display is both large and unique. Sir Wm. Armstrong, Mitchell, and Co., have sent models of steamers, battleships, ironclads, steam launches, and gun carriages. The American Transatlantic Line is represented by a model of the steamship St. Paul; the Barry Dock and Railway Co. by a model of its dock and harbour; Bucknall Bros., of London, by models of their steamers, with a track chart; the Clyde Navigation Co., of Glasgow, exhibits large models of submarine excavators, dock works, ferry boats, swing bridges, and a collection of photographs; Donald Currie and Co. are represented by models of the Dunottar Castle and Arundel Castle, and photographs of African scenery; the Darlington Forge Co. by models of marine engines; Doxford and Son, of Sunderland, by models showing the midship section of a turret vessel, specimens of ship plates, models of cruisers, torpedo boats, and destroyers; Mr. John Dure, of Barry Dock, has a model of hydraulic dock apparatus; the Eltringham Co., of South Shields, exhibit photographs of marine boilers; the Fairfield Shipbuilding Co., Govan, Glasgow, exhibits a collection of models of a number of fine steamers; Kemp, of Whitstable, shows a model of a racing cutter; and a very effective model is that of Southampton Docks and harbour by the London and South-Western Co., also of the company's steamers, Columbia, and Alma.

The Great Western Railway is credited with having sent the largest and finest collection of exhibits ever sent to any exhibition in the country. First, as announced last week, there is the well-known engine the Lord of the Isles. This ended its career when the broad gauge system was abolished, but has been to several notable exhibitions, principally Chicago, where it excited a good deal of interest.

Then there is the middle portion of the New South Wales corridor sleeping carriage, now in course of construction for South Wales. Next samples of rolling stock, sections of different rails on permanent ways, steel stampings; a model of a locomotive with a glass boiler, showing all internal arrangements, and another section exhibiting the complete working of the automatic continuous brake.

The Great Western Railway exhibits include a portrait of Sir Daniel Gooch, whose apprenticeship was passed at Tredegar, a section of the Severn Tunnel, an ingenious machine, and a model of the Emperor. The last contribution lent by Mr. Robinson. The London and North-Western, by its chief mechanical engineer, exhibits a working model of the compound locomotive Dreadnought, which is adroitly acted by a penny in the slot—the money thus collected going to the Railway Servants' Orphan Fund. In addition there is a set of photographs of the various classes of engines used on the North-Western, and a representative selection of rolling stock. The North-Eastern Railway Company, by its chief mechanical engineer, is represented by the present express of the company, Mr. Worsdell's own engine. Then there are two or three models of the Great Northern 8ft. express passenger engine. The Taff Vale Railway, as may be assumed from the fact that Mr. Riches, locomotive superintendent, is one of the most active members of the committee, is well and variously represented, rolling stock figuring largely, and the ingenious machine Mr. Riches designed for reaching the entombed miners at Tynewydd. There is also an instrument for recording the speed of trains. The London and South-Western Railway Company is represented by a pair of coaches from the Wadebridge and Bodmin Railway; the Lancashire and Yorkshire by models of the rolling stock of 1825, and that of the present day. The Great Eastern, Great Northern, and Caledonian Railways are also represented by railway exhibits, &c., the Great Eastern by a model of the oil-burning engines introduced by Mr. Holden.

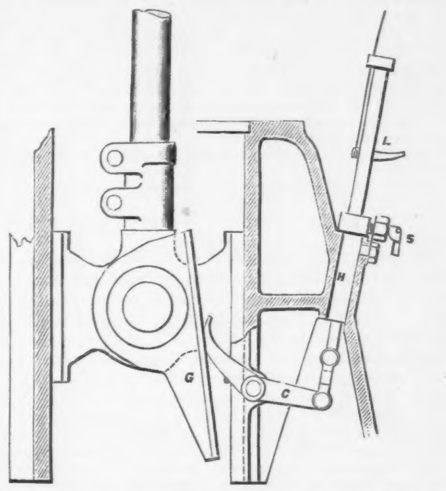
The London and India Dock Committee exhibit a plan of the Victoria and Albert Dock, with models of vessels, wool warehouses, East India Docks, tipping lift, &c. Lloyd's Registry of British and Foreign Shipping is exceedingly well represented by thirty models from the primitive wooden vessels of old days up to the latest ocean steamers. The Mersey Dock and Harbour Board is represented by models of landing pontoons, vessels, &c. Morel Bros., Cardiff, exhibit models of the steamers Llandaff and Penarth; models of marine engines, evaporators, &c., are shown by the North-Eastern Marine Engineering Co., Wallsend; and Messrs. Siemens Bros. and Co., of London, have on view a fine model of the Faraday, which is specially used in laying telegraph cables.

We purpose doing fuller justice to the vast accumulation of exhibits later on, and single out occasionally for special note those of marked interest.

Too much credit cannot be given to the executive for their successful labours in bringing such an attractive exhibition to the notice of Wales, and that, too, in combination with such an ever-increasing flow of amusement and innocent pleasure as will maintain public interest to the full for the next four or five months.

INDICATOR GEAR FOR HIGH-SPEED ENGINES.

For engines running at a high speed it is essential, if trustworthy diagrams are to be obtained, that the connection between reducing gear and indicators should be as direct and short as possible. We have pleasure in publishing an illustration and description of a new indicator gear which is being applied by Messrs. Davey, Paxman, and Co. to the Peache high-speed engine. It will be seen that the reducing motion is obtained by fixing an inclined guide on the engine crosshead and providing a double-ended lever working on a fixed pivot. One end of this lever is made circular in profile, and is kept in contact with the inclined guide; the other end is connected by link to a plunger working in a tube, the tube being fixed in a suitable position. At the upper end of the tube a spiral spring is attached, and exerts a constant upward pull on the plunger so as to keep the lever in contact with the inclined guiding surface. Through the upper part of the plunger is fixed a cross-piece, one end of which carries the indicator cord, and the other end is formed as a thumb-piece. In practice it is intended that the gear shall only be in action when required, and for the purpose of throwing it out of action a spring catch is provided. If by means of the thumb-piece the plunger is pressed down until the spring catch drops into a recess in the plunger, the lever is then held completely out of contact with the inclined guide, and remains so until the gear is again required, when by releasing the spring catch it is at once thrown into action again. In the engraving *g* is the inclined guide, C the lever, *p* the plunger, L the cross-piece, *s* the spring catch.



TRACTION ENGINES ON ROADS.

The Select Committee of the House of Commons, which is appointed to investigate the laws relating to the above, sat again on Thursday, the 30th ult., and were engaged in taking evidence from witnesses from Scotland. The Lord Provost of Aberdeen—Mr. Daniel Mearns—was the first to be called, and in the course of his examination said that this city had 110 miles of streets and roads paved with granite setts, an acreage of 6694, and a population of 135,000. He computed the cost of repairing the damage done to roads by traction engine traffic to the Corporation at £1000 per annum. This was chiefly due to the cross bars on the tires. He thought that local authorities should retain the power to make their own bye-laws, impose licence duties, license drivers, and inspect engines before granting licences. The witness saw no objection to the statutory limit of speed being increased to three miles per hour in towns and villages, and suggested that the weights hauled should be limited as follows:—For seven-ton engines, two trucks weighing six tons loaded; and ten-ton engines, three such trucks.

Mr. William Dyack, surveyor to the city of Aberdeen, attributed the whole of the damage done to the surfaces of the roads by traction engines to the cross-barred wheels, and suggested that the local authorities should have the power to authorise the use of any approved form of wheel. Statutory loads, in the opinion of witness, should be governed by the power of engine, but the length of trains hauled should be limited to three trucks, while both drivers and engines should be licensed, the latter after being inspected. Mr. Dyack saw no objection to the statutory limit of speed being increased to three or four miles an hour in towns.

The Aberdeen County Council was represented by Mr.

J. O. MacQueen, who is also chairman of the Aberdeen District Committee, a body having charge of 280 miles of roads. This witness informed the Committee that, owing to the large increase in traction engine traffic, the expenditure on the upkeep of the roads had risen from £3500 three years ago to £5400 per annum, while in the county the cost of maintaining the roads in 1892 was £21,900; and in 1895, £23,900. There were over sixty engines in use in this district weighing up to fourteen tons. Speaking of the "extraordinary traffic" clause, he considers this unworkable as at present constructed, and suggested the registration and licensing of engines by local authorities on the following scale:—Engines under six tons, 1s. per annum; over six and under seven tons, £7; over seven and under eight tons, £8; over eight and under nine tons, £9; and over nine and under ten tons, £10; with an increase of £2 per ton for engines above this weight.

Mr. Wight, manager of the Association of Traction Engine Owners of Aberdeenshire, Banffshire, Kincardineshire, and Morayshire, explained that the cross bars of the driving wheels of engines only did damage to the granite setts when these were laid upon a concrete foundation, and he considered this was due to a want of elasticity in the bed of the road. He said his association had no objection to a universal licence duty of £15 per engine, and would not object to the restriction of hours for travelling so long as the hours were universal. He thought that agricultural engines should also be licensed, and suggested a fee of half that mentioned above.

The Committee met again on Monday last and heard evidence from Sir Arthur Grant, a landowner in Aberdeenshire, who employs traction engines chiefly for hauling goods and thrashing machinery. He said that there were 230 engines and 328 wagons employed in Aberdeenshire, and the capital involved was between £130,000 and £135,000. The reason for this large amount of road haulage was the want of railway accommodation. The witness saw no objection to the payment of a universal licence fee of £25 upon engines engaged exclusively in haulage work, but considers a £10 fee sufficient for those which are engaged partly in agricultural work. He thought that the engines should be limited in weight to ten tons, and that the statutory limit of speed outside of towns and villages might be raised to six miles per hour.

Mr. W. Smith, Chairman of the Road Committee of the County of Forfarshire, gave particulars of the bye-laws made in his district for recovering from owners for damages done to the roads by their engines, and stated that instead of imposing a licence duty or a tonnage rate they would prefer to have the power of recovery from engine owners for all such damage as could be proved. Mr. Dunlop, magistrate for the City of Edinburgh, and member of the Corporation, was the last witness taken. He said they had found no damage done to their paved streets by traction engine traffic, which was restricted to the hours between 6 p.m. and 10 a.m. He would not recommend the giving-up of the powers to make bye-laws to a central authority.

The Committee again adjourned till yesterday—Thursday.

THE ROYAL SOCIETY CONVERSAZIONE.

AT the Royal Society conversazione, on Wednesday, there were, as usual, displayed various novelties that have lately enriched the domain of experimental or practical science, and, as might be expected, Röntgen's discovery was duly to the front, and at the exhibits of Mr. A. A. C. Swinton and of Mr. Herbert Jackson, the now usual exposure of the arrangement and shape of one's hand bones, of the contents of a closed wooden box of drawing instruments, and of one's own and other people's purses, and of the transparency of the diamond, aluminium, &c., and of the opacity of glass, &c., could be investigated with undiminished enthusiasm under a gratification according to temperament. Whilst Mr. Sydney Rowland exhibited a series of prints illustrating the application of this principle in surgery that were very striking, a further exposition of these rays was shown by Professor Sylvanus Thomson. An upper aluminium plate was electrotyped by them and transmitted the effect to a sheet of lead below with a pattern cut out and covered with aluminium; the corners of the lead plate were bent down, and supported it over a sheet of glass, and by means of electrical dust the portions electrified were rendered evident; and as the glass became electrified where the aluminium window permitted transmission, the shape of that window was reproduced on the glass, and so were the marks of the supporting corners of the lead plate where they were in contact with the glass. Ordinary photography was represented by printing machines and photographs of spectra, &c.; whilst colour photography had two exponents, Professor Meldola with Lippmann's interferential method, and Mr. F. E. Ives with his stereoscopic photo-chromoscope, in which the excellence of the pictures and the simplicity of the apparatus are most striking. Photography leads us to the exhibit of Professor Hartley, F.R.S., which consisted of an impressive series of photographed spectra illustrating investigations of the Bessemer flame, as seen at the North-Eastern Steel Company's works at Middlesbrough-on-Tees, in which the presence of the rare element gallium was recognised by a single line in its spectrum, and separated from both the metal and the ore of the district. One of the most striking photographs consisted of thirteen superimposed spectra taken at intervals during the "blow" and also during the "over-blow." The spectra slightly overlapped the series, showed the increase of temperature during the combustion of the carbon and the persistency of the gallium, which could be detected in ten of the spectra; that is in the spectra of the blow, but not in those of the over-blow. Another exhibit owing its existence to photography, by Professor Worthington, F.R.S., and Mr. R. S. Cole, showing instantaneous photographs of splashes, was of much interest. The photographs had been taken each with an electric spark giving an exposure of less than three-millionths of a second, which could be so timed as to pick out any desired stage of the splash within limits of error not exceeding about two-thousandths of a second. In this way the progress of a great variety of splashes, light liquids in light liquids, heavy liquids in heavy liquids, solids in liquids, &c., had been followed, and the various stages recorded were to be seen. It was remarkable how the character of the material altered the movements incident to the splash, resulting in the formation of little basins, the sides of which became distributed in spray or driplets, or the rising up of a column that toppled over at the top and dispersed, or the formation of a bubble, and others.

Professor Ewing, F.R.S., showed a new apparatus for measuring the magnetic permeability of iron or steel. The samples are used in the form of short rods, and a rod to be tested is compared with a standard rod, the magnetic qualities of which have been determined beforehand. The two rods lie parallel with magnetising coils wound on both their ends, being joined by two short yokes, so that the whole forms a single magnetic circuit. When the induction in both rods is the same, the yokes are at the same magnetic potential, and in that case a magnetic detector placed between them is not deflected; therefore, in making a test, the number of turns in the magnetising coil of the rod to be tested is varied until this is the case, and the magnetising forces required to produce the same induction in both rods is ascertained. The magnetic detector which shows when two rods have the same induction consists of a compass needle placed in a gap in an iron bar joining the two yokes. Taking into consideration its similarity to the Wheatstone bridge, the author proposes to call the instrument a permeability bridge. It can be worked with great ease. The by no means least fascinating exhibits were modifications of an experiment of M. Charles Margot by Professor Roberts-Austen, C.B., F.R.S. A wire of aluminium suspended horizontally between inductors was raised 400 degrees above its melting point by a current of 30 ampères, but a film of oxide on its surface prevented the wire from breaking. It thus formed an electrified liquid cylinder, and by means of a magnet could be contorted into all sorts of curves, and could be made to tie itself into a knot, ultimately breaking on account of local thickening. In another arrangement the aluminium wire was held vertically, and the lower attachment was made to revolve. The contortions of the bright hot cylinder of molten aluminium reminded the observer of the struggles of a worm on a fish-hook. Messrs. Read, Campbell and Co. showed a device for aërating water in a bottle. It consists of a pear-shaped receptacle about 1⅛in. long, ⅝in. diameter at the thickest part, punched out of sheet steel; it is charged with compressed gas, and the little orifice is either closed with an air-shrunk plug at the narrow end, round which the steel is compressed, or by compressing the steel itself, for which a special stopper is supplied. The "drop," as the pear-shaped receptacle is called, is placed narrow end up in the cap of the stopper, which is hinged. The cap is turned over and the arrangement for clamping it brought over the top; on this is attached a cam, which at the top of the stopper works on a button, to which is attached a steel needle; this is forced into the base of the "drop," punctures it, and the gas escapes and aërates the water in the bottle. They seem to be very safe; when heated to a high temperature the ebonite plug gives and the gas escapes without great force, as the drop burst with but little violence, and if crushed, the same harmless behaviour characterises these little bombs, at least, according to Professor C. V. Boys, who himself exhibits geometric wall brackets and geometric steady blocks, the rigidity and stability of which are obtained by having a skilful arrangement of V grooves, indentations, and angled corners, so that the brackets not alone make firm supports for physical apparatus, but the latter can always be maintained in a definite position, and when removed for use can be replaced in the same position, whilst the supports can be piled up to any height, but being geometrically clamped, carry physical apparatus with perfect steadiness.

Retaining its gases, Professor Clowes has applied his hydrogen testing flame and cylinder to a portable apparatus supported in a tripod, the idea of Mr. Boverton Redwood, so that gas from electric culverts can be tested. It is a neat portable apparatus, and gives good indications. Then the Gas Cylinder Committee, lately nominated at the request of the Home Office, had an exhibit showing the unsuitable character of hard or unannealed steel for gas cylinders, the pliant and resistant characters of good soft annealed cylinder and the violent destructive character of the explosion of mixed gases under pressure which no practicable cylinder can withstand. Professor Liversidge, F.R.S., showed flat etched surfaces of gold nuggets and ingots, demonstrated the internal structure in all cases crystalline, and gave an insight into the mode of formation of these masses.

Mr. Carl Jeiss exhibited new portable binocular field glasses and stereo telescopes, which by arrangements of prisms and astronomical oculars the rays passing from the object glass to the eye piece undergo four reflections at surfaces of the prisms, and emerge from the last prism with undiminished intensity. By these arrangements much enhanced effects are claimed to be attained. We have not space to dilate on the interesting display of ancient astrolobes and other instruments exhibited by Mr. Lewis Evans, nor to more than mention Mr. Henry Balfour's exhibit showing the composite character of the archers' bows of many nations, notably those of the far East, China, Japan, &c. Beautiful sections show the skilful arrangements of horn, wood, and sinew adopted, which to a certain extent had also been adopted by Germany. Altogether there were exhibits suggesting many matters of interest to supply topics of erudite conversation and friendly discussion during the evening.

THE BRISTOL ASSOCIATION OF ENGINEERS.—At the invitation of Mr. John Price, the contractor for H.M. docks at Portsmouth, the annual excursion of the above Association was made to that place on Thursday, the 30th ult. The party was taken over the dry docks that are being made, and which are the largest of the kind in the world. The docks are of massive construction, and are faced throughout with white Cornish granite. The dams at the entrance are of exceptional size, and although special difficulties arose in connection with them, they have been perfectly overcome. It is expected that one of the docks will be completed in a few months, although something like two years out of the five years allowed for their completion are yet unexpired. The members were permitted to view the works by the kind permission of Major Exham, R.E., whose resident staff did all in their power to make the visit a success. The party was conducted by Mr. Price and his assistants, including Mr. Reeves and Mr. Manton, the agent-in-charge. The details and history of the undertaking were explained by the Admiralty engineer, Mr. Colson. The jetty, in course of construction by Mr. Lovatt, was explained by his representative, Mr. Prowse. By the special permission of Admiral Rice, superintendent of the dockyard, the party was enabled to inspect a man-of-war, torpedo catcher, the chief shops, and the pumping station. The visitors were subsequently sumptuously entertained at lunch by Mr. Price. Mr. Price, in proposing the health of the Bristol Association of Engineers, dwelt on the importance of the development of the Bristol Docks estate. Mr. Ryan, as president of the Association, thanking Mr. Price in reply, alluded to his honourable connection with the Barry Dock and the Manchester Ship Canal. He concluded by proposing the health of Admiral Rice, and of Major Exham and his staff, coupling with the toast the name of Mr. Colson, the engineer-in-charge. Mr. Price's health was proposed by Mr. McCurrich and Mr. Colson, and the proceedings terminated by Mr. Prowse proposing the health of Mr. McCurrich, the engineer of the Bristol Docks.

THE INSTITUTION OF MECHANICAL ENGINEERS.

ADDRESS BY THE PRESIDENT—MR. E. WINDSOR RICHARDS.

IN glancing over the many able addresses of former presidents of this and cognate Institutions, I observe that the opening remarks often refer to the difficulty experienced in finding subjects to discourse upon. I too must commence in the same manner; for I confess I have found it a most difficult task to decide upon themes which could be either interesting or instructive to so learned a body of engineers and metallurgists as that forming the Institution of Mechanical Engineers. Our Institution does not confine its attention solely to the construction of machinery, as our papers and discussions show. We are equally interested, scientifically, practically, and commercially, not only in the designing of every description of installation, but also in the manufacture itself of iron and steel, so that probably I need not use words of apology for departing somewhat from the path generally followed by presidents when addressing the Institution.

Much has been persistently said and written for some time past about the decadence of our metallurgical and engineering industries; it has been alleged that the machinery we employ is neither so economical nor so efficient as that of late years adopted in competing countries; that our commerce has declined for want of energy and enterprise on our part; and that we are being rapidly outstripped in the race for the supremacy which we have so long enjoyed. As all the members are deeply concerned in this matter, and are pre-eminently those who should remove these reproaches if they are found to be merited, I thought I would lay before you some examples of actual practice, for enabling us to judge to what extent the charges made against us can be justified. This subject having been decided upon, it was my intention at the outset to describe the principal features of the machinery and plant in use at home and abroad for the manufacture of iron and steel, from pig iron to the finished products of rails, plates, billets, girders, and wire rods. But it soon became evident that with the limited time at my disposal it would be impossible to do justice even to the first portion, namely, the manufacture of pig iron; so that on this occasion I must confine my observations almost exclusively to blast furnace engineering. The principal object, then, of this address is to direct the attention of metallurgical engineers to blast furnace practice as it stands to-day, with regard to production, efficiency of appliances, and economy of results obtained; and, where possible, to give cost of labour per ton produced; and so to ascertain the relative positions and prospects in this department of engineering metallurgy, at home and in America, Germany, Luxemburg, France, and Belgium.

You are aware that in the summer of last year a delegation, organised through the British Iron Trade Association, visited Belgium and Germany, with the view of ascertaining how it was that those countries were able not only to compete with us in neutral markets, but also to send their products into our own country. The report of the delegation has been printed and published, and gives a large amount of interesting information, showing that the subjects inquired into have received most careful thought and attention. The inquiry must have entailed great labour, much time and consideration, and considerable tact. The members of the delegation are certainly entitled to the best thanks of all interested in engineering and metallurgical industries. The report deals more fully with the details of the cost of the labour of making finished iron and steel than with that of making pig iron; and directs attention to the much lower rates of wages ruling in those countries, more especially in Belgium, than here. The conclusions arrived at are that much more care and attention is given abroad than at home to details of working, that the workmen are far more industrious, and less given to strikes than ours; but the main question we have to consider after all is, what is the total labour cost per ton of material produced, rather than upon how low a rate of wages a continental workman can live, in comparison with the rates ruling here. I am always inclined to believe that, even with the higher rates paid to labour, the cost per ton is not so much more than that of the so-called cheap labour. This view would seem to be confirmed by the statement made by Mr. Herbert, Secretary to the American Navy. He says that the United States can build better warships at a cheaper rate than any other country except Great Britain, which is in that respect but slightly in the front; and he adds that American ships are, however, type for type, equal to the best in the British Navy. Now, as labour forms so large a percentage of the cost of buildin a ship, it would seem that a highly paid workman is more efficient than a cheaply paid one.

Many conflicting statements are made as to the extent to which continental countries can compete with us now, or are likely to compete with us in the near future; and this subject is of such vital importance to us as to call for an exceptional amount of attention at our hands, for we are naturally most desirous not to relinquish any of our trade in neutral markets, and especially are we anxious that material from abroad should not be sent into this country. It is necessary to bear in mind, when accusing ourselves of want of enterprise, that we should make an important and broadly marked distinction between competition which is founded on merits—that is, on the capacity of one country to produce a commodity cheaper than another by virtue of the possession of cheaper or more effective labour, cheaper materials, cheaper transport, or more modern equipment and plant—and competition which is protected by tariffs. In the examples I am about to cite, the information has been gathered by visits to the several countries, and inspection of the various works; but as such descriptions in an address of an hour's duration can only be briefly dealt with, and principal figures only can be given, it would be greatly to the advantage of the Institution if the members would take up the subjects touched upon, and contribute papers giving fuller descriptions, and so by raising discussion bring out results of working which would greatly benefit the industry.

British productions and blast furnaces.—In the years 1881-82-83, which were years of fairly good trade, the production of all descriptions of pig iron, spiegeleisen, and ferro-manganese in Great Britain averaged, in round figures, 8,500,000 tons per annum. In 1893, a year of bad trade everywhere, the production had fallen to 6,829,841 tons. In 1894 the production had increased to 7,364,841 tons, obtained from 323 blast furnaces, giving an average of 22,800 tons per furnace. As these results cannot be considered satisfactory when compared with those of other countries, the following figures show in which district the outputs were lowest. They are given in the order of production; and allowance must be made for those making cold-blast iron, and using coal, and rich or comparatively poor ores.

District.	Tons.	Furnaces.	Average per furnace.
Cleveland	2,963,419	87	34,062
South Wales	708,856	22	32,220
West Cumberland	674,840	20	23,742
Scotland	655,614	50	13,112
Lancashire	598,023	20	29,651
South Staffordshire and Worcestershire	315,924	25	12,637
Lincolnshire	287,384	13	22,106
Nottinghamshire and Leicestershire	226,950	14	16,210
Northamptonshire	212,411	14	15,172
Derbyshire	210,860	20	10,543
South and West Yorkshire	202,255	13	15,558
North Staffordshire	195,869	13	15,062

The total production of pig iron in 1895 was about 7,900,000 tons.

To the Cleveland district more than to any other must be given the credit of having greatly improved blast furnace construction and practice; and it still maintains the leading position in this country in the production of all descriptions of iron and steel.

For many years it was a school which engineers of all countries visited to their benefit. The district is much indebted to such men as Vaughan, Bell, Gjers, and many others. It was here that Cowper's fire-brick stove was brought to a practical success by Cochrane, who put up the pioneer stove to heat the blast for one tuyere only. This stove was filled with regenerative bricks, and heated from below by coal burnt on a grate, allowing the cold gases to escape through a chimney fixed on the top of the stove; it was not long before the bottom bricks proved unequal to the support of the bricks above, and the result was a collapse, but not before decided success had been attained in economy of fuel, due to the increased temperature of blast obtained. Encouraged by this success, a pair of stoves was erected sufficient to heat the blast for one furnace, and was set to work in October, 1860. Contemporaneously with these applications of fire-brick stoves, Whitwell's apparatus for heating the blast was adopted at Consett, and rapidly extended to other districts, as well as to France, Belgium, and Germany, and the United States. The adoption of this system of heating the blast effected a saving of about 2½ cwt. of coke per ton of pig iron above that obtained by cast iron pipe stoves, besides permitting a higher pressure of blast to be used, and thus increasing the output of the furnace; indeed, the invention of fire-brick stoves rendered possible the large productions of to-day.

Last year's work of Messrs. Cochrane's three furnaces, which have been fully described in the "Proceedings" of the Institution, shows highly interesting figures. With ironstone from the Cleveland mines, containing raw an average of 29 per cent. of iron and calcined 41 per cent., they made 123,594 tons of pig iron over the whole of 1895, being an average of 41,198 tons per furnace, or at the rate of 792 tons per furnace per week, with an expenditure of 21·12 cwt. of coke per ton of iron. The average temperature of the blast over the twelve months was 1490 deg. Fah.

A good and fair example of the working of a Cleveland blast furnace using native ironstone over the last twenty years is furnished by No. 8 furnace at Eston, which was put into blast in 1874, and blown out in 1894, having made from one lining 484,412 tons of pig iron. During that period the furnace was damped down thirteen weeks, in consequence of the Durham colliers' strike. The average output per annum was 24,000 tons. Formerly cast iron pipes were used for heating the blast, but latterly Cowper stoves. During the last year of its working it made 26,168·14 tons of good grey iron, using 26,891·18 tons of coke, being an average of 500 tons of iron per week and 20·55 cwt. of coke per ton of pig.

Furnaces erected at Eston in 1877 continue to produce a little under 1000 tons of Bessemer iron per week, using 50 per cent. ores. The best of these furnaces produced last year 50,800 tons of iron with 18·60 cwt. of Durham coke per ton of pig. These furnaces without any arrangements for cooling the boshes last about five years, and give about 250,000 tons of iron, and then require relining. With present engine-power the above quantity cannot be increased; it has therefore been decided to erect six vertical direct-acting high-pressure engines, as there is no water available for condensing; the air cylinders are 84in. diameter and 5ft. stroke. These engines of exceptional strength are being constructed by Messrs. Tannett Walker and Co., Leeds, and are to supply 25,000 cubic feet of air per minute at from 8 lb. to 10 lb. pressure per square inch to each of three blast furnaces. The boilers are of the Lancashire type, 30ft. long and 8ft. diameter, with two flues, 3ft. 3in. diameter, having five cross Galloway tubes, and are to work at 80 lb. pressure: so that greatly improved results in working are expected to follow shortly upon their completion.

At Jarrow-on-Tyne a blast furnace plant was constructed with all recent improvements, from which greatly improved results were expected. As these results were at first realised, it is of value to ascertain the causes, in order to avoid similar failure in future. The furnace No. 5, is 75ft. high bosh 20ft. diameter, having several cooling plates, angle of bosh 80 deg., hearth 11ft. diameter, throat 16ft., bell 11ft., capacity of furnace 14,150 cubic feet, eight gun-metal tuyeres 5½in. diameter, placed 6ft. above the hearth level. Blast of 3¼ lb. pressure per square inch, heated by four Cowper stoves, 73ft. high and 22ft. diameter, to a temperature of from 1400 deg. to 1500 deg. Fah. Durham coke with 8 per cent. ash and 1 per cent. sulphur, 19½ cwt. per ton of Bessemer pig iron. Production 1000 tons per week from Bilbao and African ores averaging 50 per cent. of iron, increased to 1100 tons during the last few weeks. Limestone 8 cwt. per ton of pig. One pair of compound condensing vertical blast engines, high-pressure cylinder 54in. diameter, low-pressure cylinder 72in. diameter, air cylinders 100in. diameter, stroke 5ft., making seventeen revolutions per minute, for 1000 tons of iron per week. From such an installation as this it would be expected that a large production would be readily obtained at a low cost; but the furnace worked with great irregularity, and was continually hanging and slipping. Increased blast pressures were tried, and failed to produce any improved results. The cause was evidently traceable to the steep boshes. So unsatisfactory and costly was the working that the furnace was blown out in June, 1893, and the boshes were altered to 68 deg. Since this alteration the furnace has worked well and economically. The engineering portion of the whole plant is well carried out. For a furnace having such a large reserve of blast and heating power, an output of only 1100 tons per week cannot be considered a good return for the large amount of money expended.

In a paper read and discussed at the Middlesbrough meeting of this Institution in August, 1893, our Past-President, Mr. Jeremiah Head, described a blast furnace of peculiar internal form, designed by Messrs. Howson and Hawdon, of Middlesbrough. On visiting last month the works of Sir Bernhard Samuelson and Co., in order to ascertain what success this new form of furnace had attained, I found there are five now in operation, giving such satisfactory results that a sixth is being prepared. Two of the furnaces were making Cleveland iron, and three hematite. No. 5 furnace, with 18ft. bosh, 70 deg. angle, 11ft. hearth, 84ft. high., had made during the previous ten weeks, with Rubio ore containing 50 per cent. of iron, an average of 1053 tons per week of good grey Bessemer iron with a consumption of 18·1 cwt. of coke per ton of iron, the coke containing 10 per cent. of ash. The blast is supplied by ordinary vertical compound condensing quick-running engines at about 4½ lb. pressure per square inch, and is heated by Cowper stoves to 1400 deg. or 1500 deg. Fah. By increasing the volume and maintaining the heat of the blast, Mr. Hawdon expects shortly to attain 1200 tons per week.

The Dowlais Cardiff new blast furnace plant is remarkable for efficient and economical working. The two furnaces, have 20ft. boshes, 10ft. hearths, are 75ft. high, and from Bilbao ores containing 50 per cent. of iron each furnace produces 1250 tons per week of good grey Bessemer iron, with a little over 19 cwt. of coke per ton. The production can be readily increased, should the state of trade require it.

From the foregoing statements and descriptions, which can be compared later with the figures obtained in other countries, it will be seen that present British practice with ores containing 50 per cent. of iron averages 1000 tons of pig per week, with a strong tendency to increase. The coke consumption varies from 18½ to 20 cwt. per ton of pig. Labour cost, including everything in connection with the blast furnaces, from unloading the ores to loading up the pig iron, but excluding establishment charges, is as low in one instance as 24d. per ton of pig, rising to 30d. for hematite iron, and to 36d. for Cleveland iron. Having described a sufficient number of works to give a fairly adequate idea of the state of blast furnace practice at home, I now pass on to the consideration of the American pig iron industry.

American blast furnaces.—Taking the same periods as before, namely, the three years 1881-82-83, we find the average production of all descriptions of pig iron for each of these years was 4,500,000 tons; and it has since increased by leaps and bounds, till in 1895 the enormous production was reached of 9,446,308 gross tons; the previous year being one of bad trade, the output was 6,657,388 gross tons. In the month of March of the present year 1896 there were 203 furnaces in operation, giving an average output of 48,000 tons per furnace per annum; so that it is probable the total production of the present year will reach ten million tons. The average production is not of much value, as in the above number there are twenty charcoal furnaces in operation. American blast furnace practice is by far the most interesting and instructive of all; it is receiving the most careful study of continental engineers, and merits our best consideration.

At South Chicago and at many other works there are furnaces doing really marvellous work. A type of furnace which has worked most satisfactorily and economically at the Edgar Thomson Works is 90ft. high, 20ft. bosh, having an angle of 75 deg., throat 16ft. diameter, crucible 13ft. diameter, eight tuyeres placed 8ft. 6in. above the level of the hearth, projecting 6in. inside the lining, and having nozzles 8in. diameter; Cowper fire-brick stoves heating the blast to about 1200 deg. Fah. Each furnace is blown by two single vertical blast engines, having steam cylinders 40in. diameter, and air cylinders 84in. diameter, together supplying about 26,000 cubic feet of air per minute at 10 lb. pressure. This furnace produces the extraordinary quantity of 11,000 tons of Bessemer pig iron per month, when using Lake ores containing 62 per cent. of iron. On many days of 24 hours the output exceeds 400 tons, using the very small quantity of 1790 lb. of Connellsville coke to 2240 lb. of iron, the coke containing 11 to 12 per cent. of ash.

The desirability and economy of these large productions of iron are questioned by many engineers and managers, owing to the hitherto great wear and tear and speedy destruction of the brickwork forming the lining of the furnace. But these objections have latterly been to a great extent surmounted, and are now best answered by the results obtained from furnace I at the Edgar Thomson Works. This furnace has been in blast for more than five years, and has made over 650,000 tons of iron, with an average coke consumption, including all stoppages through strikes and other causes, of 1889 lb. per 2240 lb. of iron. Special means of preserving the bosh lines of the furnaces are adopted, and are highly effective; indeed, the success attained is due in a great measure to this plan, which greatly prolongs the life of the furnace. Cooling plates or flat water-boxes are placed in rows about 2ft. apart, from the top of the tuyeres up to the height of the top of the boshes; they are made of gun-metal, about 5ft. long, shaped to the curves of the furnace, and placed about 6in. away from the inside line of the bosh; they are about 4in. wide by 3in. thick, and have water running continuously through. The two rows above the tuyeres, and the second and third above these, are connected together to save water; and above them three rows of plates are connected together. Before being put into position the cooling plates are tested by hydraulic pressure. Should a plate leak at any time during working, it can be readily withdrawn and another substituted. The crucible below the tuyeres is kept cool by a strong cast iron plate surrounding the furnace; a coil of 1¼in. pipe is cast therein, which serves for the circulation of water.

Another bold change has been made in the size of the bricks used in the construction of the furnace. Formerly, and as is the practice now in other countries, a huge lump of clay was used, sometimes as large as 30in. long, 15in. wide, and 6in. thick. Such a mass it was almost impossible to bake thoroughly to the core. Of late years we have reduced this thickness to 3in. with improved results; but the sizes now used in America have been reduced to 13½in. long by 3in. thick, and 9in. by 3in. to break joints, the whole 3ft. thickness of the furnace walls being made up of two 13½in. and one 9in. brick.

In order to obtain a large output with economical results, American practice adopts a large hearth, and a comparatively small diameter of bosh; the latter gives as much iron as the larger bosh, and uses less fuel per ton of iron by reason of the gases being distributed equally and rapidly over all the ore, and not working in channels as with a larger bosh. The quantity of iron produced depends on the power of the furnace to burn fuel, and in order to do this a large hearth is necessary, together with a large volume of high-pressure blast; when these are provided, the narrower the bosh the more oxygen is removed from the ores by the gases and less by solid carbon; hence lower fuel consumption.

My own practice goes to prove that a furnace rapidly driven works with greater regularity and gives a more even quality of iron, lower in silicon, than a furnace slowly driven. However much some may disagree with fast driving, every furnace manager in Europe whom I have seen for the purpose of this inquiry, whilst professing to be satisfied with the output he had already attained, was at the same time making some addition or alteration whereby he expected to obtain increased production and diminished cost.

Mr. Carnegie is so satisfied with the great economy of the results he has already obtained that he is constructing four more furnaces, and in a few weeks will have two of them in operation at his Duquesne Works near Pittsburg. The results of the working of these furnaces will be eagerly watched by all European and American engineers. The following are the leading particulars of this installation, which is to cost about £600,000. Height of furnace 100ft., bosh 22ft. diameter, angle of bosh 74 deg., crucible 14½ft. diameter, throat 17ft., bell 12½ft., ten tuyeres 8in. diameter, placed 9ft. 8in. above the level of the hearth. There are to be five pairs of blast engines, of vertical compound condensing beam type, having high-pressure cylinder 40in. diameter and low-pressure cylinder 78in. diameter, two air cylinders 76in. diameter and 5ft. stroke; the ordinary speed is to be 40 revolutions per minute, at which speed each pair of engines will deliver 25,000 cubic feet of air per minute at from 16 lb. to 18 lb. pressure per square inch; the maximum speed will be 50 revolutions, and maximum pressure of air 25 lb. A production of 500 tons in twenty-four hours is expected from each furnace, being at the rate of 180,000 tons per annum; and if the lining endures only four years of such work, the satisfactory quantity of 700,000 tons will be obtained, a quantity which an English furnace would require fourteen years to produce. There are twenty-four Babcock and Wilcox 250-horse power boilers, with two steam drums for each boiler, 36in. diameter and 23¼ft. long, and 126 tubes 4in. diameter and 18ft. long; the tubes are arranged in fourteen sections per boiler, nine tubes in each section. Each furnace has four Cowper-Kennedy stoves, with central combustion chamber, height 96ft., diameter 21ft. Every appliance for saving labour, and every improvement which their great experience has shown, will be adopted. Whilst generally in America the whole labour cost per ton of Bessemer pig iron is from 80 cents to one dollar, it is reported that this new plant will reduce the cost nearly one half.

One more example of the working of an American smaller plant. Furnace, 77ft. high; bosh, 19ft. diameter; crucible, 11ft.; six tuyeres, 6in. diameter; four Massicks and Crookes stoves. Production last year, 81,780 tons, or 220 tons per day, of Bessemer pig iron from Lake ores. Ore, 3940 lb. per ton of iron; coke, 2060 lb.; limestone, 780 lb. Total labour cost, 1·05 dol.

Germany and Luxemburg come next in production. The average of the three years 1881-2-3 was 3,254,844 metric tons of all descriptions of pig iron; and the output increased each year, till in 1894 it amounted to 5,345,632 tons, and in 1895 to 5,431,007 tons, being an average of about 28,000 tons per coke furnace per annum in the Dortmund and Bonn districts. Stimulated by the adoption of a protective tariff and by the invention of the dephosphorisation process of steel making, Germany rapidly developed all her industries, and enjoys great and increasing prosperity. Luxemburg contributes a large quantity of pig iron to German steel works, besides supplying important quantities of Minette ironstone. At Esch, in the Grand Duchy of Luxemburg, there are four blast furnaces in operation, making together about 800 tons of basic pig iron per day, which is sent by railway 120 to 150 miles to Westphalia at the low carriage rate of 10f. per ton. This blast furnace plant of the Société de Luxembourgeois is considered the most important in that region. For the last month the furnaces made their largest average of 202 tons per day, using Westphalian coke containing about 8 per cent. of ash, and Minette ironstone, the best in that district, with Greek manganiferous ore to reduce sulphur, and additions of basic slag to give phosphorus up to 2·2 per cent. A new furnace is being constructed, and will be put into operation this autumn; the height is 82ft.; bosh, 23ft. diameter; angle, 73 deg.; hearth, 11½ft.; throat, 15ft. There is much dust in the furnaces, and it is supposed to lie on the boshes, forming a protection to the brickwork, and so water cooling plates are said to be of no practical advantage. In order as much as possible to prevent the dust from passing into the stoves, there are six tubes 8ft. 2in. diameter and 66ft. high, resting in a pan of water; the dust passing alternately down and up these tubes has time to deposit itself in the water, and is scraped out without stopping the blast. Five Cowper stoves, 83ft. high and 23ft. diameter, heat the blast to 900 deg. C. or 1650 deg. Fah. Seven tuyeres of 7in. diameter. For these high stoves a powerful draught is absolutely necessary. The chimney is 270ft. high and 11½ft. diameter at the outlet. A horizontal compound condensing engine, making twenty-four strokes per minute, supplies 22,000 cubic feet of air at 7 lb. pressure per square inch, with steam at 6½ atmospheres; high-pressure cylinder 52in. diameter, low-pressure 78in., air cylinders 100in. diameter, stroke 5ft. 3in. They have never succeeded in getting these cylinders to work without cooling them with water. For the new furnace a vertical compound condensing engine is being constructed at Bayenthal.

At Uckange, in Lorraine, on the Moselle, there is a smaller and well arranged new plant of three furnaces, two in operation, each making about 123 tons per day. The furnaces use Minette ironstone containing from 33 to 34 per cent. of iron, obtained from their mines about two miles distant. A new furnace in course of construction and nearly completed is 65ft. high; bosh, 19½ft. diameter; hearth, 9ft. 9in. Four tuyeres of 7in. diameter. Four Cowper stoves 62ft. high, 21¼ft. diameter. Directly after leaving the furnace the gas is conveyed to a receiver of large diameter, the bottom part of which is tapered to receive a valve easily opened for discharging the dust thus collected. The gas is further passed through ascending and descending wrought iron tubes of considerable height and diameter, and by lowering its speed gives time for more dust to become deposited on the surface of the water receptacle below; the mud thus obtained can then be easily scraped out. By these means the large proportion of the dust is prevented from entering the stoves and boilers. There are three vertical compound blast engines.

At Ruhrort I found the largest German production, the output at two furnaces for the thirty-one days of last month—March—was 16,800 tons from ores averaging 40 per cent. of iron. The furnace was said to be 88ft. high, but the useful height would probably be nearer 80ft. Bosh 21½ft. diameter, angle 63 deg., protected by several water blocks; hearth, 12½ft. diameter. Eight tuyeres of 7in. diameter; nozzle pipes red-hot by daylight; pressure of blast, ¾ atmosphere. Four Cowper stoves 98ft. high and 26ft. diameter. The furnace was lined with carbon bricks up to the boshes only; the bricks are thus kept well below the region of carbonic acid gas, and so far are doing well. A Bayenthal compound condensing vertical blast engine, running at forty-five revolutions per minute, drove one blast furnace. It was said that this engine could run well at sixty revolutions per minute; but with the complicated cut-off gear, such a speed would soon necessitate considerable repairs. The air cylinders were 78in. diameter with 6ft. stroke.

Another set of eight blast furnaces in that district—seven in blast producing together 25,000 tons per month of basic foundry pig, ferro-manganese containing up to 80 per cent. of manganese—whilst working fairly well, offered nothing specially favourable to record, except that, being fully alive to keep to the front, they have just erected and nearly completed the first of eight pairs of horizontal compound condensing blast engines, having air cylinders 80in. diameter and 5ft. stroke; and whilst the manager expressed himself satisfied that 150 tons per day of basic iron is ample for a furnace, he is providing sufficient blast-power to give 200 tons. The Minette ironstone from Luxemburg costs 3s. 6d. per ton, and carriage 6s. 6d. This is mixed with Swedish Grängesberg ore, containing 60 per cent. of iron and 1 per cent. of phosphorus, costing 15s. 6d. f.o.b. at Ruhrort; and with puddlers' tap-cinder from England. The basic pig iron so produced, containing 0·5 per cent. of silicon and 2 per cent. of phosphorus, is conveyed to a 120-ton mixer, where the sulphur is reduced to a very low percentage by the addition of manganese. The whole of the 18,000 tons of steel produced monthly at these works is made by the dephosphorisation process; indeed very little acid steel is now made in Germany, the former being preferred.

At Mr. Fried Krupp's works at Essen, both acid and basic steels are made; but Mr. Asthöwer informed me the best steel made in their large crucible shed is manufactured from puddled iron—a somewhat despised material to-day—which is selected and cut up in suitable pieces for the crucibles. In this large casting-house they make four casts of crucible steel every day of twenty-four hours. Crucible castings up to 80 tons are made from twenty-three Siemens above-ground furnaces, which hold 100 crucibles containing 50 kilos. each. All the castings of varying weights that I examined looked perfectly solid and free from blow-holes. All rails, plates, and girders are made by the dephosphorising process, either Bessemer or Siemens. The shop containing the forging presses, plate-rolling mill, &c., is a magnificent structure. The plate mill has forged steel rolls 4ft. diameter and 13ft. long, driven by a pair of horizontal reversing engines geared 2½ to 1, the rolls making about thirty-two revolutions per minute. I saw a deck-plate rolled from an ingot 20in. thick, and reduced to 2in. in twelve minutes. Some plates for boilers lying on the floor, 12 tons weight, measured 45½ft. long, 11½ft. wide, and 1¼in. thick, made to form the complete circle of a boiler. An ingot mould to receive an 80-ton charge measured 11½ft. by 36in. by 13ft. deep. Mr. Krupp owns twelve blast furnaces, and will commence building at Rheinhausen eight of modern type, each to make 180 tons per day; three are to be at work next year. The blowing engines are to be of the same pattern as those at work at Micheville in France, described later on.

My friend, Mr. Consul Hoesch, is building some blast furnaces at his steel works near Dortmund. My powers of description will give only an inadequate idea of the magnificence of this installation. The works are laid out for four furnaces, two of which, commenced last July, are erected, and will be in operation this summer. The coal for coke-making is washed and crushed, and stocked in capacious bunkers, placed sufficiently high for it to flow into small wagons with bottom doors for charging through apertures in the tops of the ovens. The Coppée coke ovens, with some improvements by Dr. Otto, are arranged at one end of the works in two groups of fifty each. The bye-products, consisting of sulphate of ammonia, oils, and pitch, are obtained; and the cleaned gases are utilised for heating the walls of the ovens and raising steam. Each oven produces four tons of dense coke per twenty-four hours, at a cost of about 10s. per ton. The coke is conveyed by overhead railway to the blast furnaces. The ores are stocked in exceptionally large and numerous bunkers, each 230ft. long and 33ft. deep, entailing a heavy first outlay, because the Swedish ore can be obtained from the Lulea region during five months only of the year, owing to the mines being frozen up during the rest of the year. This ore is estimated to cost about 17s. per ton at the works. The two furnaces, are 75ft. high, 21ft. bosh, rising 18¾ft., angle 75 deg., crucible 10½ft. diameter, 8ft. 2in. high, throat 14ft. 8in., central tube for taking off the gases with two downcomers, six tuyeres of 5in. diameter Ten Cowper stoves, 92ft. high, 21¼ft. diameter, with chimney 245ft. high, outside diameter at bottom 16¼ft. and at top 10¾ft. Twenty-four Lancashire boilers 7ft. 2in. diameter, 34ft. long, two tubes each 30in. diameter without cross tubes, heating surface 95 square metres or 1020 square feet. The two furnaces, placed 114ft. apart from centre to centre, have separate hoists and roofed cast houses; and the hearth level is high enough above the general level for the slag and molten iron to flow into cast iron boxes and ladles, to be conveyed to the heap or to the steel works. For the two furnaces there are four compound condensing horizontal blast engines, with high-pressure cylinder 42in. diameter, low-pressure 60in., air cylinders 75in., and stroke 5½ft., to make from thirty-five to forty revolutions per minute. Steam pressure 8½ atmospheres, and blast pressure from one-half to one atmosphere, as may be required. The 100 coke ovens with bye-product plant are estimated to cost £75,000; the two blast furnaces, with all railways, bunkers, &c., £150,000.

At a works where the production of pig iron was very large, the cost of labour was as low as 1s. 9d. per ton. The total cost, including general and establishment charges, was only 3s. 3d. per ton.

In 1882 the production of Bessemer iron was 733,665 tons, and it has fallen now to 350,000 tons; whilst in 1883 the production of Thomas iron was 369,685 tons, and it has constantly and regularly increased, till it has now reached the enormous total of 2½ million tons. Germany is entitled to the highest credit for her skill, industry, and perseverance in this rapid and great development of the basic dephosphorisation process of steel making. This unexampled success has enabled her to use her own phosphoric minerals to an important extent, and to produce a material used for every purpose, where the highest quality is an absolute necessity.

France follows with an average output in the three years 1881, 1882, 1883, of 2,000,000 metric tons, which declined in 1886 to 1,516,574 tons, and gradually increased to 2,005,889 tons in 1895, when there were seventy furnaces in blast, giving an average of about 30,000 tons per furnace per annum. The furnaces in the centre, South, and North of France making Bessemer pig iron have made little, if any, progress for some years; but great impetus was given to the production of phosphoric pig iron in the East of France by the invention of the dephosphorisation process of steel making. In the Meurthe and Moselle district there are forty-three blast furnaces, which produced last year 1,264,000 tons, being an average of 30,000 tons per furnace per annum, leaving only 813,647 tons for the whole of the remaining furnaces of the country. Engineers in the whole of the Lorraine and Luxemburg districts have paid great attention to blast furnace construction and production; they state that they consider the essential points to be borne in mind for regularity of working and large production are, that every furnace should have numerous Cowper stoves, and should have its own blast power isolated from that of other furnaces. Their most economical and best results have been attained, firstly, by increased size of furnace; secondly, by higher temperature of blast; thirdly, by more powerful blast engines.

The ironstone used is the well-known minette, of three qualities—red, grey, and calcareous. These either by themselves, or mixed with one another, require neither additions of limestone in the furnace nor calcination. The ironstone in the neighbourhood of Longwy averages a little over 30 per cent. of iron. The coke is brought from Westphalia, a distance of more than 150 miles, and costs delivered 21·30f. per ton; the price into wagons in Westphalia is 10f., and the duty 1·30f. per ton. Labour cost per ton of iron varies from 25d. to 30d. The class of iron made throughout this district is mostly Thomas iron, that is, pig iron run into cast iron moulds for the Bessemer basic process, made specially low in silicon so as to contain only about 0·5 per cent.; and in order to make it high enough in phosphorus, namely, to contain about 2 per cent., an addition of phosphoric slag from the converter is necessary, as the minette by itself gives only 1·5 per cent. of phosphorus. Greek ore is also added to give about 1·8 per cent. of manganese in the iron, so as to keep the sulphur down to about 0·6 or 0·8 per cent., the iron being white. Generally, from 1150 kilos. to 1200 kilos. of Westphalian coke is required for making 1000 kilos. of iron. The forge and foundry iron is almost identical in character and analysis with Cleveland iron.

At Micheville two furnaces have recently been put in blast, which are excellent types of good construction. By the courtesy of Mr. Ferry, I am able to give the following description:—Height of furnaces, 80ft.; bosh, 22ft. diameter; angle, 72 deg.; hearth, 10ft.; throat, 16¼ft. diameter. This large diameter of throat enables capacious charging apparatus to be used, and the charges are exceptionally heavy, consisting of coke 5½ tons and ironstone 15 tons, or 1200 kilos. of coke to 1000 of pig iron. There is no greater economy found in heavy over light charges, except that the apparatus is opened less often, and there is consequently less loss of gas. A disc valve of about 16ft. diameter is lowered on the ridge of the apparatus to prevent the escape of gas when the materials are being lowered into the furnace, but as it is difficult to make so large a valve quite gas-tight, there is some escape, though not very considerable. There are only four tuyeres at work, though provision is made for seven. The average production is nearly 150 tons per day. There are four Cowper stoves to each furnace, 80ft. high and 23ft. diameter. Two pairs of vertical compound condensing blast engines, made by the Société Alsacienne of Mulhouse, are of excellent design, strongly made, and of good workmanship—high-pressure cylinders, 36in. diameter; low-pressure, 50in.; air cylinders, 78in. diameter; stroke, 5ft., and 32 revolutions per minute. The governor is adjustable to give the number of revolutions fixed upon by the manager, the pressure of the blast being disregarded. As there is not far away from the blast furnaces a steel works producing 10,000 tons of steel per month, which will soon be increased to 12,000 tons, the engineer, Mr. Hartmann, has paid the closest attention to the economical use of the furnace gases, with the view of working the engines in the whole of the works without using coal under the boilers. There are in all at Micheville four blast furnaces, producing about 3500 tons per week; one is open-topped, that is, there is a central tube taking off sufficient gas to work the blowing engine and Cowper stoves in connection with the furnace, and the remainder of the gas is allowed to escape. When the whole of this gas is utilised by cup and cone arrangement, and six more boilers now nearly ready for work are completed, there will be seen at Villerupt a steel works having a pair of vertical compound Bessemer blowing engines for the basic converters, a compound condensing cogging mill engine, a compound condensing rolling mill engine with three-high billet and bloom and slab rolls, all of which, with all the small engines, will be supplied with steam from the blast furnace gases, after these have heated the hot-blast stoves and worked the furnace blowing engines. The boilers have large combustion chambers below the level of the floor, and are of the multitubular kind, having 208 square metres or 2240 square feet of heating surface, and the tubes are so arranged that they can be brushed out whilst the boiler is at work. A thin layer of blast furnace dust deposited in the tubes largely curtails the power of the boilers to produce steam; six hours without cleaning shows a marked difference in the quantity of steam raised; two men are therefore constantly employed in brushing out the tubes of twelve boilers The gases escape from the boilers at a temperature of 280 deg. C. or 540 deg. Fah., and after passing through Green's economisers, are reduced to 160 deg. C. or 180 deg. C., or 320 deg. Fah. or 360 deg. Fah. The steam pressure is eight atmospheres.

The ingots are taken as hot as possible from the Bessemer department, placed in Gjers soaking pits, in which a small quantity of coal is used, and then rolled off. An English order for basic billets 2¼in. square has just been completed, and delivered in Antwerp at 103f. per ton, a distance of 150 miles, at a cost for carriage, wagon hire, &c., at 7f. per ton. The labour cost per ton of pig is 2·80f., and the total cost 40f. per ton. The cost varies in different districts; the Westphalian syndicate having different prices for coke for different districts, all calculations of costs are rendered most complicated and difficult. The molten metal is conveyed direct from the blast furnaces to a mixer of 120 tons capacity, and from there to three basic converters some distance away.

At the Aciéries de Longwy Mont St. Martin there is an important plant of half-a-dozen blast furnaces, with steel works, having three 15-ton basic converters and extensive rolling mills. Whilst the materials produced are of a high character, there is nothing of special importance to call for attention.

Belgium.—The average production per annum for the years 1881-82-83 was 711,705 metric tons, which declined in 1891 to 684,126 tons, and afterwards increased, till in 1895 the production was 816,039 tons from thirty furnaces in blast, the average output per furnace being about 27,000 tons. The production is still increasing. Although poor in iron ores, Belgium is advancing in blast furnace practice, and intends to hold a leading position.

The Société John Cockerill has constructed in the best possible manner, and just put into operation, a very fine blast furnace installation, having all the most recent improvements. By the courtesy of Mr. Greiner, Director-General of the Company, I had the pleasure of being present at the starting of the furnace on the 30th of last month—March—when the Minister of Public Works travelled from Brussels to light the fire, and wished success to the furnace, and increased commercial prosperity to this most successful company, and to the material interests of the Kingdom of Belgium—an instance of the great interest taken by the Government in the development of the industries of the country. The furnace is 78ft. high, bosh 20ft. diameter, angle 71½ deg. There are five tiers of water blocks above the tuyeres to protect the lining of the boshes. Hearth 10ft. diameter at the bottom, widening to 11ft. at the level of the tuyeres. Seven tuyeres of 5in. diameter, placed 9ft. apart from nose to nose, and 6¼ft. high above the level of the hearth. Throat 15ft. diameter, having two gas outlets to one large downcomer, which leads into a capacious receptacle containing water for cleaning the gases. Four Cowper stoves, lined with octagonal bricks, are 82ft. high and 22ft. diameter; the chimney, with wrought iron casing lined with bricks, is 230ft. high, with a clear outlet of 10ft. diameter.

One of the blast engines is a copy of a type adopted at some American works. It has two outside fly-wheels, an arrangement which makes it difficult to reach readily some of the working parts. It is a single vertical quick-running engine, with air cylinder 84in. diameter placed above the steam cylinder, which is 42in. diameter. The maximum steam pressure is six atmospheres, and the valve gear has somewhat complicated motions for early cut-off. The stroke is 5ft., and the speed forty revolutions per minute, with the intention of running up to sixty; if found desirable the pressure of blast may be increased to one atmosphere. A second engine is being constructed of better design, and of greater power and more strongly made, consisting of a pair of vertical compound condensing engines, with a single large fly-wheel in the centre of the shaft; high-pressure cylinder 30in., low-pressure 48in., two air cylinders each 68in. diameter, stroke 4ft., to make from forty to sixty revolutions per minute; and pressure of air from 7 lb. to 10 lb. per square inch. Great attention has been given to the boilers; they are 9ft. 10in. diameter, and have each three tubes; the two top tubes are 3ft. 3in. diameter, and the bottom one 2ft. 8in.; length 32½ft. The boilers are fired by the gas from the furnace; and each tube has a separate chamber of large capacity, to ensure complete combustion. Westphalian coke is used. The ores are principally Tafna, Rubio, and purple, all low in phosphorus, for making Bessemer pig iron. From the ordinary furnaces about 100 tons are obtained daily; and from the new furnace much better results are expected, probably 200 tons a day.

At the works of La Providence, Marchienne, Mr. Hovine has two furnaces in operation, and a new one is being constructed. Those at work each produce 110 tons daily of basic pig; and the new one, which is larger, is expected to give 140 tons daily. There are altogether seven furnaces in operation making phosphoric pig iron, the steel works using nothing but basic pig. These works are celebrated for the low prices at which they export girders, &c., to England. A rolling mill having three-cylinder engines was rolling girders in a three-high train at a high speed, direct from ingots heated in coal-fired furnaces. The labour cost per ton of Bessemer iron is 2½f.; 4f. cover all kinds of labour and salaries; and another franc is found a sufficient fund for re-lining. Labour at basic furnaces is 3f. per ton of iron, little, if any, limestone being used. Belgium, having last year reduced its tariff, has commenced to complain of Germany throwing some of its surplus production into the country at very low prices.

Several other blast furnaces are being constructed abroad, but sufficient has been said to show that they recognise the vital importance of obtaining suitable and cheap pig iron; great efforts are being made and large sums of money expended to produce it in greater quantities and at lower costs. From the foregoing figures of production and descriptions of plant, it can be seen that great progress is being made abroad, whilst our production of pig iron, compared with the average of the three years, 1881-82-83, remains stationary. America has doubled her output. Germany and Luxemburg are increasing so rapidly that probably this year will see their output also doubled, and they are steadily and rapidly advancing to our figures. France remains stationary. Belgium has increased 13 per cent.

Fuel.—With respect to our position as regards fuel, the cost of coal varies considerably in the several regions; but the following figures of values, supplied to the Secretary of the Board of Trade by Sir R. Giffen, indicate pretty accurately the relative costs of production in the five countries, and show that, as regards Germany, our costs are alike, but are considerably lower than those of France and Belgium. In 1894 the United Kingdom and the other countries here mentioned produced the following quantities of coal of the average values named per ton at the pit:—

United Kingdom	produced	188,277,000	tons at	6s. 8d.	per ton.
United States	,,	158,000,000	,,	5s. 3¼d.	,,
Germany	,,	76,741,000	,,	6s. 7¼d.	,,
France	,,	26,964,000	,,	9s. 0¼d.	,,
Belgium	,,	20,534,000	,,	7s. 5½d.	,,

Iron ores.—Swedish phosphoric and Spanish hematite are somewhat dearer on the Continent than with us; but the minette ironstone costs only about 2s. per ton at the mines, whilst similar ironstone at home costs more, being burdened by a royalty charge of about 6d. per ton.

Railway rates.—We have seen that low railway rates abroad permit of carrying low qualities of ironstone to furnaces 150 miles distant from the mines, and also of carrying coke from Westphalia to the Luxemburg, French, and Belgian blast furnaces to make pig iron, and afterwards of carrying the pig iron made in Luxemburg and Lorraine to Westphalia to be converted into finished products. In this country it must be admitted that we have a splendid railway service, and that the dividends paid are only fair and reasonable; but the rates of carriage are out of all proportion heavier than those ruling abroad.

Labour cost.—As regards the labour cost per ton of iron, there is not much difference to our disadvantage; so that it is misleading to accuse ourselves of inability to compete from this cause. But there is no doubt whatever that our labour has become far more difficult to manage, is much more ready to stop work in order to obtain an increase of wages, and is constantly agitating for fewer hours of work. Every concession made renders it more and more difficult to compete with the Continent in the markets of the world; but our workmen cannot yet be brought to see this, neither can they be persuaded to cease opposition to mechanical devices for saving labour and reducing costs; indeed, all such appliances are jealously watched, and if possible their success is prevented. Yet the favourite remedy for this state of things in many minds is to spread technical education all over the country; whereas, if the result they desire could unhappily be attained, the last state of the trade would be worse than the first, for we should have no hewers of coal nor makers of steel. The truth is that there is no lack of technical ability in this country; quite the contrary. Our continental competitors do not claim to have invented the puddling process, the rolling mill, the steam hammer, the Bessemer acid and basic processes, the hot blast stove, &c.; but they have carefully applied all these processes and inventions of ours to their own use, in a scientific and practical manner; and we are equally free to adopt their methods, if any of them are better than our own. But they can and do claim that they have trained skilful, careful, and obedient workmen. Whilst I do not concede that a continental workman understands his duties better than our workmen, I do most distinctly believe that his military training has been of great advantage to him, to his physique, and to his employers. A compulsory strict military training, to follow the sound and excellent education now given to every one, would contribute greatly to the general good of our country. Our path is strewn with difficulties; but the greatest difficulty we have to surmount, which seems insurmountable, is the barrier of tariffs set up against us. For, whilst Great Britain is free and open to attack from all the world, America demands a payment of 16s. 8d. for every ton of pig iron we send there, Germany 10s. per ton, France 15 francs minimum; and Belgium, brave little kingdom, surrounded by powerful competitors, reduced its duty in July of last year from 5 to 2 francs. In these tariffs lies the real reason of the success of foreign competition; but we have no right to complain, for these barriers have enabled those countries to develope their resources and to employ their own population. But we do complain when, after having supplied their own requirements at prices that leave them good profits, they throw their surplus products into our country and into our Colonies at lowered prices. Remove these barriers, and then the reproachful cries we are fond of raising against ourselves—of want of technical knowledge and ability, want of energy and enterprise, and decadence of our industries—would become cries of the past; and the race for supremacy would be a race run on its merits.

SOCIETY OF ENGINEERS.

AT a meeting of the Society of Engineers, held at the Royal United Service Institution, Whitehall, on Monday evening, May 4th, Mr. G. Maxwell Lawford, vice-president, in the chair, a paper was read by Mr. Arthur Rigg, past president, on "Hydraulic Rotative Engines."

The paper was devoted to the subject of "Hydraulic Rotative Engines," and took no account of any other class of hydraulic motor. Comparison was made between the great literary interest given to turbines, and the paucity of such interest concerning hydraulic engines; also between the great attention devoted to economising steam, and the little that has been done towards economising pressure water, which as a source of power is far more costly than steam.

The author next proceeded to describe all the principal types of hydraulic rotative engine by Armstrong, Westmacott, Brotherhood, and many others. This historic portion of the paper was followed by a theoretical examination of the variations which occur in the tangential driving efforts of different kinds of engines, illustrated by diagrams, and these showed how the peculiar behaviour of some of these engines can be accounted for. The loss of useful effects by contracted passages was next noticed, and the last portion of the paper was devoted to the theory and construction of the revolving cylinder type, together with the author's improvements whereby hydraulic engines are now constructed so that they can be governed automatically, so that they no longer need to use the full amount of water as if working to their maximum power, when doing little or nothing, but are governed for the first time in the history of hydraulic engines, so as to work with an economy as scientific and complete as any steam engine.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Chief engineer: Edwin J. Austen, to the Intrepid, to date April 28th. Engineers: Charles R. Hall, to the Vernon, additional; Henry S. C. Baldwin, to the Active; and Richard W. Martell, to the Intrepid, to date April 28th. Probationary assistant engineer: George H. Scullard, to the Intrepid, to date April 28th.

THE INSTITUTION OF CIVIL ENGINEERS: NEWCASTLE-UPON-TYNE ASSOCIATION OF STUDENTS.—The annual business meeting was held in the Durham College of Science, Newcastle-on-Tyne, on Wednesday, the 29th ult., when the following were elected Council for Session 1896-77:—President: John Bell Simpson, M. Inst. C.E.; past presidents: Philip J. Messent, M. Inst. C.E.; Henry H. Wake, M. Inst. C.E.; J. Watt Sandeman, M. Inst. C.E.; Charles A. Harrison, M. Inst. C.E.; Hon. Charles A. Parsons, M. Inst. C.E.; vice-presidents: J. Dobson Wardale, M. Inst. C.E.; J. Rae Baterden, A.M. Inst. C.E.; William J. Cudworth, A.M. Inst. C.E.; T. Dawson Ridley, Assoc. Inst. C.E.; E. W. de Russett, M. Inst. C.E.; members: R. E. Beavis, Stud. Inst. C.E.; A. Cole, Stud. Inst. C.E.; R. F. Drury, Stud. Inst. C.E.; G. H. Hellas, Stud. Inst. C.E.; A. G. Mackinlay, Stud. Inst. C.E.; honorary secretary, C. C. Markham, Stud. Inst. C.E., Cleveland-terrace, Darlington.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND—PREMIUM AWARDS.—At the closing meeting of the thirty-ninth session of the Institution of Engineers and Shipbuilders in Scotland which was held last week, the members voted premiums of books, of the value of £5 in each case, on account of three very excellent papers that were read during session 1894-95. One of the premium awards was to Professor W. H. Watkinson, M. I. Mech. E., of the Glasgow and West of Scotland Technical College, on account of his paper on "Water-tube Boilers;" another was to Mr. W. Carlile Wallace, formerly engineering partner of Messrs. Blackwood and Gordon, shipbuilders, Port Glasgow, and now a responsible member of the staff of Sir John Brown and Co., Sheffield. His paper was on "The Electrical Transmission of Power in Shipyards and on Board Merchant Steamers." The third award was to Mr. James M. Gale, M. Inst. C.E., a past president of the Institution, and engineer to the Glasgow Corporation Water Commissioners. Mr. Gale's paper was on "The Extension of Loch Katrine Waterworks." In former years, Mr. Gale read other papers on those works, the first of which has become a sort of "classic" in connection with waterworks engineering, and on account of it he received the Institution Gold Medal. On this occasion neither it nor the Railway or Marine Engineering Medal was awarded for any of the 1894-95 papers.

THE INSTITUTION OF JUNIOR ENGINEERS.—At a meeting of this Institution, held at the Westminster Palace Hotel, on April 17th, a paper on "Dredgers" was read by Mr. W. J. Hunter, member. The chair was occupied by Mr. H. B. Vorley, vice-chairman. In dealing first with the question of design, the author gave as the principal affecting considerations:—(*a*) Whether the dredger was required to work in smooth water or in a sea way. (*b*) The draught of water available to commence operations. (*c*) The depth of water to which the dredger was to work. (*d*) Mode of delivery of spoil, whether by ordinary shoots into barges alongside, by a travelling belt, by means of pipes, or over the stern by a travelling belt or a long shoot. After indicating the merits and objections of single and double ladder dredgers, and of open and closed wells, a description was given of the usual type of engine employed. It was very necessary to fit the bucket driving gear with some sort of friction apparatus, arranged to give way when any heavy obstruction was encountered. The shape and make of the buckets, and of the top and bottom tumblers and parts of gearing, were next considered. The second part of the paper contained particulars of construction of ordinary bucket ladder dredgers, of hopper dredgers, and of other classes of dredgers, including sand pump, grab, pneumatic, land, and spoon and bag. Reference was also made to machines for unloading barges by means of a bucket ladder with dredger action. Detailed descriptions followed of two dredgers presenting novel features, built by Messrs. Hunter and English, one for the Peruvian Corporation, and the other for the Leeds and Liverpool Canal Company. The cost of dredging was shown to vary with conditions of working, instances being given of a light-draught dredger in Spain, 1·8d. per cubic yard; on Lake Copias, Greece, with coal at 45s. per ton, 1·3d. per cubic yard; on the river Trent, 0·34d. per ton, the price in each case not including first cost of dredger and depreciation. A discussion followed the reading of the paper.

TESTS OF A 10-HORSE POWER DE LAVAL STEAM TURBINE.*

THE de Laval steam turbine experimented upon constitutes a part of the permanent equipment of the Engineering Laboratory of Purdue University, and the present paper is based upon data secured chiefly through the assistance of Charles E. Bruff, B.M.E.†

I.—DESCRIPTION OF THE ENGINE.

In the de Laval steam turbine, jets of steam, delivered from suitable nozzles, are made to impinge against the buckets of a light turbine wheel. The steam enters the buckets from one side of the wheel, and passing through, is discharged or "exhausted" from the opposite side. The arrangement of nozzle and wheel is shown by Fig. 1. The motion of the turbine shaft, which, under the action of the jets, is extremely rapid, is communicated by gearing to a heavier and slower moving driving shaft carrying a fly-wheel of small diameter; from this wheel the power of the engine is delivered. Regulation of speed is secured by means of a throttling governor, which controls the pressure of the steam admitted to the nozzles.

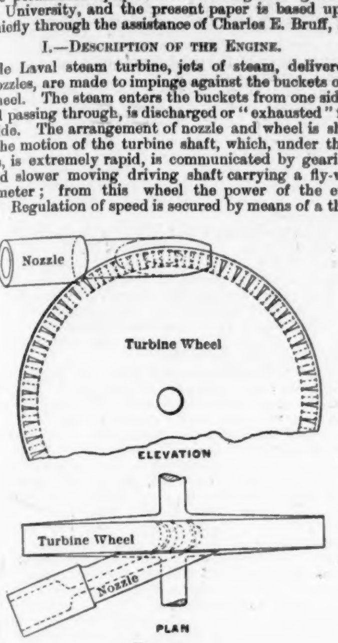


FIG. 1.

The important moving parts, with approximate dimensions, are shown by Fig. 2. The turbine wheel is built up of sixty-three steel segments, each carrying a bucket and a portion of the light outside rim. The segments are held in place by means of suitable collars, which grip them on either side. The wheel is mounted upon a long, slender shaft, having sufficient flexibility to allow the system at speed to revolve about its centre of gravity, even though this may not agree with the geometrical axis of the shaft. The gear upon the turbine shaft is of steel, solid with the shaft; that upon the drive shaft has its teeth formed in a bronze ring, which is carried by a solid iron centre. The smaller gear has twenty-one teeth, the larger one two hundred and eight teeth, giving a ratio of 1 to 9·90476.

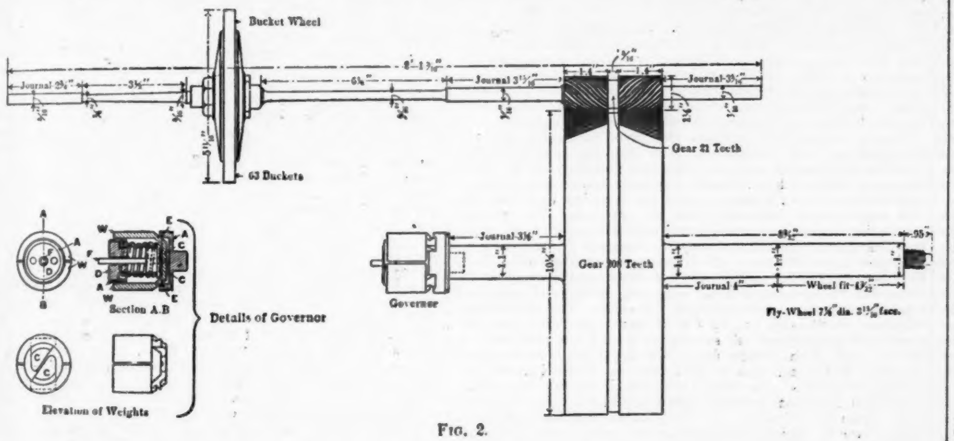


FIG. 2.

The shafts run in bronze boxes completely lined with Babbit or other soft metal. To assist in the distribution of oil, a spiral curve, the pitch of which is about half the diameter of the journal, is cut into the metal of the bearing. The outboard bearing on the turbine shaft is closed at the end, and a small pipe runs from the closed end to a point over the gears. The pumping action, resulting from the presence of the spiral oil-way, gives a constant, though small, supply of oil upon the gears. The gears do not dip in oil, though the case which encloses them receives drainage from all the bearings.

The governor is connected with the driving shaft, of which, at first sight, it appears to be but an extension. It is shown in detail in Fig. 2. The weights W W, with their arms C C, are in the form of a split cylindrical cup. Upon the outside and at the base of each weight a knife edge E E is formed, which bears upon a suitable surface in the governor frame A A. A spiral spring is fitted at its inner end with two projecting pins, which bear upon the arms C C of the governor weights. The outer end of the spring is connected with the frame by the threaded plug D. When the governor is at rest the concave surfaces of the weights are in contact with the frame, and the tension of the spring keeps the knife edges upon their seat. When the governor is revolving at speed the weights are under centrifugal action and move outward, swinging upon their knife edges, against the resistance of the spring. The motion of the weights is taken up by the pin F, by which it is communicated, through suitable mechanism—not shown—to the governor valve above the engine.

The nozzles, which serve to deliver steam to the wheel are four in number, and are so fixed in the frame of the engine as to act upon the turbine wheel at points which are equally distant from each other. Two of the four are provided with stop-cocks, which, when closed, put out of action the nozzles with which they are connected. By means of the stop-cocks, therefore, the engine may be run under the action of two, three, or four nozzles, at the will of the engineer.

The distinguishing feature of the engine, perhaps, is to be found in the form of the nozzles. All are diverging, the throat or smallest diameter being approximately 2in. from the discharge end. Three have a diameter in the throat of 0·138in., and one a diameter of 0·157in.

It is assumed that the form of the nozzles is such that the pressure of the steam as it passes from the orifice will be that of the surrounding medium, and, since the flow is nearly adiabatic, it is clear that if this condition is realised all the energy of pressure is transformed into energy of motion before the steam is allowed to impinge upon the buckets of the turbine wheel. The medium surrounding the nozzles in the machine is practically that of the exhaust, so that the expansion from the pressure of the boiler to that of the exhaust is complete before the steam has contact with any moving part of the machine.

Lateral motion of the driving shaft is limited by contact between the large gear and the bearings on either side. With this shaft fixed, the double spiral of the gears makes lateral motion of the turbine shaft impossible. All forces, therefore, tending to displace the turbine wheel laterally are transferred to the slow-moving shaft, where ample rubbing surfaces can be provided without seriously impairing the efficiency of the machine through frictional losses—a happy solution of an otherwise difficult problem. When it is remembered that the parts shown—Fig. 2—are those of a machine capable of developing 10-horse power, that the driving shaft under normal conditions makes 2500 revolutions a minute, and the turbine shaft practically ten times as many, the opportunity for the display of good design and workmanship may be better appreciated. Viewed as a piece of mechanism, the engine tested appears to merit high commendation, both as to design and workmanship, but the service which has thus far been obtained from it is not sufficient to show the effect of long-continued use.

II.—THE TESTS.

Arrangements for testing.—The power of the engine was absorbed by a Prony brake, cooled by constant streams of water. The exhaust steam was piped to a Wheeler condenser, open to the atmosphere. The water resulting from condensation was drained into tin buckets, which were changed and weighed at regular intervals.

Gauges were used to show the steam pressure both above and below the governor throttle, the former giving the pressure available at the engine, and the latter the pressure under which, in consequence of the action of the governor, the steam was admitted to the nozzles. A manometer was also attached to the exhaust pipe, but as this pipe is large—3in. diameter—and the connection with the condenser close, the observed pressure was never appreciably different from that of the atmosphere.

Conditions and results.—The boiler pressure for all efficiency tests was 130 lb. by gauge, for which pressure the particular nozzles used were designed. The rated speed of the fly-wheel is 2400 revolutions per minute—23,771 for turbine wheel—but this standard was not maintained for all the tests. The governor was adjusted several times as the work progressed, and it was not until several tests had been run that the proper speed was secured. It is believed, however, that the differences of speed recorded do not materially affect the value of results for purposes of comparison.

The tests are grouped into three series, the first including those for which all four nozzles were in action, the second those with three, and the third with two. The several tests in each series were intended to vary from each other only in amount of power delivered from the wheel. All tests were of thirty minutes' duration, and all observations were taken at five-minute intervals. The conditions of each test were maintained with such uniformity that the observations of any five-minute interval were very nearly identical with the average of all observations taken for the test.

The observed and calculated results appear in tabulated form below, Table I.:—

TABLE I.—*A Summary of Results of Tests.*

Nozzles.	Number of test.	Revolutions per minute of belt wheel.	Brake horse-power.	Steam pressures by gauge. In boiler.	Steam pressures by gauge. In engine below governor valve.	Total pounds of steam per hour.	Pounds of steam per brake horse-power per hour.
All four nozzles in action, three having a diameter in throat of 0·138in., and one a diameter in throat of 0·157in.	1	2138	0·00	130	17·1	120·8	—
	2	2545	1·63	130	42·2	210·3	128·6
	3	2038	2·36	130	48·5	230·8	99·8
	4	2118	2·97	130	55·6	254·6	85·7
	5	1917	3·46	130	61·9	275·5	79·6
	6	2072	4·38	130	70·8	313·0	71·5
	7	2128	5·10	130	76·9	328·5	64·4
	8	2576	7·52	130	99·6	403·0	53·6
	9	2453	8·24	130	104·4	422·8	51·3
	10	2411	10·33	130	126·3	491·8	47·8
Three nozzles in action, two having a diameter in throat of 0·138in., and one a diameter in throat of 0·157in.	11	2584	0·00	130	31·3	121·4	—
	12	2112	3·95	130	83·6	267·8	67·8
	13	2125	4·77	130	93·4	286·0	60·0
	14	2490	6·50	130	111·7	346·3	53·3
Two nozzles in action, each having a diameter in throat of 0·138in.	15	2546	0·00	130	42·2	99·3	—
	16	2049	1·95	130	83·5	162·6	83·4
	17	1909	3·43	130	121·1	222·9	65·0
	18	2412	3·87	130	127·0	229·6	59·3

It will be seen that, with all four nozzles in action, and with the engine developing a little more than its rated power, the steam consumption per horse-power per hour is as low as 47·8 lb. In comparing this result with results obtained from other engines, the small size of the engine tested—10-horse power—should be kept in mind, and also the fact that the rate of consumption stated is based upon brake power. The efficiency of the engine falls off rapidly as the load is decreased, and, as would be expected, the effect is most marked when all the nozzles are in action. This may best be seen by means of three heavy-lined curves given in Fig. 3. Assuming the nozzles to be cut out of action one at a time, as soon as the reduction of load becomes sufficient to permit the work to be done without them, the minimum steam consumption at different loads for the boiler pressure and speed employed is represented by the broken line *f g d e b c*, Fig. 3. Again, if instead of four nozzles, an infinite number could be employed, and if the governor could be arranged so as to regulate the number in action, rather than the pressure admitted to them, the steam consumption of the engine in question might be made to follow a line somewhat similar to the light broken line *g e c*. But the heavy lines indicate the results which were actually obtained.

The engine requires very little attention and is almost noiseless in action. The governor is quick to act, and its speed regulation appears to be fair, except when changes of load are large and suddenly made. After such a change, the engine requires a little time before settling down to steady running under the new conditions.

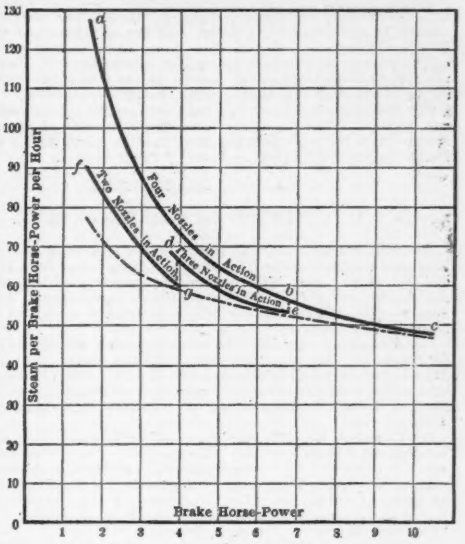


FIG. 3.

Starting power.—As the speed of the de Laval engine is high, it is evident that the force in action must be comparatively low. To determine the maximum resistance under which the engine might be expected to start, the brake was clamped upon the fly-wheel so that the latter could not turn within it. Steam was then admitted to the engine, and readings were taken from the scale under the brake arm. The result of this process, of course, depends upon the steam pressure and the number of nozzles in action. With all nozzles, and with a steam pressure of about 125 lb. by gauge, the maximum starting power is equal to a force of 30 lb. acting at a radius of 1ft. The following tabulated data—Table II.—gives the starting power for different pressures, and when two, three, or four nozzles are in action:—

TABLE II.—*Starting Power of Engine.*

	Four nozzles in action.		Three nozzles in action.		Two nozzles in action.	
Steam pressure by gauge. ..	125·2	71·1	125·2	71·1	125·2	71·1
Effective radius of brake arm, feet..	1·5	1·5	1·5	1·5	1·5	1·5
Reading of scale under brake arm, lb...	20·0	12·1	14·1	9·0	9·5	6·0
Equivalent force in pounds, acting at a radius of 1ft.	30·0	18·2	21·2	13.5	14·3	9·0

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* Presented at the New York meeting—December, 1895—of the American Society of Mechanical Engineers, by William F. M. Goss, Lafayette, Ind., Member of the Society.

† "Tests of a 10-horse power de Laval Steam Turbine," a thesis by Charles E. Bruff, 1895.

SUICIDES IN THE ENGINE-ROOM STAFF OF THE MERCANTILE MARINE.

A MEMORANDUM recently issued by the Registrar-General of Shipping and Seamen deals with the question of suicides in the engine-room staff of the mercantile marine.

In this report the Registrar-General states that it is only since the beginning of 1892 that the system has been in full working order by which officers at the ports at home and abroad hold a special inquiry into cases of deaths of firemen and trimmers reported to have committed suicide or as missing at sea, and that the memorandum is confined to deaths from above causes of firemen and trimmers which occurred since 1st January, 1892, on vessels registered under the Merchant Shipping Act in the British Islands.

An analysis of the reports of the inquiries of the officers shows that thirty firemen and trimmers serving under ordinary agreement, and nineteen Asiatic firemen and trimmers serving on vessels trading to the United Kingdom under "Asiatic" agreement—*i.e.*, special agreements terminating in India or China—committed suicide or are supposed to have committed suicide in 1894, as against twenty-seven and fourteen respectively in 1893. The figures also show that but few suicides occur in the home or coasting trade, where the voyages are short and a man feeling unwell can remain on shore.

As regards the foreign going trade, the suicides occur in no very marked degree in any particular locality, nor can it be said that suicides occur with frequency on a particular vessel or line of vessels. It should be noted, moreover, that no suicides are reported to have occurred in the record-making mail steamers running between the United Kingdom and the United States. It appears that the suicides cannot be attributed to ill-usage either by their superiors or fellow workmen, the reports in all cases being to the effect that there was no ill-treatment.

The heat of the stokehold and coal bunkers is undoubtedly very great, running in some cases to 120 deg. Fah., but to give any comparative table on this point would be misleading, as the temperature is not taken upon any system. It also appears from the reports that the number of deaths occurring either when the man was actually drunk or suffering from delirium tremens, or from the effects of a recent drinking bout, including those suffering from mental derangement, was twelve in each of the years 1894 and 1893; and the conclusion would appear to follow that the prevalence of suicide amongst firemen may to some extent be attributed to the necessity of turning to work in a hot stokehold whilst still suffering from the effects of drink.

The proportion of suicides to number employed is—as in the case among the general population—larger among the men over thirty than amongst the number under that age.

With regard to the question as to what are the number of firemen and trimmers employed in the mercantile marine of the United Kingdom amongst whom these suicides occur—when an attempt was made to obtain the numbers employed on the 5th April, 1891, on merchant ships registered in the British islands, it was found that on that day there were actually serving as firemen and trimmers—not including Lascars—on these vessels the following numbers:—

In the home trade	4,207
In the foreign trade	17,258
In the fishing trade	399
Yachting	97
	21,961

These figures—allowance being made for variation in tonnage employed—represent approximately the numbers at sea at any one time; and the total strength of the whole body of firemen and trimmers required for the mercantile marine service is obtained by adding a certain proportion to cover the number of men on shore.

The Registrar-General calculates that the rate of suicide amongst firemen and trimmers in the mercantile marine is about 1 in 900. Suicide amongst stokers in the Royal Navy is very rare. The Registrar-General concludes his report as follows:—"There can be little doubt that the figures as regards 'suicide' or 'supposed suicide' fairly represent the actual condition of things, and that though the rates of suicide I have given, based as they are on estimates, may be criticised, no amount of criticism will obscure the fact that suicide amongst firemen in our mercantile marine service is prevalent to a degree, calling for serious attention."

The rate of suicide amongst all males between the ages of twenty and fifty-five, which practically cover the active life of seamen, appears from the reports of the Registrar-General of Births and Deaths to be about 1 in 5000.—*Board of Trade Journal.*

THE INSTITUTION OF GAS ENGINEERS.

A GENERAL meeting of the Institution of Gas Engineers will take place on Wednesday, Thursday, and Friday, the 13th, 14th, and 15th of May, 1896. The first two days' meeting will be held at the Institution of Civil Engineers, Great George-street, Westminster, S.W. The third day will be devoted to a visit to the Hastings Gas Works.

On Wednesday, May 13th, the following papers will be read and discussed:—(1) "Notes on Residuals," by Chas. Hunt. (2) "The Efficiency of the London Argand at different rates of Gas Consumption, with Special Reference to its use as a Gas Testing Burner," by Lewis T. Wright. Annual Dinner at the Holborn Restaurant at 6.30 for 7 p.m.

On Thursday, May 14th, the chair will be taken at 10.30 a.m. Reading and discussion on the following papers:—(3) "Incandescent Gas Lighting," by Vivian B. Lewes. (4) "Gas, its Measurement in Relation to Temperature.—A Question for Consideration," by George Livesey. (5) "The Application of the Expansion of Fluids to the Correct Measurement of Gas," by W. Fiddes. (6) "Coal Gas Enrichment," by A. F. Browne.

On Friday, May 15th, at 9.0 a.m. the members will leave Charing Cross Station, South-eastern Railway, by the 9 a.m. train—or Cannon-street 9.5—in saloon carriages, by fast train to Hastings, *viâ* Ashford, where the first stop is made. Leaving Ashford 10.42 the train proceeds through the romantic south-eastern corner of England, passing Romney Marsh, Dungeness, the ancient cinque Port of Rye, the ruins of Camber Castle, and picturesque Winchelsea. On arriving at Hastings the party will proceed to the gas works—ten minutes' walk—where they will be received by the engineer and his staff, and conducted over the works. The Hastings Gas Works possess many points of interest, not only from their situation now, but as an example of works which have been re-constructed several times on the same site, as enlargement became necessary. At the present time the works are in a state of transition for an ultimate make of three million cubic feet per day. Attention may be directed to the gasholders, which have all been erected recently, and to No. 3 in particular, which has a steel lining placed inside the original C. I. tank, owing to the W. I. bands surrounding it having given way and being very difficult to replace. This holder has an original type of guide framing, and the inner lift of the holder rises above this. Carburetted water gas plant is also in course of erection, on somewhat novel lines, as regards arrangement. There is also a small but complete electrical installation, sulphate of ammonia works, special apparatus designed for dealing with naphthalene troubles or enrichment, a complete laboratory, and new offices and show rooms. The retorts are all 22in. by 16in., oval D 20ft. long, set in beds of sixes, which give very good results, but it is ultimately proposed to fit up No. 3 house with machinery and regenerative furnaces. The coal used is principally Newcastle, being shipped to Whitstable, conveyed thence by rail, and carted into the works. Owing to the geographical position of Hastings and the town dues on coal, it is expensive compared to other similar towns. After the inspection the members will be entertained to luncheon by the Directors of the Hastings and St. Leonard's Gas Company, in the new offices. After luncheon conveyances will be ready to proceed for a drive along the extensive sea front to West St. Leonard's, and round the charming country at the back of the town, returning along the Ridge through the old part of Hastings and fishing quarter, along the front to the Hastings pier, fifteen minutes' walk from the station. 6.0 p.m., train leaves Hastings, *viâ* Tunbridge Wells, due Charing Cross 9.7 p.m. 7.15 p.m., train leaves Hastings, *viâ* Tunbridge Wells, due Charing Cross 9.23 p.m.

LAUNCHES AND TRIAL TRIPS.

On the 1st inst. Messrs. Wm. Simons and Co., Renfrew, launched from their yard the last of the three steam hopper barges recently ordered by the Admiralty. It is of the following dimensions:—Length, 160ft.; breadth, 28ft. 6in.; depth, 12ft. 6in.; and has a hopper capacity for 570 tons of dredgings. This vessel was launched with all her machinery on board complete with steam up, and will in a few days leave for H.M. Dockyard, Devonport, where she is to be employed. Messrs. Hay, Stewart, and Scoggins, Admiralty overseers, represented the Admiralty at the launch.

Earle's Shipbuilding Company, Hull, has made a further addition to the Stettin and Copenhagen line of Messrs. Thomas Wilson, Sons, and Company, of its town, in the shape of a fine steel screw steamer, named the Zero. She is 250ft. long, 30ft. beam, by 18ft. 1in. moulded depth, and being intended for the carriage of butter and other perishable cargo, she is fitted with a Hall's patent refrigerating plant, and her main hold insulated and converted into a cold storage chamber. The vessel has a topgallant forecastle and a long poop, in the latter of which there is accommodation for twelve first-class passengers, besides quarters for the captain, officers, and engineers. The machinery is of the three-crank triple-compound type, with cylinders 18½in., 31in., and 53in. diameter, by 33in. stroke, and two boilers to work at 200 lb. steam pressure.

On Friday, May 1st, there was launched from the Cleveland dockyards of Sir Raylton Dixon and Co., Middlesbrough, a fine steel screw steamer, which has been built to the order of The Hamburg South American Steamship Co., for its passenger and general traffic to Rio Grande, under the supervision of Mr. F. G. Dietze. This is the first of two sister ships which these builders are now constructing for the same owners. The vessel is of the spar deck type, and has been built under special survey for Bureau Veritas highest class, the principal dimensions being:—Length, 310ft. 6in.; beam, 41ft. 2in.; depth moulded, 26ft.; with a deadweight carrying capacity of about 3960 tons on a light draught. The accommodation for first-class passengers is under the bridge, with dining saloon in house on bridge deck, all of which will be handsomely fitted up. Commodious and well ventilated quarters for about 326 emigrants are also provided aft in poop and 'tween decks. The decks are sheathed with teak, and all the fittings and accommodation are of a particularly complete and first-rate description. Triple-expansion engines will be supplied by Messrs. Thos. Richardson and Sons, Hartlepool, having cylinders 20in., 33in., 57in. by 45in. stroke, with two large boilers working at 205 lb. pressure. The steamer on leaving the ways was named Taquary by Mrs. R. H. Harkness, of West Hartlepool.

On Thursday, 30th ult., Messrs. Batram and Sons, of Sunderland, launched a large finely-modelled steel screw steamer for Messrs. John Herron and Co., of Liverpool. The vessel is of the spar deck type, with long bridge covering engine and boiler openings, poop, and topgallant forecastle. The following are the principal dimensions:—Length, 350ft.; breadth, 45ft.; depth moulded, 26ft. 9in.; with a carrying capacity of 5200 tons on a very light draught of water. There are six water-tight bulkheads, and the double bottom will contain about 800 tons of water ballast. The vessel is built on the deep frame principle, the hold beams being dispensed with; and the holds being particularly clear of all obstructions, and suitable for general cargoes. The deck machinery consists of six large steam winches by R. Welford, direct-acting steam windlass by Emerson, Walker, and Co., one of Riley Bros.' multitubular donkey boilers, and steam steering gear by John Lynn. The saloon and captain's room are at fore end of the bridge, and are handsomely fitted up in polished hardwood. The accommodation for officers and engineers is placed at the aft end of the bridge. The crew have comfortable quarters in the forecastle, and the poop is fitted for light cargoes. The engines will be supplied by Messrs. J. Dickinson and Sons, the cylinders being 24in., 31½in., 65in. by 42in. stroke, with two steel boilers 15ft. 6in. by 10ft. 3in., 160 lb. working pressure. In addition to the usual machinery there will be an evaporator and feed-heater, steam ash hoist, duplex feed and ballast pumps, and other modern appliances. The vessel and her machinery are being superintended during her construction by Messrs. Flannery and Gritton, consulting engineers, of Liverpool and London. As the vessel left the stocks she was named Lord Kelvin by the Mayoress of Sunderland.

At Renfrew, on April 29th, there was launched complete from the works of Messrs. Wm. Simons and Co., a large and powerful twin screw hopper dredger, constructed to the order of the Crown Agents for the Colonies, for the Government of Ceylon. It is for service at Colombo Harbour works, and was built under the direction of Messrs. Coode, Son, and Matthews, consulting engineers, Westminster, Mr. Wilson Wingate, N.A., being inspecting engineer. Its dimensions are as follows:—Length, 216ft.; breadth, 40ft.; depth, 15ft. The hopper compartments are provided on each side of well, and have a joint capacity for 900 tons dredgings, having all the necessary gear for lifting and lowering the hopper doors by steam and hand. The vessel is also adapted for loading barges of large capacity on either side when required in addition to filling its own hopper, the upper tumbler being high enough to allow sufficient angle for shoots to fill the barges when the dredger is fully loaded. The buckets have a capacity of eighteen cubic feet each, and the bucket ladder works in a central well capable of dredging to a depth of at least 36ft. under water level when the vessel is light, and the angle of the ladder does not exceed 45 deg. The weight of the bucket ladder, with buckets and mountings complete, is about 170 tons. It is propelled by two sets of triple expansion engines driving twin screws of 1000 combined indicated horse-power, and has two boilers of mild steel constructed for a working pressure of 160 lb. per square inch. An auxiliary boiler is also fitted in the stokehold to work the deck machinery when under repair. Powerful triple barrelled steam mooring winches are provided at bow and stern, each barrel working independently or conjointly as required. Steam hoisting engines are provided for lifting the bucket ladder, and also for raising the hopper doors, two independent sets of steam steering gear. Double geared anchor cranes of special construction are fitted at bow and stern. Awnings are fitted on deck fore and aft. The cabins for officers and crew are comfortably fitted up, with separate rooms for the officers, and bath rooms attached. The timber fittings throughout the vessel are of teak. On leaving the ways she was named the Sir John Coode, by Mrs. Coode, wife of the senior partner of Messrs. Coode, Son, and Matthews, whose father, the late Sir John Coode, was the founder of that well-known firm of civil engineers.

Messrs. Joseph L. Thompson and Sons, of the North Sands Shipbuilding Yard, Sunderland, have just delivered two finely modelled steel screw steamers, the Maria Rickmers and the Ellen Rickmers, to the order of Messrs. Rickmers Reismuhlen Rhederei and Schiffbau A. G., Bremen, which are intended to run in the rice trade mainly between China and Bremen. The general description of the vessels is as follows:—427ft. long, 50ft. 6in. wide, and 30ft. deep, moulded; and they are designed to carry a deadweight of over 7200 tons, with Lloyd's summer freeboard. They have been built under special survey to Lloyd's highest class, on the three deck rules, and have a full poop, long bridge, and topgallant forecastle. The poop is arranged for cargo. The officers' and engineers' berths are on the top of the bridge deck, and the passengers' state rooms and saloons are placed in a house built on the fore part of the bridge deck. On top of this house is placed the chart and wheel houses. The crew are berthed in the topgallant forecastle. The vessels are built on the web frame principle, with intercostal stringers right fore and aft. The upper and main decks are of steel, the poop, bridge, and forecastle decks being of wood. Special attention has been paid to the loading and discharging arrangements, nine derricks being fitted, six of which are of steel. Seven powerful steam winches are placed on deck at the hatches, and a patent steam windlass on the forecastle deck. The steam steering gear is placed at the after end of the engine room, and is controlled by a wheel from the steering house on the bridge forward. All the auxiliary machinery is arranged to work at the full boiler pressure. A powerful screw gear is placed at the after end of the poop. Water ballast is carried in a cellular double bottom, right fore and aft and in the after peak. The vessel is fore and aft schooner rigged, with pole masts. On the upper bridge deck amidships are placed four large boats, the two lifeboats being of seamless steel. The vessels have a graceful clipper stem finished off with a well carved figurehead, and elaborate trail boards running away from this. The engines for the Maria Rickmers have been supplied by Messrs. George Clark, Sunderland, and are of the following sizes:—27in., 43in., and 72in., with a stroke of 46in. Steam is supplied by four multitubular boilers, working at 180 lb. pressure; and all the most modern improvements in propelling machinery are fitted. The engines for the Ellen Rickmers have been supplied by Messrs. John Dickinson and Sons, Sunderland, and are of the same sizes as the above, but with three boilers only. In this vessel, Howden's system of forced draught have been adopted. The vessels, after running a most satisfactory trial, proceeded to their loading berths, and are now on their first voyage to the East. The two vessels attracted a considerable amount of interest in shipbuilding circles while being finished at the works of the builders, and are notable additions to Messrs. Rickmers' well-known fleet.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

THE demand for steam coal is good, and stems are fairly filled. The shipments for the past week reached nearly 90,000 tons. Prices are firm. House coal shipments are fairly good, with prices unchanged. Tin-plates steady, with moderate inquiry. The iron and steel works in this district are fully employed.

Coal: Best steam, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s.; house coal, best, 10s.; dock screenings, 5s.; colliery small, 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 46s.; hematite warrants, 47s. 5d. f.o.b. Cumberland; Middlesbrough No. 3, 37s. 5d. prompt; Middlesbrough hematite, 45s. Iron ore: Rubio, 12s.; Tafna, 11s. 3d. Steel: Rails, heavy sections, £4 12s. 6d.; light ditto, £5 f.o.b.; Bessemer steel tin-plate bars, £4; Siemens tin-plate bars, best, £4 2s. 6d.; all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel, coke, 9s.; Siemens, coke finish, 9s. 3d. Pitwood, 15s. 3d. to 15s. 6d. London Exchange telegram: Copper, £45 8s. 9d.; Straits tin £59 16s. 3d. Freights, firm.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

THE works were reported on 'Change in Birmingham to-day—Thursday—to be steadily engaged, and the improved Cleveland stock returns also assisted the market. Values remain much the same as a week ago. The attendance on 'Change was more limited than usual, many of the chief ironmasters being away at the Iron and Steel Institute meeting.

In finished iron, marked bars are £7, with 12s. 6d. extra for special brands; merchant bars are £6 to £6 5s.; and common bars, £5 5s. to £5 7s. 6d. The weakness in sheet iron values continues. Black sheets are quoted: singles, £6 7s. 6d.; doubles, £6 10s. to £6 15s.; and lattens, £7 15s. Hoop and thin strip are £6 7s. 6d.; angles are £5 15s.; stamping sheets are £9 10s.; and best thin sheets, £11. Galvanised sheets have strengthened with the advance in spelter, and are now about £10 5s. for 24 gauge, f.o.b. Liverpool.

Steel is in good request at £5 10s. for basic girders and angles, and £6 5s. for boiler plates. Siemens' blooms and billets, £4 15s.; Bessemer, £4 10s.; bars, £5 15s. to £6; sheets, £7 5s. to £7 10s., and angles and boiler plates, £5 12s. 6d. to £5 17s. 6d.

Pig iron prices are slightly firmer. Northampton forge pig is 40s.; North Staffordshire and Derbyshire, 41s. to 42s.; and Lincolnshire, 42s. to 43s.; Staffordshire all-mine is 55s.; part-mine, 40s. to 44s., according to quality, and cinder pigs, 35s. 6d. to 37s. 6d. Cold blast pig is 90s.

Engineers and machinists have plenty of work on their books, and the heavy ironfounders are well employed. For boiler, bridge, and general constructive works there are contracts on hand that will keep the men engaged for several weeks.

The annual meeting of the Birmingham gun trade has passed a report showing the number of barrels of all kinds proved at the Birmingham Proof-house during the year to have been 328,791, as compared with 299,273 in 1894, and 335,271 in 1893. The total amount received for barrels proved during the last three years has been:—1895, £3866; 1894, £3284; 1893, £3629. The chairman, in moving the adoption of the report, said that during the latter half of the past year there had been a considerable improvement in the gun trade, as shown by the number of barrels proved, there being an excess of 29,518 over the previous year. The exports of small-arms during the year showed an increase of £29,073. Reference was made to the proposal of the Armourers' Club of London to extend their operations so as to include the Gunmakers' Association, and it was understood that the matter would be brought up at one of the ensuing monthly meetings of the Proof-house.

In a communication to the South Staffordshire Institute of Iron and Steel Works' Managers, Mr. Thomas Morris, of Warrington, commenting upon the subject of foreign competition in the iron trade, has the following:—"The man is untruthful who says the continental puddler is as good as the English puddler, or who says the hammerman can shingle the iron better than our men; in fact, he is not truthful if he says any workman, through the whole gamut of them in the forges and mills, can equal the workman in Great Britain. Our orders leave us and go abroad to them in 99 cases out of 100 not because of better finish or better quality, or better education, but because the furnaces are kept going continuously 144 hours per week, as against our 128 to 130, and that not continuous; the puddler in Germany working for about half the wages the Staffordshire puddler gets, in Belgium for 2f. 35c. per 1000 kilos.—about 2s. for the English ton—or a little less than one-third the Englishman gets; and all others whom we term skilled workmen being paid at similar rates."

Rates of freight charged by German and United States lines to South Africa are compared with those charged by English lines by a special committee of the Wolverhampton Chamber of Commerce. It is shown that, as the result of the English shipping ring, and its agreement with the shipping companies of Germany, manufacturers of hardware in Remscheid can send their goods at 19s. 7d. per ton cheaper to Delagoa Bay than can manufacturers in Wolverhampton, and manufacturers of hardware in Berlin 21s. 6d. per ton cheaper. German competition is felt most at Delagoa Bay and north of that port, to which ports English rates of freight are practically prohibitory. For instance, the rate of freight for hardware from Wolverhampton to Tanga—German East Africa—is 75s., and the rate from Remscheid 43s. 4d. English goods to such ports are being shipped *viâ* Hamburg. The completion of the railway from Beira to Bulawayo and the development of the goldfields in Rhodesia may open up an immense trade for the Midlands, but the committee fear that German manufacturers will reap the chief benefit, the rate of freight from German manufacturing districts to Beira, the port of Rhodesia, for hardware, being 43s. 4d. against 75s. from Wolverhampton to Beira. As a result of the dissatisfaction of shippers, a joint committee of merchants and shipowners was formed some years ago to discuss all matters relating to rates, but it has been barren of results. The committee regard as increasing and serious the diversion of trade from British manufacturers which is being occasioned by the advantages derived from rates of transport not by the manufacturers of Germany alone, but by those also of America.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The position generally throughout the iron trade here remains one of quietude as regards new business. Users, as I have previously stated, are mostly well bought for actual requirements, and the present weak tone in the market is rather an inducement to hold off from further buying. At any rate, until after the Whitsuntide holidays it is not likely there will be much buying of any weight. Makers and manufacturers, although not just now replacing the contracts running out, are in the meantime holding on to late rates, whilst merchants and dealers, where business is offered, cut in with low second-hand parcels, with the result that transactions are few and difficult, except at under current quoted rates.

The attendance on the Manchester Iron Exchange on Tuesday was about an average, with again only a small inquiry stirring generally, and an easier tone in the market as regards some brands of pig iron. Lancashire makers are still firm at their late quotations of 46s. 6d., less 2½, for No. 3 foundry delivered Manchester, and are booking renewals of contracts without difficulty on this basis. District makers are also securing a moderate business at late rates, orders being reported in some cases as coming forward rather more freely; Lincolnshire remains at 41s. to 43s. for forge and foundry, and Derbyshire foundry at 46s. to 46s. 6d. net cash, delivered Manchester. Outside brands offering here could be bought at about 3d. under last week's quotations, good foundry, Middlesbrough, not averaging above 46s. 4d. to 46s. 10d. net cash delivered by rail Manchester, whilst Eglinton is readily obtainable through merchants at 46s. 6d., and Glengarnock 47s. 3d. net, delivered Lancashire ports, with about 2s. 3d. more for delivery Dock Quays, Manchester, but makers quote above these figures.

In finished iron a falling off in new business is reported, orders now coming forward not being sufficient to replace those running out. For Lancashire bars £5 10s. is the maximum figure, with North Staffordshire qualities still quoted £5 12s. 6d. to £5 15s. delivered here. Sheets continue weak, and are obtainable at £6 17s. 6d. to £7, but Association list rates for hoops are steady at £6 2s. 6d. for random to £6 7s. 6d. for special cut lengths delivered Manchester district, with 2s. 6d. less for shipment.

In the steel trade makers are doing a fair business, and firm at late quotations, but there is a good deal of underselling on the part of merchants and dealers. For No. 3 foundry hematite makers still hold to 58s., less 2½, as the minimum, but at this figure they are altogether out of the market for new business merchants being prepared to sell at 56s. 6d. to 57s., less 2½, delivered here. Steel billets still average £4 7s. 6d., with bars obtainable a trifle under £6, whilst boiler plates, although still quoted £6 7s. 6d. by makers, are still sold by merchants in odd lots at £6 5s., delivered here.

In the metal market the demand for all descriptions is fully maintained, with prices very firm at full list rates, and the probability of some advance on brass goods at an early date is bringing forward some extra inquiry in this direction.

The reports I receive generally from representatives of the engineering trades throughout this district still show activity well maintained in practically all departments, new work coming forward freely, especially amongst machine tool makers, stationary engine builders, and boiler makers, whilst the locomotive building firms are now throughout this district well supplied with work for some time to come. Of course the decided improvement which has come over the engineering industries during the present year is, as might be expected, giving rise to some agitation amongst the workmen for advances in wages. So far any actual movement in this direction is confined to a couple of engineering centres, the pattern makers in the Bolton district and the moulders in the Oldham district having brought forward the question of placing their wages on the same level as the rates ruling in Manchester. Hitherto it has been an understanding that in outside districts such as the above, the rate of wages should be on a lower scale than those which are paid in Manchester, and whether the movement for bringing the Bolton and Oldham wages up to the Manchester level will, if successful, be simply a prelude to a move for an advance in the Manchester district, so as to maintain wages there at their higher level, of course remains to be seen. The matter is at present, I understand, under the consideration of the Employers' Association, but nothing definite has yet been actually decided upon.

Messrs. Maybrick and Ashworth, of Dickenson-street, Manchester, are introducing a patent safety apparatus for application to hoists and elevators, the object of which is to prevent the hoist from moving further, in the event of the rope breaking, and so remove the risk of serious accidents. The invention consists of a governor which controls a wedge or brake, and which is so arranged that if the rope of the hoist breaks, the governor balls fly out, and bring the wedge in contact with the guides, and with an abutment on the case of the hoist, the friction of the wedge on the guide forcing the former in between the guide and the abutment, with the result that the cage is immediately stopped. A stationary rope is fixed in proximity to the path of the cage, which, passing over suitable pulleys, drives the governor by frictional contact when the cage is in motion, one of the pulleys being adjustable to impart the required tension to the rope. The arrangement is entirely automatic in action, being simply dependent on the working of the governor and wedge, and except in the case of accidents the hoist cannot descend at a greater speed than is desirable without being instantly stopped.

This week I had an opportunity of inspecting the new wells and pumping machinery put down by the Stockport and District Waterworks Company at their Wilmslow works, for the purpose of obtaining an additional water supply for the requirements of the above district. The works, which have been carried out under the supervision of Mr. T. Molyneux, the engineer to the company, consist of a well 9ft. inside diameter and 21ft. deep, lined with 14in. brickwork, with a concrete floor 18in. thick, into which is fixed a stand-pipe, to which the delivery pipes are bolted. From the bottom of the brick well there is a bore-hole 104ft. deep, 28in. diameter, lined with steel tubes of 25in. bore. From this depth there is a 14in. bore-hole unlined, 477ft. 3in. deep, making a total depth of 602ft. 3in. Messrs. Ebenezer Timmins and Sons, of Runcorn, the contractors, commenced their portion of the works in May, 1894, and when the depths of boring obtained were 450ft., 500ft., 550ft., and 602ft. 3in. respectively, tests were made of the approximate quantity of water available, and when the last-named depth was reached Messrs. Timmins were instructed to supply and fix a lift pump to raise from 750,000 to 1,000,000 gallons per day, together with the requisite engines for driving and all accessories. The engine is compound tandem, fitted with Proell's automatic expansion gear, made by Messrs. Marshall, of Gainsborough. The cylinders are 8in. and 14in. diameter, with a 22in. stroke, and the nominal horse-power is 35. The lift pump made by Messrs. Timmins is driven by a connecting rod from a crank on the mortice wheel shaft to a double L leg, to one end of which the ram of the lift pump is connected, the other carrying the balance weight. From the bottom of the ram the pump rods pass down the rising main to the bucket, which works on a gun-metal barrel fitted on top of the clack box. The working barrel is 18⅜in. diameter, and the stroke of the pump 4ft. 6in. The tank and river wall, which form the boundaries of the company's land, were built by Messrs. Fairbrother, of Hyde, the wall being 15ft. high from the rock foundation, and the tank, which is made of concrete, faced inside with brickwork, will hold 100,000 gallons. The water from the tank passes through a 12in. cast iron pipe to the well on the bore-hole in the old engine house, and is there distributed by three force pumps, including one by Messrs. Tangye, 12in. diameter and 3ft. stroke, capable of lifting 450,000 gallons per day against 180ft. head; one by Messrs. Pearn, of Gorton, 12in. diameter and 2ft. 6in. stroke, to lift 400,000 gallons against 180ft. head; and one made by Messrs. Mather and Platt, with three rams 4in. diameter, 8in. stroke, and capable of lifting about 100,000 gallons against 400ft. head. New mains have also been laid and arrangements made so that either of the two first-named pumps can be used to distribute the water in either portion of the district between Stockport and Alderley Edge. A new main is also about to be laid between Wilmslow engine house and the Alderley Edge reservoir. The engine house, engine beds, &c., were constructed by Messrs. Massey, of Alderley, and provision is made for the housing of a duplicate plant if necessary. A new boiler, 26ft. long and 7ft. diameter, to carry 120 lb. of steam, has also been constructed by Messrs. T. Oldham and Son, of Stockport, in order to provide the necessary additional steam power for the new plant. The whole of the boring operations have turned out satisfactorily, bearing out the opinion of Mr. C. E. De Rance, F.G.S., of the Geological Survey, and Mr. J. W. Gray, F.G.S., who were first consulted on the question of sinking, and the output of the new works is expected to reach about 1,000,000 gallons per day.

In the coal trade, although there is no real improvement to report, a steady tone is being maintained generally, due perhaps to a little extra buying going on here and there as a precaution on the part of consumers in the event of another possible stoppage of the pits. For house coals the demand is necessarily slackening off, but some of the collieries are still doing a fair business, which is keeping them, especially in the Manchester district, on about full time, and prices are pretty firm at late rates. This buying may to some extent be accounted for by consumers who would usually wait till winter before replenishing their cellars, ordering in supplies in order to make themselves secure against any possible contingency. Steam and forge coals are in no better demand, whilst prices continue excessively low, and it is still exceptional where more than 5s. 9d. to 6s. is got for good ordinary steam and forge coals, with 3d. to 6d. less taken on special sales. In engine fuel consumers seem anxious to get in stocks, and are placing some considerable orders, whilst there are fairly large inquiries stirring for forward contracts, which are evidently due to precautionary measures in the event of a dispute arising between the coalowners and the men. Prices show a hardening tendency, and although there is as yet nothing like any general upward move upon late rates, slight advances are here and there being got. At the pit mouth common slack still averages 3s. 6d., with best sorts 4s. 6d. to 5s. per ton.

In the shipping trade business continues quiet, with common round coals for steam purposes readily obtainable at 7s. to 7s. 3d., delivered Mersey ports.

Barrow.—The demand for hematite pig iron is well maintained, and the prospects of the immediate future are very assuring. It seems probable there will be a very brisk business throughout the year in Bessemer descriptions of metal, but the demand for forge and foundry iron is very quiet. Prices are easier at 47s. 8d. net cash warrant sellers, 47s. 7½d. buyers. Makers quote 49s. to 50s. for parcels of mixed Bessemer Nos., net f.o.b., and orders are very well held all round. There are 38 furnaces in blast as compared with 28 in the corresponding week of last year, but Messrs. Cammell and Co., Workington, are lighting forthwith the two furnaces they bought at Maryport owned by the old Solway Company. Then there will be 48 furnaces at blast, capable of producing practically 32,000 tons of metal per week.

Iron ore is in good request, and the demand for native as well as Spanish qualities is increasing. Prices, however, remain as previously quoted.

The steel trade shows activity in all its branches. Heavy rails are in good demand, and orders are very well held. Prices are steady at £4 15s. per ton for heavy sections. Plates for shipbuilding purposes are in brisk request, and makers are in a position to secure more orders than they can execute. As a consequence, prices are firm. In billets and hoops trade keeps good. West Cumberland makers are producing a deal of steel sleepers, and the makers in Furness are busy, amongst other things, on heavy steel castings.

Shipbuilders and marine engineers are looking forward hopefully for new orders, alike in commercial and Admiralty tonnage. The shipbuilding yards especially are in want of new work.

Coal is brisk at late prices, and coke is in steady and increasing consumption at stiffening values.

There is some talk of an early start being made in the development of the Walney salt deposit.

The traffics on local railways show a marked increase as compared with the corresponding half of last year, and this is one of the best evidences of how trade has improved lately.

Shipping shows more life this week. The exports from the West Coast this week represent 9218 tons of pig iron and 8602 tons of steel, as compared with 3015 tons of pig iron and 5132 tons of steel in the corresponding week of last year, an increase of 6203 tons of pig iron and 3470 tons of steel. The total shipments this year so far have reached 106,809 tons of pig iron and 147,239 tons of steel, as compared with 89,002 tons of pig iron and 119,879 tons of steel in the corresponding period of last year, an increase of 17,807 tons of pig iron and 27,360 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

AT this season of the year the collieries are working very moderately—four days a week being the average. Many of the thick seam pits are well employed, with the exception of those producing house and gas fuel, for which there is not much demand at present. During the week interest has mainly centred around the proceedings of the Miners' Federation and Conciliation Board meetings. Although no practical agreement has been arrived at, it is not expected that any great stoppage will occur, as in 1893. No improvement has taken place in the house coal trade. The summer-like weather now being experienced is seriously depressing that class of fuel. Lowest summer prices have now been reached, but little difference seems to have been made by this concession.

Quotations remain very much the same as when last reported, although there is a serious falling off in the prices asked for inferior qualities. Best Silkstone, 8s. 3d. to 9s. 3d. per ton; ordinary, 6s. 9d.; Barnsley house, 7s. 6d. to 8s. 3d.; Flockton, 7s.; and thin seam coal, 6s. per ton. Steam fuel is in better demand, the tonnage sent to Hull being well up to the average. Quite an average amount is being taken out of the district by the various railway companies, on contract account. Quotations: Barnsley hards, 6s. 6d. to 7s. 6d.; secondary sorts, 6s. per ton. Gas coal is in poor demand. Best qualities of manufacturing fuel are rather slow in sale, although the commoner qualities realise very freely. Small nuts, 4s. 3d. to 5s. 3d. per ton; screened slack from 3s. 3d. per ton; pit slack, 2s. 6d. per ton; and smudge, 1s. to 2s. per ton. Coke is in steady demand. All the ovens are well employed. Prices range from 8s. 6d. to 10s. 6d. per ton. for ordinary sorts, and 12s. for finest qualities.

The good trade which has been a feature of the heavy industries of the city for some months still continues, and with ever increased activity. The armour plate departments at all the works are working both night and day in executing Government orders. The railway material industry is also very encouraging. A large number of orders have come in both from home and abroad for tires, buffers, axles, springs, and other descriptions of railway goods. Pig iron is in increasing request, and a number of extra furnaces have been put into blast to meet the increased trade. As compared with the lowest value ever reached, prices have risen 5s. to 6s. per ton, and are very firm at current rates. Forge iron is selling at 40s. per ton, delivered in this city, while hematite iron, West Coast brands, realise 57s., and East Coast 54s. per ton. Good business is reported from all the steel, iron, and malleable iron foundries.

The chief demand in several of the lighter departments is for castings, for use in the cycle industry. The mills where employés are engaged in rolling wire for spokes report an excellent business. It is stated that every department connected with the cycle industry is extremely well off for work. A number of cutlers have disposed of their tools and gone to Coventry, Beeston, and other important cycle centres, to obtain better employment. In the majority of cases they have been successful in getting constant work, at higher wages than they could command in the cutlery and kindred trades of this district.

Manufacturers who produce lawn mowers, rollers, and similar garden tools, are well employed on late orders. Winter accumulations have been entirely disposed of, and it is expected that a better business will soon begin. Makers of disintegrating, grinding, separating, and screening machinery are full of orders, both on home and foreign account. Coal-washing machinery is also in satisfactory demand.

During the last month Messrs. Tasker, Sons, and Co., of Sheffield, have completed a specially designed machine for grinding armour plates. This piece of machinery has been ordered by Messrs. Krupp, the well-known gun, &c., manufacturers of Essen. The principle of the machine is not new, but Messrs. Tasker had to construct such a machine as would be capable of grinding chilled armour plates and similar heavy work. The machine is constructed in such a manner that either stones or the work can be made to travel. By means of an ingenious contrivance, the spindle carrying the disc can be raised from the horizontal line to an angle of 30 deg., thus enabling the angular edges of armour plates or other heavy pieces to be ground without their being moved. It can be operated either by electricity or the ordinary motive power. Messrs. Krupp's machine will be driven by electricity, the machine itself carrying the motor. The firm, who have protected themselves abroad, have several orders in hand for similar machines.

The lighter industries continue in the same sluggish condition. Cutlery in all its branches is but poorly inquired after, while the silver and plated trades are not much more satisfactory, except in the case of the larger establishments, who were heavily booked in the early part of the year. With a settlement in the Transvaal, the new market rapidly developing there for silver goods would soon become animated. Some excellent work for other parts of South Africa is now on order.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

NOTWITHSTANDING that the trade statistics are altogether favourable, that the consumption of pig iron is exceeding the production, and that the exports are continuing large, the iron market is dull and disappointing. The tone is flat and somewhat despondent, and sellers are more anxious to operate, while, as is natural in a falling market, consumers are not disposed to buy, especially for forward delivery, and nearly everybody has arranged for early needs. Thus there is next to no business doing. It is difficult to account for the present unsatisfactory condition of the market. Merchants and some of the producers have this week been selling No. 3 Cleveland G.M.B. pig iron, for May delivery, at 37s. 9d. per ton, but even that buyers have not readily paid, when warrants have dropped to 37s. 4½d. No. 1 Cleveland pig iron is at 39s.; No. 4 foundry at 37s. 3d.; grey forge at 36s. 9d.; mottled at 36s. 6d.; and white at 36s., all for early delivery; and forge qualities are not quite so scarce as they were.

Cleveland warrants are weak. Last month considerably more iron was lodged in Connal's public warrant stores than might have been expected, judging from the briskness in shipping and the activity at the finished ironworks. At April 30th the quantity of Cleveland iron in Connal's stores was 193,756 tons, an increase for the month of 6282 tons, whereas the increase in March was only 1964 tons, though trade was not quite so active, and the production was certainly no less. Of hematite iron Messrs. Connal and Co. at April 30th held 154,234 tons, the increase being 3455 tons for the month, against 5383 tons in March. The price of M. Nos. of Cleveland hematite pig iron is 46s. per ton for early delivery, but consumers are backward, as they hold that the output of this description of iron is in excess of the requirements, and still easier prices are not unlikely.

The Skinningrove Iron Company, whose works are situate on the sea coast near the extreme east of Cleveland, twenty miles from Middlesbrough, on Monday shipped its first cargo of Cleveland pig iron direct to the Continent, 561 tons being sent to Ternewzen in one of the company's own steamers. Previous to 1891 they had no facilities for shipping iron, but in that year they completed the construction of a jetty in the bay opposite their works, and since then have sent nearly the whole of their output to Scotland. The make since the blowing in of their two new furnaces has amounted to about 10,000 tons per month.

A well-known Middlesbrough firm of iron merchants has just imported a quantity of pig iron from Alabama. It has, however, been brought over on very exceptional terms, the freight being little more than a merely nominal figure, as the iron was put in as stiffening to a cotton steamer. In the ordinary course the freight would prevent the importation of such iron except at a considerable loss. If the experience of another Middlesbrough merchant firm is any criterion, this iron is not likely to be taken up by founders. The firm referred to last year imported some Alabama pig, and it is still on their hands in Liverpool, except a few sample lots. Consumers on this side have not taken kindly to it, as they say it does not suit their purposes.

It is reported that a firm of capitalists in London are negotiating with Sir Christopher Furness for the purchase of the blast furnaces at the Teesside Ironworks, and if these negotiations are carried through successfully, the new company which Sir C. Furness is to bring out shortly will be formed to carry on the engineering works of the late Teesside Company and those of Westgarth, English, and Co.

The April statistics of the Cleveland Ironmasters' Association must be regarded as satisfactory, for even the most hopeful did not look for a decrease of more than 2000 tons in the stocks of Cleveland iron, but the actual decrease was 5558 tons. This decrease is also important, as it is the first that has been reported since October last. Makers reduced their unsold stock by 14,012 tons, and they now have only about three weeks' production in stock, the total stock in the district being ten weeks' output, that is of Cleveland pig iron, no statistics being published as to the stock of hematite, &c., pig iron. The rate of production of pig iron was the same in April as in March, the 8854 tons decrease reported in April being due to the month being a day shorter than March. The total production for April was 266,096 tons, of which 133,756 tons was ordinary Cleveland iron—4468 tons decrease—and 132,340 tons hematite, basic, and spiegel pig iron—4386 tons decrease. Of the 134 furnaces erected in the North of England 95 were in operation, one less than in March, Messrs. Gjers, Mills, and Co., Ayresome Ironworks, Middlesbrough, having blown out a furnace for relining. Of these 95, there were 51 producing ordinary Cleveland iron, and 44 hematite, &c. The total stock of Cleveland pig iron at April 30th was 349,997 tons, of which 87,320 tons were held unsold by Middlesbrough makers (14,193 tons decrease); 10,821 tons held unsold by other makers in the North of England (181 tons increase); 31,830 tons were in makers' stores (1872 tons increase); 26,270 tons in the North-Eastern Railway Company's store (300 tons increase); and 193,756 tons in Connal's stores (6282 tons increase).

The shipments of pig iron from the Cleveland district during April were very good; they reached 105,470 tons—2560 tons more than in March, 1896, and 5310 tons less than in April, 1895. Satisfactory increases were shown to Germany, Italy, Norway, and Sweden. The exports for the four months of the present year have exceeded those of any previous year over the same period. They have reached 347,384 tons, and the nearest approach to this was in 1889, when 319,654 tons were despatched. As compared with last year, there is an increase of 61,941 tons, or 21 per cent. Never have either coastwise or foreign deliveries been so large. The following is the record for the past four years, and for the previous best:—

	Coastwise. Tons.	Foreign. Tons.	Total. Tons.
1896	187,120	160,264	347,384
1895	157,753	127,670	285,443
1894	182,470	130,159	312,629
1893	160,100	118,232	278,332
1889	176,031	143,623	319,654

Already this year 147,519 tons of Cleveland pig iron have been sent to Scotland, and 78,000 tons to Germany, or more than in any year since 1890. To Belgium also more was forwarded than in any year since 1890.

Messrs. Bell Brothers, the owners of the Clarence Ironworks, Middlesbrough, of several ironstone mines in Cleveland, and of the Tursdale, Page Bank, and Browney Collieries, have struck out an entirely new line with respect to their workmen—they propose to constitute themselves the savings bank for the men up to a certain point. Such of the men as desire it can leave a certain proportion of their wages each week on deposit in the hands of the firm—not less than 2s. a week. The firm offer to pay 5 per cent. interest on all deposits up to £50, and 2½ per cent. on all sums above that amount, as they do not desire to have large sums accumulating on their hands. The interest on every complete pound deposited will commence on the first day of the month following deposit, and will be calculated and added to the principal half-yearly, on June 30th and December 31st, at the rate of one penny per pound per month for the first £50, and a halfpenny per pound above that sum. The proposal is a unique one, and ought to stimulate their men to thriftiness.

There is no change of moment in the finished iron and steel trades, and quotations are maintained at the figures that have ruled for several weeks, but some of the manufacturers are more ready to accept small reductions therefrom. Common iron bars are firm at £5, less 2½ per cent. f.o.t. At Sir Theodore Fry and Co.'s Rise Carr Works, Darlington, three Siemens heating furnaces have just been completed, and two more are to be added. Puddled bars are at £3 7s. 6d., net at works. There is a good demand for bolts, nuts and rivets. Ships' rivets are sold at £7, and best boiler rivets at £8, less 2½ per cent. f.o.t. Steel ship plates are realising £5 2s. 6d., less 2½ f.o.t., and a good demand is expected to continue for them, as there is so much activity in the shipbuilding industry. Heavy steel rails are steady at £4 12s. 6d. net at works.

The River Wear Commissioners, out of ninety-eight applicants, have appointed Mr. Hilton T. Welford as superintendent of their chain, cable, and anchor proving establishment at South Dock, Sunderland.

The contract for straightening the Newcastle and Carlisle branch of the North-Eastern Railway, between the mouth of Blayden Burn and the staith of the Stella Coal Company, has been let to Mr. H. M. Nowell, of Leeds. The authorities at West Hartlepool are up in arms relative to the inadequacy of the passenger station accommodation in their town. Some improvements are being made, but it is contended that these will be far from what is needed, and they propose to follow the example of the Sunderland Corporation in having a Board of Trade inspector down to inquire into the matter. There has just been constructed at the North-Eastern Railway Company's locomotive shops one of the largest engines ever built. It has cylinders of 20in. diameter, and the piston stroke is 26in. The four coupled wheels are 7ft. 7¼in. diameter, and the weight of engine and tender is 90 tons. At a trial run on Friday the engine maintained a speed of 70 miles per hour without difficulty from Newcastle to Berwick. It is said that the engine has been built in preparation for a resumption of the railway race to the North next season.

The wages question in the engineering industry is beginning to give some trouble, indeed some of the men in the Tees district have already come out on strike, and it is feared that work will be interfered with in other parts of the North of England. The dispute has arisen because the employers refuse to concede to the machine workers connected with the Amalgamated Society of Engineers the same advance of wages as was conceded to the engineers. The strike of the men on the Tees will, it is said, involve the locking out of the engineers on the Tyne and Wear also. Thus the matter is serious, and is the more to be regretted as trade is getting into a satisfactory state. The joiners at the shipyards on the Tyne, Tees, and at the Hartlepools have had their wages advanced 1s. 6d. per week, and the labourers at the boiler and engine shops and the foundries in the North of England have also had their wages advanced generally 1s., now with a promise of 6d. more in September.

The Electric Lighting Committee of the Middlesbrough Corporation have had a report from Mr. Robert Hammond, of London, who had been requested to submit an expert opinion as to the advisability of installing the electric light for public purposes. As it was estimated that £21,000 would be required, the Committee decided to go no further at present. Stockton seems to be more in favour of electric lighting. It is said the cost would be £16,000 or £17,000, and the matter is under consideration.

The coal trade is somewhat improved as regards the steam coal branch, but it is very dull in other branches. A rumour is afloat that a local firm is about to buy a group of collieries in north Durham, but particulars are not yet ripe for publication. Coal shippers at Dunston Staiths complain greatly of the inadequate accommodation for loading coal, and in some cases steamers have to go to other places, as they are unable to get a berth. Coke is in good request, and the supply has improved now that the Brancepeth Colliery is in full work again, but it is hardly up to the requirements yet. About 13s. 9d. has to be paid for good coke delivered on Tees-side.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Glasgow pig iron market was closed on Monday, in consequence of that day being a bank holiday in Scotland. On resuming next day, the tone of business was very quiet, but steady to firm. A good effect was produced by the monthly report of the Cleveland pig iron trade, which showed a reduction in stock, notwithstanding the large output. By its means prices hardened just a little; but the amount of business was too limited to carry this impetus very far. Scotch warrants sold at 46s. 4d. and 46s. 4½d. for cash, and 46s. 6d. one month; there has been only a small business since. In Cleveland warrants there have been very few transactions, the price for a part of the week standing nominally at 37s. 8d. cash, and 37s. 10d. one month. Business was done in Cumberland hematite at 47s. 7½d. each, and 47s. 10½d. one month. There has been nothing doing in Middlesbrough hematite, while the warrant market has been exceptionally quiet; the demand for pig iron for consumption at home is large, and this remark applies equally to ordinary iron and hematite, Scotch, and Cleveland pigs.

There are 41 furnaces producing ordinary, 37 hematite, and three basic iron, the total of 81 now in operation in Scotland comparing with 75 at this time last year. At Gartsherrie twelve furnaces are in blast, seven of them making hematite pigs, and ten at Eglinton, four of these being on hematite. Summerlee ordinary is being made by six furnaces. The highest class of ordinary Scotch pig is produced at Coltness, where it is being made by three furnaces, there being six making hematite at the same place.

In the course of the past week about 100 tons more iron was withdrawn from Glasgow stores than was sent in, and the total stock now amounted to 356,000 tons, compared with 283,000 at this time last year.

Prices of Scotch makers' pig iron are steady as follows:—Carnbroe, Monkland, and Govan, Nos. 1, 47s. 6d.; Nos. 3, 46s.; Clyde, No. 1, 50s.; No. 3, 47s.; Summerlee, Calder and Gartsherrie, No. 1, 50s. 6d.; No. 3, 48s.; Coltness, No. 1, 53s.; No. 3, 48s. 6d.; Glengarnock, at Ardrossan, No. 1, 50s.; No. 3, 46s.; Eglinton, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Dalmellington, at Ayr, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Shotts, at Leith, No. 1, 52s.; No. 3, 48s. 6d.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 49s. 6d.

There is no improvement in the shipments of pig iron abroad, and the deliveries in the past week by coasting vessels appear to have been considerably less than the average of recent weeks. The total shipments amounted to only 4871 tons, compared with 8897 in the corresponding week of last year. To Holland was sent 790 tons, Italy 470, United States 15, India 373, Australia 125, France 55, Germany 357, Russia 255, Belgium 50, China and Japan 150, other countries 130, the coastwise shipments being 2101 tons, against 5991 in the same week of 1895.

Finished iron is quiet but steady, a fair business being reported, with comparatively little variation in price. The steel works are very busy, many of them working to their full capacity, with good orders in hand and in prospect.

The coal trade shows comparatively little alteration. In Fifeshire business is not quite so depressed as of late, and a rather better feeling is reported from Ayrshire, where consumers are said to be storing fuel on account of its present cheapness. The Glasgow market has been quiet. There is a good inquiry for the better classes of ell coal, but steam sells slowly. The supply of splint is very plentiful, and so is that of main. Quotations are nominally as follows:—Main coal, f.o.b. at Glasgow, No. 1, 6s. 3d. to 6s. 6d.; splint, 6s. 3d. to 6s. 6d.; ell, 6s. 3d. to 6s. 9d.; steam, 7s. 6d. per ton. The week's coal shipments show remarkably well, amounting, from the whole of the Scottish ports, to 189,614 tons, which compares with 152,063 tons in the preceding week and 29,917 tons in the corresponding week of last year. The dividend of John Watson, Limited, has been announced at 6s. per share on the ordinary shares, compared with 13s. in the preceding year, this large falling off being attributed to the exceptionally low prices ruling throughout the year.

At several works in the Glasgow district the operative engineers are on strike for an advance of wages, and their demands are understood to be greater than the employers feel warranted in conceding. It is believed that the dispute will be settled by compromise, without much further delay.

During April there was launched from the Clyde shipyards new tonnage amounting to 39,557 tons, compared with 28,567 tons in April, 1895. The output for the four months is 134,223 tons, compared with 81,434 in the same period of last year. The new orders booked in the course of the month are put as high as 7000 tons.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

A GOOD deal of animation in the steam coal trade prevails at Cardiff, and large cargoes have again been in evidence, notably two for 7000 tons and 6000 tons for Colombo. At Newport also the second largest steamer yet despatched from that port was cleared a few days ago. Swansea coal shipments for France and home ports have not been up to the average, but those for Russia and Canada have been exceptions, and prospects of the anthracite trade are good.

In house coal the time for any chance of recovery is regarded as gone, and prices are expected soon to rank even lower than at present. Steam coal prices are well maintained, and for best qualities nothing could be had in Cardiff last week under 10s., and a prominent quotation was 10s. 6d. Mid-week prices this week are as follows:—Best steam, 10s. to 10s. 6d.; market perceptibly stiffening. Best seconds in good request at 9s. 9d. to 10s.; drys, 8s. 9d. to 9s.; best Monmouthshire is selling much more freely at 8s. 3d. to 8s. 6d.; and seconds from 7s. 9d. to 8s. Best steam small varies from 4s. 3d. to 4s. 6d.; seconds, 4s.; and drys, 3s. 6d. to 3s. 9d.; best house coal, 9s. 9d. to 10s. 3d; No. 3, Rhondda, 9s. 6d. to 9s. 7½d.; brush, 7s. 9d. to 8s.; small, 6s. 3d. to 6s. 6d.; No. 2, Rhondda, 7s. to 7s. 6d.; through, 6s. to 6s. 3d.; small, 4s. to 4s. 3d. Coke shows no decline so far, though there is more quietness in the market. Cardiff prices are, furnace, 13s. to 15s.; foundry, 15s. 6d. to 16s. 9d.; and special foundry, 19s. to 19s. 6d. A large cargo, 1600 tons, left Cardiff this week for Valparaiso.

There has been a fair inquiry for patent fuel, Cardiff and Swansea, at last prices. From Swansea last week, amongst a few moderate cargoes dispatched was one of 1250 tons for Italy. Pitwood imports heavy; prices weak. I am pleased to chronicle a still larger make of tin bar in the district, supporting the view that things are a little better in tin-plate. Considerable consignments of tin bar have been sent West during the week, and I note that Cyfarthfa, in addition to long trains for the tin-plate districts, sent Midland and North quantities of crop ends of steel. A novel cargo was dispatched this week of 1020 tons steel billets, from Cardiff to Russia.

I have referred to the fact that Messrs. Crawshay Brothers, Cyfarthfa, are getting ready to figure again in the steel rail trade, and judging from preparations and the large addition of skilled hands made to the general manager's working staff, this branch will be an important one. The chief effort, of course, will be to win as high a repute for steel rails as the works have gained for steel bars, and, as those conversant with the manufacture know, this is only attained by keenest and most unremitting effort from the laboratory to the rolls. Taking a survey generally, there is more doing in the steel trade, rails being principally in demand. Stocks of pig and ore are lessening, and substantial cargoes are coming in daily. This week Dowlais had two, Cyfarthfa two, Blaenavon two, Société Commerciale one.

Swansea Exchange reports that the pig iron market has been weak, and the quotations mid-week were about 8d. lower than last week. Shipments, however, had been fairly maintained, the only exception being a slight falling off in Cumberland. Latest prices are: Glasgow warrants, 46s. 5d. cash; Middlesbrough No. 3, 37s. 9d.; hematite, 45s. 2½d.; Welsh bars, £5 10s. to £5 12s. 6d.; sheet iron, £6 15s. to £6 17s. 6d.; steel, £6 10s. to £6 12s. 6d.; Bessemer steel, tin-plate bars, £3 17s. 6d.; Siemens bars, best, £3 18s. Tin-plates remain at the old figures. Bessemer cokes, 9s. to 9s. 1½d.; Siemens, 9s. 1½d. to 9s. 3d.; ternes, 16s. 6d., 17s. 6d., to 22s. 6d.; best charcoal, 12s. 6d. to 12s. 9d.; wasters, 6d. to 1s. less, all delivered Prince of Wales's Dock, Swansea.

Other Swansea quotations are: Copper, Chili bars: £45 6s. 3d. to £45 8s. 9d. Block tin, £59 16s. 3d. to £59 17s. 6d. Lead, English, £11 5s. to £11 7s. 6d.; Spanish, £11 2s. 6d. to £11 5s.

Anthracite, best, 11s. to 11s. 6d.; second quality, 9s. to 10s.; ordinary large, 8s. 1d. to 8s. 9d. Steam coals, 9s. to 10s. best; seconds, 8s. 3d. to 9s.; No. 3 Rhondda, 9s. 6d. to 10s.; No. 2 Rhondda, 8s. 6d. to 9s. 6d.

It is expected that the dispute at Tumble will be ended satisfactorily. This will be hailed with pleasure at Llanelly. The latest report from the tin-plate works is that a few more mills have been started, and that shipments slightly exceed make. Stocks at Swansea amount to 151,535 boxes. Reports from America are to the effect that trade is much alike in both countries; only a slight improvement.

The death of Colonel North is announced. He will be remembered in the mining districts of South Wales as having acquired the Llynvi Collieries, Maesteg, Tondu, and Ogmore in 1889, but his connection in other respects was but a slight one, as he has only once since visited the district, when in token of his interest he made the workmen a present of £500.

The latest labour difficulty, with the exception of one or two collieries in South Wales, appears to have travelled north and broken out amongst the quarrymen of Penrhyn. The latest report is that 3000 men are out. The cause appears to be suspension of some for being absent without leave, and indignation of the rest, followed by abandonment of work wholesale.

The Barry Railway Company has succeeded at length in getting access to the Monmouthshire coal fields, and when the clauses of the Bill were taken on Tuesday, it also obtained running powers for passengers from its proposed new line to Caerphilly. The Committee decided, that if any alteration of the Caerphilly station became necessary it would be left to an arbitrator to say who should pay the cost.

The great struggle now pending is the Bute and Rhymney fusion. Mr. Pember's speech in opening took over three hours, and was very effective. From this it was gleaned that amalgamation scarcely conveys the objects of the promoters of the Bill. What they seek is power to purchase the Rhymney Railway. The opposition is strong. The Great Western, Midland, Taff Vale, and Barry oppose; but it has been pointed out, cogently, that three of these are out of court; the Great Western Company, Taff Vale, and Barry have their docks and railways. The object of the Bute Company is to have its railway, and be on level terms. Further, it has been shown that both the Taff Vale and the Barry have made strenuous efforts to get the Rhymney Railway, and this further weakens their opposition.

Mr. D. A. Thomas, M.P., made a statement in the House this week that the wages of over 100,000 colliers in South Wales have been reduced 50 per cent., and that Government should take immediate steps to assist them, similar to that suggested in the agricultural interest. I do not know what lines he will go upon. Doubtless it will be contended in opposition that many cases of depression have been due to the action of the men themselves, and the extreme difficulty found by coalowners in bringing about settlements by arbitration. Late cases have been Plymouth and the Mardy. And it is quite possible that it will be urged that the distress in agricultural districts has not been brought about by similar causes to those acting in the mineral districts. Wales, unfortunately, has on several occasions brought about bad trade by labour agitation, from which the counties have been free.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

VERY satisfactory accounts continue to be given of the continental iron trade, generally, all descriptions of iron and steel remaining in good demand. Changes of importance have not taken place since last week; inquiries are plentiful, and prices, on the whole, more firm than before. The business done on foreign account may also be considered pretty favourable, though heavy orders are still scarce, but makers are content with the steady, if somewhat limited, demand that is now coming forward, and hope for a more animated trade in the next quarter.

The iron business in Silesia remains in a most satisfactory state. Both raw and finished iron makers are very well off for orders, and quotations are, as a rule, extremely firm. Export has been specially brisk upon the week, and present prices are fairly remunerative.

The situation of the iron market in Austria-Hungary does not present any novel feature. A good employment is maintained at the various establishments, and makers report themselves pretty well satisfied with the present state of things, the more so because prices are showing a decidedly upward tendency, and have, in a few instances, been quite favourable compared to previous months. There is, of course, not much gained at present, but an advance in the quotations for several articles of finished iron will most likely take place in June. The works that are engaged in producing railway material have received further orders within the course of last week, one being for 450 and another for 400 goods wagons.

The French iron trade has been progressing favourably since las week; the strong tone of the market is illustrated by the fact that basis price for girders has been raised to 155f. p.t. free Paris; bars are not obtainable below 155f. p.t., while plates stand on 165f. p.t.

A most animated business continues to be transacted on the Belgian iron market. General confidence in the future of the iron trade has further increased, partly on account of the favourable results of last week's tenderings for scrap iron and steel. For old iron rails offers ranged between 82f., 86f., and 88·50f. p.t., while last year only 65f. to 70f. p.t. were obtainable. Old steel rails are to be had at 66f. p.t., last year 55f. p.t. were asked. One Government order for angles, No. 3, has been booked at 164·80f. p.t.; a short time ago prices were standing on 127·50f. p.t. Plates, which had until now not joined in the general upward movement, are also beginning to improve, and an advance of 2·50f. p.t., had last week been agreed upon for home consumption, No. 2 now fetching 155f. to 157f. p.t. Export prices are naturally a trifle less firm, but may also be considered more remunerative than before.

Some heavy rail orders have recently been booked, chiefly for East India. There is likewise a fair amount of fresh work coming in at the construction shops, and the hitherto somewhat moderate employment has changed into brisk activity. Pig iron continues scarce, but there will be an increase in production before long, two additional blast furnaces being blown in at Hourpes and Athus.

On the Rhenish-Westphalian iron market increasing activity is the general report. In the pig iron trade new contracts are coming in freely, both on home and foreign account, and in the finished iron department makers are also booking a larger weight of orders than they have been doing for many months. Prices have advanced in rather a marked way, and are now generally considered as remunerative. Here and there orders for the fourth quarter have already been placed, a fact which cannot fail to have a stiffening influence on quotations; and as the demand for all sorts of iron for structural and engineering purposes is likely to increase during the next months, prospects in the iron trade may justly be considered as highly satisfactory. Stocks in the hands of both makers and dealers are but small, generally. In the hardware and cutlery trade there has also been a much more lively occupation reported lately, and the business in tools and agricultural implements naturally shows a certain animation, and satisfactory prices are, as a rule, obtained. The only branch of the iron industry which continues weak and altogether neglected is the tube business, which does not show the slightest inclination to improve. The wagon shops continue to be reported in healthy and remunerative employment.

The production of pig iron in Germany was for March, 1896, 551,157 t., of which 159,002 t. were forge pig and spiegeleisen, 46,013 t. Bessemer, 281,465 t. basic, and 64,677 t. foundry pig. Output in March, 1895, was 481,144 t., that for February of present year amounting to 496,170 t. From the 1st of January to 31st of March, 1896, no less than 1,560,355 t. were produced, against 1,405,423 t. for the same period the year before.

Regarding German foreign trade in all sorts of raw material and finished articles, in corn, cattle, coal, dyeing materials and drugs, it has been officially stated that imports amounted to 2,561,342 t., against 1,975 981 t. in March, 1895, plus amounting to 585,361 t.; export for March of present year was 2,031,483 t., against 1,843,007 t. in March, 1895, plus being 188,476 t. Value of import was, for the first quarter of 1896, M. 1,097,423,000, against M. 965,159,000 in the previous year, which shows an increase of M. 132,264,000. Value of export for the same period was M. 861,445,000, against M. 758,895,000 in the year before, which shows an increase of no less than M. 102,550,000.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, April 30th.

FOR three weeks commercial activity has been less pronounced. The banks have been accumulating money, and are more willing to lend than borrowers are to borrow. Railroad reorganisation is progressing finely. A vast amount of dead losses will be wiped out, and unremunerative securities will soon cease to constitute a portion of the stock-in-trade of Stock Exchanges. Railroads are not making that improvement in earnings that was hoped for. The Government supply of free gold is now 126,000,000 dols. New York banks have 487,000,000 dols. deposits. Large exports of silver continue. The iron trade is rather inactive. The billet pool has not as yet succeeded in forcing consumers to pay the higher prices, except for small lots. Steel makers are hesitating, and there is some vague uncertainty as to the position of coke and ore in July, though both these interests claim there is no possibility of a break in prices. An unusual amount of work is projected in all channels. In railroad work, the projected mileage is between 30,000 and 40,000 miles, but very little work is under construction. Much of this mileage is needed and would earn dividends, but the capital cannot be had to enter on construction. There are hundreds of big enterprises, and it might be said without exaggeration, thousands of little enterprises all ready for prosecution, but influences check action—just what, it is not easy to intelligently define. The two great political conventions are the absorbing topic of the hour; there is great uncertainty as to the outcome. Municipal improvements, such as for light, water, street railways, drainage and other matters, will absorb a larger sum of money than in any two former years. Electric roads by the hundred will be built before the close of the year. Machine shops and large engine shops are gathering in a great deal of work.

THE GLASGOW LOCOMOTIVE TRADE.—In the locomotive trade of the Glasgow district, which is certainly the headquarters of the branch of the mechanical engineering industries, so far as this country is concerned, there is a very decided "boom" just now, more especially in the works of the private firms. Report has it that Messrs. Neilson and Co., of Hyde Park Locomotive Works, Springburn, have at least 170 engines on order or in course of construction, which means full and continuous employment for a large army of skilled workmen for upwards of a twelvemonth, even though no more orders should be booked during that time. But that is not actually the "record" of work at Messrs. Neilson's establishment, for at the beginning of the year 1885 there were upwards of 200 locomotives on the order books. With fairly good prices for the engines turned out, it was but natural to expect that the late head of the concern, Mr. James Reid, ex-Lord Dean of Guild of the City of Glasgow, should have been a wealthy man at his death.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

22nd April, 1896.

8505. Heating Devices for Carriages, A. Spencer, London.
8506. Axle Bearings A. Koppel, London.
8507. Chandeliers, J. Hinks and Son, Ld., and F. R. Baker, London.
8508. Bells, F. Müller, H. Rüger, and E. Müller, London.
8509. Means of Illuminating with Oils, P. G. de Schodt, London.
8510. Stands for Umbrellas and like Articles, W. Ault, London.
8511. Fishing Tackle, H. K. Reynolds, London.
8512. Drain Pipes, Water Conduits, &c., G. W. Dolman, London.
8513. Brakes, E. von Hülson, London.
8514. Electric Glow Lamps, I. A. Timmis, London.
8515. Ropes, R. Haddan.—(*C. M. A. G. Boucley, France.*)
8516. Starting Tramcars, A. J. Boult.—(*V. Dhanis, Belgium.*)
8517. Treatment of Rhea, &c., A. R. Waddell, London.
8518. Stoppers, W. J. Cunningham, London.
8519. Veil Holders, C. E. Luce, London.
8520. Cycles, R. Corsham, London.
8521. Feed-water Heater for Boilers, L. le B. Mount, London.

23rd April, 1896.

8522. Attachment to Bicycle, &c., J. G. Curtis, Cork.
8523. Pneumatic Tires for Cycles, H. O. Bridgewater, Leicester.
8524. Boxes, H. Allday, Birmingham.
8525. Diffuser, H. Allday, Birmingham.
8526. Traces, C. A. McCombie, London.
8527. Regenerative Oil Burners, W. G. Potter, London.
8528. Cleaning Chains, F. S. Willoughby and F. H. Nadin, Manchester.
8529. Safety Apparatus for Lamps, A. W. Brittain, London.
8530. Tilters, W. and S. Greenwood and A. Ashchoft, Liverpool.
8531. Chimney Pot and Ventilator, H. W. Swain, Bristol.
8532. Creating Currents of Air, &c., S. Holman, London.
8533. Consuming Smoke, J. H. Gadd and W. Harrop, Oldham.
8534. Bicycles and Tricycles, E. Segar, Manchester.
8535. Furnaces, J. H. Rosenthal, Glasgow.
8536. Doors, W. Taylor, Liverpool.
8537. Propellers, M. F. G. Reece, Halifax.
8538. Sun Blinds, H. Davenport, Manchester.
8539. Lifts, S. Skerritt and J. Hibbert, Sheffield.
8540. Measure, J. W. Hannah, North Shields.
8541. Electric Lamps, W. Woodhead, Halifax.
8542. Centrifugal Machines, J. Laidlaw and J. W. Macfarlane, Glasgow.
8543. Spindles, R. Brodie, Glasgow.
8544. Chimney Cans, T. Daly, Glasgow.
8545. Smoke Cowl with Steam Injector, W. Boyes, jun., Birmingham.
8546. Cycle Lamps, W. Hunter and H. Hunter, Birmingham.
8547. Maximum Thermometer, A. Luraschi, London.
8548. Boring and Planing Machine, C. R. Iorns, Altrincham.
8549. Construction of Ladders, W. Hayward, sen., Wolverhampton.
8550. Construction of Hurdles, W. Hayward, sen., Wolverhampton.
8551. Bicycle and Tricycle Appliances, C. M. P. H. Triscott, London.
8552. Reversible Shirt Fronts, J. Reynolds, jun., Nottingham.
8553. Ships' Anchors, J. Evans and A. Evans, Liverpool.
8554 Steam and Hydraulic Vacuum Gauge, J. Jackson, Wallingford.
8555. Internal Combustion Motor Engines, G. McGhee, Glasgow.
8556. Preventing Fraud in Bottling Liquors, C. E. Lefaux, Swansea.
8557. Preserving Flesh, Fruit, Fish, &c., H. Winks, Parkstone.
8558. Using Mine Dust of Iron from Kilns, G. Fisher, Shotts, Lanark.
8559. Advertising Device, R. H. H. Baird, Glasgow.
8560. Aerial Toy, J. E. Livsey, London.
8561. Drain or Pipe Stoppers, A. W. Bullen, Hampton Wick.
8562. Writing Apparatus for the Blind, H. C. A. Krüger, Birmingham.
8563. Window Fittings, J. Lumsden, London.
8564. Flower Pots, J. Black.—(*J. B. and E. Chéron, France.*)
8565. Folding Chair, G. D. Wilhelm, London.
8566. Preparing Jellies in Tablet Form, J. H. Payne, London.
8567. Latch Locks, E. P. O'Kelly, London.
8568. Racquet and Lawn Tennis Bats, W. Cutler, London.
8569. Making Electric Contacts by the Passing of Railway Trains, E. Tyer, London.
8570. Umbrellas, S. A. Parkes, London.
8571. Steering Lock for Cycles, R. Woodhouse, London.
8572. Fastening for Lawn Tennis Posts, &c., R. Bell, London.
8573. Bicycle Support, G. Spencer, London.
8574. Cinder Sifter and Ash Collector, H. Paine, London.
8575. Soap for Chemical Cleaning, &c., O. Schöning, London.
8576. Checking the Consumption of Stamps, J. Hart, London.
8577. Combined Washstand and Dressing Table, C. F. Turner, London.
8578. Grip for Fencing Wire, F. Kirby, Norwich.
8579. Tires for Cycles, F. I. Gibbs and W. Wright, Birmingham.
8580. A New Preparation of Tea, H. Boisselier, Enfield.
8581. Latch Keys, E. Ingram, Hereford.
8582. Tanning Extracts, H. H. Lake.—(*The Firm of Leptit, Dollfus, and Gansser, Italy.*)
8583. A New Metal Box, A. J. Spry, London.
8584. Pedal Action for Cycles, J. and H. M. Copeland, New Zealand.
8585. Dress Skirts, &c., F. Thenn and G. Souder, London.
8586. Rotation of Wheels, A. E. Woodhouse and R. B. Bristed, London.
8587. Swivels for Chains, Cuff Links, &c., H. Edmonds, London.
8588. Cultivation of Orchids, &c., A. G. C. Stollery, London.
8589. Elastic Tires for Cycles, J. Smyth, London.
8590. Pneumatic Tires, E. Hale, Liverpool.
8591. Apparatus for Turning Articles, J. Ruscoe, Manchester.
8592. Tires for Road Vehicles, F. W. R. Scott, Liverpool.
8593. Devices for Opening Oysters, J. B. Gastaldi, Liverpool.
8594. Carrier Frame for Pot Plants, G. H. Shoults, London.
8595. Fusible Metal or Alloy, T. Smith, London.
8596. Speed Regulating Mechanism, A. Paget, London.
8597. Advertising Device, W. H. Bradley, London.
8598. Stroke Counting Apparatus, J. U. Meier, London.
8599. Pill Machine, W. L. Wise.—(*P. J. Noyes, United States.*)
8600. Sewing Machines, H. H. Lake.—(*J. W. Smith, United States.*)
8601. Hydraulic Engineering, P. A. Waller, London.
8602. Preventing Deposit in Kettles, W. L. Dash, London.
8603. Type Line Justifiers, G. W. Sherer, London.
8604. High-pressure Valves, &c., E. J. Preston, London.
8605. Cycles, J. E. Bousfield.—(*E. Worms and J. P. Bonicard, France.*)
8606. Steam Engines, P. Giffard, London.
8607. Straining and Splicing Fencing Wire, J. Dalziel, London.
8608. Lookouts for Use on Board Ship, R. Türr, London.
8609. Cuffs, C. C. Clark and H. C. Barber, London.

24th April, 1896.

8610. Wheel for Vehicles, R. J. Churchill, Derbyshire.
8611. Pilot Light, W. Wright and F. J. P. Reed, Plymouth.
8612. Operating Levers or Cocks, C. E. G. Simons, Merthyr Tydfil.
8613. Pre-payment Apparatus for Meters, J. Brightman, Rotherham.
86'4. Water-closet Traps and Moulds, P. J. Davies, London.
8615. Metallic Eyes of the Handles of Trees of Spades, J. Mills, Lye, near Stourbridge.
8616. Napkin Rings for Table Purposes, W. White, London.
8617. Driving Belts, W. E. Sharples, Manchester.
8618. Side Scuttles, G. T. Temple, H. B. and J. S. Watson, Newcastle-on-Tyne.
8619. Beetle Traps, H. Whittaker, Manchester.
8620. Metal Edged Cardboard Boxes, M. Heinemann, Birmingham.
8621. Foul Linen Shoots, D. K. Tullis, Glasgow.
8622. Waste or Discharge Valves, T. Law, Glasgow.
8623. Mud Guards for Wheels, J. G. A. Kitchen, Manchester.
8624. Combined Chair and Musical Box, E. Schacht, Glasgow.
8625. Ships' Side Lights, R. Brown, Newcastle-on-Tyne.
8626. Cycles, L. and W. Hanson, and J. Sanders, Halifax.
8627. Bearings for Forge Trains, C. Billington, sen., and J. Newton, Longport.
8628. Chain Wheels used with Cycles, H. J. Heinze, London.
8629. Securing Handles to Hammers, J. R. Cooper, Birmingham.
8630. Magnetic Motors, J. Chandler, Liverpool.
8631. Driving Gear for Cycles, J. B. King, Stonehouse.
8632. Wind Musical Instruments, J. A. Kappey, Chatham.
8633. Cycle Mud Guards, H. J. Lingwood, Stafford.
8634. Manufacture of Chlorine, S. A. Sadler and R. H. Wilson, Middlesbrough.
8635. Winders, T. Holcroft and Sons, and A. H. Mould, Wolverhampton.
8636. Curling the Hair, J. Taylor and W. A. Lloyd-Davies, Wolverhampton.
8637. Folding Chair, W. Blackwell, S. Ball, and J. Mitchell, Birmingham.
8638. Screw-cutting Lathes, F. W. Walker, Bradford.
8639. Furnaces, R. A. Lewis, Lemington-on-Tyne.
8640. Broadcast Manure Distributor, R. and W. Wallace, Ayr.
8641. Chain Adjuster for Cycles, G. Wright, Nottingham.
8642. Composition Roller, G. B. Ford, Burslem.
8643. Strain Reducer for Draught Animals, F. J. Wilkinson, London.
8644. Coin-freed Mechanism, J. Tourtel, London.
8645. Pneumatic Tires, J. B. Price and E. T. Whitelow, Manchester.
8646. Memorandum or Scribbling Desk, W. Gun, Manchester.
8647. Induction Electrical Machines, F. Tudsbury, Sheffield.
8648. Tube Cleaner, A. Willis, London.
8649. Seal and Fastener, J. G. and R. T. Glover, London.
8650. Tea Baskets, A. Clark, London.
8651. Mechanical Ventilating Apparatus, J. L. Purdy, London.
8652. Oxalic Acid, C. F. Wülfing, London.
8653. Closets, F. W. Golby.—(*F. Dumay and E. Sauvegarde, Belgium.*)
8654. Auto-motor Carriage, W. March, London.
8655. Brake Apparatus, A. A. Tyler, W. March, and H. Penn, London.
8656. Conveying Cycles in Railway Vans, C. Casman, London.
8657. Cleaning Chaff and the like, S. Trewin, Watford.
8658. Brakes, E. E. Shearburn, London.
8659. Paste Carrying Plates, F. W. Schneider, London.
8660. Cells for Electric Accumulators, F. W. Schneider, London.
8661. Ornamenting Celluloid Ferrules, T. E. Weaver, Wolverhampton.
8662. Bottle Stands, M. H. H. King, London.
8663. Producing Colour Photographs, W. White, London.
8664. Cutting and Bagging Chaff, G. Bowmar, London.
8665. Construction of Vessels, G. Hough, London.
8666. Battery Electrodes, The Battery and Motor Company, Ld., and H. T. Barnett, London.
8667. Cards for Holding Buttons, J. Proskauer, London.
8668. Tires for Cycles, S. G. Coulson, London.
8669. Appliances for Sharpening Pencils, W. Pair, London.
8670. Means for Stretching Trousers, C. White, London.
8671. Covering or Wrap for the Neck, G. Szuhanek, London.
8672. Substitutes for Celluloid, S. W. Wilkinson and The Grove Company, Ltd., London.
8673. Ships' Propellers, W. P. Thompson.—(*H. Brinkmann, Germany.*)
8674. Reversing Gear, W. P. Thompson.—(*H. Brinkmann, Germany.*)
8675. Appliance for Velocipedes, F. A. Skidmore, Birmingham.
8676. Pneumatic Tires, R. Reid, London.
8677. Non-refillable Bottles, G. W. Johnson, London.
8678. Lubricating Cycles, S. Chandler, jun., and J. Chandler, London.
8679. Gas Combustion Chambers, J. Hartmann, London.
8680. Support or Stays for Cycles, A. F. Aberg, London.
8681. Cranes, S. W. A. Noble and C. H. Murray, London.
8682. Electrical Firing Apparatus, C. A. McEvoy, London.
8683. Driving Gear for Velocipedes, A. Hollands, London.
8684. Telephones, F. L. Muirhead, London.
8685. Wheels and Tires for Cycles, M. Lachman, London.
8686. Manufacturing Pipe-shaped Cigars, S. Veit, London.
8687. Apparatus for Propelling Boats, H. Barcroft, London.
8688. Chair Sleepers for Railways, A. R. Jones, London.
8689. Making Holes in Brush Backs, C. E. Flemming, London.
8690. Metallic Alloys, S. O. Cowper-Coles and S. Learoyd, London.
8691. Ores, A. J. Boult.—(*Salisbury-Jones, Bidwell, and Co., South Africa.*)
8692. Corks for Closing Bottles, W. R. Maud, London.
8693. Railway Signalling Apparatus, A. J. Boult.—(*A. Becker, Belgium.*)
8694. Folding Binocular Glasses, S. H. Cobb, London.
8695. Electrodes for Accumulators, W. Majert, London.
8696. Pneumatic Tires for Cycles, A. Pulbrook, London.
8697. Steam Turbine Blades, The Hon. C. A. Parsons, London.
8698. Steam Turbine Blades, The Hon. C. A. Parsons, London.
8699. Improved Whist Marker, A. G. C. Stollery, London.
8700. Supports for Blotters, C. E. Locke, London.
8701. Venetian Blinds, J. Manttan, London.
8702. Lamp Shades, W. R. Hitchcock, London.
8703. Union Nuts, E. Martin, London.
8704. Acetylene Gas, F. L. and E. T. Perken and A. Rayment, London.
8705. Loom Heald Shafts, G. G. M. Hardingham.—(*Felten and Guilleaume, Germany.*)
8706. Furniture Polish, W. I. Grylls, London.
8707. Charging Valve for Furnaces, J. Hartmann, London.
8708. Combined Bed and Sofa or Couch, G. Silberblatt, London.
8709. Forgings, F. Radcliffe, London.
8710. Matrix Making Machines, E. Latham, London.

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8711. Radioscope and Heat Motor, A. R. Bennett, London.
8712. Disinfecting and Cleansing Mixture, W. Hanlon, Innishannon.
8713. Elastic Tires, J. Pickles, Bradford.
8714. Duplicate Saddle for Velocipedes, T. H. Wem, Lichfield.
8715. Pumps for Tires, T. Humpage and H. I. Jaques, Bristol.
8716. Pneumatic Tires for Velocipedes, W. F. Taylor, Croydon.
8717. Spades, A. and J. Perks and W. C. Salmon, Wolverhampton.
8718. Nathaline, E. Morrice, London.
8719. Ball Castors, A. Cubitt and N. A. Thompson, Ipswich.
8720. Driving Gear, A. J. Lehmann, J. Hillyard, and G. T. Haigh, Liverpool.
8721. Weaving, J. G. Barnes, Manchester.
8722. Blind Tape Fastener, A. Cameron and H. E. Skinner, Sunderland.
8723. Tires, S. Roberts, Halifax.
8724. Tables for Surgical Purposes, J. W. Ward, Halifax.
8725. Tools for Marking Timber, J. Brawn, Birmingham.
8726. Geographical Diagram Charts, F. Cox, Liverpool.
8727. Kettles for Boiling Water, &c., H. Blandy, Nottingham.
8728. Moulding the Soles of Boots, W. H. Dorman, Stafford.
8729. Teaching Shaping, Sewing, &c., R. Greenhalgh, Manchester.
8730. Securing Picking Straps to Pickers, J. Whittaker, Manchester.
8731. Cans for Perishable Goods, J. W. Brooke, London.
8732. Cotton Yarn, L. W. Roberts and J. C. Wood, Manchester.
8733. Cycles, W. H. Dawson, Manchester.
8734. Vent Pegs, J. Magee, Glasgow.
8735. Transplanting Instruments, W. W. Richards, Birmingham.
8736. Method of Heating Liquids, L. Classey, Ireland.
8737. Fastenings for Drawers, &c., R. McTaggart, Glasgow.
8738. Potato Lifters, J Chalmers and W. Addie, Glasgow.
8739. Cycles, J. Cockburn, W. H. Luther, and J. Millar, Glasgow.
8740. Cook's Adjustable Set-square, W. V. Cook, Ipswich.
8741. Cycle Saddles, W. Wingate, London.
8742. Folding Bed Screen, A. Lange and W. Fleher, London.
8743. Speaking Tube Receivers, H. A. Cutmore, London.
8744. Cooking Stoves, F. J. Duggan and C. Isaac, London.
8745. Cotton Reels, E. A. Houchin, London.
8746. Sash Fasteners, A. Line, London.
8747. Cycles, C. H. Maleham, Sheffield.
8748. Ink Ducts, F. C. Taylor and J. Cooke, London.
8749. Pneumatic Tires for Road Wheels, B. Ljungstrom, London.
8750. Nut Locking Device, W. P. Thompson.—(*E. Meller, Austria.*)
8751. Aerial Machines, H. S. Booth, Manchester.
8752. Composition for Roads, Paths, &c., G. H. Sharpe, London.
8753. Vaporiser for Oil Engines, T. Myers, London.
8754. Subduing Noxious Odours of Oils, T. Myers, London.
8755. Silencing the Exhaust from Gas Engines, T. Myers, London.
8756. Manufacture of Rims of Cycles Wheels, H. Hill, London.
8757. Compressed Gas Cylinders, J. Airs, London.
8758. Steering Wheels of Ships, A. W. F. Bennik, London.
8759. Chain Swivels, T. Keetman, London.
8760. Footballs, W. Dalgleish and H. A. Cook, London.
8761. Mechanical Toy, W. Bottrill, London.
8762. Pocket Case for the use of Cyclists, J. W. Tysoe, London.
8763. Reversible Water Motor, A. T. Thompson, London.
8764. Self-propelling Vehicles, A. R. Sennett, London.
8765. Cure of Gout, W. J. Baker and F. W. Roloff, London.
8766. Ladies' Garments for Cycling, F. H. Müller, London.
8767. Pipes for Smoking Tobacco, A. H. B. Sharpe, London.
8768. Hardening Iron and Steel, J. A. Mays, London.
8769. Piston Slides, C. D. Abel.—(*Dingler'sche Machinen Fabrik, Germany.*)
8770. Manufacture of Alkyl Glycolic Acid, H. Imray.—(*Basle Chemical Works Bindschedler, Switzerland.*)
8771. Apparatus for Collecting Refuse, A. Hartwich, London.
8772. Gun Cleaning Implements, &c., J. Hinne, London.
8773. Producing High-speed Gaseous Currents, R. Haddan.—(*E. Chesmay, France.*)
8774. Boiler Furnaces, J. Brown and Co., and J. Nodder, London.
8775. Boiler Furnaces, J. Brown and Co., and J. Nodder, London.
8776. Incandescent Gas Burners, E. W. Hampton and J. R. Wright, London.
8777. Pneumatic Tires, S. Chandler, jun., and J. and J. C. Chandler, London.
8778. Tipcats, C. Crouch, London.
8779. Tires for Wheels of Velocipedes, J. M. Herschell, London.
8780. Boxes for Packing Biscuits, F. Vinten, London.
8781. Reduction of Composite Lead, C. T. J. Vautin, London.
8782. Refrigerating Apparatus, W. Hampson, London.
8783. Auto-cars for Road Traffic, W. S. Simpson, London.
8784. Preventing Vibration of Cycles, W. S. Simpson, London.
8785. Manufacture of Arsenic, W. Bevan, London.
8786. Device for Use with Umbrellas, H. N. Powell, London.
8787. Exhaust Steam Injectors, R. G. Brooke, London.
8788. Driving Gear, W. S. Smith, London.
8789. Appliance for Modulating Tones, F. J. Smith, London.
8790. Photographic Apparatus, T. d'Oksza and G. Bourrelly, London.
8791. Centrifugal Separators, H. H. Lake.—(*T. T. A Hansen, Denmark.*)
8792. Back Linings for Books, G. B. Soelberg, London.

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8793. Gas Cooker, W. P. Thompson.—(*G. Horn, Germany.*)
8794. Rail Cleaner for Tramways, D. E. Hipwell, London.
8795. Tires, D. E. Hipwell, London.
8796. Pneumatic Tires, J. B. Scammell, London.
8797. Dead-beat Sectioner, H. Creegan, Chester.
8798. Bicycle Standing Gear, B. Phelan, London.
8799. Clips for Cordage, R. R. Macnee, Glasgow.
8800. Hair Curlers, G. H. Twigg, Birmingham.
8801. Fastening Metallic Cork Stoppers, A. Millin, Belfast.
8802. Switchboards, C. Shore and C. Heap, Rochdale.
8803. Cutting V-pieces from Paper, &c., J. Bennett, Bristol.
8804. Frames for Photographs, &c., R. B. Miller, Dundee.
8805. Cocks or Taps, C. H. J. Rudd, Newcastle-on-Tyne.
8806. Heating Domestic Water Supply, W. Wilson, Leigh.
8807. Gas Lighting, A. Köhler, Hamburg.
8808. Picnic Knife and Fork, E. Lapp, Hamburg.
8809. Operating Window Blind Rollers, H. Lomax and Lomax, Limited, Halifax.
8810. Dynamo-electric Machines, J. Edmondson, Halifax.
8811. A Force Accumulating Motor, E. Walker, Yorks.
8812. Gas Lighting, H. G. Frost, Deal.
8813. Gas and Oil Engines, H. N. Bickerton, Manchester.
8814. Rolling Continuous Bands of Metal, H. and H. W. Guthrie, Manchester.
8815. Electric Light Switches, G. Davis, London.
8816. Rotary Engines, R. Studdert, Manchester.
8817. Automatic Locking Apparatus for Doors, H J. Hayes, Norwich.
8818. Detachable Covers for Pneumatic Tires, J. Newhouse, Lancashire.
8819. Railway Pilotman's Substitute Apparatus, J. W. Mitcherd, Merioneth.
8820. Advertising, A. E. Taylor, Manchester.
8821. Ticket Holder for Railway Wagons, E. Platt, Manchester.
8822. Station Indicator for Passenger Trains, W. Baxendale and E. Platt, Manchester.
8823. Pans of Water-closets, J. E. and W. H. Place, Manchester.
8824. Spindles for Locks and Latches, W. H. Baynes, London.
8825. Letter-boxes, &c., S. Hill and R. Hodges, London.
8826. Cyanides, J. A. Wanklyn and W. J. Cooper, Surrey.
8827. Centrifugal Governors, J. N. and W. Paxman and J. C. Peache, London.
8828. Affixing Shafts to Dog-carts, G. and J. Hayward, London.
8829. Motor, R. Quigly, London.
8830. Locking Cycles, A. H. Dickinson and H. J. Fisher, London.
8831. Manufacture of Coffee, H. Boisseleir, Enfield.
8832. Turbines, H. A. House, sen., and R. R. Symon, London.
8833. Anchors, H. A. House, sen., and R. R. Symon, London.
8834. Tea-leaf Rolling Machines, S. C. Davidson, London.
88 5. Tubulous Steam Generators, B. H. Thwaite, London.
8836. Cisterns, C. T. Lee, London.
8837. Colander, E. C. Johnston, London.
8838. Pneumatic Tires, G. F. Redfern.—(*R. Reid, Australia.*)
8839. Apparatus for Exhibiting Play-bills, L. C. Cropper, London.
8840. Tires for Wheels of Bicycles, W. Cutler, London.
8841. Device for Burning Tobacco, J. Conning, London.
8842. Tongs, W. Brittain, London.
8843. Cycle and other Lamps, W. B. L. G. Toler, London.
8844. Rafts for Use in Water Velocipedes, J. T. Harris, London.
8845. Head for Otter Trawl Net, W. Walker, London.
8846. Dynamo-electric Machine, H. Sandwith, London.
8847. New Steering Lock for Cycles, A. Gower, London
8848. Pneumatic Tires, S. B. Archdeacon and B. McA. Bannatyne, Liverpool.
8849. Drive Chain for Cycles, A. Appleby, Birmingham.
8850. Device for Wire-drawing Machines, H. Pieper, London.
8851. Pumps, Air Compressors, &c., J. G. Walker, London.
8852. Manipulating Ventilators, &c., J. G. Walker, London.
8853. Improved Generator of Electricity, H. Arzt, London.
8854. Screw Nails, E. Edwards.—(*J. Schumann, Germany.*)
8855. Propulsion of Vessels, J. F. Green, London.
8856. Cushion for Billiard Tables, W. Buttery, London.
8857. Colouring Matters, C. D. Abel.—(*The Actien Gesellschaft für Anilin Fabrikation, Germany.*)
8858. Working Single Lines of Railway, E. Tyer, London.
8859. Apparatus for Propelling Boats, H. Barcroft, London.
8860. Discharging Colour, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
8861. Purifying Acetylene, O. Imray.—(*E. Rousseau, Belgium.*)
8862. Substitution for Bolt, M. D. Martindale, London.
8863. Eaves' Gutters, W. R. Pryke and W. Palmer, London.
8864. Finger Rest for Penholders, J. T. Ahrens, London.
8865. Colour Photographs, B. J. Edwards, London.
8866. Musical Instruments, N. Calace and R. Calace, London.
8867. Thermometers, G. H. Zeal, London.
8868. Device for Speedy Locomotion, H. S. Halford, London.
8869. Pneumatic Tires for Cycles, H. S. Halford, London.
8870. Chimney for Gas Incandescent Light, M. Raphael, London.
8871. Shock Covers, H. Walker, London.
8872. Machines for Making Casks, &c., G. Rettig, London.

8873. Condensing Steam Engines, K. Lundkvist, London.
8874. Ratchet Drills, V. Kuchar, London.
8875. Brakes for Cycles, Vehicles, &c., J. McRae, London.

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8876. Manufacturing Boot Welts, A. C. Spencer, London.
8877. Machines for Printing Colours, V. Turati, London.
8878. Cloth Caps, J. G. Hudson, London.
8879. Hames of Horse Collars, H. T. Simpson, London.
8880. Pneumatic Tubes for Cycles, T. H. Williams, London.
8881. Cycle Tire, J. C. Kenwood, St. Leonard's-on-Sea.
8882. Non-slipping Floor Covering, A. Tracy, Retford.
8883. Reels, C. A. Rickards and A. Richmond, Bradford.
8884. Detecting Punctures in Tires, H. Branter, Bradford.
8885. Timing-in Clocks for Pigeon Races, J. Pitt, Bradford.
8886. Advertising, W. C. Lister, Wolverhampton.
8887. Tiles, Slabs, Wallings, &c., J. S. Rigby, Liverpool.
8888. Apparatus for Obtaining Cyanides, J. B. Readman, Glasgow.
8889. Engines, R. G. Morton, Glasgow.
8890. Electricity and Water Supply, T. Meacock, Birmingham.
8891. Joints of Cornice Poles, W. A. Bibb, Birmingham.
8892. Securing Pneumatic Tires to Rims, A. S. Cartwright, Birmingham.
8893. Regulating Steam Engines, D. Robertshaw, Halifax.
8894. Attachment of Filigree Metal Work, M. Watts, Birmingham.
8895. Bandages, M. Arnold. Manchester.
8896. Pneumatic Tires, J. Mosely and B. Bluudstone, Manchester.
8897. Tires for Vehicle Wheels, R. Hunt, Liverpool.
8898. Catching Plates, H. J. Ridley and D. Davies, Carmarthen.
8899. Round Buddle, G. Robson, Merioneth.
8900. Apparatus for Propelling Bicycles, H. A. Poole, Rochdale.
8901. Magnetising Boxes, J. Y. Johnson.—(*Electric Hardware Manufacturing Company, United States.*)
8902. Leaf Turner for Music, &c., J. Beauchamp, London.
8903. Gear Case, J. Fielding, Manchester.
8904. Valves for Gas and Oil Motors, D. Mottershead, Manchester.
8905. Saddles, H. D. Pearsall, London.
8906. Generating Electricity, L. B. Atkinson and F. G. Treharne, Penarth.
8907. Alloy of Iron, T. Twynam, Egham.
8908. Wheels, A. H. Gorsuch, J. Crowther, and G. H. Richmond, Manchester.
8909. Dress Retainer for Lady Cyclists, E. Overend, Dublin.
8910. Valves, J. Scowcroft and E. Nightingale, Manchester.
8911. Steam Traps, R. Nightingale and J. Scowcroft, Manchester.
8912. Cycle Wheels, M. Conlan and W. Moores, Manchester.
8913. Pneumatic Tires, J. Adair, Waterford.
8914. Boxes for Holding Millinery, J. Bennett, Bristol.
8915. Combined Clip and Invoice File, S. Learoyd, Huddersfield.
8916. Driving Gear for Cycles, A. E. Cotton, Nottingham.
8917. Sleeve Grip, G. Sherlock, London.
8918. Explosion Engines, D. Young.—(*L. S. Gardner, United States.*)
8919. Fixing Detonators, D. Slade and C. Tayler, Liverpool.
8920. Fare Registers, F. C. Boyd and C. E. Gierding, London.
8921. Cycles, C. A. Jensen.—(*Bolte Cycle Manufacturing Co., United States.*)
8922. Cycle Lamps, J. G. Halford, London.
8923. Cigar Holder, F. L. Schmitz.—(*F. H. Schmitz, Austria.*)
8924. Adjustable Cycle Support, M. Goodman, London.
8925. Frames for Doubling Yarns of Cotton, F. Wood, London.
8926. Brake Mechanism, G. Conaty and J. F. Mason, Manchester.
8927. Advertising Apparatus, F. Prestwich, Manchester.
8928. A New Method of Dispersing Fog, F. Frey, London.
8929. Pneumatic Tires for Cycles, J. C. Lighthouse, London.
8930. Merry-go-rounds or Roundabouts, W. Reynolds, London.
8931. Pulp Strainers, J. White and A. W. Allan, Glasgow.
8932. Hasp and Staple, W. F. Woolfenden and F. H. Greaves, Liverpool.
8933. Stop Runaway Check, C. Hillen and D. Smith, Southport.
8934. Mechanical Toy, R. H. Bishop and A. W. Pocock, London.
8935. Mantles, &c., Heated by Gas, W. B. Smith, London.
8936. Rag Dolls, J. R. Mally, London.
8937. Faces of Dolls, J. R. Mally, London.
8938. Pneumatic Tires, J. T. Trench, London.
8939. Pneumatic Tires, J. T. Trench, London.
8940. Masks, G. Lams, London.
8941. Appliance for Riding Cycles, W. Wingate, London.
8942. Propelling Apparatus for Ships, R. A. Smith, London.
8943. Metal Caps, R. Williams, Chiswick.
8944. Umbrellas, R. P. Hull, H. K. Beck, and H. M. Hawley, London.
8945. Printing on Envelopes, &c., J. S. Duncan, London.
8946. Purifying Iron, H. H. Lake.—(*Hawkins Steel Company, United States.*)
8947. Making Gear Teeth, H. G. Warren, London.
8948. Signalling Apparatus, H. H. Lake.—(*G. E. Painter, United States.*)
8949. Steam Boilers, D. and F. D. Almy, London.
8950. Boots, H. H. Lake.—(*E. B. Seaver, United States.*)
8951. Steam Generators, D. M. Thompson, London.
8952. Bottling Gaseous Liquors, J. Fletcher and Ryder and Co., London.
8953. Transportable Scaffolding, &c., P. Schulz, London.
8954. Holders for Stretching Machines, A. A. Whitley, London.
8955. Motive Power Engines, G. Gascoine, London.
8956. Grain Elevators, E. Blanchard, London.
8957. Reel for Water Tubes, H. W. Handcock and A. H. Dykes, London.
8958. Turning Over Leaves of Music, W. J. Pitt, London.
8959. Preparing Sheet Iron and Steel, J. D. Grey, London.
8960. Smoke-consuming Devices, H. H. Lake.—(*P. Sertschansky, France.*)
8961. Wrench for Turning Pipes, M. D. Martindale, London.
8962. Musical Instruments, O. Imray.—(*N. Merrill and A. W. Jones, United States.*)
8963. Musical Instruments, O. Imray.—(*N. Merrill and A. W. Jones, United States.*)
8964. Electrical Furnaces, O. Imray.—(*D. Graham, Canada.*)
8965. Drilling Holes in Brush Bodies, C. E. Flemming, London.
8966. Boot Tree or Boot Stretcher, M. Renault, London.
8967. Recovery of Precious Metals, S. Vivian, London.
8968. Cork-cutting Machines, J. A. Lafrance, London.
8969. Unfastening Doors, E. Edwards.—(*H. Hufschmidt, Germany.*)
8970. Braces, T. Parkin, London.
8971. Defensive Works for Laagers, P. B. Tod, London.
8972. Gear Chains for Bicycles, C. A. McCombie, London.
8973. Organs, R. P. Strand, D. B. Carritte, and C. A. Stockton, London.
8974. Fire Extinguishers, C. R. Arents and W. R. Johnston, London.
8975. Bottles, R. S. Dickerson, London.
8976. Sewing Machines, J. W. Mackenzie.—(*W. H. Boyer and The American Special Machinery Company, Limited, United States.*)
8977. Sanitary Paper for Toilet Purposes, A. Pitt and D. Stuart, London.
8978. Coal Crushers, S. Evans and F. J. Morgan, London.
8979. Typewriting Machines, A. M. Clark.—(*The Wagner Typewriter Company, United States.*)
8980. Motors, &c., A. J. Boult.—(*K. Henschel, Germany.*)
8981. Substitute for White Lead, &c., S. Ganelin, London.
8982. Artificial Hair Constructions, G. and H. Lichtenfeld, London.
8983. Stoppering Bottles, J. Prince and S. Higton, London.
8984. Machines for Opening Meat Tins, &c., G. Steer, London.
8985. Covers for Tobacco Pipes, T. Hooper, S. G. Moore, and F. R. Baker, London.
8986. Handle-bars of Bicycles, W. E. Webb, London.
8987. Water Gauges, J. Hopkinson and J. Lowis, London.
8988. Arc Lamps, W. P. Thompson.—(*M. Wholess, United States.*)
8989. Bicycles, W. P. Thompson.—(*H. N. Timms, United States.*)
8990. Grinding Flats in Carding Engines, W. P. Thompson.—(*J. C. Potter, United States.*)
8991. Field Glasses, W. P. Thompson.—(*E. Toussaint, Germany.*)
8992. Turbines, G. Kürtösi, London.
8993. Weighing Appliances, J. Trantom, Liverpool.
8994. Hook for Curtain Draperies, G. H. Hill, Birmingham.
8995. Incandescent Gas Lamps, J. Bartels, Liverpool.

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8996. Cycles, F. H. Keene, Ireland.
8997. Lamp Stoves, G. Salter and C. J. Holdship, Birmingham.
8998. Separating Solutions from Materials, C. J. Ellis, Glasgow.
8999. Multiplex Telephony, A. M. Rosebrugh, Canada.
9000. Wheels, W. Ives, Halifax.
9001. Increasing the Buoyancy of Ships, R. Baird, Glasgow.
9002. Regulators for Steam Engines, R. Gee, Huddersfield.
9003. Treatment of Alimentary Substances, J. Hogarth, Glasgow.
9004. Valves, C. H. Holgate, Leeds.
9005. Pneumatic Tires, J. Birtwistle, Manchester.
9006. Boat Disconnecting Gear, &c., F. S. Pett, Dover.
9007. A Non-fillable Bottle, T. Dawson, Birkdale.
9008. Attaching Flexible Coil Tires, C. Challiner, Manchester.
9009. Introduction of Different Colours, H. Fothergill, Leeds.
9010. Means for Carrying Coal, G. Simpson, London.
9011. Appliances for Carrying Bags, E. J. Pinder, Sheffield.
9012. Cycle Tires, R. H. Edmundson, Manchester.
9013. Bells, C. B. Wright and F. L. Sanders, Nottingham.
9014. Electric Temperature Alarms, G. J. Baird, Glasgow.
9015. Raising Vessels, J. B. Murray and J. P. Turnbull, Glasgow.
9016. Motor-driven Velocipedes, J. J. H. Sturmey, Coventry.
9017. Adjustable Lock Jaw Spanner, J. Reid, Millom.
9018. Machine Tool or Cutter Holders, S. Griffin, Bath.
9019. Signals for Railways, W. H. Hallsworth, Ashton-under-Lyne.
9020. Fastener for Wearing Apparel, M. Bach, Manchester.
9021. Bar to Prevent Entanglement of Cotton, L. Martindale, London.
9022. Head-lights for Railway Cars, F. E. Huntress, London.
9023. Clips, F. S. Rippingille, London.
9024. Stoves, F. S. Rippingille, London.
9025. Self-acting Tip Box, &c., J. H. Simpson, London.
9026. Apparatus for Holding Plates, W. O. Bailey, London.
9027. Pneumatic Tires, J. Pearson, J. B. Price, and E. T. Whitelow, Manchester.
9028. Holding Bobbins, J. H. Smith, O. H. Hartley, and R. N. Wailes, London.
9029. Bicycle Apparatus, F. E. Macmahon and A. J. Postans, London.
9030. Automatic Electrical Cut-out, W. W. Channon, London.
9031. Manufacture of Hats, T. Lees, T. H. Lees, and W. Morgan, London.
9032. Voxometer, A. A. North, P. Nind-Ward, and E. W. Pidgeon, London.
9033. Wire-drawn Benches, C. Bremicker, Germany.
9034. Hydrostatic Engines, C. Stimpson, London.
9035. Coin-freed Apparatus, G. Haydon and Haydon and Urry, Limited, London.
9036. Rocking and Folding Chair, C. Vogel, jun., London.
9037. Conveying Coke from Gas Retorts, J. Browne and J. Rice, London.
9038. Ploughs, J. Hornsby, J. Money, and W. Grice, London.
9039. Pear-shaped Steel Spring Truss, J. Robinson, Bucks.
9040. Pedals for Bicycles, J. Monteith, London.
9041. Treatment of Tin Ore, S. O. Cowper-Coles, London.
9042. Feed-water Heaters, W. P. Thompson.—(*J. F. Hauser, Germany.*)
9043. Electric Transmitting Apparatus, T. S. Baltazzi, Liverpool.
9044. Rotary Flat Sieves, J. Higginbottom, Liverpool.
9045. Brakes for Bicycles, G. Bradley and J. Moorhouse, Manchester.
9046. Pneumatic Tires, G. Williams, jun., Liverpool.
9047. Heating by Electricity, T. D. Farrall, London.
9048. Electric Fog Signalling Apparatus, H. Tomlins and C. R. Gurr, London.
9049. Pile-fabric Cutting Frames, J. Welsby and J. Whittaker, Liverpool.
9050. Holding or Supporting Fabrics, W. B. Mulligan, London.
9051. Cycle Saddles, T. Middlemore and T. Evans, London.
9052. Motors, A. A. Loyal, London.
9053. Tennis Rackets, E. R. Butler, London.
9054. Presser Clamp, Hope-street Factory, Ld., and J. Laird, London.
9055. Fireproof Cements and Varnishes, I. A. Timmis, London.
9056. Automatic Gas Lighting Devices. G. Loewenberg, London.
9057. Attachment for Beer Engines, W. Granville, London.
9058. Race Courses or Race Tracks, S. E. Moss, London.
9059. Bicycle Supports, J. J. McKanna and C. Lindstrom, London.
9060. Telephones, G. L. Anders and J. E. Wedekind, London.
9061. Giving Sound and Light as Alarums, M. Wilson, London.

30th April, 1896.

9062. Vertical and other Steam Boilers, J. R. Robson, Leeds.
9063. Door Latch, D. Smith, Blackburn.
9064. Lubricating Bearings, G. Kyte and Co., Cardiff.
9065. Fire-lighter, T. S. Blakeway, Manchester.
9066. Knitting Material Holders, W. J. Simmons, Bristol.
9067. Pneumatic Tires, V. Brown and R. J. Royle, Lancashire.
9068. Wick for Burners, &c., H. W. Scothon, Nottingham.
9069. Consuming Furnace Smoke, Starkey Bros., Ld., and F. Hinchliffe, Huddersfield.
9070. Cutting Gelatinous Substances, J. W. Atkinson, G. Bramley, and J. Todd, Bradford.
9071. Improved Motor, C. E. Agar and H. Ainsworth, Manchester.
9072. Needle Threaders, J. Darling and T. Clarke, Glasgow.
9073. Railway Carriage Windows, H. Macaulay, Glasgow.
9074. Sunshades, &c., for Bicycles, J. J. Wagstaff, Newport, Pagnell.
9075. Coating Pills, R. Gibbins, Derby.
9076. Making White Arsenic, T. P. Sims and W. Terrill, Swansea.
9077. Uncoupling Cattle, W. Straube and The Actiengesellschaft Maschinenfabrik Landsberg-on-the-Lech, London.
9078. Glass Wares, W. Straube and The Actiengesellschaft Maschinenfabrik Landsberg-on-the-Lech, London.
9079. Incandescent Lamps, W. R. Lane and Winfields, Ld., London.
9080. Taking Pills from Vials, C. Toft, Staffordshire.
9081. Tires for Vehicles, C. E. Harrison, Birmingham.
9082. Machine for Perforating Cheques, S. Draper, London.
9083. Propelling Cycles, F. O. Ferguson, Ilfracombe.
9084. Apparatus for Distilling, J. Longshaw, Manchester.
9085. Preparing Fluid Extracts, J. Longshaw, Manchester.
9086. Staple to Fasten to Deeds, J. L. Phillips, Llanelly.
9087. Tag for Fixing Plants to Walls, J. H. Gibson, Southport.
9088. Sheep Trucks, J. J. McMurdo and G. Symington Glasgow.
9089. Mechanically Unloading Lorries, C. Flower, Glasgow.
9090. Taps for Hot and Cold Water, A. Clifford, Kent.
9091. Key-ring Appliances G. H. Laxton, London.
9092. Oil and Gas Engines, H. Tubb and A. E. Mondey, Southampton.
9093. Cycles, J. Corp, London.
9094. Constructing Bicycle Tires, J. C. Cole, London.
9095. Washing Machines, W. Smith, D. Marks, and R. Watson, Keighley.
9096. Propelling Apparatus for Ships, G. D. Macdougald, Dundee.
9097. Tires for Cycle Wheels, S. B. Wilkins, Edinburgh.

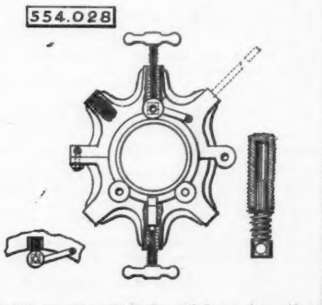
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

554,028. Pipe-cutter, *J. N. Marso, Joliet, Ill.—Filed November 29th*, 1895.

Claim.—(1) In a pipe-cutter, the combination of the frame A formed in two parts and hinged together and having the nut and bolt G for locking the two parts of said frame together on the pipe to be cut, and having the bar-holes F, the bit H, screw I attached to said bit, the screw E having a hollow inner end, the rod K having its inner end arranged in the chamber of screw E, coil spring J sleeved on said rod between its head and screw E, friction wheels B' and their axle attached to rod K, links C for pivotally connecting said wheels with frame A, and the friction wheels B and their axles all arranged to operate substantially as and for the purpose set forth. (2) In a pipe-cutter, the combination of the jointed frame A, and the means for clamping it on a pipe to be cut, the adjustable bit H, the friction wheels B, the hollow screw E, rod K fitting the hollow of said screw and having an axle attached to its outer end, the friction wheels B′ on said axle, the links for pivotally connecting said wheels and their axle with the frame A, and the coil spring sleeved on said rod between its head and screw E, all arranged to operate substantially as and for the purpose set forth.

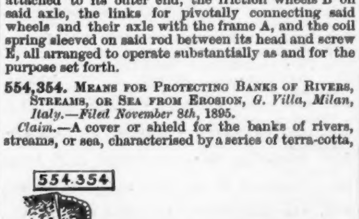
554.028



554,354. Means for Protecting Banks of Rivers, Streams, or Sea from Erosion, *G. Villa, Milan, Italy.—Filed November 8th*, 1895.

Claim.—A cover or shield for the banks of rivers, streams, or sea, characterised by a series of terra-cotta, or cement—or other suitable material—plates *a*, connected with each other by means of wires *b*, the longitudinal layers of which are held together at the bottom of the river by a wooden—or like—bar *c*, while they are fixed at the top of the bank by wires fastened to trees, piles, or the like, driven into the bank.

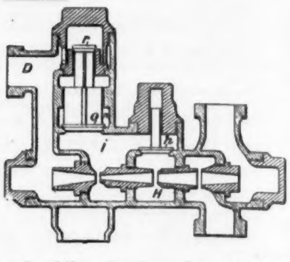
554.354



554,415. Injector, *J. Desmond, Detroit, Mich.—Filed November 11th*, 1893.

Claim.—(1) In an injector, the combination of the casing, partitions therein to form the communicating chambers H I, having an overflow common to both, the combining and delivery tubes having a spill-opening into the chamber I, the valve *h* in the passage between the chambers and the valve *o* for the overflow located between the chamber I and the overflow passage, substantially as described. (2) In an injector, the combination of the casing, partitions therein to form the chambers H I, the overflow passage *n*, discharge D, of the valves *h o* and *r*, substantially as described. (3) The combination of the combining and delivery chambers having a spill-passage therefrom, communicating with the chamber I, the valve *o* being constructed to permit fluid above the same to enter the chamber I and the valve *r* subject to pressure from the delivery and adapted to close the valve *o*, substantially as described.

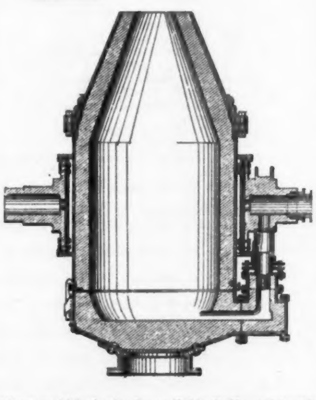
554.415



554,457. Pneumatic Converter, *C. S. Price, Westmont, Pa.—Filed April 10th*, 1895.

Claim.—(1) In a pneumatic converter, a bottom section lined solidly in its lower portion with refractory material, provided with a side blast inlet at or near the upper surface of said bottom lining, and a removable elbow lined with refractory material in which is formed part of the blast inlet, said latter portion of the blast inlet being connected at one end to a suitable blast pipe and at the other to the main body of the bottom, said elbow being removably secured to said bottom and blast pipe by suitable bolts, substantially as described. (2) In a pneumatic converter, a bottom section lined with refractory material, and a side blast inlet formed in the side lining of said bottom and connected to a suitable source of air supply, by means of an elbow lined with refractory material and provided at or near its upper end with a perforated tuyere block, said tuyere being so arranged as to be readily removed and replaced, substantially as set forth.

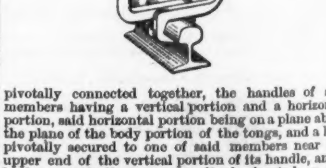
554.457



554,461. Rail Tongs, *E. Schrantz, Warrington, Mo.—Filed November 6th*, 1895.

Claim.—(1) A rail tongs, comprising two members, one of said members carrying the pivot pin and the other of said members being formed with a slot to receive said pin, said slot being somewhat enlarged at one end, substantially as described. (2) A rail tongs, comprising two members which are slidingly and pivotally connected together, the handles of said members having a vertical portion and a horizontal portion, said horizontal portion being on a plane above the plane of the body portion of the tongs, and a link pivotally secured to one of said members near the upper end of the vertical portion of its handle, and a hook or projection correspondingly located on the other member, and with which said link is adapted to engage, substantially as described.

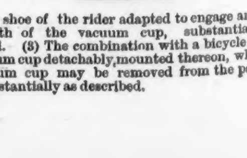
554.461



554,686. Vacuum Cup Bicycle Pedal, *E. T. Harris and A. S. Reed, Chicago, Ill.—Filed July 24th*, 1895.

Claim.—(1) The combination with a bicycle pedal, of a vacuum cup provided thereon, adapted to be engaged by the foot of the rider, substantially as described. (2) The combination with a bicycle pedal, of a vacuum cup provided thereon and a plate provided upon the shoe of the rider adapted to engage and seal the mouth of the vacuum cup, substantially as described. (3) The combination with a bicycle pedal, of a vacuum cup detachably mounted thereon, whereby the vacuum cup may be removed from the pedal at will, substantially as described.

554.686



AUXILIARY ENGINES IN SCREW STEAMERS.

IN a series of articles which we published last year—see vol. lxxx., pages 228, 299, 379, 448, 522, 543—most of the details connected with the fitting of the main engines and boilers on board a screw steamer were explained. In this article we intend to draw attention to some of the more important engine-room accessories.

In the early days of high-pressure steam, it was thought desirable to use sea-water in the boilers, in order that the heating surfaces might become covered with scale, which was thought to prevent, or at least minimise, corrosion; and as long as such views prevailed, the idea of fitting distilling appliances, or evaporators as they are more commonly called on board, was scouted as being ridiculous. It was the inventors of water-tube boilers who discovered to their cost that sea water was fatal to their creations. Fresh-water tanks had therefore to be fitted in such steamers, but as the loss of water from a marine engine and boiler may amount to one ton a day per 100 indicated horse-power, it was soon found that such tanks would have to be of enormous dimensions if used on long voyages, and it proved to be more convenient and also more profitable to fit evaporators. Originally these were small boilers heated by fires and exhausting either into one of the receivers or into the condenser, but this arrangement was a troublesome one, and soon gave way to an apparatus in which the evaporation is effected by steam which passes through coils submerged in salt water. As soon as this water begins to boil, the steam thus generated passes either into one of the receivers or into the condenser. Many alternative arrangements may be, and are being, worked. Thus some evaporators receive their steam from No. 1 receiver, and the generated steam is delivered into No. 2 receiver, while the condensed steam is drained into the hot well; the three quantities being equal, there is a loss of about 2 per cent. of power, because of the reduced quantity of steam in the intermediate cylinder, but there is a gain of about 1½ per cent. of heat in the feed. On account of the comparatively small difference of temperature between the two receivers, which is still further reduced in the evaporator, its heating surface will only evaporate about 20 lb. of water per sq. ft. per hour, or approximately one quarter ton per day. By connecting the steam coils to the main boiler, and the exhaust pipe to the condenser, the performance of such an evaporator could be increased fourfold, or for the same sized engine its heating surface could be diminished to one-fourth, because each square foot would now evaporate about one ton per day, but the external size of the evaporator could not be reduced; in fact, it would doubtless have to be increased, for, on account of the low pressure in the condenser, the volume of the generated steam would be enormous, and with a low crown to the evaporator, priming would be sure to take place; as the water in the evaporator ultimately contains much salt, it might happen that the newly formed steam would prime over as much salt, or sometimes more, than is contained in the sea. This arrangement must also be considered an uneconomical one, for the steam which is condensed in the evaporator does no work, and as its final temperature is only slightly higher than that of the condenser, no benefit is derived by leading it into the feed. The total loss of steam amounts to about 7 per cent., which is a heavy price to pay for distilling 7 per cent. of sea water.

Much uncertainty prevails as to how to determine the quantity of water produced in an evaporator, but it is really a very simple matter. First of all, the evaporator is filled with water to the usual working level in the gauge glass; this water is then run out into gallon measures, and the internal capacity up to any given mark is thus found. The evaporator is then refilled and set to work. Every time before blowing it out a sample is drawn off, and its density measured. Should this be found to contain, say, 25 oz. of salt to the gallon, whereas sea water only contains 5 oz., then evidently four times as much water as is still contained in the evaporator has been distilled. Another plan is to shut off the supply and to note the speed with which the water level in the evaporator is reduced, but this must necessarily be a short and unsatisfactory experiment. The usual method of working an evaporator is to fill it with sea water up to a certain height, which can be seen on the gauge glass; then the exhaust pipe is opened, then the drain to the hot-well, and then the steam stop valve is opened. The amount of steam condensed depends not only on the available differences of pressure or temperature, but also on the openings of the various valves, &c. The maximum quantity is of course produced if the stop valve and drain cock are full open, but the sea water would soon dry up, and has to be added to by a small separate feed pump whose suction valve can be regulated so that just sufficient more water is admitted. If less water has to be evaporated, this suction valve and also the steam stop valve or the drain cock are partially closed. If the exhaust pipe is a small one, particularly when connected to the condenser, the evaporation will be somewhat reduced. After a few hours' working, and when the saltness of the water has increased considerably, the feed is stopped and the blow-off cock opened. The pressure in the evaporator will, of course, drive out the concentrated brine. If, however, the exhaust pipe is connected to the condenser, then this pipe must first be closed, and a little time will elapse before the pressure has risen sufficiently to overcome the external head of sea water. When this point has been reached the blow-off cock is opened and the brine ejected. The evaporator is then refilled and the process repeated about once every watch. After working like this for a few days, the proceeding is altered a little. The concentrated brine is blown out, the blow-off closed until the pressure and temperature in the evaporator has risen as high as circumstances will allow. The steam is then shut off and the blow-off cock opened, and after a very short period the sea will be drawn in, and coming into contact with the hot steam coils and the scale which adheres to them, will cause the latter to crack off and fall to the bottom. Contrary to expectations, no injury seems to accrue to the evaporator by this proceeding, and it is therefore better to clean it in this manner than to nurse it carefully and ultimately to chip the scale off in port, whereby the tubes are soon worn through.

In addition to an evaporator, passenger ships carry a distilling apparatus, or small independent condenser. The necessary steam is supplied by the evaporator, and the condensed water has therefore no oily taste. The cooling water is taken from the circulating pump of the main engine. Of course the evaporator may not in this case be connected to the main condenser, otherwise there will be no tendency for the condensed water to flow out of the still.

Another very necessary engine-room fitting is the oil filter; its object is to free the feed of all oil before it enters the boilers, whereby the heating surfaces are kept clean, their heat-transmitting power maintained, and all danger of overheating reduced to a minimum. Oft repeated experiments have proved that even very thin films of oil, with which a heating surface may have become coated, add enormously to the heat-resisting power of the plates. Whether this is due to the very low thermal conductivity of oils, or whether it is due to the artificial smoothness or greasiness of the surface, whereby the formation of bubbles is discouraged, has not been decided, but there can be no doubt that a far greater amount of oil may be tolerated in a boiler whose heating surface is well covered with scale, than in one where no scale has been allowed to form, this may perhaps account for the fact that collapses of furnaces due to oil are relatively more frequent in new boilers than in old ones. That a very slight amount of oil will seriously interfere with the evaporation can easily be demonstrated by pouring samples of fresh water and milky feed-water from a marine engine into two new saucepans and boiling them. The fresh water will boil quite steadily, while the oily feed-water will boil spasmodically. If after a short time the feed-water is poured away and fresh water placed in its saucepan, the boiling will still be irregular, showing that this is due to an oily deposit, which, although it is invisible, can be shown to exist by rubbing the inside of the pan with a white rag.

The general principle of an oil filter is that the feed is made to pass through several thicknesses of some woven material, to which the oil is supposed to adhere. It is needless to say that as soon as the advantages of oil filters had been demonstrated, numerous designs were at once got out. At first all other considerations were sacrificed to the one of efficiently removing all the grease out of the water, which was, therefore, made to pass through many membranes, but it has been found that all the grease does not get removed, and that the best filtering medium is the grease itself, which collects on the membranes—or, in other words, the dirtier a filter is, the better it acts. But this is only true so long as the pressure which is required to force the feed through the filter is not excessive. Should it rise too high, the accumulated grease is forced through the membrane, or the latter bursts. This is, perhaps, one of the reasons why most filters are fitted with safety valves, which are set to a pressure of about 30 lb. in excess of the boiler pressure. By-pass valves, set to about 30 lb. per square inch, have been tried, and certainly do not waste any water when the maximum pressure has been reached, because it then goes straight into the boiler; but they have to be fitted with signalling appliances, which inform the engineer when the filter requires cleaning, and these appliances either get out of order or are disconnected, and the filter is not attended to as thoroughly as it should be. If an escape valve is fitted, the overflowing water compels attention.

In the early filters the cleaning of the membranes was a very troublesome and dirty job, each one having to be removed, scraped, and replaced. For convenience they were fitted with flat frames, and consequently took up much room. The more modern practice is to clean the filter by passing a reverse current, either of steam or water, through the filter and blowing the mud overboard. Under such conditions the flat membranes need not of course be adhered to, and the aim with all modern filters seems to be to make their bulk as small as possible, with the largest possible surface. Lenticular, cylindrical, and star-shaped frames, on which the membranes are stretched, have since then become quite common. On the other hand, as these filters are subjected to great heat, flannel, which is certainly a very good filtering material, has had to be replaced by linen, cotton, and cocoa-nut fabrics; the latter, in particular, seems to be a great favourite.

When the boilers are fed direct by the main engine pumps, the filter is invariably fitted between the two, although of course pipes could be led from the hot-well to the filter, and thence to the pumps, but in this case the available head of pressure would not be great, and the filter would have to be cleaned very often, or its area would have to be a very large one. If independent slow-working feed pumps are used, together with an overhead tank, the filter is frequently connected either to the pipes leading to this tank, or to those coming from the tank, so that the water is as pure as it can be made before it reaches the pumps. In neither case is a safety valve necessary, except as a safeguard for the filtering material, as it might tear if too great a thickness of grease were allowed to accumulate. Its amount will, of course, depend on the quantity of oil injected into the cylinders, which in modern engine-room practice has been reduced to a minimum, absolutely no oil being injected; in fact, the only points where the steam now comes in contact with the grease is at the piston-rods. At first sight it would appear that this quantity is too small to be worth troubling about, but it is a fact that even under these circumstances considerable deposits of grease collect in the filters, and the feed-water, even after being thus cleared, has a slightly milky appearance and an oily taste. By some it is believed that the coarse grease, which is easily separated from the water by the filter, is not dangerous to the boiler, as it is this portion which at once rises to the water level and adheres to the shell plates and steam stays, whereas the greasy coating on the heating surfaces, and particularly on the furnace tops, is believed to be due to the finely divided or dissolved oil in the water, which seems to pass through all filtering materials that have yet been tried. However, as no case of collapsed furnaces has occurred in vessels fitted with oil filters, and their number is daily increasing, it is but reasonable to suppose that this invention is a real safeguard.

Mention has already been made of automatic feed pumps. They owe their introduction to a well-grounded belief that the internal corrosion of marine boilers is mainly due to the air which is forced into them by the feed pumps. These, as is well known, are made twice as large as need be, even when the engine is working full power, and under ordinary conditions they deliver quite twice as large a volume of air as of water, or about ¼ per cent. of its weight. One way of keeping this air out of the pumps would be to partially close their suctions, but the inconveniences attending this method are so many and so self-evident that it has probably never been tried. However, the principle has survived, and has been adopted in automatic feed-pumping arrangements. The water, after it leaves the hot-well is forced up into a tank placed near the skylights, where it parts with its air. This tank contains a powerful float, which actuates the stop valve of the automatic feed pumps and causes them to stop if the water level sinks, whereas, if suddenly a large volume of feed-water enters the tank, the float rises, opens the stop valve, and sets the pumps working full speed. These pumps are, of course, direct-acting. It will thus be seen that on account of the great height of the tank above the pumps, these are always full of water, and as they are of the slow working type, and are not fitted with snifting valves, every possibility of introducing air into the boiler has been removed, and, as far as can be judged, with beneficial results.

Automatic pumps are generally fitted with counters, which record the number of strokes and enable one to estimate the volume of feed, but only approximately, for the leakages are considerable, they increase with age, and are affected by the speed at which the pumps are worked; the stroke also varies considerably in the same pump. From an economical point of view, particularly as a check on the coal consumption, a knowledge of the feed supplied is valuable, and some modern ships are fitted with feed meters, but they can only be used together with automatic pumps, for the air which is delivered by the main feed pumps would in passing through the meter also be measured and recorded.

The overhead tank is frequently so arranged that it receives steam from one of the intermediate receivers, whereby the temperature of the feed-water passing through it is raised, but if we are not mistaken, this causes fluctuations, not only in the water level but also to a slight extent in the power developed by the engine, as will be seen if one supposes that through some external but temporary cause an excess of steam passes through the engine, it will, after being condensed, reach the tank and feed-heater just when the main engines are slowing down again, but the larger volume of water which just then passes through the feed-heater causes a larger volume of steam to be condensed, and as this is drawn out of one of the receivers the engine will be slowed down still more. Withdrawing the steam for a feed-heater from the main engine has, therefore, the contrary effect of a governor. Independent feed-heaters are sometimes fitted. Of course it is well known that the drains from the jackets add heat to the feed, and also that it is advantageous to draw off the water which accumulates in the various receivers, but this can easily be done by leading the pipes into the hot-well.

Neither the evaporator nor the oil filters, nor the automatic feed pump, are absolutely necessary in an engine-room, but as they add to the life and to the security of the boilers, most large steamers are now fitted with them. There are, however, other auxiliary engines which may not be omitted; these are the ballast pump in tank vessels, which has, of course, to be used chiefly in port, a separate donkey pump which has to be relied upon for clearing the bilges of water when the main engine is stopped, or its pumps out of order. It is also used for filling the boilers in port, and its suctions are arranged so that water can be drawn both from the bilges, the sea, hot well, tanks, and the boiler; and the deliveries are overboard, on deck, into the boiler, and into the condenser. In small steamers the ballast and donkey pump are sometimes, but not frequently, fused into one. Passenger ships are also supplied with a sanitary pump, which ought, of course, to be kept perfectly distinct from the bilge pipes, yet, strange to say, the fatal connection is very frequently insisted upon by the owners' representative, with the disastrous result that the baths are accidentally supplied with greasy bilge water. Even the bare idea that sanitary water is made to pass through the same pipes which occasionally draw filthy water ought to lead to an entire separation of the two.

Some small steamers, particularly those engaged in the fishing trade, have powerful ejectors, which, if they are not very economical, are certainly very effective in clearing the bilges, not only of water, but also of fish refuse and other substances that find their way there, which could not be done by pumps, on account of the restricted areas at the valves. Ash ejectors are worked on the same principle, but are little used because of the rapidity with which their ducts are said to corrode. Steam ash hoists have, of course, to be fitted to all large steamers, and seem to work very satisfactorily.

With the exception of the automatic feed all the above pumps are only worked for short periods at a time, they are therefore made as simple as possible, and doubtless are also very uneconomical as regards steam consumption, but there are three sets of engines—those for the dynamos, the refrigerators, and the fans—which work almost continuously, and waste a large amount of steam unless they are of the compound condensing type. The fans are of course only necessary where forced draught is required; they take up considerable floor space, and are rather bulky objects, but artificial draught seems to be growing in favour, and many modern steamers use it. On account of the high rotary velocity of the fan, its axis is subjected to severe stresses if placed athwartships, and if the vessel rolls quickly. These forces, due to gyroscopic properties of all fly-wheels, have caused frequent fractures of dynamo shafts, and such engines are now invariably placed parallel to the ship's keel, which plan ought also to be adopted with the fans. Refrigerating engines and chambers are now almost indispensable in passenger ships, and if to all the above mentioned auxiliary engines be added the steam-steering gear, which is frequently placed in the engine-room, it will be seen that the engineer of a good sized modern steamer may find himself responsible for the working of nine or more engines and appliances, half of which are constantly at work. In very large steamers many of these engines are fitted in duplicate, and in men-of-war their number is still further increased.

THE MANCHESTER SHIP CANAL, AND CANAL AND RIVER HYDRAULICS.

THE Manchester Ship Canal Company is promoting an omnibus Bill this session to obtain power to close the tidal openings in the estuary portion of the canal embankment; to amend the section compelling the discharge of the waters of the Weaver into the river Mersey by the Weaver tidal openings or Weaver sluices; to enable the company to raise about three acres of marsh land above the level of high water of spring tides; to extend the time for the construction of Warrington Dock; and for other purposes.

The Bill has been before a Committee of the House of Commons, presided over by the Hon. E. Blake, formerly a distinguished member of the Canadian Parliament, who now represents Longford as a Home Ruler, and three other members. The Bill occupied the Committee for fourteen days, and reminded the counsel and others who were retained of the fights of the last decade, when three years in succession the tenacious Daniel Adamson and his supporters came before Parliament and fought for forty days or twenty days as the case might be. They won in the first House in 1883 and 1884, to be defeated in the second, and failed to obtain an Act until 1885, by which time they had expended £150,000 in parliamentary and preliminary expenses.

This time the fight centred on the closing of the tidal openings. It will be remembered by our readers that it was contended by Liverpool in 1883, 1884, and 1885, that the scour due to the size of the receptacle for tidal water formed by the Upper Estuary was the factor to be relied on in keeping down the Bar, and so impressed were the Committee—of which the late Mr. W. E. Forster was chairman—of the advisability of maintaining as large an area as possible to be filled by the tide, that they caused the Ship Canal to be taken as far inland as the limits of deviation on the parliamentary plans allowed, and thus reduced as much as possible the amount of ultimate abstraction due to the river walls and embankments necessary for constructing the canal within the portion of the tidal limits through which it passes.

In 1883, and again in 1884, it was proposed to construct the waterway from Runcorn downwards by training and dredging a deep water channel through the estuary. The dread of accretion following on the stereotyping of a channel in the sandy upper estuary was understood to have been the chief reason for the ultimate rejection of the measure in those years. The Manchester case for relief from tolls and rates, which were said to be oppressive, was brought out so strongly during the proceedings, that, although the Committee of the Commons threw out the Bill in 1884, which had previously passed through the other House, they obtained an admission from the representatives of Liverpool that an alternative scheme was possible which would practically leave the estuary untouched. The promoters virtually adopted this scheme, and in order to allow the maximum amount of tidal water to flow in and out of the estuary on high tides, which all parties agreed were the important tides, for the purpose of scouring the channels and sandbanks of the Upper Estuary, as well as the Bar, only neap tides were excluded from the lowest reach of the canal. This reach is 21½ miles long, and its normal level was fixed at 14ft. 2in. above old dock sill at Liverpool, and tidal openings were constructed at that level, viz., 1ft. 4in. below the level of the average high water in the Mersey at Liverpool, which is 15ft. 6in above the old dock sill datum.

Three openings, each 600ft. long, have been constructed at Ellesmere Port, Weaver Mouth, and Runcorn, distant 3¼ miles, 10 miles, and 13 miles respectively, from Eastham. There are also two sluices at Eastham, ten at the Weaver, two at Old Randles, 15 miles above Eastham, all of which are 30ft. wide, and one at Walton Lock 20ft. wide, the latter being 19 miles from Eastham and close to Warrington. The top of the sluices, except at Eastham, are above high-water mark. The tide enters through the three tidal openings and the three locks at Eastham, the gates of which open automatically when the tide rises above the normal level of the canal.

It was supposed by many persons, having regard to the depth and capacity of the canal, that the tide would flow more rapidly along it than up the tortuous shallow channels of the estuary, and flow out rather than in through the tidal openings. Experience shows this supposition to have been erroneous, in spite of the depth of 26ft. and average width 160ft., although the sectional area of the three locks at Eastham is 4000 square feet, and of the canal 4134 square feet on the average. The tide reaches the sills of all the openings earlier from the estuary than from the canal, and continues to flow into the canal until after high water. At high water the gates at Eastham are closed, and the tide returns to the estuary through the three openings, and in order to lower the canal to the normal level rapidly, the sluices are lifted at Weaver and Old Randles.

A 21ft. tide opens the Eastham gates two hours and twenty minutes before high water. High water in the canal reaches the Weaver fifteen minutes and Walton Lock thirty minutes after high water at Eastham. The time of high water is a few minutes sooner at the various openings from Runcorn to Ellesmere Port in the estuary, but at Walton Lock it is thirty minutes later than in the canal.

The tidal openings have proved a source of great expense to the Canal Company, owing to the quantity of silt brought in by the tide and deposited in the deep water of the Canal. The dredging consequent on this silting is put at £30,000 a year, and it was stated that one-half of this was due to the tidal opening at Runcorn. The large number of craft employed in dredging and removing the silt was also complained of as impediments to navigation by trading vessels. The tidal openings are also objectionable, owing to the cross currents set up in the canal opposite them, both on the flood and ebb. The owners of large vessels will not allow them to navigate while the run of the tide lasts. For these reasons the Canal Company desires to close the openings.

The opposition to the Bill was based to a considerable extent upon the assumption that the company would raise the normal level of the canal, and thus deprive the estuary of additional scour, and injuriously affect the drainage of low-lying lands. At present the canal discharges automatically by means of the tidal openings; if they are closed the sluices alone are available. These are worked at the discretion of the company under the supervision of the Mersey Conservator. The company has submitted to a clause compelling it to lower the canal to the 14ft. 2in. level four and a-half to five hours after high water at the Weaver. This settles the question of level, but the question of loss of scour remains. The Ship Canal engineer stated that the total quantity of tidal water admitted into the canal on a tide flowing 20ft. 9in. at Liverpool was 11,022,302 cubic yards, and apportioned it as follows:—At Eastham, 3,157,090 cubic yards; at Ellesmere tidal opening, 885,214 cubic yards; at Weaver tidal opening, 4,924,927 cubic yards; at Runcorn tidal opening, 1,783,070 cubic yards. To this was added 1,000,000 cubic yards as the average contribution of fresh water from the rivers during the tide.

It was admitted that the volume of tide entering the canal after the closing of the openings through Eastham Locks, even if the sluices there are raised to augment the inflow and diminish the speed of the current, will not be more than 7,000,000 cubic yards, as compared with 11,000,000 cubic yards at the present time, and that, practically, high water at Eastham will be the high-water level throughout the canal, whereas now there is an increment due to the momentum of the tide of upwards of 2ft. It was contended that under the existing circumstances the tidal water taken into the canal was simply so much abstracted from the estuary, and that when the openings were closed the estuarial tide would rise higher and no scour would be lost to the channels. This view was urged more particularly in respect to the portion above Runcorn.

The Mersey Conservator, in his last and also in his penultimate report, quoting from figures with which he had been supplied, stated that the level of high water of spring tides at Warrington had fallen of late years by more than one foot. It was stated that this represented about 2,000,000 cubic yards in the estuary, and that 1,783,070 cubic yards was taken into the canal at the Runcorn opening. It was therefore assumed that the lowering of the tidal level was due to the tidal water being diverted into the canal, and that the supply from below is limited. On the other hand, it appeared, from observations taken of the tides during the current year, that the increment at Warrington was as high as of yore; and thus this assumption seems to be disposed of. In neither case were the observations made for a sufficiently long period to warrant the assumption that so great a change had been brought about in the *régime* of the estuary by any changes wrought by the Canal Company.

The capacity of the Mersey estuary is 960,000,000 cubic yards; this includes the water remaining in the deeps at low water, as well as the portion from which the tide has ebbed at the lower end before the period of high water is reached at the upper end. The inflow of a 21ft. tide is taken as 710,000,000 cubic yards; of the average tides, 495,000,000 cubic yards. Before the Liverpool bar was lowered and practically controlled by dredging, it was urged from time to time that the abstraction of a few million cubic yards from the highest tides might cause ruin to the port. This contention is vain at the present time, when instead of 10ft. or thereabouts, as was the case formerly, there is upwards of 20ft. over the Bar at low water. The case, however, is different in the portion of the estuary above Runcorn. The capacity of this is given as 23,000,000 cubic yards, and a loss of 1,750,000 cubic yards flowing through the Runcorn tidal opening is worthy of all consideration. The trade of the Upper Mersey is a large one, and at Weston Point, Runcorn, Widnes, and Warrington, will aggregate something like 2,000,000 tons per annum, a large portion of which is carried on the estuary. It is therefore necessary to consider in what way a change in the *régime* of the Ship Canal could be made so as to safeguard the interests of these ports.

It was proposed by the Canal Company that the works for closing the tidal openings should be of timber, and of a character to be easily removed if it was found that any damage accrued to the estuary which in the opinion of the Mersey Commissioners, represented by their acting conservator, Admiral Richards, could be traced to the alterations following upon the passing of the Bill.

The Committee were anxious to go further, and to make the erection of these works subject to the consent of the Mersey Conservator, but after hearing Admiral Richards they determined to pass the preamble, and that the works should be erected on the sole authority of Parliament.

Provision has also been made for the discharge of as much water as is practicable from the sluices above Runcorn.

As we have seen, high water in the Mersey at Walton Lock is half an hour later than high water in the canal. In order to discharge from the canal at this point, it is necessary to retain the water in the canal for half an hour before the river falls low enough to enable it to flow out of the sluice way. Twenty minutes later the sluices at Old Randles are to be opened and kept open until the canal reaches its normal level, the Weaver sluices being used in addition to those above mentioned, in order that the obligation to lower the water in five hours' time may be fulfilled. This is a beneficial arrangement, and if during low tide the fresh water is discharged from the sluices high up the estuary, a beneficial effect on the channels ought to be ensured.

There is one other point in connection with the closing of the tidal openings which is of great importance to the canal, and those who use the waterway, viz., the effect on the speed of the current which will follow when 7,000,000 cubic yards of water enters at Eastham and flows along the canal to fill its length of upwards of twenty miles to Latchford, and also the Weaver estuary, which from the large quantity flowing in through the Weaver opening, appears to demand a considerable volume of tidal water. The speed of the current will naturally be increased through the Eastham Locks, and as much of the traffic can only pass these at high water, the increase in speed will be objectionable, to say the least of it.

At the present time the Shropshire Union train of barges is not navigated through the locks at the time when the current runs strongest, but remains in the river until it has moderated, whenever the number of barges exceeds three or four. The currents in the canal at the present time are found to be as follows, viz.:—On a 15ft. 6in. tide the mean is 0·91 miles an hour, the maximum 1·10 miles an hour. On a 19ft. tide the mean is 1·13 miles an hour, the maximum 1·41 miles an hour. On a 21ft. tide the mean is 1·18 miles an hour, the maximum 1·50 miles an hour. It is calculated that these velocities will be increased on the closing of the openings, and will become:—On a 15ft. 6ft. tide there will be no perceptible increase. On a 19ft. tide, mean 1·66 miles an hour, maximum 2·06 miles an hour. On a 21ft. tide, mean 2·24 miles an hour, maximum 2·84 miles an hour.

The narrowest section of the canal extends for nearly half a mile in length through the rock cutting at Pool Hall, two miles from Eastham. Here the bottom width is 120ft., the surface width 129ft., and the sectional area at the normal level of the canal 3237ft. Under existing conditions on a 15ft. 6in. tide the mean velocity through this length is 1·61 miles an hour, and the maximum 2·61 miles an hour. On a 19ft. tide the mean is 2·05 miles an hour, the maximum 2·55 miles an hour. On a 21ft. tide the mean is 2·17 miles an hour, the maximum 2·86 miles an hour.

It is calculated that these velocities will be increased on the closing of the tidal openings, and will become:—On a 15ft. 6in. tide, no increase perceptible. On a 19ft. tide, mean 3·00 miles an hour, maximum 3·74 miles an hour. On a 21ft. tide, mean 4·12 miles an hour, maximum 5·13 miles an hour. The above figures are given treating the flow as due to current alone. It is hoped that the propagation of the tidal wave in the canal will be facilitated by doing away with the cross currents set up by the water flowing in through the tidal openings, and that the maximum velocity may be diminished owing to the acceleration of the tidal wave. In the event of the closing of the tidal openings, which will no doubt be done by degrees, it is to be hoped that careful observations will be taken of the effect on the currents in the canal. It is seldom that such an opportunity of testing the theory of hydraulics by experiment on a large scale occurs. The British Association has frequently done good service in matters of a somewhat similar character. We direct the attention of their Committee to the proposals of the Canal Company, in the hope that they will arrange that the opportunity of advancing our knowledge on the question of tides and currents may be utilised as fully as possible.

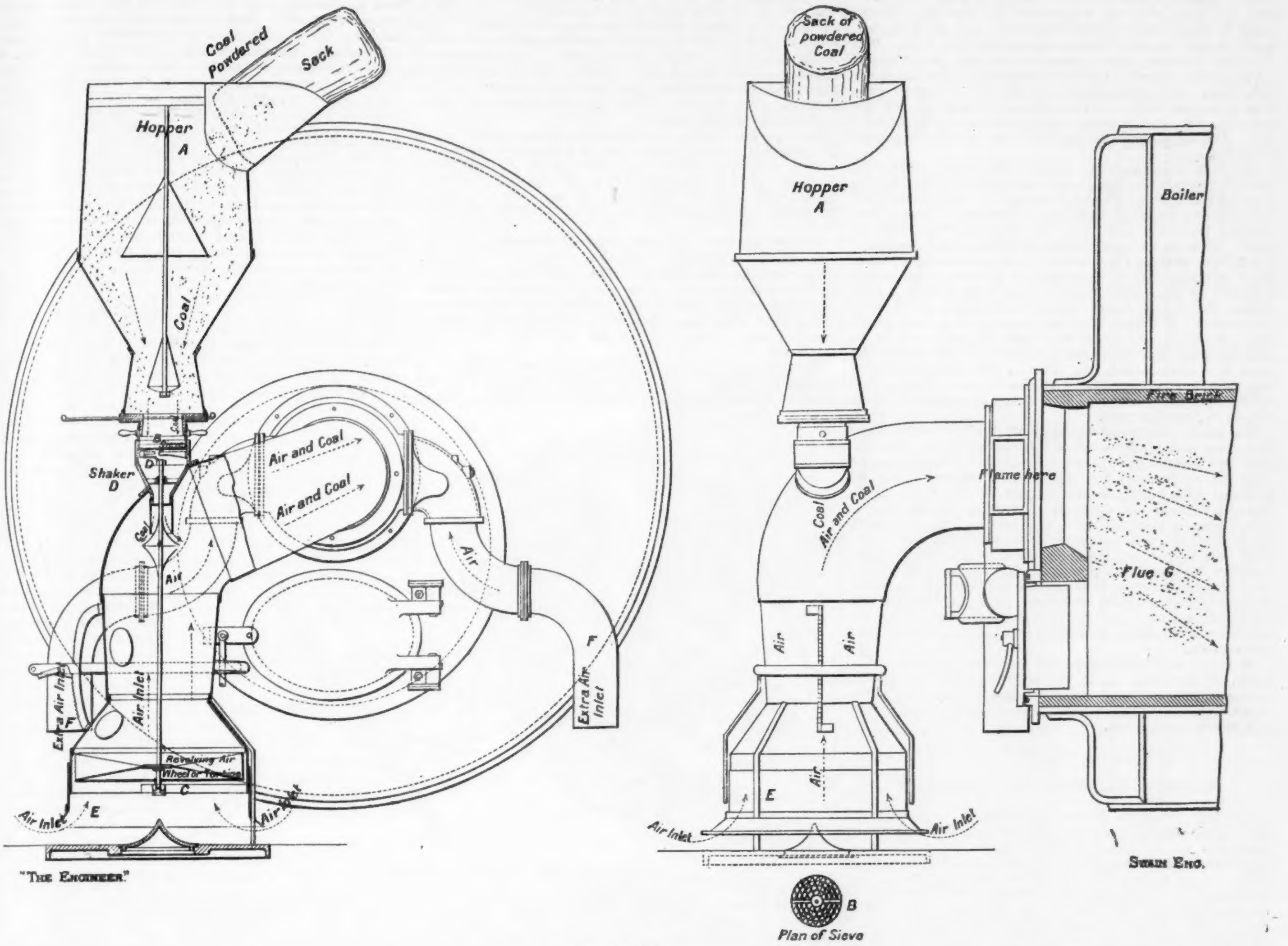
THE GENERAL POLICY OF THE AMALGAMATED SOCIETY OF ENGINEERS.

UNDER the above heading, in the forty-fifth annual report of the Amalgamated Society of Engineers, recently sent out to the members, Mr. John Anderson, the general secretary, offers some observations which are of interest. He states that during the four years of depressed trade much caution has had to be exercised to avoid ruptures with the employers.

To give the members an idea of the enormous expenditure incurred during 1893, 1894, and 1895, which caused the executive so much anxiety whilst having to resist numerous encroachments, no less than £842,324 was disbursed in the various benefits, £381,993 being required for donation alone, and £12,532 for contingent benefit, the latter amount clearly indicating that, although abstaining from an aggressive policy, all their energies had to be put forth to defend and maintain their position, and proved conclusively that the policy adopted was not a peace-at-any-price one. It was gratifying to know, however, that although such a vast amount—unparalleled in their history—had been spent, they had come through this anxious period practically unscathed, as at the beginning of 1893 their accumulated fund was £214,344, whilst last December the total worth was £206,115, or only £8000 less; and no doubt this would have been converted into a surplus but for the stirring events at Belfast and on the Clyde towards the end of the year, when the Council encouraged and helped forward the movement for a restoration of the wages in operation prior to the period of bad trade setting in, which policy had been initiated in other districts as well, owing to the returning prosperity about the middle of the year, and was now being pushed forward with

THE WEGENER POWDERED FUEL APPARATUS FOR STEAM BOILER FURNACES

MESSRS. BRYAN DONKIN AND CO., LONDON, ENGINEERS



Figs. 1 and 2

splendid results. The Society were now making wonderful progress, as in the three months from the closing of the year's accounts they had had a rapid influx of new members, and had now reached the grand total of 80,208 members.

WEGENER'S POWDERED FUEL BOILER FURNACE AND APPARATUS.

THE accompanying engravings illustrate a new form of apparatus designed by Herr Wegener for burning finely pulverised coal, and burning it in such a way that the quantity is automatically varied with the quantity of air admitted for supporting combustion. The apparatus has been in use some time on the Continent, and is now in use in the works of Messrs. Bryan Donkin and Co., where it has been shown in operation.

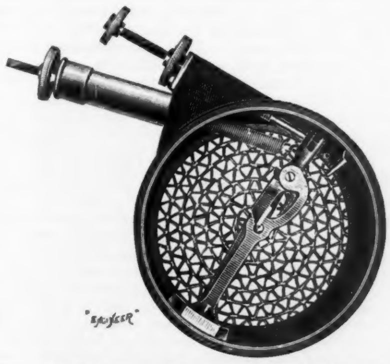


Fig. 3—WEGENER POWDERED FUEL APPARATUS

Our engravings show the apparatus in detail as applicable to any boiler, and it may be described with reference to its operation.

The small sacks of powdered coal, weighing about ¼ cwt., are put into a conical hopper A. The powdered coal gradually falls out of the sacks as required into the hopper, and then on to a sieve B, about 5½in. diameter, with small openings in it—see also Fig. 3. The powdered coal would not continue to pass through this sieve with certainty without continual tapping, and this is done in the following way:—

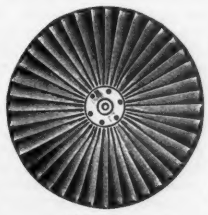


Fig. 4

Immediately beneath the hopper, and level with the boiler-house floor, is an air pipe E, about 20in. diameter, through which nearly all the air for combustion enters. As it enters, it is made to pass through the blades of an air-wheel or turbine C, and this passage of the air causes the latter to revolve like a smoke-jack. On the axis of this air-wheel there is a little knocker which taps the sieve from 150 to 250 times per minute, causing the powdered coal to descend vertically through the sieve, meeting the air for combustion as it ascends vertically. The powdered coal and air for proper combustion in this way get mixed thoroughly together, and pass on into the boiler flue, each particle of coal being surrounded by air. There is no grate, and there are no fire doors, and the stoking simply consists of putting a sack of powdered coal from time to time into the top of the hopper, and seeing that the right amount of air is going in for combustion. If there is not sufficient air for proper combustion entering through the main opening, as shown by a little smoke, there are two other smaller pipes where additional air can be admitted, each kind of coal requiring a somewhat different amount of air. The only object of the air-wheel revolving from 75 to 125 revolutions per minute, is to shake the sieve and cause the powdered fuel to go into the furnace in the quantity desired. When more steam and coal are required a greater knock is given to the sieve, and more powdered coal is burnt; when less is required a less shake is necessary. A screw adjustment for this knocking device is provided to regulate the amount of coal entering, which is done by turning a thumb-screw. The attendant can look after several boilers. An analysis of gases of combustion proves that the combustion is excellent and the amount CO_2 is higher than with ordinary furnaces.

Mr. Bryan Donkin made a careful test on a Cornish boiler at Berlin in March last, first with an ordinary grate and ordinary hand-stoking; and, secondly, a few days after, on same boiler, same conditions, and same coal, but with Wegener's patent system of powdered or molecular firing.

The following are the particulars and results of experi-

Results of Trials.

Trial.—			
Experiment number	I.	II.	Comparisons.
Date of experiment, 1895	March 29th	April 1st	
Conditions, with or without Wegener's apparatus	Without	With	
Duration of trial, continuous, hours	7·1	6·66	
Weather	Wet	Fine and dry	
Mean steam pressure (from tested Bourdon gauge every quarter hour), lb.	82	83·4	Same steam pressure
Coal.—			
Total coal burned, lb.	1600	1410	
Coal burned per hour, lb.	225	211·5	About same quantity coal
Coal burned per hour per sq. ft. of fire-grate, lb.	16·3	—	
Moisture in coal, per cent.	9·0	1·2	
Ashes and clinkers in coal, per cent.	14·8	Assumed at 15 to 19	
Water.—			
Mean temperature of feed-water entering boiler, Fah.	63°	48·2	
Total feed-water evaporated, lb.	7928	10,517	
Water evaporated per hour, lb.	1117	1,577	
Water evaporated per hour per sq. ft. heating surface, lb.	2·23	3·15	41 p.c. more water evaporated per sq. ft. per hour
Evaporation.—			
Lb. water evaporated per lb. wet coal, from temperature of feed, lb.	4·956	7·46	50 p.c. more evaporation with Wegener's app.
Lb. water evaporated per lb. wet coal, from and at 212 deg. Fah., lb.	5·90	9·00	52 p.c. more evaporation with Wegener's app.
Lb. water evaporated per lb. dry coal, from and at 212 deg. Fah., lb.	6·48	9·11	40 p.c. more evaporation with Wegener's app.
Calorific value of coal, lb. water per lb. dry coal, from and at 212 deg. Fah., lb.	12·00	11·85	About same heating power
Thermal efficiency of boiler = $\frac{\text{actual evaporation}}{\text{calorific value}}$, p.c.	54	77	42 p.c. more efficiency
Chimney and gases.—			
Mean position of damper	Full open	Full open	
Temperature of furnace gases at end of boiler tube, Fah.	above 750°	above 750°	
Temperature of furnace gases at base of chimney, Fah.	438°	418°	
Draught of chimney in side flue at front of boiler, inches of water	0·41in.	Water gauge oscillated from a slight pressure to a vacuum	
Draught of chimney at base of chimney, inches of water	0·61in.		
Mean analysis of furnace gases, taken every quarter hour: CO_2 p.c. by volume	8·73	15·35	Better combustion with Wegener's apparatus, more CO_2, less O and no CO
O ,, ,,	8·13	3·14	
CO ,, ,,	0·88	0·0	
Temperature of air in boiler-house, Fah.	54°	58°	
Smoke.—			
Total number of times smoke observed	70	7	See curve for details of smoke observations
Total duration of smoke, minutes	105	6	
Mean intensity of smoke (Mr. D. K. Clark's smoke scale) number	7	5	

In this experiment the bars were rather too wide apart for the small coal used to get the best results.

ments on a Cornish boiler, at the Artificial Stone Works, Berlin :—

General particulars.—Two experiments were made on the same boiler, at the same steam pressure, and with the same coal—powdered in second trial. The boiler is 5ft. 7in. dia. by 28ft. 4in. long, with one flue or tube 2ft. 7½in. dia. It was made in Berlin about November 1892; and all flues, &c., were cleaned about six weeks previous to the trials. The direction of smoke was—through tube, split to sides, and return under bottom of boiler to chimney. The latter was 82ft. high. The total heating surface was 500 square feet; and in the first trial with the ordinary furnace, the fire-bars were 5ft. 3in. long, making a total grate area of 13·8 square feet. The top of the boiler was fairly well covered to prevent radiation.

The first experiment was made on March 29th, 1895, with the ordinary furnace, using a very small English flaming coal —about ½in. pieces. The fire-bars were of the ordinary cast iron pattern, ¾in. wide, with $\frac{5}{16}$in. air spaces. The coal was weighed in sacks previous to the trial, and was stoked by hand. The fire was stoked thirty-five times and raked forty-eight times, making the opening of the fire-door eighty-three times in seven hours = once every five minutes. The fire was kept 2in. to 3in. thick; and the coal burned with a long flame. The fire was kept low at the beginning and end of the experiment. The feed-water was measured in a tank, which had been previously found to contain 132 gallons up to an overflow hole; and the height of water in the boiler was the same at the start and finish. Part of the steam generated was used for an engine, the remainder being allowed to blow off by the safety valves. The steam appeared dry when turned on from ½in. pipe.

The second experiment was made on April 1st, 1895, using the same coal as above, but very finely powdered. The fire-bars and furnace were taken out, and the boiler tube lined with 3in. of fire-brick for 11ft. 6in. from front of boiler, and provided with zig-zag baffles to prevent the flame going straight through—see drawing. The powdered coal was put in a hopper in front of boiler, and passed through a sieve, about 5¼in. dia, with triangular holes, about ½in. side. The sieve was tapped constantly by the axle of a revolving air-wheel or turbine, about 20in. diameter, which was driven by the current of air going through it into the boiler tube, to mix with the powdered coal for combustion. The speed of this air-wheel varied from thirty to eighty revolutions per minute, corresponding to 100 to 250 tappings of the sieve per minute.

Grinding coal into fine powder increases first cost of coal about 10 per cent. As to the economy with this system, compared with that of ordinary hand-stoking, this varies much with the different circumstances, kind of boiler, fuel, and rate of combustion.

MALLAIG RAILWAY AND HARBOUR.

THE new line to be formed from Banavie to Mallaig constitutes an extension of the West Highland Railway, and will act as an important feeder to that company's system. The district to be served by the new railway is at present wholly devoid of such facilities, and an important traffic with the island of Skye is assured, whilst from the fish conveyed an important revenue should result. The route, moreover, is rich in scenic grandeur, and cannot fail to attract large numbers of tourists and holiday makers, whilst the numerous lochs in the neighbourhood afford such excellent fishing that sportsmen will not fail to avail themselves of this means of gaining so favourite a spot.

The Mallaig line will be a single one throughout its entire length of 39 miles 5 furlongs 3·50 chains, and is estimated to cost £318,057 10s., whilst the pier and breakwater are estimated at an additional £45,000, bringing the total expenditure up to £363,057 10s. The route traversed will be apparent from the accompanying map. Leaving the West Highland Railway's Fort William and Banavie branch near the latter place, the new line strikes due west, and, running through Corpach, skirts the northern shore of Loch Eil for its entire length, taking Corribeg and Kinlocheil on its route. The first point of interest reached is Glen Finnan, at the head of Loch Shiel, whence, still pursuing a westerly course, the line takes the southern shores of Loch Eilt, and runs on to Kinlochailort. The heads of Lochs Airlot and Nan Uamh are then passed, and turning north near Arisaig, the railway runs between Loch Morar and Bourblach, finally reaching Mallaig at the southern end of the Sound of Sleat, near the entrance to Loch Nevis, its terminus.

The principal features of interest along the route will be the steel swing bridge over the Caledonian Canal at the point of crossing between Banavie and Corpach, and the viaduct at Glenfinnan, 120ft. high, and consisting of nineteen arches of concrete, each having a span of 50ft. The remaining works will comprise two or three other viaducts, having arches of similar span to the number of six to ten, and three short tunnels which will be concrete lined. The general design of the viaducts may be briefly stated to be—Piers, 6ft. wide at the springing, with batters of 1 in 50, the arch being 2ft. 6in. thick at the crown, and the spandril walls of similar thickness. The concrete in the interior of the viaducts will be mixed in the proportion of 5 to 1, whilst 1ft. of fine 4 to 1 concrete, with a granolithic face, will be employed for the exterior portions.

The fencing of the line will be formed by half-round posts cut from logs 6½in. diameter. Each post will have a length of 6ft. 6in., they will be spaced 6ft. apart, centre to centre, from those on either side. The posts will be sunk by pitting them 2ft. 6in. into the ground, the earth being subsequently punned in hard all round. The posts will be charred at ground level to prevent decay. The rails will be four in number, each rail being sawn square, 4½in. by 1in., and fastened to each post by two 3in. nails.

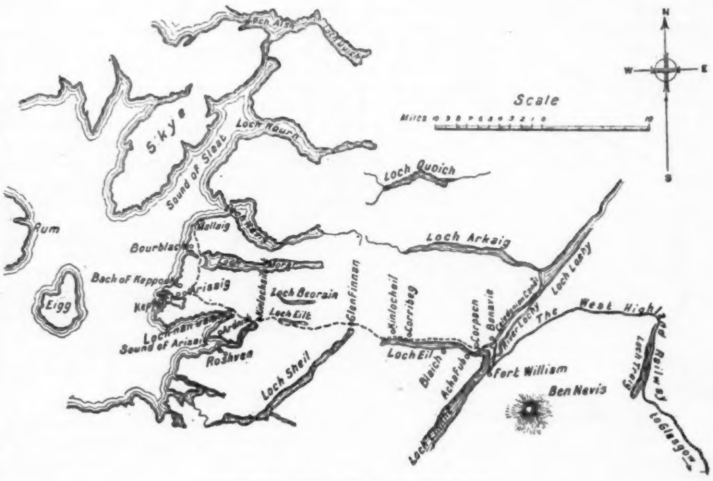
Where wire fencing is employed, seven lines of galvanised solid wire, No. 6 gauge, will be used, the height of the top wire being 4ft. from the ground level. The standards will be of malleable iron, $2\frac{1}{10}$lb. per foot, and spaced 7ft. apart from centre to centre, twelve straining and winding pillars of malleable iron being erected for each mile. The occupation roads and fences will have iron gates 10ft. wide by 4ft. high, hung on larch posts 9ft. long and 9in. diameter.

The width of the cuttings and embankments at formation level will be 15ft., whilst the ditches along the route will be 2ft. and 6in. wide at the top and bottom respectively, and 2ft. deep. The concrete used throughout the undertaking will consist of five parts of stone—broken to pass through a 2in. ring—with one part of Portland cement, and a suitable proportion of sand. The tunnels, which will be furnished with recesses every twenty-five yards, will be lined with fine concrete composed of four parts of stone to one part of Portland cement, with the requisite amount of sand. The mortar employed on the work will be formed of one part of Portland cement to three parts of sand. The line will be of the customary 4ft. 8½in. gauge, with 84 lb. steel rails, the sharpest curves being those of twelve chains, with one or two exceptions, in which 10-chain curves are unavoidable. The steepest gradient will be 1 in 50, and the estimated time for completion is three years. The occupation roads throughout the contract will have a width of 12ft., and will be metalled for a width of 9ft. with 4in. hard stones for a depth of 6in., overlaid by 3in. of stone broken to pass through a 2½in. ring, and bonded with fine gravel.

The Portland cement is specified to be ground extremely fine, and to leave not more than a 7 per cent. residue on a sieve with 2500 meshes per square inch. The weight is required not to be less than 112 lb. per imperial—striked—bushel, and after an immersion of seven days in water, briquettes are to bear a tensile strain of 400 lb. per square inch.

It only remains to be added that all footpaths will have 4in. bottoming, overlaid by 2in. of fine gravel or whinstone chips, and that the ballast of the permanent way will be formed of stone broken to pass through a 2½in. ring, laid 7in. below the bottom of the sleepers and to within 6in. of the top of the rails. The rails themselves will be in 30ft. lengths, twelve sleepers being laid per rail and 40 lb. chairs being employed.

Turning now to some brief notice of the harbour to be formed at Mallaig: an area of 40 acres having a minimum depth of 10ft. at low water, or of 35 acres affording 20ft. at low water, will be obtained. The breakwater, which will be formed of 10-ton — 5 to 1 — concrete blocks, and will be 500 yards long, will run in a northerly direction from near the site of the present small pier to the "Red Rocks," and will shelter the harbour from the south-west or prevailing winds. The work will be executed on the sloping concrete block system, and is estimated to occupy one year. A pier of pitch pine 450ft. in length, with an arm 200ft. long at its extremity running in the direction of the breakwater, is also included in the scheme. The width of the pier and arm will be 35ft. and 25ft. respectively, and the whole will be carried on 12in. piles. The pier will be of ordinary construction, and calls for no special remark. It will be furnished with a travelling crane. An hotel at Mallaig is also included in the scheme, and will be erected on a site granted by Lord Lovat free of charge.



BANAVIE AND MALLAIG RAILWAY

The line will be furnished with stations at suitable points, and, as the property of the West Highland Railway Company, will be worked by the North British Railway Company. The engineers of the Mallaig railway and harbour are Messrs. Simpson and Wilson, C.E., of Glasgow.

In regard to the financial arrangements of the undertaking, some recently issued correspondence between the Treasury and the West Highland Railway Company fully details the guarantee and other provisions. The memorandum relative to the Bill which the Government propose to introduce this session sets forth that in June, 1892, the then Government stated their readiness to introduce a Bill guaranteeing a dividend of 3 per cent. for thirty years on the estimate for the railway—£260,000—and at the proper time to ask Parliament to vote £30,000 towards the harbour. The offer was subject to four conditions, viz.:—(1) "The promoters must obtain an Act for the construction of the railway and harbour." (2) "They must enter into an agreement with the North British Railway Company to work and maintain the railway in perpetuity for 50 per cent. of the gross receipts." (3) "The remaining 50 per cent. of the gross receipts must be applied in the first instance towards paying a dividend of 3 per cent. on the £260,000." (4) "The plans of the harbour works must be approved by the Government."

The West Highland Railway Act, 1894, satisfies the first two conditions, whilst in regard to conditions Nos. 3 and 4 an agreement has been signed between the Treasury and the West Highland Railway Company agreeing that :—(*a*) "From the date of the opening for traffic of any portions of the railway the company will in the first instance apply 50 per cent. of the gross revenue arising therefrom, after paying thereout of Government duty, and poor, school, county, and other rates and taxes, towards the payment of a dividend of 3 per cent. on the above-mentioned capital of £260,000, and that the Treasury will guarantee for thirty years from the date of the opening for passenger traffic of the railway 3 per cent. on £260,000, and will pay half-yearly to the company such sum as along with the 50 per cent. of the gross revenues as above-mentioned will enable the company to pay a dividend of 3 per cent. on £260,000." (*b*) "That the Government will pay to the company £30,000 towards the cost of the construction of the pier and breakwater, on the completion thereof being certified by the Board of Trade."

The conditions laid down by Government being thus fulfilled, the Bill proposes to make formal provision (1) "For the guarantee by the Treasury of the dividend." (2) "For the payment of £30,000 on the completion of the pier and breakwater."

GLOUCESTER WATERWORKS.

THE operations for supplying Gloucester with water from Newent are rapidly nearing completion. The well sinking and the headings are finished, and the contractors have cleared away their plant. A temporary pumping station is being erected away from the well, and when the pipe laying is completed, this plant will be available for a time for the supply of water to Gloucester. The permanent buildings, in course of erection, will consist of an engine-house, boiler-house, workshop, and coal store. The well is 168ft. 6in. deep, and at the depth of 145ft. there are two headings 6ft. high and 5ft. wide, running, one in a westerly, and the other in a north-easterly direction. Needless to say, these headings, which are respectively 145ft. and 117ft. long, increase the flow of water from the sandstone. A 14in. main has been laid the whole of the distance from Newent to Gloucester, with the exception of about 1¼ miles of the route. A covered reservoir, 100ft. long by 60ft. wide and 18ft. deep, and capable of holding 675,000 gallons of water, has been constructed at Madam's Wood, Upleadon. About two-thirds of the walls of the reservoir are erected, and the work of digging out the basin has been begun. This will take about a fortnight to complete. The reservoir will be covered with a low roofing of rolled joists, and arches of cement and concrete. The site is three miles from the well and eight miles from Gloucester, and is 250ft. above the sea level. The water from the well will, in the first instance, be pumped into the reservoir, out of which it will run by gravitation into Gloucester. The present supply of water to the city is from Whitcomb reservoirs, and the new 14in. main from Newent has been connected with the old 12in. main at Gloucester Cross.

On entering the city at Westgate Bridge the new main has been carried under the paved footpath, but at Over a steel lattice girder bridge has had to be constructed to convey the pipes across the Severn. This bridge, which has just been floated over the river, was built on the Gloucester side of the stream. It is 222ft. long, with a clear span of 219ft. Its weight is 60 tons, and crosses the Severn between the railway and the road bridges. The depth of the centre of the girder is 17ft., with a tension boom of 6in. of camber, and a top compression boom of 8ft. The water pipes will be carried over on the floor of the bridge on rolled joists, fifty-two in number. There are two piers, 9ft. high, one on either side of the river, upon which, when completed, the bridge will rest. The piers consist of four screw piles 15in. in diameter, which have been sunk to the blue lias, a depth of some 40ft. Fittings have been provided at one end of the bridge to allow for expansion. The work of floating this huge structure was successfully accomplished on a 10 o'clock p.m. tide. One end of the bridge rested securely on two "longboats"—failing negotiations for a lighter—lashed together, and the other end was supported on a trolley on rails. Winches erected on the opposite bank were got to work, and the boats, with the bridge attached, were hauled safely across the river in the space of about twenty-five minutes. All that now remains to be done is to hoist the bridge into position on the piers by screw jacks. Mr. W. Fox, London, is the engineer.

The pumping machinery supplied by Messrs. Summers and Scott, Gloucester, consists of two compound engines of the inverted cylinder type, arranged with a fly-wheel between them. The diameter of the high-pressure cylinder is 16in., stroke 4ft. 6in.; the diameter of the low-pressure cylinder is 28in., stroke 4ft. 6in.; the diameter of the well pump 14¾in., stroke 4ft. 3in.; diameter of the double-acting bucket pump 10½in., with 4ft. 6in. stroke. The high-pressure engine drives a lift pump in the well, by means of a bell crank lever worked from the crank pin by means of a connecting-rod. The low-pressure engine drives the horizontal force pump direct from the crank by means of a similar connecting-rod. The bell crank is fitted at the inner end with a balance of sufficient weight to balance the pump-rods and bucket and half the load. The force pump is a double-acting pump fitted with a gun-metal liner and bucket. The framing consists of four box section girders joined together by strong transverse pieces. Two of these girders have the pedestals for carrying the crank shaft cast on them. At the front end the girders carry the A-shaped frames for supporting the cylinders, and at the outer end the pedestal brackets for the pump bob centre and the force pump. The A frames have the slide bars cast in them, the cylinders being secured to the top by means of strong bolts. The fly-wheel is 16ft. diameter, and about 11 tons in weight, and fitted with a special arrangement of hand barring gear. A suitable platform, handrail, and ladder are fixed round the engines at a convenient height for getting at the slide bars and valve gear, and are made of such pattern as to suit the style of the building generally. A suitable polished handrail is also provided on the ground level where necessary, to fence off the moving parts of the engines. There are three Cornish steam boilers, 22ft. long by 6ft. diameter, and an economiser on the Green principle. There is a travelling crane at the top of the engine house, for lifting the heaviest or any part of the machinery. The engines are constructed to run at eighteen revolutions per minute, and may be increased to twenty-five revolutions, if necessary.

THE ANNUAL DINNER OF OLD STUDENTS OF KING'S COLLEGE, LONDON, will be held at the Holborn Restaurant, on Monday, June 29th, with Sir Benjamin Baker, K.C.M.G., LL.D., F.R.S., president of the Institution of Civil Engineers, in the chair.

LOCOMOTIVES FOR BULGARIA. — The Secretary of State for Foreign Affairs has received a despatch from her Majesty's agent and Consul-General at Sofia, in which he states that tenders for locomotives required for the Bulgarian State Railways are invited by the Bulgarian Government. A copy of the conditions of tender is enclosed in Mr. Elliot's despatch, and may be viewed at the Commercial Department, Foreign-office, between the hours of 11 a.m. and 6 p.m.

WHEELER-STERLING PROJECTILES.

The Wheeler-Sterling Company began the manufacture of armour-piercing projectiles about twelve years ago, and has achieved remarkable success, as is well known by those who follow the records showing the recent development of armour and its attack. It would be hardly necessary then to mention such a fact were it not that the methods of stating what has been achieved differ in the States and in England, that is to say, the matter is stated in stronger terms in the States. Diffidence and modest appreciation of success is, no doubt, rare in England, and it is not surprising if it is a drug in the American market. There is, however, a certain difference in the way English and Americans express themselves. If an English manufacturer stated publicly as an undoubted fact that he personally was the best of his kind, it would be thought bad taste; and the result of such a statement being made by an American in England has been that the speaker was put down, if not as an impostor, at all events as a man whose "geese were swans," and, practically, what he said after that carried no weight. Now this estimate was a mistake. The Englishman, no doubt, at times thinks as much of himself as his American cousin, and the fact that he keeps it to himself is more a matter of taste and custom than of humility. We prefer the English custom, but that may be due to our insular prejudice. The other—we will not call it the American custom, but the custom which is to be met with in America—is perhaps the more truthful and simple one. What, however, concerns us here is that we must be on our guard not to assume that an American product or man is a "fraud" because inflated language is used. We have before us a case in point—a report of the Wheeler-Sterling Projectile Company. It contains language that would prejudice English readers; but if they put down the report and conclude that the projectiles do not deserve attention, we believe that they will make a great mistake.

For example, on page 21 we read that Commodore Sampson considers the American shells the best, and that the "Wheeler leads." "This expression," it is remarked, "coming from such a high authority, settles all doubt as to the superior quality of the Wheeler-Sterling shells." "That America can beat the world in the manufacture of projectiles," we are told, is "a fact." A reader naturally says if an American officer's opinion on American projectiles is thus to settle the matter *ipso facto*, the facts in this pamphlet must be largely discounted. Nevertheless, our sober belief is that the Wheeler-Sterling projectiles have at the present moment the best record to show of any, and we consider Commodore Sampson a very high authority.

Again, on page 20 the Sterling Steel Company "has excelled the projectile makers of the world," and "is furnishing the Government with a grade of shells which no armour made in this or any other country can withstand." Now this statement is so unbusiness-like that it is difficult to deal with. It has no value unless some proportion is stated between the shot and plate. On the 14th of last September, a 14in. Carnegie-Harvey plate kept out all Wheeler-Sterling projectiles, including one from a 12in. gun, until a 13in. shell was fired at it with 1800 foot-seconds, a blow which completely outmatches such a plate. We recently gave reports and photographs of Krupp plates which exhibited still more remarkable powers. Hardened faced plates, so far as records go, keep out all projectiles—including the Wheeler—better than untreated steel plates kept out the shot of their own time. There is nothing in the above, however, that could well mislead anyone. A more serious matter is the following, which, however, may not be intentional. We are told that naval enthusiasts claim that "another revolution in the armouring of warships will be brought about by the new Wheeler-Sterling shell." Then follows a statement that no shells in the past carrying explosives have "ever succeeded in penetrating even the thin armour of the non-vital sections of the ship," but that a Wheeler shell of 13in. had penetrated a 7in. steel plate and backing, and was recovered practically uninjured. This is considered a proof that it could have carried a high explosive safely through the armour, although it adds, "No explosive was used, of course, in to-day's test." Some of the trials with "semi-armour-piercing shells" would give the impression to a casual reader that bursting charges were employed in the shells, but we do not think that they were, in most cases; or, indeed, that this impression is intended to be conveyed. In the trials when 5in. shells burst after passing through 2in. of steel plate, the shells may have only performed what has been done years ago in this country. We are told that the United States requirements, now arrived at based on the great success achieved with the Wheeler shells, are expressed as follows: "That the shells should successfully perforate a nickel steel plate one-half a calibre thick," and then be in a condition to be exploded. The plate is apparently not a "Harveyed" one. The plan appears to be to charge the recovered shell and burst it. In our own British official records of trials we read on November 13th, 1891, a Palliser 6in. projectile filled and fuzed, and a cast steel armour-piercing common shell passed through a Brown steel plate 4in. thick, bursting in their passage; some Palliser fragments were left behind, but the whole of the steel sheel fragments passed through. This is an old story of four and a-half years ago; the shells were very inferior, of chilled iron and cast steel, but they drove their fragments through steel two-thirds of their calibre, so that practically even when the cast steel shell does not pass intact through the armour it so bursts that its explosive effect does not carry any fragments back outside, and must therefore be fairly through the armour. Five-inch shells getting intact through 2in. of steel four years later is no great achievement, especially as it would be difficult to prove that the shells were not exploded in their passage like what we may call their rude English forefathers.

What should have been done is not to fire an empty shell through a plate, and argue from its non-deformation that the bursting charge would not have exploded, but to fire a shell charged, and show that it can be recovered with its charge not fired. At all events, it is quite a mistake to suppose that the thin armour employed on the non-vital parts of ships could not be attacked successfully hitherto by semi-armour piercers, or armour-piercing common shell. This has been understood for many years in England, but the hit must be fairly direct, and the shell from its small capacity, has a greatly reduced bursting charge. This armour, however, keeps out common shell with really large bursting charges, and probably keeps out the semi-armour piercers at any considerable angle.

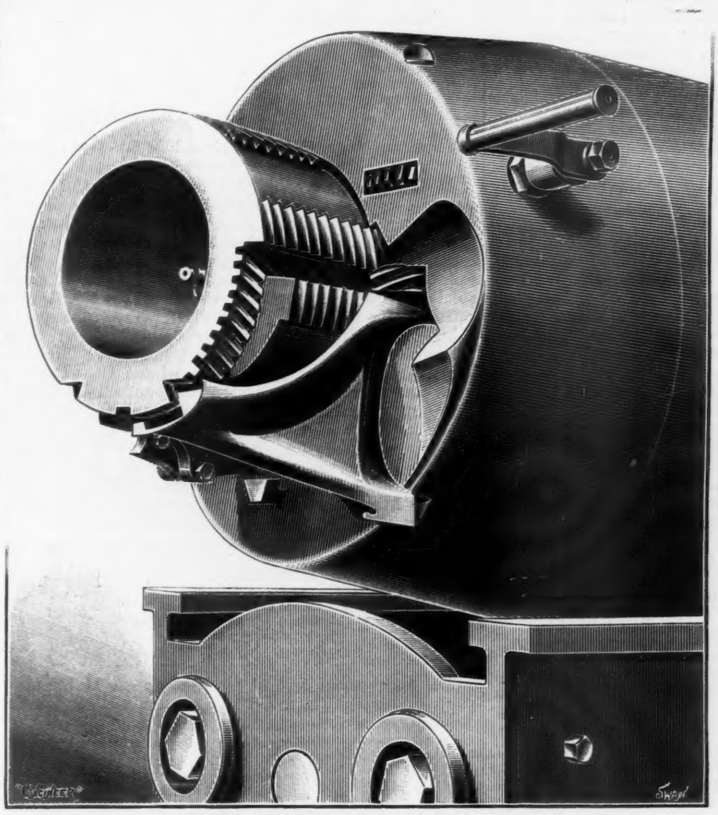
We must now conclude by noticing the strong features which belong to the Wheeler-Sterling shells. They are far too important for us to be able to ignore them safely. We have already said that their record is, we believe, the best of any yet achieved. They are considered to have beaten the Carpenter projectiles; and in larger calibres than 6in. the Carpenter have, so far as we can judge, beaten the Holtzer, and the Holtzer were the accepted international standard for 6in. calibre, and may be expected to be good for higher calibres. The Wheeler have, indeed, produced very remarkable results; they have passed nearly or quite unbroken through Harveyed armour; for example, a 12in. projectile perforated a 14in. nickel steel Harveyed plate with 1858 foot-seconds velocity, with only a broken point on February 24th, 1895. Again, we are told that perforation was achieved by 12in. projectiles through a 14in. Carnegie plate at 15 and 20 deg. with the normal, but we are not told if the projectile broke. It is implied, but not positively stated, that the plate was Harveyed.

It is most desirable that we should appreciate the results achieved, and, if possible, test these projectiles in England. We are told that the shells are not liable to spontaneous fracture; this should be tested in this country, for it has been seriously questioned. We have, at all events, one picked sample of Wheeler shot, a 6in. recovered projectile presented by Captain Jaques to our United Service Institution. Colonel Bainbridge has an experimental 6in. recovered shell made in the Royal Laboratory. The Wheeler has passed through a 7in. steel plate; the Woolwich one has passed through a 9in. steel plate. Both appear to be uninjured. We ought to test these two, and we trust that the test might lead to further competition. We all need to test foreign shot. Our own projectiles have been often very second-rate; Krupp's shot, used in his late remarkable trials, we think show evidence of being soft. Surely, since our ships will be attacked by foreign shot, and our own shot will attack foreign plates, we ought to try how our own plates resist foreign shot, and then we could judge by comparison the excellence of our own shot, and further the results of foreign plate trials would be correctly estimated by us if we knew the exact powers of the shot. At present we are too apt to use only our own plates and our own shot, and in England, America, and on the Continent, have fallen into mistakes in consequences.

BREECH MECHANISM OF THE U.S. 13IN. BREECH-LOADING GUN.

We described, in a paper which appeared in The Engineer, upon the commerce destroyer Columbia, the breech gear and other details belonging to the 8in. rifled breech-loading gun mounted in that vessel, commending the simplicity of the mechanism by which the breech screw is revolved for one-sixth of a turn, withdrawn from its position within the breech, and subsequently hinged away to the right or left, as wanted, upon the "carrier"—all operations being performed by so many turns of a winch handle.

The same system has been applied to the United States 13in. breech-loading guns, which comprise the main armament for their new battleships, but still further economy of parts has been observed in the design of the system by which the breech opening and closing movement is effected. Instead of the employment of two spindles and six or seven gearing wheels, as fitted to the earliest Canet guns of large calibre—which system, in a modified form, was adopted by the United States—the working mechanism of the "breech-plug," as the breech-screw is termed in America, is now actuated by a single spindle, which is contained within the metal of the gun itself, having two gearing wheels, as may be seen in the engraving, one of which is acted upon by the winch, and the other turns, runs out, and hinges away the carrier. The weight of the mushroom and breech-block combined is, in proportion, much lighter than in the earlier designs. There are also four sections of the interrupted screw on the plug and in the breech-box, instead of three as heretofore. Although this is such a heavy piece of ordnance, it requires under service conditions only two men on the crank handle to open or close, the breech being closed with nine turns, and locked with nine turns of the crank handle, eighteen turns altogether, independently of the hingeing away of the carrier.



BREECH MECHANISM OF THE U.S. 13in. GUN

An engraving is given of this breech mechanism, taken from a photograph, published in the "Proceedings" of the United States Naval Institute. It shows the plan for the movement of the opening and unlocking gear so admirably that we have thought it worthy of reproduction. No drawing has as yet been published of the analogous gear which is employed for the opening and closing of the breech-block, by hand, of the 12in. wire guns in the barbettes of the Majestic and Magnificent. But from a personal inspection of the breech mechanism in the British guns, and actual working of the gear, we are inclined to think that the American system has advantages. The securing of the revolving spindle and its gearing wheels within the actual mass of the gun's breech is a good idea.

The working of the winch and spindle can almost be learned from the engraving, without descriptive matter. But it may be briefly remarked that the flat-pitched thread of the lowest gearing wheel is—in the drawing—just about to engage with the diagonal thread seen in the slot on the breech plug. When, by engaging with this, it has forced the plug home to its seating, it is no longer controlled by the edges of the slot cut in the plug, so endeavours to work round the toothed edge of plug-face, and in doing so gives the necessary eighth of a turn to the breech plug. Precisely the same action is accomplished in the design of the breech gear for the guns of the Magnificent, but there is a greater complexity of parts. The way in which the final turns of the winch handle brings away the carrier, in the American gun, is too obvious to require any explanation.

The 13in. breech-loading United States gun is loaded with an ordinary hydraulic sectional rammer, and the recoil is controlled by an hydraulic cylinder, the running in and out being accomplished by independent hydraulic motors. The recoil of the gun during experiments was nearly the same in each round, varying between 47in. and 47½in., the full recoil allowed by the design being 52in. The dimensions, &c., of the gun are as follows:—Length, 40ft.; calibre, 13in.; weight, 60·5 tons; weight of projectile, 1100 lb.; weight of service charge, 550 lb.; muzzle velocity, 2100 foot-seconds; muzzle energy, 33,627 foot tons; perforation of wrought iron at muzzle, 34·6in.

THE IRON AND STEEL INSTITUTE.

The proceedings on the second day of the meeting were commenced with the reading of a paper by Baron Jüptner von Jonstorff "On the Introduction of Standard Methods of Analysis." This paper, communicated in reply to an invitation by the Council, is a review of the causes likely to produce differences in the results obtained by analytical chemists, and the methods proposed for obtaining uniformity in determination. The subject has for some time been under the consideration of chemists engaged in analytical work for iron and steel manufacturers, and it formed a principal topic at the International Congress on the testing of materials, held in Zurich last autumn, as well as having been under investigation for several years by commissions of an international character, working independently in America, Germany, Sweden, and the United Kingdom, whose results, notwithstanding the greatest care taken in performing the analytical work, show differences which, although they may for many technical purposes be disregarded, are sufficiently appreciable to have a disturbing influence on others, and as this is the case with work done with all precaution to ensure complete accuracy, it is evident that large differences may be expected from the current practice of working laboratories, where more summary methods must necessarily be employed.

Regarded from a general point of view, the sources of error in chemical analysis are:—(1) Gross errors in the analysis. (2) Impure reagents. (3) Errors due to the apparatus, &c. (4) Errors due to the operations. (5) Errors due to the analytical methods. (6) Personal errors. (7) Errors due to the differences in the calculation of the analyses caused by the values of the atomic weights on which they are based. (8) Want of homogeneity of the sample.

These various sources of error are noticed in detail by the author, who makes many valuable suggestions, which, however, are of too special a character to be given here. It will be evident, however, that some of those, notably Nos. 1, 2, and 7, are wholly, and Nos. 3, 4, and 5 partially, avoidable, while Nos. 6 and 8 are probably beyond remedy. The last point especially is of extreme importance, and, therefore, the author's suggestion that in most cases it is better to make determinations upon a number of separate samples and to compute the average result; rather than to sample from a number of points, mix the samples and make a single determination upon the mixture is commendable; although in many instances it may appear to be only a counsel of perfection.

A proposal for a new International Commission upon the subjects referred to in the paper was made by Dr. Wedding and the author, and adopted at the Zurich Conference. The principal object proposed seems to be an entirely laudable one, namely, a complete comparative study of all the more important methods of determining the constituents of iron and steel materials, taking into consideration possible sources of error. We may then either be satisfied with this comparison, or pass on to the setting up of standard methods. Such methods are, however, not to be prescribed for use at all times, but, on the contrary, it must be left to every chemist to work as he thinks best. Our aim must be to arrange as many different methods as possible, and to ascertain their relative conditions of value.

The proposals indicated by the author in this paper were generally well received by the chemists present, notably, by Mr. Snelus and Mr. Stead. Dr. Wedding gave an outline of the scheme proposed for working out the idea contained in the paper, which consisted of the formation of an international association of chemists, who were to divide the work among them, *e.g.*, one taking phosphorus, another sulphur, and so on, and after collating all the literature upon each subject, working it out experimentally. This work would, of course, be honorary except in so far as analytical assistance became necessary, which must be paid. It was thought that the latter work could best be done in a central laboratory, and for this purpose Zürich was admirably well suited. The annual cost would probably be about £3000, which could be met by 300 of the large ironworks in the world, each subscribing £10 per annum, the direction of the work to be under the author of the paper.

A member advocated the formation of special chemical libraries in the principal ironmaking centres, and Mr. Ainsworth thought that the Institute might devote part of its surplus income to an investigation of the kind. This latter proposition met with support from the chairman, who considered that part of the accumulated funds might well be expended upon immediate benefits.

Mr. Roberts-Austen then brought forward an account of some experiments upon the rate of diffusion of carbon, which, when stripped of much irrelevant matter, seemed to show that if a piece of iron is carburised from one end by cementation, the proportion of carbon in the metal diminishes with the distance from the contact of the two substances. A curve constructed from the numerical results obtained during the carburising of a steel rail by the Harvey process was exhibited in illustration, as well as two drawings of the concentration of copper by kernel roasting in pieces of pyrites, which did not seem to have much bearing on the matter under description. Mr. Osmond had, the author stated, succeeded in carburising electrotype iron with a diamond.

The next paper was that by Mr. J. H. Darby, of Brymbo, "On the Application of Mond Producer Gas to the Manufacture of Steel." This form of producer, which was originally designed for saving the ammonia contained in fuel gas produced from bituminous coal, is a very considerable departure from the usual practice, the gas being loaded with a large quantity of water vapour, added of design, to carry away the ammonia and protect it by lowering the temperature of the issuing gas, the steam so used amounting to 2¼ tons for every ton of coal gasified. By this means a proportion of more than 70 per cent. of the nitrogen contained in the coal may be recovered in the form of sulphate of ammonia, or nearly 100 lb. of that salt per ton of coal. This is done by carrying the gas through a series of up-and-down jacketed pipes, which are cooled by a mixture of air and steam intended for the grate supply of the producer, moving in the opposite direction to the gas, the heat absorbed being retained by casing the jackets with non-conducting covers. From these pipes the gas then passes into a rectangular cooler partly filled with water, which being churned into a fine spray by revolving beaters, precipitates all suspended matter, besides cooling it to 100 degrees. The next element in the combination is a lead-lined scrubber, filled with perforated bricks, where the ammonia is absorbed by dilute sulphuric acid in a 38 per cent. solution of sulphate of ammonia. After clarifying, the clear liquid is evaporated in pans heated by steam coils supplied continuously until the contents are boiled down to a thick mass, which when drained gives a fair quality of sulphate with the required strength of 24 per cent. of ammonia, which is readily saleable. The mother liquor containing free acid is pumped back to the scrubber. The gas on entering contains only 0·13 per cent. by volume of ammonia, but only about one-tenth of that quantity escapes condensation. No water is, however, deposited, as the quantity present is not sufficient to saturate the gas at the issuing temperature, namely, 80 deg. In a second scrubber filled with blocks of wood the water vapour is condensed by injection of cold water; the dried gas, cooled down to 50 deg., passes to the service main. The condensing water, which is raised to 78 deg., is cooled in a third scrubber by a current of air from a blower which becomes heated to about 74 deg. and saturated with water vapour, in which state it is forced on to the producer. The same water is constantly used for condensing the steam in one scrubber, and giving it up to the air in the other, so that about one-half of the steam required in the producer is recovered and returned to it, the remainder being furnished by the exhaust steam from the engines driving the blowers and pumps.

The gas producers are of a peculiar form, 21ft. high and 10ft. in diameter, which are fed in such a manner that the products of distillation of the coal are made to pass downward through the hot fuel, where the tarry substances are permanently gasified. The primary air is finally heated by passing through a jacket space in the casing of the converter. From 20 tons to 22 tons of coal are gasified in twenty-four hours, the ash of the fuel being deposited in the water tub of the ashpit in an unclinkered condition and almost entirely free from carbon.

The gas obtained in a dry state on an average contains:

	Per cent. by volume.
Carbonic anhydride	17·1
Carbonic oxide	11·0
Olefines	0·4
Methane	1·8
Hydrogen	27·2
Nitrogen	42·5
	100·00

Total combustible gas 40·4, giving about 1350 K.C. Cals. as determined by a calorimeter, per m³.

At 50 deg. the gas contains about 111 grams of water vapour—per metre cube measured dry—and this amount of moisture is no apparent drawback in the steel furnace.

Owing to the general belief that washed gas was not satisfactory in the manufacture of steel, Dr. Mond, by the author's advice, determined to put down a small steel furnace to demonstrate whether his gas would work satisfactorily and give the high temperatures required quickly and sufficiently. During the latter portion of 1895 a regenerative furnace was erected at the Winnington Works of Messrs. Brunner, Mond and Co. It was a three-ton furnace, and measured 12ft. between the blocks. The best performance was a complete charge in 7 hrs. 35 min., thus working rather faster than three charges per day of twenty-four hours. No hitch of any kind occurred in working this furnace, nor did any trouble develope itself with the washed gas. The steel made contained from 0·14 to 0·45 per cent. of carbon, 50 per cent. containing under 0·2 per cent. of carbon.

The average complete analysis of nine casts gave the following results:—

	Per cent.
Carbon	0·240
Silicon	0·038
Sulphur	0·039
Phosphorus	0·037
Manganese	0·457

The mechanical test of twelve samples of the steel containing from 0·16 to 0·22 per cent. of carbon gave the following results:—

Cast. No.	Carbon per cent.	Diameter, inches.	Breaking strain per sq. in. tons.	Elongation in 8in., per cent.	Percentage of contraction of area.	Limit of elasticity per sq. in. tons.
20/1	0·17	1·14	25·6	35	50	16·4
2	...	,,	25·5	32	51	16·4
25/1	0·22	,,	25·8	35	53	16·6
2	...	,,	27·6	32	53	17·0
30/1	0·16	,,	25·8	36	53	16·4
2	...	,,	25·8	33	53	15·9
35/1	0·16	,,	25·4	33	56	16·7
2	...	,,	25·2	35	56	16·1
40/1	0·18	,,	27·3	32·5	53	17·6
2	...	,,	27·1	33	53	17·3
41/1	0·17	,,	26·2	35	53	17·1
2	...	,,	26·3	34	51	17·4

There were no skulls in the ladle from the beginning to the end of the experiment, the metal always being hot and settling quietly in the moulds. During the experiment forty-one charges were converted into steel. Average time: charging, 18 min.; melting, 3 hrs. 9 min.; working, 5 hrs. 39 min. Average duration of charge, 9 hrs. 6 min. Shortest time taken, including charging and repairs, 7 hrs. 35 min. Total make of steel, 99 tons 3 cwt. Yield on the metals charged, 95·33 per cent.

Description.	Weight of materials charged.				Used per ton of steel.
	Tons.	Cwt.	Qrs.	Lbs.	
Hematite pig iron	79	10	3	0	16·04 cwt.
Steel scrap	23	12	3	0	4·77 cwt.
Ferro-manganese	0	16	2	2	18·7 lb.
Iron ore	16	10	0	0	3·39 cwt.

The measurements as to the quantity of gas used have been given; but as the furnace was drawing its supply from the works mains, it is difficult to arrive at this accurately. The author would prefer to let the question of consumption rest by saying that three charges of steel were made in twenty-four hours, and that the amount of gas consumed by the furnace was not appreciable at the gas-producer. The experiments show conclusively that gas of the composition given is entirely satisfactory for the manufacture of the softest kinds of steel, and that it does not contaminate the metal with sulphur. From the following analysis it will be seen, that the constitution of the gas is considerably modified by the action of the generator, as shown by Table A in the next column.

These analyses are averages of the results obtained by two separate chemists, and agree within the limit of experimental error.

In illustration of the latter analyses some figures were produced by Mr. Bauerman, who showed that the change indicated was an evidence of a reversal of the action of the producer by the regenerator, *i.e.*, carbonic acid was partially reduced by hydrogen with the production of carbonic oxide and water vapour, a reaction which he believed had not been previously recorded as such. The figures seemed to correspond to a reduction of about one-third of an equivalent of carbon dioxide with a consumption of 0·66 per cent. of hydrogen. Mr. Snelus gave an account of the working of the furnace which he had examined at the author's invitation. Mr. James Riley went into the different trials that had been made of saving ammonia from producer gases but was not very sanguine as to the profit to be realised upon the large cost of the plant. Mr. Paul, in a most interesting speech, went into the chemistry of the subject, and gave some figures as to the actual decomposition of carbon dioxide by hydrogen which corroborate the statement in the paper. The discussion was summed up by Dr. Ludwig Mond, who dealt with the points raised by the different speakers in a manner that made it unnecessary for the author to add anything more in reply.

TABLE A.

	Mond Gas. No. 1. Before regenerator.	No. 2. After regenerator.
Carbonic anhydride	17·8	10·5
Carbonic oxide	10·5	21·6
Ethylene	0·7	0·4
Methane	2·6	2·0
Hydrogen	24·8	17·7
Nitrogen	43·6	47·8
	100·0	100·0
Calorific value	1430	1444

With the termination of this discussion the interest of the audience diminished, and the remaining business, which consisted in the discussion of Mr. Howe's paper, adjourned from the Birmingham meeting, and of sundry communications based upon it, was conducted before a very attenuated body of members, and such remarks as were made by Mr. Hadfield and Professor Arnold were mainly adverse to the position taken by the writer. It was somewhat unfortunate no supporters of the "allotropic" hypothesis were present, but we suppose that their absence may be taken as evidence that the controversy is no longer of any particular interest, in this country at any rate. A long paper by Mr. J. S. de Benneville "On the Study of Alloys with Iron Carbides, mostly of Manganese and Tungsten," was taken as read, as no one apparently was able to give an intelligible account of it in a small compass. This terminated the business, when, after the customary vote of thanks, the meeting adjourned, to reassemble at Bilbao in September next.

INSTITUTION OF CIVIL ENGINEERS OF IRELAND.

LIGHT OR SECONDARY RAILWAYS.

ON the 6th May, 1896, Mr. Alfred D. Price, M. Inst. C.E., read a paper on "The Location, Construction, and Equipment of Light or Secondary Railways," of which we give an abstract.

There has been considerable misunderstanding as to the term light railway, so that the author commenced by defining it, as applying to a "secondary line, whether of the broad or narrow gauge, which is laid out, and constructed, on economical basis, to meet the requirements of a light traffic to be conveyed at moderate speeds."

He proceeded to show the importance of railways as the main channels of circulation between man and man, and that upon their progress and efficiency depends in a great measure the vitality of a nation—just as life in the animal, the plant, and even the firmament itself, is dependent upon the natural law of circulation, in the blood, the sap, and the water. He pointed out that Ireland has not the centres of consumption arising from manufactures which in England and Scotland have enhanced the value of the more remote regions, but that our outlying congested districts are dependent on the carriage of their produce to great distances, for which, if there are no facilities, the real value of the produce is depreciated from having neither local demand nor means of transit; it therefore appears that a fully extended cheap carrying system is peculiarly necessary for this country. He drew a comparison between our old railway system and that of a tree—if nature could produce such—on which the branches are as heavy and strong as the trunk, or, a river, the tributaries of which were as large as its debouchment.

Having quoted several Acts of Parliament—from 1868 to 1889—authorising the construction of light railways, he went on to give his experience and typical examples of different systems—branches of the Great Southern and Western Railway—to Castleisland, to Mitchelstown, to Valencia, and to Kenmare; the 3ft. gauge railways of County Antrim and of County Donegal, and steam tramways, or railways partly on the margins of the public roads and partly upon land acquired for the purpose. Details of cost per mile were given and the effects of gradients and curves.

In conclusion, Mr. Price advocated the construction of economical extensions and branches as feeders to the trunk lines—these extensions to be adapted for the working of the ordinary goods wagons of the parent lines, with specially constructed passenger corridor cars, with end doors and central buffers, to be worked by light bogie locomotives at moderate speeds. Under certain favourable circumstances the public roads should be availed of. Frequent stopping places should be provided to give passengers the opportunity for alighting or for joining the train. No platforms would be necessary, and no buildings except where required for goods.

In this agricultural country the value of land adjacent to a railway is much enhanced, upon which fact the author advocated the principle of guarantees upon the lands so affected, as against the method of baronial guarantees at present in force.

The question of State aid and control was touched upon. It was advocated that the State should guarantee 3 per cent. upon sufficient capital to construct and equip the lines, and that a rate should be levied upon property improved in value, whether in lands or existing railways, provision being made for a rebate according as the undertaking paid anything more than its working expenses, so that there should be a local interest in the efficient working of the line and development of traffic.

State aid in the form of grants or loans implied State control—which should commence at the very initiation of the scheme—in determining the route, location, &c., and should be continued all through the construction, with a permanent control after completion, to insure that the line is maintained and worked for the convenience of the public, the development of the natural resources of the country, and the encouragement of industry amongst its inhabitants, which are the main objects aimed at by such expenditure of the public funds.

RAILWAY MATTERS.

The Najibabad-Kotdwara Railway has been opened for traffic.

The final inspection of the new railroad from Connah's Quay to Bidston by Colonel Yorke, for the Board of Trade, took place on Monday. This is the line that Mr. Gladstone traversed a few weeks ago. The line will be opened for passenger traffic next Monday.

Travellers to Newcastle will have noticed at the north end of the High Level Bridge one of Stevenson's earliest locomotives. It was known as "Puffing Billy," and has been deteriorating owing to exposure to the weather. The North-Eastern Railway Company has decided to place this relic in the interior of the Central Station, just as No. 1 Locomotive is preserved on the platform of Darlington Station.

Messrs. Killick, Nixon, and Co., Bombay, have been granted the concession for the Ahmedabad-Parantij Railway. This railway will be on the standard gauge, 161 miles long, and is estimated to cost, without rolling stock, Rs. 1,42,84,830, or Rs. 88,726 per mile, taking exchange at 13 pence the rupee. The project embraces also an extension of the line from Amalnar to join the Great Indian Peninsula Railway at Jalgaon. Whether this extension also will be thrown into the concession granted to the Bombay firm will, *Indian Engineering* says, depend upon the result of certain negotiations now pending with the Great Indian Peninsula Railway Company.

A serious railway accident took place on the 11th inst. in Algeria. A special train conveying from Mostaganem to Algiers 140 Algerian riflemen, destined for Madagascar, ran into a passenger train from Algiers at the entrance to a tunnel near Adelia station. The collision was so violent that both engines were wrecked. The night was dark, with rain falling, and the military train was descending an incline. The line is a single one, and there is as yet no explanation of the simultaneous presence of the two trains. Out of ten officers, who were in a first-class carriage next the engine, six were killed and three injured. Forty privates and the engine driver and fireman were also injured. The passengers in the other train were merely shaken. The injured were at once cared for by the French colonists in the neighbourhood, and they will be conveyed to the nearest military hospital.

In a report on the collision that occurred on the 11th March, at Bellahouston, on the Glasgow and South-Western Railway, Colonel H. A. Yorke says:—"Some three hours' shunting has to take place every night at this place—two trains of thirty-three wagons each having to be marshalled there—and there is not a single lamp in the yard. In my judgment it is not fair to the men or beneficial to the company to expect such work as this to be performed in absolute darkness. The accidents, fatal or otherwise, to men engaged in shunting operations still far exceed in number those incurred by other classes of railway servants, and no precaution should be omitted which would tend to increase the safety of these men. And it seems probable that the shunting operations would be carried on more quickly and with less likelihood of damage to rolling stock and goods, such as occurred on the occasion referred to, if goods yards were properly lighted."

It is not often that the cause of an accident is so clear as in that which occurred, on March 20th, at St. Blazey Station, on the Cornwall Minerals Railway—worked by the Great Western Railway. In this case, when the 12.56 p.m. passenger train from Par to Fowey was being set back over the points at the north end of St. Blazey Station, in the trailing direction, the two leading coaches left the rails. One passenger is reported to have complained of slight injuries. In concluding a report on this accident, Lieut.-Colonel G. W. Addison says:—"Signalman Prideaux admits that, as the Fowey train was being pushed back to the north end of the station loop, he reversed the loop points too soon, *i.e.*, before the train had passed over the points, and thus caused the derailment of the carriages. His only excuse is that he was very much hurried, as people were waiting at Middleway level-crossing, and clamouring for him to come out to open the gates, then closed across the road." Poor "worrited" Prideaux; but why send a Board of Trade soldier to Blazey's station to inquire into such a paltry affair?

On the 7th inst., a Committee of the House of Commons, presided over by Sir Mark Stewart, had before them a Bill promoted by the Corporation of Sheffield, seeking to repeal the restriction imposed by a local Act of 1872 upon their working the tramway constructed by them. This repeal was strenuously opposed by a company who, as lessees of the Sheffield Corporation, at present work the city tramways, and are themselves promoting a Bill to substitute mechanical for animal haulage, and for other purposes. The two Bills were taken together, the Committee being only authorised to consider the Corporation Bill by a resolution of the House, passed, after some opposition, on Monday, to suspend Standing Order 171. Witnesses on both sides spoke to the results of municipal tramway working at Glasgow, Leeds, Huddersfield, Plymouth, and other places, and there was also frequent reference in argument and evidence to the new powers proposed to be given to municipal bodies, county and district councils, by the Light Railways Bill now pending. After a three days' hearing the Committee unanimously passed the preamble of the Corporation Bill, and limited the company's Bill to one for their winding up voluntarily, but accompanied by an undertaking from the Corporation to buy up the company's cars, horses, and equipment, in addition to their fixed plant, at the expiration of their lease next July. Mr. Clifford, Q.C., appeared for the Corporation of Sheffield; Mr. Balfour Browne, Q.C., and Mr. Lewis Coward for the company. As the first case of this nature heard and decided since Standing Order 171 was suspended, the proceedings and finding of the Committee excited much interest among tramway authorities, private and municipal.

In a report on a collision which occurred on the 18th of February at London Bridge station, on the South-Eastern Railway, Major Marindin says:—"As to the cause of this collision, which narrowly escaped being a very serious one, there is no doubt whatever. The 5.30 p.m. down North Kent train arrived at London Bridge station at 5.45 p.m., and stopped on No. 5 line at a point about 84 yards short of the end of the platform. After the station work was completed, the driver received the usual signal from his guard that the train was ready to start, and having, as he believed, seen that the signals were off for No. 5 line, he put on steam and started steadily. When the train had run for about 80 yards the front guard of the train on looking at the signals, then close by, saw that the signals for No. 5 line were at danger, and those for No. 6 line, the actual junction with which was only 66 yards ahead, were off, and he at once applied the continuous brake and shouted to his driver, who then for the first time perceived that he was running against signals. He at once shut off steam, but before the train could be brought to a stand the engine had reached the fouling point of the junction of Nos. 5 and 6 lines, and was struck by the second or third vehicle in the down Ostend mail, which had entered the station on No. 6 line at about the same time that the North Kent train started, or very soon after, and was running with all signals off for it, at a speed probably of about twenty-five miles an hour. It is a matter for the company to consider whether a platform inspector or a guard should not be instructed to see that the fixed signal is off before he gives the driver a signal that the train is ready to start. This is the rule upon some lines, and although a guard's signal should never be taken by a driver as a signal to start unless he himself sees that the fixed signal is off, it seems to me that it would tend to prevent such accidents as the one under consideration if the rule were general, although I am aware that there are reasons of some weight against it."

NOTES AND MEMORANDA.

In Greater London 3671 births and 1948 deaths were registered last week, corresponding to annual rates of 33·1 and 16·5 per 1000 of the estimated population.

The deaths registered last week in thirty-three great towns of England and Wales corresponded to an annual rate of 18·5 per 1000 of their aggregate population.

Piles from 100ft. to 105ft. long are being used by the Tacoma Land Company, of Tacoma, Washington, in replacing a portion of its sea wall with a pile and stringer wharf. The water is 30ft. deep and the outer row of piles range from 100ft. to 105ft. in length, 10in. diameter at the tip and 22in. at the butt. The piles are made from the "Washington Fir"—the Douglass Pine—and from the same timber, a few piles were cut and recently used, 120ft. long and 24in. at the butt. Sticks 90ft. long, three-car lengths, in squared timber are often shipped East; and, *Engineering News* says, it is expected that changes in the alignment of the railway will soon permit the shipping of 100ft. lengths.

Lord Rayleigh, in a communication to *Nature*, contributed the following on the chemical position of argon. The gas was prepared from atmospheric air with the aid of oxygen and alkali only:—"Weighings at 0 deg. C. upon a large scale—two litres—and with the apparatus formerly employed for other gases, give, as the density of argon, $(O_2 = 16)$ 19·940, a number in almost exact agreement with that obtained by Professor Ramsay, working upon a relatively small scale, and with gas derived by magnesium. In spite of its greater density, the refraction $(\mu - 1)$ of argon is only ·961 of that of air; so that if we take for air under standard conditions $\mu = 1{\cdot}0002923$, then for argon $\mu = 1{\cdot}000281$."

"There is, perhaps, no country in the world where art, science, and industry, are so much encouraged by the awarding of prizes for meritorious work and progress as in France; and although it might possibly be argued that no invention or appliance of the first order of importance was ever the direct outcome of a prize competition, still it is not to be denied that the origin of many advances can be traced to the stimulus of a prize competition. Even," says the *Electrical Engineer*, "if such competitions do not always result directly in bringing out the desired improvement, they nevertheless draw attention prominently to the object in view, and set to work many who would otherwise remain passive, if not in total ignorance of the needs of the times."

An auxiliary assay balance has been described by Mr. Robert Law, F.I.C., applied to bullion assaying, the object of which is to give the weight of the gold "cornet" with sufficient accuracy to enable the assayer to put the correct weight in the pan of the ordinary assay balance, and to decide the remaining fractions by means of the rider alone. This auxiliary balance is of such dimensions as to be easily accommodated in the case of the ordinary assay balance. The advantages claimed are:—(1) Saving of time in weighing when gold of varying finenesses is under assay. (2) Reduction of the wear in the weights. (3) Increased life for the ordinary assay balance. (4) Avoidance of much of the concentrated attention which tends to make the assayer's work monotonous.

A recent paper in the *Comptes Rendus* described a self-registering thermometer balance, containing either gas or saturated vapour, by MM. H. Parenty and R. Bricard. The two arms of a balance carry respectively a barometer and an air thermometer, both dipping into the same mercury trough. At constant temperature, and with varying atmospheric pressures, the alterations in the weights of the two arms caused by the movements of the mercury are identical, and the balance remains in equilibrium; but an alteration of temperature causes a motion of the beam, which can easily be made self-registering. For a small range of temperature the sensitiveness of the apparatus is considerably increased by substituting a volatile liquid for the gas. The device also readily acts as a temperature regulator.

After making a number of experiments on the heat conducting power of iron and steel, Mr. W. Beglinger arrived at the following conclusions:—The results show that the heat conducting power of the different kinds of iron is altogether different. It is, therefore, of the greatest importance to know the coefficient of the inner heat conducting power. Steel and wrought iron show a more uniform conduct in this matter than cast iron. It is not confirmed that hardening reduces the conducting power of steel by almost one half, though it may be conceded that hardening will reduce it slightly. The difference in working, by forging or rolling, showed only in one case, with wrought iron, considerable differences for the conducting power, steel never. Casting seems to cause far more irregularities. Wrought iron showed generally better conducting power than steel.

According to statistics collected by the office of Road Inquiry of the United States Department of Agriculture, the amount of loss each year by bad roads of the country is almost beyond belief. Some 10,000 letters of inquiry were sent to intelligent and reliable farmers throughout the country, and returns were obtained from about 1200 counties, giving the average length of haul in miles from farms to markets and shipping points, the average weight of load hauled and the average length per ton for the whole length of haul. Summarised, it appears that the general average length of haul is twelve miles, the weight of load for two horses 2002 lb., and the average cost per ton per mile 25 cents, or 3 dols. for the entire load. Allowing conservative estimates for tonnage of all kinds carried over public roads, the aggregate expense of this transportation is figured at 946,414,600 dols. per annum. Those in a position to judge calculate that two-thirds of this, or nearly 631,000,000 dols., could be saved if the roads were in reasonably good condition. At 4000 dols. per mile a very good road can be constructed, and if an amount equalling the savings of one year were applied to improving highways, 157,000 miles of road in this country could be put in condition. The effect of this would be a permanent improvement, and not only would the farmer be astonished in the sudden reduction in his road tax, but he would also wonder at the remarkable falling off in the cost of transportation. Such a work ought to afford a good investment. He would also find that he required fewer horses and less feed for them.

Mr. Langhorne, writing to the *Times* concerning traffic on London and the Tower Bridges, quotes an article in "Knight's Year Book" for 1861, "Thames Embankments and Crowded Streets":—On London Bridge, in 1853, between 9 a.m. and 6 p.m., there crossed 63,080 pedestrians and 11,498 vehicles. In 1856 between 8 a.m. and 6 p.m., October 22nd, pedestrians not stated, 15,992 vehicles. In 1857—authority not stated—between 8 a.m. and 8 p.m, February 11th, 85,690 pedestrians, 14,890 vehicles. In 1859—Mr. Harvey—between 6 a.m., March 16th, and 6 a.m., March 17th, 107,074 pedestrians, 20,444 vehicles, or 4461 pedestrians and 850 vehicles per hour. In 1895—Bridge House Committee—between 6 a.m., September 20th, to 6 a.m., September 21st, 108,598 pedestrians, 21,646 vehicles, or 4522 pedestrians and 902 vehicles per hour. Between the same hours there passed over the Tower Bridge 25,255 pedestrians and 8751 vehicles, which may be taken to represent roughly the increase of traffic which would have passed over London Bridge on the day stated, had the Tower Bridge not been built. Adding the traffic of the two bridges together we have a total of 133,853 pedestrians and 30,397 vehicles, or at the rate of 5577 pedestrians and 1266 vehicles per hour. Comparing this with Mr. Harvey's figures in 1859, we find the 1895 returns in excess of the 1859, roughly, 1000 pedestrians and 400 odd vehicles per hour. Going back to Mr. Bennoch's figures for 1853, it seems fair to infer that the pedestrian traffic has more than doubled, and the vehicular probably trebled, in forty years.

MISCELLANEA.

The new United States battleship Massachusetts, on her trial trip, covered 62 knots in 3 hours 50 min. 23 sec., an average of 16·15 knots. The premium earned by the contractors amounts to 100,000 dols. The trip was entirely satisfactory, and shows that the battleship is the swiftest of her class.

The City and Guilds of London Institute is issuing advertisements inviting applications for the professorship of mechanical engineering and applied mathematics at the Technical College, Finsbury, rendered vacant by the appointment of Professor John Perry, D.Sc., F.R.S., to a professorship at the Royal College of Science.

The meeting and show of the Bath and West and Southern Counties Society is this year at St. Albans, commencing on Wednesday, the 27th May, and closing on the 1st of June. The list of implement exhibitors has been published, and a general programme, from which it appears that there will be working dairies in operation, with the usual attractions.

There is not much prospect, says the *Naval and Military Record*, that 1896 will witness the keel-plate of Devonport's first battleship in position. The slip from which the Arrogant will be launched on the 26th inst. requires so much alteration that the officials of the Works Department anticipate it will take until the end of the year before they are able to hand it over to the Chief Constructor.

At a meeting of arbitrators appointed under the South Staffordshire Mines Drainage Acts, held at Dudley on Wednesday, the solicitor to the Mortgagees' Committee called attention to the Commission's financial position, and said it would be disastrous to the district if the pumping engines had to stop. It was shown that, although the full parliamentary rate per ton of coal raised was 9d., yet that owing to trade depression, graduations had of late of necessity been freely allowed, the consequence being that the average rate for last year was less than 5½d. The tonnage of minerals on which rates were paid was also a decreasing quantity. The arbitrators, therefore, this week, have allowed graduations in as few cases as possible. It is, however, satisfactory to know that progress was reported with the Tipton new drainage scheme, which at a cost of £100,000 will unwater a large area, and greatly benefit the coal trade. The arbitrators made a draft award for the Tipton district.

Sir William H. White, Director of Naval Construction, will within the next few days pay a visit to the Clyde district, the inspection of the unfortunate cruiser Dido in the Clyde Trust's Graving Dock being the object of his visit. This vessel, it will be remembered, met with a serious mishap while being launched on the 17th of last month from the yard of the London and Glasgow Shipbuilding Company. Since being docked about twelve days ago it has been ascertained that the damage sustained has been more serious that at first supposed. Several strakes along the port bilge—on which she settled down after having swerved from the upright end from the line of ways—are indented for a considerable portion of her length, and even the line of inside framing has been damaged at parts. But for the wood sheathing with which the under-water portion of her hull was covered, the damage sustained would have been of a considerably more serious nature. As it is, the repairs will necessitate her being in dock for six weeks or so.

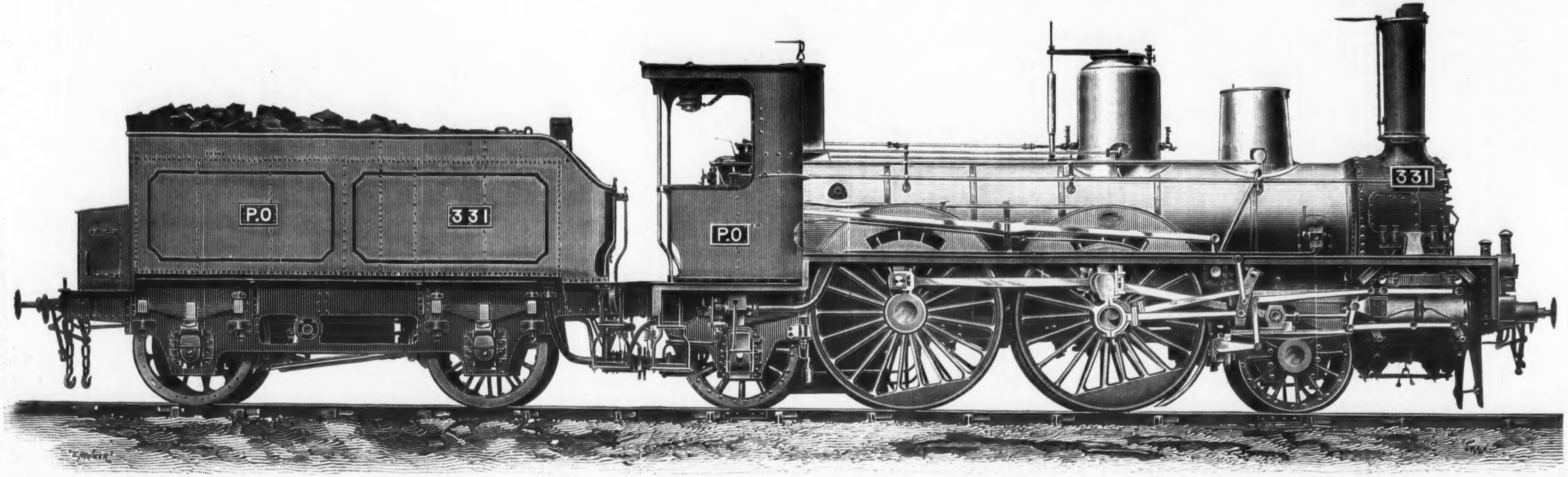
An experiment on a large scale is being made with the sewage of Exeter by means of what is called the "Septic Tank System" devised by Mr. F. J. Commin the Exeter City Surveyor. The plant, which was laid down in January last, and was filled on the 22nd of that month, and has been at work ever since, is situated close to the river Exe, near the main sewer from St. Leonard's, a part of the flow from which is dealt with by the system. The quantity handled is ordinarily 7500 gallons per day, which would represent the sewage of from 300 to 400 people. There is no "treatment" in the ordinary sense of the word. No chemicals or other ingredients are added to the sewage. The "Septic Tank" is 24ft. long by 9ft. 6in. wide, and from 3ft. 6in. to 4ft. deep, and is arched over and covered with earth. Its capacity is about 6000 gallons. During the progress of the sewage through this tank, which occupies some twenty hours, it is cut off from light and air. The tank is formed with inlet and outlet, arranged so that the upper portion of the contents are undisturbed. A sewage scum forms on the top, eventually reaching 3in. in thickness, and by this all soluble solids are thrown into solution by bacteriological action. The outflow from the tank is comparatively clear and odourless, and is considered quite fit for discharge into the sea or tidal water, or for filtration or for utilisation on land.

In connection with the launch by Messrs. William Denny and Bros., Dumbarton, on the 30th ult., of the twin-screw Channel steamer Sussex, for the Newhaven and Dieppe service, built to replace the ill-fated Seaford, lost last year, reference was made to the fact that the same builders have not only constructed several vessels for this route—the service indeed having been inaugurated many years ago by a vessel from their stocks—but they were pioneers of steam service generally across the Channel. In the year 1821 the first steam vessel which crossed from Calais to Dover was built by the grandfather of the present younger members of the firm, the late Mr. William Denny. This vessel was called the Rob Roy, and was only 90 tons burden, with engines by David Napier, of 30 horse-power. Her speed was not great, being something like seven to eight knots; but in rough weather she would do the passage in less time than the sailing boats then sailing; in fine weather with favourable winds, the sailing boats beat her. In sharp contrast to this old-time order of things is the performance of vessels like the Sussex and many others, which Messrs. Denny have been instrumental in providing for present-day service. The Sussex, fitted with forced draught on the closed stokehold principle, is intended like the Sleaford, which she replaces, to develope a speed of not less that 20 knots per hour on the Newhaven and Dieppe crossing.

The Bridges Committee of the London County Council have prepared a scheme, which will shortly be submitted to the Council for approval, for the construction of a tunnel under the Thames to connect Millwall with Greenwich. It is intended that the tunnel shall be for foot passenger traffic only, having a footway of 8ft., with a headway of 9ft. 4½in. in the centre reduced to a minimum of 7ft. 6in. at the outsides. The cast iron tubing would be lined inside with concrete faced with glazed tiles, and the tunnel would be lighted by electricity. The shafts on either side of the river would be 32ft. 8in. internal finished diameter, and a spiral staircase 6ft. wide would be constructed, 20ft. clear diameter being left in the middle, in which hydraulic lifts might be constructed at some future date, should necessity arise. The height of the stairway would be 43ft. 6in. on the north and 51ft. on the south side of the river. The total estimated cost of the works amounts to £65,000. The land which would be required would cost £5500, making a total for land and works of £70,500. In addition to that, as the law at present stands, £25,000 would have to be paid as compensation to persons interested in the existing ferry and ferry rights, but the committee hope the Council will succeed in obtaining a clause by which improvement of interest will be considered, thereby reducing this amount very considerably. The capital cost of the tunnel, including compensation for the ferry rights—viz., £95,500—has been reduced to an annual sum, and amounts to about £4190 per annum for the first year, diminishing each year till the debt is paid off in fifty-three years. The committee ask the Council to seek the necessary parliamentary powers to carry out this scheme, which they state will meet a long-desired requirement of the people living on both sides of the river

LOCOMOTIVE ENGINE WITH CORLISS VALVES, PARIS AND ORLEANS RAILWAY

M. E. POLONCEAU, ENGINEER



ECONOMICAL HIGH-POWER LOCOMOTIVES.

By James Dunlop.

With their engines pressed to their utmost limit of power and endurance, most locomotive superintendents will be inclined to doubt the possibility of the double adjective above being realised, experience having proved to them that the present construction of locomotive is much the reverse of economical when developing its extreme power. Limited in respect to the dimensions of the boiler, and consequently in the amount of steam at disposal, it is somewhat surprising to find no attempt has been made in this country to make the engines more economical in their use of the steam by improved construction of cylinders and valve gears capable of conforming to all the requirements of locomotive practice. There is, of course, the failure of numerous arrangements of expansion valves working on the back of the ordinary slide valve to point to as a reason for attempting nothing in this direction, but the reasons for these failures should be sufficient to point out the direction in which they may be remedied and made conducive to success. In the first place, such arrangements do nothing towards reducing the clearance spaces, but increase them rather. As a consequence a greater quantity of steam is lost each stroke than formerly, this loss being further increased by the reduced compression, which was intended to be an economical feature of the arrangements. In the second place, the live steam was still admitted by the ports and passages just cooled down by the previous exhaust; these passages being at a lower temperature than formerly, the initial condensation was also much increased, the lower temperature being due to the reduced compression. These reasons might also be used to show why locomotives, when moderately loaded, are as economical as they are in comparison with other classes of engines. This appears to be due to a balance that is struck between the amount of expansion obtained, and the proportion of the work of compression that is saved, the latter proportion being greatest when the time duration of compression is the least, a circumstance that explains all the various proposals to limit the compression as a fraction of the stroke.

A further objection, if not a reason, for the failure of these arrangements was the different handles required for their manipulation. The problem before locomotive superintendents whose engines are generally taxed to their utmost is, therefore, the restoration of the balance above mentioned. The first step towards this would be the reduction of the clearance spaces, and consequently of the losses due to clearance; the second, the separation of the admission and exhaust passages so as to reduce initial condensation; and the third, the use of a valve gear actuating independent admission and exhaust valves, so that the requisite amount of expansion and proportion of work of compression saved may be such as will bring about the desired balance.

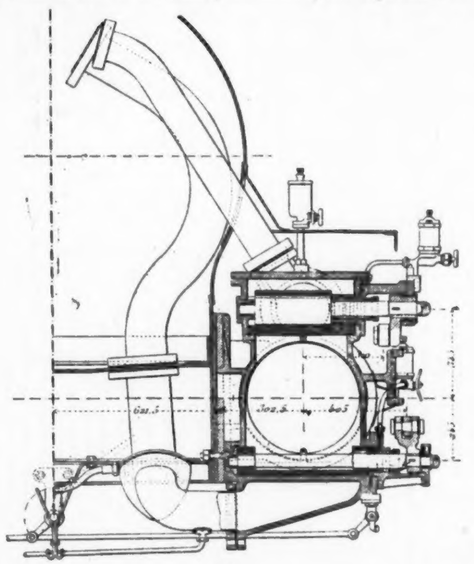


Fig. 3

On the Paris and Orleans Railway this has already been done by M. E. Polonceau on seventeen of his locomotives, and the result is that, while being 15 per cent. more economical in fuel compared with ordinary engines doing similar work, the power of these locomotives has been increased considerably. The accompanying illustration—Fig. 1—is that of one of the passenger engines, and it may be noticed the engine is fitted with Corliss valves, one at each corner of the cylinders. The two upper valves are for admission and the lower valves for exhaust, both sets of valves being actuated by a Gooch link motion, and all adjustments made by one reversing handle. The detail views—Figs. 2, 3, 4, and 5—show the construction of the cylinders, valves, and valve gear. The link motion has two excentrics and rods for forward running, and one excentric and rod only for backward running. This is for the double purpose of preserving the stresses in one direct line, and of providing an ample amount of surface for wear, there being no great necessity for unusual surfaces on the backward excentric, &c., as in France there are no double-ended suburban engines, and a Government regulation prohibits the use of an engine tender first. The link is of the box type, and is longer at the upper end than at the lower, for the purpose of accommodating an extra deep die block to which two radius rods are jointed one above the other, the lower radius rod being the one that is adjusted symmetrically on either side of the centre point—or suspension point—of the link, as in ordinary slide valve motions. The result is that the upper radius rod has an unsymmetrical adjustment range on either side of the suspension point of the link, a peculiarity of which the effect will be seen later on. This upper radius rod is jointed to a rocking lever, which is used simply to alter the direction of the movement transmitted by the link, and to make a convenient connection to the exhaust valve, levers, &c. The lower radius rod is coupled direct to the admission valve levers, and the motion transmitted to the admission valves is exactly the same, and has the same effect on the cut-off as an ordinary slide valve, according to the position of the die block in the link. The radius rod actuating the exhaust valves, owing to the unsymmetrical adjustment mentioned, will for one direction of running—the forward—cause the exhaust valves to move so as to effect release and compression at much later periods than those corresponding to the cut-off when compared with the periods given by an ordinary slide valve. In the other direction the opposite takes place. As a matter of fact, practically no expansion can be obtained in backward running, release and compression taking place immediately after cut-off. These results and a comparison with an ordinary slide valve gear are given in Table I.

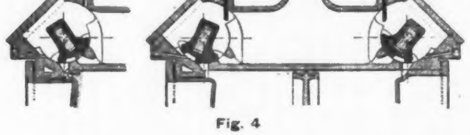


Fig. 4

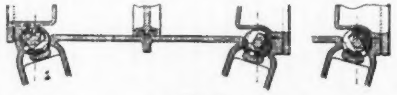


Fig. 5

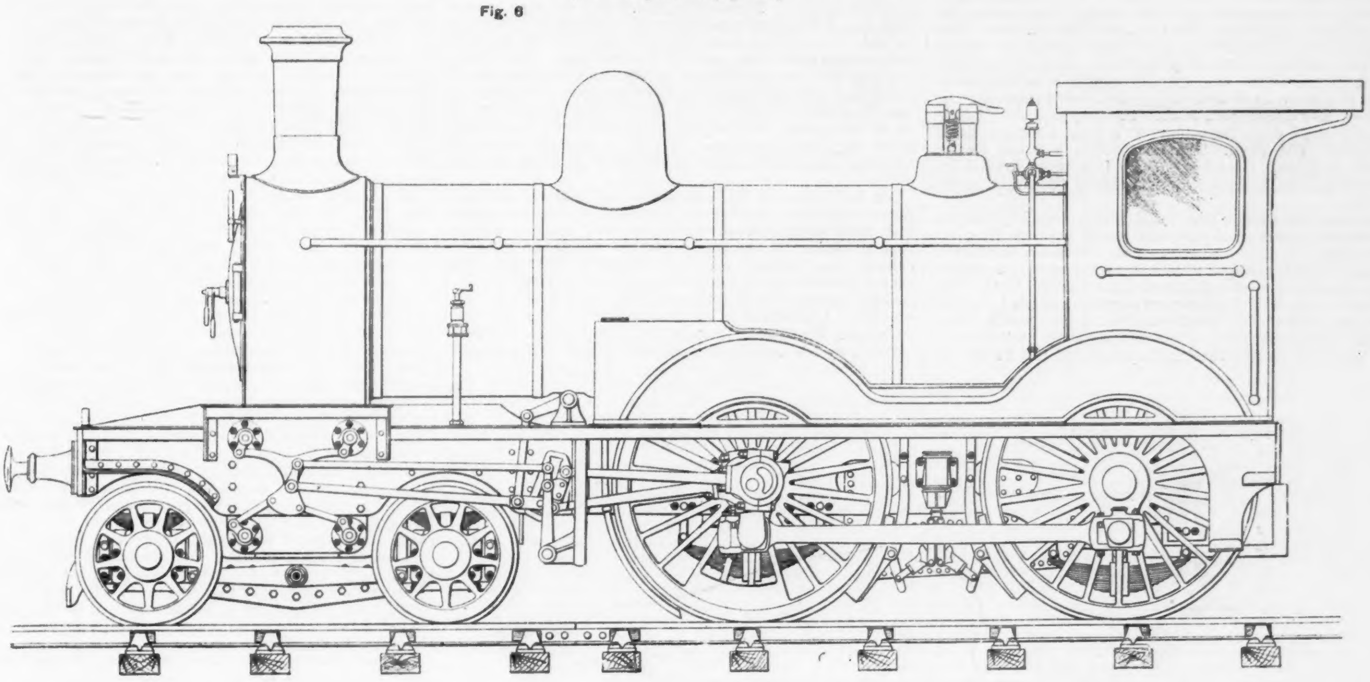
The construction of the admission valve is that known as the Trick, the exhaust valves being ordinary double-ported. As both constructions give a double opening at each end of the cylinders, no wiredrawing at early cut-offs or excessive back pressure is experienced, while the position of the exhaust valves is such as to ensure at all times the complete draining of the cylinders. The small amount of the clearance spaces will be appreciated, as will also the substantial nature of the construction throughout. The patentees of this gear are MM. Durant and Lewcauchez.

As in this country engines are generally required to work equally well in either direction, the arrangement illustrated in Fig. 6 was produced to meet these conditions, while giving all the economical results obtained in forward running by the arrangement just described. So far as the cylinders and valves are concerned, the construction is practically the same, with the exception of the exhaust valves, the latter being single ported, a circumstance that admits o a further diminution of the clearance spaces. The gear is

LOCOMOTIVE ENGINE WITH CORLISS VALVES, PARIS AND ORLEANS RAILWAY

(For description see page 490)

Fig. 6



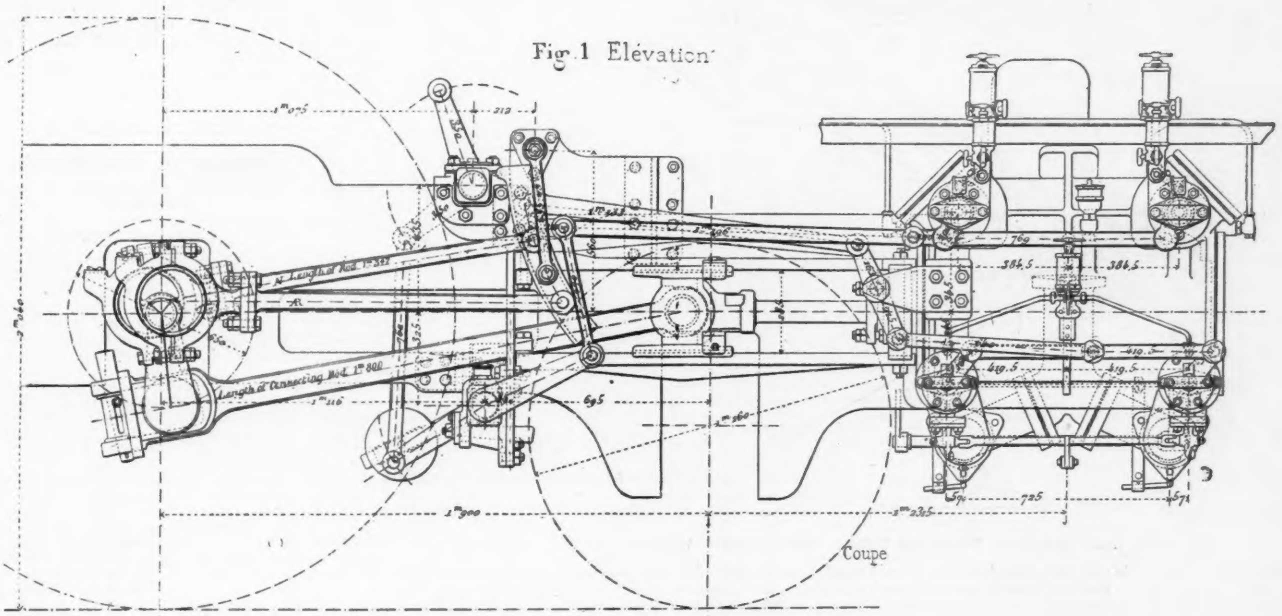
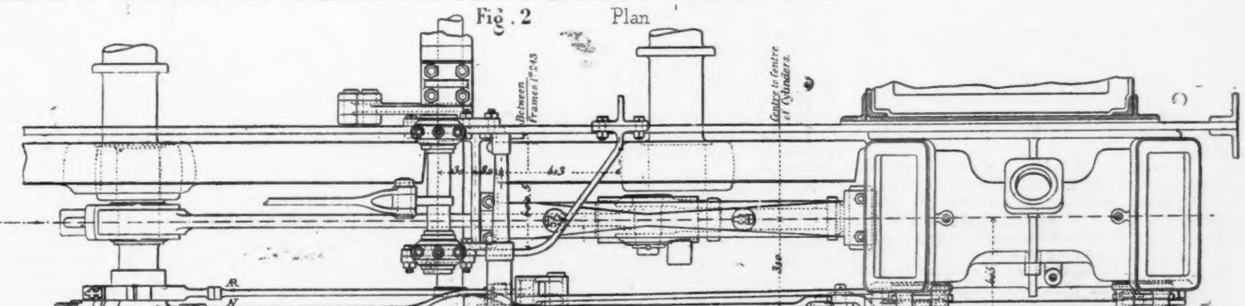


Fig. 1 Elévation

Fig. 2 Plan



a modified Gooch motion, having one radius rod only, which is jointed to a somewhat T-shaped piece coupling the admission valve levers. This coupling-piece carries at its lower centre a double-ended lever, the upper centre of which is coupled to a prolongation of the link-hanger, the lower centres of this lever being coupled to the exhaust valve levers by the links shown. By this arrangement the admission valves have exactly the same motion and effect on the cut-off as an ordinary slide valve, according to the position of the die block in the link. The motion of the exhaust valves is a compound of the variable motion of the admission valves, and the invariable motion of the link-hanger, which is in time with the motion of the piston, and it may be understood that this compound motion is the equivalent of that obtainable from a second radius rod placed some distance above or below the radius rod actuating the admission valves, according to whether this rod is in forward or backward gear. This makes the results of both backward and forward running alike, and causes the exhaust valves to be moving to effect release and compression at much later periods than those corresponding to the cut-off when compared with the periods given by an ordinary slide valve. These results and a comparison with an ordinary slide valve gear are given in Table II. The disposition of the pins at the bottom centres of the double-ended lever, and the lengths of the links coupling this lever to the exhaust valve levers, is such that a peculiar dwelling and active period is alternate imposed on the motion of the exhaust valves, this being the feature that admits of the use of single-ported exhaust valves with their attendant diminution of the clearance spaces. A further result is the reduction of wear during the dwelling periods. In addition to economical use of the steam, the use of Corliss valves has resulted in a much lessened wear of the parts of the link motion, this being due to the fact that Corliss valves require much less power to work them than ordinary slide valves do, Corliss valves being in equilibrium during the time the ports are open. Their construction also is an economical one, the greater part of the operations in machining consisting of plane turning and boring. Stuffing-boxes are used on the valve spindles of the Paris and Orleans engines, but these spindles may be constructed so as to require no stuffing-boxes, thus doing away with a source of considerable trouble; in fact, as a whole, the question of applying this type of cylinders and gear to locomotives in this country may be worthy the careful consideration of many of our locomotive superintendents at the present time. The arrangement illustrated in Fig. 6 is the invention of the writer.

TABLE I.

Release and compression.

Cut-off.	Ordinary gear.		French gear.		Cut-off.
	Forward.	Backward.	Forward.	Backward.	
Per cent.	Per cent.		Per cent.	Per cent.	Per cent.
75	88	Same as forward	96	82	75
62·5	87		95	68	62·5
50	82		94	55	50
37·5	76		92	43	37·5
25	68		90	32	25
12·5	58		88	25	12·5

TABLE II.

Release and compression.

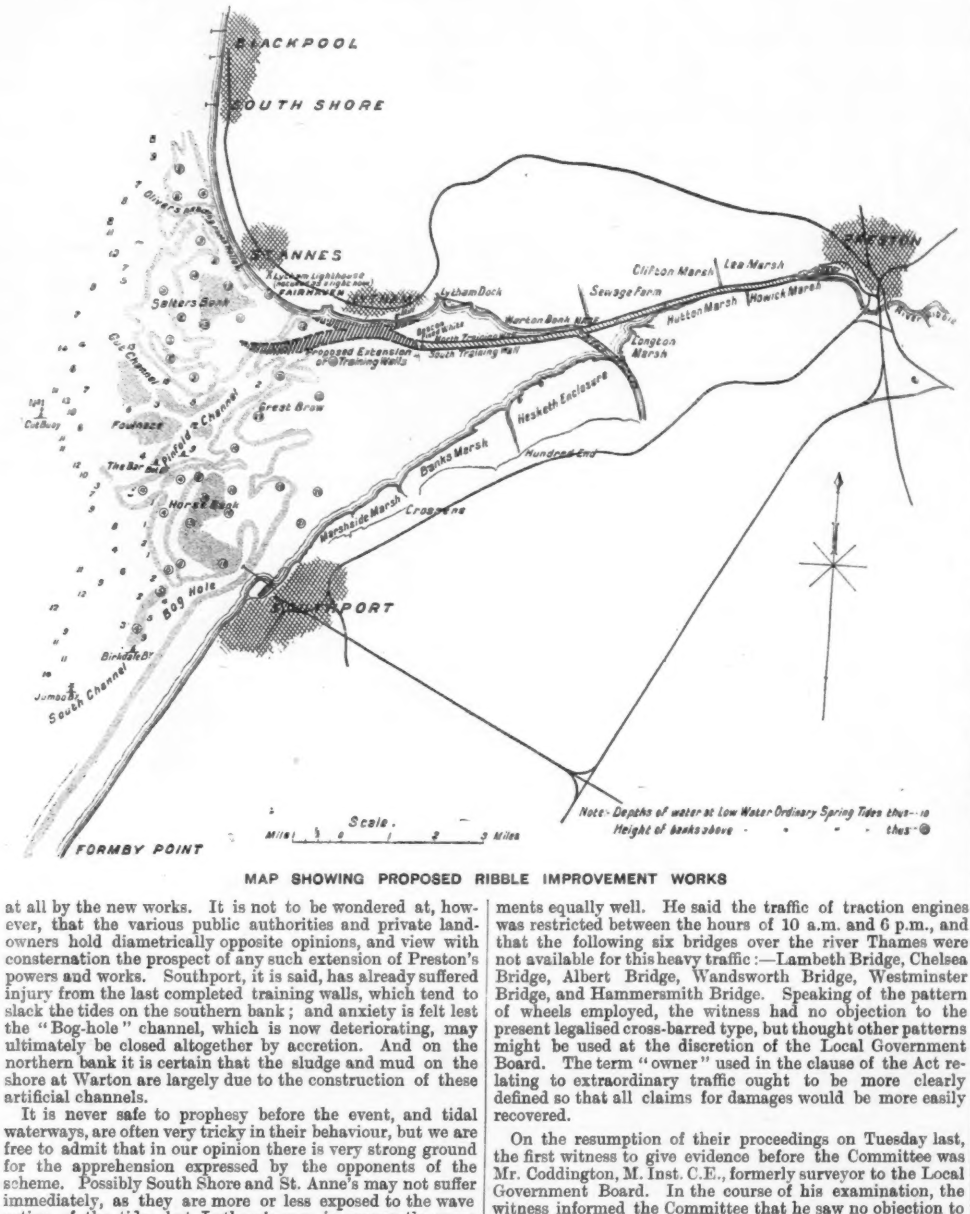
Cut-off. Per cent.	Ordinary gear. Per cent.	Dunlop's gear. Per cent.	Cut-off. Per cent.
75	88	98	75
62·5	87	97	62·5
50	82	95	50
37·5	76	93	37·5
25	68	87	25
12·5	58	72	12·5

Backward and forward are alike.

PRESTON AND THE RIBBLE NAVIGATION.

The map which we publish to-day, showing the estuary of the river Ribble with its shoals and sand banks, and the training walls already constructed by the Corporation of Preston, is of special interest at the present time, as the Bill is now being considered by the Lords Committee. The Preston Corporation, having spent their ratepayers' money lavishly in constructing a dock below the town, are naturally anxious to secure the best possible approach to their basin. Since 1889 they have accordingly obtained powers for and have actually constructed double training walls about eight miles in length down the estuary to a point almost opposite to Lytham Old Dock. The Corporation now are seeking powers to extend these walls some four miles further out towards the Bar, and the above map shows the situation at a glance.

Although, in 1889, a firm belief was expressed by the promoters that their then proposals would be final, they now claim that, largely on account of an alteration in the Gut channel, they are obliged to seek further powers if a channel is to be secured to shipping bound for Preston Dock. The promoters and their witnesses are sanguine enough to suggest that the foreshore of Lytham and St. Anne's would be improved by the extension of the existing walls as indicated; and they also declare that Southport would not be affected at all by the new works. It is not to be wondered at, however, that the various public authorities and private landowners hold diametrically opposite opinions, and view with consternation the prospect of any such extension of Preston's powers and works. Southport, it is said, has already suffered injury from the last completed training walls, which tend to slack the tides on the southern bank; and anxiety is felt lest the "Bog-hole" channel, which is now deteriorating, may ultimately be closed altogether by accretion. And on the northern bank it is certain that the sludge and mud on the shore at Warton are largely due to the construction of these artificial channels.



MAP SHOWING PROPOSED RIBBLE IMPROVEMENT WORKS

It is never safe to prophesy before the event, and tidal waterways, are often very tricky in their behaviour, but we are free to admit that in our opinion there is very strong ground for the apprehension expressed by the opponents of the scheme. Possibly South Shore and St. Anne's may not suffer immediately, as they are more or less exposed to the wave action of the tides, but Lytham's case is apparently more serious, and we shall watch with interest the fate of the present Bill.

Preston no doubt is entitled to consult her own special interest, but it must also be conceded that other authorities have an equal right to the natural action of the tides and waterway, and it may be possible to show that a course may be taken which will leave Southport in possession of the distant view of sea water which it has always enjoyed, with occasional inflows for temporary seaside boating, and yet allow Preston to improve the river and enable shipping of some importance to go to the large town now provided with docks.

TRACTION ENGINES ON ROADS.

On Thursday, the 7th inst., the first witness to give evidence before the Select Committee of the House of Commons was Mr. Cowan, M. Inst. C.E., county surveyor to County Down, Ireland. In this county there are 2500 miles of roads, of which about 400 miles may be classed as main roads. The cost of maintenance of these roads varies from £6 to £400 per mile per annum, according to the locality. The witness's experience of traction engine traffic was decidedly favourable to its more extended use across the channel, although the roads are chiefly poor. He gave an instance of an engine which had been running for two years, making two journeys per diem over the same road four miles in length without causing any damage. The road had previously been brought up to the required strength. The engine weighed 9¾ tons, and hauled loads varying between 6 and 15 tons, excluding the weight of the trucks. The latter were constructed with the rear axle longer by twice the width of the tires than the leading axle, so that the wheels broke gauge completely. It should be stated that the road is very hilly, one of the gradients having a rise of 1 in 12. The cost for maintenance per annum since this form of traffic has been in vogue has been at the rate of £64 per mile. Mr. Cowan said that they had no bye-laws for regulating traction engine traffic, and so far no complaints had been made, but considers that the imposition of a licence fee on these engines would be advantageous, while a plate giving the number of licence might be affixed on them. He saw no objection to an increase in the maximum limits of speed to three and five miles.

Mr. A. R. Binnie, M. Inst. C.E., chief engineer and surveyor to the County of London, was next examined, and stated that there were between thirty and forty traction engines licensed under this authority, and as far as he knew no damage was inflicted upon the roads by their use. The licence fee charged is £10 per annum, with a rebate of £5 if licensed in one other county, and £6 if licensed in two other counties. Questioned as to the imposition of a universal licence fee, Mr. Binnie thought the arrangement of rebates adopted by his County Council would answer the requirements equally well. He said the traffic of traction engines was restricted between the hours of 10 a.m. and 6 p.m., and that the following six bridges over the river Thames were not available for this heavy traffic:—Lambeth Bridge, Chelsea Bridge, Albert Bridge, Wandsworth Bridge, Westminster Bridge, and Hammersmith Bridge. Speaking of the pattern of wheels employed, the witness had no objection to the present legalised cross-barred type, but thought other patterns might be used at the discretion of the Local Government Board. The term "owner" used in the clause of the Act relating to extraordinary traffic ought to be more clearly defined so that all claims for damages would be more easily recovered.

On the resumption of their proceedings on Tuesday last, the first witness to give evidence before the Committee was Mr. Coddington, M. Inst. C.E., formerly surveyor to the Local Government Board. In the course of his examination, the witness informed the Committee that he saw no objection to raising the maximum limits of speed in towns and villages to three miles an hour, and on country roads to six miles an hour, except when passing up and down hills, when four miles would be a safe limit. Regarding the licence duties to be imposed on traction engines, Mr. Coddington considered that lighter types should be encouraged by the imposition of only a nominal fee. We understood the following scale to be that suggested:—Nine-ton engines, 10s. or 20s. per annum, but above this weight the rate to be increased by between £5 and £7 per ton, while the licensing authorities were also to be empowered to examine the engines before granting licences. The number of attendants to each engine should be kept as at present, but it should not be compulsory that one man should walk twenty yards in front of the engine. Mr. Coddington does not consider that the power to make bye-laws ought to be surrendered to a central authority, and would give power to road surveyors to obtain summary conviction of persons acting in contravention of the law with respect to the weights carried by trucks. Further, he thought it desirable that local bodies should be able to prohibit the use of traction engines on certain roads within their jurisdiction. This prohibition, however, was not to apply to agricultural engines. In case the owner of a traction engine wished to use such a road, he should give three months' notice of his purpose to do so, during which period the authority might consider the advisability or not of raising the standard to that of traction engines, any dispute to be settled by an appeal to the Local Government Board. The witness also considered the "extraordinary traffic" clause in its present form unworkable, and did not sufficiently protect the local authorities.

Mr. J. Cartwright, M. Inst. C.E., the surveyor for Bury, was the next witness called, and described the "exceptionally good roads" in his county borough. He stated that no licence fee was necessary for engines working in the district of Bury, but a deposit of £100 was demanded from the owner before his engine was allowed to traverse their roads. After the deposit is made a man is deputed to follow the engine, and take note of all damage done, the amount of which is deducted from the deposit before the latter is returned. This power would appear to have had the effect of almost preventing the use of traction engines in Bury, and it is to be hoped that with the anticipated legalising of wheels more suitable for sett-paved roads, the necessity for imposing such a severe restriction on the use of these engines will be obviated.

Mr. Aveling, of Messrs. Aveling and Porter, Rochester, said that with the improved differential speed gears which are now fitted by the best makers, the maximum limit of speed on country roads might safely be increased to six miles instead of four miles, while a speed of three miles an hour in towns would render traction engines less obstructive than the present limit of two miles prescribed by law. With regard to the power to make bye-laws, he considered this should be given up to a central authority, towns of 100,000 inhabitants only retaining the power to frame their own bye-laws. The witness also suggested that a £10 licence fee should enable the owner of an engine to travel in every part of the country, agricultural engines being exempted. By the term agricultural engine, Mr. Aveling was understood to mean one that was employed by a farmer for his own exclusive use. With regard to the much-discussed extraordinary traffic clause, he thought that this would be satisfactory to owners if amended in two directions, *i.e.*, the action for damages should be brought against the person who initiates the traffic complained of, and not against the owner of the engine, and such cases should be brought before the justices within a reasonable period of time. He would not recommend the granting of licences to drivers, and did not consider the inspection of engines by licensing authorities necessary, if it were made compulsory to insure them in some recognised society which periodically made a thorough inspection of the plant insured by them.

Captain Gaynor, of the Royal Engineers, Chatham, was the last witness called, and gave evidence of the great utility of traction engines to the military authorities, who effected an enormous saving by their use. He said they had eight traction engines in employment, and sometimes hauled as many as six trucks in one train. They had never been prosecuted for damage done to the roads, and did not take out licences for their engines.

It is anticipated that the hearing of evidence will be concluded at the next sitting of the Committee.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

PERMANENT WAY.

Sir,—From the letters which have appeared in this week's Engineer, I am afraid that the momentous question of the immediate prevention of accidents on railways, due to matters connected with the permanent way, is about to give place to the consideration of what kind of material shall be used, at some distant future, instead of at once treating for a radical change in more "practices" than the solitary one condemned by Major Marindin.

I am of opinion that plate-laying should be considered more a question of charge and responsibility of the engineer than the inspector of permanent way; and, that with the single change to the lighter steel chair, all else would be right for the present, except—as a poetical bishop once said of the island of Ceylon—only the man would be wrong.

It seems to be quite the thing now-a-days for someone to tell us how much better things are managed somewhere else. Would Mr. Fforde, or any other M. Inst. C.E., be surprised to hear that even had a train of loaded ballast wagons actually been standing in a siding near by, with the necessary labour always at hand, and plenty of opportunities offering to distribute it, that ballast would not have been made use of in time to prevent the Little Bytham accident. Yet it is true that had so much ballast been properly placed in contact with the sleepers, on any—even an "antiquated"—system, that catastrophe might never have happened.

One M. Inst. C.E., at least, does not know all the secrets pertaining to the art and mystery of plate-laying. When a road requires repairs the first thing to be done is to "open out," that is, remove all the ballast from the sleepers, in order that the navvy may better be able to get at the under side of it with his lever and his beater; and be it remembered that the ballast is never cast back until it shall be quite certain that it will not have to be "opened out" again. This can only be determined after trains have gone over it in its incomplete, and possibly dangerous, condition; that is to say, by direct experiment.

In minor repairs—those including a joint or two, more or less—this filling in may immediately follow the lift and one packing, especially where the ballast is ballast and the labour trustworthy. But in more important repairs this would not follow as a matter of course, and in relaying greater lengths still less likely to be done, for the sleepers would certainly have to be lifted again and again. It must not be forgotten again that the presence of an inconvenient quantity of ballast, or that amount which would prevent the beater getting well under the sleeper, is purposely avoided. This was the condition of affairs at Little Bytham, and the absence of an amount of ballast which would have steadied the road was not accidental, it was only the result of another reprehensible practice. This would be all right from a navvy, or ganger, or inspector point of view—in which unfortunately the pay-sheet plays no unimportant *rôle*—if all concerned only knew other than by "rule-of-thumb"—sometimes called "experience"—what ballast might be dispensed with, and how much was required to be present to prevent a passing train of known weight and velocity knocking the road altogether out of shape. The engineer of the line should know this; but then there exist absolutely no data for him or his subordinates to go upon.

Where are the tables which would show us what amount of lateral pressure is exerted, even on a straight road, by the ever-present oscillations of a train of 100 to 500 tons, extending over lengths up to 100 yards, at all speeds up to 100 miles per hour? What positive evidence is there either of the amount of pressure as centrifugal force on the outer rail of curves up to 80 or 100 chains radius, and what amount of opposition to such centrifugal tendency is offered by the *vis inertiæ* of the way itself, plus the friction which would obtain, of various small areas of the under side of the sleeper in contact with the ballast as the load passes over it. What is known of the centripetal, or compensating element, which in this way comes into play, and is absolutely necessary as a per-contra, in the account of safety *versus* danger?

No, Sir, nothing of this kind of information is come-at-able yet, and an altogether new field for investigation is presented; and unless some new method of plate-laying be devised, which will give back to the permanent way its old preponderating margin of safety, such an inquiry will inevitably be forced upon us. Continually increasing weights and higher velocities must be met by corresponding and adequate compensation, or——. I will leave the rest to your imagination.

I was fortunately not in the accident which happened some five years ago near Dijon—France—but I was on the spot by the next through train from Genoa; and I saw at once what was the matter—want of ballast. The official report exonerated the permanent way, because, forsooth, it had just undergone an extensive repair, and the gangs had only just left it. As in the matter of history, accidents repeat themselves also.

Just one word with reference to the machine depositor, spreader, and trimmer. I have very good reasons to object to it, wherever intelligent and decently paid hand labour can be obtained; as the work is then more likely to be well done—that is what is wanted—and, in consequence, the public be better served.

Lilford-road, S.E., May 11th. J. W. Wilkins.

Sir,—Is it not time that your various correspondents who advocate more or less sweeping changes in permanent way should ask themselves why it is that more than 90 per cent. of the rails in this country are carried in chairs on cross sleepers? It is quite certain that chairs are, in a sense, an after thought. The flat-footed, or Vignoles rail, was only given up after years of use. The chair seems to be a survival of the fittest, and before your readers can persuade me that it is not used because forty years' experience has proved it to be better than any of its rivals, they will have to explain on other grounds why it enjoys so extensive a popularity. Why, for example, did the Great Western give up the longitudinal sleeper? Why did the London, Chatham, and Dover give up the Vignoles system? Why did the Great Southern and Western of Ireland give up a 90 lb. ∩ rail on cross sleepers for a much lighter bull-headed chair road? I can understand the advocacy of a steel chair, but I cannot understand the advocacy of the flat-footed rail. Will any of your readers tell us what the relative cost per ton of different patterns of rail is? This is a point that they do not appear to consider at all. Old Ganger.

Preston, May 11th.

THE LIQUEFACTION OF GASES.

Sir,—I am duly grateful to "Zero" for his kind offer to instruct me out of his vast stores of learning. I am loth, however, to trespass on his condescension, for I feel his time would be more profitably spent in studying the proposition that heat cannot of itself pass from a cooler to a hotter body. After reflecting upon this he may see how absurd is the analogy he suggests between the reduction of temperature suffered by the hot gases in a boiler flue, and that undergone by the gas in Hampson's apparatus. In the case of the flue the gas is surrounded by a medium much cooler than itself, and naturally heat passes from it into that cooler medium. Hence the temperature progressively falls from one end of the tube to the other. But in Hampson's apparatus the gas in the tube is enclosed by a medium not cooler than itself. Why, then, should it part with its heat, or become cooler at one point of the tube than at another?

In his first letter "Zero" said we can "fancy a means by which the temperature of the air at one end of a tube will be 500 deg. Fah., and at the other zero." Of course the unrestrained imagination can fancy anything, but science deals with facts, not fancies. What we want to know is why the heat and cold obligingly stand apart in the Hampson machine in the picturesque manner described, until the cold at one end of the tube is so great as to induce a change of state in the gas. But it is just this point that "Zero" has slurred over in all his letters.

The conception of internal work, though a commonplace of the text-books, seems unfamiliar to "Zero," who states that "the energy in a gas is a function of its temperature, and of nothing else." That is not true of the actual gases we meet with in nature, as "Zero" will find by reference to recognised authorities. "Zero" says I have given no scrap of evidence that any energy escapes from within the apparatus to the external world. What I did say was that some energy disappears within the apparatus in doing internal molecular work on the gas itself, and that that disappearance is a fact proved by experiments, which experiments "Zero" shows a curious disinclination to face. The question of its reappearance I did not deal with.

"Zero" in his last letter says it is a simple matter of calculation how much the Joule effect can accomplish, and yet in his first letter he cast doubts upon its very existence, let alone the accurate determination of its amount. If he has found a way of getting exact results from inexact data, it would be worth knowing. But his statement that "Joule's effect" is too small to take account of is not warranted by facts. For air it amounts to slightly over ¼ deg. Cent. per atmosphere difference of pressure on the two sides of the orifice; hence working with about 100 atmospheres the reduction of temperature would be, say, 20 deg. Cent. That is at ordinary temperatures. "Zero" is apparently unaware that the Joule cooling effect increases rapidly as the temperature of the gas employed decreases, or, to put it more properly, as the temperature of the gas approaches the critical point. Therefore, the cooler does the gas in the coils become the greater is the proportional cooling produced. In this way the Joule effect is amply sufficient to account for the action of these "self-intensive refrigerating machines," the efficiency of which, as I said before, is ridiculously small.

If "Zero" does indulge in a mathematical disquisition, I hope he will express all his temperatures either in Fahrenheit or in Centigrade degrees, and not mix up the two scales together, as he has done in his letters. This precaution may make his results less sensational, but not less instructive.

Finally, I should like to pay a tribute to "Zero's" complaisance as an opponent. I ventured in my last letter to differ from his categorical assertion that the expanding gas in Hampson's machine does no external work, with the result that he promptly abandons his contention and cheerfully agrees that it does. Perhaps, now, he will abandon in the same graceful manner his position that the "Joule effect" has nothing to do with this method of liquefying gases. Cryos.

May 6th.

Sir,—In reply to your correspondent, I regret that I am unable to supply the information for which he asks. Indeed, I do not know that Dr. Hampson is in possession of it himself.

A tolerably complete statement has, however, been made concerning the Linde apparatus, and appeared in The Engineer for October 4th, 1895, page 325. I may add that the explanation of the theory given there appears to be Schröter's, and is not sound. The temperature reduction due to the Joule's effect is quite too small to permit the machine to have any commercial success whatever, if it depended on that for its action. Zero.

May 12th.

CIRCULATION IN WATER-TUBE BOILERS.

Sir,—I have to thank you for the note which you were kind enough to append to my letter in your issue of last week. Unfortunately I fail to distinguish which is the point which you appear to have conceded to me, and what it is which you regard as the "main fact." It is important that we should not confuse the issue.

I regard as the main facts that in every case the cause of circulation is the superior pressure of the downcomers due to the greater mean density of their contents, and that the entraining action of the bubbles in the water in the up-tube cannot lift the whole contents, water and steam, as they are lifted bodily, for this would be a violation of the principles of action and reaction, which declares that no material action between parts of a body can move that body as a whole.

Possibly it is on the question of the existence or otherwise of "entraining action" that you imply that we differ. Here I think we are entirely agreed, for although you said in your article of April 3rd "Professor Lambert will have none of it," and now again imply that I do not admit the existence of entraining action, for you say that if I am right a ship has no following wake and a boiler no priming, yet I submit that nothing I have said or written should bear this construction. Certainly entraining action exists. I have gone so far as to explain it by calling it "frictional drag," but I cannot admit that it is the cause of circulation. A ship in motion always has a following wake, and bubbles rising through water have a following wake also, due to their entraining action on the water; but it is not this entraining action which makes the whole mass of bubbles and water ascend bodily in an up-tube of a boiler.

A sailing ship running before the wind has an entraining action, causing a following wake, but this is not the cause of the motion of the ship and water. The real cause is an outside force, viz., the wind pressure, and all motion and entraining action soon cease when this outside force is withdrawn. I venture to submit these observations in response to your kind suggestion that I should write you again on the subject. Carlton J. Lambert.

Royal Naval College, Greenwich,
May 5th.

CANALS.

Sir,—I was much interested by your account of the Thames and Severn Canal in your issue of this week. The people of this country are now feeling the results of the foolish policy of abandoning the canals as soon as railway competition set in.

At one time there was a water communication from Portsmouth to London, *viâ* the Portsmouth and Arun Canal, the river Arun, and the Wey Navigation. The first-named canal was bought up by the London, Brighton, and South Coast Railway, and as it ran parallel to the railway it is scarcely necessary to add that it is now closed. All but a small portion near Chichester is filled in, and little more than a year ago the engine-house for the pump that supplied the canal with water from the Arun was pulled down. This canal joined the Arun about four miles below Arundel. The connection with the Wey Navigation was made by a lock near Pulborough. The river section is still used to a small extent by barges, but the navigation, as such, is so completely abandoned that the landowners have been permitted to obstruct the towing path with stiles, fences, and, in some cases, even hedges.

May 11th. Geo. T. Pardoe.

LOCOMOTIVE FIRE-BOXES.

Sir,—In reading your article on "The Fire-boxes of Locomotive Engines" in last week's Engineer, it recalled to mind a sketch of arrangement of roof stays you illustrated for me in The Engineer of December 5th, 1879, page 414, which, if you will look up, I think will meet your view of the case. The flat-topped fire-box casing with through stays will not do for traction or portable work, where the engine is bolted to the boiler. The stays are in the road of everything, and I cannot see any advantage in the plan for locomotives. Joseph J. Tyrrell.

Stamp End Works, Lincoln, May 11th.

SAFETY IN COLLIERY WINDING.

In connection with recent over-winding accidents at collieries, the following abstract of a paper read by Mr. C. M. Percy, the well-known Lancashire mining engineer, before the members of the Manchester Geological Society, at a special meeting held in the Wigan Mining School, on Friday, will be of interest. Whilst unfortunately, he said, many causes of mine accidents were beyond their control, accidents with colliery winding appliances were capable, with means already at their disposal, of being made well-nigh impossible. What they required was a thoroughly good equipment, and the fundamental essential was an efficient pair of winding engines, which were not liable to get out of order, and amply sufficient to deal with the load. They should be capable of the easiest possible manipulation, and the load must be made uniform throughout the operation of winding, whilst the brake-power should be sufficient to hold the engines to any position. To have a pair of engines was, he thought, sufficient power, and then, even allowing one-third for overcoming frictional and general resistances, they should calculate upon the possibility of only one engine being available. The arrangement of conductors in the shaft was also important for safe winding, especially where two cages worked in the same shaft, and collision had to be guarded against. The general preference was for wire conductors, as they were less likely to become disorganised, and allowed freer winding, besides being altogether more convenient in a pit shaft. Good winding ropes were of course an absolute necessity; the material for the wire had now a strength up to 140 tons per square inch, and the high qualities should always be used. Even with the above precautions, accidents might take place; over-winding might occur, owing to the cage being drawn too high, either by not being stopped in time, or started the wrong way. To prevent this detaching hooks had long been in use, but the prejudice against them had not entirely passed away. It was argued that they made winding enginemen careless, but the contrary was the case. Where they were not applied an over-wind might take place, but unless something broke nothing was said about it; where, however, the hooks were applied, every over-wind made its own record. Accidents were possible, however, even with the most efficient detaching hooks, and Mr. Percy described an appliance in use at many of the Wigan Coal and Iron Company's collieries which had been very effective in the prevention of accidents. Under ordinary conditions this arrangement interfered in no way with the winding engineman and his work, but only acted when the dominions of safety were invaded. An essential part of the mechanism was a governor arrangement worked from the winding engines, which determined the speed at which the cage would be allowed to pass a given point. If the predetermined speed was exceeded, a catch was automatically liberated, and falling weights applied the brake and shut off the steam. The limit of speed was a determinable quantity, and the point of action could be fixed at will. In the discussion which followed several colliery managers referred to the arrangement described by Mr. Percy having prevented what might otherwise have been serious accidents, although there had been cases where even this arrangement had not prevented over-winding, and Mr. Percy remarked that it was necessary they should use the ordinary detaching hooks as well as the arrangement he had referred to.

CATALOGUES.

Diamond Machine Company, Providence, R.I., United States. Grinding and Polishing Machinery.—This is a catalogue of special lathes and lathe appliances, many of which are of novel design and quick action. Emery wheel machinery of various kinds, including planing and shaping machines in which the work is done by emery wheels.

The London Emery Works Company.—In our notice of the catalogue of this company last week, it was mentioned that the otherwise exellent catalogue had not the name on the back. This was so with the early copy we had; but we find that the name is on the back of every copy now sent out. The name and trade mark of the emery and glass paper sent out by the same company is the Atlas brand.

Campbell Gas Engine Company, Limited, Halifax, England.—This illustrates the Campbell oil engines in their various types, the oil engine being shown as applied to marine, portable, and fixed engine purposes. The gas engines illustrated are from 30-brake horse-power downwards, the fixed engines including a very handy little vertical engine of several sizes down to 1½-brake horse-power, useful for many purposes.

Smith and Grace, Thrapston. — Pulleys, Shaftings, Bearings, and all accessories for the transmission of power.—Since Messrs. Smith and Grace began to devote special attention to shafting and mill requirements, they have introduced numerous improvements in pulleys, couplings, collars, and self-oiling loose pulleys and bearings. Their designs are not slavish copies of old patterns, but represent the best practice in this branch of engineering manufacture.

Barry, Henry, and Co., Aberdeen. Price Lists of Conveyors and Elevators.—The economical advantages of the conveyance of materials by mechanical means, such as the steel tray conveyors, the elevators, and the spiral conveyors illustrated in this catalogue, has added experience to that which until only a few years ago guided manufacturers of this class of machinery; and it is now possible, as shown by this catalogue, to obtain machinery of this kind for any purpose.

P. R. Jackson and Co., Limited, Salford Rolling Mills, Manchester. Two vols.—This catalogue is in two sections, the first one relating to the numerous forms of toothed gearing, pulleys, worm wheels, fly-wheels, worms, and other steel and iron castings, and the various forms of manholes, stop valve columns, and other steel boiler blocks, of which the firm have made a speciality. The second section deals more particularly with the pistons and piston rings manufactured by the firm in a great variety of sizes. It also mentions the removable field magnet dynamos made by this firm.

Easton, Anderson, and Goolden, Limited, London and Erith.—The specialities recently, or within the last few years, taken up by Messrs. Easton, Anderson, and Goolden, Limited, are clearly described and well illustrated in this catalogue by excellent engravings. The applications of the dynamo and electric motor are numerous, not only in mining machinery, but also in lifting machinery hitherto operated by steam engines or by fly ropes. The catalogue also describes and illustrates the pulverising machinery now manufactured at Erith, and the pumping machinery of various kinds, water supply machinery, and lifts, for which the firm has long been so well known.

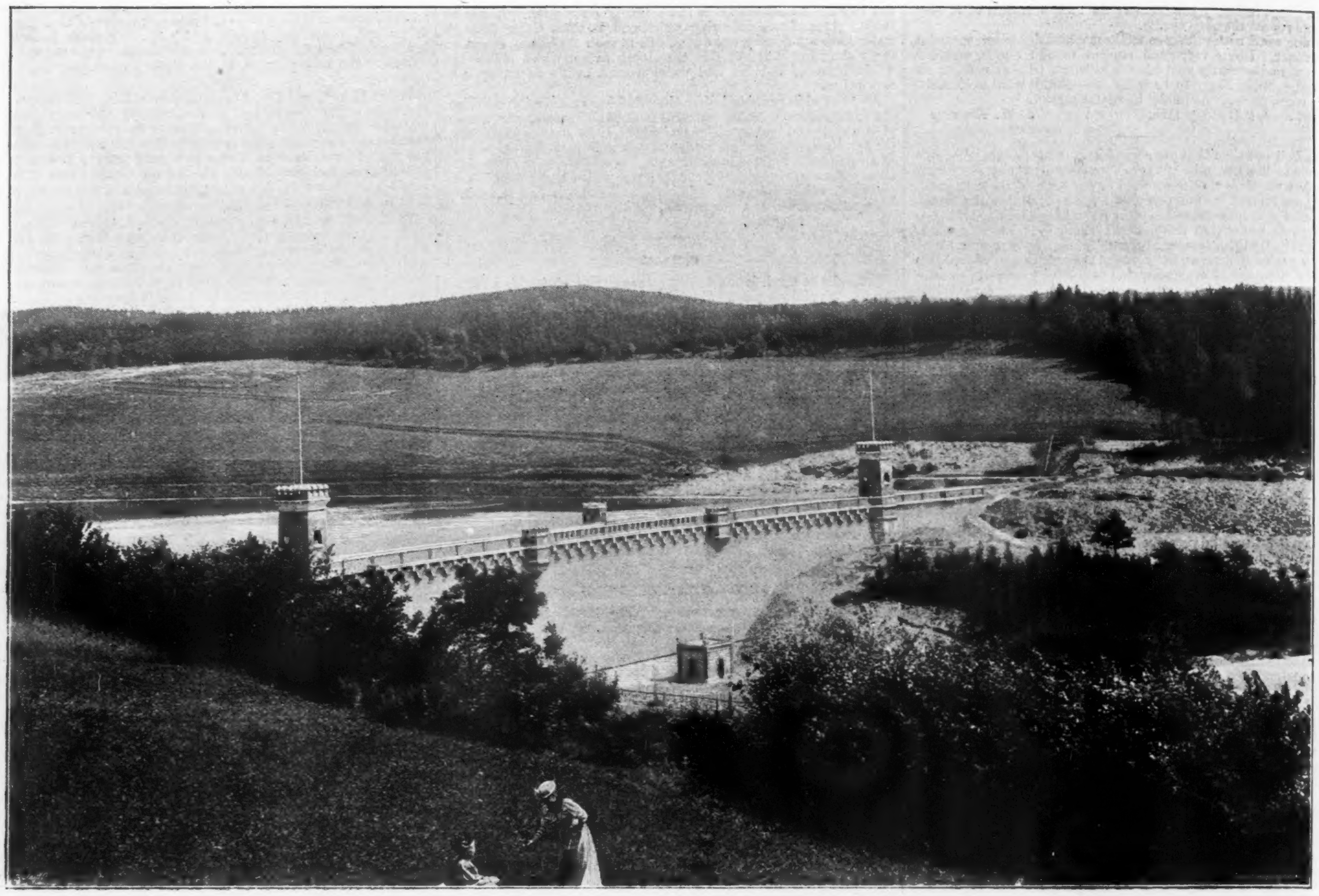
Rose, Downs, and Thompson, Limited, Old Foundry, Hull. Tenth edition.—In this edition of their now well-known catalogue of oil presses, oil kettles, edge runners, and other machinery for treating all kinds of oil-bearing nuts and seeds, Messrs Rose, Downs, and Thompson have included several new machines, chiefly of the smaller sizes, to work by hand-power, similar to those made for export, and working on a combination of the Anglo-American and Box systems. They also show a newly-introduced mill on the Anglo-American system for the treatment of those seeds and nuts which require a second pressing. Other machinery includes plant for fish manure and drying purposes and for the treatment of oils and fats by the fullers earth process.

The Metric System.—The Bill introduced into Congress making the metric system compulsory in this country after January 1st, 1901, has been sent back to the House committee, and the probability of its being adopted in this session is very slim. It will be a good thing if it does not pass in its present form. We believe that the ultimate adoption of the metric system is this country is certain, but to make it compulsory and at such an early date is unwise and would work a hardship to many. Manufacturers who have considerable foreign business would probably reap sufficient benefit from it to off-set the expense to them of the change, but there are many others who have no resulting advantages to look forward to, and these parties deserve more consideration than the Bill mentioned gives them. If it is conceded that the adoption of the system will some time be an accomplished fact, then it is clear that the earlier the change is undertaken the less expensive it will be. The change should not be attempted without plenty of preparation, however, as without it the cost would be excessive and needlessly great. Such legislation as is desired in aid of this movement should be framed on more practical lines than the Bill mentioned. The large manufacturers, if assured that only reasonable legislation was contemplated, would doubtless be able to suggest the lines on which a satisfactory law could be framed. They have a right to be heard in this matter, for upon them will come the great burden of a change. Expensive scales, templates, jigs, drawings, taps, dies, &c., would have to be changed, and this is one of the objections to a sudden and compulsory adoption of the system. But drawings become obsolete, and templates and special tools wear out, and if a reasonable period is allowed in which to effect the change, the manufacturing and engineering industries could doubtless provide a way for reducing to a minimum the confusion and expense incident thereto. —*American Engineer and Car Builder*

Institution of Junior Engineers.—At the meeting of this Institution, held at the Westminster Palace Hotel on Friday, 8th May, the chairman, Mr. H. J. Young, presiding, a paper, "Notes on Belgian Electrical Engineering Practice," was read by Mr. A. Anstruther-Thomson and Mr. G. C. A. Allingham, members. The communications embodied particulars which had been collected by the authors during the Institution's summer meeting of last year. Belgian electrical practice was difficult to define exactly. It was usual to associate English practice with high-speed engines, direct coupled to dynamos or alternators, and continental with slow-speed engines driving multi-polar dynamos; no rigid distinction existed, however. Belgian practice seemed strongly influenced by both the foregoing characteristics, and was therefore extremely interesting as showing a variety of types, and affording exceptional opportunities for comparison. In contrasting English with foreign practice, the advantages of employing a consulting engineer over the foreign plan of giving the contract for the complete plant to some large firm, were indicated. The system of free publication of central station accounts to which in this country we were accustomed, was not adopted in Belgium. Originally high-speed dynamos were driven from slow-speed engines by belts; to secure the advantages of direct-coupling in England the engine speed was increased, whilst on the Continent the dynamo speed was diminished. After briefly touching on the term "load factor," and its influence on central station practice, the preference shown on the Continent for continuous current and large batteries was pointed out. Descriptions were given of some Belgian central stations, the Van Rysselberghe system at Antwerp, and the application of gas engines in sub-stations at Brussels being specially mentioned. The different types of plant in use in Belgium and England were then dealt with, including boilers, engines, steam turbines, dynamos, and batteries. With regard to electricity for power purposes, there were no long distance transmissions in Belgium, and hardly any multiphase plant, but the use of electromotors in workshops was steadily increasing. Several instances were given, notably the important installation at the Herstal Small Arms Factory. In reviewing the question of electric traction, after referring to the Belgian experiments on accumulator cars, the trolley system, in which American designs are naturally largely employed, was considered, and descriptions of two Belgian electric tramways were given. General conclusions appeared to show that in electrical practice Belgium occupied a position intermediate between England and the Continent. The authors expressed their appreciation of the excursion to Belgium, and the hope that the Institution would organise other meetings abroad; to their Belgian hosts their hearty thanks were due for the exceedingly kind reception which had been extended. In the discussion which ensued the following members took part:—Messrs. H. B. Vorley, W. B. Clarke, F. M. Short, A. H. Dykes, Assoc. I.E.E., T. E. Dowse, and K. E. Gaumbe.

THE REMSCHEID AND CHEMNITZ WATER WORKS

(*For description see page* 498)



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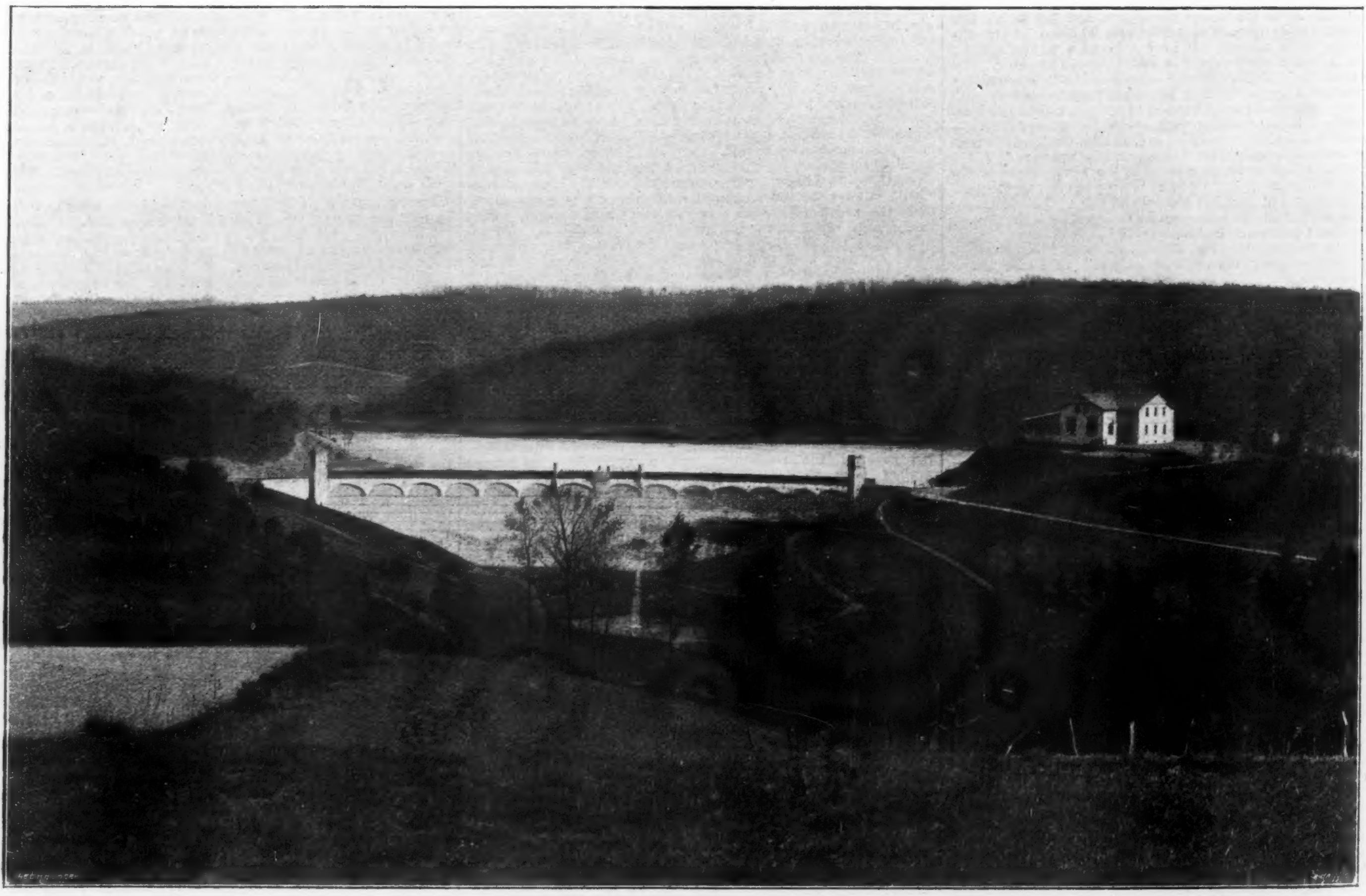

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⁂ *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

CROSSINGS AND CURVES.

(*To the Editor of The Engineer.*)

Sir,—Will you or any reader of this journal oblige a student with the formulæ for calculating mathematically the distances between intersections of crossings, &c., for setting-out permanent way fittings correctly, or give the name of a good treatise on the subject. Student.

May 11th.

[Presumably, as you do not state otherwise, you "take off" from the "straight" and not from a curve. You must have for data the radius of the curve and the gauge of the track. Put the former = R, the latter = g, the angle of crossing = θ, and D = distance from springing of curve to intersection of the crossing. If the difference between R and $g = d$ we obtain

$$D = \sqrt{(R + d)} \times g.$$

For the angle of crossing $\operatorname{cosect} \theta = \frac{R}{L}.$

If instead of R being given θ is known, the value of R will be

$$R = \frac{g}{1 - \cos \theta}.$$

Practical platelayers allow a little margin over and above the calculated length of D, according to the degree of the curve.—Ed. E.]

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of The Engineer.

MEETINGS NEXT WEEK.

Royal Meteorological Society.—Wednesday, 20th inst. at 7.30 p.m. Paper: "The Exposure of Anemometers," by Richard H. Curtis, F.R. Met. Soc.

The Institution of Civil Engineers.—Tuesday, May 19th, at 8 p.m. Papers submitted for discussion: "The Magnetic Testing of Iron and Steel," by Professor J. A. Ewing, M.A., F.R.S., M. Inst. C.E. "Magnetic Data of Iron and Steel," by Mr. Horace F. Parshall, Assoc. M. Inst. C.E.

Royal Institution of Great Britain.—Tuesday, May 19th, at 3 p.m. Lectures: "Ripples in Air and on Water," by Mr. C. Vernon Boys, F.R.S., A.R.S.M., M.R.I. Thursday, May 21st.—"The Art of Working Metals in Japan," by Mr. W. Gowland, F.C.S., F.S.A. Friday, May 22nd, at 9 p.m. Discourse: "Hysteresis," by Professor J. A. Ewing, M.A., F.R.S.

Society of Arts.—Monday, May 18th, at 8 p.m. Cantor Lectures: "Applied Electro Chemistry," by Mr. James Swinburne. Tuesday, May 19th, at 8 p.m. Paper: "Bronze Casting in Europe," by Mr. George Simonds." Wednesday, May 20th, at 8 p.m. Paper: "Orthochromatic Photography," by Captain W. de W. Abney, C.B., F.R.S.

The Institution of Mining and Metallurgy, London.—Wednesday, May 20th, at 8 p.m. Papers to be read: "Estimating and Sampling Ore Reserves, as practised on the Witwatersrand, South Africa," by Mr. Wilfrid Wybergh, Associate. "Notes on the Treatment of Zinc-box Precipitate—'Slimes'—from the Cyanide Process, as practised at the Standard Consolidated Mines, Bodie, California," by Mr. R. G. Brown, Member. "Note on a Safety Hook used in California and other deep mines of Colorado," by Mr. J. H. Collins, Past-president.

THE ENGINEER.

MAY 15, 1896.

ENGINEERS OR ARTIFICERS?

In a recent impression we considered the position of the engineer branch of the Naval Reserve, and we pointed out that our war needs could not be satisfied even if every engineer in the Reserve could be sent to sea in a ship of war. It will be remembered that Mr. Durston, writing to the Institute of Marine Engineers, maintained that The Engineer was in error as regards the supply of engineers available for service; and we suggested that the Admiralty did not contemplate the necessity—or shall we say the possibility?—of fitting out all our available warships at once. It was beyond all question that the statements which we made in our impression for 8th March, 1895, were absolutely correct, based as they were on official statistics. Taking our fleet ship by ship, but excluding harbour ships, and those which would in all probability be unfit for service, it appeared that there were not enough engineers by some hundreds to supply them. The reply of the Admiralty might be that inasmuch as all the ships could not go to sea, it was unnecessary to provide crews for all. The other alternative is that in an emergency the Admiralty would utilise engine-room artificers as engineers. On these points we possessed no positive information. But at the dinner of the Royal Naval Reserve, Mr. Goschen was a guest, and he made a speech which supplies some information bearing on this point. Further back, however, he said in Parliament that at the present moment every ship which could reasonably be sent to sea could be manned without difficulty, explaining, that such a proceeding would involve a draft of some 5000 men from the Naval Reserve. He even went further, and said, "If we were to send every possible ship to sea which is seaworthy, excluding harbour ships, we could man the whole of them, though it is impossible to suppose they could all be ready at once, by taking a draft of 11,000 from the Naval Reserve." It is clear from this that he relies on the Naval Reserve to supply engineers as well as stokers and bluejackets. But it is certain that even with the aid of the Reserve there would not be engineers enough. Mr. Goschen doubtless knows this just as well as we do, and it seems therefore tolerably evident that but one way lies out of the difficulty; he must rely on artificers to discharge the functions of engineers.

Now we do not say that the artificers are not quite competent to do what is wanted; neither do we assert that the artificer is just as good as the engineer for all practical purposes. It is quite unnecessary that we should express here and now any opinion on the matter. We are dealing with the policy of the Admiralty, not with the relative merits or demerits of two classes of men. The Admiralty insist on maintaining a standard of education for naval engineers which is exceptionally high. So much is expected, and the training is so long and laborious, that young men will not enter the Navy as engineers in sufficient numbers, the pay and position representing an inadequate return for the education. In other words, a man competent to pass the Admiralty examination and fulfil the Admiralty conditions can do better than become a naval engineer, the very excellence of his education and training rendering his social position as one the more irksome. But the Admiralty maintain that the high education is essential. How is it, then, that they are prepared to hand over the engine-rooms of our warships to artificers who have not had this training or anything like it, and that, too, in time of war, when all the resources of a scientific training are most likely to be needed? There is, moreover, an aspect of the case which seems to have hitherto escaped everyone who has written or spoken about it. Is it likely that the artificer will be able to exercise sufficient control in the stokeholds should an action be fought, or any unusual efforts be required? Englishmen make, no doubt, the best fighting material in the world, but they require to be led, and the demands which will be made on the nerve of the engineer in time of peril will be excessive, and unless he has absolute control below, and is feared and respected by the firemen, the results of an action may be anything rather than what they ought to be. It is known that in the American war firemen have more than once been kept to their work at the point of the revolver. We believe that an English crew of firemen will do all that men can do, but they will only do it if they are properly led and controlled, and that can only be done by an officer invested with adequate authority. That an artificer cannot possess unless he is given rank as an engineer. If the Admiralty contemplate this, then does their policy appear more than ever anomalous. "It will be seen," says Mr. L. Cathcart, in *Cassier's Magazine*, writing on the rank of engineers in the United States Navy, "that viewed from any standpoint, either directly or by comparison, the duties of the naval engineer officer are essentially combatant and military. To class him as a member of the civil branch is a mistake. Civil officers take no part in military operations, and are not called upon by the nation to risk life in its cause. Justice to him requires that he be given positive military rank in due recognition of his service; and wisdom imperatively requires it in view of the relatively large force of men which he must organise, instruct, and direct in peace, and which in battle, amid grave dangers and sudden emergencies, he must control in the performance of functions vital to the ship."

But this is not all; Mr. Goschen assumes that the staff available at the moment for our ships of war will continue to suffice in war time. There cannot be a greater mistake. It is a matter of common knowledge that even during the naval manœuvres, whenever a ship is driven, drafts have to be made from the deck hands to assist in the fire rooms. Even if this were not so at the beginning of a cruise involving some fighting, what would the position be toward the end? When we hear of important vessels going to sea with one engineer and one assistant-engineer, we wonder what is to happen if one is wounded, and the other fell ill. Is it to be assumed that the engineer of a ship will enjoy an immunity to which any other man in the ship is a stranger? We believe, on the contrary, that in any war the expenditure of engineers will undoubtedly be very heavy, and for this expenditure the Admiralty make, and have made, no provision whatever. It is argued that it would be useless to have more engineers, because there is not a sufficient number of ships available for their training. If it could be shown that the ships in commission are already overmanned in the engine-room department, there might be some reason in this contention; but nothing can be further from the truth. The position as it stands is this: The Admiralty hold that naval engineers must have a very admirable and complete scientific and practical training. They admit that there is not a sufficient number of engineers available to supply all our ships. They hold that all our ships will never be wanted or available at once. Even so they admit that they have not engineers enough, and will draw what they want from the Naval Reserve. But the Naval Reserve cannot supply a sufficient number, and therefore as a final resource they rely on engine-room artificers. Such a policy only needs to be stated to secure its condemnation. It is based on a complete misconception of what would occur in war time, and it is only possible because the engineer is not adequately represented at the Board of Admiralty.

CIRCULATION IN WATER-TUBE BOILERS.

It will be seen from Professor Lambert's letter, which will be found in another page, that the points of difference between his theory of circulation in water-tube boilers and ours are at least few in number. We stated that as for the theory of training action he would have none of it. To this he takes exception. Yet our words are strictly true as far as circulation in a water-tube boiler is concerned. He believes in the entraining action of bubbles; but says that the action does not cause circulation. For the purpose in hand this seems to us to be a distinction without a difference; the main question remains as it was. "In every case," says Professor Lambert, "the cause of circulation is the superior pressure in the downcomers due to the greater mean density of their contents." Here we join issue. We state definitely that the mean density of the water in the downcomers is the same as the mean density of the water in the riser, and that so long as this is the case no circulation can be brought about in the way Professor Lambert suggests. It is true that the contents of the riser weigh, other things being equal, less than the contents of the downcomer. It remains for Professor Lambert to show how, under the circumstances, there can be a greater "pressure"—the word is his own—at the base of the downcomer than there is at the base of the riser. Such an effect could ensue only if the mean density of not the whole contents, but of the *liquid* in the riser was less than that of the liquid in the downcomer. But it is clear that the presence of bubbles of steam in the water can have no effect on the mean density of that water. We have already said that so long as a continuous thread of water extends from top to bottom of the riser, so long will the pressure at the base or junction of the two tubes remain the same for both tubes. Professor Lambert in a previous letter maintained that while what we stated was true of water at rest, it was not true of water in motion. For the soundness of this statement, we really fear that we must ask some proof. In short, for a definite explanation of what the term "mean density" is intended to convey.

Professor Lambert has not, we think, mastered the facts. Let us consider what actually takes place. Let us take first the case of a single glass tube—a test tube—and heat water in it; the depth of water is, say, 6in. A bubble of steam is formed suddenly, or at least rapidly. The immediate effect is to raise the level of the water in the tube by an amount precisely proportionate to the volume of the bubble. The effect is the same as if a cork was forced down under the surface, or more water was poured in at the top. The bubble rises to the surface and escapes, and the water level falls. Why did the bubble rise? Simply because an equal bulk of water fell. The velocity with which the bubble rose could not have been greater than that at which the water fell under the action of gravity. It must, however, be much less because the water, even if at rest, would offer some resistance to the upward movement of the bubble through it. If the bubble was nearly equal in diameter to that of the tube, then the space between its sides and the inner surface of the tube would be so contracted that the rise of the bubble would be very slow. This can be well illustrated by blowing air into the bottom of a small bore tube containing water. Now the rise of a bubble, or bubbles, is one thing, and circulation is quite another. Indeed, a continuous rise of bubbles in a tube may take place without the change of place of any very considerable quantity of water. Going back now to the consideration of the phenomena in a single tube, it is obvious that if the tube were full to the top of "solid" water to begin, the moment a bubble was formed the water would overflow, and when the bubble had risen to the surface and escaped the water would fall back to a lower level. This is an important fact, and must not be overlooked. Seeing that the rise of a bubble represents the fall of an equal volume of water somewhere, let us next suppose that instead of having a contracted single tube with which to work, we have a large open vessel such as a saucepan. In that the bubble will rise through the line of least resistance, and the water will fall through the line of least resistance, and the last will be usually found somewhere near one side of the saucepan. If Professor Lambert will boil very slowly in a glass beaker water containing a few grains of oatmeal or sawdust, he will have before his eyes the picture we wish to draw. If now, instead of having a wide vessel, we use two tubes connected at the bottom, and some distance apart, we can regard their contents as a section, so to speak, cut out of the great body of water in the saucepan, and we have in a word the old familiar U tube. When a bubble of steam is produced near the bottom in the rising leg, the first effect is to raise the level in both legs; but as the load over the bubble is least in the rising leg, the effect will be to make the level in it rise much more than the level in the downcomer for the moment. In a word, water is ejected from the riser in the way we have described, but this is immediately replaced by the descent of the water in the downcomer and a general levelling of the water in the tank or reservoir uniting the two legs of the U tube. If the experiment is properly carried out, coloured water being put into the downcomer and clear water into the riser, it will be seen that the formation and rise of each bubble in the riser will be followed by a transfer of coloured water from the downcomer until the whole is mixed. Heat is best applied by a spirit lamp with a small flame. If the experiment is carried out with two large vertical tubes united by a small horizontal tube, no transfer will take place, the water descending along the sides of the riser, that course offering the least resistance. As the heating goes on and ebullition proceeds, the formation and escape of the bubble becomes continuous, and the water will descend in the downcomer to push the bubbles up; simply because, in the first place, there is no reason why it should not so descend, and in the second place because, it is far easier for it to descend through a tube which is open full bore than it is for it to descend through a tube which is partially blocked by bubbles, round which it would have to squeeze. It is true that the entraining action takes place. The volume rising is represented not only by that of the bubble, but by that of the bubble and the water the bubble drags with it. It will be evident, we think, that circulation in this way is simply a question of the line of least resistance. The bubble rises not of its own volition, but because it is forced up from below. But the mere rising of the bubble in this way is not necessarily accompanied by anything like rapid or efficient circulation. It is often "a toss-up" whether water will descend the downcomer, or descend in the riser round the bubble. It will come down the downcomer only if the resistance to its descent therein is much less than its resistance to descent in the riser. Circulation brought about in this way is a very very feeble thing, as inventors of water-tube boilers know only too well. An admirable example of its feebleness was supplied by the little turning mills or propellers in Mr. Yarrow's experiments, which had to be hung with the utmost delicacy on fine pivots, in order to ensure their rotation.

But, it may be said, circulation is not a very feeble thing in the tremendous rush of water, for example, up the tubes of a Paxman boiler, the top mouths of which had to be fitted with deflectors to prevent the water being dashed against the top of the steam space; see also the rush in Yarrow and Thornycroft boilers. The inconsistency is one of appearance, not of fact. The conditions obtaining are profoundly modified, as will be seen in a moment. When ebullition becomes violent, the water is ejected from the top foot or two of the tube. The steam bubbles fill the whole cross section. There is no longer even a continuous thread of water extending down the riser, and we have a virtual difference of head in the two legs of perhaps two or three feet. Now, a difference in head of even a single foot would give a velocity of 8ft. per second, and a difference of 3ft. would give a velocity of nearly 14ft. per second, or 840ft. per minute; so that even when we have made a considerable allowance for friction, a highly efficient circulation remains. And thus it came to pass that in Mr. Yarrow's experiments, the flyers which turned so dubiously in the downcomers when the rate of boiling was slow, spun round fast enough when the fire was urged, the glass tubes of the risers the while showing that they contained much more steam than water.

We trust that we have now made our meaning quite clear to Professor Lambert. It is our misfortune more than our fault that we have failed to understand him. We believe that the views we hold are identical with those of Professor Watkinson. Everything turns on what Professor Lambert intends to convey by the words mean density. If he could show that the steam was mixed up with the water so as to diminish the hydraulic head, he would be right. The mean density of a mixture of alcohol and water is less than that of water alone, but no mixture of steam and water can have a less mean density in the same sense. To put the matter conversely, are we to assume that a mixture of fine sand and water would exert a greater pressure per square inch than a similar column of water without the sand, because the sand happens to be much heavier than the water?

MAJOR WILSON'S REPORT ON THE CEYLON RAILWAY SYSTEM.

Closely adjacent as the island of Ceylon lies to India, it would not seem as if the management of its railways has been kept as fully up to date as it has been in that continent. From time to time, and especially of late years, complaint has been made both as to restriction of facilities afforded and as to the cost of working. This reached its highest point when it became known that eight very powerful locomotives recently obtained had perforce remained unused because the bridges on several of the local lines were not of a strength to permit of their employment. It was alleged that the necessity for strengthening them had previously been made the subject of representation to the Government by the railway authorities, but that the required funds for doing this had been withheld. Working expenses had also been annually on the increase, and so strong were the remonstrances raised, that at length the Ceylon Government sought from that of India the services of an expert to report upon the whole position of the island system.

In response to the application made, Major Wilson, R.E., deputy manager of the North-Western Railway of India, was selected to visit Ceylon. The report written by that officer as the result of his inspection of the railways of the Colony lies before us. We fear this can only be viewed in the light of a grave indictment of the Government of Ceylon. On a previous occasion we have had to remark upon the shortcomings that had been allowed to prejudice the successful working of one important addition to the local system. This had been of a particularly costly character, it having been designed to meet the traffic requirements of many tea estates of high altitude. It seemed difficult to realise what we have been assured was the fact, that the stations on this extension, when opened for traffic, were without any roads by which they could be approached. Shortsightedness, of which this was but a single instance, would seem, from Major Wilson's report, to have characterised much of the dealing of the Ceylon Government with the railways of which it is the proprietor. Persistent refusal has been made to admit any private competition for the construction of railways in Ceylon. No doubt the revenue of that Colony has benefitted largely by profits made on these in the past; but progress with the development of the systems has been seriously retarded by the policy pursued, while the planters, who are the chief maintainers of the lines, complain that to produce these profits they are severely taxed by inordinately heavy rates of carriage. Major Wilson reports fully upon this allegation. From the statement furnished by him we gather that, approximately, the passenger fares in Ceylon are in proportion 5·12 and 3·84, as compared with 3 and 2·25 on Indian lines with which comparison may fairly be made. As to goods rates, the proportion would seem to be 1·76 and 1·20 in Ceylon, against ·66 to ·16 in India. There is, therefore, evidence that the outcry raised by the Ceylon planters has not been without warrant; and when we consult the comparative tables given as an appendix to the report, we find this conclusion strengthened by the statement that the average sum received in Ceylon for the carriage for one mile of one ton of goods has been 29·32 pies, against 5·24 pies on the East Indian Railway, and 5·27 pies on the Sind-Pishin section of the North-Western Railway of India. The last was selected by Major Wilson as having features much in common with those lines in Ceylon that are within its mountain zone.

We cannot attempt to follow the report through all its elaborate dealing with the many items of comparison made. It may, however, be quoted, as summarising that comparison, that the working expenses of the Ceylon lines amount to from 53·19 to 66·04 per cent. of gross earnings, as against 27·44 on the East Indian Railway. Under this heading the Sind-Pishin section above referred to does not come into comparison, it being a purely military line with very restricted traffic, and worked at a heavy loss to the Government. Major Wilson admits that the rates charged on the island railways, though heavy in comparison with those of Indian lines, are not excessive when the working expenses are taken into account. He contends, however, that these last should be capable of great reduction, and that much of the procedure involving them is out of date and uneconomical. The expert probably travelled beyond his commission when commenting, as he has done in his report, upon the routes adopted for the several Ceylon railways. The opinion he offers as to these is, in several instances, of a very adverse character; but it may well be doubted if the brief inspection of them he was able to make could render him competent to judge on points that had taxed to the utmost the ingenuity and professional knowledge of such engineers as Colonel Moorsom, Mr. W. T. Doyne, and Sir G. L. Molesworth. In other respects the report would seem to hold the balance between India and Ceylon with the utmost fairness.

It is natural, we suppose, that Colonel Wilson should incline towards a preference for Indian methods of administration and working, but at least he cites sufficient of chapter and verse to justify such a preference. After reading his report, the conclusion is forced upon us that the condition of things as regards the Ceylon railways is largely due to that island being considered a sort of "pocket borough" by the Colonial-office. The admission of outside light, of the experience that is daily extending, is denied to its railway administration. Highly successful as its lines have hitherto been in a financial sense, things relating to them seem to have got into a deeply worn rut or groove, needing external assistance for extrication. The sooner this is recognised by the Colonial-office the better must it be both for the working of such lines as have already been constructed, and for the much-needed further development of railway facilities throughout the island. This further development we learn to be urgently demanded; but to judge from the slow progress in the past, it is not likely of rapid attainment under the ultra-conservative policy pursued in Downing-street. Massive railways of 5ft. 6in. gauge, although perhaps well suited to the heavy traffic to and from the estates in the mountain zone, are not of the character that can ensure this rapidity. Mr. Chamberlain regards the Crown Colonies as being within the category of his "improvable estate." To develope this in the case of Ceylon evidently requires a complete change of the railway policy that has brought about the state of things therein existing as revealed by Major Wilson.

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THE ATMOSPHERE OF GREAT TOWNS.

A determined battle has been fought of late years for life under more cleanly conditions in the populous centres of the Midlands and the North. Manchester has been signally successful in smoke suppression, largely through vigorous enforcement of the law. There is no need for fresh legislation on the subject; the need is for compelling observance of that which exists. Now, Sheffield has taken up the work in earnest. A Smoke Abatement Association was formed some considerable time ago. Its object was chiefly educative and persuasive. It now seems as if a new departure was about to be undertaken. Nowhere had the doctrine of black smoke and good business being inseparable taken deeper root than in Sheffield. People had got it firmly into their heads that if they were to have brisk trade they must submit to the dusky billows of smoke which used to strike strangers passing through the city—the two stations being right in the region of the tall chimneys—with mingled awe and amazement that people could exist under such conditions. The Smoke Abatement Association set itself to prove that it was possible to do a great deal of work without being smothered with filth in the doing of it. One means employed was to have a series of competitions amongst engine tenters and firemen. The results of these competitions having been carefully ascertained, his worship the mayor—the Duke of Norfolk, G.M.—presented the prizes at a public meeting held in the Cutlers' Hall on Wednesday, when addresses on the subject were delivered by Professor Ripper, Sheffield Technical School; Mr. A. E. Fletcher, late her Majesty's Chief Inspector of Alkali Works; and Mr. Fred. Scott, the secretary of the Manchester Committee for Testing Smoke-preventing Appliances. The attendance included many engine tenters and firemen, as well as members of the general public. A feature of the gathering was the exhibition of models of smoke-preventing appliances, which were explained by persons familiar with their working. The committee of the association, however, lay great stress on the fact, which they have successfully demonstrated, that smoke-prevention does not require costly apparatus, but can be secured by the existing means at the manufacturers' command, given sufficient boiler power, careful stoking, and due regard to the construction of the furnaces. Having made it clear that smoke is not essential, the Abatement Association will proceed, in the event of the offence being persisted in, to compulsory means of enforcing the law, and where neglect is continued, compel that cleanliness to which it is held the general public are entitled, to say nothing of the workers who live in the neighbourhood. "You cannot afford to make smoke," has been urged upon employers for a long time. Some of them have paid heed to the warning and benefitted themselves and others thereby; the majority, however, are still making as much dirt as ever, and it is high time they were vigorously dealt with, that the reproach so long and justly hurled at Sheffield may be wiped away.

THE HYATT-HENOCHSBERG GOLD EXTRACTION PROCESS.

This process is a pneumatic amalgamation process, in which the finely pulverised dry ore, propelled by a current of air, through a restricted channel, encounters in its way sundry pools of mercury, and was to be seen on Wednesday, the 13th inst., at work at the office of Messrs. John H. Hackworth and Co., Queen Victoria-street. The apparatus consisted of 18ft. of 3in. piping, coiled into a four-coil spiral and mounted horizontally; one end of the spiral projected into a dust chamber, the other end served for the attachment to the air machine, in this instance a hand-power Root's blower. At the top of the first limb of the first coil the feed-hopper was fixed and communicated with the interior by a pipe continued some way down, and provided at the throat with a balanced swing valve that prevented escape of air, but yielded to any slight pressure from above. The lower ends of the spiral were detachable and had been charged with mercury before the arrival of the visitors, the quantity used being insufficient to entirely obstruct the passage. Material representing ore, and consisting of silver sand, to which coarse and moderately coarse gold had been added, in the presence of the visitors, was charged in the hopper, the blower was set to work slowly, and soon a cloud of dust would be seen issuing into the dust chamber. After some little time and the expenditure of much work on the blower, the sand had disappeared from the hopper, the blower was stopped, and the lower parts of the coils were detached severally, and examined separately; they contained clean, bright mercury and a not inconsiderable proportion of sand. The mercury was subsequently found to contain gold, as might be supposed, the bulk of it being in the first bend. The demonstration was conducted by Mr. Hyatt, the inventor, with the assistance of Mr. Hackworth, from whom we ascertained that the apparatus used was capable of dealing with five tons of ore in a day of ten hours, and would save from 80 per cent. to all of the gold; and that apparatus of any size and capacity could be constructed; such being the case, there would be a large and useful field open to this appliance wherever dry free milling ores are encountered. The inspection demonstrated clearly that the apparatus was of admirable simplicity, that it could be very easily worked, that a moderate current of air, stated to be about 1¼lb. per square inch, sufficed to carry away most of the sand, and that much if not all the gold remained; but owing, as is frequently the case on such occasions, to an absence of the necessary data, it is impossible to judge whether the work done had been effected at the rate of 6 cwt. or five tons in ten hours, whether or not all the gold had been saved, whether it was accompanied or not by a loss of mercury, and whether or not it could deal with different class material successfully. But anyway the apparatus is so simple, and can certainly not be very expensive, so that it should be well worth the while of mining men, requiring an appliance for treating dry free-milling gold ores, to bear this process in mind.

THE MARINE ENGINEERING LOCKOUT.

IN reference to the dispute in the Northern engineering trade, it would be in the highest degree regrettable if, at the present time, when shipbuilding is active and large orders are in hand, the current and anticipated prosperity should receive a check or be thrown away through an insane conflict between capital and labour. All must earnestly hope that an amicable settlement will be speedily effected, and we are glad to see that the gradual locking out of from 10,000 to 12,000 men on the Tyne, Wear, and Tees, will in most cases be postponed for a fortnight in order to give the men full time to consider their action and the position it would place them in, so that there is hope that the breach may yet be healed before the notices expire. This action is a significant comment on the speech of Mr. James Hall, at the Newcastle and Gateshead Chamber of Commerce, on the occasion of the recent annual meeting of that body, when—probably foreseeing the turn affairs were taking—he strongly urged how suicidal was the policy of strikes to both capital and labour. We notice also that the same line was taken in a paper read at the British Iron Trade Conference by Mr. W. Jacks, on "Continental Competition," in which he said:—"Since I have been connected with business I have never known a serious strike which had not disastrous results in the country, from the carpenters' strike, which drove shipbuilding from the Thames, down to the ill-starred Scotch coal strike of 1894." Strikes, he pointed out, alarmed capital and prevented its employment in home industries. Never in the history of the world was there such an amount of accumulated wealth seeking investment, but the holders prefer lending it at 2 or 3 per cent. on stable security, rather than invest it in industrial undertakings, on account of the insecurity of the latter. We hope that the men, looking back upon the disastrous losses inflicted upon both employed and employers by the conflict upon the Clyde and at Belfast, which must still be fresh in their remembrance, will meet the conciliatory spirit shown by the employers in an amicable manner, and avoid a dispute which they seem too ready to precipitate instead of making any possible effort to avert it.

SAFETY IN CAISSON WORK.

THE construction of bridges, where the foundations for pillars have to be laid under water, has always been accompanied with danger to the lives of workmen working in caissons. Investigations by Rameaux, and more especially by Paul Bert, have fully demonstrated why air compressed beyond a certain degree is always dangerous to animal organism. According to a recent report of the United States Consul-General at Vienna, Dr. Neudorfer, an Austrian authority, who has made a scientific study of the subject, suggests various methods for obviating this danger. There are two things that the workers in caissons have to guard against:—(1) The concentrated oxygen, which, at a pressure of five atmospheres, affects the nervous system injuriously, causing cramp, tetanus, oxidation, and the formation of carbonic acid gas. It has been proved, he says, by experiments on men and animals that when there is an increase of 20 per cent. in the amount of oxygen, the process of oxidation in the body is less rapid, less carbonic acid gas is formed, and the heat of the body is diminished. The first danger is the least serious, as the pneumatic pump causes a gradual compression of oxygen, to which the system gradually adapts itself, and in any case there are premonitory symptoms which make it possible to remove the workmen before the case becomes dangerous. Little inconvenience is caused until the pressure exceeds four atmospheres. (2) The concentration of nitrogen, which affects the blood instead of the nervous system. With the increase of pressure, the nitrogen becomes more and more concentrated, and the absorption of this gas by the blood increases proportionately, when a decrease in the atmospheric pressure occurs proportional to a smaller density of nitrogen, the gas escapes in fine bubbles, which pass through the veins and prevent the blood, by its expansion, from circulating in the capillary veins. This checks the flow of arterial blood and affects the spinal column and the brain. In experimenting with animals, death is caused instantaneously when a high-pressure is suddenly reduced. The best method for obviating this danger is to reduce the pressure slowly, so that the blood can get rid of the free nitrogen gradually. At the entrance to the caisson there should be a separate compartment filled with compressed air. When the workman desires to leave his work he should shut himself in this compartment, and gradually reduce the pressure by letting the compressed air escape. An hour and a-quarter should be spent in reducing the pressure of 3½ atmospheres, so that the rush may be as small as possible. The decrease of pressure is regulated according to the regulator of Denayrouze. In cases where, in spite of all precautions, a workman is affected, inhalations of pure oxygen are found to be the most simple and effective remedy. Dr. Neudorfer does not seem to be aware that caissons with air locks are constructed with this separate chamber, but an hour and a-quarter seems a long time for making the change from one pressure to the other. The whole statement is a good specimen of Austrian physiology, and will probably be contradicted in a month, as the manner of German physiologists is.

LITERATURE.

Torpedoes and Torpedo Vessels. By Lieut. G. E. ARMSTRONG, late R.N. London: George Bell and Sons. 1896. Price 5s.

THIS work constitutes one of a series of handbooks on matters connected with the Navy, which are being issued by Messrs. Bell and Sons, under the editorship of Commander Robinson, author of "The British Fleet." This volume seeks, in the words of the author, "to convey to the mind of the general reader an elementary knowledge of the most modern development of naval warfare, namely, the science of torpedoes." He remarks with truth that hitherto "all the books which have been written on the subject are of so detailed and technical a nature that the ordinary man in the street has been entirely precluded from learning its intricacies." Consequently, submarine warfare has always been invested with a certain amount of mystery which it is difficult to dispel. But in the opinion of the author there is no reason why the average Englishman should not be as versed in this subject as in any other branch of naval warfare. He considers such knowledge desirable, believing the next great naval war will bestow upon the torpedo and its users a halo of romance, which will eclipse entirely that surrounding the gun and the ram. Another point in favour of this contention is that the torpedo, as applied in the swift craft of to-day, is the weapon of the young officer desirous of mounting the highest pinnacle of fame by executing deeds which have their counterpart in the cutting-out expeditions of old. While recognising fully the desirability of the general public having a knowledge of torpedo warfare, and the methods by which it is carried out, we do not think it is possible to combine this with details of construction in such a small compass as this volume affords. An adequate description of the elaborate mechanism by which the Whitehead torpedo is manipulated, mechanism which has been developed and perfected during an experience of twenty years, would require for that portion of the subject alone a volume of twice the size. The ordinary individual does not require this, while such information is furnished to the expert by official manuals. In a handbook it would suffice to give a general description of the Whitehead, the system of propulsion, plan for keeping an uniform depth, and method of ignition on striking an object. In a chapter of twenty-three pages no more is possible, but the attempt to give minor details leads to principal features being dismissed in a few words. Perhaps the most notable advance in the Whitehead torpedo is that which first enabled it to pass from a speed of 10 knots an hour to 20 knots, by the adaptation of the three-cylinder engine of Mr. Brotherhood. Previous to this the torpedo could not be considered a practical weapon. Successive improvements in the propelling machinery, and other portions, have resulted in a speed for 600 yards of 30 knots. There can be no doubt that the present position of the Whitehead torpedo is as much due to the exertions of Mr. Brotherhood in perfecting the engines, as to the talented man after whom the torpedo is called. In this volume only twelve lines are devoted to the engines, and after an imperfect description we are told, "the great advantage of these three-cylinder engines is that there is no possibility of their being hung up through getting on a dead point!" In the chapter on the different methods of discharging torpedoes little is said as to the advantages and disadvantages of effecting this from above or below water. For a long time the simplicity of the arrangement by which a torpedo was ejected into the water from a port, and then sped on its way, led to all our early ironclads being so fitted. The only modification was when the increased speed of the submarine projectile, and its tendency to dive when dropped from a height, led to special orifices just above the water-line being made for above-water torpedo discharge. There were difficulties in shooting torpedoes from the broadside under water in ships of high speed. These have been overcome. But what changed the whole situation and position of Whitehead torpedoes both in ships and boats was the great development of quick-fire guns. The liability of the torpedo to be destroyed, its air chamber burst, and its large charge of gun-cotton exploded by the projectiles of quick-fire guns, when mounted behind unarmoured sides, led to increased attention being given to discharging the torpedo from below the water-line where it is protected. Most of the difficulties alluded to have been overcome, and now all large ships, even cruisers, are being fitted to use the Whitehead torpedo in this manner. This important part of the subject is not dealt with in this volume, and the ordinary reader will fail to grasp from it the leading principles upon which our ships are now equipped with a weapon which the author considers the "outcome of the highest mechanical ingenuity and perfection of construction."

In dealing with torpedo boats and catchers Lieut. Armstrong is more satisfactory, and this part will be read with most interest by those who desire to acquire information on this interesting subject. The development of the torpedo boat, from the craft 80ft. long to the present dimensions of 140ft., is clearly described. Our early unwillingness to add to the torpedo flotilla is deprecated, but not altogether attributed to the right cause. It was considered then that the torpedo boat was the arm of a nation which stood on the defensive at sea, and hence should not be largely represented in our fleet. What we should have done then is what we are doing now, procure larger and faster boats to act as catchers, which is the proper antidote to hostile craft of this description. Instead of this, we eventually took up the construction of the sea-keeping torpedo vessel, first in the Scout and then in the Rattlesnake class. Lieutenant Armstrong speaks in very disparaging terms of the latter type, and condemns the Admiralty for persisting in their construction. There is no doubt that the speed of some of these vessels has not come up to what was anticipated; but they are good sea boats, and habitable vessels. Though a much higher speed has been attained with the later catchers of the Hornet class, they will not stand much rough usage, and the breakdowns among them have been numerous. For narrow waters they would be of great service in hunting down hostile torpedo boats; but for ocean work, or even the Mediterranean, it is doubtful whether they fulfil the necessary conditions.

A lack in this volume is of any detailed account of what the torpedo has done, in those wars where it has been used. A short account is given, it is true, in the concluding chapter, of some torpedo attacks in the China-Japan War, and the vessels sunk at Wei-hei-wei; but no deductions are made, or any ideals imparted as to the future of the torpedo in naval warfare. Some good illustrations are given, and it is well brought out by the publishers. Though lacking in some respects, the volume will no doubt interest others besides "the man in the street."

SHORT NOTICES.

The Flashing Point of Petroleum. By Dr. Lobry de Bruyn, Amsterdam. Translated from the *Chemiker Zeitung.* 1896, No. 26.—The author of this pamphlet is the chemist to the Dutch Navy, and it originated in the discussion which followed on the wish expressed by the Congress of Fire Brigades that the flashing point of petroleum should be raised to 104 Fah. The pamphlet is one which is of very considerable interest just now, in view of the probable modification of our rules on this subject. The author comments severely on the present low test adopted for oil used in petroleum lamps, and supports the increase of the flashing point on the ground of the present danger and loss of life and property.

Petroleum Legislation: Its Necessity, its Failure, and the Remedy. Reprinted from the *Oil and Colourman's Journal*, April 1st, 1896.—This is a useful discussion of the main points to be considered with respect to the use of the petroleums now so generally employed, and so often with fatal results. It gives a statement of the standards of petroleum used all over the world, which shows that the test is a higher one in nearly every country than our own, and it condemns the Abel flash test as giving a lower standard of safety than was previously used or was intended.

Crossley's Otto Gas and Oil Engines as applied to Pumping at Public Works. Crossley Bros., Ltd., Engineers, Openshaw, Manchester. Manchester: George Falkner and Sons, The Deansgate Press.—This is not a catalogue, but a collection of extracts from numerous journals describing installations, supplemented by detailed information supplied by the firm, and profusely and admirably illustrated. The book cannot fail to be of use to any and every one interested in pumping either on a small or a large scale, whether for town or house supply, or for the disposal of sewage.

BOOKS RECEIVED.

The Naval Annual, 1896. Edited by T. A. Brassey. Portsmouth: J. Griffin and Co. London: Simpkin, Marshall, and Co. Limited.

The Old Light and the New. Dealing with the Chemistry of Colour and the New Photography. Illustrated. By Wm. Ackroyd, F.I.C. London: Chapman and Hall, Limited. Price 1s. 6d. net.

Thames Bridges, from the Tower to the Source. By James Dredge. Reproduced from *Engineering.* To be completed in seven parts. Part I., price 5s. London: Office of *Engineering.*

The Water Supply of the City of New York, 1658 to 1895. By Edward Wegmann, C.E., M. Am. Soc. C.E. First edition. First thousand. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1896. Price £2 2s. net.

Catalogue of the Hopkins Railway Library. By Frederick J. Teggart, B.A., Ass. Librarian. Palo Alto, California. Library of the Leland Stanford Junior University. 1895. Price 1·50 dols. bound, 1·25 dols. unbound.

Modern Stone-cutting and Masonry. With special reference to the making of working drawings. By John S. Siebert, C.E., and Frederic Child Biggin, B.S. First Edition. First thousand. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1896. Price 6s. 6d. net.

Shop Kinks and Machine Shop Chat. A series of over 500 practical paragraphs in familiar language, showing special ways of doing work better, more cheaply, and more rapidly than usual. By Robert Grimshaw, M.E., &c. With 222 illustrations. London: Sampson, Low, Marston, and Co. 1896.

The United States Public Works. Containing a Summary of the Methods of Construction and Character of Materials and Plant used in Public Works under the Charge of the War and Treasury Departments, and of the Commissioners of the District of Columbia, including Works of River and Harbour Improvement, Buildings at Posts of the United States Army, Lighthouses, Public Buildings, Life Saving Stations, and Works of Municipal Engineering of Washington, D.C., &c. Published as a Book of Reference for all persons interested in the Public Works, and for Engineers and Contractors in general. By Captain W. M. Black. Illustrated by over forty photogravures and working drawings. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1895. Price 21s. net.

HORSELESS CARRIAGE NOTES.

IT is satisfactory to find that the Royal Agricultural Society is taking up the horseless carriage as a thing to be encouraged, and although the society does not lead in this matter, it is well that it should give a prize for vehicles specially suited to agricultural purposes and districts.

The draft regulations for the proposed competition in connection with the Manchester meeting of self-moving vehicles for light and heavy loads had been amended and settled, and they are now submitted for the formal approval of the Council as follows:—

Regulations for Competition of Self-moving Vehicles for Light and Heavy Loads at the Manchester Meeting of 1897.

(1) The competing vehicles will be divided into two classes, the one for light loads and the other for heavy loads.

(2) The light-load class to be for such vehicles as would take the place of a light spring cart for the conveyance of loads up to two tons. The heavier vehicles to be capable of taking five tons, exclusive of the weight of the vehicles.

(3) Prizes of £100 and £50 will be offered for the best machines in each class. In the case of equal merit in either case the prize money may be equally divided.

(4) In both classes the self-moving vehicles are to be propelled exclusively by mechanical means.

(5) In the case of oil engines heavy oil alone shall be used; Sp. G., ·8; flashing point not less than 73 deg. Fah.

(6) The design of engine and form of vehicle will be left entirely to the manufacturer.

(7) Trials will be made of the engines carrying a declared weight for an ordinary load over a distance not less than 50 miles out and 50 miles return, during which run the consumption of fuel, water, &c., will be carefully noted.

(8) The maximum speed to be at the rate of ten miles per hour.

(9) Such further trials as the judges may consider necessary to test the efficiency of the vehicles ascending or descending hills will be made.

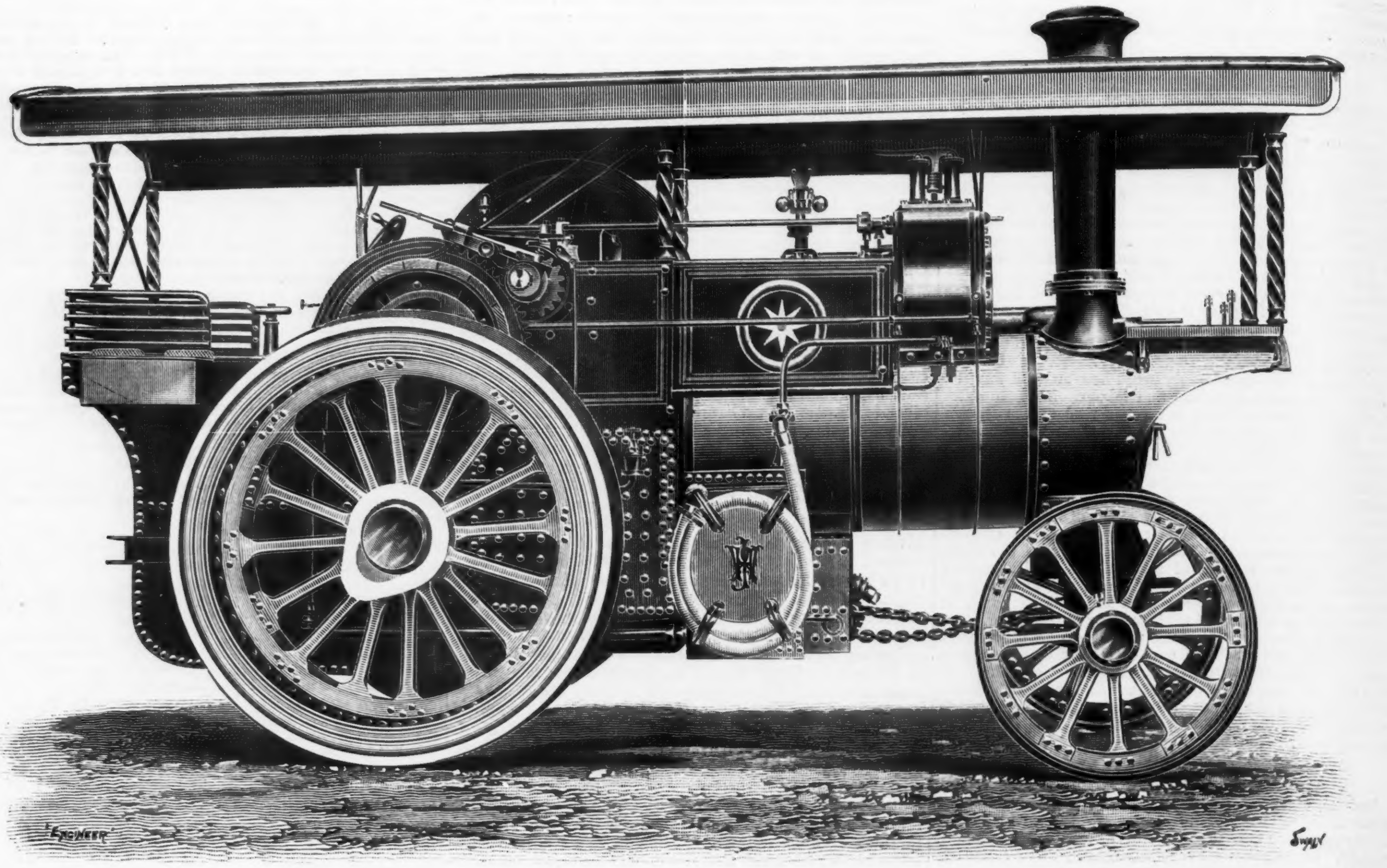
(10) The points to which the special attention of the judges will be called for:—Due regard to the convenience of the public. Ease of handling, with special reference to stopping, starting, and steering. Economy in working. Price. Simplicity. Strength of design. Weight of vehicle.

These are the draft regulations, before the final conditions are published perhaps some modifications may be made.

THE wide belief in the necessity for encouraging the production of satisfactory mechanically-propelled vehicles is further shown by the action of the Shropshire and West Midland Agricultural Society, which offers prizes, as will be seen by our advertisement columns, of £10 and £5 in open competition for "auto-cars or horseless carriages best adapted for rural districts."

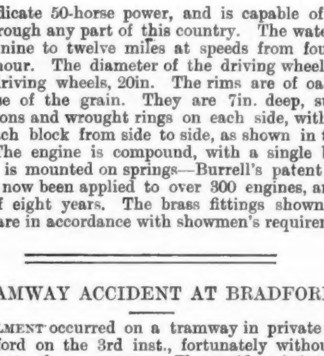
COMPOUND TRACTION ENGINES

MESSRS. CHARLES BURRELL AND SONS, THETFORD, ENGINEERS



TRACTION ENGINE WITH WOOD RIMMED WHEELS.

We illustrate above a traction engine, very similar to, but larger, than one shown by Messrs. Burrell at the Crystal Palace. The principal feature of novelty in the engine is Mr. F. Burrell's patent wood block wheels. The engine at the Palace is a light 6-horse power compound road locomotive weighing 7 tons, and capable of hauling 17 tons gross load up 1 in 15, and working on from 3 to 4 cwt. of coal for a day's run. The engine is double-geared; that is, each wheel is driven independently with compensating gear on the countershaft. The engine is not on springs. The engine we illustrate is one of thirty-five supplied to leading showmen in this country, and is provided with a dynamo support in front.

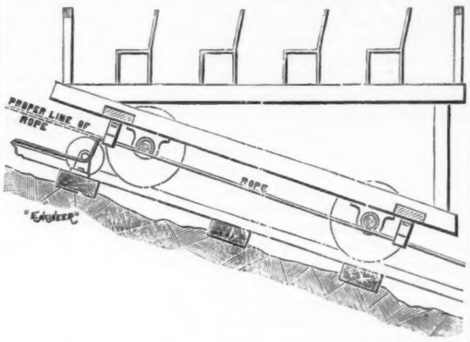


It will indicate 50-horse power, and is capable of hauling 50 tons through any part of this country. The water supply lasts from nine to twelve miles at speeds from four to six miles per hour. The diameter of the driving wheels is 7ft.; width of driving wheels, 20in. The rims are of oak blocks set endwise of the grain. They are 7in. deep, supported by angle irons and wrought rings on each side, with a rivet through each block from side to side, as shown in the cross section. The engine is compound, with a single balanced crank. It is mounted on springs—Burrell's patent system, which has now been applied to over 300 engines, and stood the test of eight years. The brass fittings shown in the engraving are in accordance with showmen's requirements.

TRAMWAY ACCIDENT AT BRADFORD.

A DERAILMENT occurred on a tramway in private grounds near Bradford on the 3rd inst., fortunately without doing bodily harm to the passengers. The accident is interesting, as giving a hint as to a source of danger to be avoided.

The tramway in question has recently been constructed in Shipley Glen, a favourite place of resort for Bradford people, and conveys passengers up an incline. The line is double, and is worked by an endless rope, the power being supplied by a gas engine. As one car ascends the other descends, and the rope has its direction changed at each journey. The cars are slight structures, made with an approximately level platform, and are only wide enough to take two passengers abreast. There is no fence or arm at the end of the seats. The cars are without springs or brake, and no attendant travels on them. In the event of the rope failing, the cars would have a run to the bottom, hindered only by the drag of the trailing rope. The gauge of the line is about 21in., and the rails consist of battens about 3in. by 2in., on the upper surface of which strips of iron ¼in. by 1½in. are fixed by wood screws. The battens are nailed to sleepers, and the line is so laid that a ride on it at ten miles an hour is decidedly trying to the nerves.



The winding machinery is operated by the man at the top of the incline, and the line being curved he cannot see the lower end. The cars were not stopped at the proper place in one journey, causing a collision with the stops. The lower car had its ends broken, and the stops were also injured. The passengers were severely shaken, and there were some who complained of bruises on the shins caused by the seats in front of them. The collision appeared to have caused a surging in the rope—of steel wire about ½in. diameter—as it was off the guide pulleys for about one-third of the way on the line of the ascending car. This was at the upper end, and well in view of the man who was winding, but instead of lifting the rope on by hand he trusted the guide on the car to lift it. The ascending car did pick up the rope until it came to a pulley, where the spindle was projecting. The rope got under this spindle, and an accident was a certainty. A gentleman in the front of the car held up his hands as a signal to stop, but no notice was taken, and the car went over the bracket. Fortunately the rope did not break, but the bracket was torn up and the car derailed. It ran thirty or forty yards over sleepers and ballast, one pair of wheels being over the ends of the sleepers. One gentleman jumped off, but the other passengers kept their seats. There was naturally great alarm amongst them, but no physical injury was done.

A sketch appended shows the cause of the accident. It is in nowise to scale, nor is it intended to illustrate the construction of the car.

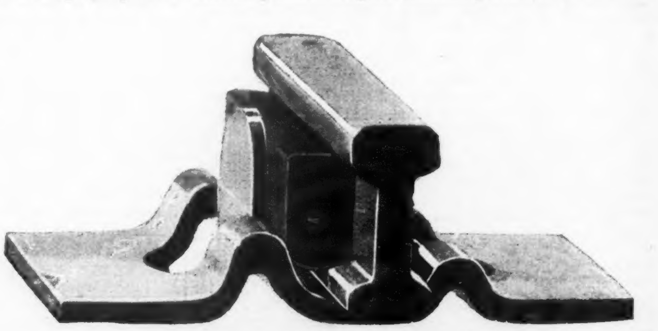
THE Admiralty have invited tenders for the construction of a defence boom in Southampton Water to extend from Calshot Castle to the opposite shore.

MASONRY DAMS—REMSCHEID AND CHEMNITZ

IN THE ENGINEER, vol. lix., 1885, we published an illustrated account of the Remscheid waterworks, and of the arrangements adopted for securing a supply chiefly by pumping from natural underground reservoirs partly formed by building intercepting walls. On page 494 we now publish a view of the handsome masonry dam which has been erected for the Remscheid water supply, and on the same page is a view also from a photograph of the dam built in connection with the Chemnitz water supply. In a future number we shall give some particulars of both.

HARRISON'S PATENT STEEL RAILWAY CHAIR.

WE give below a sketch of this chair. These chairs have now been tried on the Glasgow and South-Western Railway for over eighteen months, and to all appearance are as good as new. Orders are, we are told, now in course of execution for the Great Northern, North-Eastern, Caledonian, and Hull and Barnsley Railway Companies. The weight of the chair is only 18 lb., against an average weight of 50 lb. of cast iron chairs; and as regards cost—if manufactured in quantities—a reduction of 25 to 35 per cent. per chair would be, we understand, obtained, and a much longer life assured. The chairs are manufactured from 8in. flat steel bar or sheared plates, corrugated and stamped out, as in the sketch.



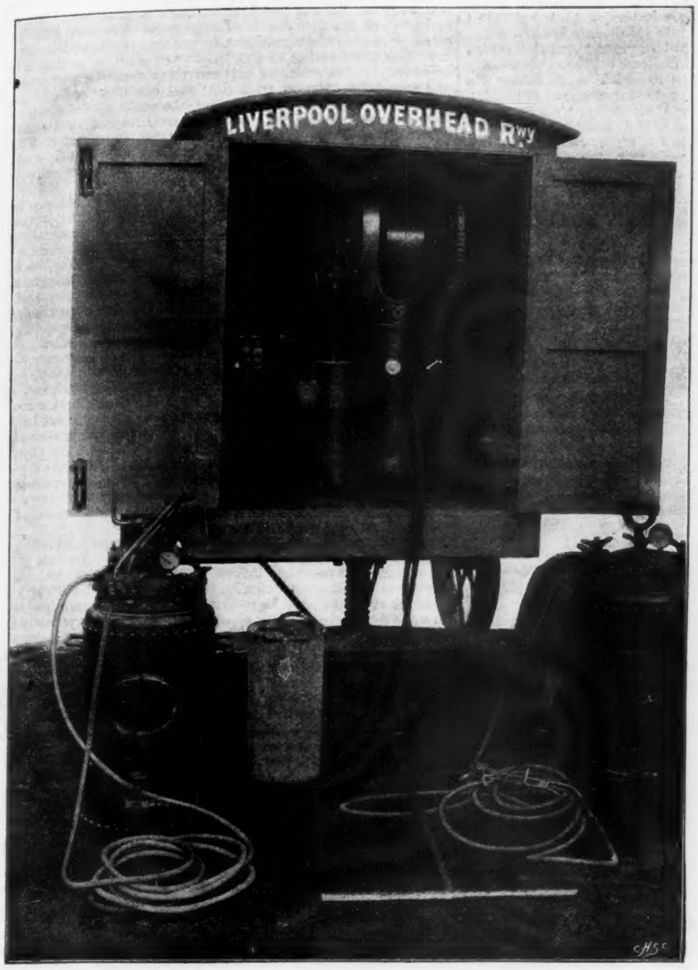
STEEL RAILWAY CHAIR

The patentee recommends a steel of 35 tons breaking strain per square inch, and 20 per cent. elongation in 8in. With such a steel the maximum amount of strength, combined with ductility, is obtained, and they should be practically unbreakable. The chairs manufactured up to the present have been ½in. thick, which, as far as the experience gained, has proved to be quite equal to any stress or strain they may meet. Mr. R. M. Harrison, C.E., of 228, West Regent-street, Glasgow, is the patentee.

A LOOSE boiler on the steamer St. Pierre caused the loss of the vessel early in March. The steamer had been purchased by the Canadian Pacific Steam Navigation Company, and was on her way from Halifax, N.S., to Victoria, B.C. The rolling of the vessel during the heavy weather prevented the boiler from being secured, and the feed pipes were broken. Sail was set, but the vessel began to leak and the crew was taken off by the Hamburg-American Line steamer Normannia bound for the Mediterranean.

ELECTRIC-DRIVEN PORTABLE PAINTING MACHINE.

In our Lancashire Notes recently brief reference was made to a specially-designed portable painting machine which was being constructed by Messrs. A. C. Wells and Co., of London and Manchester, for the Liverpool Overhead Railway Company. The accompanying illustration is taken from a photograph of the completed machine, as supplied to the company, and will, no doubt, be interesting to our readers. It may be added that Mr. Cottrell, the engineer and general manager of the Overhead Railway Company, had for some time past been casting about for a cheaper method of painting the large surface of iron girder work upon which the railway is built, the ordinary hand process involving a very considerable item of expenditure. After making several experiments with one of Messrs. Wallwork and Wells' "Lightning" painters, of which an illustration and description was some time back given in The Engineer, Mr. Cottrell had the above special carriage designed by the inventors and fitted with an electric motor, driven by power from the existing current. The motor is connected with one of Messrs. Wallwork and Wells' double air compressors, which supplies the necessary power to two of their No. 2 size painting machines. The car is arranged to carry the whole plant, and can be wheeled upon the tram lines underneath the railway. Some forty hands have been engaged in painting the iron girder work, and it is estimated that with this new plant a great saving will be effected.



WALLWORK AND WELLS' PAINTING MACHINE

NEW CANTILEVER BRIDGE AT PARIS.

For some years past the rapid decentralisation of the population of the city of Paris, due to the creation in its exterior quarters of thoroughly modern habitations for all classes, has created the necessity for more bridges to connect the right and left banks of the Seine, particularly between the industrial quarters of Grenelle-Javel and the purely residential quarters of Auteuil-Muette—small districts which count an increase of 14,000 inhabitants in a city whose population entire of 2½ millions in April, 1896, had only augmented by 87,000 in the same period of years, viz., 1891-1896.

The site chosen for the new bridge, which has just been completed, is between the bridge of Grenelle—so well known for the reproduction of "Liberty enlightening the World," erected on its mid-length—and the last, or high and low level, bridge at the fortification limits. Conjointly with the State, bearing half the costs, the Municipality decided to erect a bridge which would not be too greatly in arrear of modern practice.

As a matter of fact, out of the thirteen bridges existing before the construction of this one, from the Pont du Palais at the city centre to Auteuil, there are only five of iron: the light footbridge, Pont des Arts; the Pont St. Peres, composed of three arches of five hollow elliptical-section ribs, a structure of excessive resilience; the heavy cast iron Pont de Solferino, composed of three arches of nine massive girders each; the footbridge of Grenelle, supported upon round iron columns of large diameter; and finally the Pont de Grenelle, whose six iron arches are built into stone piers. The whole of the bridges are devoid of any elegance.

The Pont de Mirabeau, as the new bridge is called—for it connects the Rue Mirabeau of Auteuil to the Rue de la Convention at Grenelle—is composed of a central *volée* or river span of 100 m., and two half-spans or *culasses* of 36 m. each. The height to the middle of the central span is 8 m., or 25ft. 9in. above normal water level. Each half of this bridge is formed of seven frames of mild Longwy steel, poised upon the pier pivots, and slightly out of equilibrium so that the preponderance of the weight in the middle exerts a shoreward or *culée* pressure upon the piers. During the progress of the work the maintaining scaffoldings were removed entirely after assuring the balance by ballasting the shore span or *culasse*. The supporting cintre served successively for each side of the bridge.

The roadway measures 12 m. in width, and the footway pavements 4 m. each. On the right bank each pavement is placed in direct communication by means of stone stairways with the lower embankment, which is exceptionally wide at this part. The extremities of the frames are anchored down to the masonry of the embankment or *culée* by vertical rods, connecting their ends to bolts cemented into the stonework, so that the bridge may expand without lifting the frame ends or forcing the abutments.

The bridge was commenced April, 1894, at the Creil works of MM. Daydé and Pillé, and comprises about 2700 tons of metal put together by hand and hydraulic riveters. The iron employed comes from Denain and Anzin.

The masonry was commenced in May, 1893, by M. Letellier, public works contractor. The foundations of the piers rest on the solid chalk at a depth of 11 m. on the right bank, and 11·39 m. on the left, or, in other words, 16 m. below water level. The work throughout is done in Portland cement and rubble, excepting in the construction chamber, which is filled with hydraulic mortar or *béton*. The cap course is of Cherbourg granite. From the water level downwards the piers are bowed outwards, and have at their base an area of 28 m. in length by 10 m. in width.

Iron caissons enveloping the piers, having a working chamber of 2 m. in height and weighing 110 tons each, were employed in the building of the foundations. Four diving chambers were used for the entry and exit of the workmen and materials, air being supplied to them by four compressors installed on the right bank of the river. The first caisson was lodged on August 8th, 1893, and by October 24th the pier foundations of the right bank were finished and the first granite stone laid a day or two later. Without changing the positions of the air compressors, the work of the left pier was achieved in the same manner, the air pipes being carried on a cable 8 m. below the surface of the water, this latter pier occupying the three months, October to December, 1893.

The bridge was opened for regular vehicular traffic on April 20th, 1896. The first trials of the bridge were for dead weight; this was done by loading it with 800 tons of sand—400 kilos. per square metre — and finally, on April 19th, by passing over it twelve lorries, each loaded with 16 tons of stone and drawn by eight horses, representing a rolling load of about 200 tons. In both series of trials special apparatuses were employed for taking very elaborate indications of the flexions produced.

The piers of the bridge, though of themselves quite in keeping with the mechanical appearance of the bridge, are to be ornamented with four allegorical figures representing such subjects as Navigation, Commerce, Industry, and Science, modelled by the sculptor, Injalbert, and now being cast in bronze by Thiébaut Frères, of Paris.

The bridge was designed by M. Résal, chief engineer and professor at the school of Ponts et Chaussées, under the direction of M. Rabel, principal engineer, and carried out by M. Alby, engineer-in-charge.

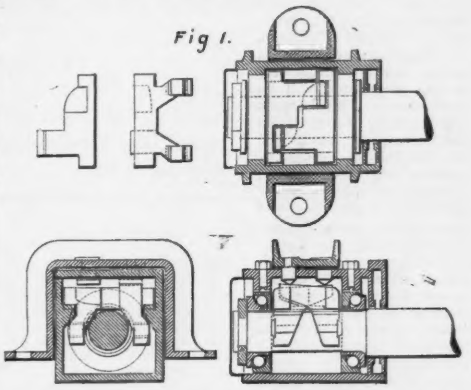
SIDE PRESSURE BALL BEARINGS.

The obstacle to the general adaptation of ball bearings to vehicles has been the difficulty of adjusting the pressure upon the races required to keep them in position, without on the one hand jamming the balls hard and fast between the ball races, or, on the other hand, leaving the balls so loose as to bunch and let the outer ball races slide down till they rest upon the cones. The methods hitherto used for "tempering" the races, either by Bown's ratchet nut and screw or by lock nuts and screws, are open to the objections that they put an unknown amount of side pressure upon the upper balls only, and that they require great skill and experience on the part of the manipulator.

Under these circumstances the ball races for vehicles of heavier proportions than the bicycle are necessarily of costly materials and workmanship, the slightest flaw occurring in a ball race which would check the course of the balls, leading inevitably to their being crushed as they are driven round the race by the momentum of the vehicle. The very finest and hardest quality of steel has to be used for ball races, which it takes long to cut by the hardest tools, and after hardening many of these costly productions are rejected for some apparently trifling flaw on the surface. Under these conditions the price of ball bearings for heavy vehicles has necessarily been prohibitive, and the danger of failure at a high speed causes a natural disinclination to incur risk as well as expense.

The automatic adjustment of the side pressure by bringing the weight of the vehicle to bear horizontally upon the ball races through the medium of a pair of bell-crank levers, it is claimed, not only overcomes those difficulties in the way of producing economical and workable ball bearings, but also distributes the pressure due to the weight of the vehicle more uniformly over the balls. The invention has already been adapted to the axle-boxes of tramway cars, the naves of carriages, and the hubs of cycles.

Fig 1.

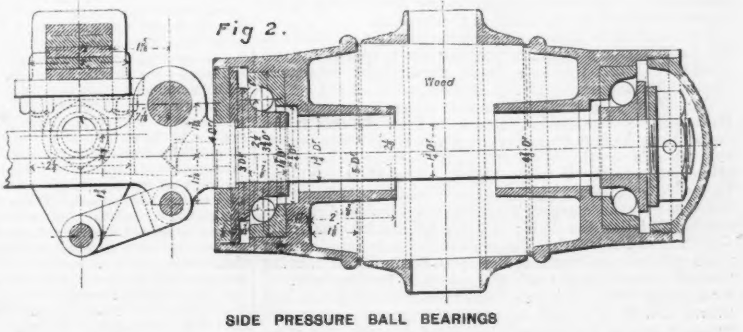


For railway and tramway car axle-boxes side-pressure ball bearings consist of two rings of balls in each axle-box, mounted at each end of the box between cones and ball races. The cones are free to move lengthwise on the journal, while the ball races move freely lengthwise in the ends of the box. The cones are checked by stops at each end of the journal, and the ball races are pressed outwards against the balls and cones by a pair of bell-crank levers bent at right angles, the horizontal arm of the lever carrying the weight of the car, while the vertical arm, which is forked to work over the journal, bears horizontally against the back of the ball race. The fulcrum of each bell-crank lever is a pair of knife-edges carried in the angles of a pair of brackets cast on the sides of the axle-box. Fig. 1 is the elevation, plan, and section of a tramway axle-box, as shown in the Exhibition at the Crystal Palace.

The application of side-pressure ball bearings to the naves of carriage wheels differs in mechanical detail from the axle box owing to the wheel rotating on the axle in the one case while, in the other, the axle rotates in an axle-box. The carriage wheel being free to move or press laterally, communicates the side-pressure from the one ball race to the other, so that a single bell-crank lever seated on the axle immediately within the nave communicates side-pressure from the weight of the carriage to the ball bearings, as shown on Fig. 2, which is a section of the nave for a dog-cart wheel.

In view of the probable demand for a practicable ball bearing for heavy automotor cars and horseless carriages, the Side-pressure Ball Bearings Syndicate's exhibit at the Crystal Palace attracts much attention. There is little doubt as to the advantage which would accrue in a competition of horseless carriages to the builder who successfully applies ball bearings to his carriage. These bearings are shown by the syndicate, whose offices are at 22, Walbrook.

Fig 2.



SIDE PRESSURE BALL BEARINGS

A Fast Yacht.—Mr. J. S. White, of Cowes, has just completed a new yacht, which is probably the fastest of her size afloat. She is named the Scud, and is owned by Mr. A. H. E. Wood, who formerly possessed the fine steam yacht Rona. The Scud is 85ft. long, with a beam of 10ft. 6in., and depth of 5ft. 10in., and on her steam trials developed a speed of 20¼ knots an hour, or 23½ statute miles. She has one propeller, the steering is on J. S. White's turnabout system, and her engines are of 530 indicated horsepower, the steam being generated in a Blechynden water-tube boiler. The pressure at the trials was 200 lb., not quite full pressure. The revolutions of the triple-expansion engines were 428 per minute. She has very much the appearance of a second-class torpedo boat, so far as her deck arrangements are concerned, and her bow and stern are of naval fashion. At the bow she carries a powerful electric search-light. She is beautifully fitted below. The saloon and state-room are aft, fitted with the electric light, and upholstered in royal blue and golden yellow. The crew are berthed forward. Running at over 20 knots there was hardly any vibration. The vessel has commanded a good deal of interest amongst the yachting fraternity in the Solent.

RAILWAY SCHEMES IN THE HIGHLANDS.—SESSION 1896.

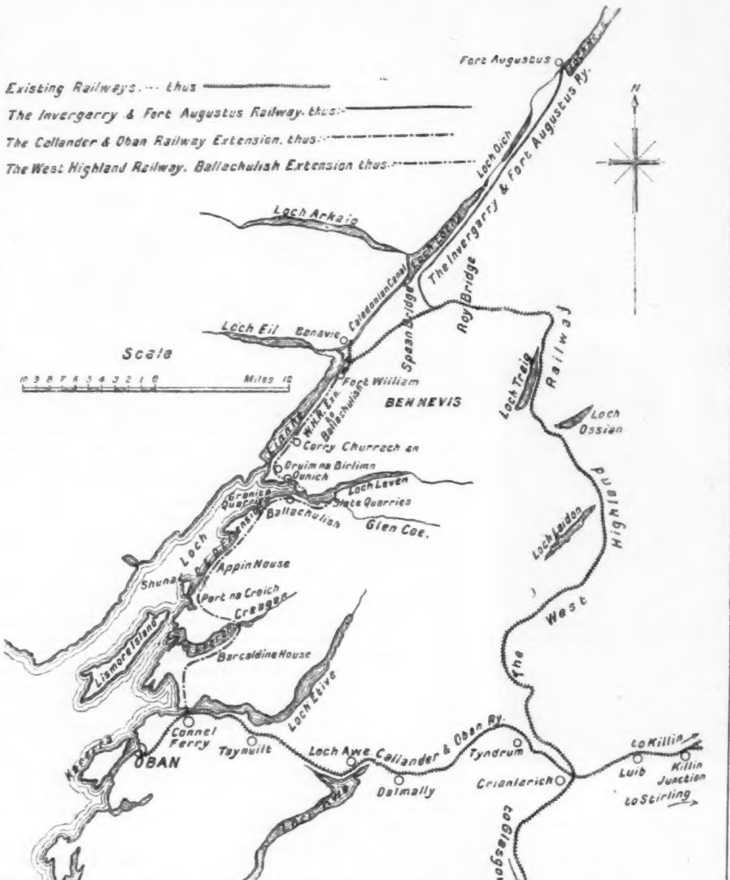
Some time ago—The Engineer, December 20th, 1895—we placed before our readers a *résumé* of the Private Bills deposited for the present session of Parliament. Since then we dwelt in some detail on the Ayrshire group of projected lines, giving the more salient features of each proposal, and accompanying our remarks by a map showing each of the rival routes—The Engineer, February 22nd, 1896—and we now propose concluding our remarks on the subject by similarly describing the Highland schemes, and briefly alluding to the more interesting features of each :—

The Invergarry and Fort Augustus Railway.—This line commences near Spean Bridge on the West Highland Railway, and running in a westerly direction, bends northwards till the shores of Loch Lochy are reached. The route then follows the loch, and skirting the southern shores of Loch Oich for their entire length, spans the Caledonian Canal near Fort Augustus, terminating at the southern extremity of Loch Ness, where a substantial timber pier will be formed. The line, which will be a single one throughout its entire length of twenty-four miles, is estimated at £6000 per mile, or some £150,000 for the entire scheme. The principal works of engineering interest involved will be the swing bridge over the Caledonian Canal, near Fort Augustus, and the viaduct over the river Spean at the other end of the line. No tunnels occur along the route, and no difficulties of any magnitude will be encountered. The sharpest curve will be one of twelve chains, whilst 1 in 62 will be the ruling gradient. Stations will be erected at suitable intervals, and every provision made for the transport of sheep, a class of traffic from which considerable revenue is anticipated. The beauty of the scenery is too well known to need special comment at our hands, though in this connection it may be pointed out that during the season tourists will avail themselves of the proposed route in very considerable numbers. The landowners along the route, who are also the promoters, are favourable to the scheme, and the engineers are Messrs. Formans and McCall, C.E., of Glasgow.

The Callander and Oban Railway ; Ballachulish extension.—The Callander and Oban Railway Company's proposed extension to Ballachulish starts from the company's existing line near Connel Ferry, crosses Loch Etive by a fixed bridge of a single span of 500ft., with a clear headway of 50ft. above high water, and running northwards, sweeps past Barcaldine House—a seat of the Camerons—and crosses Loch Crenan at Creagan in three spans each of 100ft. and two spans each of 60ft., all of which are 40ft. above high water. The proposed line then turns westward, and running through the Strath of Appin, passes Portnacroich, thence following the coast line very closely, it reaches Appin House, and finally terminates at Ballachulish with a branch eastwards to the famous slate quarries of the district at the entrance to Glen Coe.

The length of the undertaking is some twenty-five miles, and the parliamentary estimate provides for a cost of £10,000 a mile. The line will be a single one throughout its entire length. The engineer is Mr. Wolfe Barry, C.B., F.R.S.

The West Highland Railway Company's extension to Ballachulish.—The halfway attock on Fort William by the Callander and Oban Company—just described—is to be met by proposals by the West Highland Railway Company to extend its system to Ballachulish. The West Highland Railway's extension will commence at Fort William by junction with the company's existing main line, and running south, will follow the shores of Loch Linnhe for practically the whole of its length. Passing Corrychurrachan, the new route will curve eastwards at Druim-na-Birlimn, and, running through Ounich, will reach Ballachulish, its terminus. A road bridge over Loch Leven forms part of the proposals, and across this it is sought to carry a tramway, one branch running east to the Ballachulish slate quarries, the other west to the granite quarries on the shore of Loch Linnhe. The total length of the undertaking is twelve miles, and a parliamentary estimate of about £9000 per mile has been put in. The principal feature of the undertaking is the bridge at Ballachulish, consisting of three fixed spans of 144ft. each, and two swing spans each of 90ft., the whole being 8ft. above high-water level. The engineers are Messrs. Formans and McCall, C.E., of Glasgow. It only remains to be added that the line presents no features of difficulty in construction, the gradients are easy, and twelve-chain curves are the sharpest necessary. The line will be laid with 80 lb. steel rails, and in every respect will be a first-class one.



HIGHLAND RAILWAY SCHEMES

The Sanitary Institute.—The council have accepted an invitation from the city and county of Newcastle-on-Tyne to hold a Sanitary Congress and Health Exhibition in that city in the autumn of this year.

Brussels International Exhibition, 1897.—The Department of Science and Art has received, through the Foreign-office, a copy of a Belgian Decree applying Article XI. of the Convention concluded in Paris on the 20th March, 1883, for the protection of industrial property, to the goods, &c., that may be sent to the Brussels International Exhibition which is to take place next year.

THE "JAMES FORREST" LECTURE.

"PHYSICAL EXPERIMENT IN RELATION TO ENGINEERING."

By Dr. Alexander Blackie William Kennedy, F.R.S., M. Inst. C.E.

It has been the expressed wish of the gentleman in whose honour the "James Forrest" lectures have been instituted, that they should deal with the relation of various sciences to our own profession. To those of us—and they are many—who have long enjoyed his friendship, and who are to some extent familiar with the extent to which our profession is in his debt in matters innumerable, it is practically a duty to meet his wishes in such a matter. But it must be acknowledged that the duty—as regards the lecturer—must grow every year more difficult, as the field becomes limited by his predecessors ; and even at present it was with no little nervousness as to the selection of a subject that I accepted last year the invitation to give this lecture in 1896.

There is perhaps no science, except those in the biological group, of which it might not be argued, with some degree of plausibility and reasonability, that the profession to which we all belong was a direct application. The sciences of mathematics and of physics, of chemistry and of geology, concern themselves with the exact statement of the nature and relations of facts and phenomena with which we as engineers have continually to concern ourselves. But the point of view of the purely scientific investigator and of the engineer, in regard to these facts and phenomena, are no doubt very different. In rare and exceptional cases, one man can play both *rôles*, but this happens so very seldom that for all practical purposes they may be regarded as distinct from each other. And no one who is not terribly narrow—on one side or the other—would deny that either might form a worthy life-work for any man, however high his aims or ambition.

I excepted just now the biological sciences from those with which engineers were directly in touch. But, in spite of this, I confess that I have had a great wish for years past to devote some time to the working out of a theory of evolution in relation to engineering progress. I cannot help thinking that there is something in relation to things inorganic which closely resembles the position of natural selection in the organic world. The struggle for existence, which too obviously exists among engineers themselves regarded as organic beings, seems also to exist in effect among engineering productions. There is also among them a survival of the fittest, and the laws which determine what is the fittest at any time, and how the standard of fitness alters as time goes on, are probably capable of fairly exact statement—in correlation with the laws of general human progress—at any rate they are very well worthy of examination. This biologico-engineering investigation would be no doubt rendered more difficult by the fact that artificial selection continually comes in to help and accelerate, or it may be to hamper and impede, but in any case to modify, the inorganic equivalent of natural selection. I have found this whole subject a most tempting one, full of fascination, and to some extent also of surprises. But finally I felt constrained to leave it, at least as far as this lecture is concerned, to someone—some fortunate person—whose mind was not so overcrowded with the innumerable details of every-day work as my own, or who was able, in spite of these details, to obtain at the same time a broad and comprehensive view of the whole subject from a point higher and more commanding than any that I seemed able to attain to. I hope that in some future year I may have the pleasure of listening to a "James Forrest" lecture in which "Evolution in Engineering" may be adequately dealt with. For myself, I have found it necessary to be content with a much more limited subject, although one perhaps on which my own work gives me more right to speak, "Physical Experiment in Relation to Engineering."

We are all at this present time so familiar with the idea of physical laboratories—places in which physical experiment is carried out systematically and continuously, both for purposes of scientific investigation and of education—that it is hard to realise how very modern an institution the physical laboratory is. Until quite lately the most distinguished investigators worked in laboratories which they had made for themselves and which were essentially their own private studies. The Royal Institution laboratories—originally, I think, rather chemical than physical in conception—nevertheless became to a great extent physical, and in this way were early and notable extensions of the purely private laboratory, and happily exist still to furnish admirable physical work. But it is practically only within the last thirty years that physical laboratories, as we know them to-day, have come into existence. Thanks very much to this growth of experimental and physical teaching, we have now an army of trained physical investigators distributed all over the country, whose principal occupation—besides teaching—is the making of researches in experimental physics, and in this way contributing to our knowledge of the phenomena of the world around us, the phenomena which it is our business to turn to the "use and convenience of man." Not only this, but within the last twenty years there have come into existence numerous well-equipped engineering laboratories in connection with our technical colleges and schools. These engineering laboratories are, of course, simply physical laboratories modified in a certain special direction for our special purposes, and the investigations carried on in them are of the nature of physical experiment as fully and completely as those which are carried out in physical laboratories proper. The aim and scope of the two classes of experiment, however, differ considerably, as do their relations to our own work, and it will be my object this evening to put before you what, according to my own view, are the relations between these classes of experiment, and especially between each class and our own work. I need hardly say that I am bound to look at the whole matter throughout from the point of view of the engineer. I do not for a moment pretend that I am capable of taking up the position of the physicist, and of course I keep in mind also that I have to speak to an audience consisting essentially of engineers, and not of physicists.

Physical experiment, so far as it has relation to our own profession, may fairly be considered to serve three distinct purposes. In the first place, from the purely academic or educational point of view, it is most important and helpful in the training of engineering students. (And it is well to remember that although a great many of us never were engineering students, nor had any opportunity of obtaining such training, yet the most conservative must now recognise that in the future our sons and successors must look on the student stage as being as essential as the pupilage or the apprenticeship.) Then, secondly, what may be called purely physical experiment is necessary to supply us with most of our most important constants, whether connected with the thermal properties of steam, the electromotive force of a Clark cell, the density of water, the elasticity of steel, the coefficient for a *vena contracta*, or a thousand other matters of similar nature. Lastly, technical experiments, which are essentially physical experiments, but of a much more complex nature than those of the physical laboratory—although not on that account more difficult to carry out—are necessary for determining many matters ; such, for example, as the efficiency of a dynamo, the steam consumption of an engine, the flow of a river, the resistance of a ship, or even the deflection of a girder under a moving load.

Let us consider, in the first place, the purely educative or academic type of experiment. Here the first requirement is the very simple one—which indeed may be served by an endless variety of experiments, extending far beyond the limit of Physics—that the student should learn first to see and to measure, and then to write down what he has seen and measured. (Anyone who has had to do with laboratory work knows very well how necessary it is to differentiate in this fashion.) The experiments require to be, as far as possible, quantitative rather than merely qualitative ; but, otherwise, the simpler they are the better. It is unnecessary here to go into any details about them, but with a view to emphasising their importance, it is worth while just to look for a moment at the sort of thing by which, in actual engineering work, these simple experiments may be said to be represented. Perhaps those whose work lies greatly in experimentation, like my own, know best how very hard it is to find assistants, unless they have been trained in a laboratory, who can be trusted at first even to take quarter-hourly readings of a steam gauge or a counter, or any such duty, ridiculously simple and easy as it appears. To ask an untrained man to count the revolutions of an engine which has no continuous counter attached, or to read the dials of an ampère-hour meter, at exactly regular intervals of time, is merely to court disaster. The story is familiar of how Robert Houdin had so trained his faculty of general observation, that one look at a shop window would impress its contents on his mind more vividly and accurately than ten minutes of hard looking would do in the case of an ordinary man. It is really just the same with the simplest of our observations. The ordinary mind does not naturally and at once see, and see accurately, the simplest thing that is before the eyes. One has to look, to exercise conscious mental effort, as well as merely to see, and we all of us require to be taught how to look, even in these most simple matters. And when the enforced looking has to be done at exactly a particular time and no other, the average mind is apt to find the whole process an intolerable burden, all the more because it is inclined to despise the work as being too childishly easy for consideration at the very time when it is failing to carry it out!

So far as concerns the training of the faculties of observation at the stage of which I am speaking, probably chemical experiments would serve as well as physical. In certain respects possibly they might even be better, but with this we need not now concern ourselves. An important point is, perhaps, that in their earlier stages the student should not be allowed in any way to get the notion that his experiments are more than mere rough exercises. Any standard of accuracy which he can possibly attain is comparatively a very low one, and by the nature of the case the experiments he can do must be simplified down enormously before they can be put into his hands, so that at best he is only making a rough determination of one element in an artificially simplified operation, the full conditions of which he is not even in any position to understand. The actual figures which are obtained by him can under no circumstances be regarded as having any intrinsic value ; and one of the difficulties of the case is, no doubt, to persuade the student to exercise his highest degree of care in obtaining results which at the same time he is told, or knows, are of no use whatever. The engineering student, I am sorry to say, is generally a terrible utilitarian. The unhappy professor has to enter into all kinds of subterfuges to get him to take an interest in, or do any careful work at, matters which the omniscience of youth has once pronounced to be "useless." Later on, of course, he is wiser and a trifle less narrow-minded ; but I suppose the stage of first yearness is one through which all of us have to pass in one fashion or another, to the grief of our pastors and masters, and to our own later regret.

More interesting to most of us, perhaps, than this purely academic matter is the consideration of physical experiment under the last two headings which I have mentioned.

From among these comes experiment which really belongs to pure physics, but in which we engineers may claim to be as much, or even more, concerned than the physicists, although both the difficulty and the honour of the experiment must fall to them. I suggest that we are even more concerned than the workers in pure science for two reasons, of which the first is that the whole of our interest is practically concentrated on what constitutes only a small part of the boundless region open to the physicist. He can spread his affections over glass and sealing-wax, and let them roam from ice to iron. We have only one love, or at any rate never stray very far from a limited number of matters which concern what I have heard contemptuously called "technical materials." He interests himself legitimately and equally in argon and carbon, in steam and in ethyl-alcohol ; he loves to extend his thermal conditions so as to get liquid air or gaseous carbon. We, on the other hand, are compelled to deal with a very small number of materials, and with these materials only in states in which we can readily obtain them. In fact, as every one knows, nineteen-twentieths of our liquid and gas problems affect only liquid and gaseous—or vaporous—water, and only the remaining small percentage is left to be distributed between coal-gas and producer-gas, liquid carbonic acid and anhydrous ammonia, and so forth. So far as the more or less "permanent" gases are considered, our interest is throughout perhaps rather chemical than physical.

Then, again, we may claim to have a first interest in certain physical results, because of the extraordinary frequency with which we have somehow or other actually to make use of them—I mean a real live use, and not merely a use in an examination question, or in a text-book or a lecture. Not only would our whole work become mere guess work without the knowledge of these results, but, having this knowledge, we are compelled by the very nature of our work to make such continual use of it that probably we are much more familiar both with the figures concerned and with the phenomena which they represent, than even the men to whose magnificent accuracy and unlimited diligence we owe their original investigation and determination. I mean, of course, such results as refer to the thermal relations of water and steam, to the calorimetry of fuels generally, to many hydrodynamic problems, to most problems in elasticity and what is clumsily called the strength of materials, to frictional questions, to innumerable problems relating to electrical matters, and certainly to an enormous number of matters bearing on mechanics, which, of course, is to be considered as a branch of physics.

I feel so strongly this sense of our paramount interest in certain physical problems that I have not hesitated sometimes to resent the way in which physical writers and speakers are occasionally inclined to instruct us how to express our ideas, for example, as to mass and weight, and sundry vital matters of that kind. I really think that people who have to deal with these matters as much, as often, and as thoroughly as we have, and who are on the whole reasonably competent beings, may be assumed to know how best to manage our own affairs in these respects. Mechanics are to us the breath of our nostrils, and not a mere vehicle for examination papers; and it should be remembered that the requirements of the latter case may be very different from those of what I may venture to call "real life." I feel some satisfaction in remembering that the only fatal case of a misused "g" that I can call to mind was on the part of a physicist, whom we all admire none the less for the way in which he scolds us, but who in the very act of showing us the way we ought to use that symbol, proved conclusively that all submarine cables would break by their own tension while lying on the sea bottom! It would perhaps be hardly proper, or even safe, that I should here say anything, as I am much tempted to do, as to the vexed question of units, which from time to time seems to agitate many minds. Let me only suggest that, on the whole, it does not seem to me that the people who would be most affected by the change are at present those who are most anxious for it. In fact, admitting certainly a few notable and very distinguished exceptions, it really seems as if engineers in general were content to go on in their own way, unconscious of the terrible pitfalls and difficulties by which it is understood that they are surrounded on all hands. I quite admit, of course, that it by no means follows that the pitfalls do not exist, although I confess to being somewhat sceptical about their reality.

But having spoken so strongly of engineers as being the users of certain physical results, I must look at the other side of the matter. We engineers may have, as I urge, more interest in these matters than anyone else, but it is certainly true that we have not ourselves to thank for the determination of the results which we require and which we make so much use of. For practically the whole of these results—results without which, as I have said, our profession would hardly exist, would at best be a mere trade instead of, as we are proud to consider it, a scientific profession—we are indebted to workers in physical science pure and simple, men without the least taint or suspicion of technical or utilitarian intent.[*] It would therefore ill become us engineers if we were to say or do anything which should, even in the most indirect fashion, tend to belittle the work of pure physicists, on which every day shows us more how much we are dependent. Our gratitude is so real and so deeply seated that we need not, and do not, even resent the expression of regret which has sometimes been heard from a discoverer, that what he has done should be of any use whatever.

A physical experiment such as is necessary for the determination of any one of the physical constants which we have in continual use differs very essentially from such physical experiments as we engineers have to carry out in the course of our own work. It is at once much simpler and much more difficult. It is simpler because its object is the solution of one certain problem, which has been by much care and pains isolated from all its surroundings, from all related and, so to speak, adjacent problems. The first work of the physicist, dealing with his problem, is in fact to find out a way of so isolating his question that its solution may give him exactly the one quantity he wishes to know and no other. Of problems of this kind I confess I speak as an outsider, but as an outsider it has been to me often a matter of the greatest interest and even wonderment to see what enormous pains a physicist takes, and must necessarily take, to make sure that he is measuring exactly the thing he wishes to measure—that thing, that whole thing, and nothing but that thing; to see also what innumerable precautions he has to take to ensure the absence of minute errors, or to find out where any such errors might occur and whether they have occurred, and to evaluate them if they are unavoidable. I have found, too, that in such cases suggestions derived from my own experience in engineering experiment have been often received with a coldness which I am afraid was no more than they may have deserved. For, as I shall endeavour to show, the conditions under which experiments of this kind have to be made are absolutely different, both as to aim and method, from those of the experiments—more technical if not less physical—which we have to carry out for ourselves in our own work.

In a physical experiment of the second category, such as those of which I have been speaking, the primary points may be said to be, first, that the object of the experiment should be single, definite, isolated, separable and separated from all surroundings; secondly, that it should be general in its nature, and should not relate merely to one special case; next, that as a problem it should be capable of exact determination; and lastly, that the final result should be as nearly absolutely accurate as it is possible for any physical determination to be. Take as examples such matters as the determination of the density of steam, of the variation of the specific heat of water with change of temperature, of the calorific value of pure carbon, or of the mechanical equivalent of heat. Such problems properly stated admit each of one exact solution, one answer which is absolutely right, even in the mathematical sense of that phrase. It is the highest object of the physicist, in dealing with such a problem, to obtain the right solution. He spares no pains to obtain it, he determines each minute correction with the patience and care of a man who knows that the value of his whole work may be vitiated by a single overlooked source of error, even of the smallest magnitude. We engineers are possibly in some danger of forgetting occasionally, in view of the familiarity and matter-of-courseness of certain figures with which we have frequently to deal, that just these every-day and familiar numbers, on account of their very importance, were those which required and obtained for their determination the most careful, exhaustive, and accurate experimentation in the hands of the most experienced physicists.

After speaking in this fashion of the nature of experiments in pure physics, it may sound at first absurd, but it is nevertheless true, to say that physical experiments in the third category—the technical experiments which we engineers have so often actually to carry out—do not fall under a single one of the conditions which I have just given as characteristic of experiments in pure physics. We cannot, even under the most favourable circumstances, put before ourselves exact and isolated problems; we have much more often to deal with special than with general cases; we cannot choose problems which are capable of finally exact solution; and therefore, lastly, we should treat the matter entirely wrongly if we attempted to obtain more than a certain limited degree of accuracy in our solution—an accuracy very limited indeed when compared with the all but mathematical accuracy with which problems in pure physics can be solved.

The conditions under which engineers have to carry out physical experiments, of course, vary very greatly. In certain simple cases they are essentially physical investigations, be it in connection with friction, with elasticity, or what not, which at first sight do not greatly differ from the experiments which I have just discussed. There is probably, however, more difference than appears at first sight, although the spirit in which both sets of experiments have to be made is the same. Take, as an example, the determination of the elastic modulus—or the specific extension—of a piece of steel. Probably, with very perfect instruments and with extreme care in manipulation, a value of the modulus could be obtained which should be accurate, say within 1 in 2000, for that particular piece of steel. But a figure so obtained would not be accurate even for other pieces of steel made at the same time, and out of the same ingot as the one experimented on; while, of course, there is no one absolute value for the modulus of elasticity of the widely-differing material, of which all sorts go by the name of steel. Under such conditions—and I have chosen a particularly favourable example—it would be mere affectation, and, in addition, would be actually misleading, to claim anything like physical accuracy for our results. Indeed, I must go further and say that the truly scientific way of treating an experiment in engineering physics is to recognise from the outset its limitations as to accuracy, and to be careful not to state a final result in a form which should lead to the supposition of any greater degree of accuracy than that which the conditions of the work can actually allow.

The difference between physical and technical experiments may easily be illustrated by another example from the region of elasticity. The determination of the deflection of a beam, transversely loaded, as a physical experiment would resolve itself into the test of the behaviour of a piece of homogeneous material, preferably of the simplest possible cross-section, probably rectangular. It would be a matter of importance to ensure that the material was exactly of a certain chemical nature, and that it was mechanically free even from the slightest defects; it would also have to be machined to certain exact dimensions. Even with every care, the almost unavoidable imperfection in the material, minute variations in uniformity of structure, and so on, would be very difficult to deal with and to allow for. As a technical experiment, on the other hand, the beam might consist of plate, and angle iron secured together by rivets, the whole forming a structure with absolutely no pretence to homogeneity, nor to absolute exactness of dimension. Its rough surface would be carefully left intact, and not in any way machined, its riveted parts would be brought together as well as was reasonably possible with the appliances at the command of the engineer, but without any attempt to make a special fit between surfaces. In fact, the whole thing would be constructed in imitation of the way in which a riveted beam, such as is used as a girder, is usually made. The result obtained would obviously not be a general one applicable to steel as a material, or to beams as geometrical forms, because the data of the problem, even the dimensions of the beam itself, could not be determined with minute accuracy, nor would the actual final result be comparable in accuracy with the determination of the similar problem treated from the purely physical point of view. Hence, as the experimenter cannot for a moment pretend, and should not for a moment delude himself into supposing, that his results could be more accurate than his data, it is his first duty in this line of work to find out within what limits of accuracy his experiment can be carried out, and, when he has obtained his results, to state it only within these limits. Under these conditions the statement of a result in round figures is often much more accurate than its statement down to the last decimal place which appears in the arithmetic. I have heard it said by some of the students of the greatest of our physicists, Lord Kelvin, that this was a point upon which, even in a great deal of purely physical work, their master always insisted most strongly. But I am afraid that it must be admitted, as a weakness of much of our engineering experimentation, that its results are given in figures which are absolutely ludicrous as indicating the value of the quantities actually measured. In these matters, perhaps, our friends in America are even worse than we are, and those of us who have anything to do with steam vessels or with steamship trials, are perhaps the worst sinners. I suppose no physical problem could very well be much more complicated than that—I ought rather to say those—involved in the carrying out of a marine engine trial at sea, especially when power and speed are both concerned. When it is considered that the final result depends on the accuracy of our knowledge of the dimensions of the steam engine itself, and of the steam engine indicators, on the uniformity of elasticity and proper scale of the indicator springs, the accuracy with which the revolutions are observed, the accuracy of timing on the mile and of observing the distance at the same time, to say nothing of the assumption that the indicators themselves and their gear, unlike every other thing in the universe, are entirely devoid of hysteresis, it will be seen how entirely out of the question it is that the figures obtained, even for a single run in one direction, should admit of statement in, say, more than three figures. When to this is added the uncertainty of the method of averaging speed as between a number of runs under different conditions as to tide and wind, the matter becomes still more striking. Or, when coal and water are also to be measured, and the weighing or measuring of both, and the calibration of all the heavy apparatus used for the purpose, as well as the personal errors due to making observations of large quantities under awkward physical conditions, in a minimum of time and in the worst of atmospheres, are considered, the uselessness, and, indeed, the absolute inaccuracy of extremely minute figures, become absolutely glaring. It is sometimes useful, no doubt, under these conditions, to work out results to four significant figures for the sake of mere arithmetical checking; but no one who has had anything to do with the matter would suppose for a moment that more than three figures were of the least importance, and the statement of results of observations in five or six figures merely causes the enemy to scoff. Let me again say here that I am not suggesting, and I do not think, that an experiment of a technical nature is unscientific because its result is only capable of expression within one or two per cent. instead of within one or two hundredths per cent. I wish only to urge very strongly that in a really scientific spirit such an experiment must be undertaken only with a distinct recognition of its limitations, and of the limitations of accuracy of result such as I have roughly indicated.

But I must claim for technical experiment that it is truly scientific work if only it be conducted with full recognition of its conditions and limitations, and not as if it were a laboratory experiment badly done—a mistake which I fear is too often made. Let it be recognised first of all that our object is generally the determination of certain facts, or quantities, or ratios, which are to be found under certain very complex conditions. As I have elsewhere said, the duty of the engineer is to recognise these conditions and deliberately to include certain of them in his experiment. The physicist has to spend much thought and trouble on the modification of conditions, which are disturbing elements in his work. All conditions which might modify his main result, or which might make it difficult for another experimenter to obtain precisely the same value for the quantity looked for, have to be either eliminated or evaluated. The conditions are his enemies, in fact. Otherwise with us, the conditions in general form part of our problem, and for many purposes the reduction of the experiment to its lowest terms, which is the object of the physicist, would not only be impossible, but would, if it could be done, make the result quite useless to us.

The determination of the efficiency of a steam engine is, of course, a very common piece of work, and may serve as an illustration of the two different ways of approaching such a matter in connection with this question of conditions. From the physical point of view, I imagine it would be best to endeavour to reproduce the working of the much-abused Carnot cycle.[†] If this were absolutely successful it would merely give us a result which would agree with those which we can already calculate from the physical data which are in our possession, and this result would add nothing to our present knowledge, nor would it give any additional help to the designer of steam engines.[‡] But it would, if it could be carried out, be an experiment strictly physical, and following in the lines of, for instance, Joule's classical experiment on the mechanical equivalent of heat. The engineer, on the other hand, who has to work at the same problem, has to deal with it in the fashion in which it is now handled in so many engineering laboratories. He has to make himself an actual engine, in which the normal conditions of engine working—as to loss of heat by conduction, condensation, radiation, and so on—are, or can be, reproduced, and he has to make his experiments on this machine, and as nearly as possible under conditions resembling those under which engines normally do work. Then one by one certain of the conditions may be altered, so that some estimation may be made of the effect of each. So may be obtained figures as the result of *bonâ fide* technico-physical experiment, which are also in a form more or less directly applicable to engineering work.

I have just mentioned the variation of conditions one by one. This is hardly a matter which I need insist on. It is of great importance even in a physical experiment, where all the conditions are simplified to the last extent; but in a technical experiment, where the conditions themselves are very complex and often not easy to grasp, it is obviously vital. It is no doubt one of the great difficulties of all technical experiment to find out exactly what the conditions are, and it may in many cases need more experience and more care to determine and define the actual conditions than it does to carry out the measurements involved in the experiment. This is a matter which will be recognised by every one who has had to do with work of this kind, but about which probably it is unnecessary to say more here. Bearing on it, however, is a matter which may fairly be mentioned, namely, the combining of the results of several technical experiments. This is often very tempting, but is always very difficult. A simple case is, for instance, the determination of the efficiency and of the economy of a steam engine. A certain experiment may show a certain maximum efficiency; another experiment, on a more or less similar machine, but carried out at another time, may show a maximum economy. Naturally there is a strong temptation to state both maxima as belonging to the machine tested. It is no doubt possible that they may do so; but, on the other hand, without the most minute knowledge of the circumstances of the case, it is quite unsafe to assume that they do, and in this respect the difference between the general character of purely physical work and the special character of technical experiment comes into clear relief.

In fact it is much more difficult to handle rightly the results of engineering experiment when they have been determined than those of pure physics. It is by no means always, or obviously, easy to apply these last, at least one has known very ludicrous mistakes to occur through their misapplication. For instance, I have seen elaborate calculations based on the determination of the weight of steam used by an engine from the pressures shown by an indicator card and the measured dimensions of the engine; and quite recently I was confronted with certain supposed phenomena, which rested entirely on the assumption that a vessel of certain dimensions actually received from a steam-pipe suddenly opened to it only the weight of steam corresponding to its volume and its pressure shown by a gauge. In both cases the troublesome phenomena of condensation were entirely left out of account, and the result of a purely physical determination was applied to a technical problem with very disastrous results. But it is infinitely more difficult often to interpret and to apply the results of our own experiments. For instance, let it be found that one boiler, engine, and dynamo together require the consumption of so many pounds of coal per electrical unit, how much coal per unit will another boiler, engine, and dynamo require? Put baldly into this form the question sounds ridiculous. But after all, is it any more absurd than our constant endeavour—that is, before the days of the present development of engineering experiment—to arrive at similar comparative conclusions from the, doubtless unimpeachable, figures of an engineering pocket-book? I am sure there must be many of us who can still recollect how painfully we endeavour to make the statements of Molesworth furnish us with an answer to our own problems, and how entirely we failed to get things to fit in. I do not suggest that the fault lay with the pocket book; the fault lay in the endeavour to correlate figures and results which in no way belonged to each other, which represented the result of experiments made under conditions quite unknown to us, but certainly varying from each other, and no less from the conditions—possibly also unknown to us—of the problem we actually were trying to work out. I dare say that many of us who have been hungry and thirsty for facts and figures during most of our lives, remember very well the joy with which, at a certain stage, we put down in our note-books any kind of experimental results of which we could hear, or of which we could obtain possession by any means, whether they related to steam engine trials, or to girder tests, or to the discharge over weirs—I do not say to dynamo trials, because there were no dynamos in those days! And I am sure that all of us must have suffered pain and disappointment later on when we found how extremely difficult it was to make any use of the much-valued figures that filled our pages—they would never, somehow or other, seem to tell us just what we wanted; there was always something about them which eluded us, one particular matter of vital importance in the data, or in the result, of which we had no memorandum. The fact is that it is always extremely difficult to apply accurately the results of experiments made by others, however carefully made and however accurately described. To realise this, even in reference to purely physical work, one need only see how many pages in the "Philosophical Transactions" are sometimes necessary to describe the methods and precautions involved in a determination which has not one-tenth the complexity of such matters as we are compelled constantly to try to measure.

To anyone who wishes to realise to the full the difficulty of dealing with, or applying, the very simplest kind of experimental result, I recommend the maddening task, so often lightly spoken of by those who have not tried it, of calibrating indicator springs, and then trying to apply the results to the correction of the corresponding indicator diagrams.

The fact is that no one can usefully apply physical results who has not himself studied the methods by which these results are obtained, either by the royal road of work in a physical or technical laboratory, or by the hard and up-hill method of self-education in the making of technical experiment, without the advantage of the preliminary training which I have mentioned earlier; and hence the importance of the knowledge of how to make accurate observations, which I have insisted upon as a thing quite apart from the knowledge of the actual figures to be obtained by such observations. It would perhaps be cruel to say that no one can usefully apply physical results who has not studied the methods by

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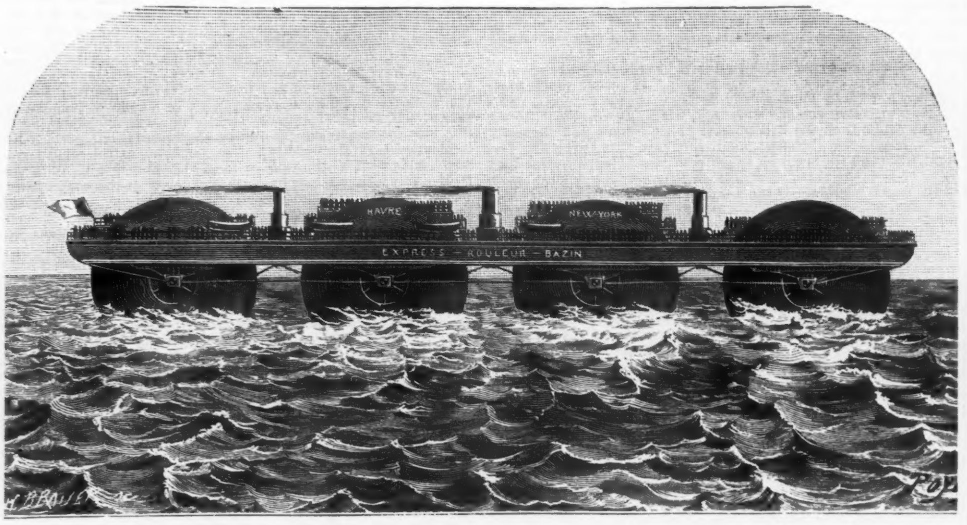
[*] I think probably the only notable exception to be made in this matte, is in regard to scientific experiments relating to strength and elasticityr some of which have been made by engineers and with a more or less definitely technical intention. But probably such men as Bauschinger, Martens, and Tetmajer, are to be considered essentially as in the position of physical workers.

[†] I need hardly say that I do not for a moment suggest that any physicist would wish to obtain experimentally a result for which he has already given us all the constants, and which we can therefore completely obtain by calculation based on physical results already before us.

[‡] I do not wish here to be understood in the least as sharing that great objection to the Carnot cycle which I know fills the breasts of some of my friends. It appears to me that it would be just as reasonable to object to the asymptote of a hyperbola or to the line at infinity! We require these limiting cases, and should get on very badly without them, and I am not inclined to say that they are useless—indeed, I think they are extremely useful—although I am perfectly conscious that they represent a state of affairs which is technically, and even physically, unattainable.

THE BAZIN WHEEL STEAMBOAT

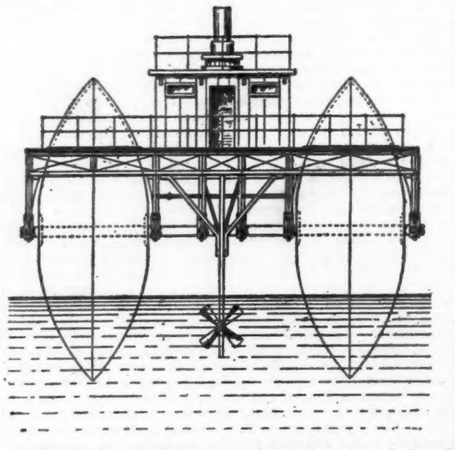


which they are obtained, were it not that nowadays the possibility of such study is open to everybody. One may therefore state the truth in this matter without the fear of making anyone unhappy. I do not know whether I should be far wrong in suggesting that a certain amount, perhaps a great deal, of the very rapid improvement which has taken place in late years in engineering practice in respect to efficiency in the working of machinery, economy in the production of energy, and economy also in the use of material, has been due directly or indirectly, or both, to the growth of the habit and knowledge of experiment among the present generation of engineers. No one who is familiar with the progress in such matters as I have this evening dealt with, during the last twenty years, and has noted the extraordinary development which has taken place, can fail to be struck with it. No doubt a considerable part of this development has been due to the better education generally of engineers, and particularly to the great extension of engineering literature, in which undoubtedly the engineering newspapers have played a most honourable and important part. But these general causes in themselves would not, I believe, have been sufficient if it had not been for the contemporaneous development of what I may venture to call experimental training, accompanied by a demand on all hands from inventors, manufacturers, and even from the public, for reasonably exact numerical statements in relation to everything which can be measured, instead of the vague generalities which used to pass muster as critical examination of the advantages and disadvantages of any new proposals.

I hope I need not say here that I quite recognise that an engineer's life is not made of experimentation, and that the work of *doing* is even higher than that of *measuring*, at least from our point of view. But in dealing with my subject of to-night, I am, of course, bound to take up and emphasise this aspect of engineering work. I hope that it may be considered that I have been able to justify my choice of a subject which at first might appear so limited, but which in reality I believe so important, as that to which I have addressed myself this evening — the relation of physical experiment to engineering.

THE BAZIN DISC WHEEL STEAMBOAT.

CURIOUSLY enough interest is being taken by French marine engineers in an experimental vessel now being constructed at the Saint-Denis Works of the Cail Company for a concern which was formed some time ago to work a so-called new system of propulsion of M. Ernest Bazin. It is hoped that this novel boat, which has already been in hand six months, will be launched in July next, and it will make its first trial trip across the Channel as soon after that date as possible. Writing on this subject our Paris correspondent says:—"Though at one time the *navire rouleur*, as it is called in France, met with a great deal of criticism among marine experts, who were rather sceptical as to the success of this new departure from the generally accepted ideas of naval design, it is significant that a fuller acquaintance of the theory laid down by M. Bazin has led them to place faith in the capabilities of the disc wheel vessel. This theory is by no means a new one with M. Bazin, who has been working at it for twelve years or more, and an inspection of the models to be seen at his works at Levallois shows that the system has been applied in a great many different ways before the inventor was able to evolve the remarkable vessel which is now to be put to a practical test. It may be said that the first idea of M. Bazin was to apply a revolving motion to the vessel for the driving action in order to overcome the enormous waste of power due to the resistance of the water and the friction. As is well known, this resistance is proportional to the square of the speed of the vessel, and as the ratio of horse-power necessary to drive a ship increases enormously with the high speeds sought to be obtained, it is believed that the limit in the keel boats has almost been reached. In the problem which he has set himself to solve, M. Bazin believes he has suppressed the resistance of the water to the forward movement of the vessel, and in so doing he has not only added to the speed, but has secured, he says, great economy in motive power as well. To attain this end he designed a vessel in which a flat rectangular deck would be supported by hollow disc wheels of steel running upon their axes. Experiments were made to show the action of these wheels in the water, and in the presence of a large company they were repeated a few days ago by M. Bazin in a tank constructed for this purpose at his Levallois Works. First, a hollow wheel was placed in the tank, and it floated vertically with about a third of its bulk immersed. Spun round without any forward movement, the wheel continued to revolve for some time without moving from its place, and this proved to M. Bazin that he could not rely upon the revolution of the wheel alone for the propulsion of the vessel. He then pushed the wheel forward without revolving it, and the effect was exactly the same as with an ordinary keel, that is to say, it threw up a good deal of water in front and left a trail behind. Moreover, it only advanced four or five feet, and did not show the slightest tendency to revolve. This convinced M. Bazin that he would have to give to the wheel both a revolving and a forward motion. Thereupon, spinning the wheel and pushing it forward, the hollow disc travelled the whole length of the tank with scarcely any agitation to the water whatever. Still pursuing the experiments, the inventor gave a more convincing illustration of the absence of any resistance and friction with the revolving disc. Two sticks were placed in the water, and a disc was propelled horizontally. On meeting the sticks the wheel pushed them forward a few inches and then stopped. Repeating this experiment with a revolving disc, the wheel passed over the sticks, which sank under the wheel and rose at the identical place, while the disc continued its course to the end of the tank. After thus proving that the wheel must have both a revolving and a forward movement, M. Bazin soon found that nothing was to be gained by revolving the disc too quickly, and that it was merely necessary to do this in proportion to the propelling force of the screw. If anything, too much power upon the wheels would be likely to cause a certain amount of friction. Under these circumstances, the relative power upon the propeller and the wheels would have to be calculated with a certain nicety, as the discs would have to turn in exact proportion to the distance covered by the boat. This fact having been settled, M. Bazin proceeded to demonstrate the stability and speed of the wheels. A framework carrying six disc wheels, three on each side, was placed in the tank. A cord was attached to it and drawn up over a pulley, and carried a weight of 200 grammes, which represented a certain propulsive force. The frame was pulled back to one end of the tank, and allowed to go forward by the action of the weight at the end of the cord. According to the watch, the time occupied in travelling the whole length of the tank was twenty-three seconds. The same experiment was then repeated with the wheels revolving by clockwork, and though losing two or three seconds at the start before getting up full speed, the apparatus went from one end of the tank to the other in eleven seconds. By comparing these results, M. Bazin estimates that the speed of a disc wheel steamboat would be 31 or 32 knots, while the smaller power required results, according to his estimate, in an economy of about 66 per cent. of coal. One of the advantages claimed for the system is the practical impossibility of sinking. Supposing that one or two, or even more, of the wheels were perforated in collision, the vessel would not do more than sink a few feet, a fact which was exemplified by the inventor removing the plugs from two of the wheels, and allowing the water to enter. As soon as the water had entered to a certain height in the wheel, it turned up with the orifice at the top, thus permitting of the damage being repaired with the greatest ease. Meanwhile, it would be possible for the vessel to proceed at reduced speed. Having thus, as he considers, demonstrated the speed, economy, stability, and safety of the Bazin wheels, the inventor showed a working model in a large basin constructed for that purpose. As the model is on a scale of one-twenty-fifth of a Transatlantic boat, which it is proposed to build with a length of 130 m., the deck or platform represents a height of six or seven metres above the sea, while the upper deck is about 13 m. above the water level. The deck itself is built up with girders, and being hollow, it has an enormous carrying capacity, either for merchandise or coal. There are eight discs or floats, four on each side, and owing to their convex form they offer little resistance to the wind, while the head wind has a clear passage underneath the deck. In appearance the model is very elegant, and certainly destroys any prejudice that might be entertained against the form of the vessel. The motive power was supplied by dynamos, one working the propeller and four others turning the floats. Upon the connection being made the propeller revolved with great rapidity, and the wheels turned slowly, and after a few seconds lost in getting under weigh, the model sailed the whole length of the basin at great speed. To show the conduct of the vessel in rough weather, the water was agitated to represent waves, on the same scale as the model, of five to seven metres in height, and though rolling slightly at her moorings the model behaved splendidly when in motion. The miniature waves rose nearly to the level of the deck, but the model rode as steadily as in the previous experiments. It is claimed that in the roughest weather the passengers would feel very little movement of the vessel. In the experimental boat now being constructed the steering is done with an ordinary rudder, but it is proposed to steer the Transatlantic vessels by means of a column of water forced out of the stern by a pump, so that instead of the progress of the vessel being impeded by the resistance of a rudder, it will be assisted by the water thus expelled at the stern. On the boat taking up its berth it may be driven by the steering gear alone, and this acts, it is alleged, so efficaciously that the vessel can be turned round its own length.

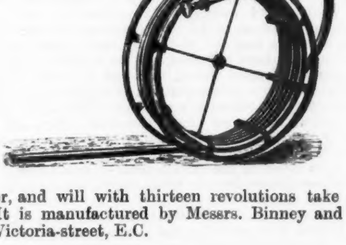


"It may be added that Admiral Coulombeaud, one of the foremost naval authorities in France, is taking a keen interest in the Bazin disc wheel boat, which he thinks is destined to effect great things in the water transport of the future. He admits having been sceptical as to the practicability of the system when it was first mooted, but after making a close study of the invention, he has fallen in with most of the ideas enunciated by M. Bazin. After going to some pains in making a comparison between the *navire rouleur* and the ordinary keel boat, the Admiral has come to the conclusion that the Bazin boat requires only about twenty-seventh of the power necessary to drive an ordinary boat of the same size at a given speed. Taking the Transatlantic Touraine as an example, he further states that if this vessel travelled at 20 knots, the disc wheel boat, with the same horse-power, would attain a speed of 47 knots; but as it is not proposed as yet to construct a vessel to run at more than 30 knots, such a boat would only require a fourth of the power employed in the Touraine. His deductions also show that the power necessary for the floats is one fourth of that employed for the propeller, and upon all the other points he is in accord with M. Parrot, professor of the Ecole Centrale, who has drawn up an exhaustive theory of the working of the Bazin boat. Admiral Coulombeaud does not believe that the present form of the disc wheel boat is a permanent one. It will be greatly modified to suit the different conditions of transport, and this is especially the case with the floats, though for Transatlantic vessels the present disc wheels could hardly be improved upon. The opinions thus expressed by some of the leading naval authorities in France give special importance to the trials that are to take place before long with the experimental vessel now being built, and if successful it is probable that a boat will be put in hand to run between Havre and New York. The following dimensions of the boat now building at the works of the Cail Co. may be interesting:—Number of floats, 6; diameter of the floats, 10 m.; length of the boat, 39 m.; breadth, 12 m.; superficial area of the midship frame, about 50 m.; burden, 274 tons; power developed by the boiler, 700-horse power, of which 550-horse power will be upon the propeller and 150-horse power on the axes of the floats. There will be a separate engine for the propeller and for each pair of disc wheels."

We have here history repeating itself. The boat on rollers is an invention as old as the steam engine.

GOSSAGE'S HOSE REEL.

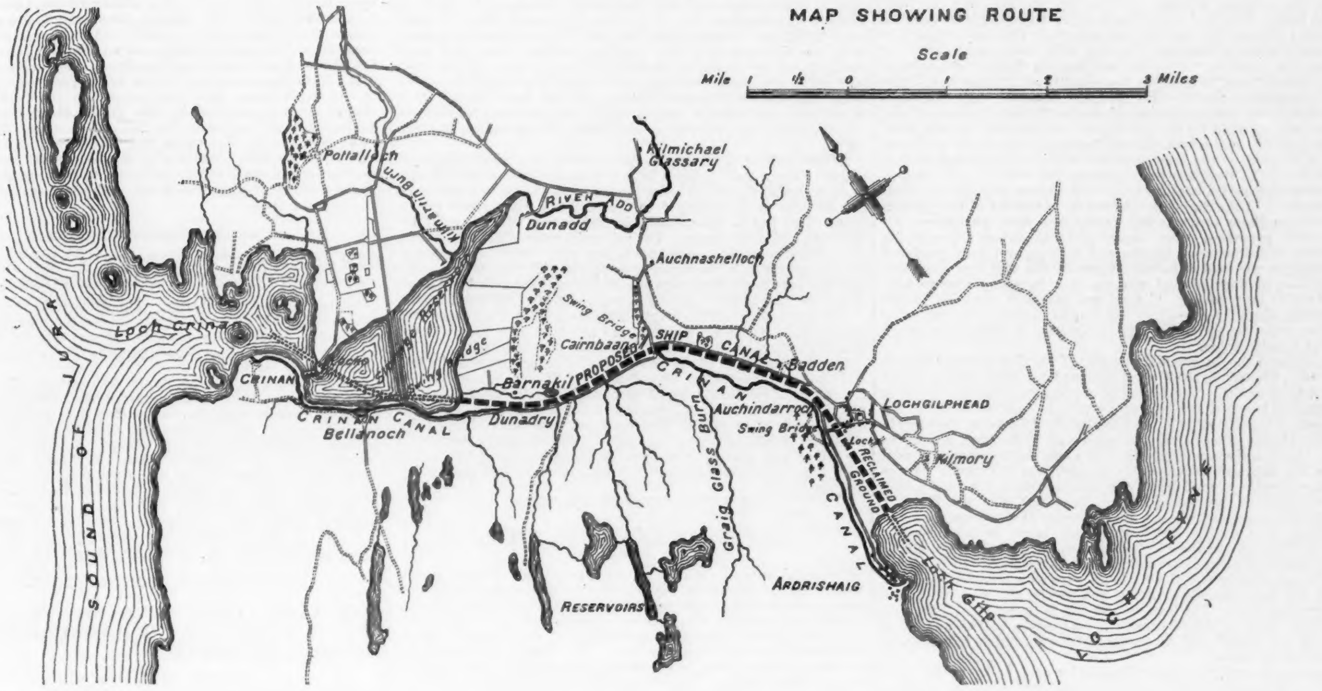
WE illustrate a very simple and handy reel for garden hose. The engraving explains itself. The drum of No. 1 is 18in. in diameter, and will with thirteen revolutions take 60ft. of hose. It is manufactured by Messrs. Binney and Son, 62, Queen Victoria-street, E.C.

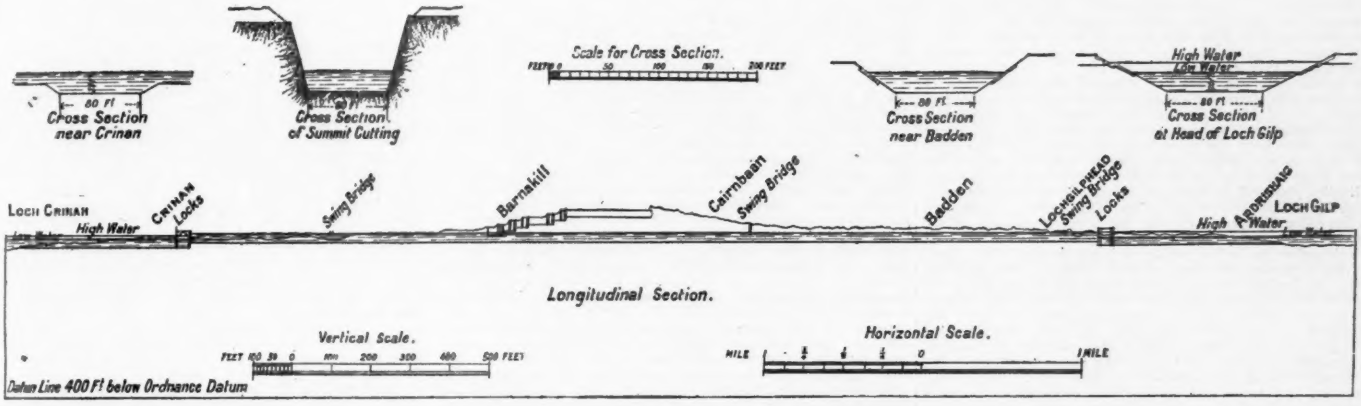


TRADE AND BUSINESS ANNOUNCEMENTS.—Mr. F. Heron, who for the last ten years has been general manager of the large works of the Phœnix Iron Company, Phœnixville, Pennsylvania, resigned his position, and has been appointed general manager and director of the Universal Construction Company, with works and offices in Chicago, Illinois. The Universal Construction Company has taken the North Chicago works belonging to the Illinois Steel Company, and is engaging in all classes of structural work.—Messrs. William Simons and Co., Limited, Renfrew, have received an order to construct a large and powerful hopper dredger for Devonport. The vessel is to be employed in removing blasted rock, and is the second vessel ordered for this purpose.

KING'S COLLEGE ENGINEERING SOCIETY.—At the general meeting on May 8th—Professor Adams in the chair—Mr. Mowat read his presidential address, his subject being "Horseless Carriages." The author commenced by briefly referring to their early history, describing and illustrating—by lantern slides—the various productions of Trevithick and other pioneers of steam road traction. He next cited several examples of coaches which had actually achieved considerable success on the road—those of Gurney, Hancock, Maceroni, Squire, and Hill—attributing their financial failure to oppressive tolls, the then existing railway mania, and also to public prejudice. Mr. Mowat then spoke of the rekindled interest in mechanical road carriages, resulting from their general use on the Continent and of the encouragement THE ENGINEER had given to motor carriage builders. Passing from this he briefly discussed the various advantages and disadvantages of different means resorted to for locomotion, the petroleum engine, electric and steam motors, showing that each had its good points. A few remarks on speed and gearing closed the paper. Mr. Mowat provided a large number of lantern slides of the various types of carriages. The meeting closed with a vote of thanks to Mr. Mowat for his most interesting and instructive paper.

THE CRINAN SHIP CANAL


MAP SHOWING ROUTE
Scale
Mile 1 ½ 0 1 2 3 Miles
Kilmichael Glassary
River Add
Dunadd
Poltalloch
Kilmartin Burn
Auchnashelloch
Loch Crinan
Crinan
Swing Bridge
Cairnbaan
Barnakil
Proposed Ship Canal
Badden
Crinan Canal
Bellanoch
Dunadry
Auchindarroch
Lochgilphead
Kilmory
Reclaimed Ground
Canal
Craig Glass Burn
Reservoirs
Ardrishaig
Loch Gilp
Loch Fyne
Sound of Jura


80 Ft
Cross Section near Crinan
Cross Section of Summit Cutting
Scale for Cross Section.
FEET 0 50 100 150 200 FEET
80 Ft
Cross Section near Badden
High Water
Low Water
80 Ft
Cross Section at Head of Loch Gilp
Loch Crinan
High Water
Low Water
Crinan Locks
Swing Bridge
Barnakill
Cairnbaan Swing Bridge
Badden
Lochgilphead Swing Bridge
Locks
Ardrishaig
High Water
Loch Gilp
Low Water
Longitudinal Section.
Vertical Scale.
FEET 100 50 0 100 200 300 400 500 FEET
Horizontal Scale.
MILE 1 ¾ ½ ¼ 0 1 MILE
Datum Line 400 Ft below Ordnance Datum

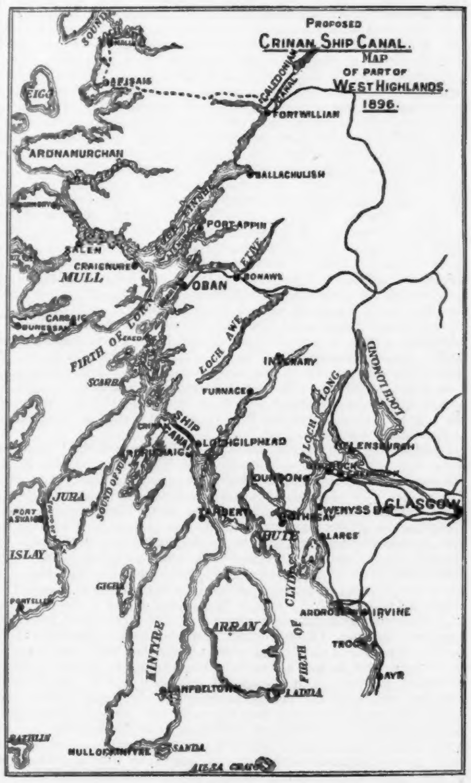
THE CRINAN SHIP CANAL.

We have recently laid before our readers—ENGINEER, April 3rd, 1896—some information concerning the conditions of the Crinan Canal, which is attracting serious attention, and have given some particulars of proposals to form a new ship canal along the same route, capable of accommodating vessels drawing 18ft. of water. We now give some details of the proposed canal, but a short account of the present canal will in the first place be of interest.

The present Crinan Canal connects Loch Fyne with the Sound of Jura, and affords a sheltered passage from the Clyde to the West Highlands and islands, eighty-five miles shorter than the exposed voyage round the Mull of Kintyre, a promontory much obscured by fogs, and subjected at all times to strong currents, and the full force of the Atlantic Ocean. Leaving the sea in the Loch Gilp branch of Loch Fyne, the canal passes for about 2½ miles due north, for the most part along the shores of South Knapdale, thence in a north-westerly direction it runs through the Vale of Dail, where the summit level occurs, and finally, after traversing the shores of inner Loch Crinan, the canal enters the sea at Crinan, the total length being nine miles.

No less than eight locks occur between Loch Gilp and the summit level—which is 59ft. above high water of spring tides —and seven locks between the summit level and Loch Crinan —thirteen of them being 96ft. by 24ft., and the remaining two, at Crinan, being 108ft. by 27ft. The average depth of water in the canal is about 11ft., affording passage to vessels drawing 9ft. 6in. Nine reservoirs in the Knapdale Hills, ranging from 8ft. to 25ft. in depth and from 6 to 45 acres in extent, feed the canal, the surplus water passing into Loch Sween in the Sound of Jura. The canal is chiefly cut through chlorite schist, traversed by trap dykes, showing indications of considerable geognostic disturbance. The undertaking was authorised by Act of Parliament in 1793, and was carried out by John Rennie, father of the perhaps more famous engineer of the same name. The original capital was £120,000, in 2400 shares of £50 each, the first chairman being John, Duke of Argyll.

The canal was opened for traffic in 1801, and owing to bursts which occurred in 1805 and 1811, and great trouble both with reservoirs and embankments, received Government assistance for works and repairs. Without detailing the financial history of the enterprise, we may briefly state that by 1814, in addition to its share capital, the canal had incurred £67,810 of other obligations. In 1816 an Act of Parliament empowered the Barons of the Exchequer in Scotland to advance £19,400 to be expended under the supervision of the Caledonian Canal Commissioners, and this sum was spent by Thomas Telford in 1817 in repairing and renewing the lock gates, in providing new cast iron bridges, and in forming the breakwater at Ardrishaig harbour to enlarge and increase the shelter. Subsequently, by order of the Treasury, the pecuniary affairs of the canal were placed under the Barons of the Exchequer at Edinburgh, and by Act of Parliament in 1848 a new body of Caledonian Canal Commissioners was appointed, and the Caledonian and Crinan Canals vested in them as one undertaking. The Commissioners are the Speaker of the House of Commons—chairman —the Chancellor of the Exchequer, the First Lord of the Admiralty, the Vice-President of the Board of Trade, the Lord Advocate of Scotland, and the member for Argyllshire, with whom are associated the Duke of Argyll, Colonel Malcolm, of Poltalloch, and several other prominent noblemen and gentlemen connected with the district. The secretary is Lord Duncannon.


Proposed Crinan Ship Canal. Map of part of West Highlands. 1896.
Caledonian Canal
Fort William
Arisaig
Eigg
Ardnamurchan
Ballachulish
Port Appin
Mull
Craignure
Oban
Firth of Lorn
Loch Awe
Furnace
Inveraray
Ship Canal
Lochgilphead
Ardrishaig
Loch Long
Jura
Islay
Gigha
Kintyre
Tarbert
Bute
Dunoon
Glasgow
Largs
Arran
Firth of Clyde
Ardrossan
Irvine
Troon
Ayr
Campbeltown
Ladda
Sanda
Mull of Kintyre
Rathlin
Ailsa Craig

The traffic carried by the canal consists mainly of coals, bricks, barley, and general merchandise going north, and of slates from the Easdale and Ballachulish quarries, and granite from Mull and Bonawe quarries, with produce going south, whilst fishing boats use the canal freely, and the passenger and tourist traffic in the summer months is very large. The revenue is, however, decreasing on account of the small size of the locks and of the canal being insufficient in depth to carry the larger class of vessels now being employed in the West Highland traffic, which have, therefore, been forced to go round by the Mull of Kintyre. The canal, in short, is in exactly the same condition as when opened nearly 100 years ago. As far back as 1839, competent authorities pronounced the canal too small, and its enlargement was called for. The matter has, however, remained in abeyance, notwithstanding the enormous developments of the past half century.

The scheme now being actively canvassed consists in the formation of a ship canal with a uniform depth of 20ft. of water, capable of navigation by vessels of 1500 tons at all states of the tides; as contrasted with the present canal, to which access can only be gained at Ardrishaig for five or six hours of each tide. The summit level will be only 6ft. above high water of spring tides in Loch Fyne, and only one lock will consequently be required at each end. From lock to lock the length will be six miles, but including the dredged entrance channels, the total length will be nearly eight miles. The engineers of the scheme, Messrs. Crouch and Hogg, of Glasgow, departing from the route of the existing canal, have selected the lowest ground throughout, and with the exception of a stiff bit of rock cutting between Cairnbaan and Dunardry, the work presents no features of difficulty, the material being such that it could be readily excavated by dredgers cutting their own flotation. A storage reservoir will be formed at Crinan, whilst the reclamation of the foreshore —300 acres—at the head of Loch Gilp, with the excavated material, forms another feature of the undertaking. Estimates of traffic show a return of about 2½ per cent. on the calculated cost of £500,000. The benefit to the Highlands and islands will be incalculable, and the prosperity of this extensive district, and the improvement of the condition of its population by affording direct access to the commercial centres of Scotland, can hardly be over-estimated.

THERMAL EFFICIENCY OF STEAM ENGINES.—With a view to arriving at a definition of a standard or standards of thermal efficiency for steam engines, the Council of the Institution of Civil Engineers has remitted the question to the consideration of a committee, comprising the following members:—Dr. Alexander B. W. Kennedy, Member of Council, and Messrs. T. Hudson Beare, Bryan Donkin, James A. Ewing, J. Macfarlane Grey, Michael Longridge, W. H. Maw, and H. Riall Sankey.

THE INSTITUTION OF CIVIL ENGINEERS.

THE EQUIPMENT AND WORKING OF ROLLING MILLS.

AT the ordinary meeting on Tuesday, the 5th May, Sir Benjamin Baker, K.C.M.G., the President, in the chair, two communications dealing with English and American practice in regard to the equipment and working of rolling mills, were read.

The first paper on "American and English Methods of Manufacturing Steel Plates," was by Mr. Jeremiah Head, M. Inst. C.E. Mild steel was made by the Bessemer acid, the Bessemer basic, the open-hearth acid, the open hearth basic processes. Of these the two basic processes were suitable for phosphoric, and the two acid for non-phosphoric pig iron. Plates were made in England by the open-hearth acid, and in America by the Bessemer acid and by both the open-hearth processes. The Bessemer basic process had scarcely yet obtained a footing in America because of the abundance of pure ores from the shores of Lake Superior. About three-fourths of the pig iron made from these ores was sufficiently free from phosphorus for the acid processes. The capacity of American open-hearth furnaces varied between 15 tons and 35 tons, and they produced ten charges per week. In basic furnaces the slag was less abundant than in England, and was too poor in phosphorus to be a marketable by-product. Natural gas was still available in the Pittsburg district for heating, but was becoming scarce, and at its present price was as costly as producer gas, in spite of its much higher calorific value.

In England the intermediate process of cogging was now almost universal, whereas in the United States plates were usually rolled direct from ingots. The former plan permitted the use of larger ingots, and lessened the risk of wasters, as well as reducing the number of ingot moulds in use and slightly decreasing the waste in scrap. On the other hand, it entailed two re-heatings instead of one. An American melting-house, in which the ingots were poured from the top and subsequently cogged, was described. It was arranged on the ground level, with the exception of a small pit for the reception of the casting ladle. When full, this was lifted by an electric crane and poured into a series of ingot moulds, each standing on a bogie. These were then taken to the stripping-house, where an overhead hydraulic stripper held the ingot firmly down and at the same time stripped off the mould. In a typical English melting-house, the furnaces were on a charging platform, while the ingot moulds, standing in a casting pit, were filled from a travelling ladle. The moulds and ingots were lifted by steam cranes in front of the furnaces. A comparison of the number of lifts on the English and American systems showed an advantage in favour of the latter.

Ingot soaking furnaces were heated by coal, or by producer or natural gas, except in one case in Scotland, where no external heat was applied. Vertical furnaces with the lids level with the floor were in favour both in England and America. Where direct rolling was adopted, the ingot moulds were arranged in groups of six on a base-plate, and were filled from below by ducts radiating from a central runner. The upper ends of ingots so made were usually sounder than if they were cast from the top.

The typical American plate mill consisted of a single stand of three chilled rolls, driven by a single-cylinder non-reversing engine through a set of three pinions. The middle roll, which was smaller in diameter than the other two, was not driven. A copious supply of water kept the rolls constantly cool. The live roller tables in front and behind were pivoted, and were raised and lowered to admit the piece through the top or bottom openings. The English plate mill consisted of two stands of two rolls each, worked dry and driven by a pair of reversing engines. There were fixed live roller frames on one side and a traversing one on the other.

The American method of rolling an ingot tapered in two directions into a rectangular plate of equal thickness was next described. In England the cooling and flattening of the plate was effected on an iron-plated floor, and required a considerable amount of space and manual labour. During shearing the plate was manipulated by a gang of twelve men. A truck with universal motion had been introduced to assist in this operation, but had not been generally adopted. In America the plates as they left the rolls moved slowly along a series of live rollers 360ft. long, cooling on the way. At the far end, having been inspected and marked in transit, they were delivered to the shears. During the shearing operation the weight of the plate was supported by a number of inverted castors, which allowed it to be moved horizontally in any direction. The sheared plate was deposited in the railway wagons by an electric crane.

The ratio of saleable plates to ingots was much higher in steel than in wrought iron manufacture, because of the smaller furnace waste and the smaller allowance necessary for shearing. A table was given comparing results where ingots were cogged and where they were rolled direct. A plate mill, supplemented by a cogging mill, had nearly twice the capacity of one not so assisted. The yield and output were largely influenced by the shape and size of the plates manufactured.

The turning of the rolls to ensure uniformity of thickness of the plates was a somewhat delicate operation. The central portion of the roll was apt to become hotter than the ends, and the differential velocities thus caused tended to produce buckling of the plate. To compensate for this the rolls were often turned slightly hollow. A fresh difficulty arose in rolling very broad plates by the springing apart of the rolls. This could not be altogether avoided, and could only be minimised by making the rolls as stiff as possible and keeping them cool.

The American standard plate mill was not suitable for very narrow or thin plates. It was therefore sometimes supplemented by a universal mill for strips of breadths not exceeding 3ft. The English standard plate mill was smaller than the American, and was often supplemented by a larger mill for very broad plates, and also by a sheet mill.

Modern English plate shears were driven by a pair of reversing engines, which were capable of cutting 2in. plates without a fly-wheel, and were somewhat larger than American shears. The latter were driven by a single cylinder with a fly-wheel.

In the second paper on "Four American Rolling Mills," by Mr. Samuel T. Wellman, four mills, typical examples of modern American practice, were described in reference more particularly to the appliances which, during the last ten or eleven years had been brought to a high degree of perfection, to save labour and time in the passage of the material through the successive processes. In American Bessemer steel works where rails were made, the three-high blooming mill was almost exclusively used, having proved its superiority for producing large quantities of blooms of one size. The two-high reversing mill was, however, preferable when many sizes of blooms and slabs had to be manufactured, as all sizes of squares and flats within the range for which the mill was adapted could be dealt with on one set of rolls. The tendency was in the direction of the manufacture at every works of all sizes and shapes, so that it seemed likely that the reversing mill would largely take the place of the three-high blooming mill. The use of the three-high or Fritz mill was almost universal in the United States for finishing rails and other heavy bars.

At the Joliet works of the Illinois Steel Company the rail mill was fitted with automatic machinery, and the blooming mill was equipped with Siemens regenerative ingot heating furnaces and Wellman electro-hydraulic charging machines. The ingots were brought in front of the heating furnaces from the converting works on wagons, and all the operations for dealing with them at the furnaces were effected by these machines, the power for driving which was stored in a tank, charged first with air to a pressure of 100 lb. per square inch, and then with water until the pressure reached 400 lb. per square inch. The ingot, on leaving the furnace, was carried on a wagon driven by a wire rope to live roller tables, along which it travelled to a three-high Fritz mill with the three rollers fixed, the ingot, measuring 16in. by 6in., being rolled in thirteen passes to 7½in. by 5½in. The bloom was carried over driven rollers to the bloom shear, where the ends of the bloom were cut off and the remainder cut into two pieces, each of which was rolled into two rails. The scrap bloom ends dropped on a conveyor in the pit under the shear, by which they were lifted and dropped into wagons. The blooms now passed from the shears, first to the roughing rolls, at which they were manipulated by automatic machinery, then to the finishing rolls and on to the saws. The greatest output of the mill in twelve hours had been 679 tons of billets, and the best month's work 27,003 tons, the average output being about 500 tons per shift of twelve hours. The number of men employed was thirty-five per shift.

The rail mill at the South Works of the Illinois Steel Company, South Chicago, was equipped with a three-high blooming mill and finishing train, the ingots being heated in vertical gas furnaces of the Siemens type, arranged to use producer gas or crude petroleum. The ingots were drawn in and out of the furnaces by Wellman hydraulic cranes. The rail trains were 27in. in diameter, and were fitted with lifting and tilting roller tables for carrying the bloom through the successive passes. The capacity of the mill was very great, 1025 tons of rails having been rolled in twelve hours, and the monthly output having reached 38,093 tons.

The new rail mill at the Edgar Thompson Steel Works was next described. Its capacity had hitherto not been fully tested, but a monthly output of 36,300 tons of rails had been reached.

The new plate mill of the Illinois Steel Company was the largest and most complete in the United States. The train consisted of two stands of rolls of the Lauth three-high type, capable of dealing with ingots 24in. thick, and weighing seven or eight tons. The heating furnaces were of the Siemens type, and were charged by electro-hydraulic charging machines. Electric cranes were used for lifting and moving the plates at the cooling beds, for dealing with them at the shears, and for loading them into the railway wagons.

LAUNCHES AND TRIAL TRIPS.

THE trial trip of the last of the three steam hopper barges ordered by the Admiralty, and constructed by Messrs. Wm. Simons and Co., of Renfrew, took place recently at Skelmorlie with very satisfactory results. Six runs were made with and against the tide, and it was found that a speed of 9¼ knots was obtained, which was over the contract amount. The Admiralty were represented by Messrs. Hay, Stewart, and Scoggins, and the builders by Mr. Wm. Brown. The barge will in the beginning of next week leave for H.M. Dockyard, Devonport, where she is to be employed.

On Monday, April 27th, Messrs. Allsup and Co. launched from their shipbuilding yard at Preston, a steel twin screw tug, built to the order of the Preston Corporation. The dimensions are:—Length, 120ft.; breadth, 22ft. 6in.; depth, 11ft. The boat—whose yard number is 158—was named the Perseverance, and is a sister ship to the Enterprise, and both are principal tugs for work on the river Ribble. The hull was towed straight under the crane to receive the engines and boiler. The boiler weighs 27 tons, and is 14ft. 6in. diameter; the engines, two sets of compound surface condensing, with cylinders 17in. and 34in. by 24in. stroke, working at a pressure of 100 lb., built by Messrs. Allsup and Co. Messrs. Allsup have another tug of similar dimensions in frame, and a paddle excursion passenger steamer of 130ft. long well in progress, and a cargo steamer for the coasting trade ready for launching.

On Wednesday, May 13th, there was launched from the dockyard of Sir Raylton Dixon and Co., at Middlesbrough, the first of some steel towing vessels, built to the order of the American Petroleum Company, of Rotterdam, for the Scheepvaart En Steenkolen Maatschappy. These vessels are 170ft. in length, with a beam of 32ft. and depth of 13ft. 7in., having a deadweight cargo capacity of 1000 tons, and built under Lloyds' special survey, 100 A1. These vessels are intended for a new departure in the coal carrying trade across the North Sea. The screw collier, carrying herself 1700 tons of coal, will tow one of these craft with 1000 tons between the coal ports of the North of England and Rotterdam, and for this purpose they are specially constructed with water ballast, and fitted with sails and very heavy chains and anchors, so as to be quite independent and seaworthy, should the steamer have to cast them adrift at any time through stress of weather. The other vessels for the completion of this scheme are also being built by Sir Raylton Dixon and Co.

On Tuesday, May 12th, the s.s. Elizabeth Rickmers went for a very successful trial trip off the mouth of the Tyue. The steamer has been constructed by Messrs. Wigham, Richardson, and Co., to the order of Messrs. Rickmers, Reismuhlen, Rhederei, and Schiffbau, A.G., of Bremen, for their well-known Eastern service. She is built of steel on the web frame principle, 427ft. in length, 50½ft. beam, and 30ft. in depth, and will carry about 7200 tons deadweight on a moderate draught of water. She is also fitted with every accommodation for a limited number of passengers in the citadel amidships. The arrangements for working both ship and cargo are very extensive and of the most modern type, including eight steam winches as well as various other steam deck gear. The vessel is rigged as a two-masted schooner, and her lower masts are of such a length that she can go up the Manchester Ship Canal in ballast. The engines are of the quadruple-expansion type, self-balanced on the Yarrow, Schlick, and Tweedy system, and working at 215 lb. pressure. This type of engine is now coming to the front, not only on account of the saving in fuel due to the quadruple expansion, but also because of the absence of all vibrations due to the self-balancing. Messrs. Wigham, Richardson, and Co. have several more sets of self-balanced engines in course of construction for steamers of various descriptions. A large company of visitors were present at the trial trip, including Mr. Paul Rickmers, Mr. Heine, under whose superintendence the vessel has been built; Mr. J. Denham Christie, Mr. Patterson and Mr. Muir, of the builders' firm; Mr. A. Gulston, of Sir W. G. Armstrong and Co.; Mr. Duckitt, &c. During the trial the machinery worked in a most satisfactory manner, and immediately on the conclusion of the trip the vessel sailed for Middlesbrough under the command of Captain Andresen, to load.

On Tuesday last the ss. Leitrim, a fine spar-decked steamer built by C. S. Swan and Hunter, of Wallsend, for Mr. R. S. Hudson, of Sunderland, proceeded to sea on her trial trip. The vessel, which has been specially designed and constructed for the conveyance of frozen meat from the River Plate to the United Kingdom, is 365ft. between perpendiculars, by 48ft. 6in. beam by 30ft. 4in. depth moulded, and has been constructed to the highest class at Lloyd's for the carrying of a deadweight cargo of about 6500 tons. Two of the holds have been completely insulated for the conveyance of frozen mutton, and have an internal capacity of about 100,000 cubic feet, capable of carrying about 41,000 carcases. The refrigerating machinery, which is of the latest type, has been supplied by the Linde British Refrigeration Company on its system of ammonia and brine pipes; whilst for rapid handling of the frozen meat, as well as the deadweight cargoes, a large number of steam winches, with horizontal auxiliary boiler, which also supplied steam to the refrigerating plant, &c., and a complete system of quarter-breadth derrick posts and derricks, have been fitted in suitable positions, so that loading or discharging may be carried on at both sides of the vessel simultaneously. The derrick posts have been made of an unusual length, so that in the event of the vessel carrying cattle on the upper deck the derricks will work over all; and the upper and 'tween deck arrangements generally have been so planned to enable the vessel to carry a maximum number of live cattle, in the event of her being fitted for this branch of the meat trade, and, anticipating this, the 'tween decks are ventilated by Blackman's patent steam fans. The steering gear is of the new type of hydraulic gear supplied by Messrs. Fawcett and Preston. The machinery has been constructed by the Wallsend Slipway and Engineering Company, and has cylinders 24½in., 40in., and 68in. diameter by 48in. stroke, supplied by steam at 180 lb. pressure by two large boilers fitted with Serve tubes and Ellis and Eaves' system of induced draught. The whole of the machinery worked without a hitch, and to the entire satisfaction of all connected therewith, and during the progress of speed trials the mean speed attained was about 12½ knots. During the construction the vessel and machinery have been superintended by Mr. T. Graham on behalf of the owners, and he, together with Mr. R. M. Hudson, jun., was present on the trial trip. The builders were represented by Mr. G. B. Hunter and Mr. C. Stephenson; the engineers by Mr. L. Rusden; Messrs. John Brown and Co. by Mr. Gross and Mr. Brown; and the Linde British Refrigeration Company by Mr. Westwood. After the trial trip the Leitrim sailed for Barry Dock, where she arrived after a satisfactory run of sixty-four hours, and where she will load cargo for the River Plate.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

GOOD attendance on 'Change. The demand for steam coal continues good, with heavy shipments during the past week. Prices are steady. House coal shipments are very fair, for the season of the year. Tin-plates in moderate inquiry. The iron and steel trades continue fully employed.

Coal: Best steam, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s.; house coal, best, 10s.; dock screenings, 5s.; colliery small, 4s. 3d. to 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 46s. 1d.; hematite warrants, 47s. 5d. f.o.b. Cumberland; Middlesbrough No. 3, 37s. 3d. prompt; Middlesbrough hematite, 44s. 7d. Iron ore: Rubio, 12s.; Tafna, 11s. 3d. Steel: Rails, heavy sections, £4 12s. 6d.; light ditto, £5 f.o.b.; Bessemer steel tin-plate bars, £4; Siemens tin-plate bars, best, £4 2s. 6d.; all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel, coke, 9s. to 9s. 3d.; Siemens, coke finish, 9s. 3d. to 9s. 6d.; ternes, per double box, 28 by 20 C, 18s. 6d. to 20s. Pitwood, 15s. 3d. to 15s. 6d. Freights: Homewards are firm

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

MUCH gratification was expressed on 'Change in Birmingham on Thursday at the satisfactory nature of the Board of Trade returns for April in regard to those exports in which this district is especially interested. The increase in the value of metals for the month amounts to 27 per cent. as against April last year, compared with 22 per cent. for March, and 33 per cent. for February, this last advance being due to exceptionally large shipments of rails to India. This month again the increase is largely due to shipments of railway material. In fact, the demand for railroad material has been enormous. This month we exported £313,174 worth, as against £97,000 worth in April, 1895, an increase of 222 per cent. Next in the order of improvement comes old iron 206 per cent., bar and angle iron 86 per cent., hoops and sheets 55 per cent., galvanised sheets 25 per cent., and unwrought steel 21 per cent. The only noticeable decrease is in the export of tin-plates to the United States. This being the chief centre of the galvanised iron trade, much satisfaction is caused by the advance of 49 per cent. on the first four months of the year in that department, chiefly due to increased demand in Australia, South Africa, Argentina, and India. The exports of hardware and cutlery have increased 8 per cent. for the month, and 16 per cent. for the four months; machinery has advanced 4 per cent. for the month, and 15 per cent. for the four months; whilst engines have increased 22 per cent., and 28 per cent. for the two periods respectively. Railway rolling stock shows an increase of 109 per cent. for the month, and 92 for the four months. Cycles show a falling off for the month, but an increase upon the four months of 20 per cent. The statistics relating to Midland industries cannot but be considered very pleasing, though there seems no immediate prospect of an improvement in prices.

Steel continues in good call at £4 5s. for Bessemer billets and blooms, £4 12s. 6d. for Siemens. Angles and boiler plates, £5 12s. 6d. to £5 17s. 6d.; sheets, £7 5s. to £7 10s., and bars, £5 15s. Basic angles and girders are £5 10s., and boiler plates, £6 5s.

Some rather startling announcements concerning German competition in the galvanised sheet iron trade were made by Mr. W. W. Walker at the annual meeting of the Wolverhampon Chamber of Commerce on Wednesday. He stated that the price of black sheet iron in Germany was £1 per ton lower than it was here. The idea that German sheets were rubbish was an exploded fallacy. The Germans bought spelter from Silesia in Austria at 20s. per ton less than makers here could buy it. The Germans also got their chemicals cheaper. The wood for packing cases came from the Baltic, and was cheaper to the German, as were also the wire nails. The Germans were shipping the residuals from Antwerp and Hamburg to the Eastern countries at the same rate by the same steamer which came to London. Labour was between 30 and 40 per cent. lower than in England, and freights were lower in Germany. Reckoned altogether, he calculated there was a saving of £2 per ton in favour of the German manufacturer. He only knew of five corrugating machines leaving the country for the Continent, but their output would total up to something like 100,000 tons per year.

Pig iron prices are steadily maintained at recent rates—42s. for Lincolnshire forge, 41s. to 42s. for North Staffordshire and Derbyshire, and 40s. for Northamptonshire. Staffordshire cinder pig is 35s. 6d.; part mine, 40s. to 42s. 6d.; and all mine, 55s. Cold blast pig is £4 10s.

A meeting of manufacturers of Birmingham and Walsall in the trades likely to be affected by the introduction of the auto-car was held this week at the Walsall Chamber of Commerce. Mr. Crosbee—Messrs. Crosbee and Sons, Birmingham—presided, and there was a good attendance. Mr. J. Scott, of Walsall, proposed a resolution to the effect that the amendments suggested by the Walsall Chamber of Commerce, which have already appeared in our pages, *re* the Locomotives and Highways Bill, should be approved by the meeting, with the following alterations and additions, viz.:—(1) That the rate of speed in the towns shall not exceed five miles an hour, and ten miles an hour in the country. (2) That in case of a horse-drawn vehicle meeting an auto-car in a road too narrow for them to pass, the auto-car shall give way. (3) That whilst any tax remains on horse-drawn vehicles, such tax should equally apply to the auto-car. (4) That all auto-cars be numbered. This was seconded by Mr. D. Power—Walsall—and carried unanimously. Mr. Jaggar proposed the formation of an association, to be called "The Road Safety Association," for the purpose of arousing public opinion to the necessity of amendments to the Bill, with Mr. G. Harries as hon. treasurer, and Mr. A. Law—secretary of Walsall Chamber of Commerce—secretary. Those present were constituted a special committee to further the work of the association.

The greatest activity still reigns in the cycle trade and all things appertaining thereto. During the week an important conversion has taken place resulting in the formation of the Perfecta Seamless Steel Tube Company, with a capital of £145,000, divided into 30,000 cumulative 6 per cent. preference shares of £1 each, and 115,000 ordinary shares of £1 each, of which 10,000 preference shares and 30,000 ordinary shares have been applied for by the vendor, and will be allotted in full. The remaining 20,000 preference shares and 85,000 ordinary shares are now offered for subscription. The company has been formed to acquire the business of weldless tube and cycle fittings manufacturers carried on by Mr. Albert Edward Hill, at the Perfecta Works, Plume-street, Aston, established in 1891. Mr. Hill was one of the first manufacturers of seamless steel tubes, and owing to his great success in producing the finest quality, the demand has been so great that he has, during the last three years, increased the productive capacity of the works six fold. The site is freehold, and comprises 7200 square yards. It has a canal frontage of 800ft., and two private basins. The plant is modern and of the best character. The profits of the concern from April 1st, 1893, to April 30th, 1896, after making provision for depreciation, &c., is certified to be £20,597, and the net profit for the nine months ending April 30th, 1896, at £11,513, or at the rate of £15,351 per annum. The purchase price is £131,000. The vendor guarantees the book debts, and guarantees a profit of not less than £40,000 in the first two years, and will deposit securities to that amount with the company.

The Cycle Contract Company has just been registered with a capital of £20,000 in £1 shares, to carry on the business of manufacturers of and dealers in cycles, tubes, tires, parts, accessories, india-rubber, &c., mechanical engineers, fitters, machinists, founders, wire-drawers, tube-makers, metallurgists, saddlers, &c. The number of directors is not to be less than three nor more than ten. The subscribers are to appoint the first, the remainder as the company may decide.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The position continues one of activity as regards the engineering and all the principal iron-using industries of the district, with a large weight of both raw and manufactured material going into consumption; but the deliveries are almost entirely on account of contracts placed some time back. The result is that although both furnaces and forges are mostly kept fully going with orders already on the books, they are just now booking little or no new business of any moment, and although the present lull as regards actual buying is regarded as only temporary, it has for the time being a depressing effect upon prices. Makers and manufacturers are, however, still confident as regards the future; and the only really serious result I hear of, following the falling-off in trade during the last month or so, is that the Wigan puddling forges of the Pearson and Knowles Company have been closed, owing, I understand, to the absence of foreign business to keep them going.

Business on the Manchester Iron Exchange all through continues extremely quiet, little or no new buying of any moment coming forward either in raw or manufactured material, and there is a good deal of pressure to sell for immediate delivery at very low figures, especially with iron held in second hands, whilst here and there makers are perhaps not quite so firm as they have been. As regards local brands of pig iron, makers are still holding to 46s. 6d. less 2½, for foundry qualities, but in forge numbers they would have to give way to secure orders. In district brands some very low-priced parcels of Lincolnshire forge are offering in the market at about 9d. under makers' quoted rates, which remain at 41s. net cash, with foundry still quoted 43s. delivered Manchester. Derbyshire has shown a slight giving way upon late rates, and for delivery here foundry brands scarcely now average above 46s. net cash. Outside brands are being cut very low in the open market, good foundry Middlesbrough for immediate delivery being obtainable at 45s. 9d. to 46s.; although makers quote 46s. 4d. to 46s. 10d. net cash, delivered Manchester. Eglinton is offered freely at 46s. 6d., and Glengarnock 47s. to 47s. 3d. net prompt cash, delivered Lancashire ports.

In the finished iron trade makers are in most cases kept well engaged on specifications in hand, but there is a continued falling off in the weight of new business coming forward, with the result that prices show a weakening tendency, although no really quotable change can be reported, except in the case of one large concern. For Lancashire bars £5 10s. remains about the minimum, with North Staffordshire qualities ranging from £5 10s. up to £5 15s. Very low prices are being taken for sheets, £6 17s. 6d. to £7 2s. 6d. and £7 5s., according to quality, being the average figures. Hoops are steady at the Association list rates of £6 2s. 6d. for random to £6 7s. 6d. for special cut lengths, delivered Manchester district, with 2s. 6d. less for shipment.

Only a moderate business is reported generally in the steel trade, with no appreciable alteration in prices. Hematite makers still hold to 58s., less 2½, as the minimum for good foundry qualities, but merchants are taking 1s. below this figure. Steel billets remain at about £4 7s. 6d. net cash; local steel bars, £6; and boiler plates, £6 5s. to £6 7s. 6d., delivered here.

In the metal market an active demand continues to be reported generally, and although there is no official alteration in list rates for manufactured goods, the tendency is in an upward direction.

The usual monthly returns of the principal engineering trades union organisations show a continued substantial improvement in trade and a further considerable decrease in the unemployed list. The Amalgamated Society of Engineers has now only about 2½ per cent. of the total membership on donation benefit, which is a less percentage than has been reported for six years past. In the Manchester district the position is even better, only 1¾ per cent. of the local membership being on out-of-work support, all the leading firms in the district being fully employed, whilst there is a continued increasing demand for pattern makers. The Steam Engine Makers' Society has not more than 1 per cent. on donation, and this would have been still further lessened but for the dispute on the North-East Coast, which has for the time being acted as a check to the steady decrease in the number of out-of-work members on the books of the society that has been going on during the last twelve months. The returns as to the state of trade continue much as indicated last month, increasing activity being reported generally, some of the leading branches, such as stationary engine building, being now full of orders for a considerable time forward.

The Amalgamated Society of Engineers is this year in a position to present a very satisfactory annual report, showing substantial progress, both numerically and financially. Only on two former occasions has the number of admissions during 1895 been exceeded, the membership at the end of the year being 79,134, or a clear gain of 3624 members, as compared with the previous year, whilst the society has now 554 branches. With regard to the financial position, the total assets of the society have risen from £184,601 to £206,115, this sum including the superannuation levy and funds invested. The income for the year was £296,959, or £28,588 more than in 1894, this being the greatest yearly income since the formation of the society. Turning to the expenditure, which reached a total of £278,696, or a decrease of £2828 on the previous year, donation benefit has been reduced from £138,976 to £108,947, owing to the substantial decrease of unemployed members, which would have been more marked, the report states, but for the social war towards the end of the year. Sick benefit cost £45,726, and superannuation £58,990; funeral benefit amounted to £12,375; contingent benefit, £8108, or an increase of £5620; benevolent grants, £3867; accident benefit, £2700; whilst management expenses amounted to £22,466, which was a little less than in 1894. The society commenced the year with a balance of £160,093, which was now increased to £169,577, a sum of £21,338 having been taken from the general balance for the superannuation reserve fund. As regards the employment returns, there has generally been a steady decrease in the out-of-work list all through the year, with the exception of the period of the Belfast and Clyde labour disputes, and then the increase was only comparatively slight during November and December, and the total percentage of unemployed considerably less than at the same period the previous year.

At a meeting of the Northern Society of Electrical Engineers, held on Monday in Manchester, Mr. John Hesketh read a paper on "The Use and Economics of Rectifiers for Arc Lighting." Of all the existing systems of arc lighting, he said, scarcely one existed in which some glaring inefficiency did not appear, and it was undoubted that there were more inefficiencies in our present arc lighting methods than in any other branch of electrical engineering. The blue tinge of the alternating arc was an objection which might be overcome by colouring during diffusion, or alteration in the constitution of the carbons. Amongst the possible solutions of the question of efficient arc lighting were the following:—Alternating current arcs, with a separate transformer for each lamp; arcs, three in series of 100 volt network, or separate transformer for three arcs; any number of arcs in series off an alternate current transformer giving varying voltage and constant current, and delivering alternate currents into the lamps; or, as in the latter case, but with a commutator or rectifier in the secondary circuit, so that pulsating currents were delivered into the lamps. The balance of advantage was greatly in favour of the third solution, as in addition to every economy gained by systems using only one type of generating plant, it possessed the great advantage of giving arc lamps a photometric curve very nearly equal to that of an ordinary continuous current arc. Mr. Hesketh then described in detail a type of rectifier for arc-lighting, which he said consisted of two parts—a constant current transformer, and a synchronous motor—in which was fixed the rectifier commutator. In arc lamps intended for use with rectified currents, main cores should be laminated, and the bobbins split, but this need not be done for the shunt coils. The pull on the core was rather less, and was more sluggish than with a continuous current, so that a fresh adjustment was necessary. The lamps were also perceptibly longer in striking than with continuous currents, but the illumination from a rectified arc lamp was not perceptibly different from that of a continuous current arc. There was also an undoubted influence on telephone circuits when rectified currents were used in series circuits, as generally arranged. The means for the prevention of such interference were peculiar to each case, but, speaking generally, they were such as applied to the prevention of interference of one telephone line with another—perfect electrical balance on the circuit and perfect insulation.

In the coal trade the amount of business doing in the better qualities shows a decided falling off, and except where pits are going on short time, stocks are accumulating. With the present exceptional weather, requirements for house fire purposes are necessarily being considerably curtailed, and very few of the local collieries are now running above four days per week, some of them not exceeding three.

Quoted list rates are without alteration, but there is a disposition to give way upon present business of any moment, and supplies from Yorkshire and Derbyshire are offering at extremely low figures, in some cases quite 1s. to 1s. 6d. under the quotations of Lancashire collieries for similar qualities. In the lower qualities of round coal, for steam and forge purposes, business continues slow, with supplies excessive, and prices as low as ever. At the pit mouth best Wigan Arley averages 9s. 6d. to 10s. Pemberton 4ft. and seconds Arley, 8s. to 8s. 6d.; common house coals, 6s. 6d. to 7s.; with steam and forge coals, for inland sales, averaging about 6s.; but quantities for anything like prompt clearance obtainable at 6d. to 9d. less. Engine fuel is less plentiful, so far as local supplies are concerned, with a hardening tendency in prices; but with slack coming in more freely from other districts, any really general upward move is checked. Common slack can still be bought readily at 3s. to 3s. 3d.; good medium sorts, 3s. 6d. to 4s.; and best qualities fetching 4s. 6d. up to 5s. in some cases, at the pit mouth.

A moderate business is doing for shipment, but only at very low figures; ordinary steam coal, delivered Mersey ports, or Partington tips, Ship Canal, averaging 6s. 9d. to 7s. 3d. per ton.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

CONSIDERING the season of the year, the pits are fairly well employed. Many of the smaller collieries engaged in the production of house and gas fuel are not doing much, although four to five days a week is the time worked by the larger pits. House coal is in poor demand. Although the lowest summer prices are at present in operation, this seems to have no stimulating effect in the trade. The Metropolis is taking but a poor supply, which is accounted for by the very keen competition of seaborne fuel. Values continue low, and concessions have to be made to effect sales of any consequence. A quiet trade in this class of coal is now looked forward to, and stocks are at present accumulated at one or two of the collieries.

Quotations are as follows:—Best Silkstone, 8s. 3d. to 9s. 3d. per ton; ordinary, 6s. 9d. per ton; Barnsley house, 7s. 3d. to 8s. 3d.; Flockton, 7s. to 7s. 6d.; secondary sorts from 6s. 6d.; while thin seam coal only realises 6s. per ton. There is a better business doing in steam fuel, and the season's trade bids fair to be a good one. A large increase is reported in the tonnage sent to Hull and the other Humber ports. For the month of April just ended the trade done by Yorkshire pits with Hull exceeded that of April, 1895, by 12½ per cent., or more than 10,000 tons. Grimsby has also taken an increased tonnage. The railway companies are taking a large amount of hard coal on contract account. Values remain very much the same as when last reported.

Barnsley hards, 6s. 6d. to 7s. per ton, while secondary qualities realise 6s. per ton. There is only a moderate business doing in gas coal, while manufacturing coal is in fairly good request. Small coal is rather scarce, owing to the heavy demand for the coke trade. This has had the effect of stiffening values, which range as follows:—Small nuts, 4s. 3d. to 5s. 3d. per ton; screened slack, 3s. 3d. per ton; pit slack, 2s. 6d. per ton; smudge, 1s. to 1s. 6d. per ton.

The satisfactory feeling which has existed in the heavy industries for the last few months still continues. There has been an excellent demand for Swedish Bessemer steel. This is due to the cycling "boom," at present in full swing. It is rumoured that one firm of cycle makers in Coventry alone have placed an order for 2000 tons of this material. Makers are now full up with work, and are not very eager to accept any more orders at present. Values range from £9 10s. to £15 15s. per ton f.o.b., and there is a general idea that these figures are not the top prices by a long way. Manufacturers in this city are continually expressing their regret that this cycle business was not secured for Sheffield at the outset.

In the lighter industries business is not so flourishing. A good trade is at present doing in hammers, spades, forks, shovels, and similar field and garden tools, and one or two local firms have of late fully doubled their output. Large quantities are being forwarded to South Africa, West Australia, and other mining districts. An increase in the home demand has taken place since the development of the allotment movement. The tool trade is in an excellent condition. The introduction of the Sloyd system and of technical education in schools has had the effect of creating a large demand for joiners', carving, and similar tools. Makers of anvils, vices, and heavy engineers' tools, report a very good trade. The local file industry is considerably disturbed at present by a wages dispute. Trade being good, the men are asking for the return of the 10 per cent. they conceded to their masters when they were badly off for work. The masters appointed a committee to consider the question, and they recommended the employers to comply with the request. The general body of the masters, however, have decided not to do so, and meetings of both sides are being held. It is hoped that an amicable arrangement will yet be come to, so that the activity in trade may not be interfered with.

Hardware and cutlery during April showed a considerable increase in the foreign markets, the value of exports having been £162,803, against £149,540 for April of 1895. Australasia and the British Colonies generally showed the largest increases. In unwrought steel last month's foreign business reached a value of £191,625, against £157,274 for April of 1895. All markets showed an increase except Holland and France.

The directors of the Parkgate Iron and Steel Works have been able to present a better report of the operations of the company for the year ending March 31st last than they did for the previous twelve months. Whilst the late depression in trade continued for nearly the whole of the first half of the past year, an improvement has since set in, resulting in an increased demand for the different materials produced at the works. The whole of the blast furnaces, five in number, have been in full operation since the middle of February last, whilst the steel works have also been fully employed. The falling off in the demand for finished iron still continues, but this is in some measure compensated for by the increased demand for steel. The gross profit made during the year was £15,507 17s. 4d.; after paying interest on debentures, and writing off £3000 for depreciation, the dividend is £3 per share, carrying forward £938 17s. 3d. The shares are £100—£75 paid up.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

BUSINESS has been much interfered with this week in this district by the strikes of engineers at Stockton, Middlesbrough, and the Hartlepools, and the threatened extension of the dispute to other parts of the North of England. Naturally buyers will not operate under such uncertain and unsatisfactory circumstances, and the demand in almost all departments is practically paralysed. The precipitate action of the Stockton engineers, who were the first to strike, is generally condemned even by their own class in other parts of the district. The matter in dispute is a comparatively trivial one, and might easily have been adjusted by arbitration, as the masters offered. Besides this, the matter does not affect the men at present, and will not until September, and before that period some settlement might have been amicably arrived at, without any dislocation of the trade of the district. The strike came as a surprise to almost everybody, and it is not easy to believe that so small a grievance could have such widespread results. At one of the leading engineering establishments, which employs over 2600 hands, who have all stopped, the total sum in dispute is only 3s. 6d. per week—seven men at 6d. per week each. That the conduct of the men is unreasonable does not admit of doubt, and many of the men themselves who have been obliged to come out are dissatisfied that they have had to stop on such a slight pretext, just when they were getting into regular work, and were earning fair wages.

The dispute has arisen in this wise. When at the end of March the employers and the engineers entered into an arrangement that the members of that society were to have 1s. per week advance at once and another 1s. in September, the masters believed there were in the society none but skilled men earning over 30s. per week. But it turns out that the constitution of the society has been altered, and there are now admitted to membership unskilled men earning at present under 30s. per week. These include machine men, planers, &c. Of course the employers never intended that these lower paid men should receive the same advance as the skilled men, because in their ageements with all the other classes of workmen it is stipulated that all men receiving under 30s. per week will have an additional 6d. given them in September, and not 1s. as in the case of the higher paid men. They did not see their way to pay the lower class members of the Engineers' Society on different terms or similarly paid men in other departments would agitate to have like treatment. Besides, when reductions were being made during the period of depression, all the men with the lower wages had their wages reduced by smaller amounts than the skilled men, 6d. being taken off from the former where 1s. was demanded from the latter. Naturally the masters thought it right that advances should be made in like proportions.

But the officials of the Engineers' Society are determined to hold the masters to their agreement, even though it was made under a misapprehension, and so far they have not accepted the offer of the masters to refer the dispute to arbitration, though the Tyne and Wear men appear to favour that step, as do a good many who are out on Tees-side. The Stockton men were the first to come out, and the Middlesbrough men followed to support them. The employers then agreed to give 25 per cent. of the members of the Engineers' Society their notices, but the Hartlepool men all struck when this action was taken. It is regrettable to see trade complicated by a dispute which, in the first instance, was of such slight dimensions and of such trivial importance, and which might so readily have been settled by arbitration, without any stoppage of work.

The boilersmiths and platers at the Tees-side Iron and Engine Works, Middlesbrough, have come out on strike for an advance of wages, and the same classes of men have given notice to cease work on Saturday at Messrs. Head, Wrightson, and Co.'s works at Thornaby.

The price of Cleveland pig iron has been reduced 6d. per ton this week, and there can be little doubt that the fall has been induced by the engineers' strikes, which have made the future of the market so uncertain. Consumers generally have withdrawn their offers, or have reduced them to figures at which sellers will not at present look. No one apparently needs to buy iron for prompt delivery, as consumers have fair stocks or have arranged with makers for supplies. This is not a time to buy for forward delivery; in fact, for the present, speculation is altogether suspended. No. 3 Cleveland pig iron has dropped to 37s. 3d. per ton for prompt f.o.b. delivery, a lower rate than has been known since January, but it is stated that makers have not taken so low a figure. It is 1s. 9d. per ton below the best price of the year, and only 1s. above the worst. Few buyers will pay more than 37s. Cleveland warrants were as low as 37s. 1½d. cash on Monday, but on Tuesday advanced to 37s. 6d., though on Wednesday they fell back to 37s. 3½d. The general market has not responded to the changes in warrants, being depressed by the labour troubles. No. 1 Cleveland G.M.B. pig iron is 38s. 6d. to 38s. 9d; No. 4 foundry, 36s. 9d.; grey forge, 36s. 3d.; mottled and white, 36s., the last-named being relatively dearer than the better qualities, as both mottled and white are so scarce. Shipments are well maintained, in fact they are much better than might have been expected, considering the heavy exports of March and April. The total exports of pig iron this month up to Wednesday from the Cleveland district were 45,888 tons, as compared with 46,957 tons in April, and 46,521 tons in May, 1895, to 13th. Local and inland deliveries are also good, yet the stock of Cleveland pig in the public warrant stores increases, Connal's having on Wednesday night last 197,041 tons, or 3285 tons increase this month. Cleveland hematite pig iron is in poor demand, and weak in price, some sales of M. Nos. having been made at 45s. 9d. per ton f.o.b., though 46s. is the regular quotation. Deliveries are very good to Sheffield, though they are hardly satisfactory on export account.

A stronger business is being done in steel rails, and manufacturers have no difficulty in securing plenty of orders; indeed, they can hardly keep up with their contracts, though they are working more fully than for years. Heavy steel rails are quoted £4 10s. to £4 12s. 6d. net at works. Steel billets are about £4 5s. net at works, but are scarcely in such good demand as rails. The plate and angle manufacturers have not yet found their trade detrimentally influenced by the engineers' strikes, but they expect the demand to fall off if the dispute is not soon settled. The quotation for steel ship plates is £5 2s. 6d.; steel ship angles, £4 17s. 6d.; iron ship plates, £5; iron ship angles, £4 15s.; all less 2½ per cent. and f.o.t. Common bars are firm at £5, less 2½ per cent. f.o.t., and works are well employed.

The current going works and business of Black, Hawthorn, and Co., engineers, Gateshead, were offered for sale by public auction on Tuesday at Newcastle. The works are freehold, and occupy an area of about six acres. They adjoin and have direct access to the North-Eastern Railway. The firm have been well known as manufacturers of tank locomotives and colliery engineering work. The minimum price at which the place would be sold was announced by the auctioneer to be £40,000. There was no bid, and the property was withdrawn.

The coal trade is quieter, even in the steam coal branch, now that the rush of shipments brought about by the opening of the navigation season is over, and as some of the steam coal pits are not fully employed, there is some easing in the price of best steam, though 8s. 3d. f.o.b. is still quoted.

The death is announced of Mr. John Nixon, one of the founders of the Northumberland Miners' Association, for many years its treasurer, and of late years its president. He was seventy-five years of age.

The sale of collieries referred to last week is that of the Earl of Durham's. Altogether he sells fourteen collieries, producing 12,000 tons per week, and employing 8000 men, to a syndicate headed by Sir James Joicy, who are already the owners of thirteen collieries, employing 4000 hands.

Blast furnace coke is cheaper, the supply being larger, and exports are easier, so that more is offered to local blast furnace owners, who have this week been able to buy at 13s. 6d. per ton, delivered on Tees-side. At the Malton Colliery, near Lanchester, Mr. S. A. Sadler, of Middlesbrough, the owner, is adding thirty-five coke ovens to the seventy already in operation.

So far as the voting of the Durham miners has been made known, they seem as antagonistically disposed as ever to a continuance of the Concilliation Board, the commendations of their executive with respect to the benefits of the organisation having apparently had little effect upon them.

Coal shipments last month from North-Eastern ports reached 1,447,149 tons, or 67,295 tons more than in April, 1895.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE was a smart drop in the prices of warrants towards the end of last week, in consequence of the fresh dispute in the marine engineering trade. It is alleged that "bears" who had for some time being doing little or nothing, eagerly took advantage of the anticipated spread of the labour quarrel to the Clyde and Belfast to depress prices, and the expectation was therefore formed that the market would likely in a few days exhibit a smart reaction. The favourable nature of the Board of Trade returns was not without its effect in steadying the market, and there is besides a pretty wide-spread conviction among those connected with the shipbuilding and marine engineering trades that an amicable settlement of the quarrel between employers and workmen is likely soon to be effected. Scotch warrants fell from the best point of last week 9d.; Cleveland iron, 6d.; and Cumberland hematite, 8½d. per ton. The price of Scotch in a few days improved to the point from which the fall began, and hematite gained 4d., and Cleveland warrants 3d. of the decline. A good deal more warrants changed hands this week than for several weeks past, the transactions being largely speculative. Business was done in Scotch warrants from 45s. 10½d. to 46s. 4½d. cash, and 46s. 1d. one month, but fluctuations continue to take place.

There are eighty-one furnaces in blast in Scotland, compared with seventy-six at this time last year; and of the total, forty-one are producing ordinary, thirty-seven hematite, and three basic iron.

A small decrease has occurred in the stock of pig iron in Connal and Co.'s Glasgow stores, which now contain about 356,000 tons, compared with 282,700 tons at this time last year.

While pig iron warrants have been fluctuating, owing to reasons above explained, the prices of the special brands of makers' pig iron have been comparatively steady. The quotations are as follows:—Govan and Monkland, f.o.b. at Glasgow, Nos. 1, 47s.; Nos. 3, 45s. 9d.; Carnbroe, No. 1, 47s. 3d.; No. 3, 46s.; Clyde, No. 1, 50s. 6d.; No. 3, 47s. 6d.; Gartsherrie, No. 1, 50s. 6d.; No. 3, 48s.; Calder and Summerlee, Nos. 1, 51s.; Nos. 3, 48s.; Coltness, No. 1, 53s. 6d.; No. 3, 49s.; Glengarnock, at Ardrossan, No. 1, 51s.; No. 3, 47s.; Eglinton, No. 1, 47s. 6d.; No. 3, 45s. 6d.; Dalmellington, at Ayr, No. 1, 47s.; No. 3, 45s.; Shotts, at Leith, No. 1, 53s.; No. 3, 49s.; Carron, at Grangemouth, No. 1, 52s.; No. 3, 48s.

The pig iron shipments are considerably larger than last week, when, however, they were exceptionally small. In the past week the total has been 8003 tons, which compares with 7317 in the corresponding week of last year. There was despatched to Australia 400 tons; Holland, 600; India, 300; United States, 65; Canada, 100; South America, 20; France, 215; Italy, 140; Germany, 235; Belgium, 40; Spain and Portugal, 68; China and Japan, 150; other countries, 210; the coastwise shipments being 5450, against 6382 in the same week of last year.

The malleable iron department is fairly active, the home trade absorbing a considerable amount of iron. The demand for abroad is not what it might be, but considerable shipments are being made to places where foreign competition has little effect, or where Scotch finished iron is preferred on account of its distinctive qualities. The steel industry is very busy, probably busier than ever before in the course of the history of the mild steel manufacture. Scarcely anything is heard about prices, which are understood to be nominally without alteration.

The coal market continues very dull and heavy. A fair volume of business is being done; in some qualities, indeed, the turnover might be said to be extensive. Supplies are, however, so very large that prices are kept down, and the figures are nominally without change. The total coal shipments in the past week from Scottish ports amounted to 180,743 tons, against 161,366 in the corresponding week of last year.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE result of personal observation over a considerable extent of the Brecon, Midland, Cambrian, and London and North-Western lines, during the last few days, has been to prove that South Wales coal is maintaining its position against that of North Wales. Monmouthshire coal, that of Nantyglo, Tredegar, Ebbw Vale, is well in evidence, and even patent fuel, I see, is becoming of more general use. As for anthracite, I find that the use is extending. and amongst some good customers the Crystal Palace is named as one.

The steam coal trade at Cardiff last week was, as usual, in thorough animation, but house coal was very slack, the exceptionally fine weather telling adversely. Prices falling. Monmouthshire coal for shipment at Cardiff active.

Swansea Exchange report for last week indicates a more hopeful state of things, and there is now a strong probability, as was remarked, that things are settling down into a more satisfactory condition, port statistics showing an increase of 10,000 tons over those of the corresponding week for last year. In coal there has been a good deal of activity, and three large steamers were cleared with anthracite for San Francisco, totalling 9993 tons.

Cardiff prices, mid-week, were as follows:—Best steam, 10s. 3d. to 10s. 6d.; best seconds, 9s. 9d. to 10s.; seconds, ordinary, 9s. 3d. to 9s. 6d.; drys, 8s. 7½d. to 9s.; best small, 4s. 9d. to 5s.; good small, 4s. 3d. to 4s. 6d.; seconds, 4s., drys, 3s. 6d. to 3s. 9d. House coal, best, from 9s. 9d.; No. 3 Rhondda, 9s. 6d.; No. 2 Rhondda, which is in fair demand for bunkering purposes, 7s. 3d. to 7s. 9d. German demands for anthracite are improving.

April statistics are just to hand, and show favourably in regard to coal and patent fuel, but a falling off in iron and steel shipments, as compared in each case with the returns for March.

Cardiff shipped in April 1,159,641 tons of coal, indicating a better trade even than January. Newport total was 241,636 tons foreign, and 83,719 tons coastwise. Swansea, 96,662 tons foreign, and 49,204 tons coastwise. Llanelly, 14,895 tons foreign, and 8107 tons coastwise. I note that for April the collective totals from the Welsh ports show that 14,145 tons of iron and steel have been shipped, 7928 tons of coke, and a quantity of patent fuel. The coast shipment from Cardiff since the beginning of the year has totalled 4,584,641 tons. Since January Cardiff has sent 21,534 tons steel, Newport, Mon., 11,658 tons; Swansea, 2998 tons. This exceeds late averages.

Last week I announced the success of the Barry Railway in getting access into Monmouthshire. This week, I am very gratified in being enabled to record the dispensation, at the hands of an unquestionably able and impartial committee, of the powers sought by the Bute Docks for the amalgamation with the Rhymney Railway. This gives it the powers and circumstances of a railway of its own, and places it not upon an unfair advantage over competitive powers, but upon the same level. As I remarked lately, the Taff has its railway and docks, the Barry theirs, and now the Bute has succeeded. This concession will restore the balance of power to an equitable position, and when the immense capital invested is considered, and the long period of up-hill and adverse time regarded, the concession is simply a reasonable one. In announcing the decision, the chairman said the Committee are of opinion that the Bill shall proceed, but that clauses be introduced giving equal facilities on equal terms in respect of traffic conveyed by any of the railway companies having access to the docks, similar to those contained in the Bute Docks Transfer Act, 1886.

The Port Talbot Railway and Docks Bill is the next one of importance to come on.

I see that in connection with Swansea a very important project has been revived, that of the floating of Swansea Docks. This is the scheme of Mr. Rosser, and has the advantage over others of a connection between all the docks at all states of the tide, and the formation of basins outside the present harbour. Dock gates are by this scheme to be constructed between the present piers; the water from the Tawe is to be brought through all the docks, and overflows are to be provided at various points.

The question now discussed in the district is whether the Harbour Trust will seriously consider this, or the other scheme, that of Mr. Westlake. Fairly, it may be stated that the Trust are thoroughly alive to every suggestion for improving the harbour.

With regard to the Llanelly Dock Bill, which will come before the House of Commons, an important communication has been received by the Harbour Commissioners from the Great Western Railway, proposing, it is understood—though particulars are not made public—an alternative scheme, which is to be duly and promptly considered.

Work has been resumed at the Trumble Colliery, Llanelly. The points in dispute have been referred to a committee of four. An agitation amongst the Ebbw Vale hauliers is causing some attention.

Swansea Exchange report in connection with the iron and steel trades, mid-week, indicates weakness in the pig iron branch; prices slightly lower. Most of the works in the finished iron and steel trades are well employed. There is no change in quotations for steel rails, bars, or sheets. Glasgow pig is quoted at 46s. 2½d., cash buyers. Bessemer and similar bars remain at past figures, and I am glad to note that a larger make is going on, though in tin-plate the quantity brought from works last week was in excess of shipments, so stocks have been again increased. For rails there is a fair demand. One cargo was sent away this week to Douglas. Cyfarthfa preparations for rail make are now understood to be complete. I note that the demand for bars is much improved, also for "small goods." A little better tone prevails in some of the tin-plate districts.

During last week sixteen mills were in operation in the Briton Ferry district.

I am pleased to record that a satisfactory dividend was announced last week at the half-yearly meeting of the Briton Ferry Steel Works. Mr. Bevan, the retiring director, was re-elected. I hear that a large foundry and extensive engineering works are projected.

Tin-plates are slightly better. The latest figures are: Swansea Siemens coke finish, 9s. 3d. to 9s. 6d.; Bessemer coke, 9s. to 9s. 3d.; ternes remain from 16s.; best charcoal, 12s. 6d. to 12s. 9d.

Patent fuel and coke prices, mid-week Cardiff, were unaltered. Pitwood a little firmer.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

FAIR accounts can be given of last week's business on the iron markets over here. A considerable degree of activity is noticeable in nearly all departments; raw as well as manufactured iron meets with a good demand, not only on home, but also on foreign account, and though prices have remained stationary for the last two weeks, there is so much firmness to be perceived in all branches of the iron trade that the bright confident tone of previous weeks was not only well maintained, but has even further increased.

With regard to the iron business in Silesia most satisfactory reports continue to be received. The blast furnace works are very busy just now, a considerable amount of large orders coming in. The malleable iron industry is also in a fair condition, the contracts booked reaching, in a number of instances, far into the last quarter. Some of the leading firms are contemplating the extension of their establishments, and there has also been talk of an additional rolling mill being built by a well-known Breslau firm.

On the Austro-Hungarian iron market the condition remains much as was previously reported. The position of producers is, on the whole, satisfactory, though competition is keen, which prevents prices from rising more quickly; but for most articles a very good inquiry is experienced, and compared to the same period last year, a decided improvement can be noticed for bars, girders and plates. With regard to the business in railway material, the hopes that were entertained at the beginning of the year have not been fulfilled; however, there is a fair activity going on at the shops generally. For hardware, a slightly better inquiry has been experienced, especially in Bohemia and Hungary. Prices show a rising tendency all round, but an official advance has not taken place lately.

No material change is noticeable on the French iron market, business in nearly all departments being satisfactory. Pig iron is becoming exceedingly scarce, and prices have, consequently, been showing a hardening tendency. In the manufactured iron and steel trade a strong tone is reported generally, quotations moving steadily in an upward direction. Exports during the past week have been rather heavier than formerly.

According to the "Comité des Forges de France," the French iron ore mines yielded 3,117,000 t. ore in 1894, output of the air-shafts being 665,000 t. Compared to the year before, the production of the iron ore mines increased by 232,000 t., while output of the air shafts was 23,000 t. higher than in 1893, total increase thus amounting to 255,000 t., or 7 per cent. against the previous year. Average prices were 3·07f. and 3·30f. p.t. The total quantity of iron ore, at the average price of 3·26f. p.t., was worth 12,297,000f., the number of mines being 71, while there were 45 air shafts.

In Belgium the business in iron and steel has been exceptionally strong during the week now past; large lots are being exported, and there are indications that a lively continuance of trade will be experienced for many months ahead. Prices for pig iron continue to show much firmness, although imports from Germany, France, and Luxemburg have been rather heavy. All sorts of structural iron are in in active request, and quotations are considered fairly satisfactory, although it is exceptional where any really appreciable advance is being got. Belgian export figures for the first two months of the present year show a fair increase against 1895; in manufactured steel export increased 180,000 t.; in steel rails alone 10,000 t., in girders 4000 t., more were exported than last year. Export in manufactured iron was 26,000 t. higher than during the corresponding period in 1895.

Demand and sale continue unusually brisk on the Rhenish-Westphalian iron market. Producers and buyers are entertaining the most hopeful views with regard to the development of the iron trade. There is, all things considered, good reason to expect a further improvement in occupation and in prices, and even if a temporary lull should set in, the orders on hand and those now offering would secure a brisk employment for at least several months to come. Iron ore is in active request, and fair prices are obtained. The Nassau ore mines have even ventured a slight advance, M. 9·70 p.t. being the list quotation for the 50 p.c. red iron ore. Siegerland qualities range between M. 2·50, 2·80, and 3·20 p.t. as before; two-thirds of the present output of the Siegerland ore mines have already been disposed of, a number of the orders booked reaching into the first quarter of next year. A good number of inquiries continue to be received in the pig iron trade, consumers being extremely anxious to place their orders for the last quarter, and stocks are very small in consequence. Figures for March show output in iron and steel to have been 551,000 t., which shows an increase of 70,000 t. against the same month last year. At present the blast furnace works are hardly able to produce the quantities required, especially basic is very briskly called for. List rates during the last week were:—Spiegeleisen, 10 to 12 p.c. grade, M. 59 p.t.; forge pig, No. 1, M. 53 to 55 p.t.; No. 3, M. 42 p.t.; hematite, M. 65 p.t.; foundry pig, No. 1, M. 65 p.t.; No. 3, M. 57 p.t.; basic, M. 56 p.t.; German Bessemer, M. 60 p.t. at works; Luxemburg forge pig, 56f. p.t., free Luxemburg.

The manufactured iron and steel industries are in exactly the same position as before, which means a good deal of activity at the mills and foundries and a strong upward movement in quotations.

There have also been rather more foreign orders booked upon the week, which has had the usual favourable effect on the tendency of the iron market. For bars and girders, and also for sheets, a vigorous demand is coming forward, and the heavier sorts of plates also meet with a lively request. Wire and wire nails have been in fairly good call, comparatively speaking; there are more export orders booked, and quotations begin to be a trifle more paying. The slight changes that have, since last week, taken place in the employment of the foundries and machine factories, have all been more or less in the direction of an improvement, and there is now hardly any branch of the iron trade that could be regarded as weakly or unremuneratively occupied.

Latest list prices per ton at works are as under:—

Good merchant bars, M. 118; angles, M. 128; girders, double T, free Burbach, M. 94 to 97; hoops, M. 120 to 125; billets in basic and Bessemer, M. 85 to 86; heavy plates for boiler-making purposes, M. 160 to 165; tank ditto, M. 135; steel plates, No. 1, M. 145; No. 2, M. 130; tank ditto, M. 120 to 125; sheets, M. 155 to 160; iron wire rods, common quality, M. 125; drawn wire in iron and steel, M. 118 to 130; rivet iron, M. 138; rivets, good merchant quality, M. 175 to 180; complete sets of wheels and axles, M. 280 to 290; axles, M. 220; steel tires, M. 200; steel rails, M. 118; steel sleepers, M. 110; fish-plates, M. 120 to 130; light section rails, M. 100.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, May 7th.

THE disturbing political conditions, are rightfully or wrongfull, credited with some of the hesitancy displayed by promoters and managers of many new industrial enterprises in the prosecution of work. Production of iron and steel has gone beyond daily and weekly demand. Prices have been shaded during the past few days on almost all products, despite the vigorous efforts made in several branches to preserve remunerative quotations. In the Western States, where agricultural interests have been presenting summer and autumn requirements, there is a better condition. The many small industries there depending on agriculture, mining, lake transportation, &c., are all buying freely, and the aggregate is quite an encouraging sum. In the regions east of the mountains trade and industry move at a laggard's pace. Pig iron at all points is perceptibly lower. The efforts made to preserve coke and lake ores 25 per cent. above a fair market price has checked demand. There is no escape from these quotations except in non-production, and that is a resort not to be thought of while a margin remains. Railroad building is not increasing, and a minimum of railroad work is being done. In many quarters the impression prevails that the formulation of a gold platform at St. Louis will stimulate and encourage investments of home and foreign capital on an extensive scale, sufficient to swing the pendulum in the other direction. The present dulness may terminate suddenly, but with the enormous production stronger prices are impossible unless exceptional causes should be precipitated. Coal production is in excess of all former years, and combinations of producers are securing more favourable margins to owners. General trade is not satisfactory, but an early improvement is anticipated. Gold exports keep the public in remembrance of the fact that their metallic basis needs watching.

AN ENORMOUS PLATE.—At the Cardiff Exhibition is a boiler plate some 70ft. long. We have received from the Stockton Malleable Iron Company, Stockton-on-Tees, particulars of a still larger plate, the largest plate ever rolled. The total length sheared is 76ft. 3in. Its rolled width varied from 5ft. 2in. to 6ft. 2in. The sheared width is 5ft., and the thickness 0·6in. The sheared weight of the plate is 5 tons 10 cwt. It was rolled on Tuesday, the 5th instant.

NEW PIER AND LANDING STAGE FOR THE CITY OF BANGOR.—A new pier and landing stage for accommodating the ferry and steamer traffic in the Menai Straits, at Bangor, was opened by Lord Penrhyn, yesterday, the day being observed as a general holiday. The pier is 1550ft. long, and 24ft. wide, and is constructed of iron screw piles, and steel girders which carry the timber deck. There are eight embayments upon which are built ornamental kiosks, and the head is increased in width to allow ample room for promenading. The landing stage at the end of the pier consists of floating pontoons approached from the pier by a bow-string girder bridge. The pier will be of great service to the neighbourhood, and will command a fine view of the Straits and Welsh mountains. The works, which have cost about £20,000, were designed by Mr. John J. Webster, M. Inst. C.E., Westminster, Mr. Alfred Thorne being the contractor.

THE INSTITUTION OF CIVIL ENGINEERS.—YORKSHIRE ASSOCIATION OF STUDENTS.—At the invitation of Mr. A. Creer, A.M.I.C.E., this Association made their first monthly excursion of this session to the York City Sewage Works. Meeting at the Guildhall on Saturday, May 9th, the visitors, numbering about thirty, were taken down the river in launches to Fulford, where the primary screening apparatus was examined, and also pumping engines, in duplicate, capable of dealing with 3,000,000 gallons per twenty-four hours. Taking boat again, the party was transported to Naburn, where the deodorising and precipitating processes were at work. A special feature, which caused much interest, was that of caking the sludge by compressed air at 80 lb. per square inch. Mr. Creer here, as at the former stage, gave a very careful description of the works, which have been carried out on the most modern and approved system. On arriving back at York a vote of thanks to Mr. Creer was proposed by Mr. S. Utley, seconded by Mr. C. R. Fenwick, and unanimously carried, this ending a most enjoyable and interesting afternoon.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

_ When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

30th April, 1896.

9098. Separating Gas, J. Maynes and C. L. Watchurst, London.
9099. Checking the Receipt of Money, J. M. Black, London.
9100. Substitute for Wood, J. C. Nichol, Birmingham.
9101. Calico Printing Machines, J. F. Shandley, London.
9102. Chimney Pots, J. Duckett and Son, Ld., and J. Duckett, London.
9103. Shoe for Horses and like Animals, E. Bush, London.
9104. Swinging Window Sashes, W. Nicholson, London.
9105. Roller Bolts for Splinter Bars, W. G. H. Sedwell, London.
9106. Furling and Reefing Ships' Sails, J. Phillips, London.
9107. Fastening for Stay Busks, &c., S. H. Budds, London.
9108. Apparatus for Aerial Navigation, J. Waelde and J. F. C. Abelspies, London.
9109. Buttons, Hooks, and like Fastenings, L. J. Marks, London.
9110. Children's Mail-carts, C. I. Whitfield, London.
9111. Match-boxes, T. Colborne, London.
9112. Steels for Sharpening Knives, R. W. Mellish, London.
9113. Bicycle Support, G. F. Piper, London.
9114. Knives, Vegetable Papers, &c., E. Bronsdon, London.
9115. Steps for Vertical Shafts, B. J. B. Mills.—(*H. Trenta, France.*)
9116. Velocipede Handles, J. M. Menzies, London.
9117. Pin for Fixing Hair Fasteners, H. M. Knight, London.
9118. Internally Stoppered Bottles, J. W. Tilley, London.
9119. Folding Boot Tree, F. Furner, London.
9120. Umbrella and Tent-pole Fittings, J. Johnson, London.
9121. Driving Motor Carriages, &c., J. Monteith, London.
9122. Azo Colouring Matters, H. E. Newton.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
9123. Treating Refractory Ores, F. Ellershausen, London.
9124. Adjustable Cycle Handle-bar, J. H. Knight, London.
9125. Reed Organ Actions, A. L. White, Chicago, U.S.A.
9126. Raisin Seeders, F. H. Chase and T. E. Dougherty, London.
9127. Producing Cold by Volatile Liquids, M. Douane, London.
9128. Lamp Burners, F. Deimel, London.
9129. Aeroplane for Raising, &c., Airships, R. Kosch, London.
9130. Burglar and Fire Alarm or Signal, E. Trotter, London.
9131. Water-tube Boilers, J. Miyabara London.
9132. Holder or Clip for Cigars, &c., H. Vose, London.
9133. Cleansing Incandescent Mantles, P. P. Adolph, London.
9134. Retailing Liquors, E. Moser, F. Schazt, and F. Rindermann, Liverpool.
9135. Kettle for Culinary Purposes, A. Sansome, Birmingham.
9136. Device for Malting Drums, R. B. Robertson, London.
9137. Filters, H. L. Doulton, London.
9138. Road Signal Apparatus, J. Rayman, London.
9139. Photographic View Finder, S. J. Levi and A. J. Jones, London.
9140. Military Equipments, H. J. Rose and W. Gilbert-Cooper, London.
9141. Cycles, J. Brandenburg, London.
9142. Aeronautical Ships, E. J. Pennington, London.
9143. Motor Driven Vehicles, J. B. Carse, London.
9144. Flying and Soaring Machines, P. C. Pilcher, London.
9145. Automatic Steam Governor, R. J. White, London.
9146. Apparatus for Drying Tea, &c., W. A. Gibbs, London.
9147. Incandescent Gas Burners, S. Falk, London.
9148. Travelling Trunks, J. Foot and R. J. Foot, London.
9149. Cycles, E. de Toni, London.
9150. Pneumatic Tires for Vehicles, J. B. Carse, London.
9151. Motor Driven Vehicles, J. B. Carse, London.
9152. Bottles, J. R. Clair, London.
9153. Swings, P. J. Job and P. B. H. Seabrook, St. Leonard's-on-Sea.
9154. Horseshoes, F. S. Perkins and H. Stanning, London.

1st May, 1896.

9155. Firing Appliances for Small-arms, F. Beesley, London.
9156. Combustion of Fuel, W. Hassall, London.
9157. Warming and Ventilating Buildings, A. F. Long, London.
9158. Gear for the Transmission of Power, J. E. Weyman, Cheltenham.
9159. Handles for Flushing Cisterns, R. Eccles and the Castle Rubber Company, Limited, Warrington.
9160. Trundling Hoop and Handle Combined, J. E. Taylor, Chester.
9161. Polishing Cotton, W. Bamford and H. H. Harris, Oldham.
9162. Hats, Helmets, &c., F. T. S. Hamilton, Liverpool.
9163. Constructing Windows, W. Thompson, Newcastle-upon-Tyne.
9164. Construction of Boot Lasts, J Blakey, Halifax.
9165. Cooking Ranges, J. N. Mitchell and W. Morrison, Glasgow.
9166. Buffing Pads for Boots and Shoes, G. Riley, Leicester.
9167. Lubricators, H. McClenahan, Liverpool.
9168. Cycles, D. Doyle, Youghal, Co. Cork.
9169. Instrument for Drafting Bodices, M. A. Fitton, Huddersfield.
9170. Elevators, R. Birtwistle, Manchester.
9171. Underground Conduits for Electric Railroads, W. Fairweather.—(*Munson, Roberts, Alston, Reid, and Reid*, ——.)
9172. Carding Engines, W. Hopkinson and R. Tyack, Accrington.
9173. Making Wire Cloth, J. Brodie, R. Miller, and R. Weir, Glasgow.
9174. Pressing Cloth on to Tenter Hooks, W. Thompson and A. W. Glover, Leeds.
9175. Golf Clubs, H. J. Just, Accrington.
9176. Apparatus for Catching Flies, R. Swann, Preston.
9177. Appliance to Assist Hearing, K. Macqueen, Bristol.
9178. Cycle Tires, S. Bunting and W. A. Courtland, Birmingham.
9179. Card Covered Raising Machines, J. and W. Blamires, Huddersfield.
9180. Cooking Ranges, A. T. Hebron, Whitley, Northumberland.
9181. Milking Apparatus, W. H. Lawrence and R. Kennedy, Glasgow.
9182. Gas Heating Apparatus, T. Fletcher, W. Russell, and Fletcher, Russell, and Co., Manchester.
9183. Pneumatic Ball Cushion Tire, A. L. Binns and J. F. Garvey, Liverpool.
9184. Water Decomposing Process, J. T. E. F. Cosson, Brussels.
9185. Making Pipe Joints, J. Wood and W. Clark, London.
9186. Folding Bedsteads, J. G. Winship, London.
9187. Sewing Machine, J. Marshall and E. A. Leech, London.
9188. Ink Wells, J. S. Mallary, J. A. Leonard, and C. P. Wilson, London.
9189. Bean Harvesters, A. A. Snure, London.
9190. Apparatus for Planing Blocks, J. S. Hoerner, London.
9191 Tire Shrinking Apparatus, M. D. Gould, sen., London.
9192. Churns, W. Deacon, London.
9193. Dust-bin, G. L. Lavington and E. A. Wright, London.
9194. Turbine, J. Farrar, Halifax.
9195. Fastenings for Door Knobs, J. Newbould, Sheffield.
9196. Knife-cleaning Machines, T. E. Peckett, Sheffield.
9197. Cycles, J. E. Hatch, Birmingham.
9198. Bicycles, J. E. Evered and D. G. Pappa, London.
9199. Internal Combustion Motor Engines, G. McGhee, Glasgow.
9200. The Cyclists' Tea Basket, M. O'C. Eccles, London.
9201. Veterinary Rasps and Files, J. E. Arnold, London.
9202. Incandescing Fire-grate Bottom for Stoves, J. D. Wood, London.
9203. Cooking Utensils, S. York and R. I. Knight, London.
9204. Binocular Field, &c., Glasses, J. H. Steward, London.
9205. Stretchers and Ambulances, B. Hardcastle, London.
9206. Ships' Divisional Bulkheads, S. A. Johnson, London.
9207. Increasing Furnace Combustion, H. J. Dowsing, London.
9208. Advertising, D. R. S. Galbraith, London.
9209. Conveying Signals from Railway Stations, &c., to or from Railway Trains in Motion, F. J. Agabeg, London.
9210. Attaching Tires to Wheel Rims, J. W. Bowley, London.
9211. Sanitary Traps for Sinks, &c., H. E. Hadley, London.
9212. Printed Pile Carpet, C. Hughes and W. Youngjohns, London.
9213. Educational Game, C. W. Faulkner and N. Winchcombe, London.
9214. Speed Indicating Apparatus, A. Inokuty, London.
9215. Tool for Bending Bandage Bars, E. Stendel, London.
9216. Coin-freed Meter Apparatus, J. F. Simmance, London.
9217. Transport and Storage of Cycles, J. Oller, London.
9218. Appliance for Supporting Bicycles, F. Sabel, London.
9219. Bulkhead Closer, D. B. Morison and R. Cockburn, London.
9220. Reducing Sulphide Ores of Lead, C. T. Vautin, London.
9221. Protecting the Bottoms of Vessels, J. Gordon, London.
9222. Book or Music Holders, &c., W. J. Pitt, London.
9223. Caissons for Pier Foundations, W. De H. Washington, London.
9224. Stop Valves, J. Hopkinson and J. Lowis, London.
9225. Warming Vehicles, J. and H. E. Gresham, Manchester.
9226. Splints, E. Stendel, London.
9227. Carrying Heavy Books, &c., A. Chapman, London.
9228. Head-rest for Dentists' Chairs, E. Jung, Liverpool.
9229. Tubes for Cycle Frames, &c., C. Binks, Liverpool.
9230. Rims for Wheels for Bicycles, J. T. Hircock, London.
9231. Device for Closing Mouths of Bottles, L. Bouneu and G. de Margeot, London.
9232. Treating Oil, F. B. Aspinall and The Electrical Oil Refining Company, Ld., London.
9233. Gas Meters, H. A. Willey and S. Simpson, London.
9234. Blast Furnaces and Cupolas, O. J. Wilmart, London.
9235. Feed-water for Steam Boilers, A. Montazeau, London.
9236. Coin-freed Mechanism, F. Saunders, London.
9237. Combination Hand Tools, R. Teichmann, London.
9238. Pneumatic Tires for Bicycles, R. Pattison, London.
9239. Stripping Insulation from Wires, W. McMurtrie, London.
9240. Pneumatic Tires for Bicycles, W. F. Goerdes, London.
9241. Garment Hooks, C. C. Blossom, London.
9242. Dentistry, W. L. Mason and H. A. Curtis, London.
9243. Signal Indicators, R. Morris and J. Crabtree, London.
9244. Manufacturing Incandescent Bodies, W. Nicholls, London.
9245. Tipping Buckets, C. Q. Henriques, London.
9246. Dough-notching Knives, M. Dare, London.
9247. Bells for Cycles and other Vehicles, H. Elsom, London.
9248. Filter, J. H. Southcott, O. P. Payne, and J. C. Sunter, London.
9249. Igniting Blasting Charges, H. M. Edwards, London.
9250. Fastener for Coats and Vests, J. Bedford, London.
9251. Hairpins, A. W. H. Barrett, London.
9252. Ladies' Hair-combs, A. W. H. Barrett, London.
9253. Boot Brushes, A. C. Clarke, London.
9254. Brushes for Shaving Purposes, J. Walton, London.
9255. Bicycle Rest or Support, J. Aynsley, London.
9256. Air and Exhaust Valves for Engines, J. B. Petter, London.
9257. Arc Lamps, C. Grahner, London.
9258. Astatic and Dead-beat Galvanometers, T. Clark, London.
9259. Explosion Engines, A. J. Boult.—(*La Société J. Landry and G. Beyroux, France.*)
9260. Machinery for Sifting Flour, E. Trummer, London.
9261. Ventilating Shafts, &c., W. Williams, London.
9262. Distributing Electricity, R. Pippette, London.
9263. Bearings for Wheels, W. H Dunkley, Birmingham.

2nd May, 1896.

9264. Adjustable Hat Peak, R. S. and J. S. Brown, London.
9265. Cycle Rack, W. E. Harper, Bath.
9266. Electric Lighting Fuses, J. MacK. Urquhart and W. H. Dingle, London.
9267. Pressure Gauges, F. Edwards, London.
9268. Utilising Air for Cycles, B. H. Thwaite, London.
9269. Argentiferous Ores, &c., B. H. Thwaite, London.
9270. The Glove Safety Purse, D. H. Thompson, Scarborough.
9271. Cigarette Machine, G. Thompson, Fife.
9272. Water-tight Doors, J. Donald and W. Johnstone, Barrow-in-Furness.
9273. Milking Machines, A. Shiels, Glasgow.
9274. Extinction of Fire, J. H. R. Dinsmore, Liverpool.
9275. Apparatus for Operating Auto-cars, R. Harrison, Herts.
9276. Metal Heads of Golf Clubs, C. Playfair, Belfast.
9277. Apparatus for Hoppling Sheep, J. S. Anthony, Derby.
9278. Tire for Cycle Wheels, &c., J. S. Anthony, Derby.
9279. Collapsible Gates, J. Robertson and J. Watt, Glasgow.
9280. Machines for Checking Time, M. Loftus, Wrexham.
9281. Ascertaining the Temperature of Kilns, C. Copeland, Staffs.
9282. Constructing Auto-cycles, W. H. Eaves, Coventry.
9283. Constructing Auto-cycles, W. H. Eaves, Coventry.
9284. Switching Gear of Electrical Transformers, A. H. Walton, London.
9285. Load Sustaining Hoists, C. J. Hart and B. C. Barton, Birmingham.
9286. Bogies for Railway Vehicles, J. H. Graham, London.
9287. Hinge for Railway Wagon Doors, H. Hyde, Sheffield.
9288. Telephone Receivers, A. Marr, Manchester.
9289. Electro-deposition of Copper, W. E. Heys.—(*E. Dumoulin, France.*)
9290. Ruling Machines, J. Joly, Dublin.
9291. Harrows, F. C. Merrill, London.
9292. Weighing Scales, J. G. J. Davis, London.
9293. Bedsteads for Trapping Insects, G. Ipson, London.
9294. Hat Brim Curl Trimming Machines, G. Atherton, Manchester.
9295. Shaping Sheet Rubber Tubing, W. G. Wrench, Glasgow.
9296. Pneumatic Corks or Stoppers, E. Guthrie, Manchester.
9297. Decorating Fenders, H. E. and E. O. Newey, Dudley.
9298. Decorating Fire-dogs, H. E. and E. O. Newey, Dudley.
9299. Apparatus for Printing Late News, J. H. Watt, Liverpool.
9300. Attaching Collars to Fronts, A. B. Coates, Stockport.
9301. Breaking up Macadamised Roads, P. S. Swan, Arbroath.
9302. Refrigerators, D. B. Walker, Glasgow.
9303. Trawl Nets for Surface Fishing, G. Davidson, Glasgow.
9304. Drinking Troughs for Dogs, S. M. Buchan, Glasgow.
9305. Gas Lamps for Railway Carriages, J. Sharp, Glasgow.
9306. Valves, A. T. Macfarlane, Glasgow.
9307. Controlling Feed-water, A. G. Mumford and A. Anthony, London.
9308. Improved Carrier for Golf Clubs, H. Verschoyle, London.
9309. Hand Cameras, S. Hebblewhite, London.
9310. Transmitting Motion to Parts of Machines, F. W. Farr, London.
9311. Sewing Machines for Boots, &c., F. W. Farr, London.
9312. Dating or other Stamps, J. W. Sutton, London.
9313. Velocipedes, A. P. Blackman, London.
9314. Tea Strainers, A. R. Pritchard, London.
9315. Cocks for Preventing Leakage, C. King, London.
9316. Treatment of Gas, C. E. Botley and C. F. Botley, jun., London.
9317. Props or Stands for Bicycles, W. Parry, jun., Liverpool.
9318. Shoe Heel Paring Machines, W. R. Mudd, London.
9319. Game for Parlour Tables, F. H. Madge, Liverpool.
9320. Measuring Liquids, H. Mayer.—(*C. Mayer, Germany.*)
9321. Sectional Tires for Cycle Wheels, C. Parnacott, London.
9322. Weaving Machinery, — Zubler, London.
9323. Lithographic Reproduction, M. Fischer, Brussels.
9324. Manufacture of Picture Frames, M. Kaelin, London.
9325. Cooking Ranges, G. G. Brodie and J. D. Prior, London.
9326. Furniture for Bed-rooms, &c., H. Cowley, London.
9327. Adjustable Sliding Sight Bar, G. J. Brownnutt, Bucks.
9328. Cycle Chain Gear, W. G. Parry and W. H. Hillsdon, London.
9329. Bottles for Spraying Liquids, M. de Laski, London.
9330. Saddle Cover for Velocipedes, M. de Laski, London.
9331. Pince-nez, &c., F. H. B. Carr, London.
9332. Permanent Electric Ways, A. Rincklake, London.
9333. Cycle Locks, F. W. Godwin, London.
9334. Linotype Machines, T. P. Ritzema, Birmingham.
9335. Carriages, Count A. de Dion and G. Bouton, London.
9336. Explosion Motors, Count A. de Dion and G. Bouton, London.
9337. Petroleum or Gas Engines, Count A. de Dion and G. Bouton, London.
9338. Gear Wheels, Count A. de Dion and G. Bouton, London.
9339. Cycle Pedals, E. W. Fraser, Bromley-by-Bow.
9340. Blackboards, L. Lahrmann, London.
9341. Fountain Pens, R. W. Barker.—(*E. Frischknecht, United States.*)
9342. Flying Machines and Apparatus, H. Middleton, Slough.
9343. Dyestuffs, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
9344. Tapping Casks, J. H. McCullough and R. Crawford, London.
9345. Antiseptic Preparations, &c., J. Ascough, London.
9346. Billiard Ball Returner, W. Buttery, London.
9347. Handles for Cycles and Vehicles, J. McRae, London.
9348. Pneumatic Tires, B. P. and D. W. Alexander, London.
9349. Electrical Measuring Device, H. A. Rowland, London.
9350. Wearing-edge Protectors, &c., W. Hoffmann, London.
9351. Dredging Pipe Sewers and Drains, E. Murray, London.
9352. Mattresses, J. Sibley, London.
9353. Moulding Screw-stoppered Bottles, C. Gray, London.
9354. Stoppering Devices, A. J. Boult.—(*L. Bouneu, Belgium.*)
9355. Compressing Device for Moulding, C. H. Gray, London.
9356. Treating Defective Sight, C. Dion and Y. A. M. P. Goubaux, London.
9357. Packing Food, H. H. Lake.—(*Vacuum Pan and Jar Co., United States.*)
9358. Apparatus for Producing Carbite, R. Pictet, London.
9359. Raising and Stacking Hay, &c., H. Reeves, London.
9360. Velocipede or Cycle Pedal Motion, M. Bliss, London.
9361. Closets, M. J. Adams, London.
9362. Dynamo-electric Machines, W. B. Sayers, London.
9363. Stoves, E. Laroche, London.
9364. Skates, E. O. Friederich, Germany.
9365. Perforating Machines, W. C. Barns and E. Selby, London.
9366. Producing and Burning Vapour, R. Poitrimol, London.

4th May, 1896.

9367. Control of Cycles, G. Quick, London.
9368. Maritime Vessels, W. P. Thompson.—(*W. R. Brüner and F. L. Anderson, United States.*)
9369. The Locke Cycle, S. H. Locke, Heaton Moor, Lancashire.
9370. Construction of Beetling Engines, J. W. Frazer, Belfast.
9371. Universal Advertising Letters, G. J. Gillett, Charlbury, Oxon.
9372. Pneumatic Tubes, W. R. and W. Swinburn, Great Grimsby.
9373. Coin-freed Machinery, G. Salter, Birmingham.
9374. Apparatus for Filtering Sewage, W. Birch Manchester.
9375. Locking Window Fastenings, G. Ashton, Manchester.
9376. Construction of Toy Puzzles, E. Taylor, Blackburn.
9377. Cycles, W. T. Smith, Keighley.
9378. Tobacco Pipe, J. O. Martinson and J. B. Archer, South Shields.
9379. Gas Motors, T. Bush, Coventry.
9380. Expanding Reels or Drums, R. Wallwork, Manchester.
9381. Pneumatic Hammers, E. Samuelson, Banbury, Oxon.
9382. Attachment Bosses of Cycle Saddles, J. B. Brooks, Birmingham.
9383. Propellers for Steam Ships, F. Wakefield, Birkenhead.
9384. Cotton Blanket Sheet, A. Warburton, Manchester.
9385. Joints for Tramway Rails, W. E. Kenway, Birmingham.
9386. Band for Sewing Machines, C. A. McCombie, London.
9387. Cycles, J. Melling, London.
9388. Obtaining Copper from Copper Ores, C. A. Burghardt and G. Rigg, Manchester.
9389. Handles for Cycles, S. Whittaker and G. H. Richmond, Manchester.
9390. Rotary Cutting Machines, A. Muir and H. S Clement, Glasgow.
9391. Rulers, G. M. Davies, Cardiff.
9392. A Novel Game, A. G. Rowlett and C. W. Faulkner, London.
9393. Stud Extractor or Driver, W. L. Wynn, Birmingham.
9394. Cutting Out Leather, J. Blakely and W. F. Blampey, Halifax.
9395. Apparatus for Winding Certain Warps, J. Rhodes, Bradford.
9396. Bicycle, R. Flucke, Berlin.
9397. Shot Register for Fire-arms, P. Gehlich, Berlin.
9398. Pulleys, W. Snelgrove, Birmingham.
9399. Air Tube for Pneumatic Tires, T. J. Rickard, Newport, Mon.
9400. Shuttle Guard for Looms, F. W., A., and J. Jepson, Burnley.
9401. Combined Shirt and Drawers, C. E. Corfe, Winchester.
9402. Electric Gas Lighting Devices, O. von Morstein, London.
9403. Cap Spinning, &c., Machinery, M. Crossley, London.
9404. Flushing Water-closets, J. and C. Wilby, London.
9405. Trap for Catching Rats, E. G. Kendall, Birmingham.
9406. Tires, A. Mapplebeck, Birmingham.
9407. Water-closets, J. Duckett and Son, Ld., and J. Duckett, London.
9408. Galvanising Iron, E. Rousseau, Catford Bridge.
9409. Hand Vices, J. W. S. Neal, London.
9410. Lanterns, J. Tabrar, London.
9411. Spring Wire, T. Shepherd. London.
9412. Flower Holder or Clip, W. S. Tansley, London.
9413. Automatic Reference Paper, A. A. M. Fournet, London.
9414. Saddle Covers, The Eadie Manufacturing Company, Ld., and H. J. Milward, Birmingham.
9415. Escapement for Watches, F. Scherzinger, London.
9416. Appliances for Drain Pipes, J. A. Kershaw, London.
9417. Cooking Utensils, J. H. Trinder, Surrey.
9418. Lock and Hasp, S. R. Foreman and G. A. Askew, London.
9419. Grindstones, F. A. Ziegner, London.
9420. Infusers, E. Fowler, London.
9421. Device for Fixing Curtain Poles, F. A. Müller, London.
9422. Applying Strips to Box Corners, H. Inman, London.
9423. Floats for Supporting Weights, E. L. Berthon, London.
9424. Converting Horizontal into Rotary Motion, J. H. Nelson and A. E. Freeto, London.
9425. Puzzles, W. M. Williams, London.
9426. Bottles, F. E. d'Humy, London.
9427. Pencil Holders, A. P. Gillespie, London.
9428. Devices for Spreading Shoes, P. Fournier, London.
9429. Accommodation Skirt, &c., F. Hooper, London.
9430. Heating of Laundry Irons, C. Stephens, London.
9431. Lifts, G. Zahikian, London.
9432. Preventing Overheating of Shafts, M. Evans, London.
9433. Umbrella Frames, E. W. Golby.—(*F. Prager, Germany.*)
9434. Dress Coverings, M. Moscovitz, London.
9435. Cycle Locks, T. Baxter, Liverpool.
9436. Mechanism for Operating Auto-cars, J. G. Horsey, London.
9437. Knee or Bed Covers for Trains, &c., M. Bliss, London.
9438. Mechanism of Linotype Machines, The Linotype Co., and C. L. Ireland, London.
9439. Knives, J. F. Wilke, London.
9440. Velocipedes, H. J. Kloos, London.
9441. Attaching Wallets to Cycles, F. Weintraud, London.
9442. Tricycles, P. Dorigny, London.
9443. Show Cases for Cabinets, H. Broughton, London.
9444. Balloons, &c., H. Broadbent and A. Swan, London.
9445. Trucks, H. A. L. Barry, London.
9446. Cocks, E. H. Page, London.
9447. Reversible Variable Speed Gear, A. G. Cooke, London.
9448. Centrifugal Pumps and Ventilators, F. Pelzer, London.
9449. Door Fastening, J. Haswell, London.
9450. Apparatus for Spraying Liquids, G. S. Spurrier, London.
9451. Presses for Bundling Hay, W. J. Perkins, London.
9452. Inhaler, A. M. Paddon, C. E. Hedmondt, and H. L. Pringle, London.
9453. Wheeled Vehicles, &c., Sir A. H. Grant, Bart., London.
9454. Steam Engines, C. Bellens, London.
9455. Biscuit for Human Food, B. F. Hartzhorne, London.
9456. Tool Rest, J. F. Lorenz and H. Leistner, London.

5th May, 1896.

9457. Garden Chair, D. S. Hawks, Welshpool
9458. Feeding Bottle Holder, G. Royle, Bedford.
9459. Velocipede, W. Wingate, London.
9460. Bicycle Chains, J. Hollis, Ilkeston.

9461. Radiographic Vacuum Tube, J. Buckland, Taunton.
9462. Keeping Tobacco Moist, C. and L. W. Lee, Bilston.
9463. Motor Power for Velocipedes, F. T. Pritchard, Leamington Spa.
9464. Tea Strainers, W. H. Pike, Cardiff.
9465. Letter-box Plates and Letter-boxes, E. Miles, Swansea.
9466. Water Telescope, G. Hopkins and R. W. Archer, Reading.
9467. Boots for Animals, F. H. Ayres and R. Evans, London.
9468. Shoulder Pads for Coats, &c., W. H Sladdin, Brighouse.
9469. Bottle with Self-locking Lock, W. Sherwood, Birmingham.
9470. Cycle Frames, F. S. Willoughby, Manchester.
9471. Igniting Cigarettes and Cigars, E. Guthrie, Manchester.
9472. Cycle Mud-guards, E. D. Hopcroft, Kidderminster.
9473. Attaching Heels to Shoes, W. H. Dorman, Stafford.
9474. Folding Sheets of Paper, K. Geiger, Manchester.
9475. Skimming Molten Iron, H. Gerling, Birmingham.
9476. Crane Apparatus for Elevating Buckets, S. Porter, Liverpool.
9477. Dyes, L. P. Marchlewski, E. S. Wilson, and E. Stewart, Liverpool.
9478. Frame for Christmas Cards, W. Jones, Newport, Mon.
9479. Cycles, G. O'C. Holloway, Birmingham
9480. Subways, A. S. Krotz, W. P. Allen, and O. S. Kelly, Manchester.
9481. Gas Meters, G. H. Smith, Manchester.
9482. A New Tire for Cycle Wheels, J. Blakey, Halifax.
9483. Double Cased Oven Doors, W. E. Jaques, Salop.
9484. Steel Wire Suspender, &c., W. J. Byard, Bradford.
9485. Lubricators, C. Ankers, Liverpool.
9486. Fire Lighters, E. Jones, Bradford.
9487. Brushes for Cleaning Cycles, G. and H. Zierlien, Halifax.
9488. Picker Spindles of Weaving Looms, J. Appleyard, Bradford.
9489. A Toy, J. H. Ruddick, Newcastle-on-Tyne.
9490. Manufacture of Cricket Balls, J. Lane, London.
9491. Railway Permanent Way Chairs, F. G. Hopkirk, Belfast.
9492. Hammerless Gun Locks, O. Horton, Glasgow.
9493. Photographic Cameras, &c., E. Wood, Rochdale.
9494 Steam Valves, J. C. Jackson and J. Ogden, Manchester.
9495. Spinning Frames, S. M. Rutnagur, Manchester.
9496. Pneumatic Tires, P. A. Birley and C. Macintosh and Co., Ltd., Manchester.
9497. Improved Window Fastener, R. Ellis, Lancashire.
9498. Removing Liquids in Kettles, S. Diplock and W. T. Lalonde, Weston-super-Mare.
9499. Combustion of Gases, S. Diplock and W. T. Lalonde, Weston-super-Mare.
9500. Spanners and Wrenches, G. F. Forster, Liverpool.
9501. Ladies' Blouses, L. S. Willoughby, London.
9502. Flat Printing Presses, T. E. Allison, London.
9503. Reversible Octave Concertina, F. A. Hanks, London.
9504. Three-way Railway Switch, S. C. Adams and H. P. Crouse, London.
9505. Bottles, J. S. Harrison, London.
9506. Spring Heel for Boots, &c., H. D. Richey, London.
9507. Ball Bearings, F. W. Engels and H. R. Kirschbaum, London.
9508. Cycle Crank Attachments, F. W. Engels and H. R. Kirschbaum, London.
9509. Letter Carriers' Register, J. D. Miller, S. M. Jones, and C. M. Towson, London.
9510. Photographic Burnishers, G. C. W. Gennert, London.
9511. Vent Plug for Barrels, G. H. W. Davis, Birmingham.
9512. Shedding Motions of Looms, T. Crook London.
9513. Coop for Fattening Geese, M. Rosenberger and F. Belággi, Birmingham.
9514. Casting Ingots, W. Kirkham and D. Evans, Sheffield.
9515. Pneumatic Tires, C. Lyon and C. Poose, London.
9516. Appliances for Testing Sight, N. Davidson, London.
9517. Railway Signalling, W. R. Sykes and F. T. Hollins, London.
9518. Reaching Elevated Parts of Buildings, E. J. Palmer, London.
9519. Machines for Drawing Corks, W. Vaughan, Birmingham.
9520 Improved Night-dress for Children, L. High, London.
9521. Artificial Musk, S. S. Bromhead.—(*Messrs. Gretsch and Mayer, United States.*)
9522. Thread Cutting Implements, C. Elterich, London.
9523. Mouse Traps, N. Fellows and H. S. Stacy, London.
9524. Process for Extracting Gold, J. A. Bruce-Fraser, London.
9525. Ball Castors for Furniture, G. J. S. Collins, London.
9526. Oil or Gas Engines, H. S. Maxim, London.
9527. Type-writers, F. P. Gorin, London.
9528. Telegraphic Relays, H. H. Lake.—(*C. G. Burke, United States.*)
9529. Fasteners for Shoes, H. H. Lake.—(*Pratt Fastener Company, United States.*)
9530. Incandescent Electric Lamps, J. Devonshire.—(*H. C. Wirt, United States.*)
9531. Dynamo-electric Machines, J. Devonshire.—(*C. P. Steinmetz, United States.*)
9532. Brooms, &., J. H. Smith and G. H. Wilkes, London.
9533. Extinguisher for Candles, J. W. Kay, London.
9534. Electric Switches, J. Lavender, London.
9535. Metals of Railways, O. Klink, London.
9536. Driving Gear for Cycles, W. F. Brenton, London.
9537. Electro-mechanically Propelled Vehicles, J. Lavender, London.
9538. Quick-firing Gun, The Right Honourable D. M. B. H. Cochrane, London.
9539. Filtering Apparatus for Oil, R. Conrader, London.
9540. India-rubber Tires for Cycles, G. H. Jones, London.
9541. Sash or Waistband Fasteners, F. W. Powell, London.
9542. Forming Compound Cycles, C. A. Rollason, London.
9543. Machines for Making Matches, G. M. Hathaway, London.
9544. Purifying Chlorine Gas, P. Jensen.—(*D. and H. Chappelen, Norway.*)
9545. Pelvimeter, E. J. Brady, London.
9546. Application of a Douche to a Wound, E. J. Brady, London.
9547. Nipples for Cycle Wheels, &c., G. Skinner, London.
9548. Supplying Projectiles to Turret Guns, J. Vavasseur, London.
9549. Sleeping Cars, L. F. Ruth, London.
9550. Wheels for Velocipedes, &c., J. R. Gibson, London.
9551. Elevator Cars, W. P. Thompson.—(*T. J. Vail, United States.*)
9552. Annealing Metal, W. P. Thompson.—(*W. E. Harris, United States.*)
9553. Railway Indicators, W. P. Thompson.—(*F. Zillger, Germany.*)
9554. Sifting Machines, W. P. Thompson.—(*W. D. Gray, United States.*)
9555. Electric Burglar Alarms, T. A. Clarke, Liverpool.
9556. Fireproof Buildings, R. H. Davis, Liverpool.
9557. Distillation Overflow Pipes, H. Herzel, Liverpool.
9558. Incandescent Burner, N. Killian, Liverpool.
9559. Tires, E. Hale, Liverpool.
9560. Furnaces, A. H. Wethey, London.
9561. Trap for Mice and Rats, C. R. von Blumencron, London.
9562. Pneumatic Mail Collectors, &c., H. Fleckl, London.
9563. Adjustable Supports for Furniture, J. Feely, London.
9564. Umbrellas and Parasols, &c., F. Zich, London.
9565. Electric Melting Apparatus, M. Schindler, London.
9566. Dressing or Wash for Hop Plants, B. S. Dyer, London.
9567. Drawing-off Ale, Stout, &c., J. Gray, London.
9568. Inhalers, F. Schutze, London.
9569. Cabinets for Cycles, E. McClelland and T. S. D. Wallace, London.
9570. Magazine Rifles, H. H. Lake.—(*The Lee Arms Company, United States.*)
9571. Steam Engines, C. F. G. L. P. de Chasseloup-Laubat, London.
9572. Type-writing Machines, W. Heath, London.
9573. Refrigeration Apparatus, A. J. Boult.—(*G. F. Knox and E. L. Sharpneck, United States.*)
9574. Safety Fuses, H. Hohendahl, London.
9575. Rotating Devices for Rock Drills, P. A. Newton.—(*The Ingersoll-Sergeant Drill Company, United States.*)
9576. Pharmaceutical Substance, H. E. Newton.—(*The Farbenfabriken vormals F. Bayer and Co., Germany.*)
9577. Treating Auriferous Slimes, J. H. Pollok, London.
9578. Making Lucifer Matches, J. C. Donnelly, Liverpool.
9579. Pneumatic Tires, H. S. Maxim, London.

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9580. Combined Manhole Filter and Dirt-box, J. T. Neech, Tyldesley, near Manchester.
9581. Antiseptic Animal Size, F Humphrey, Bristol.
9582. Antiseptic Mineral Size, F. Humphrey, Bristol.
9583. Antiseptic Clair Colle, F. Humphrey, Bristol.
9584. Pneumatic Cycle Seat, J. A. Bonds, L. Dawes, and S. Dawes, London.
9585. Graduated Handrail Wreath Measure, W. J. and I. Harrison, Derbyshire.
9586. Brackets for Rain Water Gutters, A. Doman, Dudley.
9587. Water-tube Boiler, S. J. Hamblin, Newbury.
9588. Detachable Covers for Tires, W. D. Mastaglio, Newcastle-on-Tyne.
9589. Shaft Governors, F. Bosshardt.—(*J. R. Frikart, Germany.*)
9590. Breast-strap for Weaving Looms, H. Spencer, Blackburn.
9591. Wet Gas Meters, H. O'Connor, Edinburgh.
9592. Tires of Vehicles, W. Menzies, Dundee.
9593. Sewing Sweat Hat Bands, J. Kelso.—(*A. Kelso, United States.*)
9594. Tires for Cycle, &c., Wheels, J. A. Beattie, Glasgow.
9595. Tandem Cycles, G. W. Bendie, Glasgow.
9596. Cog-wheel Driving Bands, G. Moore, jun., Birmingham.
9597. Handle-bars of Cycles, A. G. and H. H. C. Adamson, Glasgow.
9598. Corsets, E. Young, Glasgow.
9599. Artificial Fuel, R. Bradshaw, Liverpool.
9600. Blowing Apparatus, T. Duncan, Oldham.
9601. Decorating Glass for Leaded Lights, E. W. Brock, Bristol.
9602. Sewage Precipitation Tanks, H. Walker, Nottingham.
9603. Preparation for Glazing Linen, M. Holding, Halifax.
9604. Liquid Container, G. H. Shaw, Ashton-under-Lyne.
9605. Ladies' Skirts for Cycling, M. A. Ward, Bristol.
9606. Lighter for Cigars and Pipes, J. G. Squire, London.
9607. Lessening Carriage Vibration, J. Annandale, Glasgow.
9608. Sewing Machines, W. H. Inslee.—(*The Singer Manufacturing Co., United States.*)
9609. Igniting Cigarettes and Cigars, E. Guthrie, Manchester.
9610. Fire-engines, J. C. Merryweather and C. J. W. Jakeman, London.
9611. Tyres for Cycles and Vehicles, H. Thompson, London.
9612. Breaking Up Dried Fruits, T. Johnson, London.
9613. Combination Folding Tent and Bed, J. Long, London.
9614. Power Hammers, W. H. Botting, London.
9615. Ironing Machine, W. Lanfear and G. A. Macdonald, London.
9616. Bicycle Support, R. C. Mann, London.
9617. Powder for Cleaning Teeth, J. Berman, London.
9618. Aprons and Rugs for Vehicles, &c., H. G. Ives, Bristol.
9619. Electric Lamps, S. P. Eastick and E. Sayer, London.
9620. Socket Connection for Pipes, &c., F. Offen, London.
9621. Cartridge Holders, H. S. McKenzie, London.
9622. India-rubber Waterproof Fabrics, T. Birnbaum, London.
9623. Cycle Driving Gear, J. Greenall and A. Jones, London.
9624. Cycle Tires, J. Whitehead and J. A. Crane, Handsworth
9625. Locks, Sir G. H. Chubb and G. G. Exton, London.
9626. Rotary Blowers or Exhausters, T. W. Green, London.
9627. Feeding Ore to Crushing Machines, The Sandycroft Foundry and Engine Works Company, Ld., and R. O. Ahlers, London.
9628. Elastic Tire for Velocipedes, Sir H. W. Tyler, London.
9629. Separating Paper Sheets, A. S. Coghill, London.
9630. Combustion of Acetylene Gas, C. Coppeaux, London.
9631. Churning, Whisking, Mixing, &c., P. Dutto, London.
9632. Friction Gear Hoisting Apparatus, R. F. Sturrock, London.
9633. Metal Capsules, B. J. B. Mills.—(*E. Stern, France.*)
9634. Luggage Carriers, A. J. Boult.—(*The Rochester Bicycle Combination Holder Company, United States*)
9635. Protectors for Sink Pipes, &c., J. Gowland, London.
9636. Producing an Optical Delusion, E. Prentice, London.
9637. Arc Lamps, A. Blahnik, London.
9638. Pulleys for Transmitting Power, J. H. Lee, London.
9639. Guard for Cricket, J. G. and W. A. Green, London.
9640. Spindles of Spinning Machines, C. Bergmann, London.
9641. Bicycles, &c., H. Gläser and R. Kolbaba, London.
9642. Pneumatic Tires, W. A. G. Birkin, London.
9643. Wheels for Cycles, &c., T. W. N. Crawford, London.
9644. Fittings for Lavatory Basins, O. Elphick, London.
9645. Bulbs for Producing Rays, R. M. Deeley, London.
9646. Softening Water, E. d'Huart, and M. and G. Glaesener, London.
9647. Hat Boxes for Silk Hats, F. W. Longmore, London.
9648. Roller Skates, W. P. Thompson.—(*H. Strieffler, Germany*)
9649. See-saw, W. P. Thompson.—(*E. Schneider, Germany.*)
9650. Electromotors and Dynamos, E. Lanhoffee, London.
9651. Cloak, H. A. Meyer, Liverpool.
9652. Valves, &c., L. H. Jung and H. A. Clifton, London.
9653. Pumps, Valve Guards, &c., F. Edwards, London.
9654. Framing for Bedsteads, P. Jensen.—(*H. J. Kollén, Sweden.*)
9655. Dry Docks, W. W. Horn.—(*A. Cameron, United States.*)
9656. Depositing Metal, The Improved Electric Glow Lamp Syndicate, Ld.—(*C. Schwabe, Germany.*)
9657. Attaching Tires to Rims of Wheels, S. Chandler, jun., and J., J. C., and S. B. Chandler, London.
9658. Drying Butter, R. A. Lister and G. E. Snoxell, London.
9659. Seed and Manure Drills, &c., J. Wilson, London.
9660. Let-off Motions for Looms, J. Poyser and F. L. Ball, London.
9661. Extinguishing Fires, &c., J. M. Raymond, London.
9662. Headlocks for Cycles, V. F. and W. F. Drew, London.
9663. Bottle Case, H. Penn, London.
9664. Bolt, J. W. Sutton, London.
9665. Apparatus for Drying Materials, E. Stauber, London.
9666. Pneumatic Tires, H. S. Maxim, London.

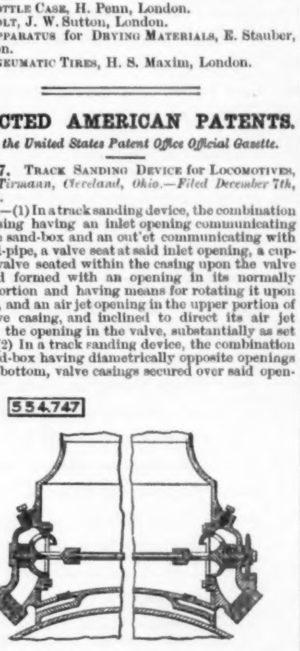
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

554,747. Track Sanding Device for Locomotives, *H. Tirmann, Cleveland, Ohio.—Filed December 7th*, 1895.

Claim.—(1) In a track sanding device, the combination of a casing having an inlet opening communicating with the sand-box and an outlet communicating with the sand-pipe, a valve seat at said inlet opening, a cup-shaped valve seated within the casing upon the valve seat and formed with an opening in its normally upper portion and having means for rotating it upon the seat, and an air jet opening in the upper portion of the valve casing, and inclined to direct its air jet through the opening in the valve, substantially as set forth. (2) In a track sanding device, the combination of a sand-box having diametrically opposite openings near its bottom, valve casings secured over said openings and formed with inlet openings communicating with the sand-box and outlets communicating with the sand-pipes, valve seats at the inlet openings of the casings and having inwardly overhanging hoods at their upper portions, cup-shaped valves upon said seats having pivots journalled in the valve casings and formed with openings in their normally upper portions and with inwardly projecting shanks formed with openings which register with said first mentioned openings, springs which force said valves upon their seats, a rod having its ends attached to the shanks of the valves, and air jet chambers in the upper portions of the valve casings and formed with inwardly inclined jet openings, substantially as set forth.

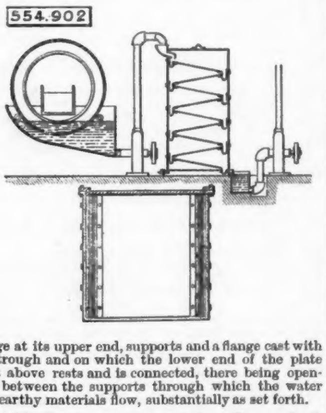
554.747



554,902. Amalgamator for Separating and Saving Gold, *T. G. Barlow-Massicks, Prescott, Ariz.—Filed January 23rd*, 1895.

Claim.—The combination in an amalgamating apparatus, of the cast iron troughs, each with an upwardly-projecting flange at one side and an inclined flange at the other side, an inclined plate, fastened to such flange at its upper end, supports and a flange cast with the trough and on which the lower end of the plate next above rests and is connected, there being openings between the supports through which the water and earthy materials flow, substantially as set forth.

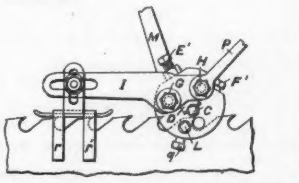
554.902



555,005. Device for Swaging Saw Teeth, *S. H. Holley, Marquette, Mich.—Filed July 3rd*, 1895.

Claim.—In a device for swaging the points of saw teeth, the combination with body A, provided with slot J; anvil B, held in position by set screws F and F'; die C, block D, in slot O, provided with groove *a* and set screws E and E', and handle N; set screw K, with small set screw *q*; set screw L, with handle M; guide I having slot *u*, held to body A by bolts H and G; with finger U and rest S, held to guide I by bolt V; finger U being provided with guards and extensions *r*, *r'* and *r*² and slot *u'*; and stop P; all substantially as shown and described.

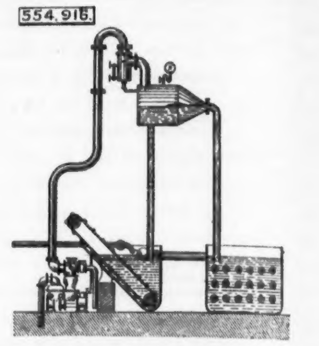
555.005



554,916. Vacuum Pan, *H. H. Dow, Midland, Mich.—Filed June 13th*, 1895.

Claim.—In apparatus for producing granular salts or similar solid substances from liquids by evaporation, the combination of an open heating vessel provided with means for heating the liquid therein, and thereby separating and depositing the less soluble impurities accessible for removal, and elevated separating vessel having a pipe ascending into it from the heating vessel and having a descending pipe from its bottom, means for reducing the atmospheric pressure in said separating vessel to raise the liquid from the heating vessel into the separating vessel and to produce evaporation without the application of heat to said latter vessel, and a settling vessel having the descending pipe opening into it and from which the settled solids may be removed, substantially as set forth.

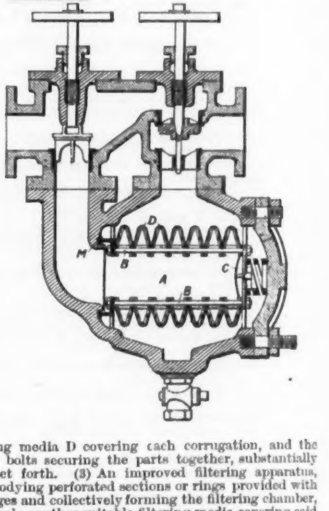
554.916.



555,020. Filter, *W. Railton and R. Campbell, Liverpool, England.—Filed April 30th*, 1894.

Claim.—(1) An improved filtering apparatus, embodying a filtering chamber formed of the perforated corrugated sections or rings having flanges, the end pieces C C, longitudinal stay bolts B passing through said flanges and end pieces, the seating M against which one set of end pieces C rest, and tightening devices for forcing the filtering chamber against said seating, substantially as and for the purpose set forth. (2) An improved filtering apparatus, embodying the perforated corrugated sections or rings forming the filtering chamber A, the filtering flannels or other filtering media D covering each corrugation, and the stay bolts securing the parts together, substantially as set forth. (3) An improved filtering apparatus, embodying perforated sections or rings provided with flanges and collectively forming the filtering chamber, flannels or other suitable filtering media covering said perforated sections and having the edges clipped between the flanges of the adjoining sections or rings, and bolts passing through said flanges for securing the sections or rings together and binding the covering or filtering media in position, substantially as set forth.

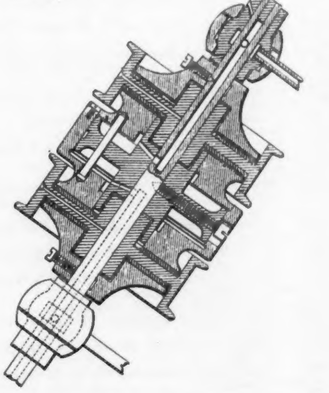
555.020



555,036. Fluid Controlled Clutch Mechanism, *D. H. Church, Newton, Mass.—Filed July 20th*, 1895.

Claim.—The combination with a shaft, a pair of pulleys thereon, and means for resisting movement of said pulleys longitudinally of the shaft; of a single closed cylinder embracing the shaft between the pulleys, a piston in the cylinder, and channels for admission of fluid under pressure into the cylinder on either side of said piston, one of said last mentioned parts being held from longitudinal movement and the other constituting a one piece double faced clutch member to engage the pulleys under longitudinal movement—the admission of fluid on one or the other side of the piston effecting a clutching of one pulley and at the same time a positive unclutching of the other pulley.

555.036



ON THE TRANSMISSION OF HEAT THROUGH METAL PLATES FROM HEATED GAS AT THE ONE SIDE TO WATER BEING HEATED AND EVAPORATED AT THE OTHER.

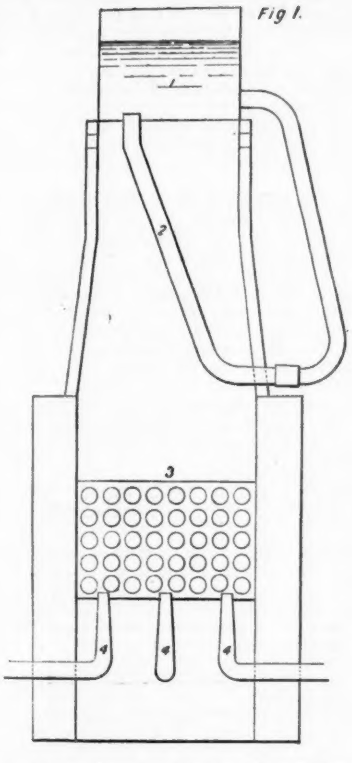
By Mr. A. BLECHYNDEN.

THIS may be regarded as part of a continuation of that on the same subject by the author, and read at the summer meeting of the Institution of Naval Architects at Cardiff, July 12th, 1893, and is an account of some further experiments on the transmission of heat through metallic plates. The object in view was to ascertain how the rate of transmission of heat through copper plates compares with the rate of transmission through steel plates of the same thickness and under the same condition.

The apparatus employed in most of the experiments was identical with that described in the previous paper as having been employed in the experiments with the steel plates, and for a description reference may be made to that paper; in other cases an almost entirely different apparatus was used. The experiments whose results are given in tables 1, 2, 2A, 3, and 3A, were made with the identical apparatus previously used.

The experiments with the copper plate P, and the steel plate G, of which the results are given in Table 4, were made with the furnace as originally described. The plates formed the bottoms of two semicircular pans, each 5in. radius, and so made that they could be placed together side by side and form one circle of the same diameter as the original boiler. Each plate was ·08in. thick, and their surfaces were as nearly as possible of equal smoothness; but while the copper plate had a clean metallic surface, that of the steel plate was oxidised. The tubes K and L were experimented upon with the apparatus shown in Fig. 1. Into each of the semicircular pans just described a tube was fitted, as shown in Fig. 1, the one end being connected to the side and the other to the bottom. The tubes were partially in and partially out of the furnace; the inner part forming the upcast, while the outer formed the downcast tube. The tubes were solid drawn, 1·1875in. diameter outside and ·09375in. thick. K was of steel and L was of copper.

Fig 1.



The copper plate I was a piece of boiler plate, such as is used for the fire-box of a locomotive. Its surfaces were smooth and clean, just as they had left the rolls. B was a Siemens-Martin steel boiler plate. The side which was next the water was machined, but the lower side was left untouched.

For the method of experimenting with the plates, reference may be made to the paper above referred to. The experiments with two semicircular fans were carried out in a somewhat similar manner to those with the circular plates. The time required to reach the boiling point was noted, as well as the evaporation in a given time, so that there were two records to check the relative rates at which heat was transmitted by the two plates. For all practical purposes the experiments with the two tubes, K and L, were conducted in the same manner.

The furnace temperatures were estimated by means of a Siemens pyrometer, Pouillet's determination of the specific heat of platinum being the basis; for the other temperatures mercurial thermometers were used. The remarks in the previous paper hold good in regard to sources of error. The results of the various series of experiments are given in the accompanying tables and diagrams. Tables 1 and 3 are for a series of experiments with the copper plate I; No. 1 being with the surfaces thoroughly clean, No. 3 with them slightly smoked with the products of combustion from the furnace, and No. 3A with the surfaces thoroughly sooted. Table 2 is a copy of Table 6 of the paper read at the summer meeting of the Institute of Naval Architects in Cardiff, 1893, and is introduced for comparison of the plate I with the plate B, which was the same thickness. Table 2A gives the results of experiments with a steel plate H, which was of the same thickness as the plates I and B, but was machined very smoothly on both sides, almost bright on the fire side, so as to present a clean metallic surface to both sides of the furnace and water, somewhat similarly with the plate E of the Cardiff paper. The surfaces were, however, brighter than those of the plate E. Experiments were also made with this plate with its fire surface smoked as shown in the table. The effect of its greater smoothness was to reduce its rate of absorption much below one with a surface like E. Table 4 gives the comparative results of the thin steel and copper plates placed over the same fire. Tables 5 and 6 give the results of steel and copper in the form of tubes placed in the same fire.

TABLE 1.—*Plate I: Copper ·46875in. thick. Surface Clean. Water being Heated and Evaporated.*

Duration of experiment.	Temperatures.		Water.			Heat transmitted per square foot per hour = H.	T − 212. = D	Modulus $\frac{H}{(T-212)^2}$
	Of feed-water.	Of furnace.	In boiler at commencement.	Added during the experiment.	In the boiler at termination of experiment.			
hours min.	Deg. Fah.	Deg. Fah.	lb.	lb.	lb.	B. thermal units.	Deg. Fah.	
1 3	60	1260	15	2·5	8·06	16,550	1048	·01505
1 17	59·3	1177	15	5·0	10·96	14,720	965	·01582
1 14	53·6	1084	15	5·0	13·56	10,450	872	·01376
1 21	51·1	1076	15	5·0	12·156	11,400	864	·01530
1 28	50·75	1039	15	5·0	13·46	8,904	827	·01305
1 20	52·85	1021	15	5·0	12·735	10,770	809	·01650
1 30	49	966	15	5·0	13·19	9,050	754	·01593
1 20	48·2	959	15	2·5	11·62	8,377	747	·01501
1 29	50	765	15	2·5	14·03	4,645	553	·01512
1 3	54·2	740	15	2·5	15·43	4,180	528	·01495
1 11	54·6	730	15	2·5	14·78	4,620	518	·01715
1 15	49·0	662	15	2·5	16·156	2,550	450	·01260
1 18	55·2	629	15	2·5	16·156	2,385	417	·01371
							Mean... ...	·01492

TABLE 2.—*Plate B: Steel ·46875in. thick. Water being Heated and Evaporated.*

Duration of trial.	Temperature.		Water.			Heat lost by radiation, in B. thermal units per hour.	Heat transmitted per square foot per hour = H.	T − 212. = D	Modulus $\frac{H}{(T-212)^2}$
	Of feed-water.	Of furnace = T.	In boiler at commencement.	Added during the experiment.	In the boiler at termination of experiment.				
hours min.	Deg. Fah.	Deg. Fah.	lb.	lb.	lb.		B. thermal units.	Deg. Fah.	
1 0	51	1465	15	10	5·287	600	38,950	1253	·02474
1 3	59	1360	15	10	8·3	600	31,940	1148	·02420
1 0	58	1340	15	5	3·976	600	30,850	1128	·02425
1 19	60	1335	15	7·5	1·82	600	30,450	1123	·02410
1 8	56	1280	15	5	3·58	600	28,140	1068	·02462
1 30	56	1240	15	10	5·975	600	25,150	1028	·02410
1 0	61	1205	15	5	8·20	600	23,550	993	·02385
1 23	—	885	15	—	8·59	600	9,350	643	·02260
1 7	—	850	15	—	9·91	600	9,175	638	·02255
1 10	—	625	15	—	12·91	600	4,270	413	·02495
								Mean... ...	·023996

TABLE 2A.—*Plate H: Steel ·46875in. thick (both sides machined). Water being Heated and Evaporated.*

Duration of trial.	Temperature of furnace, T.	Weight of water.		Heat units transmitted per hour per square foot, H.	Modulus $\frac{H}{(T-212)^2}$	Condition of surface.
		In boiler at start.	In boiler at finish.			
hours min.	Deg.	lb.	lb.	British thermal units.		
1 4	965	10	6·406	3850	·01246	Smoked
1 9	959	10	6·218	3770	·01235	Smoked
1 3	1022	10	6·75	3590	·01003	Smooth and bright
1 0	1059	10	6·109	4360	·01115	Smooth and bright
1 0	866	10	7·57	2940	·01259	Rough and bright
0 55	977	10	7·109	3650	·01145	Rough and bright

TABLE 3.—*Plate I: Copper ·46875in. thick. Surface slightly Sooted. Water being Heated and Evaporated.*

Duration of experiment.	Temperatures.		Water.			Heat transmitted per square foot per hour = H.	T − 212. = D	Modulus $\frac{H}{(T-212)^2}$
	Of feed-water.	Of furnace.	In boiler at commencement.	Added during the experiment.	In the boiler at termination of experiment.			
hours min.	Deg. Fah.	Deg. Fah.	lb.	lb.	lb.	B. thermal units.	Deg. Fah.	
1 13	50	1089	15	5	11·48	13,238	877	·01721
1 32	58·4	993	15	5	10·67	11,710	781	·01922
1 30	51	755	15	2·5	13·53	5,185	543	·01758
1 5	53·2	741	15	2·5	14·75	5,497	529	·01965
							Mean... ...	·018415

TABLE 3A.—*Plate I: Copper ·46875in. thick. Surface Smoked. Water being Heated and Evaporated.*

1 25	68·633	1072	15	7·5	9·937	17,195	860	·0234
1 20	74·9	1013	15	5	8·687	16,130	801	·0252
							Mean... ...	·02422

TABLE 4.—*Copper Plate P, Steel Plate G. Thickness ·08in. Tried Simultaneously over the same Furnace. Water being Heated and Evaporated.*

Plate.	Duration of experiment.	Temperature.		Water.			Heat transmitted per hour per square foot = H.	T − 212. = D	Modulus $\frac{H}{(T-212)^2}$	Notes.
		Of feed-water.	Of furnace = T.	In each boiler at commencement.	Added during the experiment.	In each boiler at termination of experiment.				
	hours min.	Deg. Fah.	Deg. Fah.	lb.	lb.	lb.	B. thermal units.			
G	1 24	50·6	1021	7·5	2	4·34	13,880	809	·02120	Plates perfectly clear
P	1 16	51	1021	7·5	2	6·46	9,450	809	·01447	
G	1 7	49·5	946	7·5	2	5·95	12,320	734	·0229	Plates slightly sooted
P	0 58	49·5	946	7·5	2	6·96	10,540	734	·01955	

NOTE.—The differences of time under the head of "Duration of experiment" for each experiment are due to their having been measured from the moment the water reached boiling point in each pan. They ended at the same time. In the case of the copper plate, therefore, as it transmitted heat less rapidly than the steel plate, the water in the pan P was longer in reaching the boiling point, which left less time for actual evaporation.

An explanation of their origin may be interesting, as the experiments with the steel and copper plates seem like going over old ground. The first experiment with the copper plate I arose through a discussion as to the advisability of adopting copper in place of steel in the fire-box of a locomotive form of marine boiler. It was suggested that copper should be used, on the ground of its superior conductivity; but as the matter was open to doubt, notwithstanding the fact that it has been often asserted, and even in recent years, that copper is much superior as a heat conductor in the form of a plate to steel, it was determined to test it. Accordingly a single experiment was made, when it was found that the modulus of conductivity, or:—

$$\frac{\text{Heat transmitted per square foot per hour}}{(\text{Difference of temperature on the two sides})^2} = \cdot 015$$

which, being compared with that for a steel plate B of the same thickness, viz., ·024, appeared exceedingly low, and on this account the accuracy of the experiment was doubted.

It will be remembered that Weidmann gives the relative conductivities of copper and iron as 74 and 12, and that Despretz gives the more moderate ratio of 897 to 374. Both these experimenters refer to the internal conductivities only, but as the surface resistance enters the problem of the heat transmission through a plate forming part of the heating surface of a boiler, the problem becomes somewhat more complicated.

Rankine, using Peclet's figures, has given in his "Treatise on the Steam Engine" formulæ and figures for the purpose of estimating the external and internal resistance of a plate of metal to the transmission of heat, and consequently its rate of transmission. The rates thus calculated per hour per square foot of surface for plates 0·5in. thick, the surfaces being assumed as smooth and metallic in the first, and as coated with lampblack in the second case, and for a difference of temperature of 1000 deg. Fah. between the two sides, are for:

	Clean surface.		Lampblack surface.	
Copper ...	... 3415	...	8240	British thermal units, and for
Iron ...	... 3390	...	8230	,, ,,

The difference between these figures for the two metals is sufficiently unimportant to permit of their being regarded as equal, and given as they are on such authority, similar calculations have caused it to be generally accepted that the rate of transmission is little affected by the metal *per se*. As will afterwards be shown, this view is upheld by the experiments whose results are herein given. At the same time many persons have held to the opinion that so long as the surfaces are clean, a copper plate is a better conductor than steel or iron, but that they practically become equal when their surfaces are sooted.

Fig 2.

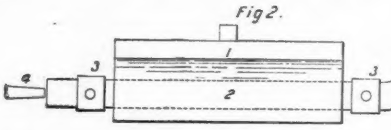


TABLE 5.—*Copper Tube L and Steel Tube K tried simultaneously in the same Furnace. Water being Heated and Evaporated. Surfaces of Tubes Clean. Diameter of Tubes outside* 1·1875*in.* *Thickness* ·09375*in.* *Surface Exposed to Fire* ·712 *square feet.*

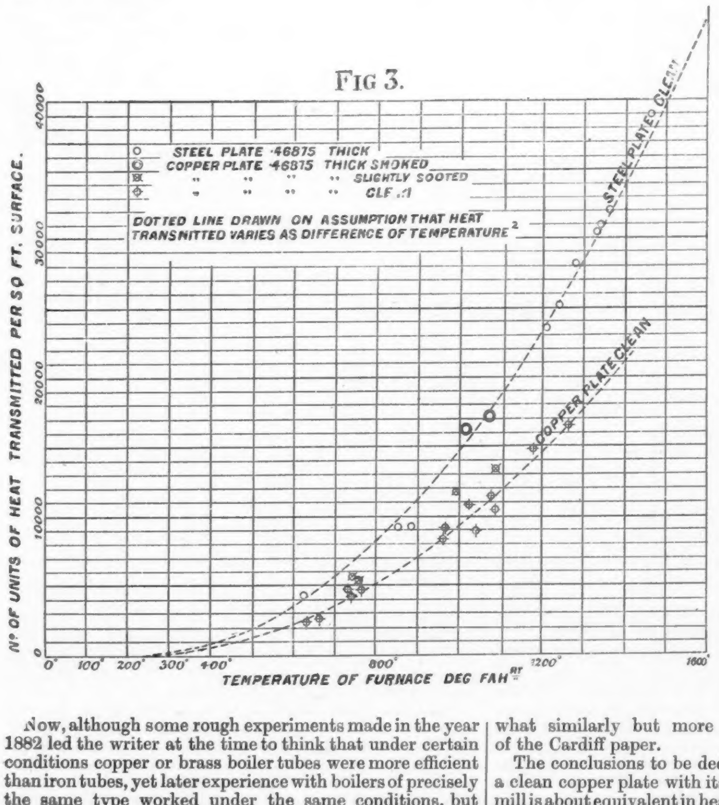
Duration of experiment.	Temperature.			Water.			Heat transmitted per hour per square foot = H.	T − 212 = D.	t − 212 = d.	H / D d.	Tube.	No. of experiment.
	Of feed-water.	Of furnace. Top T.	Of furnace. Bottom t.	In each boiler at commencement.	Added during the experiment.	In each boiler at the termination of experiment.						
hours min.	Deg. Fah.	Deg. Fah.	Deg. Fah.	lb.	lb.	lb.	B. thermal units.	Deg. Fah.	Deg. Fah.	Deg. Fah.		
1 3	47·7	1030	—	10	5	5·328	13,570	818	—	·0203	K	1
1 1¾	48·0	1030	—	10	5	7·875	10,500	818	—	·0157	L	
1 34	57·8	842	1116	10	4	7·03	6,570	630	904	·01154	K	2
1 32½	53·55	842	1116	10	4	7·843	6,002	630	904	·01052	L	
1 33	52·0	821	950	10	2	5·87	5,654	609	738	·01258	K	3
1 31½	52·0	821	950	10	2	6·46	5,221	609	738	·01161	L	
1 32	50·3	788	943	10	4	7·5	6,330	576	731	·01505	K	4
1 34¾	55·5	788	943	10	4	8·01	5,700	576	731	·01355	L	
1 37½	48·9	656	827	10	2	7·42	4,125	444	615	·0151	K	5
1 36	48·7	656	827	10	2	8·18	3,525	444	615	·0129	L	
							Means :— (2) to (5)	Copper	... ...	·01214		
								Steel	.. ...	·01356		

TABLE 6.—*Copper Tube L and Steel Tube K, tried simultaneously in the same Furnace. Water being Heated and Evaporated. Surfaces of Tubes well Sooted. Diameter of Tubes outside* 1·1875*in.* *Thickness* ·09375*in.* *Surface Exposed to Fire* ·712 *square feet.*

Duration of experiment.	Temperature.			Water.			Heat transmitted per hour per square foot H.	T − 212 = D.	t − 212 = d.	H / D d.	Tube.	
	Of feed-water.	Of furnace. Top T.	Of furnace. Bottom t.	In each boiler at commencement.	Added during the experiment.	In each boiler at the termination of experiment.						
h. m.	Deg. Fah.	Deg. Fah.	Deg. Fah.	lb.	lb.	lb.	B. thermal units.	Deg. Fah.	Deg. Fah.			
1 35	49·0	734	837	10	2	7·21	4540	522	625	·01395	Steel	1
1 35	49·0	734	837	10	2	6·22	5240	522	625	·0161	Copper	
1 22½	48·7	778	857	10	2	6·59	5668	566	645	·01552	Steel	2
1 22	48·7	778	857	10	2	6·4	5967	566	645	·01631	Copper	
1 25	48·4	798	927	10	2	6·5	5591	586	715	·01334	Steel	3
1 27	48·4	798	927	10	2	5·68	6228	586	715	·01486	Copper	
1 32	48·0	834	965	10	2	5·56	5905	622	753	·0126	Steel	4
1 34	48·0	834	965	10	2	4·54	6678	622	753	·0142	Copper	
1 40	50·16	821	968	10	4	6·75	6440	609	756	·014	Steel	5
1 39	50·16	821	968	10	4	6·25	6920	609	756	·01505	Copper	
1 35	49·0	786	975	10	4	7·46	6181	574	763	·01411	Steel	6
1 35	49·0	786	975	10	4	6·65	6846	574	763	·01563	Copper	

Mean of steel, ·01392. Mean of copper, ·01536.

FIG 3.



Now, although some rough experiments made in the year 1882 led the writer at the time to think that under certain conditions copper or brass boiler tubes were more efficient than iron tubes, yet later experience with boilers of precisely the same type worked under the same conditions, but some having brass and others iron or steel tubes, forced upon me the conviction that there was no advantage under ordinary conditions of working, so far as heat transmission was concerned, in brass over iron or steel. He was, therefore, inclined to think that the view generally held, viz., that so long as the surfaces were clean, copper was superior to iron or steel, might be correct, but that such superiority disappeared in the case of sooted surfaces. It was, therefore, a matter of some surprise to find such a marked inferiority of copper to steel indicated in the experiment. And thinking that there might be some error in the measurements of the temperatures, it seemed the most sound and certain means of obtaining comparative data to place two vessels, the one with a copper and the other with a steel heating surface, over the same fire, when, let the temperature be what it might, or the temperature measurements err as they might, the comparative results would be accurate. Accordingly, the two semicircular pans described were made and placed over the same fire, when the fact indicated by the previous experiment was fully confirmed. This will be evident by an examination of the two first lines of Table 4, the moduli being, for

Copper	·01447, and for
Steel	·02120

On a second trial with the same apparatus, however, it was found that a change had taken place in the conditions, and that the modulus of the copper plate had materially altered, having increased to ·01955.

An examination of the surfaces of the plates having shown that both had become sooted, it appeared that the slightly oxidised though comparatively bright surface of the steel plate in the first instance was not equivalent to the clean metallic surface of the copper plate, and that while a coat of lampblack might make a considerable difference in the case of a clean copper plate at least, its influence was not great in the case of a steel plate with its surface in the condition it leaves the mill. To test this point the systematic series of experiments of Tables 1, 2A, 3, and 3A were made.

The series Nos. 1, 3, and 3A were made with the plate I. In the case of No. 1, the surface of the plate next the fire was kept clean, but not polished; in No. 3 the surface was slightly smoked, and in No. 3A it was well sooted. The series whose results are in Table 2A were made with a steel plate, with both its surfaces smoothly machined somewhat similarly but more smoothly than the plate E of the Cardiff paper.

The conclusions to be deduced from these facts are that a clean copper plate with its surfaces as it comes from the mill is about equivalent in heat-transmitting power to a steel plate with its surfaces machined like the plate E, or, that in the case of these two metals at least, clean metallic surfaces are about equal in heat-transmitting properties irrespective of the metal; that the oxidised though comparatively bright surface of the steel plate is approximatively equivalent to a fire and soot dirtied copper plate; that, additionally, soot-dirtying a steel plate whose surface is as from the mill makes little difference in its heat-transmitting properties; and that merely sooting a machined steel plate affects its rate of transmission very little—see Table 2A. The results of the experiments just referred to are further emphasised by those with the tubes K and L, given in tables 5 and 6.

In the first two lines of Table 5 it will be seen that the moduli of the tubes are ·0203 and ·0157 respectively, and that in the remainder of the experiments they apparently fall. The reason of this is because the temperature of the furnace was measured at the upper station only in the first two experiments, but in the remainder it was measured at the lower station as well. The first two moduli only are therefore comparable with those of the plates, as in their case the temperatures at the lower station—14—are not recorded. (See note on this point in Cardiff paper.)

Now, on examination of the values of H ÷ D^2, it will be evident that as the experiments proceed there is a gradual though somewhat irregular approach to equality, evidently due to a slight deposit of soot on the surfaces, as was also found in the case of the plate I.

With the object of further verifying this view, the tubes were sooted as was done in the case of the plate I, and further experiments were made, whose results are given in Table 6. The average of the moduli indicate that while the modulus of the steel plate remained as before, that for the copper increased considerably, the said averages being for copper ·01536, and for steel ·01392. A comparison was also made with a brass tube, a welded steel, and a welded iron tube in an apparatus similar to that illustrated in Fig. 2, with the results that for the differences of temperature of 1700 deg. and 800 deg. Fah., at the ends of the tubes the rates of transmission were for the brass tube, 7600 British thermal units; for the iron tube, 11,800 do. do.; and for the steel tube, 10,000 do. do. per square foot per hour, the surface being measured on the inside of the tubes. It seems clear that the difference in the performance of the tubes is due simply to a condition of surface. The brass tube was clean and metallic, the steel and iron tubes were coated with oxide, but the steel one was much smoother than the iron.

It appears evident, therefore, that these experiments uphold Peclet's views, that the great difference between the efficiency of copper and steel plates found in the first experiments was only due to the difference between their surfaces, which view is upheld by the experiments with the plate E—see tables 12 and 13 of the Cardiff paper—and also by a steel plate of the same thickness as I and B, with its sides machined similarly to E, whose nominal modulus H ÷ D^2 was found to be about ·0148, or just equal to that found for the plate I; its true modulus H ÷ D*d* was ·011.

Now by actual experiment the heat transmitted by copper and steel plates of ·46875in. thickness, both having clean metallic surfaces, and for 1000 deg. Fah. difference of temperature, are:—

Surface.		Clean metallic.		Copper sooted steel as from mills.	
Copper	... ...	11,200	...	18,100	British thermal units
Steel	... ...	11,000	...	18,000	,, ,, ,,

In other words, they are equal in efficiency, but their rates appear very much greater than estimated by Peclet. It also appears from these and the former experiments that the rate of transmission follows the square of the difference of the temperatures much more closely than Peclet thought.

THE PROBLEM OF SPEED.*

By M. J. A. NORMAND.

OUR eminent President, M. de Bussy, has invited me to give you some particulars of the Forban. It has seemed to me that I cannot better comply with this invitation than by examining from a general point of view the speed of torpedo vessels. The Forban represents the last step in the march of progress. We shall best understand the laws governing advance in speed by looking back upon the road which has been traversed. The figures which I shall quote will all be taken from torpedo boats of my own construction, because concerning them alone have I exact information, but I acknowledge that extremely remarkable results have been achieved by other builders.

It is chiefly in small vessels up to 200 or 300 tons displacement that progress has been manifested, and the reason is that in them the phenomenon of resistance presents a very special character not observable in vessels of larger displacement.

This character consists in a rising of the vessel due to the vertical component of the direct resistance, as I explained at our last session.

Let D = displacement in tons.

Let V = speed in knots.

The direct resistance is proportional to $D^{\frac{2}{3}} V^2$, and the phenomenon of lifting occurs when the ratio of direct resistance to displacement $\frac{D^{\frac{2}{3}} V^2}{D}$ or $\frac{V^2}{D^{\frac{1}{3}}}$, attains a certain value. In a torpedo boat of 125 tons, this is at a speed of about 20 knots, which corresponds to the speed at which the propulsive efficiency reaches its lowest point; above this speed it improves.

Calling V_1 the speed at which propulsive efficiency is a minimum, $\frac{V_1^2}{D^{\frac{1}{3}}} = \frac{400}{5} = 80$. The worst speed is consequently given by the formula

(1) $V_1 = 9\sqrt{D^{\frac{1}{3}}}$. Thus for a vessel of 300 tons $V_1 = 9\sqrt{6 \cdot 695} = 23 \cdot 3$ knots, and for one of 8000 tons $V_1 = 9\sqrt{20} = 40$ knots. We shall probably not live to see the formula verified for vessels of 8000 tons. These figures are approximate, and

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* A paper read before the Maritime Technical Association, 1895.

should be corrected for variation of resistance with absolute size, but the law appears to be correct.

The principal lesson taught by the Forban is that the performance of such a vessel improves gradually from 20 to 31 knots. It might have been feared that the slight improvement in performance observed at the highest speeds of all torpedo boats would change sign at still higher speeds, but this does not prove to be the case. What has been already said will explain why the greatest progress has been made in small vessels. This progress is considerable. Eighteen years ago the highest speed attained was 18 or 19 knots; in 1889 it reached with difficulty 21 knots; in 1892 it rose rapidly to 24 knots in an 80-ton torpedo boat and to 25½ knots in 120-ton boats. Then after having slightly exceeded 27 knots in the Chevalier, it has reached to-day more than 29 knots in the Boxer, 30 knots in the Sokol, and 31 knots in the Forban.

It must not be supposed that the speed has increased some 60 per cent. in this space of time, other things remaining equal. The figures given above do not represent the curve of progress realised, they require to be corrected for difference of absolute size and of load carried on trial. I shall try and deduce the real law for this curve. Few studies are so interesting, and the value of this is far from being confined to torpedo vessels, and the law once found can be applied to vessels of the largest size.

Let V = maximum speed in knots.
F = I.H.P.
D = displacement in tons.
a = the fraction of displacement devoted to propelling machinery, which does not include spare gear or reserve water, the importance of which is arbitrary.
π = the weight per indicated horse-power at full power.
M_D = the corresponding coefficient of performance.

Then

$$(2) \quad V = M_D \sqrt[3]{\frac{F}{D^{\frac{2}{3}}}},$$

and $\pi F = a D$ or $F = \frac{a}{\pi} D$.

This value of F substituted in equation (2) gives

$$(3) \quad V = M_D \sqrt[3]{\frac{a}{\pi} D^{\frac{1}{3}}}.$$

The formula (3) is as general as (2), and can be applied in the same way to ships of all descriptions. The slight change in form, as compared with (2), brings out the causes of progress more clearly. Thus it shows that maximum speed depends (1) on proportional efficiency; (2) on the fraction of displacement devoted to propelling power; (3) on the weight per indicated horse-power of propelling power; (4) on displacement.

We will examine separately the influence of the different factors. It will be seen from the table of results of different types of torpedo boats which I have built since 1886 that the propulsive efficiency has not improved, it would even appear to have diminished, but that is probably apparent only. In the Balny the length was twelve times the beam, while in more recent types it is between nine and nine and a-half beams. The propulsive efficiency in proportion to the displacement is less, but the hull has become, if not lighter, at any rate stronger, and the sea-going qualities have been improved. A notably better performance can be obtained by getting rid of the deadwood of the stern, as has been done in most of the English torpedo boats, but the effect is to render them unsteady on a course which may even prove dangerous when steaming in company and in bad weather.

At any rate, it must be admitted that no sensible reduction in propelling efficiency due to absolute size is apparent between displacements of 50 and 200 tons. The advantage which results from increase of displacement depends greatly upon the arbitrary conditions of the problem. If we suppose as I did in 1885, in my "Etude sur les Torpilleurs," that the crew, and all the weights appertaining to the crew, as well as provisions and water, increase only as the square of the lineal dimensions, and that the weights of artillery, torpedoes, and electric light remain constant, then the improvement is considerable; but in practice this is not so, because these weights vary much more often as the cube. When dimensions are increased it is for the purpose of obtaining a greater radius of action, and of rendering the vessel more habitable and able to remain for longer periods at sea. It would not be far from the truth to suppose that by increasing the dimensions only, other things remaining equal, the ratio of all the weights to the displacement will vary but little.

The values of M_D, a and π in the formula (3) being constant, the speed will then vary as $D^{\frac{1}{9}}$. Now if the displacement of a 20-knot torpedo boat be doubled, the speed becomes $20 \times \sqrt[3]{\sqrt[3]{2}} = 21{\cdot}6$. Therefore it is neither to a better performance, or to augmented displacement, that the great progress of recent years must be attributed. It is due to variations of the ratio $\frac{a}{\pi}$ the cube root of which is one of the coefficients of speed, variations which depend upon those of the portion a of the displacement appertaining to the propelling machinery, and above all to the weight per horse-power of propelling machinery π. This weight, which was 72·7 lb. in 1889 in the Avant-garde, is only 35·3 lb. in the Forban—that is, a reduction of one-half in six years. It may be seen by examining the formula (3) that this reduction alone increases the speed in the ratio $\sqrt[3]{2} = 1{\cdot}26$, or from 20 to 25·2 knots.

The increase really amounts to nearly 6 knots when account is taken of the improvement in performance which takes place at extreme speeds. It is due to this, and also to the fact that nearly 20 per cent. more of the displacement has been given to the propelling machinery, that such exceptional results have been obtained in the Forban. It must be admitted that it has been necessary to sacrifice weights, which, if not indispensable, were at least useful; but it does not appear that more sacrifices of this nature have been made in the Forban than in recent British destroyers. As I explained in this place last year, the weight per indicated horse-power of propelling machinery varies with the size. It is high in engines of low power, on account of the exaggerated importance of auxiliary machinery and of tools, and also because a certain minimum thickness of working parts is necessary to provide for wear. It seems to reach a minimum value in sea-going torpedo boats and destroyers, but in the latter vessels, which have from 4000 to 6000 indicated horse-power, this result can only be attained at the expense of a very high rate of revolution. Thus the revolutions of the Sokol were 420, while in the Forban they do not exceed 365. As the linear dimensions of the engines and of the vessels increase, and as the service becomes more prolonged and important, the weight per indicated horse-power of both engines and boilers must increase. In torpedo boats and destroyers of from 120 to 300 tons, which are alone dealt with in this paper, it may be assumed that the weight per indicated horse-power is independent of size. It will in that case depend only, other things being equal, upon the economy of engines and boilers and upon the type of boilers. The same observation is applicable to the hull, and within the same limits of displacement, the proportion borne by the weight of hull to the cube of the linear dimensions is fairly constant. Above about 300 tons the ratio of the weight of hull must be increased if it is desired that a given stress upon the material be not exceeded.

I first introduced feed heaters, steam traps, and cylinder relief valves discharging into the steam chests in Nos. 126, 129, and the Avant-Garde, and although the engines were double-expansion only, the saving of steam was considerable. Later, in the torpedo boats 147 and others, and those of the Lancier type, the pressure was raised, triple-expansion adopted, and water-tube boilers substituted for locomotive. By these means the coal consumption was again reduced, and the total saving in weight of boilers was partly due to the fact that the weight of the water-tube type is only half that of the locomotive, and partly to a further economy in steam consumption. In 1886 the consumption of coal was 2·64 lb. per indicated horse-power at full speed and 2·2 lb. at low speed, and these figures were comparatively low. In consequence of the alterations already described, it has to-day fallen to 1·54 lb. and 1·1 lb. respectively. The reduction is such that, although the radius of action is extended, the actual weight of coal is less, the weight saved being available for machinery. Nothing shows more clearly the truth of the principle too long ignored, that economy tends to lightness. The history of the progress of the torpedo boat is that of the progress of the steam engine.

It only remains for me to examine the possibilities of a further rise in speed. There is no doubt that we are far from having reached the limit. By simply perfecting means already known, by employing stronger materials and higher pressures a considerable advance may be made. We must abandon at least for the present, the employment of light alloys of aluminium for the shell plating of vessels. It is regrettable, because when we consider that the tension on the material of small vessels is very small, and that the minimum thickness of plating is determined by the resistance of the material to compression and by wear, we find that by the use of an alloy of a specific gravity of 2·8, and having tensile strength of 12·7 tons per square inch with 16 per cent. extension, a reduction of about 40 per cent. would be effected in the weight of hull proper, and of about 20 per cent. in the total weight of hull, including fitting, and armament.

But there is another direction in which progress may be made, and to which I wish to call attention. The volume of the above water portion of these small boats amounts to from one and a-half to twice the underwater volume. No doubt some reserve buoyancy is indispensable, since the vessels depend upon water-tight compartments for safety, and it is necessary that they should be navigable and seaworthy with at least one compartment full; but is it necessary to have so large a reserve as that now adopted? It would not be if there were a raised platform deck upon which the work of the ship could be done, and under which the sea could freely pass. Between the submarine vessel in which there is no reserve buoyancy, and the present type in which there is much more than is required for the safety of the ship, there lies a mean, the adoption of which would probably admit of a large reduction in the weight of hull, which now amounts to more than one-third of the whole displacement, and the weight saved could be added to propelling machinery. It is possible for a Whitehead torpedo to attain a speed of 30 knots, because the total immersion affords sufficient displacement to enable a powerful motor to be carried. Although the Forban is probably too small to be fitted with a raised deck, let us see, if only to fix our ideas, and without troubling to consider the necessary change of form and proportions, what would be gained in this little vessel if she were immersed as deeply as would become possible if she were so provided. Suppose the displacement increased in the proportion of two to three, that is from 126·8 to 190·2 tons. This is not an unreasonable assumption since the volume of the above-water portion of the hull is now as much as 1¾ times the displacement in trial condition. The additional displacement, amounting to 63·4 tons, would be disposed of as follows:—

	Tons.
For flying deck	4·00
For extra coal to give the same radius of action (the consumption per mile would vary as $D^{\frac{2}{3}}$	2·50
For strengthening of hull to suit extra power ..	2·50
	9·00

The remaining weight available for increasing power would be 54·4 tons, and the total weight of machinery would become 118 tons. The value of a would be $\frac{118{\cdot}08}{190{\cdot}21} = {\cdot}621$. If the weight per I.H.P. and the efficiency remained unchanged the speed would become $V = 5{\cdot}74 \sqrt[3]{\frac{0{\cdot}621}{0{\cdot}0159} \times \sqrt[3]{190{\cdot}21}}$ $= 34{\cdot}9$ knots, or 4 knots more than at present. The propulsive coefficient of the vessel would probably not be reduced. The worst speed would be about $V_1 = 9\sqrt[3]{\sqrt[3]{190{\cdot}2}} = 21{\cdot}6$ knots, or 13·3 knots below the maximum, instead of 11 knots below it as in the Forban, and the effect of the lifting action would be very considerable. I must admit that so large an increase of speed is not possible in the Forban unless very great modifications are made in the design of the machinery, which now occupies so much space in the vessel that it cannot well be enlarged.

The same is not true of larger vessels, and it seems probable that several additional knots could be obtained in this way if the steam pressure were considerably raised and the cylinder volume reduced. The use of petroleum fuel would greatly facilitate the solution of the problem, because the length of the grates has already attained a maximum with coal, and the power of the boilers is now limited by the width of grate that the beam of the vessel will accommodate.

This is not the place to examine whether excessive speed has really the importance generally attributed to it, but if the flying deck is ever adopted it will probably be for other reasons—an extended radius of action, for example. The space between the flying deck and the top of the vessel would be used for storing a reserve of coal in bags. This would form an excellent protection to the machinery, and would be safer than internal coal protection where water-tube boilers are employed. In case of bad weather, or of circumstances requiring the attainment of the highest possible speed, the vessel could be rapidly lightened.

The form of the transverse sections would be such as to secure stability with coal so stowed, and in this manner a greater amount of consumable stores could be carried in a vessel of given size than would be otherwise possible, unless she were provided with water ballast, and the guns and torpedo tubes could be carried as high above the water as in a vessel of three times the displacement. Sixteen years ago I proposed to fit a flying deck in the case of torpedo boat No. 60, and the proposal was accepted on condition that the stability was augmented; but the increase of beam required to effect this would have prevented the attainment of the desired speed, and the project was abandoned. Since then the principle has been successfully applied in American "whalebacks."

These are, if I am not mistaken, the causes of recent progress, and some of those which may lead to further advances in the speed of small vessels. The principles are very simple, but their application is difficult.

In conclusion, I must apologise for having written at such length about vessels of apparently such little interest as torpedo boats, but size is not a sure test of importance. A celebrated foreign engineer has said that no other class of ship has contributed so much to the progress of naval construction. Nothing is more true, and in addition to the light which torpedo boats have thrown on the theories of resistance and of propulsion, they have taught most valuable lessons on steam engine design. Improvements applicable in small vessels are equally so in large, and there is no reason why the most powerful machinery should require more than 11 lb. of steam per indicated horse-power, and the weight of boilers could be reduced to a fraction of what it is to-day. When these results are achieved, let the tiny vessels which have led the way not be forgotten.

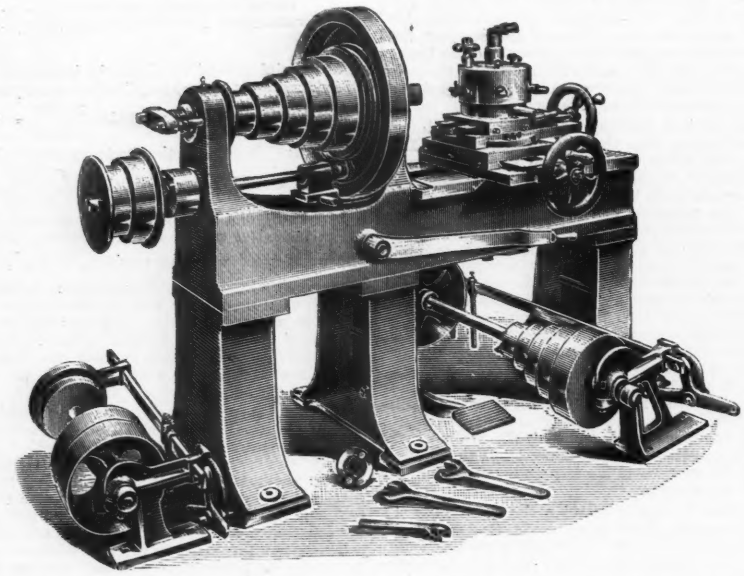
Torpedo Boats.

		Balny.	Avant-Garde.	No. 128.	No. 149.	Lancier	Chevalier.	No. 183.	Ariel.	Forban.
Date of trial		1886	1889	1890	1892	1893	1893	1894	1895	1895
Number of screws		1	2	1	1	2	2	1	2	2
Type of engines		Double expans.	Double expans.	Double expans.	Triple expans.	Triple expans.	Triple expans.	Triple expans.	Triple expansion	Triple expans.
Type of boilers		Loco.	Loco.	Loco.	Normand.	Du Temple.	Du Temple.	Normand.	Du Temp. Normand	Normand.
Working pressure of boilers in pounds per square inch		132	142	142	170	170	212	200	200	212
		Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Weights on trial. Hull and fittings, including mast, awning, and small boats	P	24·45	39·00	27·11	29·31	40·49	42·69	27·42	39·40	46·12
Weights on trial. Propelling machinery, complete with water but without reserve water or spare gear	P^1	21·30	47·66	29·79	27·67	48·62	51·83	30·32	50·95	63·68
Weights on trial. Coal	P^2	10·00	13·28	8·24	9·85	15·18	8·00	10·50	15·50	8·00
Weights on trial. Guns, ammunition, torpedo tubes and torpedoes, air pumps, and accessories	P^3	2·45	5·64	1·86	4·32	9·12	5·88	4·33	8·20	4·09
Weights on trial. Remainder making up displacement on trial, crew, provisions and water, reserve feed-water, electric light plant, and sundries	P^4	3·86	4·61	4·10	4·60	6·36	4·92	4·51	6·70	4·92
Displacement on trial equal to sum of above weights	D	62·06	110·28	71·10	75·75	119·77	113·82	77·08	120·75	126·81
Weight of boilers with water, fire-bars, ash-pans, firebrick, mountings, and tools	P^5	11·20	25·78	15·95	12·51	20·40	20·00	13·33	23·09	26·76
Mean speed on continuous run on official trial in knots	V	19·525	20·975	20·975	24·510	25·794	27·220	24·590	25·870	31·029
Approximate I.H.P. at this speed	F	585	1450	1039	1352	2400	2000	1707	2720	4000
	$\frac{P}{D}$	0·394	0·355	0·382	0·387	0·338	0·377	0·356	0·326	0·363
	$\frac{P^1}{D} = a$	0·343	0·432	0·418	0·365	0·406	0·457	0·393	0·422	0·502
	$\frac{P^2}{D}$	0·161	0·120	0·116	0·130	0·127	0·071	0·136	0·129	0·063
	$\frac{P^3}{D}$	0·040	0·051	0·026	0·057	0·676	0·052	0·056	0·068	0·032
	$\frac{P^4}{D}$	0·062	0·042	0·058	0·061	0·053	0·043	0·059	0·055	0·040
Weight of propelling machinery complete per I.H.P, ...	$\frac{P^1}{F} = \pi$	0·0364	0·0328	0·0286	0·0204	0·0202	0·0172	0·0177	0·0187	0·0159
Weight of boilers and water complete per I.H.P.	$\frac{P^5}{F}$	0·0191	0·0178	0·0153	0·0093	0·0085	0·0067	0·0078	0·0089	0·0066
Speed coefficient	$\frac{a}{\pi}$	9·42	13·18	14·60	17·85	20·03	26·40	22·15	22·50	31·60
Radius of action at 10 knots with coal carried on official trial		1600	1800	1800	1800	2000	1140	2190	2030	1240
Performance or value of M_D in the formulæ $V = M_D \sqrt[3]{\frac{F}{D^{\frac{2}{3}}}} = M_D \sqrt[3]{\frac{a}{\pi} D^{\frac{1}{3}}}$	M_D	5·86	5·27	5·34	5·70	5·57	5·40	5·35	5·37	5·74

N.B.—The tons are metrical tons of 2204 lb.

BRASS FINISHERS' LATHE

MESSRS. CARTER AND WRIGHT, ENGINEERS, HALIFAX.



BRASS FINISHERS' AND CYCLE MANUFACTURERS' CAPSTAN LATHE.

This lathe, in addition to the ordinary arrangement of a capstan lathe for turning, boring, and facing, possesses a very simple, powerful, effective, and sensitive arrangement for screwing and tapping, whereby a valve or any other class of work to be operated upon can be turned, bored, and faced by the ordinary driving belt, which operates directly on the spindle cone, and then tapped or screwed by an increased power obtained by a large driving disc mounted on the cone spindle, the disc having internal grooves cut therein to admit a small driving pulley. The latter is mounted on a shaft with oscillating bearings, and receives its motion from a separate cone and overhead motion. When tapping or screwing, the lever in front of the lathe bed is raised, thereby pressing the periphery of the small driving pulley within the outer groove of the disc, and the tap or die, which is held in a steel rack socket in the capstan rest, is forced into the work by a rack pinion on the rest, and as soon as the required length is screwed or tapped, the lever in front of the bed is released and the foot applied to a brake—in a convenient position for the workmen—which acts directly on the periphery of the disc, thereby stopping the rotation of the spindle. The lever is then depressed, and the small friction pulley runs the disc in the opposite direction at an increased speed. For cycle work the fast head spindle is hollow, and a universal chuck and a cutting-off rest with two tool posts are fitted to the bed. When for ordinary brass work, a two-jaw universal chuck without a cutting-off rest is used, but for valves a universal chuck with rotary jaws, so that a valve can be finished at one setting, is provided. With a chuck of the latter construction a youth can bore, face, chase, and seat the body of an inch valve in two minutes.

The above illustration is from a 9in. lathe with six tool-holders, and sufficiently represents its construction without further description. The lathes are made in three sizes—7in., 9in., and 12in. centres, by Messrs. Carter and Wright, Hexagon, Ironworks Halifax.

THE CARDIFF EXHIBITION.

Now that the Cardiff Exhibition has been made more ship-shape, and is in all but the engineering department practically complete, it is possible to form a better opinion of its merits, and the result of further inspection confirms the favourable view expressed in The Engineer on May 8th. The buildings are seen to be admirably contrived for their purpose, as well they might be, since Mr. E. Seward, the architect, has made a special study of exhibition requirements at home and on the Continent. They afford ample space, abundant light, and are at the same time sufficiently compact. The structure is in every way worthy of the site which, though in the centre of the town, affords a delightful combination of meadow, grove, and garden. The variety of the attractions is exceptionally large, and, while popular tastes are duly regarded, the distinctive note of the undertaking is undoubtedly to be found in the suggestive or educational value of the objects gathered together in the mining, maritime, and engineering sections. It was to be expected that in the largest coal port in the world, as Cardiff claims to be, the colliery and shipping industries would be well represented. These departments are, in fact, the most prominent and comprehensive in the Exhibition, that portion of the building set aside for the mining exhibits presenting a series of object lessons as interesting to the engineer as they should be useful to the engineering student. In the grounds close by there has been erected a model of a coal mine in operation, which is a striking piece of realism, and does credit to the ingenuity of Mr. Gascoyne Dalziel, M.E., and the mining engineers who assisted him in its construction. Something of the kind has been done before at Newcastle, but nothing on so large a scale or so elaborate in detail. The visitor passes through swing doors to find himself at the bottom of the downcast shaft of a modern steam-coal pit, with the engine plane stretching into the darkness beyond. He is supplied with a safety lamp, and discovers duplicate roadways leading to the workings, laid with rails, and provided with trams, hauled on one track by steam power and on the other by electricity. Blocks of coal from the steam collieries of the district are piled high to form the walls and face, in such a manner as to show how the seams lie *in situ*; and here an electric coal cutter—Atkinson and Goolden's patent—is at work. The roof and sides are timbered with a prodigal disregard of material, which would vex the heart of some parsimonious colliery managers, and it is really a perfect piece of work of its kind, performed by Mr. Jenkins, of the Cymmer Colliery, who is said to be the most expert timberman in South Wales. The processes of pumping are illustrated by an electric pump, capable of discharging 8000 gallons an hour against a head of 500ft. There are intake and return airways, supplied by one of Waddle's fans, which drives 50,000 cubic feet of air a minute through the workings. Barometer, thermometer, anemometer, all are in their proper places, and in addition there is a Shaw's gas-testing apparatus, which, according to the patentee, will detect and register so infinitesimal a trace as 0·1 per cent. of foul air in the ventilating current. Everything here—trams, rails, &c.—was in actual use in pits in the Rhondda Valley or Monmouthshire a month or so ago, and the height and width of the roadways are those of an ordinary steam-coal colliery.

Near at hand is a separate exhibition of coal as it is won from the mine, or rather as it can be won by special effort. To exemplify the hardness of certain seams, Glamorganshire and Monmouthshire coalowners would seem to have entered into a friendly competition for the production of the largest block. The palm must be given to the enormous mass shown by Powell's Tillery Company from the well-known Monmouthshire black vein; it weighs about five and a-half tons, and was hewn some three-quarters of a mile from the bottom of the shaft. Only a trifle smaller is the specimen of the Patent Nut and Bolt Company, Cwmbran, 10ft. 6in. long, 3ft. 9½in. in height, 3ft. 3in. wide, and weighing about four tons. The Dowlais Company sends similar examples from its new colliery at Aberdare Junction, which is sunk to a depth of 740 yards, and is the deepest pit in the coalfield. These are the more conspicuous of the exhibits of coal; but we must not omit to mention the United National Company's section, about 10ft. high, showing the run of the veins in the Risca Colliery, with the intervening and supervening shale and rubbish. A pumping engine in motion, from Messrs. Bever and Dorling, Dewsbury; a horizontal air compressor, supplying air at 80 lb. pressure to a 1in. Reidler pump, from Messrs. Fraser and Chalmers, Threadneedle-street; a case of all sorts of explosives, in *fac simile*, from Nobel's Company; and safety lamps in any number from various makers, including the first Davy ever used underground, are all worth notice. So, too, is the model from Messrs. Robey, of Lincoln, of a ten-head stamp battery, comparatively light in structure, with its strength concentrated in those parts subjected to the greatest working stress. The heads, which can be worked in sections of five, if needful, are made in one solid forging of steel, and are said to be unbreakable; while it is claimed as a feature of the battery that all the working parts are accessible, with large spaces between them, so that there is room to take out parts for renewal, and give the millman a full view of the front plates and easy access to the mortar box.

The South Kensington Museum lends a valuable collection of models, most of which have been seen elsewhere, though several no doubt derive a special interest from their present surroundings. Three, for instance, illustrate several methods of timbering levels, as well as what is called "overhand and underhand working," in a Freiberg mine. Another shows the tubbing and guides used in La Grange shaft at Guzin, France. A Japanese model exhibits a section of a gold and silver mine at Aoban, Sado Island. There are, besides, several cabinets of mineralogical specimens, that from the Imperial Institute embracing the native ores of India, Canada, New South Wales, and South Africa, in connection therewith being examples of quartz, &c., from the Rand and Matabeleland, lent by the De Beers Company, which also sends a sectional model of the Kimberley mine. One of the most valuable contributions to this section is made by the South Wales and Monmouthshire Coalowners' Association, whose secretary, Mr. Gascoyne Dalziel, has been for some months engaged in gathering the material. It consists, in one form, of a picture of the South Wales coalfield, and, in another, of a history of the trade. Mr. Forster Brown and Mr. Theodore Vachell have assisted Mr. Dalziel to prepare a vertical section of all the coal seams proved in East Glamorganshire and Monmouthshire, and this is further illustrated by samples of each vein of coal, labelled and numbered to correspond with the chart. The thickness of the steam coals in the Aberdare Valley is shown in a supplementary section by Mr. Thomas Evans, M.E., while another drawing represents the strata penetrated in sinking the Harris' Navigation Colliery, the deepest in South Wales until the neighbouring Dowlais pit was opened. Tables and diagrams, the outcome of Mr. Dalziel's laborious effort, show the actual selling prices of South Wales coal f.o.b., from 1845 to 1895, and the fluctuations in miners' wages in the district from 1875 to 1896, which is practically the period in which wages have been regulated by the sliding scale agreement. Plans of Cardiff, Penarth, and Barry Docks, and of Newport and Swansea Docks are at hand to enlighten the stranger from afar as to the accommodation provided for coal shipments, and lest it should be thought that this is ample, it may be well to remark that on every hand new docks or dock extensions are even now being made.

Other exhibitions, especially the Naval Exhibition, will no doubt have familiarised a good many visitors with the principal maritime objects collected together from all parts of the country. It is nevertheless an interesting and instructive department, and probably the most extensive of all. At a glance one perceives that the chief contributors are Messrs. Armstrong, Mitchell, and Co.; Messrs. Laird, of Birkenhead; and Lloyd's Register of British and Foreign Shipping, who divide between them most of the 8400 square feet of space. Most of the models and other exhibits from the three sources have been described in these columns in other connections, and considerations of space compel us now merely to refer to them *en bloc*, while we pass on to other features. Models of harbours and docks are present in number and variety, from the large-scale plan in relief—132ft. to 1in.—of the Tyne, with its jutting piers and populous banks, to the extensive but more highly-finished model of Southampton Harbour, showing the existing docks, the new works in progress and those in contemplation—a truly graphic example of what a model ought to be—on a scale of 50ft. to 1in., and exposing an area of 1090 acres, of which the dock and quay basins occupy 360 acres. This fine work was designed and constructed by Messrs. J. P. Jordan and J. P. Maginnis. It is, of course, a loan from the South-Western Railway Company, which sends also models of its twin-screw steamers Columbia and Alma, of the Southampton and Havre service. From the Mersey Dock and Harbour Board come models of the Mersey from the bar to Warrington, and of the approaches to the landing-stage. Sunderland is represented on a scale of 40ft. to 1in., with the new piers in course of construction; and the River Wear Commissioners contribute likewise models of a radial crane for setting concrete blocks of 52 tons weight; of the sand pump suction dredger Sandhill; of Wake's steam concrete bag barge, constructed to deposit concrete bags 56 tons and 115 tons in weight for the foundations of the new piers; and of a dredger and hopper barge, capable of lifting about 600 tons per hour. The Floating Pontoon Dock at Avonmouth, and Barry Docks are the subjects of other models. The 900-ton gates of Barry Dock are represented in model by the Thames Ironworks and Shipbuilding Company, and so are the Chatham and Dover bridge at Blackfriars, Woolwich Ferry, the Blackwall Tunnel, and the Royal Albert Docks, from the same company's works. A general model of the East India Docks is lent by the London and India Docks Joint Committee, which sends an interesting reproduction of the automatic tipping lift designed by Mr. H. F. Donaldson, M.I.C.E., and capable of lifting thirty sheep a distance of 50ft. in one minute.

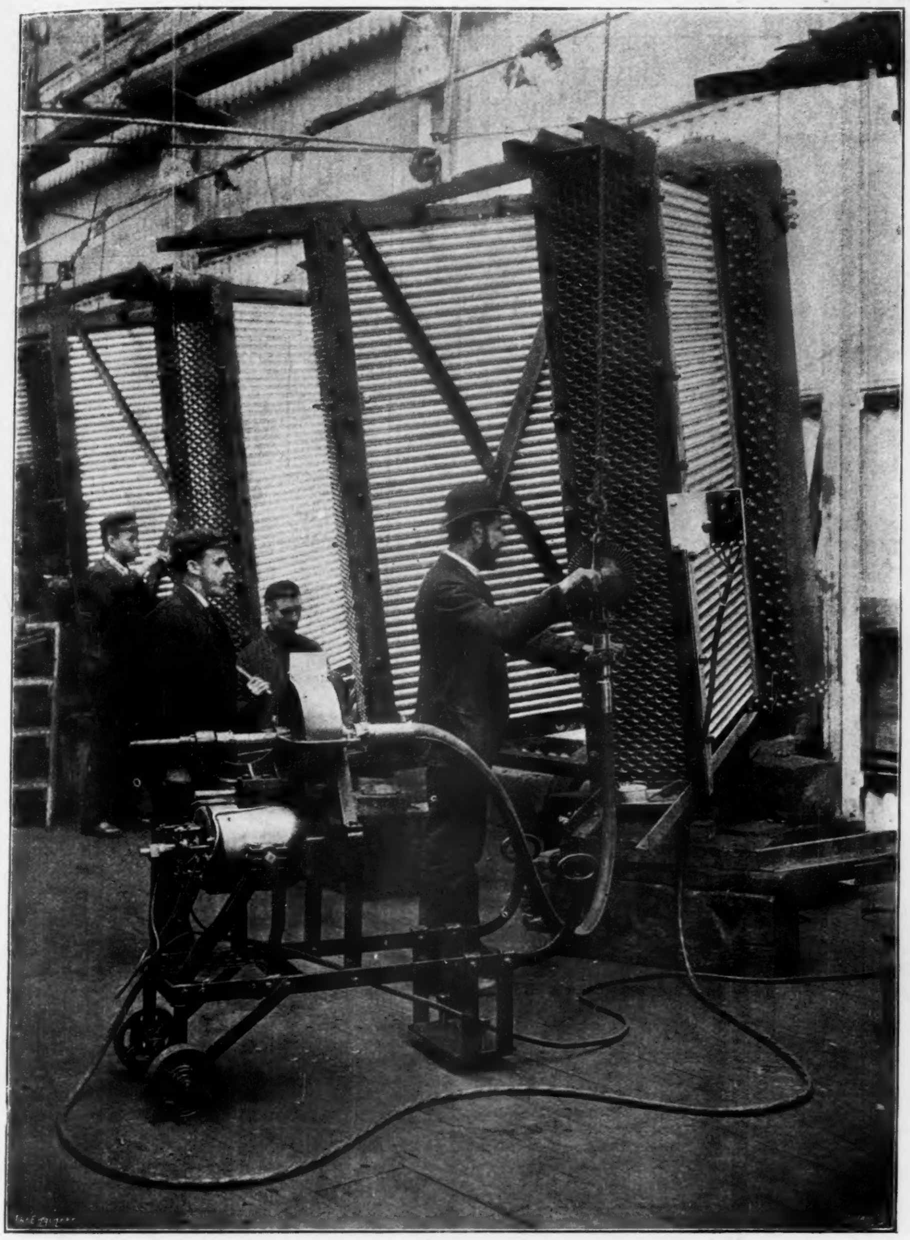
The telegraph steamship Faraday, at once identified by her two funnels abreast, to allow of the cable being paid out amidships; fine examples of the fleets of Donald Currie and Co., the Union Steamship Company, and the American Transatlantic Line; and models of some of the best productions of the Clyde builders have their place here. Noteworthy exhibits of water-tube boilers, machinery, and all kinds of shipping appliances represent the North-Eastern Marine Engineering Company, Wallsend; T. L. Thompson and Sons, North Shields; the Darlington Forge Company; William Doxford and Son, Sunderland, including models of the latest type of torpedo destroyers; John Brown and Co., Sheffield; and a number of other eminent firms.

TRACTION ENGINES ON ROADS.

The House of Commons Committee sat for the last time to hear evidence on the above subject, on Thursday, the 14th inst. The only witness on that day was Mr. C. Mulvany, M. Inst. C.E., County Surveyor of Roscommon, Ireland, who has the supervision of 1200 miles of road, the upkeep of which costs between £5 and £16 in the country districts per mile per annum, while the main roads involve an expenditure of £30 per mile for a similar period. In the towns the expenditure is greater, and varies between £80 and £100. Although he had no material evidence of the employment of traction engines in Roscommon, the witness informed the Committee that he had had an opportunity of inspecting their operation in Tyrone, where, with the use of a 14-ton engine, no serious damage was done, but he thought the trucks, which were sometimes overloaded, did considerable damage to the roads. Mr. Mulvany stated that they had no bye-laws in the West of Ireland, nor had the local authorities the power to make them. With the further extension of the employment of this kind of traffic on the public roads, he thought that the weight of engines ought to be restricted to 10 tons, and that the trucks should be constructed so that the wheels broke gauge, under which circumstances the roads would be benefitted rather than injured when they had been raised to a standard suitable for the traffic. He considered that an annual licence fee of £10 for the whole of Ireland would be a reasonable one, but that the owners of engines should still be liable for extraordinary traffic, and thought that the maximum limit of speed on country roads might be increased to six miles per hour. With regard to the third man employed, the witness considered that it should not be necessary for this person to precede the engine. We understand that the Committee will not sit again until June 8th.

King's College Engineering Society.—At the meeting of this Society on the 15th inst., the President opened a debate on "Horse Haulage *versus* Motor Traction," by referring to some of the points for discussion in his paper of May 8th. Mr. Bailey followed, taking the side of horse haulage. He did not attempt to oppose the car for long distance work, but based his arguments in favour of the horse on short trips and canal work. Mr. Standen then rose for the opposition. Referring to many interesting points, he said the motor would make a great difference to the railways. Mr. Hogarth then seconded Mr. Bailey, giving many valuable remarks as to cost and maintenance of a horse, coupled with many arguments against motors. Mr. Tolmé, in seconding Mr. Standen, compared the endurances of horses *versus* motors, much to the advantage of the latter. He also pointed out how useful motors had become in crossing the deserts in Algeria. Mr. Carter and Mr. Simpson joined in the discussion which followed, dealing with characters and efficiencies of motors. Mr. Mowat brought the debate to a close with a few remarks bearing on each side. The division resulted in a majority of two in favour of motors.

EXPANDING TUBES IN YARROW BOILERS



ARMOURED TORPEDO BOAT DESTROYERS FOR THE ARGENTINE GOVERNMENT.

In previous issues—March 13th and 27th ult.—we noted as under construction at the shipyard and works of Messrs. Yarrow and Co., of Poplar, for the Argentine Government, four new torpedo boat destroyers of a type which is a modification of the Sokol, a vessel of the destroyer class built by the same firm for the Russian Government.

In the issue of the later date we fully described one of these vessels, and showed the points of difference between it and its prototype. The principal of these were, it will be remembered, that both the sides and deck—for the length of the machinery and boiler space—were armour plated, and the shape of the hull above water so far modified that all "tumbling home" of the sides is done away with, thus allowing the deck to be the full width of the ship, and the bows made with a considerable flare in order to throw off the seas when going against them, and keep the decks drier.

In previous destroyers, the side plating above water has only been of normal thickness throughout the length of the vessel; but it being recognised that the protection of the vitals of a warship—her propelling machinery, boilers, &c.—is of far greater importance than a slight reduction in her speed, these vessels have been given such a thickness of armour-plating for the part of their sides referred to, as will be proof against the small class of projectiles.

Last Saturday afternoon, the first of the four vessels abovementioned, which has been completed to the launching condition, was put into the water with her machinery and boilers on board, from Messrs. Yarrow's yard with complete success, in the presence of a number of naval and engineering experts.

The boilers for supplying the engines of these vessels with steam are, as we have previously stated, six in number, of Messrs. Yarrow's special water-tube type, each being capable of developing a minimum of 700-horse power. A feature of novelty in their construction worth noting is the method by which the tubes in them—which are perfectly straight—are expanded at their ends, or made to fit the tube plates absolutely steam and water-tight. This is ordinarily effected by means of a percussion expander worked by hand, the mandril being driven up by blows from a hand hammer. The work is not only tedious but laborious, resulting in the expanding of about seventy tubes in a working day.

To accelerate the rate of progress of this work, and to minimise the physical labour attending it, Messrs. Yarrow have brought out a special expander, the body of which is made to revolve, leaving the mandril free to feed itself, thus disposing of the necessity for the use of the hammer during the process of expanding the tube end. The necessary motion is given to the expander by electricity or steam, the motor in the former case being one of those made by Mr. Kodolitsch, of Trieste, which conforms to all the requirements for this class of work; and in using steam the driving power is obtained from ordinary shafting by rope gearing. It is found that the new expander ensures a uniformity of work which cannot be obtained by hand, and that the rate of getting through it is increased from seventy tubes a day per man to thirty tubes per hour.

On the occasion of the launch of the destroyer above referred to—which, by-the-bye, was not named—the experts and other visitors who witnessed it were afforded an opportunity of inspecting a large stern-wheel steamer building by the Messrs. Yarrow—her construction being nearly completed—for the Russian Government for the use of the Trans-Siberian Railway, a work of great magnitude, now being rapidly proceeded with, and to be completed in the year 1900.

This vessel is 120ft. long and 24ft. beam, and in her loaded condition will draw 12in. of water. Her stern wheel is driven by a pair of horizontal engines, placed directly aft—one on either side—of 150 indicated horse-power, supplied with steam from a boiler of the locomotive type, located forward, and she is to have a running speed of twelve miles an hour. The vessel, whose engines and stern wheel were in motion, as she lay on the stocks on which she has been built, will shortly be taken to pieces and shipped to the port of Vladivostock, the eastern extremity of the Trans-Siberian Railway, and from thence transported to the interior of Siberia, and there put together. The main deck of this vessel is flush, and upon it the cargo is generally carried, the cabin accommodation provided being on the upper deck.

In addition to the destroyers building for the Argentine Government, Messrs. Yarrow have also on hand for the Chilian Navy six first-class torpedo boats, which will be an improvement on the Viper, built by them for the Austrian Navy, and whose speed trials we lately noticed. These vessels will be 152ft. 6in. long, 15ft. 3in. beam, and will be fitted with triple-expansion engines to indicate about 2000-horse power, and to drive them at a guaranteed speed of 25½ knots an hour. Steam will be supplied by water-tube boilers of the Yarrow type. The boats will have a large range of action, as their bunker capacity is to be 40 tons, and they will be armed with torpedo ejectors and quick-firing guns.

THE ELECTRICITY STATION AT THE EARL'S COURT EXHIBITION.

The Exhibition at Earl's Court this year is an improved edition of the Empire of India Exhibition, which attracted so many visitors last year. The London Exhibitions Company has spared no trouble to produce an interesting spectacle, and there is now a very complete central station where electricity is generated for the whole of the lighting. Our supplement gives a general view of the interior of the station, and it will be seen that, although merely devoted to the service of an exhibition, the plant is of very considerable size, and is, in fact, capable of a larger output than that used in many stations supplying small towns.

It will doubtless be of interest to our readers to have the details of this station. Mr. G. C. Fricker acted as consulting engineer, and Mr. A. W. Money is the resident engineer for the Exhibitions Company. The whole of the plant is installed in one large room. This is, of course, not an ideal plan, as the boilers should be kept quite apart from the engines wherever it is possible to do so, in order to avoid dust and ashes being carried into the bearings of engines and dynamos. It was, however, found impossible to carry out this system in the present instance owing to the limited space at disposal. A canvas screen has, therefore, been drawn across at the back of the stoking floor, and this appears to obviate most of the difficulty. The presence of the whole of the plant in one room has this advantage—that the engineer-in-charge can overlook the whole of the attendants from the elevated gallery which surrounds the switchboard. The board itself is arranged upon three sides of a square tower, not shown in our engraving, and the upper part is surrounded by the gallery alluded to, and is reached by a flight of steps. In order to give a general view of the plant, both the board and the canvas screen have been omitted in our general view, otherwise only a very limited portion of the whole plant could be seen at once.

The station building adjoins the Exhibition theatre, and is close to the Midland Railway siding. Coal is brought within a few yards of the station by truck, and then has to be reloaded into carts and unloaded at the station itself. It seems rather a pity that some arrangement could not have been made whereby the trucks could be brought up to the coal store itself, where the coal could be directly dircharged without using any carts. Ten tons of coal can be stored inside the engine-room itself.

Steam generating plant.—Steam is generated by means of nine boilers of the locomotive type, and of the well-known semi-portable form built by Messrs. Davey, Paxman, and Co., of Colchester. Each boiler is 18ft. 6in. long over all, and has a barrel 4ft. 6in. diameter; the whole of the shell is of mild steel. The fire-box shell is the same width as the barrel, and the internal fire-box is 5ft. 6in. high by 4ft. 6in. long, and has a grate area of 20 square feet; there are 100 iron tubes 2¼in. diameter inside. Steam is collected at the top of a dome, and passes through a steam pipe 3in. diameter to a common receiver, which consists of a mild steel tube 20in. inside diameter, built up in short lengths with flanges welded solid on. At first sight it would appear that some trouble must be found with a long receiver such as this passing across nine boilers, and connected to the separate stop valve of each by a length of about 3ft. of straight pipe; these straight branches, however, enter stuffing-boxes and glands on the receiver, so that there is a certain amount of elasticity which would not be obtained by direct coupling, and we are assured that no trouble has ever been experienced from deterioration of the joints of the stop valves due to expansion and contraction of the receiver. The whole of the boiler fittings are by Messrs. Dewrance and Co., except the injectors, which are by Messrs. Holden and Brooke, of Manchester. Some little difficulty was anticipated owing to the lack of water storage, so a large concrete tank was built in the floor under the barrels of the boilers; this tank is 60ft. long by 5ft. wide by 4ft. deep, and is always kept full of water from the public mains through ball cocks, so that it can give several hours' supply. The makers calculate for an evaporation of at least 9·5 lb. of water per pound of coal from and at 212 deg. Fah., and a consumption of about 19 lb. of coal per square foot of grate per hour. The working pressure is 120 lb. per square inch. Each boiler is provided with a separate vertical wrought iron chimney, 18in. diameter and 30ft. high. Besides the injector supplied to each boiler there are also two of Mumford's steam feed pumps; these feed a common supply pipe connected to each of the clack boxes, so that there is a double feed to each boiler. In ordinary work it is found that one feed pump is sufficient to supply all the feed-water required, although we are told that the boilers steam slightly better when the injectors are used than when the pumps are employed The joints of the steam pipes are made with corrugated brass rings, coated with red lead cement. These rings are made by Messrs. Newton and Nicholson, of Tyne Docks, South Shields.

Engines and dynamos.—Leaving now the steam generating plant, we shall describe the steam and electric plant; the former was all supplied by Messrs. Davey, Paxman, and Co., and the latter by the Brush Electric Company. At one end of the building are three fine sets of Peache's patent high-speed engines, direct-coupled to alternators. We will not now describe the Peache engine in detail, as we dealt with it in our issue of December 6th, 1895, upon page 550, and our readers will doubtless recollect the ingenious arrangement by which the use of excentrics is obviated. The whole of the joints of the rods inside the oil chamber are partly cut away at the top, so as to allow perfectly free access of the lubricant to the wearing surfaces. We carefully examined a number of these joints and could find no trace of wear or scoring, although the engines have now been in use a considerable time. Two of the engines consist, as will be seen, of three compound single-acting tandem sets in parallel, and each engine developes 220 indicated horse-power, and is direct-coupled to a Mordey alternator capable of developing 100 kilowatts, at a speed of 325 revolutions per minute. The other engine consists of two compound single-acting tandem sets in parallel, and the engine developes 150 indicated horse-power and is direct-coupled to a Mordey alternator, which developes 75 kilowatts at a speed of 350 revolutions per minute. The sizes of the cylinders are in all cases the same, 10in. and 15in. by 10in. stroke.

On another page, by the courtesy of the inventor of the engine, Mr. J. C. Peache, we are able to reproduce some indicator diagrams, Fig. 6, taken from one of the six-cylinder engines in ordinary work. Although they fairly represent the distribution of steam in the engines, they only give about three-quarters of the full capacity of the engine. The speed had to be reduced from 400 revolutions per minute to about 325, to suit the Mordey alternator to which it is coupled, and the M.E.P. is also less than is recommended in usual practice. It must always be remembered that the engines at Earl's Court are the first which were built, and in the engines now being built many details have been altered, as, for instance, the arrangement of the governors.

The total power indicated for the three sets of the one engine, as shown by the diagrams, is 171·3 indicated horse-power. The normal indicated horse-power of this size of engine is 260 indicated horse-power.

The frequency of each alternator is 130 alternations per second. All the machines are of the Brush Company's new armoured coil type. Each alternator frame serves as an oil reservoir, and the lubricant is caused to circulate to the bearings by means of a small centrifugal pump.

Passing to the other end of the building, we find the other half of the plant; this consists of three engines. The first is of the Colchester type, horizontal, compound side-by-side engine. The high-pressure cylinder is 12¾in. diameter; the low-pressure 20in. diameter, and the stroke 24in.

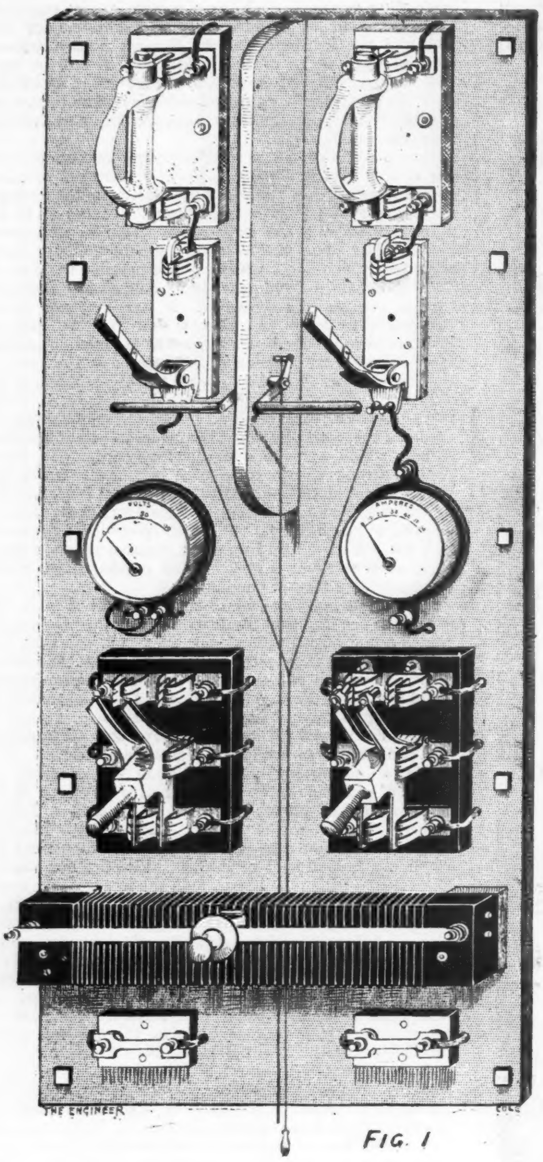


FIG. 1

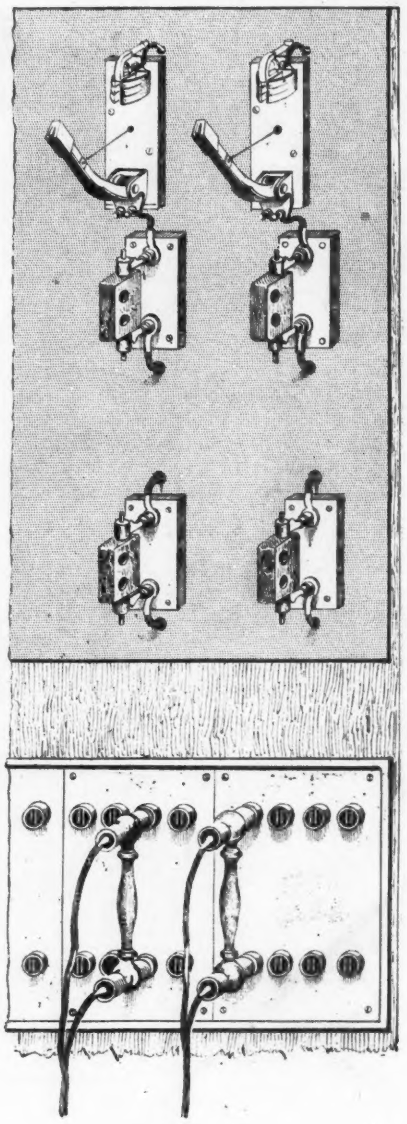


FIG. 4

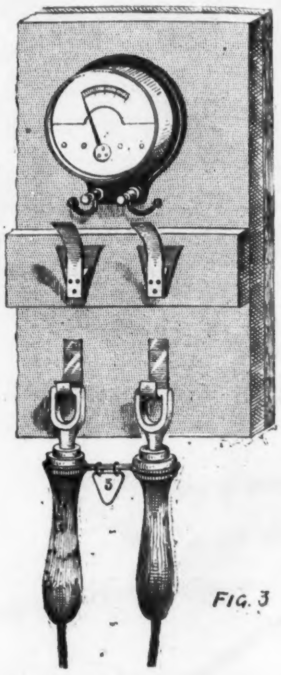
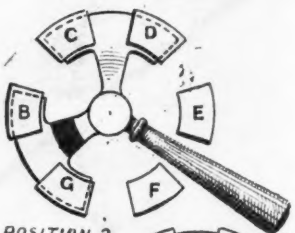
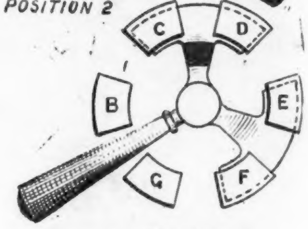


FIG. 3



POSITION 2



POSITION 3

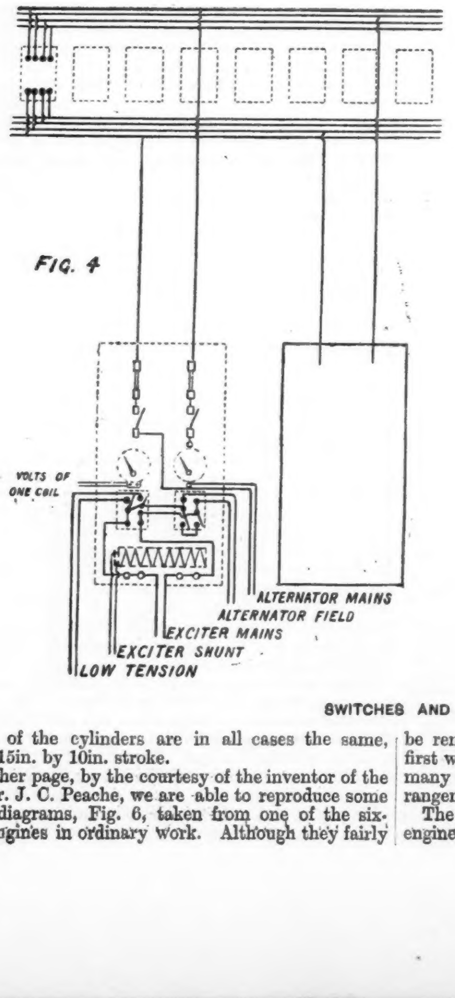


FIG. 4

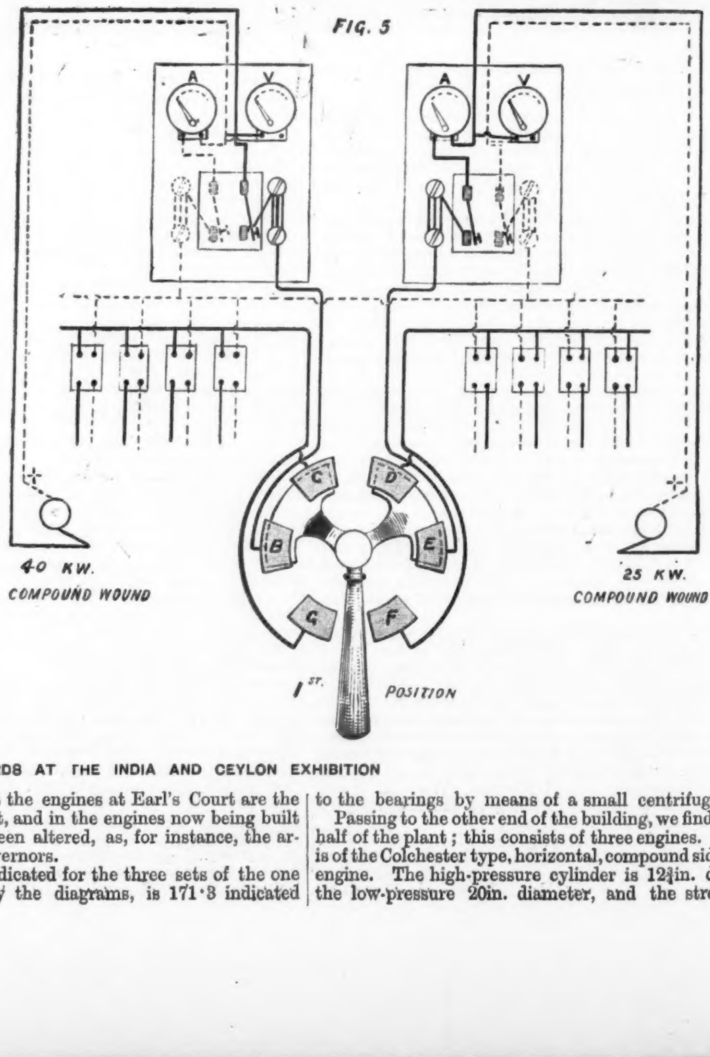


FIG. 5

SWITCHES AND SWITCH BOARDS AT THE INDIA AND CEYLON EXHIBITION

This engine will develope 140 indicated horse-power with 120 lb. of steam, when running at 100 revolutions per minute; it has a fly-wheel 9ft. diameter, and drives by means of a double leather belt 16in. wide a 75-kilowatt Mordey alternator. The second engine is of the girder type, and has the same size cylinders as the first, but is provided with two fly-wheels, each 8ft. 6in. diameter and 11½in. wide. Each fly-wheel is provided with a double leather belt, 10in. wide. One drives a Brush arc lighter for fifty-five lights, and the other drives a 40-kilowatt direct current compound wound 100-volt Brush machine, used for the lighting of the theatre by means of arc lamps, placed two in series, and also for the charging of accumulators for the electric launches.

The third engine is of the Colchester type, developing 220 indicated horse-power, at 100 revolutions with steam of 120 lb. pressure. The cylinders are compound, the high-pressure being 18¾in. diameter, and the low-pressure 28in. diameter by 24in. stroke. The fly-wheel is 10ft. diameter, and has a double leather belt 2ft. wide driving on to a pulley 4ft. diameter fixed to a countershaft carried upon pedestals placed on the floor. This countershaft is of mild steel, 4½in. diameter, and runs at 250 revolutions per minute. It carries five driving pulleys, four of which each drive by belting a 55-arc light Brush machine series wound; and the fifth drives also by belting a 25-kilowatt Vienna Brush compound wound machine. All the engines are fitted with Messrs. Davey, Paxman, and Co.'s governors, and the high-pressure cylinder is provided with an expansion valve which works at the back of the steam valve proper. This arrangement of valve gear has been fully illustrated in our columns. One excentric drives the main slide valve, while two other excentrics drive the subsidiary valve through a die to a link; the position of the link is controlled by the governor. In Fig. 8 we give indicator diagrams taken from these engines, which clearly show the good distribution obtained with this type of valve gear.

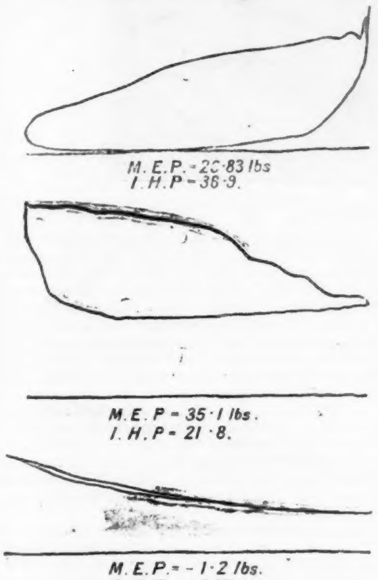


Fig. 6—Indicator Diagrams from the Peache Engines at 310 Revolutions per Minute

Switchboards.—The upper part of the central structure in the centre of the building is occupied by three switchboards. The first consists of four marble panels, one of which we illustrate in Fig. 1. At the bottom is the adjustable resistance in the shunt coils of the exciters for the alternators. At the right side above is a throw-over switch with carbon break; the middle contacts are the terminals of the field of an alternator, the lower terminals are used to short circuit the field on itself when breaking circuit, and the upper terminals are connected with the centre of the left-hand throw-over switch; these two switches are shown diagrammatically in Fig. 2. The left-hand switch has its lower terminals connected to the exciter of the alternator and its upper terminals connected direct to the omnibus bars of the 40-kilowatt or 25-kilowatt direct current machines, so that the alternator can be excited either by its own exciter or by any one of the other direct current machines. Above these switches are fixed the voltmeter and amperèmeter; the voltmeter shows the electro-motive force of one coil, no transformer being used, and the amperèmeter shows the ampères flowing in primary. Above these there is a double-pole trigger switch and double-pole Bates fuses.

An Ayrton and Mather electrostatic gravity voltmeter is used to calibrate the others, and reads up to 2400 volts. Next to this board is the Brush arc light switchboard, with five circuits and connections for six machines. One of the circuits is shown in Fig. 3, and an amperèmeter is provided for each circuit. The board is extremely simple, and the method of hanging on the connector to two gun-metal hooks leaves little to be desired; it seems distinctly preferable to the plug system for a small number of circuits. By means of this board any circuit can be connected to any machine. This is the low tension board for the arc lighting. Adjoining this board is the high tension board for connecting any machine to any feeding circuit; one of the panels is shown in Fig. 4. Sixteen circuits, each consisting of 7/18 cable, leave the station and carry currents 2000 volts potential; each circuit leaves the station through a single-pole switch and double-pole Bates fuses. There are four pairs of omnibus bars behind the board, and by means of plugs it is easy to connect any circuit to any alternator. A diagram of connections is shown in Fig. 4A. On the ground level there is another board which carries a special switch, designed by Mr. Money, and shown diagrammatically in three different positions, 1, 2, and 3 in Fig. 5. It enables the lighting to be effected entirely either by the 40-kilowatt direct current machine, or by the 25-kilowatt direct current machine, or jointly by both.

Each machine is shown connected through double-pole switches to the mains leading to the switch, and each is provided with an amperèmeter A and a voltmeter V. The switch itself consists of a Y-shaped handle with metal arc-shaped contacts. In one of the limbs of the Y there is insulation; outside the handle is a ring with six contacts, the shaded portions representing insulation, and the unshaded portions metal contacts. In Position 1, the 40-kilowatt machine is feeding lamps L, the current passing back through C, the handle, and B to the dynamo. In the same way the 25-kilowatt machine is feeding lamps L¹, and the current passes back through D, the handle, and E to the machine; but the machines are not in parallel. In Position 2, the 40-kilowatt machine is doing the whole of the work and lighting lamps L and L¹, for the current flows from the + terminal to the outside leads through the lamps, and back from the L section to G, and from the L¹ section through D and C also to G, and thence through B to the machine. Position 3 shows the 25-kilowatt machine doing all the work. This switch can be easily manipulated, with scarcely any spark. The currents in the arc light circuits are kept constant by means of Brush-Geipel regulators.

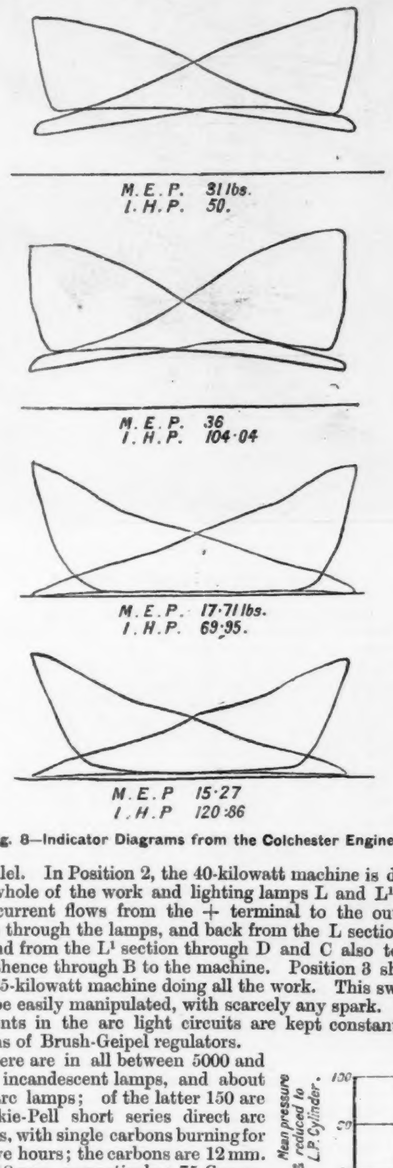


Fig. 8—Indicator Diagrams from the Colchester Engines

There are in all between 5000 and 6000 incandescent lamps, and about 275 arc lamps; of the latter 150 are Brockie-Pell short series direct arc lamps, with single carbons burning for twelve hours; the carbons are 12 mm. and 18 mm. respectively; 75 Crompton Pochin arc lamps are worked direct off the Brush 55-light machines. There are also 32 arc lamps for 15 ampéres, each of a type designed by Messrs. Money and Nash; these are run two in series direct off the 105-volt machines, and have single carbons, and light the auditorium of the theatre; also 36 alternate current arc lamps by Messrs. Siemens Brothers and Co. run in parallel off 50-volt converters. There are transformer sub-stations about the Exhibition grounds, and these are supplied with current through leads run into iron gas barrel 1in. diameter buried in the ground. Messrs. Siemens Brothers and Co. supplied the whole of the cable used in the Exhibition.

Quite recently Prof. Alex. B. W. Kennedy has made very careful trials of a Peache high-speed engine at the works of Messrs. Davey, Paxman and Co., Colchester; but before dealing with the results then obtained, we will say one or two words about the construction of the engines.

As stated earlier in our article, the engines at Earl's Court are, with the exception of an experimental engine, the first of this type which have been built, and differ in the arrangement of the governor from the standard type at present being constructed. All parts of the engines are as readily accessible for examination or removal as in the case of a double-acting engine of the usual construction. The moving parts and their fastenings are strong, and do not call for special knowledge or undue nicety in fixing or adjusting, and there are no internal glands. The steam cylinders are perfectly isolated from the working chamber. No steam or heat can get from the cylinders to the working chamber, and the temperature of the bath of lubricant never rises above 100 deg. Fah., or thereabouts. Consequently the lubricant remains in good and effective condition, and no artificial cooling, such as cold water cooling pipes, or other devices, have to be resorted to. The isolation of the steam cylinders from the working chamber precludes the possibility of oil from the working chamber being drawn up into the condenser if the engines are worked condensing. All bearings are made of ample size, and the engines will readily bear loading up to an M.E.P. of 60 lb. or more per square inch referred to the L.P. piston. We may add that these engines were running through the last season of the Exhibition, and that then, as now, the demands were such as to need all three engines at work at the same time. During the evening they are therefore running without any reserve plant. Although one of the three engines is a two-crank engine, Messrs. Davey, Paxman and Co. have definitely adopted the three-crank type as their standard, to the exclusion of the single or double-crank type.

REPORT ON TEST OF HIGH SPEED ENGINE—PEACHE'S PATENT—AT COLCHESTER ON APRIL 16TH, 1896.

14, Old Queen-street, Westminster,
London, S.W., 11th May, 1896.

Messrs. Davey, Paxman, and Co., Colchester.

Dear Sirs,—I have pleasure in reporting to you the results of trials which I carried out at your works on the 16th ult. upon one of Mr. Peache's high-speed engines. The main objects of the trial were the determinations of the efficiency and the steam consumption of the engine at various loads.

The engine tested was of a new type, specially adapted for high speed running. It was a single crank compound engine, the two cylinders being tandem, and respectively 10in. and 15in. diameter, with a length of stroke of 10⅛in. The exact dimensions were 10·02, 15·00, and 10·11, as found by measurement after the trial, and these dimensions have been taken into account in the calculations.

The engine was intended to work at about 80 indicated horse-power, and at about 375 revolutions per minute. The work done was taken up by a brake wheel, having a channel-shaped rim cooled by water. The brake wheel was encircled by eight ropes each about 1½in. diameter, the weight of the ropes on the two sides being carefully balanced. The brake was loaded with dead weights on one side, and the back pull taken up by a spring balance.

The engine was non-condensing. It was therefore necessary to determine the weight of steam used by weighing the water as it went into the boiler. This was done by a special arrangement erected for the purpose, in which the measuring tank was placed on the platform of a weighing machine, which was afterwards checked with dead weights. The water was passed through this tank, 2 cwt. at a time. The feed pump used during the trial was supplied with steam from a separate boiler. The whole of the feed and steam pipes—the latter being temporarily covered with non-conducting material—were visible, and all the connections were checked.

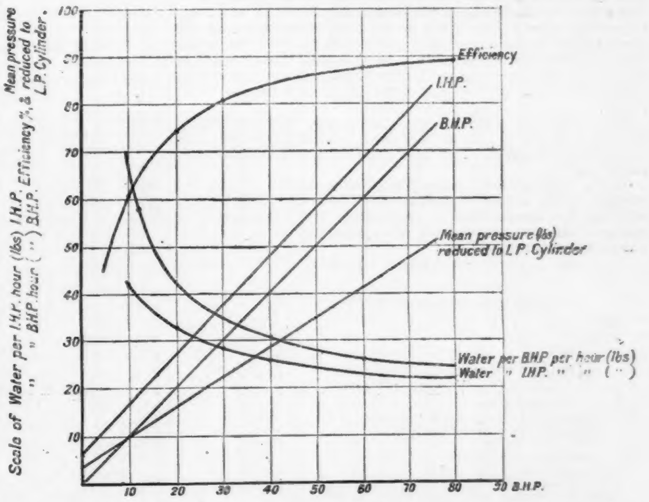
The boiler used was a locomotive boiler. The water level was kept low in the gauge glass, but in spite of this the steam blown off from the indicator cocks on the engine looked by no means very dry, and I am afraid that the steam consumption may on this ground have been somewhat larger than if the steam had been entirely free from moisture. No allowance, however, has been made on this account, as the quantity of wetness in the steam was not measured.

I had the whole of the apparatus to be used on the trial tested beforehand, and a rehearsal of the trial was run on the 15th April, to make sure that everything was in working order. The actual trials I carried out on the 16th April.

A full power run was carried out over about five hours, the results of this trial being the most important. At three-quarter load, half load, and quarter load, the trials lasted about one hour each, the exact times being stated in every case in the annexed table. The engine worked exceedingly well, indeed without the slightest hitch or difficulty of any kind, during the whole of the day, and after the trial was over I found the bath of lubricant to be quite cool, although the engine had been running continuously for very nearly twelve hours. The principal results are shown in the table appended to this report, and also in the diagrams, of which copies are enclosed.

It is necessary to make the following remarks as to the indicated horse-power. The indicator cards were worked out by a planimeter in the usual way, and the high-pressure cards reduced to the area of the low-pressure piston. Indicator diagrams taken from the valve chamber, which were found to be positive, were worked out, and the mean-pressure taken for each power and then reduced to the corresponding pressure on the low-pressure cylinder. Indicator diagrams were also taken from the controller at each power. These cards were found to be negative, and the corresponding mean-pressure was deducted from the effective mean-pressure on the low-pressure piston. The differences due to the addition of the valve power and the subtraction of the controller power were very small, but I think it right to take them into account.

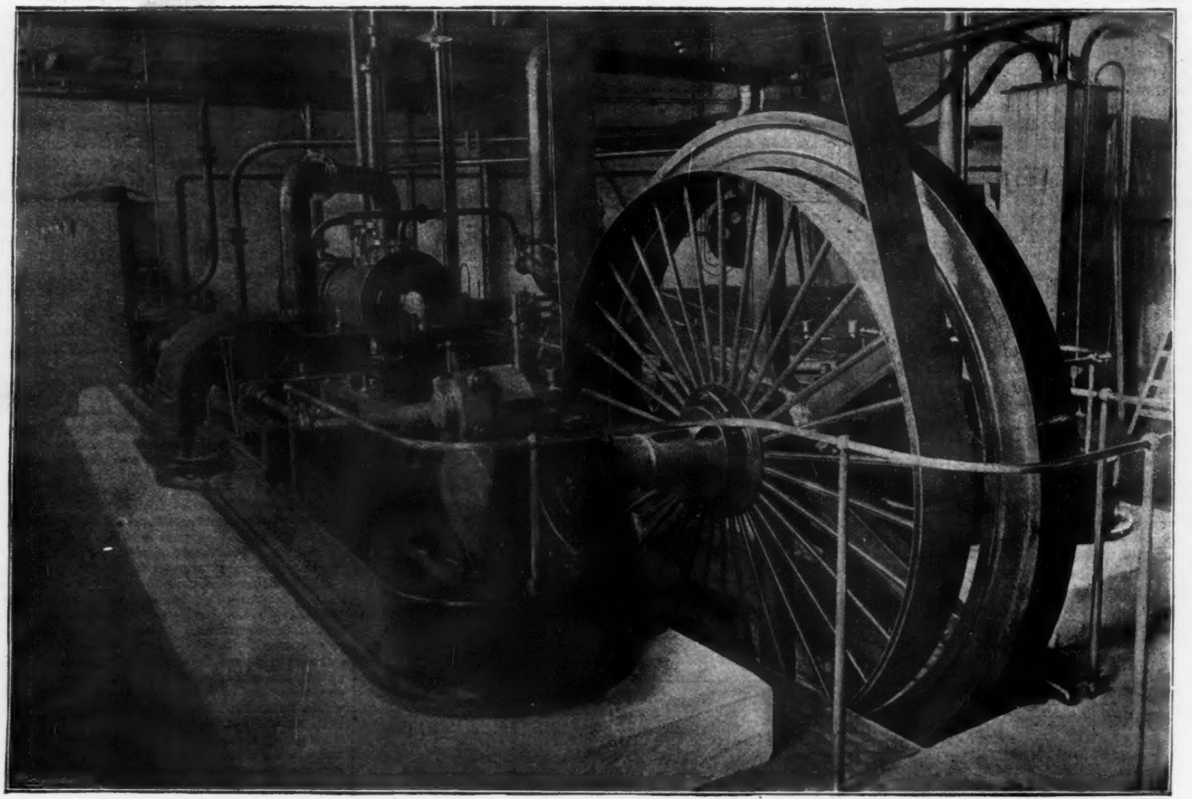
The brake horse-power was found from the brake weights and



AMMONIA ICE-MAKING PLANT—ENGINES AND PUMPS

(*For description see page* 517)

Fig. 1



speed in the usual manner, the whole of the dimensions being carefully measured and the weights checked, and an addition was made for the power necessary to drive the brake itself. This was necessary, as the brake was a very heavy one and had two bearings of its own. Separate trials showed that at 386 revolutions the power necessary to drive the brake wheel empty was 1·8-H.P., and a corresponding allowance has been made in each case.

In the diagram on preceding page are shown the principal results as to efficiency and economy. The dots show the exact observations made; the lines, straight and curved, are drawn so as to correspond as closely as possible to the whole of the observations. The base of the diagram represents brake horse-power, and the lines upon it show the mean pressure—reduced to low-pressure cylinder—the indicated horse-power and the efficiency, the total water per hour, and the water per brake horse-power hour and per indicated horse-power hour. As to these last figures, it will be seen that the very satisfactory result is attained of 22·5 lb. of feed-water, measured into the boiler, per indicated horse-power per hour, and 25·2 lb. of feed-water similarly measured per brake horse-power per hour. The mechanical efficiency at full load, or ratio, of brake horse-power to indicated horse-power was 89·2 per cent. It is a matter of common knowledge that figures of this kind, especially for a small engine, and where it had been impossible to make sure that the steam was thoroughly dry, are extremely good. It is satisfactory to notice also that the rate of increase of water consumption per horse-power hour as the horse-power diminishes is not unduly rapid. This is shown both by the diagram and table.

Diagram No. 719* is practically a plotting of the log sheet of the trials upon a time base. It may be noticed that the full power trial lasted actually about six hours, although the effective running time was only 5 hours 21 minutes. The water used in the different portions of the trial is plotted separately as well as continuously. The reason for the principal pause was that I wished to let the water-level down in the boiler gauge glass, in the hope that the steam might become somewhat dryer in consequence. The actual water used is of course stated only for the times during which it was actually measured and not for the pauses, although the engine continued to run without any alteration of load for the whole period.

The engine ran without a governor, so that it was necessary between each pair of tests to bring down the steam pressure, as is shown on the diagram. The total number of indicator diagrams taken was 142.

On the whole matter I am very glad to be able to say that the working of the engine was satisfactory from beginning to end, and that the results, both as to efficiency and economy for an engine of this size and working non-condensing, were quite first-class.—Yours faithfully,

(Signed) ALEX. B. W. KENNEDY.

Table giving Principal Results of Trial.

Date of trial	April 16th, 1896	
Duration of trial—	hrs.	min.
At full load	5	21
At three-quarter load	1	10½
At half load	1	1
At quarter load	0	54
Dimensions of engine—		
Diameter of high-pressure cylinder	10·02in.	
Diameter of low-pressure cylinder	15in.	
Length of stroke	10·11in.	
Diameter of piston-rod	1·87in.	
Radius of brake to centre of rope	30·7in.	
Boiler pressure at full load	185 lb. per sq. in.	
Horse-power taken up by brake wheel (at 386 revolutions per minute)	1·80	

	Full load.	Three-quarter load.	Half load.	Quarter load.
Mean effective pressure reduced to low-pressure cylinder, lb.	50·4	40·34	26·5	17·35
Mean revolutions per minute	376	363	385	391
Mean I.H.P.	84·1	65·0	45·3	30·1
Mean B.H.P.	75·0	57·0	38·14	23·14
Mechanical efficiency of engine, per cent.	89·2	87·7	84·2	76·8
Feed-water per hour, lb.	1890	1493	1186	969
Feed-water per I.H.P. per hour, lb.	22·5	23·0	26·2	32·2
Feed-water per B.H.P. per hour, lb.	25·2	26·2	31·1	42·0

HORSELESS CARRIAGE NOTES.

AT a meeting of the Engineering Section of the London Chamber of Commerce on Monday, the Light Locomotives Bill came up for consideration, and the recent action respecting the increase of the minimum weight from two tons to four tons was referred to. The resolution passed in favour of this recent increase in weight was on Monday adversely criticised, and the feeling was that two tons for an empty vehicle was the maximum weight it is advisable to sanction at present, and that the heavier vehicle would be unsuitable for what is the experimental stage in a new industry. It was felt that the demand for the greater weight would cause delay in the passage of the Bill. Of course, we hope that this will not be the case, but rather than run any risk of this there is no doubt the majority of those interested in the development of the motor carriage would prefer to leave the maximum for the unloaded vehicle at two tons. A change, if necessary, could be made by an amendment another year, but two tons is sufficient for the carriage of from 30 cwt. to two tons of passengers by motors now available. Since the Monday meeting the four tons has passed the House of Lords, but it has yet to pass the House of Commons.

Great progress was made in the House of Lords on Tuesday, when, on the motion of Lord Harris, the House went into Committee on the Locomotives on Highways Bill.

Lord Harris moved to amend Clause 1 by substituting four tons for two as the maximum weight of unladen vehicles exempted from enactments restricting the use of locomotives on highways. He remarked that the President of the Local Government Board had agreed to make this amendment in deference to representations that had been made to him. Lord Thring agreed that the maximum weight of unladen vehicles should be raised, but he suggested that some limit should be placed on the load that the vehicle might carry, and that there should be flexibility in the Bill to encourage inventions for distributing the weight between two vehicles. The Earl of Kimberley said no doubt many improvements would be made in the development of these vehicles, and power should be given to make bye-laws, as to weight and width of wheel—subject to the consent of the Local Government Board and the Secretary of State—to meet unexpected changes and inventions. Lord Harris said, with regard to weight, the erection of a large number of weighing machines would be necessary all over the country, and obviously in London, and it would be ridiculous to expect carriages carrying persons to be weighed whenever a policeman or some one else demanded it. He did not think Lord Thring's suggestion was a practical one. His instructions were to adhere to the maximum weight of carriage unladen, and not to refer to the weight of a loaded carriage. The other points alluded to he would bring under the attention of Mr. Chaplin. But he would ask their lordships to accept the Bill now, as he was not empowered by Mr. Chaplin to accept any suggestions at present for further amendments in the Bill. The amendment was then agreed to.

Lord Harris then moved to omit the latter part of the clause and insert the following:—"(*a*) Section 26 of the Highways and Locomotives Amendment Act, 1878, shall apply to light locomotives as if they were drawn by animal power, and as so applied shall extend to London; (*b*) a light locomotive shall be deemed to be a carriage within the meaning of any Act of Parliament, whether public, general, or local, and of any regulation made under any Act of Parliament, and, if used as a carriage of any particular class, shall be deemed to be a carriage of that class, and the law relating to carriages of that class shall apply accordingly." Lord Harris said the principle of Section 26 of the Highways and Locomotives Amendment Act, 1878, had been extended by Section 41 of the Local Government Act, 1888. The former section empowered local authorities to make various regulations as regarded width of wheel, skids going down hill, and other matters. It had been pointed out that the clause was not clear as to the law that would apply. It was considered doubtful whether the Inland Revenue could levy a tax for this class of carriage, and the clause had been amended to make it perfectly clear that, whatever the kind of carriage might be, and whether the Act of Parliament was a public, general, or local Act, the Act and any regulations under it would apply to these carriages. The clause, with the proposed amendment, was agreed to.

Lord Harris moved to amend Clause 2, which regulates the keeping and use of petroleum or any other inflammable liquid by substituting £10 for £2 as the fine for any breach of the regulations. He remarked that it had been considered that a penalty of £2 was not sufficient, and that it was desirable to make it heavier. The clause, with this amendment, was agreed to.

Lord Harris moved to omit from the Bill Clause 3, which provided a penalty of £10 for negligently driving a light locomotive or suffering it to be without due control. He said that the statutory provisions which the House had approved in Clause 1 rendered this clause unnecessary, for the ordinary law as regarded negligent and furious driving would apply as much to locomotives as to any other kind of vehicle. The omission of the clause was agreed to.

Clause 4, which provided that the Local Government Board may make regulations for the use of light locomotives, and a fine of £10 may be inflicted for any breach, was also agreed to, as well as the insertion, after Clause 4, of certain new clauses of a consequential character. The Bill then passed through Committee.

THE American Motor League has been organised for the purpose of advancing the interests and use of motor vehicles. This is to be done "by reports and discussions of the mechanical features, by education and agitation, by directing and correcting legislation, by mutual defence of the rights of said vehicles when threatened by adverse judicial decisions, by assisting in the work of constructing better roads, better sanitary and humane conditions, and in any other proper way which will assist to hasten the use and add to the value of motor vehicles as a means of transit." The officers will include a president, secretary, treasurer, and attorney, and a vice-president from each State having more than 100 members of the League. Annual meetings will be held for reading and discussing papers, and considering plans bearing upon the work of the League. The membership fee is 1 dollar per year, with an entrance fee of 2 dollars—4s. 2d. and 8s. 4d. respectively. Mr. Charles E. Duryea, of the Duryea Motor Wagon Company, is president; Mr. J. Allan Hornsby is secretary; Mr. Charles B. King, treasurer; and Messrs. H. D. Emerson, H. P. Maxim, and H. G. Morris are vice-presidents.

ROYAL METEOROLOGICAL SOCIETY.—The monthly meeting of this Society was held on Wednesday evening, the 20th instant, at the Institution of Civil Engineers, Great George-street, Westminster, Mr. E. Mawley, F.R.H.S., president, in the chair. Mr. R. H. Curtis, F.R. Met. Soc., read a paper on the exposure of anemometers, in which he gave the results of a comparison of the records from the three anemometers at Holyhead, viz., the Robinson, the bridled, and the pressure-tube anemometers. It was clearly shown that the force of the wind is greatly affected by surrounding objects. The author is of opinion that for anemometrical records to be reliable and of value not only must the instrument be exposed in an open place free from local obstructions, but it is also absolutely essential that the stand which carries it shall offer practically no resistance to the wind, and that the instrument should not be placed on the roof of a house. The paper was illustrated by a number of lantern slides. An interesting collection of photographs of clouds sent to the Society by Mr. H. C. Russell, F.R.S., of the Sydney Observatory, was also exhibited.

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* We have not thought it necessary to reproduce this.—ED. E.

AMMONIA ICE-MAKING PLANT, SHEFFIELD

THE PULSOMETER ENGINEERING CO., LONDON, ENGINEERS

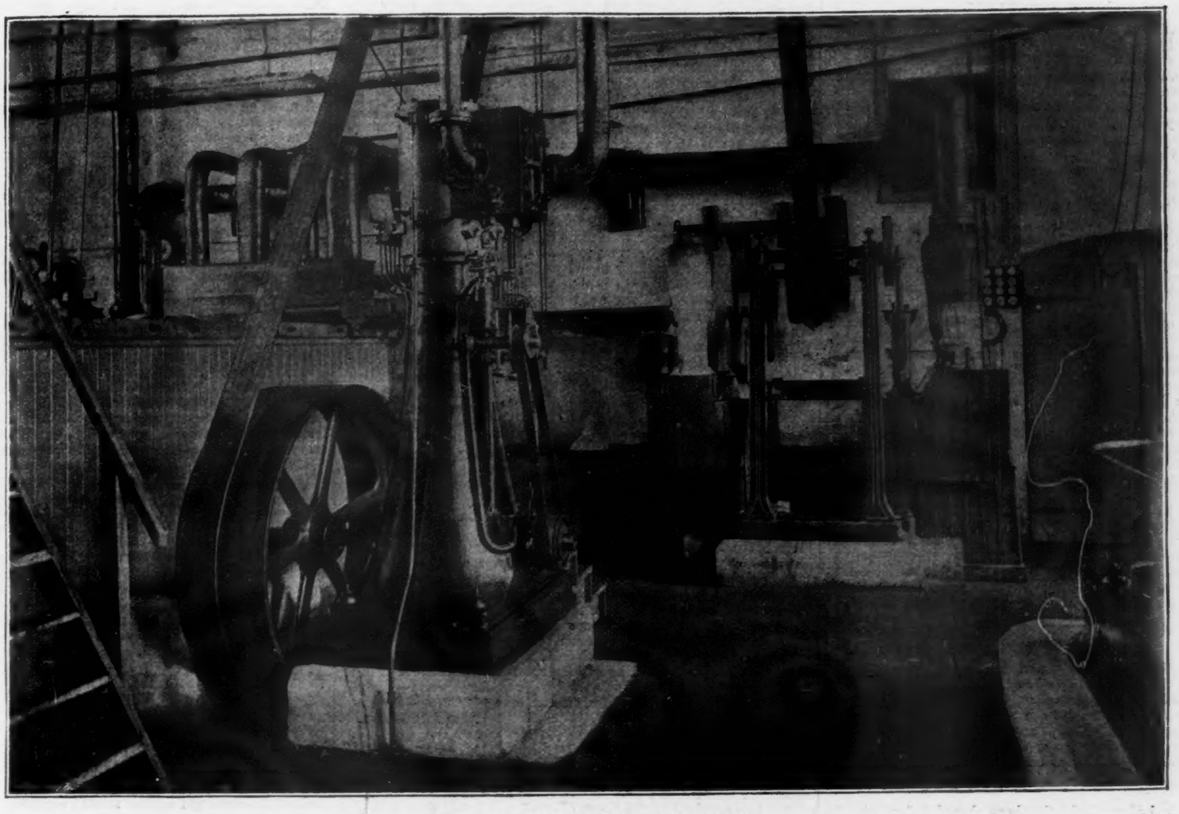


Fig. 2 AUXILIARY ENGINE AND PUMPS

AMMONIA COMPRESSION ICE-MAKING AND REFRIGERATING PLANT.

The Sheffield Pure Ice and Cold Storage Company of Bank-street, Sheffield, ordered last year from the Pulsometer Engineering Company, of Nine Elms, S.W., a large ice-making and cold storage plant, of which we now give illustrations. It was required by the contract that the plant should produce not less than 20 tons of hard transparent ice every twenty-four hours, in blocks weighing about 5 cwt., and of a thickness of not less than 12in., and this with condensing water at a temperature of 68 deg. Fah. The machine had also to maintain continuously 70,000 cubic feet of cold storage space at a temperature not exceeding 21 deg.; the coal consumption had also to be guaranteed. On a trial which extended over two months we understand that the output was considerably in excess of that specified, while the coal consumption was less.

The boiler is of the Lancashire type, constructed of mild steel and to pass Lloyd's Rules for a working pressure of 110 lb. per square inch. Water circulating cross tubes are fitted in the two flues. The sizes of boiler and grates are specially arranged so that a poor quality of coal can be burned. The donkey pump is of the contractor's Deane pattern, mounted on a cast iron tank supplied with the usual ball valve, and water from the main.

The engine is of the horizontal compound side-by-side type, driving the ammonia pumps tandem. The high-pressure cylinder is fitted with automatic cut-off expansion gear, and the low-pressure cylinder with an ordinary slide valve. The surface condenser, which is placed between the engines, is fitted with brass tube plates and tubes with screwed ferrules. The air pump and water circulating pump, together with the feed pump, are driven from the crosshead of the low-pressure cylinder by means of bell-crank levers. The ammonia pumps, which are of the contractor's latest pattern, are of the double-acting type, and are cast in special metal, and are fitted with special suction and discharge valves, without springs. The gas condenser is placed above the engines in a large wrought iron tank, and consists of extra heavy wrought iron tube tested to 2000 lb. per square inch. The connecting branches and tees of this condenser are made of wrought iron wherever they come in contact with ammonia.

On the engine-room floor, in a wrought iron tank carefully lagged with charcoal and wood, are placed the refrigerators, so as to be close to the ammonia pumps. These refrigerators are also of extra heavy pipe, and the couplings and tees are also made of wrought iron. Between the ammonia pumps and refrigerators are placed two large steel receivers. These are made from mild steel and welded up, the usual cast iron receivers being entirely dispensed with on account of the risk attaching to them.

The illustration Fig. 1 gives a very fair idea of the engines and pumps. Fig. 2 shows clearly the auxiliary engine which is used for driving the various parts of the machinery when the main engine is not running. It also shows the two brine pumps. These brine pumps are of the double-acting type fitted with brass valves, liners and rods, and are provided with first and second-motion shafts, with mortice gearing. The water pump, which is of a similar design, cannot be seen on the illustration. This water pump draws from a large dam or reservoir just outside the engine-room, and discharges into the condenser tank.

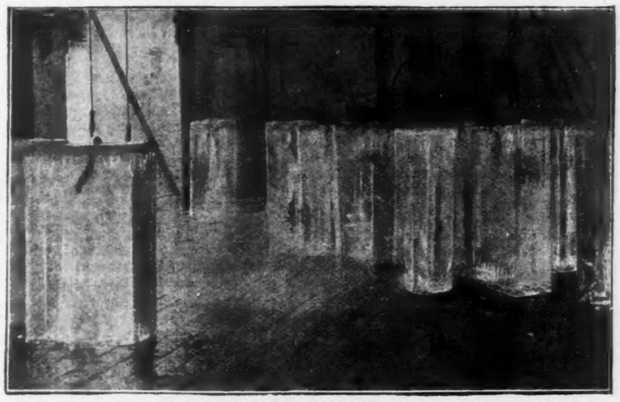


Fig. 4—THE ICE HOUSE

Fig. 3 gives a view of the ice house looking towards the engine-room, and is sufficiently clear to describe itself. We may mention, however, that the ice is of beautiful quality.

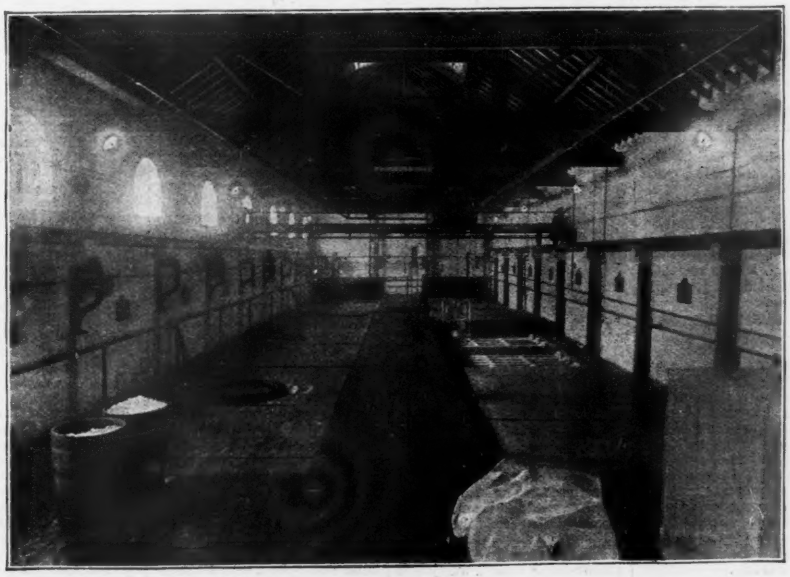


Fig. 3—THE ICE HOUSE

Fig. 4 shows the other end of the ice-house, with a view of the crusher and some of the ice. At this end is placed a circular saw for cutting up the blocks required. The ice is lifted and removed from one end of the building to the other by handy rope travelling cranes with both horizontal and cross travellers. The cold rooms are fitted with brine coolers, and are supplied with brine from one of the refrigerators. The atmosphere in the rooms is perfectly clear and cool and dry. The total capacity of these rooms is about 70,000 cubic feet.

The building is fitted throughout with electric light and the cold rooms are served by an hydraulic lift.

The whole of the work is finished in the best style, and has been running without the slightest hitch since it has been taken over.

THE CHANNEL SQUADRON.

This squadron, which comprises eleven warships and a number of torpedo-boat destroyers, under command of Vice-Admiral Lord Walter Talbot Kerr, with Rear-Admiral Armand T. Powlett second in command, arrived in the Clyde on the 19th inst. The fleet left Luce Bay, off the Wigtonshire coast, where they had been anchored since the 16th inst., at half-past six o'clock on the morning of the 19th, and about 5.30 in the evening they anchored at the Tail of the Bank. With a total weight of exceeding 100,000 tons the present combination of British warships is by far the strongest ever amalgamated as a Channel Squadron. In all there are seventeen vessels, including six battleships, each over 14,000 tons displacement. Of these the Majestic and Magnificent are the most powerful battleships afloat, and the largest as well, if the 15,300-ton ships Italia and Lepanto of the Italian Navy are excepted. Besides these two great battleships the squadron comprised the battleships Empress of India, Royal Sovereign, Resolution, and Repulse; the twin-screw cruisers Blake, of the first class, and Bellona, of the third class; the first-class twin-screw gunboat Halcyon; the first-class twin-screw torpedo boat Speedy; and the torpedo-boat destroyers Lightning, Surly, Decoy, Sunfish, Hardy, and Sturgeon. The crews of the fleet number roughly about 5500 hands. The visit on this occasion coincided with the Queen's birthday holiday in Glasgow and the neighbourhood, and the weather being favourable, the number of visitors inspecting the vessels was enormous. As on former occasions, the tars were entertained both at Glasgow and Greenock, and arrangements for the enjoyment of the officers were also carried through. It so happened that H.M.S. Benbow, the Clyde guardship, had not yet returned to her station at the Tail of the Bank, and as a consequence there were no formalities on the arrival of the squadron, but at noon on the 20th all the vessels were bedecked with flags in honour of her Majesty's official birthday, and a royal salute of twenty-one guns fired from the vessels. The squadron departs early on Saturday (to-morrow) for Stornoway.

H.M. cruiser Barham is to receive a set of Thornycroft water-tube boilers in the place of her old locomotive boilers. The Admiralty have decided to expend £28,218 on her refit.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

LOCOMOTIVE FIRE-BOXES.

SIR,—I have read with much interest your leader on this subject in your issue of the 8th inst. Nevertheless, there are one or two points on which I should like to add a few words.

In the first place, I think you decidedly under-estimate the average life of a locomotive boiler. On one of our largest railway companies no complete examination of a boiler is made until it has been at work five years, and even then, as a rule, the only repairs that are required are the replacing of a few fire-box stays, and, in some cases, of the fire-hole ring rivets, the heads of which are apt to be burnt. After this a complete examination is made every three years, and the boilers frequently last twenty years or more in constant use before being removed, with a mileage of about 500,000 or 600,000 miles.

The questions of the crushing of top rows of tubes in the copper tube plate, and that of the use of sling stays, are really only one. I know of no case of the holes becoming flattened where the sling stays have been well up to their work, but where the slings stays are broken or slack, the load on the tube plate certainly does crush it, causing the tubes to become oval. It is not very obvious how any load comes on to the sling stays, as the inside fire-box will certainly expand slightly more than the shell. Probably the bridge stays themselves deflect a little, and the foundation ring certainly does, causing grooving in the plates just above it, and a tendency to leak at the corners. Also the copper box is in compression, while the shell is in tension, and the effect of this is not negligible over a length of several feet.

The advantage of the Belpaire system of staying is undoubtedly due to the fact that instead of a large part of the whole load on the fire-box crown being taken through the foundation ring, it is taken direct by the through stays, thus saving grooving in the saddle plate, and just above the foundation ring, and probably diminishing to a very great extent the breaking of the screwed stays in the water space. A lesser advantage is that the roof of the inside fire-box is not nearly so much encumbered as in the ordinary method of staying.

I hope that others who have had some experience with locomotive boilers will give their opinions on this subject.

39, Dairy House-road, Derby, May 18th. C. E. WOLFF.

DUTY OF PUMPS.

SIR,—I think it is quite a new experience for engineers to learn that, by lowering the consumption of coal utilised by an engine, its duty will be diminished. Nevertheless, this, the latest enigma, is implied in the formula for the duty of an engine quoted by your reviewer from the work on "Pumps and Pump Motors," by P. R. Bjorling, in your last week's issue, where it is stated that the duty of an engine using 5 lb. of coal per horse-power hour is $= \frac{5 \times 1,980,000}{112} = 88,214 \cdot 28$. Your reviewer finds fault with a point of arithmetic, but overlooks the above absurd statement. In this expression the duty is made to be directly proportional to the coal used, instead of being inversely as that quantity. The question seems so simple that one would hardly think such a mistake possible, and in its simplest form it may be stated thus:—Work done per pound of coal $= \frac{1,980,000}{5}$, and therefore for 1 cwt. $= \frac{1,980,000}{5} \times 112 = 44,352,000$ foot-pounds, which I venture to give as the correct duty of this engine. J. B.

London, May 13th.

PERMANENT WAY.

SIR,—I notice in the correspondence on above, "F. J. P." criticises what I have suggested under the designation of "an altered form of permanent way." He prefers to define it as a "mixture of the old G. W. R. longitudinal road—which he states they have condemned and are doing away with—and of the present sleeper road." But, query, is not this "an altered form?" So there seems to me but trifling ground for objection, whilst he appears to overlook what I aim at, viz., a combination of the good points of both, viz., the continuous homogeneous rail-bearing of the first, and the greater resistance offered by the last to transverse oscillation, and greater bearing power besides.

I find that objection is taken to the use of the flat-bottom Vignoles rail on the longitudinal sleeper on the ground that the rail crushes into the sleeper through the pressure being applied in the direction of the fibres. But the pressure is similarly applied to transverse sleepers actually, and in the case of two 30ft.—4in. base—Vignoles rails the area to support the load = 20 square feet, while 20 chain, 1ft. 3½in. long by 6¼in. broad = 14ft. 6in. bearing, or 0·27 less bearing area to carry the load! To meet the objections made I suggest the selection of a harder grained wood for the longitudinal than was formerly used; and possibly the timber quoted by "F. J. P." as used in Argentina for sleepers, and which he describes as nearly "as hard as boxwood," would be very suitable. Perhaps in some further future communication he will kindly give the name of this wood, and from where it is supplied and its cost. Such statistics will be valuable in connection with the general interests of this subject.

The steel chair, of which an illustration is given in last week's ENGINEER, is formed, I notice, in the same simple manner that wrought iron chairs were made in the United States of America thirty years ago, a flat plate with the four corners perforated for spikes, and the central portion nicked at the sides, and turned up to clip the rail—or, as in the present case, the rail and the wood key. I think it preferable, however, to do away with the chairs altogether, so that the rails shall bear wholly on a wooden cushion, and which, as I increase its thickness, must add to the smoothness of travel of the load.

I join issue with "F. J. P." as to the impossibility of packing the extra sleepers I advocate, and venture to assure him that it is quite practicable.

Briefly summed up, what I suggest (1) will give continuous and uniform bearing to the rails; (2) will enable lighter rails to be used in place of increasing their weight per yard; (3) give increased bearing area, primarily, to the rails, and finally to the sleepers; (4) create a track which, when made, will cost less to maintain than in existing practice; (5) diminish number of detail items per mile; (6) get full service out of the ballast bed.

3, Derby-road, Hightoun, Wrexham. J. H. R. ROSE.

SIR,—In a recent leading article in THE ENGINEER there appears the following statement:—"We have not the least hesitation in saying that a first-class road cannot be made with flanged rails spiked to cross-sleepers." It would have seemed to me that roads of this construction which carry, as do several in the United States, heavier trains at higher speeds than any which are run in this country, are at least high enough class for all practical purposes. But I did not take up my pen merely to say this. It occurred to me that the purport of a conversation I had last summer with two very distinguished American railway men, the one the president of one of the principal companies, the other the first vice-president of a yet greater company, would be of interest to your readers in this connection. Here is a rough sketch of our dialogue.

Vice-President: Your roads won't do for our traffic.

W. M. A.: I don't understand.

Vice-President: They're not strong enough.

W. M. A.: Well, I always understood that our chair roads were accused of being extravagantly costly, but I thought they were admittedly better and stronger than your Vignoles system. Do you deny this?

Vice-President: Certainly I do. They possess no advantage to set against the increase of cost. And, mind you, I speak from experience. We took out from England two or three miles of standard North-Western road, rails, chairs, fastenings, and everything complete. The only thing we did not import was the ties themselves. We took out likewise North-Western permanent way hands, and they laid their own road in our main line alongside of our own standard pattern of road. And so we tested the two systems side by side. Your system not only was much more difficult to maintain, but was so knocked about by our heavy traffic that after a year or two we had to take it out, while our own road of the same age was still in perfectly good condition.

W. M. A.: Well, you surprise me.

Vice-President: The truth is, your chairs make too rigid and unyielding a road. Our system with the rails resting directly on the ties gives an elasticity that spares both road and rolling stock.

W. M. A.: Then if I understand rightly, your position is, that we are making just the same mistake that the old engineers made when they fastened their rails straight down on to granite blocks, or even in some cases direct on to the live rock itself.

Vice-President: Precisely so, only of course in a less degree. I may say that we don't even use tie-plates, so that our rail rests direct on the soft elastic wood of the sleeper.

President: I quite agree with all that Mr. —— has said. Of course you must remember that we are not talking about the weak Vignoles rails with wide-spaced sleepers that one sees on the Continent, and that our roads are laid with about 90 lb. rails, and besides, have a tremendous lot of wood in them. You here in Europe put ten or eleven sleepers under a 30ft. rail where we should put at least fifteen. In the main line my company have as many as sixteen or seventeen ties under each rail—in fact, I'm not sure whether we haven't lately gone as far as to use eighteen.

W. M. A.: Well, I must confess this is a perfectly new light to me. I should be interested to know what our English engineers would say to it.

Vice-President: Why, Mr. Eddy, who was trained on the English system, has come back from Australia a convert, and declares that chair-roads are a mistake.

Such, Sir, was the upshot of our conversation as accurately as I can remember it; and, as it made a great impression on me at the time, I do not think I am likely to be far wrong in my recollection. I do not, of course, presume to express any opinion of my own upon a technical subject. But I will just say this: English railway men fought hard against continuous automatic brakes; they have had to acknowledge themselves wrong. They fought hard against bogie carriages. Mr. Patrick Stirling probably died unconverted, but he has left no successor. Is it not possible that in standing out against the opinion of the civilised world—I ought perhaps to make an exception in the case of France—they are wrong also? W. M. ACWORTH.

47, St. George's-square, S.W.

SIR,—I notice in the last number of THE ENGINEER a letter from Mr. J. W. Wilkins, in which he alludes to my remarks on the cause of the late accident to the Leeds express, and infers that even if a train load of ballast had actually been standing in a siding near by, with the necessary labour at hand and opportunity to distribute it, that ballast would not have been made use of in time to prevent the accident; he further proceeds to say that if the ballast had been properly placed in contact with the sleepers, that catastrophe might never have happened.

I need not allude to his remark as to the ignorance of one M. Inst. C.E. of the art and mystery of platelaying; his exposition thereof will no doubt be appreciated by many members of that Institution. I may say, however, that Mr. Wilkins' statement constitutes a very grave charge against the officials in charge of the permanent way when the accident occurred; but I leave them to fight their own battle.

My previous letter was based on Major Marindin's report as quoted in the newspapers, that the accident was attributable to a deficiency of ballast; and this apparently is also Mr. Wilkins' opinion. I pointed out how this deficiency could have been made good in a rapid and economical manner; of course, if the officials purposely omitted to deposit the ballast which the Government inspector considered to be necessary, there is no more to be said. Mr. Wilkins concludes by saying that he has very good reason to object to the machine depositor, spreader, and trimmer, when intelligent and decently-paid hand-labour can be obtained. I am afraid that, in spite of the "good reasons" alleged, mechanical work is rapidly supplanting hand-labour in many branches of industry, and probably before long the operation of ballasting will be no exception to the rule. JAMES FFORDE.

17, Victoria-street, S.W., May 19th.

SIR,—Once upon a time there was a giant who performed before all the crowned heads of the world, more or less. In his exhibition the giant stood upon the heads of two ordinary men and swung clubs, and performed other antics. His legs were well separated, his feet turned outwards, and the heels of his boots were deep so that they would not slip over the heads of his supporters. The supporters also stood with their legs apart—so as to increase the base as much as possible—and they had their boots stuck under bent nails in the floor of the stage, further to increase the stability of the whole. The giant's weight increased, and he took to heavier clubs, and operated them more furiously, so that the manager of the entertainment was obliged to get two bigger men to support the giant; their feet were spread as far apart as possible and pushed into straps secured to the stage floor. The giant complained that the heads were not steady enough to enable him to do as he would like, and that he never could tell exactly how far apart they would be at any time during his performance.

The stage manager decided that some change must be made. He knew that two still bigger men would not do, even if he could get them, because he saw that lengthening the man only increased the leverage on the feet attachments, and he had broken several of these already. So he got two high-backed chairs and fastened them securely to the stage opposite each other, with the backs outwards. He then made the two supporters sit sideways on the chairs facing the audience, and he stuffed a hard old-fashioned sofa cushion between the side of each man's head and the back of his chair. The giant said that would give them the support just where they wanted it, and on trying the arrangement he was delighted to find that the men's heads did not wobble about and could be depended upon, and that he was able to use heavier clubs than ever, and to perform various surprising feats with a feeling of security that he never enjoyed before. FOUR-FOOT.

May 18th.

SIR,—It will be plain from letters which have already appeared in THE ENGINEER, that I consider the hold which a sleeper has upon the "formation" of a line of railway is not always adequate to retain it in position on the passage of heavy trains at great velocities. It will be admitted that the only means at present depended on is the friction set up between the under side of a straight sawn sleeper and the small area of ballast in effectual contact with it; and even this will greatly depend upon the kind of ballast used. The small friction of ballast filled in against the edges of the sleeper and boxed against the end of it may be left out of the calculation altogether.

No great stretch of imagination in the way of design was required, when once the idea was accepted that more friction was desirable; and I will just say what under these circumstances presented itself to me as a means to that end. I suggest an attachment in the form of T iron, or like a V with ears to allow it to be spiked to the underside of the sleeper below each rail; or, what would perhaps be nearly as effective, and less costly—the diagonally sawn half of a block of wood, 5in. by 5in., spiked flat across the sleeper. This sort of arrangement would offer more than twice the resistance to lateral motion that fully boxing up does; beside the advantage of the sleeper being—so to say—"let into" the solid, and the additional advantage of its being always there. Then possibly the navvy might "open out," and leave opened out with impunity. J. W. WILKINS.

May 20th.

EVAPORATORS.

SIR,—You refer, in your remarks on the above subject, to the necessity for keeping a regular control over the volume or weight of the supplementary steam raised in the evaporator and passed to the boilers. Besides the system for determining this quantity pointed out by you, there is another very simple arrangement which I have had occasion to recommend in more than one instance, and which answers satisfactorily. Steam will be admitted to the coils of the evaporator at a known pressure, and, consequently, temperature; and the condensed steam resulting will be drained off, say, at atmospheric pressure in a continuous stream. It is only necessary to pass this rejected water over an accurately constructed tumbling bay, or through any of the trustworthy self-registering meters which exist, to know at any time what is the weight of steam which has been used inside the coils, and to deduce from this the amount of vapour raised. The simple theory of the operation would be of course this: Supposing steam is admitted at an average pressure of about 20 lb.—there is little advantage to be gained by using steam of very high pressures for mere evaporating work—or a total temperature of about 1192 deg., then 980 deg. will have been employed in the coils. Say that the water in the evaporator has been raised from 45 deg. to the temperature of steam at about 8 lb. = 1185 deg., it follows that every pound of condensed steam discharged should correspond to ·86 lb.—nearly—of supplementary steam passed to the boilers.

The actual result will not be precisely the foregoing, as there are various disturbing influences which come into play. For instance, the steam will probably not be admitted to the coils perfectly dry, and against this the condensed steam had a temperature higher than 212 deg. immediately before its discharge. Further, there is naturally an amount of heat lost in the course of the operation. But these things being fairly constant in a given apparatus, it will suffice to establish a coefficient, preferably by direct experiment, and the amount of steam passed to the boilers can be checked at every moment with an accuracy and ease which leave nothing to be desired. E. STEPHENSON.

Hornsey Rise, May 18th.

THE LIQUEFACTION OF GASES.

SIR,—I do not think anything would be gained by continuing the discussion of the action of the Linde or Hampson process with your correspondent "Cryos." If he will read any good treatise on thermodynamics he will find most of his difficulties cleared away. He evidently has not read what has appeared in THE ENGINEER on the subject, nor has he heard or read Dewar's last lectures. Indeed, he does not appear to read anything with care; thus, for example, I said that no external work was done in the Hampson apparatus, and he immediately calls my attention to the compressing pump. That is not part of the Hampson apparatus, and is indeed only a pump used by the Brin's Oxygen Company, utilised for the purpose. Dewar uses the Hampson or Linde process without a pump. Why "Cryos" should insist on the need for the Joule effect is a puzzle to me, seeing that the mere expansion of air will give him ten times as much cold. If Dr. Hampson depended on the Joule effect, he might pump for a century before he got liquid oxygen, much less liquid air.

"Cryos" seems to be quite unaware of the fact that it is more than doubtful that any Joule effect whatever could be got in the apparatus used, which has little or nothing in common with that employed by Lord Kelvin.

"Cryos" must try again to master the theory of the Linde process. When he has done that he will see that his remarks about temperature in the two ends of a tube are beside the mark.

May 19th. ZERO.

SIR,—If your correspondent, "Cryos," will take the trouble to think the matter out, he will see that the work done on the air pump piston by the low-pressure air during the suction stroke must all reappear on the compression side. The effect will be as has been pointed out by Schröeter, that the work to be done by the compressing engine is reduced. By no stretch of definition can this be called external work.

It seems to have escaped "Cryos's" attention that very great doubt exists as to whether there is any such thing as "Joule's effect." The experiments of Kelvin and Joule are by no means unimpeachable.

If "Cryos" can refer me to any authority who has proved by direct experiment that the figures he gives in his fourth paragraph are accurate, I shall be obliged to him. At present, I believe they are pure deductions, with no foundation in ascertained fact. J.

May 20th.

PUFFING BILLY *v.* NO. I.

SIR,—There appear to be one or two errors in your note *re* the above. (1) At the time the loco was put up on the High Level Bridge the Newcastle papers stated that it was No. 1—Stockton and Darlington—removed from Darlington, unless I am much mistaken; but as this was fourteen years ago there is room for doubt on my part. (2) Puffing Billy was not built by Stephenson but by Hedley, of Wylam. As my authority, I may say I had this from an old millwright, who had worked for Hedley on Puffing Billy. Puffing Billy was the first loco to run on smooth rails and without a rack, and followed Hedley's experimental truck. The two engines are very much alike at a casual glance. I saw Puffing Billy under steam at the North-East Coast Exhibition, Tynemouth, 1882, but what became of it after that I am not quite sure. GEO. S. PARDOE.

81, Harrow-road, W., May 18th.

(*For continuation of Letters see page 527.*)

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—The summer excursion of this Institution will be to Cardiff and district. Arrangements have been made with the North-Eastern Railway Company to run a special train to Cardiff, *viâ* Leeds, Crewe, and Pontypool-road, on the 22nd of June, calling at Sunderland and Stockton-on-Tees, and will return from Cardiff at about 9.30 a.m. on Saturday, June 27th.

SEWERAGE OF WESTGATE-ON-SEA.—The Rural District Council of the Isle of Thanet, Kent, at the desire of the Parish Council of Westgate-on-Sea, have instructed Mr. E. Bailey Denton, M. Inst. C.E.—Messrs. Bailey Denton, Son, and North, of Palace Chambers, Westminster—to immediately prepare plans for the sewerage of this favourite seaside resort. The method of disposal has been for some time past a bone of contention amongst the inhabitants, but it has now been decided to pump the sewage into the main outfall sewer of the Borough of Margate, discharging into the sea at the North Foreland, should the terms imposed by that borough prove acceptable to Westgate. Failing this, the sewage will be raised to and utilised upon the marsh lands beyond Birchington. The works will not be commenced until October, but will be finished by April, 1897, so as not to interfere with the popularity of next year's summer season.

RAILWAY MATTERS.

THE Belgian Chamber of Representatives has guaranteed the issue of Congo Railway Bonds.

ON the London and North-Western Railway a new type of detonator, known as the "Duplex," will henceforth be used throughout the system for fog-signalling purposes in place of the ordinary detonator hitherto employed. Instead of putting two fog-signals on the rail, ten yards apart, only one of the new design will be used, and, of course, there will thus be but one report.

WRITING on the steam tramways in Italy, a tramway manager in Italy states in reply to a letter by Mr. Armstrong, suggesting to a contemporary the adaptation of steam tramways as used in Italy to the purpose of the proposed light railways in England, that the modifications he considers as "easy" would have to be such as would eventually turn a "tramway" into a "railway," or, if the comparison is suitable, a "mouse" into a "rat." Most tramway and railway engineers will only partly agree with this.

A GENERAL classification of the accidents on the American railways in March shows the following:—

	Collisions.	Derailments.	Other accid's.	Total.	p. c.
Defects of road	0	10	0	10	8
Defects of equipment	10	15	4	29	21
Negligence in operating	24	2	0	26	19
Unforeseen obstructions	0	15	1	16	12
Unexplained	23	20	0	53	40
Total	57	72	5	134	100

THE vote in the Brussels Chamber, May 15th, on the Congo Railway Bill, passes a Bill which provides an immediate loan of 5,000,000f. to take up that now due, and the guarantee of a further loan of 10,000,000f. at 3 per cent., practically secures the success of the enterprise. The station at Tumba, a distance of 187 miles from the starting-point at Matadi, will be opened in July, and the directors confidently anticipate that the traffic receipts on this section of the line will in a few months give such results as will enable the company to raise the 20,000,000f. still necessary for the completion of the line to Leopoldville, without having any further recourse to State assistance. The *Times* says the Government have, indeed, given their formal pledge not to exceed the limits of the present measure.

THE record of train accidents in the United States in March includes 57 collisions, 72 derailments, and five other accidents, a total of 134 accidents, in which 28 persons were killed and 95 injured. These accidents are classified by the *Railroad Gazette* as follows:—Collisions: trains breaking in two, 10; misplaced switch, 8; failure to give or observe signal, 1; mistake in giving or understanding orders, 4; miscellaneous, 11; unexplained, 23; total, 57. Derailments: Broken rail, 5; loose or spread rail, 2; defective bridge, 1; defective switch, 1; bad track, 1; broken wheel, 1; broken axle, 5; broken truck, 6; failure of drawbar, 1; broken car, 2; runaway train, 1; derailing switch, 1; animals on track, 1; landslide, 2; snow or ice, 5; washout, 1; malicious obstruction, 1; maliciously misplaced switch, 2; accidental obstruction, 3; unexplained, 30; total, 57. Other accidents: Boiler explosion, 1; cylinder explosion, 1; breakages of rolling stock, 1; other causes, 2; total number of accidents, 134.

THE passing of the preamble of the Sheffield District Railway Bill knits various collieries and villages with the M. S. and L., at Woodburn Junction, and in that view of it will be useful. Bus that could not be the whole that was meant by the Bill. By means of what is known as the East to West Railway, the new line, if sanctioned as applied for, would have given the Great Eastern access to Sheffield. The Committee, by refusing running powers into the Victoria Station, do not prevent the Great Eastern passengers getting to Sheffield, but they certainly make it considerably more inconvenient for that company. At the same time, although local evidence was strongly in favour of the District Railway Bill, it is undeniable that the Victoria Station of the M. S. and L. is an awkward one to deal with, and admittedly inadequate for the traffic at present passing through it, that will be enormously increased by the company's new line to London, in view of which extensive additions are at present being arranged for.

IN a report on a collision which occurred at 10.16 p.m. on the 2nd ult. at the London-road Station, Manchester, on the Manchester, Sheffield, and Lincolnshire Railway, when the 10.15 passenger train was leaving the station, from No. 3 platform, it came into collision with a light engine which was standing outside the station on the same line as the train had been signalled to leave by, a Board of Trade inspector says:—"This accident was primarily due to the forgetfulness of signalman Paine, on duty in the station cabin, who, within a few minutes of having placed a light engine upon the loop line, lowered the starting signal for the 10.15 p.m. train to leave the station on the same line. I understand it is proposed to put the following rule in the appendix to the company's time-book, which should prevent any future misunderstanding on this point:—'Drivers of all engines on arrival at London-road Station after dark must immediately place a red tail lamp in front of the engine, so that when the engine moves in the opposite direction such red light will act as a tail lamp.'"

AN important railway improvement, which has been in progress for some years past, was successfully completed on Monday, when the new southern tunnel approach to New-street Station, Birmingham, was thrown open to traffic. The object of the extension is to give to the North-Western and Midland Companies independent approaches, and to do away with the system of joint lines and crossings of rails on the level, which has made the traffic so difficult to work, and which was the cause not only of frequent delays, but of some danger. Up to the present the whole of the trains of the two companies entering and leaving the station on this side—some 400 a day, or an average of one in every 3½ minutes—have had to use one tunnel with but one up and one down line. In such circumstances, the wonder was that the traffic worked so smoothly as it did. Now, however, the Midland station will be entered through the new tunnel, and the London and North-Western and Midland trains will in no case use the same line of rails. Exclusive of permanent way and signals, the purchase of land and buildings, the work has cost about £100,000, while the total outlay has been something like £250,000.

THE Bill promoted to extend the time for the purchase of lands for the purposes of the City and South London Railway Act, 1893, and for the completion of the underground railway and other objects, came before a Select Committee of the House of Commons on the 18th inst. The main question before the Committee was the demolition of the Church of St. Mary Woolnoth, in King William-street, near the Bank of England, for the purpose of erecting a station. Amongst other witnesses called was Mr. C. G. Mott, chairman of the company, who said the church was not wanted. There were ten churches within a radius of 200 or 300 yards, two of them being actually in the same street as St. Mary's. Besides, St. Mary's had no congregation and there were no peculiar associations connected with it. It merely resembled a room in the Mansion House. The money that would be paid for it would be sufficient to enable several other churches to be built in districts where churches were wanted and where congregations could be easily obtained. If the church were left standing the company would not have as useful a station as would otherwise be secured, and the cost of the works would be increased. The Committee found the preamble of the Bill proved, subject to the insertion of a clause for the protection of St. Mary Woolnoth, and declaring that it shall be referred to the arbitrator to take into consideration the additional liability which will devolve on the company in consequence of giving up their present rights.

NOTES AND MEMORANDA.

IN a recent paper read before the Paris Academy of Sciences, on the theory of gases, by M. J. Bertrand, a critical examination of the well-known formula of Maxwell for the relation between the velocities of the gaseous molecules and their components in any arbitrarily chosen direction is given. This formula is described as necessarily absurd, since it gives an apparent solution of a problem insoluble from its very nature.

FLOUR mills in New South Wales employ about 700 hands, with machinery and plant worth £244,365, while the Colony's breweries employ 744 persons, and possesses machinery and plant to the value of £122,000, with an annual output of about 10,000,000 gallons. There is a growing industry in connection with the making of butter and cheese, in which about 1000 persons are employed, the butter factories having machinery and plant to the value of over £50,000.

FROM some experiments made to determine the best angles for the heads of countersunk rivets for ships' plates, Professor Weighton concludes that for ¼in. plates the countersink should not be less than 56 deg., and even a greater angle would seem to be not amiss; and second, that for ½in. plates the countersink should not be less than 35 deg. For other thicknesses the angle of countersink would be in proportion, and the following would be about the angles proper for the different thicknesses:—¼in. plate, 56 deg. angle of countersink; ⅜in., 45 deg.; ½in., 35 deg.; ⅝in., 26in.

THE manufacture of sugar in New South Wales is an important industry, and its record shows it to be a progressive one, but the business is falling gradually into the hands of large establishments. In 1882, 70 mills worked by steam and 16 by cattle manufactured 270,000 cwt. of sugar and 560,000 gallons of molasses, while in 1890-91, the year showing the largest yield, 31 steam and two cattle mills manufactured 530,660 cwt. of sugar and 1,074,080 gallons of molasses; the number of hands increased in the same time from 1039 to 1621. Last year there were two refineries, melting 756,200 cwt., possessing machinery of 650-horse power, and employing 440 hands.

THE British Consul at Jerusalem writes that since the opening of the railway between Jaffa and Jerusalem the necessity for a harbour at Jaffa has become all the more urgent, and sooner or later it will have to be constructed, or the Jaffa-Jerusalem railway will have to be extended to Port Said. As far as tourists are concerned, the advantages of a connection by rail with Port Said would be very great, for the intervening country being perfectly level, the distance—about 220 or 230 miles—could be accomplished in ten hours. Jerusalem could thus be visited without the necessity of a sea voyage to Jaffa, where in rough weather the landing is uncertain; and travellers on their way to or from India and Australia would also have an opportunity of seeing the Holy Land by breaking their journey for a few days at Port Said.

THE application of aluminium to the construction of things for which it is particularly suited is gradually extending. There have been many materials employed, and still more suggested, for the manufacture of cocks suitable for use in chemical works and those industries in which acid and corrosive fluids have to be controlled. The field for a cock applicable to the brewing, vinegar, and similar trades has up to the present been practically a virgin one. Seeing this Messrs. Bennett, Sons, and Shears, London, have recently made an aluminium and ebonite cock upon the lines set forth in Deaville's patent. The barrel is made of aluminium, and is fitted with a vulcanised plug, and the wear and tear is very small. The use of aluminium presents a great advantage over numerous well-known alloys, as it is not of such a poisonous nature as lead, and so is especially suitable for dealing with dietetic substances.

IN a paper on "Influence of Character of Sand on Cement Mortar," by A. S. Cooper, in the J. Franklin Institute, the author describes numerous experiments he has made on the influence of sands of varying fineness and character of grain on the tensile strength of cement-mortar briquettes prepared with them. He arrives at the following conclusions:—(1) Other things being equal, a fairly coarse sand, *e.g.*, one passing through a 12 sieve—twelve wires to the inch—and caught on a 16 sieve, gives mortars of higher tensile strength than do finer sands; (2) this effect of size of grain disappears with sands fine enough to pass a 40-mesh sieve and caught on a 60-mesh sieve, sands finer than this give similar results; (3) the character of the surface of the grains is of moment. The *Journal* of the Society of Chemical Industry points out that mere sharpness of grain is not the only point to be considered, for an extremely sharp sand may have a smooth surface on each facet, and a moderately rough surface is preferable.

IN one of the reports of the Geological Survey of Norway is a communication by A. Helland on the depths of the lakes in Jotunheim and Thelemark, as ascertained from soundings by himself and others; but unfortunately all of them have been made in the line of the length of the lakes, none of them transversely, thereby missing a most important clue to the explanation of their origin. He gives longitudinal sections of four of the principal lakes in Jotunheim, but the irregularities in the bottoms are not favourable to the glacial erosion theory which he supports; transverse sections would probably prove more instructive. Of the forty-two lakes mentioned, no less than twenty-three of them have their bottoms below sea-level. The following series of figures represents the number of feet below sea-level of the first twelve, viz., 1417, 1085, 715, 712, 593, 568, 528, 456, 456, 456, 361, and 190. The first is the Hornindals Vand, the surface of which is only 177ft. above sea-level, but the bottom is 1417ft. below it; the second is the Mjösen Vand, the surface of which is 397ft. above, and bottom 1085 below sea-level. The great depth below sea-level seems to militate against the theory that they were eroded by ice.

IN a discussion on a recent paper by Mr. R. Davison, on "White Metals for Wearing Surfaces," before the Institute of Marine Engineers, Mr. James Adamson said he remembered one steamer at Glasgow, which required to have the whole of her main bearings filled up with new white metal within nine months. She had only made two round voyages before the whole shaft had to be lifted and the main bearings refilled with white metal. After the ship was lined up, she ran with the second lot of white metal for nine years, and, he believed, it was actually cheaper in price. He was acquainted with another steamer which ran for fourteen years with the same metal that she had in when she left the builders' hands, and she was running hard during all that time. Another steamer ran for eight years without her bearings requiring to be lined up, and still another ten years. He had found from experience that a hydrocarbon oil ran better with white metal bearings than ordinary engine oil, and in the case of the steamer to which he referred that ran for twelve years without her bearings having to be lined up, nothing but hydrocarbon oil was used from the time she left the builders' hands. Mr. Adamson gave an instance where white metal had been applied to worn excentric straps with good results. These straps, he said, had previously given trouble every voyage, and in one case the brass had worn down $\frac{3}{16}$ths of an inch in a six weeks' voyage. White metal was then put into them, and they had now been running for nearly four years without giving any trouble whatever. There were six of these excentric straps, and they were treated with three different kinds of white metal as an experiment. All of them had done equally well and had never given any trouble. He did not think that white metal did well, as a rule, with water, especially salt water. Mr. Wilson said he found white metal in a certain ship, and they could only run it with the best castor oil and a little water. The moment they took the water off they had trouble. That only referred to the bottom ends. The main bearings ran a little better.

MISCELLANEA.

AN inquiry has been held in Glasgow by Admiralty experts into the cause of a recent explosion on board the first-class cruiser Terrible. It was found that the paint in the bilges gave off an inflammable gas that found its way into the circulating pump chamber through the bilge connection. Some of the workmen who were passing with a naked light ignited this volatile gas, with the result that the circulating pump chamber burst so badly that a new one will have to be substituted. Fortunately the force of the explosion spent itself in the chamber.

DAMAGE to the extent of about £20,000 was done at Hull an the 15th inst. by the collapse of some old gates, used for dry dock purposes during the extension works at the fish dock. The docks are owned by the North-Eastern Railway Company. Almost all the vessels moored in St. Andrew's Dock broke away and a smack was smashed up, many other vessels being sunk or seriously damaged. There was no loss of life, though both women and children were on the sunken vessels. The collapse of the gates is said to have been due to the hidden springs being freed by pile-driving and excavations.

AN alarming explosion occurred on the 14th inst. on board the French ironclad Admiral Duperré. A loud report was heard and the after part of the vessel was soon filled with thick smoke, which was found to be issuing from the central powder magazine on the lower deck. The door of the magazine was hurled a distance of 30ft., and investigation showed that a cartridge about 13in. long had exploded, but that none of the other cartridges among which it was packed were discharged. The magazine contained 3000 kilogrammes of gunpowder and mélinite shells, none of which were disturbed in any way. The explosion is attributed to the overheating of the magazine by pipes from the boilers.

THE first platform of the great tower at Wembley Park has been opened to the public. The base of the tower covers about an acre of ground, and the platform, which has just been completed by Messrs. Heenan and Froude, the contractors, is at an elevation of 155ft. from the ground, or 400ft. above the sea level. The whole tower when completed will be 1150ft. in height. From the first platform, on a clear day, the Crystal Palace, Windsor Castle, and the grand stand on Epsom Downs can be distinguished. Access is gained by means of two lifts constructed to carry fifty-five persons each, and worked by means of steam engines undeath the base of the tower. The platform is composed of concrete on metal girders, and 2600 tons of steel have already been used in the construction of the first platform.

THE general report for 1895 of the Conservators of the river Thames has been issued as a Parliamentary Paper. It says, among other things, that in the case of farms, manufacturing premises, and private residences, from which pollution formerly passed into the streams of the Thames basin, the notices served resulted in a complete diversion of the sewage in 534 instances. The powers of the Conservators with respect to pollution from houseboats and other vessels were also carried into effect, with the result that the passage of sewage from those vessels was effectually stopped. The Conservators found that they have no power to expend their funds on works for the prevention of floods, but they will continue to carry out the works for navigation purposes in such a manner as to afford the best means of escape for the water in times of flood.

THE secretary of Lloyd's, replying to the recently published comments of the Chamber of Commerce of Plymouth on a previous statement from Lloyd's, states that the desire of Lloyd's is that "any further money that the Government can grant—for the object of saving life at sea—should be granted to the extension and improvement of lights and fog signals, rather than to the further extensions of telegraphic communication." This statement is dated April 8th, 1896. The Plymouth Chamber of Commerce, in a reply dated May 14th, asserts, according to the *Times*, that it does not object to the building of additional lighthouses where necessary, but it is at issue with Lloyd's in that "the Chamber insists on the paramount necessity that lighthouses, when built, should be utilised to the fullest extent possible for the saving of life and property by putting them into telegraphic communication with the general telegraphic system of the country."

OWING to its sheltered position, its comparative immunity from tidal disturbance, and facilities as regards depth of water at all times, the measured mile at Skelmorlie, and the stretch of firth between the Cloch and Cumbrae Lights, have become the favourite rendezvous for new steam vessels from all quarters. The fleet of high-speed Channel steamers plying between Dover and Ostend, built by the Belgian firm of Cockerill, as well as by Messrs. Denny, Dumbarton, have been tried under the same conditions on the Skelmorlie course; and the vessel presently on hand by the former company will also be sent to the Clyde for trial. Of the formidable fleet of torpedo destroyers now possessed by this country a large proportion have been put through their paces at Skelmorlie mile, not only those built on the Clyde, but those of Birkenhead and Barrow production. Two destroyers from Messrs. Laird's stocks at Birkenhead, the Quail and the Sparrowhawk, have during the past fortnight been undergoing their trials, and it is stated that during the ensuing summer and autumn as many as nine of these phenomenally speedy craft will be sent round to the Clyde from Birkenhead for trial.

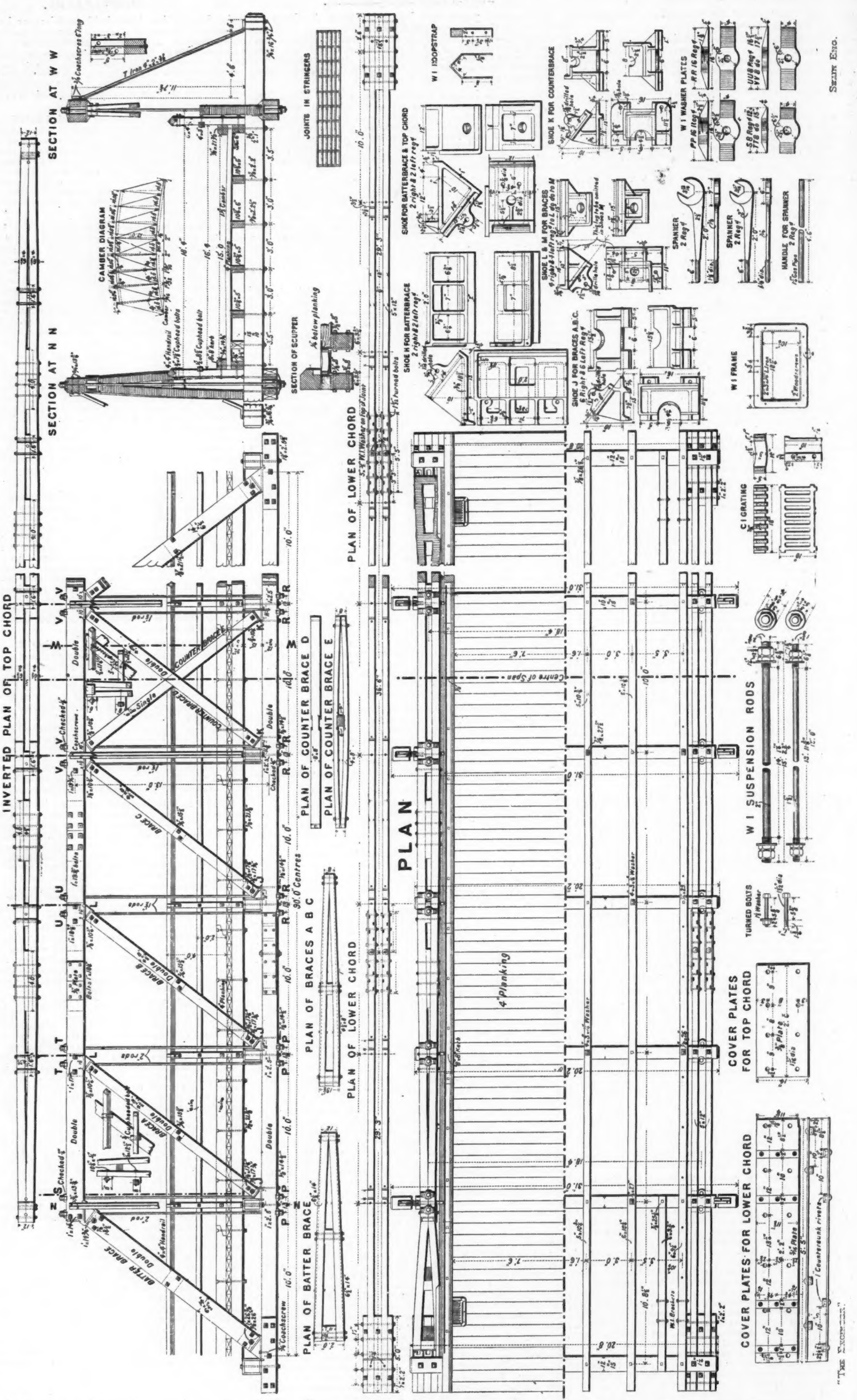
THE death is announced of the editor of the *Leeds Mercury*, Mr. Herbert Stanhope Baines. Mr. Baines had been recommended by his medical adviser to take a short sea voyage; not because of any organic disease, but simply on account of some giving way of nervous force, under the pressure of work and engagements. He sailed for the Canary Islands on the 11th of last month, in Messrs. Elder, Dempster, and Co.'s steamer Accra. He arrived at Las Palmas on the 17th, and allowed himself to be tempted to proceed on the 18th to Sierra Leone, and thence further down the Gold Coast. Having changed from the Accra to the Benin for the return journey, he seems to have succumbed to the influences of that trying coast on Saturday last, the 9th inst. Mr. Herbert Baines was the second son of the late Mr. John William Baines, and his father was the second son of the late Sir Edward Baines. Born on the 5th January, 1868, he commenced his education at the Leeds Grammar School, whence he passed, in 1885, to the London University, and whence, again, after matriculation, he went on to Caius College, Cambridge. He took his B.A. degree with honours in 1889 in the Classical Tripos.

THE Corporation of Chester, as the promoters of a Bill empowering them to construct a weir or tidal dam across the Dee, appeared on the 14th inst. before the Court of Referees—Mr. J. W. Lowther presiding—to object to the *locus standi* of certain petitioners. The Great Western Railway Company, as the owners of the port of Saltney, claimed that they had a special interest, which might be injuriously affected by the stoppage of the tidal flow in the estuary. The reply of the promoters was that the interest of the company was represented by the Dee Conservancy Board, to which they appointed two of the twenty-five members. The committee granted the petitioners a general *locus standi*, and a similar position was conceded to the London and North-Western Railway Co. A *locus standi* was also granted, on the ground of special interest, to the Hawarden Embankment Trustees, the Chester Gas Company, and the owners of property below the proposed works. In the case of the United Alkali Company and the District Councils of Hawarden, Holywell, and Mold, *locus standi* was refused. In reference to the provisions of the Bill enabling the Corporation to prevent the pollution of the Dee, a limited *locus standi* was given to Flintshire County Council and Llangollen Urban District Council. The Bill will come before the Police and Sanitary Regulations Committee after Whitsuntide.

TIMBER BRIDGE OVER GLENNIES CREEK, NEW SOUTH WALES

MR. P. ALLEN, ASSOC. M. INST. C.E., ENGINEER

(*For description see page 524*)


INVERTED PLAN OF TOP CHORD
SECTION AT N N
SECTION AT W W
CAMBER DIAGRAM
SECTION OF SCUPPER
JOINTS IN STRINGERS
PLAN OF BATTER BRACE
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PLAN OF COUNTER BRACE D
PLAN OF COUNTER BRACE E
PLAN OF LOWER CHORD
BATTER BRACE
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BRACE B
BRACE C
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PLAN
4" Planking
W I HOOPSTRAP
SHOE FOR BATTERBRACE & TOP CHORD
SHOE H FOR BATTERBRACE
SHOE J FOR BRACES A.B.C.
SHOE K FOR COUNTERBRACE
SHOE L & M FOR BRACES
W I WASHER PLATES
SPANNER
HANDLE FOR SPANNER
W I FRAME
C I GRATING
W I SUSPENSION RODS
TURNED BOLTS
COVER PLATES FOR TOP CHORD
COVER PLATES FOR LOWER CHORD
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"THE ENGINEER"

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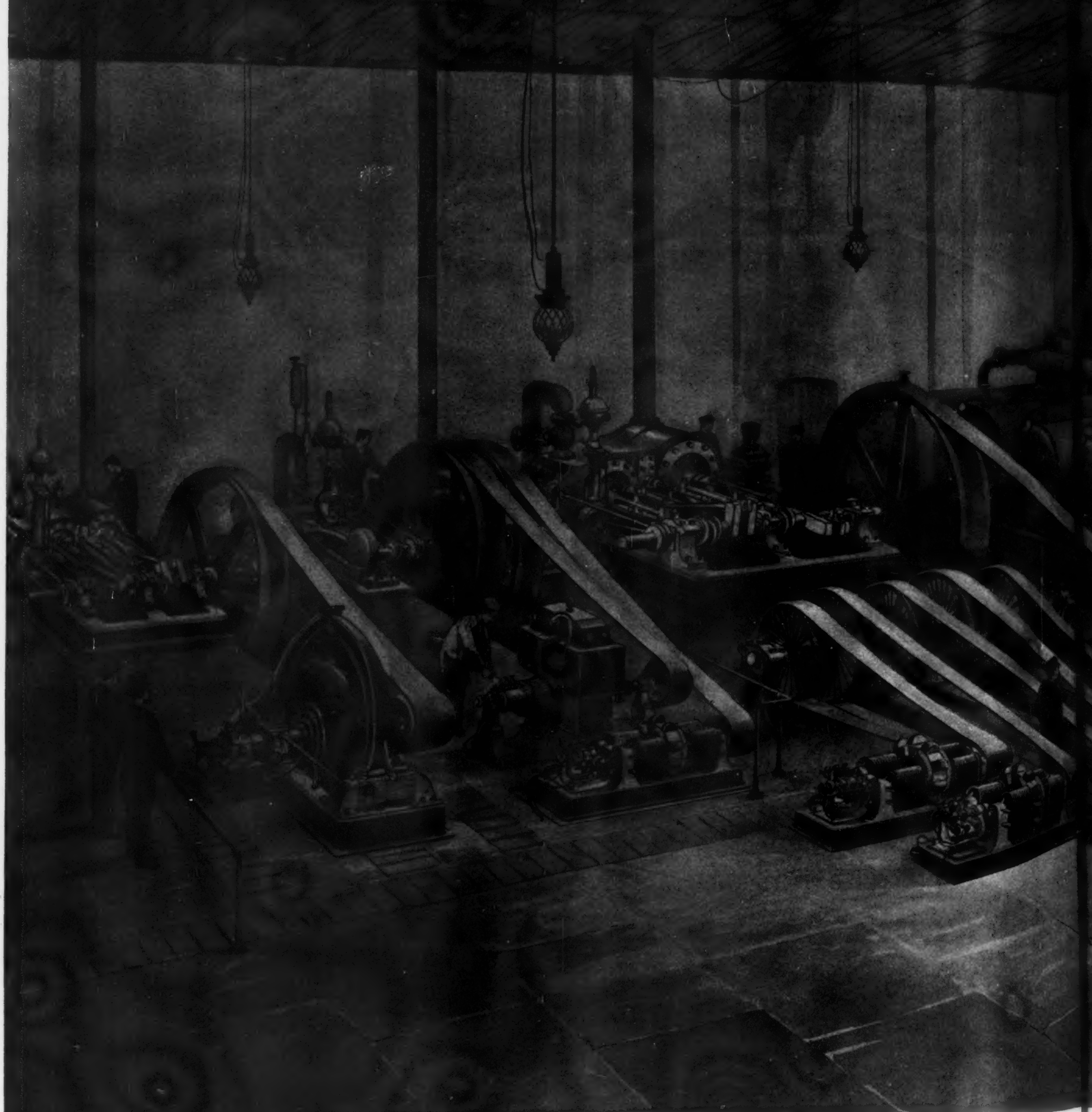
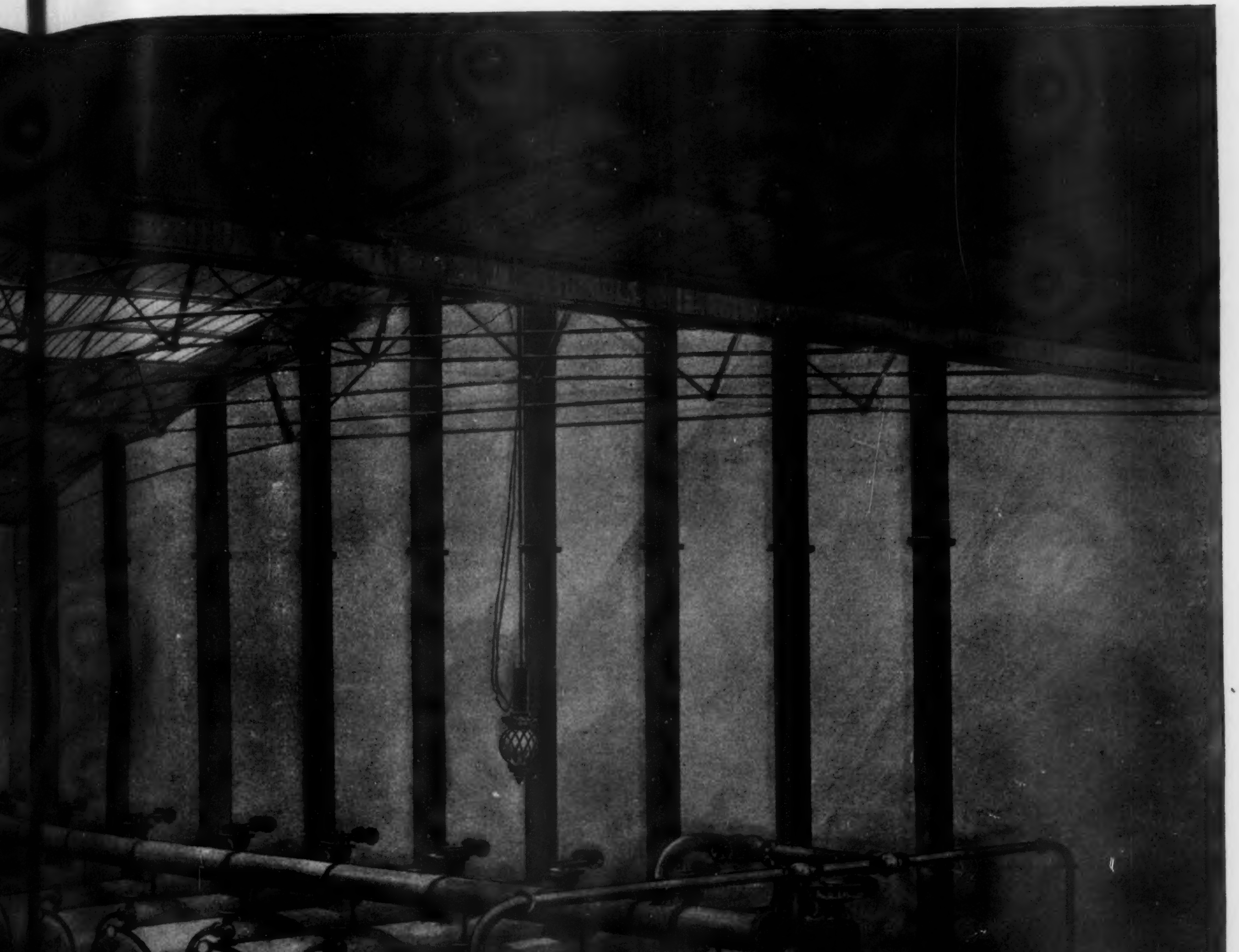
THE ELECTRIC LIGHT INSTALLATION IND AN

MESSRS. DAVEY, PAXMAN, AN O., COLCHE



D A AND CEYLON EXHIBITION, EARL'S COURT

, AN O., COLCHESTER, ENGINEERS



FOREIGN AGENTS FOR SALE OF THE ENGINEER.

AUSTRIA.—GEROLD AND Co., *Vienna.*
CHINA.—KELLY AND WALSH, LD., *Shanghai and Hong Kong.*
FRANCE.—BOYVEAU AND CHEVILLET, *Rue de la Banque, Paris.*
GERMANY.—ASHER AND Co., *5, Unter den Linden, Berlin.*
A. TWEITMEYER, *Leipsic.*
INDIA.—A. J. COMBRIDGE AND Co., *Esplanade-road, and Railway Book-stalls, Bombay.*
ITALY.—LOESCHER AND Co., *307, Corso, Rome.*
BOCCA FRERES, *Turin.*
JAPAN.—KELLY AND WALSH, LD., *Yokohama.*
RUSSIA.—C. RICKER, *14, Nevsky Prospect, St Petersburg.*
S. AFRICA.—GORDON AND GOTCH, *Long-street, Capetown.*
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CORRUGATED IRON.

(*To the Editor of The Engineer.*)

SIR,—We would like the names of makers of corrugated sheets, with ¼in. corrugations, and also manufacturers of machinery for stamping and punching holes in the sheets after corrugation. K. P.

Neath, South Wales, May 18th.

THE VELOX DRILLING MACHINE.

(*To the Editor of The Engineer.*)

SIR,—We want the name and address of the maker of the "Veloz" or "Velox" Drilling Machines, being unable to find out where and by whom these machines are supplied. We shall be obliged to any reader who can inform us. C. W. E.

Glasgow, May 15th.

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF JUNIOR ENGINEERS.—Saturday, May 30th, at 10.30 a.m. Visit the Fowler-Waring Cable Works, North Woolwich.

INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, May 28th, at 8 p.m. Paper: "The Utilisation of Water Power, especially with a small fall, with some examples of Plants for the Generation of Electrical Energy," by Mr. Alph Steiger.

ROYAL INSTITUTION OF GREAT BRITAIN.—Tuesday, May 26th, at 3 p.m. Lectures: "The Building and Sculpture of Western Europe," by Professor T. G. Bonney, D. Sc., LL.D., F.R.S. Thursday, May 28th.—"Lake Dwellings," by Mr. Robert Munro, M.D., M.A. Friday, May 29th, at 9 p.m. Discourse: "John Wesley: Some Aspects of the Eighteenth Century," by Mr. Augustine Birrell, Q.C., M.P. Saturday, May 30th, at 3 p.m. Lecture: "The Moral and Religious Literature of Ancient Egypt," by Dr. E. A. Wallis Budge, M.A., Litt. D., F.S.A.

"THE ENGINEER"
HORSELESS CARRIAGE COMPETITION.

WE have recently received suggestions from many quarters that it would be expedient that our Competition should be postponed until the spring of next year, for the reason that the date already fixed does not allow sufficient time to competitors to produce really satisfactory vehicles for trial, and, further, that until the Bill now pending in Parliament has been passed, designers cannot be quite sure that they are working on the right lines. So far as we are concerned, we are perfectly ready and willing to abide strictly by the conditions which we have already published, but we shall be glad to have the views of those who are interested, so that we may decide upon a course which will lead to the best results for all.

THE ENGINEER.

MAY 22, 1896.

THE PROBLEM OF SPEED.

WE print on another page a very interesting and instructive article by M. Normand, of Havre, upon the problem of speed. Taking as his text that remarkable little vessel the Forban, which, by attaining a speed of 31·029 knots on her official trial last year, won for herself the much-coveted title of the fastest vessel in the world, M. Normand traces the process of evolution of speed through a long series of torpedo boats built by him, and by examining the laws which have governed progress in the past he endeavours to forecast the line of advance in the future. M. Normand deals only with his own vessels, because, as he says, it is only concerning these that he has exact information. It is noteworthy that the speeds of his torpedo vessels at the beginning of the series fall far below those which were being obtained in this country at the same time. For example, his list begins with the Balny, built in 1886, and having a speed of 19·525 knots. Mr. Yarrow, in the preceding year, had achieved 25·1 knots. Again, in 1889 the speed of the Avant-garde was only 20·975; but two years before this Messrs. Thornycroft's Ariete had attained 26 knots. In April last year H.M.S. Boxer, by the same builders, had the lead with 29·314 knots; but she was soon beaten by the Sokol, built by Mr. Yarrow, which made 29·77 knots on official trial. The Sokol had held the proud position for a few weeks only when the Forban came with a rush to the front, and put up the record by 1¼ knots. Even her speed has been since surpassed by Messrs. Thornycroft with the Desperate, which now claims first place with a speed of 31·034 knots; but it is only fair to say it was not attained on an official trial, but when the vessel was at a light draught of water.

A study of M. Normand's series makes it abundantly evident that the governing factors in speed evolution have been the assignment of an ever-increasing fraction of the displacement to the propelling machinery, and an enormous increase in the amount of power which has been got out of a ton weight of engines and boilers. Thus in the Balny one-third of the displacement is devoted to propelling machinery, but in the Forban the fraction is increased to one-half. Again, in 1889, a horse-power was obtained for a weight of 72·7 lb., but M. Normand has now succeeded in reducing this to 35·3 lb. This is a very remarkable achievement, and one which should cause our own builders to look to their laurels. That such a low weight per I.H.P. should be accompanied by a comparatively low speed of revolution is very creditable. The revolutions of the Sokol were as many as 420 per minute, while in the Forban they did not exceed 365. Another point upon which M. Normand is to be congratulated is the very low consumption of coal both at full speed and at moderate speed. Such figures as 1·54 lb. per I.H.P. at full speed and 1·1 lb. at low speed will almost excite incredulity in this country; but there is no doubt that M. Normand, by paying the greatest attention to the steam economy of his engine, has attained to a very high degree of perfection, and to his economical engine is due in no small degree the success of the Forban, for not only is he able greatly to reduce the heating surface of his boilers as compared with what would be required with a more wasteful engine, but from the conditions of contract, according to which the quantity of coal to be carried on trial is determined by the amount necessary to give the vessel a certain radius of action, any improvement in economy reduces the load to be carried.

M. Normand appears to think that the greatest opportunity for obtaining a still further increase of speed will be found in effecting a considerable reduction in the volume of the vessel above water. He assumes that the displacement of the Forban could be increased from 127 tons to 190 tons, by immersing her more deeply in the water, the lines being appropriately modified, but the total depth of the vessel remaining unchanged. To get rid of the inconvenience of such a low freeboard as would then remain, he proposes to fit a flying deck upon which all the work of the ship could be done, and under which the sea could freely pass. After allowing weight for this deck, for some extra coal to give the same radius of action as at present, and for some strengthening to the hull, he estimates that there would remain an available weight of about 54 tons to add to the machinery, and that this would result in an increase of four knots in speed. Even if it be granted that sufficient range of stability could be secured under such conditions, is M. Normand right in assuming, as he does, that the value of the coefficient $\frac{V^3 D^{\frac{2}{3}}}{\text{I.H.P.}}$ would remain unimpaired? It seems to us very doubtful.

There are some other points in the paper to which we think exception might be taken. M. Normand ascribes the improvement which takes place in the performance of a small vessel after a certain critical speed has been passed, to a rising of the hull out of the water. Now there is no doubt that vessels of suitable form, driven at very high speed, can be made to lift, and more or less to skim on the surface, but is there any evidence that torpedo vessels do so? It would seem as if a necessary condition of a reduction of displacement—which is, of course, a consequence of any lifting action—is that water should be driven downwards by the vessel, and this downward velocity must continue until the vessel has passed. Then the reaction of this vertically moving water would serve to support so much of the weight of the vessel as was in excess of the displacement. To secure this condition the vertical longitudinal section of the vessel must continuously descend from forward to aft, or, in other words, the buttock lines should have their lowest points at the extreme stern, terminating there in an abrupt corner. The buttock lines of torpedo boats rise from amidships to the stern, and the water is probably rising too, after the midship section has passed, and if this is so it can have no vertical reaction such as we have described to assist in supporting the weight. A ricochetting shot rises out of the water because it imparts a downward velocity to a large quantity of water struck by it, and the equivalent of the energy required to change the direction of the shot is to be found in the downward momentum of the stricken water. It is true a round shot may be considered to be a vessel with buttock lines rising from the midship section to the stern, and does not, apparently, fulfil the conditions prescribed; but the velocity of the shot is so great that a trench is ploughed in the water, which does not close up immediately behind the shot, and we are far from having attained this speed in torpedo boats. We thought it was now generally accepted that the improvement in performance referred to was due to the subsidence of the wave-making element of resistance at a critical speed, which, in vessels of similar form, is proportional to the square root of the length.

A GREAT WELSH WATER SCHEME.

THE London County Council, in proceeding with Mr. Binnie's Welsh water scheme, is threatened with more than a sentimental opposition by the South Wales counties whose watersheds it was proposed to tap for the storage reservoir at Llangorse. When discussing, a few months since, the cry of "Welsh water for the Welsh," then being raised in the Principality, we referred to a proposal, originating with the late Lord Swansea, that the counties concerned should unite in forming a Water Authority to preserve the water sources for home consumption, or at least to safeguard them from outside attack. That proposal now appears to have taken practical form in more ways than one. The Glamorganshire County Council has formulated a plan to combine all the health authorities within its borders, together with portions of the counties of Monmouth, Brecon, Carmarthen, and Cardigan. These would constitute the Water Authority Lord Swansea suggested, and it is in contemplation that the new Board should, in due course, seek powers to secure and conserve the watersheds within its area for the future supply of a population which, it is claimed, is increasing by leaps and bounds year after year. To this end the services were enlisted of Mr. J. A. B. Williams, M. Inst. C.E., the designer of the Breconshire reservoirs of the Cardiff Corporation, and Mr. R. E. Middleton, M. Inst. C.E., and between them these gentlemen have devised a project which in its first stage would cost £1,315,000, and in its completion a sum roughly estimated at ten millions sterling. The first stage is the construction of a storage reservoir near Trecastle, on the north border of Carmarthenshire, and the head waters of the Usk. The reservoir would contain 4,538,000,000 gallons, yielding a daily supply of 12,000,000 gallons, to be distributed to surface reservoirs in different districts as may be arranged. At an additional cost of £300,000 for a second line of pipes, the daily supply could be increased to 23,000,000 gallons.

It may be objected that this is a comparatively small quantity for division, even as a supplementary supply, over the wide area represented by the Water Authority, and for a population which, according to Mr. Williams' forecast, will have increased from 802,000 to 7,782,401 in a hundred years' time. This criticism has been anticipated by the engineers. Their scheme comprises ultimately the reservation of the Irfon and the Towy, and the construction of fifteen reservoirs in those water areas for storage and compensation purposes. Altogether they would annex a gathering ground of 122 square miles—18 square miles on the Irfon, 43 square miles on the Towy, and 61 square miles on the Usk. The estimated yield is 44,000,000 gallons from the Irfon, 20,000,000 gallons from the Towy, and 51,000,000 gallons from the Usk. From these sources it is reckoned that a daily supply of 115,000,000 gallons could be obtained. Even this would not be sufficient, on Mr. Williams' figures, to cope with the growing demands of the population as another century rolls in upon us. On present data he sets down the deficiency in 1995 at 131,674,000 gallons. With the 115,000,000 to be drawn from the three valleys named, there would yet remain a daily deficiency of nearly 17,000,000 gallons a hundred years hence. Of course that would be an argument for an extension of the works still further afield, the available watershed, presumably, being pre-empted meanwhile, and notices issued "Trespassers Beware." The point of immediate interest, however, is that the project of Messrs. Williams and Middleton strikes at a vital point of Mr. Binnie's plan. The Usk is his chief source of supply for the Llangorse reservoir, with its storage capacity of thirty-eight thousand million gallons. The Irfon came next, and the Towy was not an inconsiderable factor in his estimate. By damming the Usk Mr. Binnie calculated on a supply of 182,000,000 gallons per diem, and from the Irfon 135,000,000 gallons. Obviously, therefore, the joint-county scheme in South Wales is of intimate concern to the London County Council and to metropolitan consumers.

SANITARY CONDITIONS AT HONG KONG.

It is understood to be a moot point as to whether the prevalence of bubonic plague at Hong Kong is to be attributed to local sanitary conditions or to its introduction from the adjacent mainland. It is certainly the case that there have been and are many instances of the visitation in Canton and other large Chinese centres, but we believe the authorities of these trace—or pretend to trace—its introduction among them by natives returning from the British island. But whether this last claim be or be not correct, it is certain that the condition of our most Eastern possession has long been known to be favourable to the propagation of this class of disease. As far back as 1889 the drainage of the chief settlement there was a matter of anxious consideration by the local government, and in our issue of May 3rd of that year was discussed the proposals put forward for perfecting, or at least amending, this. As we then stated, the difficulties to be overcome were great and singular. Differences of race among the inhabitants, varying tastes as to locality of residence, and local configuration, all combined to render the problem of efficient drainage one particularly hard to solve. How far the propositions towards that end then made have been carried out we are not aware. But the danger that must attend delay in the adoption of remedial measures was at that time fully recognised, and we have no doubt that to some extent, at least, the drainage of this settlement has, since we last addressed ourselves to the subject, been materially improved. It is, therefore, natural to feel surprise that an outbreak of the kind lately suffered from should, for the first time, we believe, in the history of the Colony, have made its appearance. But medical opinion seems to be divided upon the point as to whether the particular form which this disease has taken can be attributable to defective drainage. Upon the medical aspect of the case we can offer no opinion; but we do know that the Great Plague that devastated London in 1666 was of the same bubonic type as that we are now discussing; and that old-time experience warrants the belief that, even if the outbreak then occurring had not its immediate origin in the then state of London, it was fostered and developed by it. And this would seem to have been the case with the more modern example in Hong Kong. The Governor, Sir William Robinson, on the first appearance of the disease, took most energetic measures to combat it. In our article above referred to we made particular reference to the predilection of the Chinamen for having their houses huddled together in hollows, into which it was almost impossible for the wind to penetrate. We referred to this fact as presenting, perhaps, even greater obstacles to perfect sanitation than did even the drainage difficulties. The Governor and the other local authorities appear from the first to have coincided with us in this opinion, and free use was made of the axe and of even more speedy methods for destruction among these rookeries. That, at all events, the evil had been largely fostered in these was apparent from the results obtained by the adoption of this course. The disease showed immediate abatement, and would probably have disappeared altogether had economic conditions and the provision for housing dispossessed residents admitted of the clearance being made as complete as was desirable. As it is, the disease still lingers in the Colony, and the numbers attacked seem to fluctuate considerably day by day and week by week. We do not ourselves think that the outbreak is to be attributed to inefficient drainage. Although, as we have said, we are ignorant of the extent to which improvement has been effected in this since we discussed the subject in 1889, we have good reason to believe that the then existing state of things has been materially ameliorated. This cause can, therefore, hardly be assigned for the outbreak, and still less for its fluctuating continuance. We believe it has ever been recognised that all the outbreaks of plague in Europe have been introduced from the East. Indeed, we believe it is acknowledged that this form of disease, that of which the bubo is the chief external development, is ever present among Eastern native communities. It needs but some stimulating conditions to present themselves to invite its speedy covering of large continents. That in this case of Hong Kong it has not travelled far beyond the island itself, seems to point to the existence of local conditions specially favourable to its existence. For the reasons we have named, we do not think that this condition can be attributable to defective drainage. The primary cause, there can be little doubt, was the herding together of people whose domestic habits are particularly uncleanly, in quarters to which the wind had little chance of access. To destroy the germs of the disease, and wholly to extirpate it, these quarters of residence must be not merely thinned but almost wholly destroyed. An instance occurs to our memory of an experience illustrating the results that might be expected to attend such an operation. An outbreak of cholera occurred among the Malay soldiers at an Eastern station. The lines in which these men were housed were in successive rows almost athwart the course of the prevailing winds. These rows were relatively so close to each other that they induced draughts, to which the soldiers were exposed at every exit from their heated huts. The cases multiplied with such rapidity that the commandant applied to the engineer in charge of the local public works, the telegraph to headquarters not having at that date been constructed. On his own responsibility that officer utterly demolished every alternate row of the lines, sweeping them utterly away in the course of a single day and night—of course, burning every stick and leaf obtained from them. Within two days of this drastic measure being adopted the disease was checked, and within a week there was an entire cessation of fresh cases being reported.

Some such course as this would seem to be desirable in the case of Hong Kong. It is, we believe, at present a local disease, fostered entirely by local conditions. If it be not so, how is it that with the stream of Chinese ever proceeding between Hong Kong and the Straits Settlements, these last have presented no instances of the plague? We fear that consideration for the island revenue may operate towards making its authorities hesitate in taking steps as thorough and as full as those we suggest. If so, the case must be one in which Imperial help should be given. For so long as the Chinese residents are permitted to live in hollows without ventilation, and on a soil that must be largely composed of the detritus from granitic rocks, so long may we be assured that Hong Kong will remain the centre from which the plague may at any time take its departure to ravage throughout not only the East, but even, possibly, the far distant West. While we here in England may be better guarded than heretofore against its incursion, and may perhaps disregard the possible danger to ourselves, it should never remain open to be said that any spot under British administration should continue a possible plague centre. If the difficulty is, as we apprehend it to be, too serious to be fully met from local revenue, then let it be, as we have suggested, a case for help from Imperial funds.

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THE BISCAY AND MEDITERRANEAN CANAL.

The project of uniting the Bay of Biscay with the Mediterranean by means of a canal capable of accommodating large sea-going vessels has again met with condemnation at the hands of the Commission appointed by the French Government to investigate the matter. For many years the idea has attracted a good deal of attention, not only from the commercial advantages which would arise from a shortened length of voyage between the ports of Northern Europe and the Mediterranean, but also to a large extent from the desire to provide a means of naval communication for the French fleet in time of war, without being compelled to pass under the guns of Gibraltar. In The Engineer of November 9th, 1894, we gave some particulars of the various schemes which had been proposed for the construction of such a canal, and then expressed the opinion that it seemed to be a waste of time and money to make further investigation into their feasibility. The engineering features present no special difficulty; there is no doubt about the possibility of making such a canal, but it would be at such a cost as to make the investment distinctly unprofitable. The promoters of the present scheme have had the benefit of the fullest publicity and criticism. Premiums amounting to £4000 were offered for competitive designs, and an exhibition of the various plans was held in Paris in June, 1894. Various ideas of a more or less original nature, including ship railways and rolling docks propelled by electricity, had their respective advocates. The several schemes finally selected indicated a canal of a length varying from 220 to 320 miles, of a size sufficiently large to admit of navigation by the largest armour-plated warships, and at a cost estimated at £40,000,000 to £60,000,000. After repeated pressure the French Government, towards the end of last year, consented to appoint a Commission of engineering and commercial experts to inquire into the practicability of the idea, and their report has just been issued. From the financial point of view the Commissioners cannot see that there is any probability of a large enough traffic being attracted to the new canal to make it a profitable investment. Then the shortening of the distance between the ports of Northern Europe and the Mediterranean would be largely discounted by the slow speed necessitated in navigating a canal where the waterway would be restricted and the locks numerous, so much so that little time would be gained by the new route. Objection is also raised to the danger of floods along certain sections of the canal which it was proposed to construct in raised embankments. The Commissioners unanimously condemn the project as one which it is inadvisable to attempt to carry out. After the thorough investigation which the various schemes of the last twenty years have received, it is probable that this is the last that will be heard of the idea for some time to come.

SILK FROM WOOD.

We have recently had an opportunity of inspecting a number of specimens of artificial silken materials which have been produced by a novel process from wood pulp. The process now extensively employed in a works erected at Besançon, in France, is briefly as follows:—Wood in the form of cardboard is treated with a solution of nitric and sulphuric acids until it forms a pulpy mass, after which the acids are expelled by hydraulic pressure, and the mass is then thoroughly washed in water vats. It is next partially dried before being treated for some hours in a revolving cylinder containing alcohol and ether. After this the mass is passed through a filter, which it leaves resembling thick gum, and is run into cylinders, whence it is forced by pneumatic pressure into pipes into the spinning department. The spinning machinery is served with a common pipe, from which the gummy material is forced through small taps arranged close together, each tap having a glass tube or nozzle of exceedingly minute bore. We are informed that the combined diameters of ten of these tubes are only equal to the thickness of a human hair. The effect of the pneumatic pressure is to force the pulp through the nozzles in an almost invisible filament, and according to the thickness of thread required so is the number of these filaments regulated. By the pressure of the fingers they are made to adhere in the form of a thread, and are passed through guides on to bobbins. Before the silk thus produced can be employed in spinning, it has to be denitrified to render it uninflammable—an operation necessary owing to the chemical treatment which it underwent in the early stages of its production. It has also to be placed in the form of hanks on two revolving rollers, to stretch and roll it, giving to the material a very high gloss. Although the artificial silk is said to take dye much more readily than natural silk, it is not quite so strong, having only about 80 per cent. of the tenacity of the latter. We are informed that a company is in course of formation with a view;) work this process in this country, and that a mill is tob) erected in the neighbourhood of Manchester at a cost) £30,000, for the manufacture of silk yarn from wood pulp for sale to weavers, who will, it is expected, work it up by means of their existing machinery. As the artificial material is said to cost only about one-fourth that of the natural silk, the experiment will be watched with some interest.

COMPLICATIONS IN THE COAL TRADE.

In all probability no such important complications have occurred in the history of the English coal trade as now confront coalowners and those who hold the responsible position of advising the men. On the one hand a gigantic amalgamation in the Durham coal trade has sprung into existence by which one firm will become the sole owners of twenty-seven of the most important collieries in the county capable of producing four and a-half million tons of coal per annum, whilst the Conciliation Board, which has regulated wages in the same county, is likely to be dissolved early in August. As is well known, a third and probably a more serious complication than either of the two mentioned, awaits solution by the combination or otherwise of the Conciliation Board connected with the federated area. The position of the English coal trade, it will be seen, is crucial, inasmuch as the crisis which affects the Durham and Northumberland coalfields may be said to be represented by the Miners' National Union, whilst the dead-lock which exists in respect of the Conciliation Board arrangement, which of late years has governed the federated area, is represented by the Miners' Federation of Great Britain. What course will be adopted time only will reveal. The three important complications referred to as occurring almost at one and the same time are sorely perplexing to all interested in the coal trade. The complications are all the more harassing, on account of their occurrence at one of the most critical periods of the year, when a number of important coal contracts are in the market, and railway companies and other large consumers of coal are asking for renewals which will insure them supplies of locomotive and other fuel from the 1st of July next. In addition to tendering, as it were, blindfolded, the coalowners have to face a large and excessive output of coal at a time when prices in the open market are favourable to purchasers. As an example of the critical position of affairs, it may be stated that the Midland Railway Company, which is a large consumer of locomotive and other coal, has had its tenders on hand more than a week, and, doubtless having an eye to the situation, is only asking for supplies for three, six, and nine months. A meeting of South Yorkshire coalowners was held on Tuesday to consider the situation. As is usually the case, the price at which tenders were to be sent in has not been stated, but sufficient has leaked out to show that a price in advance of the North-Eastern current contract, viz., 7s. per ton of 20 cwt., has been asked, but it does not follow that it will be sustained. Of late the best South Yorkshire hards have been procurable in the open market at rates lower than those contracted for, but in face of the great uncertainty which exists it is held that so valuable a quality of coal as is demanded for export and railway purposes ought not to be sold at reduced rates. In the face, however, of the fact that a large number of new collieries on an extensive scale are being opened out and developed in the great Midland coalfield, extending from Leeds to Nottingham, it is difficult to see how the law of supply and demand can be set aside either by combination or the most skilful arrangements for putting an artificial value on coal.

EXPLOSION ON A FRENCH IRONCLAD.

An explosion is reported as having occurred on board the French ironclad Amiral Duperre last week. As far as can be made out from the telegram, a small cartridge, 13in. long, exploded in a "magazine containing," so says the telegram, "3000 kilo*metres* of gunpowder and melinite shells." None of the other cartridges were exploded. If this account is substantiated, it is a strong argument in favour of those who assert that no danger of wholesale explosion is to be anticipated from a single shell being exploded from any cause in a turret containing a store of loaded ammunition. This point has been one over which much contention has raged, as not a few persons in authority consider it exceedingly dangerous to have charged shell stored in any place which may be entered by an enemy's shot. Danger from the fuses is almost out of the question, as they should not come into action until struck twice, the first to release the hammer, the second blow to cause it to strike the detonating powder. If the violence of explosion, which was sufficient to blow the door of a magazine "30ft." was not able to cause the ignition of a number of cartridges in close proximity to the one fired, the danger of a disastrous explosion from a similar cause in action seems considerably minimised.

LITERATURE.

The Electrical Transmission of Energy. By Arthur Vaughan Abbott, C.E. New York: D. Van Nostrand Co. London: Sampson Low, Marston, and Co., Ltd. 1895.

The author is an American electrician of repute, and addresses his preface from Chicago. He states that he has been personally indebted to many authors for his knowledge of the subjects of which the book treats, and that having passed it through the sieve of practical experience, he now writes from his own standpoint. It is a volume of considerable size, containing nearly 600 pages, and provided with a number of folded sheets of statistical diagrams at the end.

After referring to the elements of the subject, he deals with the properties of wire, and gives useful comparative tables of wire gauges, and a short account of the manufacture of wire. Referring to the abrasion caused by the branches of trees swaying against insulated overhead wires, he states that a coating of bamboo has been found an efficient preventive. Ordinary fishing poles are sawn longitudinally, the knots are cut out with a gouge, and the bamboo is then lashed to the wire. After describing the methods of testing insulation resistance, he says, "While 100 megohms per mile is a very common requirement, it is impossible . . . to give a definite standard." A comparison of this with the 2500 megohms per mile now demanded by the St. Pancras Vestry for house supply at 220 volts serves to explain why electric installation is carried out more cheaply in the States than here. Again, he says, "In this country it is not uncommon to use wire in a single rod up to ½in. diameter." Although a number of tables of insulated wires are given, there is no mention of the insulation resistance of the different makes, and the author states that they are sold solely by weight. This strikes an Englishman as a rather strange system. Most of the wires seem to be merely braided, without any coat of india-rubber whatever, and the plan most usually adopted is to use a number of single insulated wires in parallel to avoid the extra cost of stranded cable.

Dealing with aërial conductors, the author gives both American and British specifications for wire, including that of the G.P.O. A useful table of sags and tensions to be observed in erecting wires is given, and the factor of safety is assumed at from four to five. Such circuits are provided with 35 to 42 poles per mile in the country, 40 to 50 poles in cities, and 45 to 55 poles in electric railway work. No process of pole preservation is employed, but he considers the process known as vulcanising good, that is, baking the poles in a closed vessel at 500 deg. Fah., thus coagulating the albumen. The best method of staying is with the Y guy, one guy branching into two parts connected to the top of the pole, and also to a point below the lowest cross arm. The author gives much valuable information on the subject of anchor poles and the strength of guy rods. In the States glass insulators are almost universally used, as their transparency prevents the formation of cocoons under the bells. A test upon a telegraph line from New York to Boston gave an insulation resistance of 6000 megohms per mile. The McIntire splice appears to be very largely used; this consists of two copper tubes drawn side by side out of the same piece of copper; the ends of the opposite wires are entered, and the whole is twisted, making a perfect joint without soldering, and giving 66 per cent. of the strength of the solid wire. As a device to obviate humming, the author's experience leads him to recommend wrapping the line wire with india-rubber, and then with lead, and fixing the wire to the insulator with a second wire treated in the same manner.

Dealing with electric railways, the author points out that the leakage of return current from the rails is a great source of annoyance; owing to the derangement of telegraphs and telephones and corrosion of pipes, the rails are now being aided by copper returns, and we believe that complete metallic circuits will be used in the near future. The author considers that no dependence should be placed on the earth circuit, and that the losses due to the circuit should not exceed 3 to 5 per cent.

A good deal of space is devoted to the subject of rail-bonding; but, in our opinion, the electric welding process, or the process by which the ends of the rails are cast solidly together, will be found preferable, and the latter process is the cheaper of the two. The author appears to favour the use of bonds, electrically welded on; but these, we know, have been found to snap in the winter and cause trouble. Iron poles are largely used for railway lines, but their use is attended with some danger owing to leaky span wires. Treating of underground circuits, he refers to the Valentine wooden conduit as being the simplest and cheapest of all; but it is no use for lead-covered cables, owing to the destructive action of the acids produced by the decay of the wood. He favours the use of light iron pipes, cement-lined, and laid in concrete, and then connected to manholes. The separate duct system of terra-cotta pipes, used largely in the States, appears to us to have very great advantages for a drawing-in system. The Brooks oil insulator system has, it is stated, not been found satisfactory. He considers that in the Callender solid system it is neither necessary to put any insulation on the copper, nor to use the cast iron boxes. The Johnson system he considers good, but far too expensive.

Chapter V. deals with electrical instruments for testing; the Boyer speed recorder is recommended for car tests, and useful tables of the specific resistance of insulating materials are given. Dealing with electric heating he says, "Car heaters operated by coal cost from 15·00 dols. to 25·00 dols., with an installation expense of 1·50 dols. With fuel at 4·50 dols. per ton, and labour 1·50 dols. per day, the cost of operating coal car heaters is about 16 cents per day of twenty-four hours. Per contra, electric heaters cost from 35·00 dols. to 40·00 dols., and the expense for current amounts to from 30 to 40 cents per day in moderate weather, and from 60 to 80 cents per day in the coldest weather." These figures are based on fuel at 3·00 dols. per ton at the generating station.

In Chapter IX., speaking of the three-wire system of distribution, the author says, "So far attempts to make incandescent lamps of much more than 200 ohms resistance have not been commercially successful; and for the standard 16-candle-power lamp, an available difference of pressure at the lamp terminals of about 100 volts is all that can be rendered useful." This statement hardly agrees with British practice at Bradford and St. Pancras. The subject of the design and proper proportion of feeders and distribution circuits is fully dealt with, and the usual practice in the States is well described.

At the end of the book he says of gas engines:—"If the gas costs 1·00 dol. per 1000 cubic feet, the cost of producing electrical energy may be estimated at 7 to 10 cents per kilowatt-hour for small engines under 10-horse power, and from 3 to 5 cents for engines of 50-horse power and over." We can heartily recommend the work as an interesting review of United States practice. The author is evidently a thoroughly practical man, and though some of the methods described may not commend themselves to British engineers for work in this country, it is always valuable to see how difficulties are surmounted elsewhere.

An Elementary Treatise on the Calculus for Engineering Students. By JOHN GRAHAM, B.A., B.E., Demonstrator and Instructor in Mathematics in the City and Guilds of London Technical College, Finsbury. London: E. and F. N. Spon. 1896.

THIS book is very well adapted for the service for which it is designed, as it provides a clear and interesting introduction of the subject, which an engineer now-a-days, especially of Electricity, cannot afford to neglect.

The author is indebted to Professor Perry for many good practical illustrations of the use of the calculus as required in familiar problems of mechanical and electrical engineering, such as the determination of the strongest and of the stiffest beam which can be cut out of a cylindrical log; the proper design of a cable of minimum cost when the power wasted is balanced by the interest, prime cost, depreciation, and repairs; the best way of arranging the cells of a battery, and so forth. The author has done well to introduce the integral calculus at an early stage, as it is now considered in authoritative circles that the notion of integration is more familiar and easier grasped than that of differentiation. We cannot perceive the rate of growth of a tree, for instance, except by noticing its integrated growth at the end of ten or twenty years. Again, any continuous function can be integrated, but it is not every function which can be differentiated. Thus, if we take very small steps alternately parallel to the two sides of a triangle, in proceeding along the third side we make a figure indistinguishable in shape and area from the rectilineal triangle; but in describing the third side we have made it equal in length to the other two sides, contrary to the theorem of Euclid. We have now a path or line which cannot be differentiated, as the analytical thumb, passed along this apparently straight edge, feels the rugosities; just as the thumb of a skilled mechanic will detect the difference between a surface according as it has been planed or milled. In an analogous manner, the surface found on a body turned in a lathe by the slide rest will, analytically speaking, be differentiable in the circumferential, but not in the longitudinal direction. Chapter XX. is a useful little chapter on Fourier's Series, which bears the marks of Professor Perry's inspiration. The author does well in such an elementary treatise to steer clear of the analytical refinements concerning uniform convergence in the neighbourhood of a discontinuity. Following Professor Perry, he trusts more to graphical demonstrations, and it is a pity that this most convincing method is so completely ignored in the advanced treatment by mathematicians. The ordinary part of Differential Equations, as much as is required for most applications, given here in a condensed form, enables the author to wind up with a complete solution of a number of useful mechanical and electrical problems.

The Number Concept: its Origin and Development. By LEVI LEONARD CONANT, Ph.D. New York: Macmillan and Co. 1896. 8s. 6d.

THIS book is addressed to the psychologist and grammarian, and not to the arithmetician. The author traces the gradual evolution of language as required for expressing higher and higher numbers, and he has made a very valuable collection of the numerals in use among savage tribes, pointing out whereabouts the word "innumerable" first occurs. He gives the familiar story of the crow who could count up to five, after which came the innumerable, and thence the fatal *dénouement* to the crow. But even with human beings the difficulty of keeping count can be easily increased, as we notice with the balls which a juggler keeps moving in the air and with other familiar tricks; and it is not very long ago that a great statesman deplored in a speech the "innumerable votes of censure of the other party." In reality, too, even the most complex of modern languages fails in numeration when it is required to record the large number expressing astronomical results, and the new index method must be resorted to.

The author traces very clearly the origin of our denary numeration in the primitive mode of counting on the fingers; if man had been born with twelve fingers and toes, instead of ten, we should have had the duodecimal scale, which possesses great advantages in the eyes of its advocates, but is not likely at this stage to prevail.

SHORT NOTICES.

Sheffield Smoke Abatement Association. Report by Mr. R. Heber Radford, as to the Stoking Competition, held March, 1896. Sheffield: Sir W. E. Leng and Co. 1896.—This pamphlet gives the results of experiments made in connection with the offer of competitive prizes to engine tenters and firemen. The experiments took place at Messrs. Davy Brothers' Works, Sheffield, and extended over five days in March last. Five competitors entered, and the experiments showed that Lancashire boilers can be fired by hand with clean small coal, so that no dense smoke need ever issue, and without any considerable amount of smoke at any time.

The Hotels of Switzerland: A Tourists' Guide. The Basle Association of Swiss Hotel Proprietors and Managers. Price 50 centimes.—This book contains a list of public inquiry offices in Switzerland, a map, about twenty pages of remarks on questions daily recurring during travel, and a list of about 145 pages of the hotels, giving brief particulars of and prices at all of them, and an illustration from photographs of each. The book is published at the Central Office of the Association of Swiss Hotel Proprietors at Basle.

Bicycling for Ladies, by Miss F. J. Erskine. London: Iliffe and Son, Price 1s.—This is a book which may be recommended as written by a rider for the information of riders and learners. The instructions are so written that they may be understood as read, and any reader will be interested in them, whatever preference may be felt as to machine or attachments. It is a book that is not written in the interests of a cycle but of cycling.

Notes on Motor Carriages, with Hints for Purchasers and Users, by John Henry Knight, with illustrations. London: Hazell, Watson and Viney, Limited, 1896. Price 1s.—The very general interest now displayed in horseless carriages will cause many people to look for some enlightenment on the new vehicle. These notes in Mr. Knight's little book will satisfy the requirements of many readers and afford an introduction to a more extensive study of the subject. The book contains eighty-four pages of small size, in which a glance is given of the history, followed by a chapter explaining the working, of an oil engine, some chapters on modern motor carriages, motor carriage contests and hints to purchasers.

Duncan's Manual of British, Foreign, and Colonial Tramway, Omnibus and Electric Railway Companies, containing abstracts of accounts, Directory of Directors, &c., &c., 1896. Nineteenth edition. London: T. J. Whiting and Sons, Ld., price 3s. 6d.—The nineteenth edition of a properly revised annual calls for few remarks, but it may be noted that the slow but apparently certain growth of public interest in mechanically propelled tramcars and modern improvements making mechanical methods a commercial success, will increase the numbers of people who will be glad to turn to this manual. The time has come when on many lines in this country, which with horse haulage cannot possibly pay, mechanical propulsion, which is increasingly successful on the Continent and in America, must be adopted, and the facts and figures given n this manual are especially valuable just now in this connection.

BOOKS RECEIVED.

Computation Rules and Logarithms: With Tables of Other Useful Functions. By Silas W. Holman. London: Macmillan and Co. 1896. Price 5s. net.

Graphical Calculus. By Arthur H. Barker, B.A., B.Sc. With an introduction by John Goodman, A.M.I.C.E. London: Longmans, Green, and Co. 1896. Price 4s. 6d.

Water Supply. Considered Principally from a Sanitary Standpoint. By William P. Mason. First Edition, First Thousand. New York: John Wiley and Sons. London: Chapman and Hall, Ld. 1896. Price 21s. net.

Summer Tours in Scotland: Glasgow to the Highlands. The Royal Route, with Time Tables and List of Fares, by David MacBrayne's Royal Mail Steamers, Columba, Iona. &c. Official Guide. New Edition. Glasgow: David MacBrayne, 119, Hope-street. Price 6d.

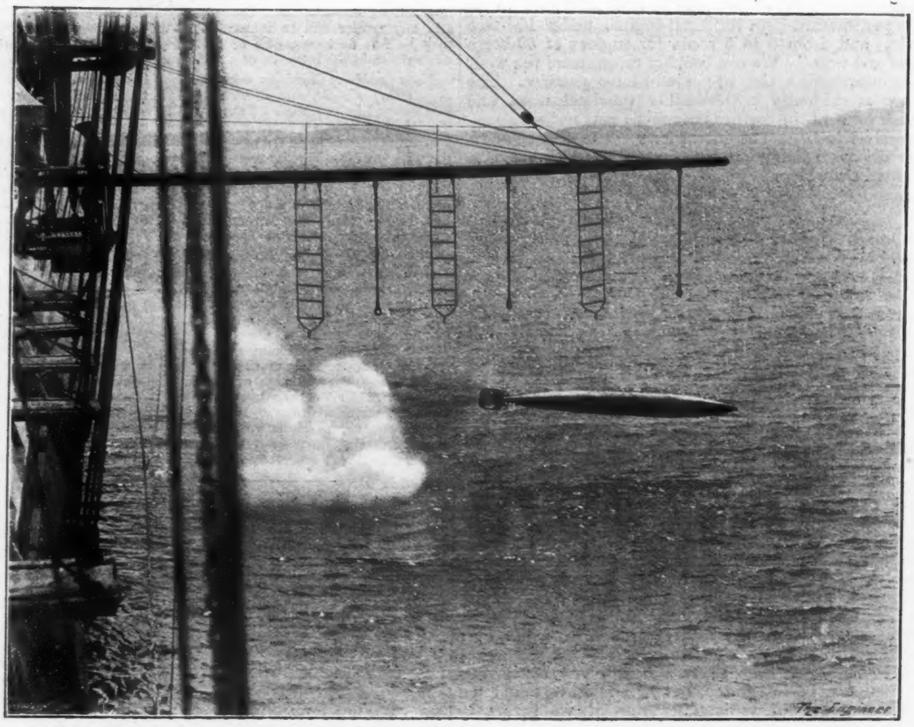
Modern Opera Houses and Theatres. Examples Selected from Playhouses Recently Erected in Europe. With Descriptive Text, a Treatise on Theatre Planning and Construction, and Supplements on Stage Machinery, Theatre Fires, and Protective Legislation. By Edwin O. Sachs, Architect, and Ernest A. E. Woodrow, A.R.I.B.A. Volume I. With 100 plates and 93 illustrations in the text. London: B. T. Batsford, 1896.

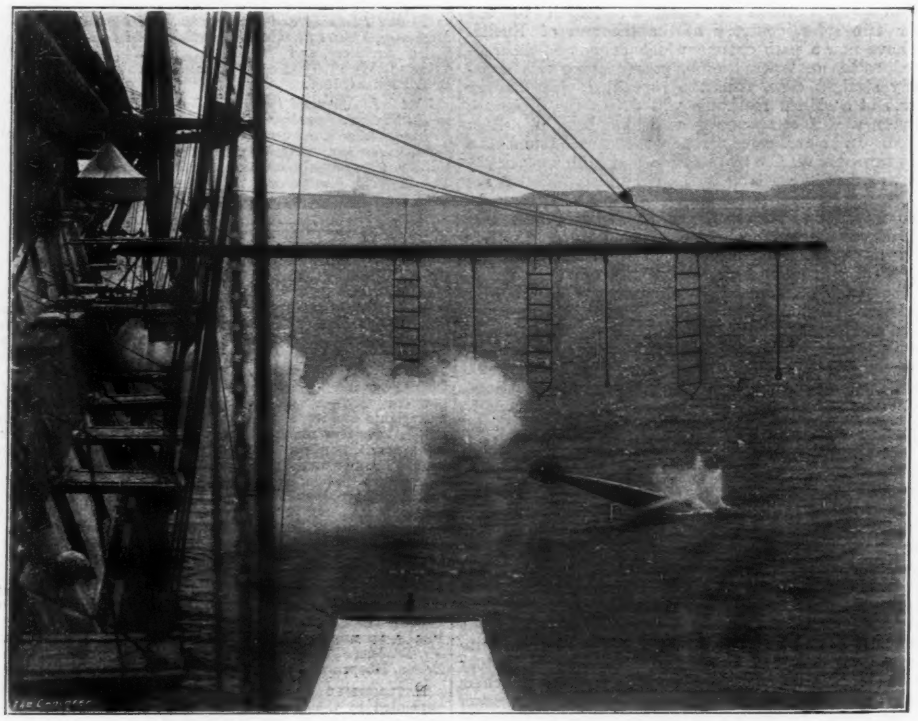
Electric Lighting and Power Distribution. An elementary manual on Electrical Engineering, suitable for students preparing for the preliminary and ordinary grade examinations of the City and Guilds of London Institute. By W. Perren Maycock, M.I.E.E. Third Edition. Thoroughly revised and enlarged. In two volumes. Vol. I. 231 illustrations, index, and ruled pages for notes. London: Whittaker and Co. 1896. Price 6s.

TRADE AND BUSINESS ANNOUNCEMENTS.—The business of Messrs. Conrad Knap and Co., of 11, Queen Victoria-street, London, manufacturers of the "Root" water-tube steam boilers, has been formed into a private limited liability company, no shares being offered to the public. The business will be carried on at the same address, under the style of Conrad Knap and Co., as before, with the addition that Messrs. Penney and Co., Lincoln, will take an active interest in it, being represented on the directorate by Mr. Charles Cousins. Mr. Conrad Knap is the managing director of the new company.—Messrs. Alexander Mather and Son, engineers, millwrights and ironfounders, of Orwell Works, Dalry-road, Edinburgh, have now removed from Fountainbridge, where they have so long carried on business, to more commodious premises at Dalry-road. The new works are situated within five minutes' walk from Haymarket Station, North British Railway, off Dalry-road. The buildings have been specially designed and fitted to suit the requirements of the various branches of their manufactures, and a siding on the Caledonian Railway runs direct into the works. To facilitate the carrying out of all contracts entered into, considerable additions have been made to tools and machinery.—The business of the late Mr. Bradshaw Brown, recently carried on by him at Billiter-square-buildings, E.C., and Millwall, E., will in future be conducted by Mr. Harry Hooper, the late Mr. Bradshaw Brown's senior partner in the Millwall business, and Mr. Thomas W. Price, F.S.I.—for many years manager and confidential clerk to the late Mr. Bradshaw Brown—and the name of the firm will be Bradshaw Brown, Hooper, and Price.

HAULBOWLINE DOCKYARD.—In July last a committee was appointed by the Admiralty to inquire into and report upon the appliances of her Majesty's dockyard at Haulbowline, Queenstown, and to consider whether anything still required to be done to complete the fitness of the dock for carrying out the purposes for which it was constructed—namely, as an emergency dock in time of war, and to execute ordinary repairs to ships on the station in time of peace. The report of the committee has now been issued as a parliamentary paper. The subjects inquired into were embraced under the following heads:—Present appliances; *matériel*; dock; basin; towing power; offices, workshops, &c.; machines; general transport; lighting; water; cambers, bridges, &c.; and fire service. The committee strongly recommend the carrying out of various works, the approximate cost of which they estimate at £50,000, and they also think there should be a permanent staff of about 112 men organised, at a cost of about £8900 a year, though it is thought that the annual expenditure would probably be about £10,000. As regards superintendence, the committee said that the yard is somewhat peculiar in character, and in their opinion the work to be done is of such a character that it cannot be entrusted to the care of any officer of lower rank than a constructor. With him should be associated an inspector of shipwrights, and an officer of the rank of a second assistant engineer, or a foreman of fitters. It is, too, considered that the system of police should be assimilated with that of the other dockyards. The report adds:—"In conclusion, the committee wish to state that, although attention has been directed to other questions of an important character, the recommendations have been kept strictly within the terms of the reference, and the proposals contained herein—requiring an expenditure of only £50,000—are absolutely necessary, and have been arrived at after very careful consideration. By the expenditure of this moderate sum, the place, on which upwards of three-quarters of a million have been already expended, with no appreciable result, will be converted into a compact dockyard, from which a profitable return can be expected in time of peace, and capable of ready expansion in time of war, so as to be of considerable value to the nation. And, further, should it considered advisable to increase, at a future period, the scope of the work in this dockyard, that there is room available for the necessary extension, and that such an increase would result in still greater economy."

TORPEDOES IN FLIGHT





MODIFICATIONS IN THE DESIGN OF DESTROYERS.

THE great speed with which our flotilla of torpedo boat destroyers has been got together will account in some measure for the number of breakdowns which have taken place, and for the considerable modifications in design which are observable in the new vessels now being brought forward. Many of the difficulties which have been encountered are due, we cannot but think, to the stringency of the Admiralty conditions in regard to weight of propelling machinery and fixed displacement.

One of the most important and valuable modifications which have been effected is the abolition of bow torpedo tubes. The torpedo armament of these vessels is now confined to two torpedo guns of twin-tube character, which are worked from the deck. It was altogether a mistake giving the destroyers a bow tube. The effect of this singularly illogical contrivance, which we should be glad to see removed from our war vessels altogether, was to create in front of the earlier boats of the class under consideration, an enormous bow wave when the speed exceeded 22 or 23 knots, and, in a heavy sea with head wind, the violent blows which the bows received from the waves not unfrequently forced the door open, allowing water to enter and fill the fore peak. But there was another and more cogent reason for the abandonment of the bow tubes. It was feared that there was a chance of the torpedo being overrun during an action if the destroyer was steaming fast and discharged one of these missiles from her bow tube. In engaging an enemy the vessel would presumably be kept running at full speed, but as the extreme speed of an 18in. torpedo is only somewhat in excess of 28 knots, there would be every probability of its being overtaken by the boat, for the following reason. The torpedo does not start upon its run in a horizontal straight line, but in an undulating line, and the waves of this line gradually straighten out as the torpedo proceeds on its course. No matter how horizontally the torpedo is launched, it deflects at an angle when it touches the water, owing to its inclination to turn a summersault upon its head as the latter enters the denser medium. This sets up the wave action. The accompanying engravings, which are taken from two striking photographs published by Mr. West, of Southsea, show the movement very clearly. Though the torpedo has been launched almost horizontally, as seen in our first picture, the second shows it entering the water at an obtuse angle to its original course. In the engraving the vessel is seen to be at rest. But it is needless to say that the wave action would be greatly enhanced in the case of a torpedo leaving the bow tube of a vessel steaming at 27 or 28 knots. In such a case the tendency of the tail end of the torpedo to turn over, so soon as the head entered the water, or denser medium, would be so great that the undulations of the torpedo, at starting under water, would seriously affect its speed. The danger of over-riding would therefore be imminent. This is not a theoretic danger. Quite recently a large war vessel of high speed, after discharging a torpedo from her bow tube, overran it, struck it, and the air chamber exploded beneath it with great violence. The war vessel's skin was too stout to be affected by the explosion, but the incident sufficiently illustrates the importance of the argument. Had the torpedo been a charged one, the war vessel would have been sunk, and in the case of a "destroyer," the accident might possibly have been fatal, whether the torpedo was charged or not.

The "sitting down" of the earlier torpedo boat destroyers in the water, when running at high speed, has been modified to a great extent by hollowing out the run beneath the counter until it presents a completely flat surface to the water it is gliding over. This is a perfect remedy in a smooth sea, or even when it is blowing a little and the wind is on the beam. But when a severe head gale is encountered, and the little craft is pitching and scending, the greatest care has to be exercised in so heading the vessel as to prevent her counter flogging the sea when she comes down aft. There is, in fact, considerable danger of her frame being injured by the blows which she receives below her stern. This is a point only fully realised by naval officers who have had experience of these boats during a gale in a sea-way, and not one of which shipbuilders are likely to know much. But it is an important one, and its recognition is imperative.

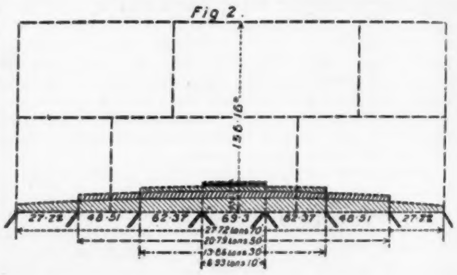
TIMBER BRIDGE CONSTRUCTION IN NEW SOUTH WALES.*

THE necessity for the economical designing of timber bridges in the Colony of New South Wales may be gauged from the fact, that in the last ten years some 680 timber structures have been erected at a cost of £634,000, so that any economy in a type design means a very large saving in the annual expenditure of the Colony. Formerly the wood lattice and vertical tie bars or suspenders was the type used for 65ft. to 100ft. spans. The defects in this design may be briefly summarised—weakness in suspension rods, no means of taking up slackness in braces, caused by shrinkage of timbers, and tendency of top chord to incline inwards owing to want of lateral stiffness. Although this type of truss has for many years carried the traffic without accident, yet in view of the increase in settlement and the greater risk of the structures being subjected to heavier loads, it was thought desirable in 1886 to adopt an improved design for 65ft., 75ft., and 90ft. spans.

These structures were designed for a distributed live load of 84 lb. per square foot of roadway and a traction engine weighing 16 tons, on a 10ft. 4in. wheel base, having 9½ tons on the leading wheels. The improvements in these trusses are the increased sectional area of suspension rods, the providing of means of taking up slackness in braces, increased lateral stiffness imparted to truss by splaying principals, the introduction of iron in lieu of timber side braces, the more general use of sawn timber free from heart, and the more effective splicing of chord.

In 1893, to replace the 1886 type of truss bridges, Mr. Hickson, M.I.C.E., Engineer-in-Chief for Public Works for New South Wales, approved of the author's designs for new standard type of truss bridges for 70ft. and 90ft. spans. The 90ft. span is designed for a traction engine of 16 tons and a distributed live load of 18·8 cwt. per foot run, or 7½ cwt. per lineal foot more than for the 90ft. truss bridge previously in use. The truss is divided into nine panels of 10ft., with a depth of 13ft. measured between centres of triangulations, and carries a 15ft. carriageway and two 5ft. footways. The timber generally employed is tallow wood for the planking and ironbark for the stringers, floor beams and trusses, the timber in trusses being cut free of heart; but in many districts the local timber, with a somewhat shorter life could be used for the planking and stringers.

Fig 2.



The flat decks in the old types of bridges resulted in water lying in pools on the surface of the planks, more especially in the centre of the roadway, where the wear is greatest; 3in. scupper pipes along kerb line, even if not choked up, are therefore of little service. To provide against this a camber of 1½in. in cross section of deck is provided in the new type of bridge, permitting of the quick escape of water through the large gratings at ends of spans. Unlike previous designs, 4in. transverse planking spiked to longitudinal stringers has been adopted, thus permitting of shorter lengths being obtained at a cheaper rate and of their being replaced with less trouble than diagonal planking. Longitudinal stringers varying from 10¾in. by 5in. to 9in. by 6in.—to give camber in deck—pitched 3ft. apart, are bolted to the floor beams, in lieu of the intermediate floor beams used in all previous designs, effecting a saving in cost, and permitting of the concentrating of the loads at the apices, thereby relieving the bottom chords of secondary stress.

In all the old types of trusses the suspension rods passed through the floor beams, and as the braces were also butted against the floor beams, the renewal of these timbers was rendered practically out of the question. In the latter design on another page, the floor beam, 15in. by 12in. spaced 10ft. apart, are placed between the suspension rods, admitting of easy renewal, and at the same time saving the expense of boring large holes through floor beams for the passage of suspension rods. With a view to renewals, the horizontal thrust from the braces is taken up by means of castings, having lugs 1½in. deep let into the chords, and, where two lugs are necessary, it will be noticed that the deeper lug is at the back of the casting, so as distribute the thrust over a larger area and reduce the risk of failure by shearing between the lugs.

The advantage in using castings in lieu of a number of timbers bolted together to form butting blocks for the braces, is the doing away with to a great extent of one of the most troublesome questions in connection with timber bridge work, viz., the lodgment of water. No matter how carefully the timbers may be bolted together and painted, water will, after a short time, find its way between the surfaces

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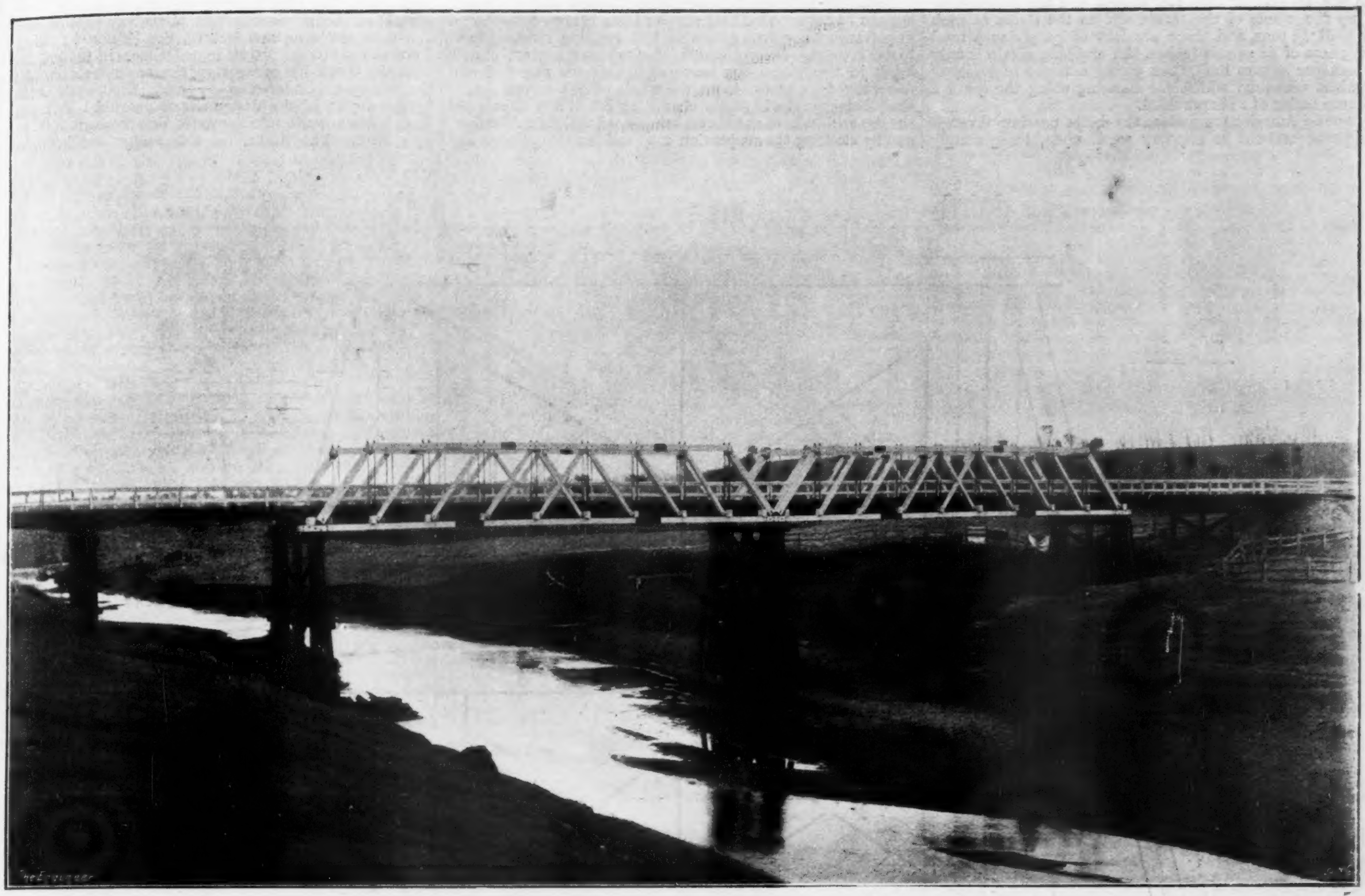
* Paper read before the Engineering Section of the Royal Society of New South Wales, September 18th, 1895, by Percy Allan, Assoc M. Inst. C.E.

TIMBER BRIDGE OVER GLENNIES CREEK, NEW SOUTH WALES

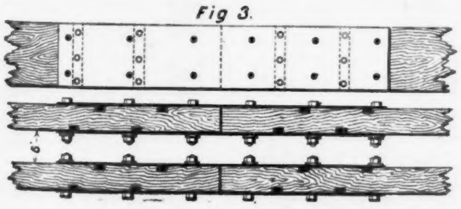
MR. P. ALLEN, ASSOC. M. INST. C.E., ENGINEER



with its accompanying ill effects; again, in the endeavour to get a close joint along the exposed surface, the butting surfaces will oftentimes be made slightly concave; in such cases when the water does penetrate—there being no escape—the evil will be intensified. The batter braces, which consist of two 14in. by 6½in. timbers bowed and stiffened with hardwood distance pieces, have been substituted for principals; thus reducing the horizontal thrust to such an extent as to permit of the introduction of castings in lieu of the large timber butting blocks, with the heavy bolts, previously necessary.

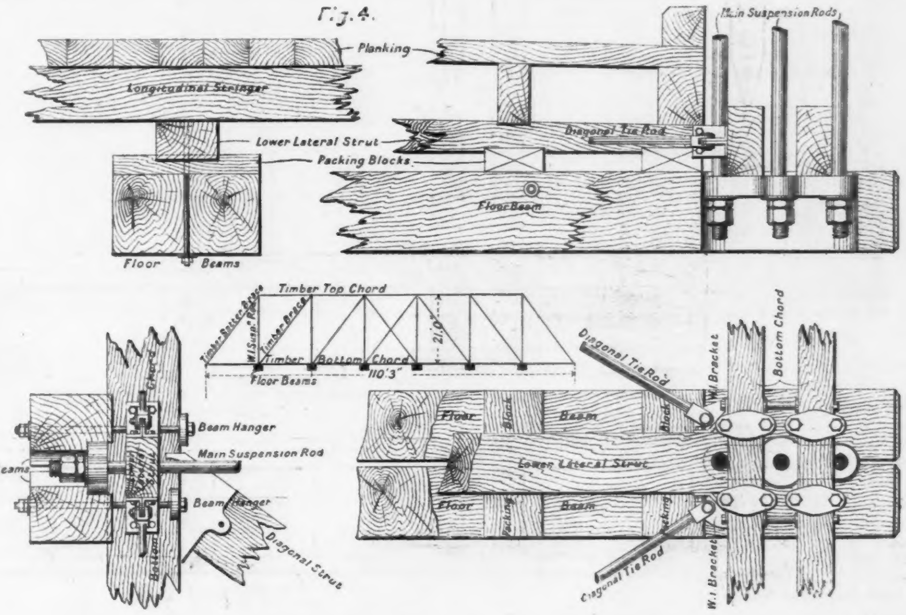
In most of the American Howe trusses counterbraces are introduced, with a view of stiffening laterally the main braces, however the braces in the truss under consideration are comparatively short, and as columns require no lateral stiffening, counters in the end bays are therefore not provided. As all the braces in the truss are at the same angle, any shrinkage in the timbers can be taken up by means of the suspension rods; the iron wedges in the 1886 design are, therefore, not arranged for in this later type of truss. The main braces are formed each of two timbers 8in. by 4½in., bowed to prevent warping and twisting, and connected together with bolts and hardwood distance pieces, all the timbers being connected to the cast iron shoes at the top and bottom with ⅞in. bolts. Formerly it was the practice to have the top chord in one piece 16in. by 14in. by 42ft. long, which, having to be bored for the suspension rods, rendered renewal very costly, if not impracticable. As one of the objects in designing a new type of truss was to permit of renewals, a chord, consisting of two timbers 14in. by 6½in. bowed and stiffened with hardwood distance pieces, was adopted, thus securing better timber and giving greater stiffness as a column. The side braces adopted in previous trusses being a source of inconvenience when footways had to be provided, the author decided to design this chord as a column with a varying load, unsupported in a lateral direction; none of the text books, however, consulted by the author treated of such a case. The stress in the top chord of a 90ft. span ranges from 69·3 tons in the centre to 27·72 tons in the end bay.

Fig 3.



As the maximum stress extends only over a length of 10ft. of the chord, it would be obviously incorrect to take this stress on a column the total length of top chord, nor could it be assumed that this maximum stress was acting only on a column 10ft. long. The author, therefore, has dealt with the case in what he submits is a practical way of looking at the question. Starting with the end bay there is a stress of 27·72 tons, which extends for the whole length of the chord—70ft. Taking the least diameter, the ratio of length to least diameter is 48 to 1, and the ultimate buckling strength of a timber column of this proportion being 2·36 tons per square inch, the area required on the point of buckling would be 11·74in., whilst at the ends of the column the area required, when at the point of failure by direct crushing, would be 5·87in. Setting up these ordinates and plotting in as a parabola, the area shown on diagram—Fig. 2, page 524—is obtained. In the second bay the stress is 48·51 tons, extending for a length of 50ft., but as part of this stress, 27·72 tons, has already been provided for, it leaves only 20·79 tons to be dealt with. Taking the ratio of length to diameter, this gives a column of the proportion of 36 to 1, requiring an area of 6·77 square inches when the column is on the point of buckling at the centre, and an area of 4·4 square inches when on the point of failing by direct crushing at the ends, the required additional area being shown on the diagram, page 524, Fig. 2. In the third bay there is a stress of 62·37 tons extending over a distance of 30ft.; 48·51 tons of this stress has already been dealt with, leaving only 13·86 tons to be provided for. Proceeding as before, the area shown in centre is arrived at; in the middle bay the stress is 69·3 tons extending over 10ft., of which 62·37 tons has been provided for, leaving 6·93 tons to be arranged for.

Fig. 4.



The whole of the varying stresses having now been dealt with, the outer dotted black line represents the total area required when the column would be on the point of failing. The actual net area of timber provided is 156·16 square inches, Fig. 2, page 524, and as the maximum area required at the centre is only 23·65 square inches, the column has a factor of safety of 6·6 against buckling, irrespective of the stiffness imparted by the splaying of the feet of braces. The bottom chords of the 1886 type of trusses for 90ft. spans 14in. by 18in. were built up of four 14in. by 4½in. flitches, planed on all surfaces to ensure good butting, the whole being drawn up with ⅞in. bolts. This is a costly and undesirable design of chord, offering as it does, after a few years, an entrance for water between the flitches, causing decay, which is especially serious on account of the design of truss being such that the bottom chord cannot be renewed, thus necessitating in some cases the replacing of the whole structure, which under other circumstances, with a few new flitches, might have lasted for several years longer. Again, some of the flitches are 53ft. 6in. long, and having to be free of heart and sapwood, are difficult to obtain, and this oftentimes occasioned delay in the erection of the structures, the simple-minded sawmill proprietor supplying all the short and profitable sizes in the bridge, and then pleading inability to supply the more costly flitches.

The bending stress in the bottom chord of the new truss having been eliminated by the omission of intermediate floor beams, only a direct stress has to be provided for, resulting in a considerable reduction in the sectional area of the bottom chord, which consists only of two flitches, 12in. by 5in., placed 6in. apart, thus being always accessible to the brush, and permitting of the renewal of these important members; again, the longest flitch is only 36ft., a length easily procurable. Perhaps the most important connection in a timber truss is the bottom chord joint. Fig. 3 shows the cover adopted for the new type of truss. As the two flitches in the bottom chord are independent of one another, the whole stress in each flitch has to be taken by the two 12in. by $\frac{7}{16}$in. wrought iron plates placed on either side of the beam; on each of these plates four wrought iron strips 12in. deep by 1¾in. wide by 1in. deep are rivetted; these strips are let tightly into the timber, and are designed to take up the whole of the stress, and as the stress in each flitch is 31·18 tons, and there are four strips giving a total bearing area of 48 square inches, the crushing strain is only ·65 tons per square inch, thus giving a factor of safety of 7½ against crushing, whilst for shearing along the grain a minimum factor of 15 is provided.

Following American practice, the bolts passing through cover plates are not in any way relied upon, being simply provided to keep the plates up to their work; however, as the bolts had to be provided, the author determined to obtain the benefit of them, and arranged for the bolts to be turned and passed through drilled holes in the plates. The above joint has also met with the approval of the engineer-in-chief for railways, and has been adopted for some of the proposed bridges on the Narrabri-Moree line, whilst in some of the later American railway bridges it has proved successful, despite the fact of it being necessary in some of these pine bridges to arrange for fitting in eight strips in each plate, instead of four, as shown in Fig. 3. With this joint, requiring as it does only a straight cut, no difficulty is found in obtaining an almost perfect bearing with ironbark timber, and so far in the 146 joints in the bridges already erected in this Colony, no trouble has been found in effectively making this connection. The suspension rods, which in the author's design of truss have a minimum diameter of 2in. and 1¼in. respectively, are placed on either side of floor beams, and pass through the space between the chords, thus saving the boring of holes through chords and floor beams, and permitting of easy removal in connection with the system to be adopted in renewing chords.

One of the features of the new type of truss is that any member can be renewed without staging from below—a matter of importance when deep gorges or fast running streams have to be crossed. Briefly stated, the top and bottom chords being in two pieces, the suspension rods are removed and re-arranged so as to throw the whole weight on one flitch; there being no strain on the remaining flitch, any member of the top and bottom chord can be replaced with sound timber; and by slacking the suspension rods and inserting temporary struts, any of the braces can be renewed, whilst the renewal of the cross girders is obviously a simple matter. In the superstructure of one of the new 90ft. spans carrying a 15ft. deck, there is 500 cubic feet less timber than in the 1886 type of truss, which, in conjunction with the greater ease in framing together—notably in the bottom chord, where no fitting is required—the fewer bolt holes to be bored and the short lengths of timber employed, effect a saving of over £100 in each 90ft. span. The economy is more marked when it is considered that the old trusses were designed to carry a 15ft. carriageway, whereas the new trusses are designed to carry two 5ft. footways in addition to a 15ft. carriageway. Thus it will be seen that the later design of truss bridge offers greater facilities for traffic at a much reduced cost.

The piers carrying truss bridges vary in accord with local circumstances; one of the heavy type is that shown in Fig. 6, consisting of nine vertical piles 12in. by 12in., arranged in groups of four under heels of trusses, also one short vertical pile upstream and two short vertical piles downstream, carrying up and downstream struts. The pier is stayed with wales and braces 12in. by 6in., and internal compression struts 12in. by 12in., seated on hardwood chocks secured to piles with bolts, the chocks being set end on to do away with shrinkage, the previous system of seating butting blocks on the wales not being satisfactory, the blocks shrinking away from the struts, resulting in a slackness in the bracing. At Glennies Creek, near Singleton, the superstructure of one of the 90ft. spans cost, erected in position, £450, while in the same bridge a pier of the design above described 28ft. 4in. high from bottom waling to capwales, driven about 16ft. to rock, cost £200. The timber for this bridge was brought from Cape Hawke to Newcastle by sea 61 miles, thence forward by train to Singleton 49 miles, thence by road 9 miles, or a total carriage of 119 miles.

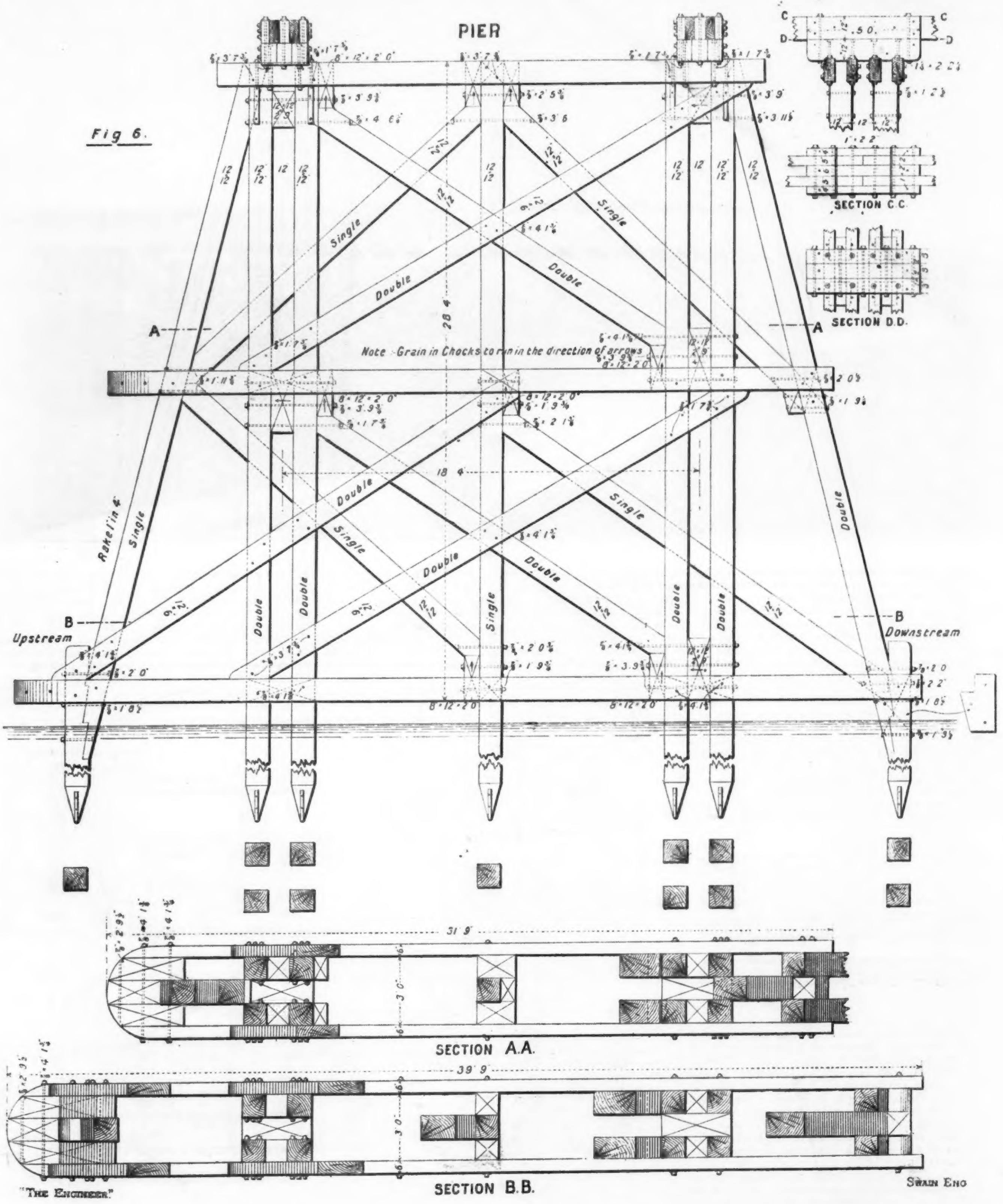


Fig 6.

Late in the year 1892 it was decided to erect a new bridge over the Murrumbidgee River at Wagga Wagga. Design were submitted for a light iron lattice girder bridge, carryin a timber deck resting on iron cross girders, but the amount available being insufficient, the author's design for a timber truss bridge was decided upon, and a contract for construction let to Mr. S. Stokes on October 4th, 1893, at schedule rates, totalling £12,604. As this bridge is now nearing completion, and, reckoned by the floor space per span—3165 square feet—is by far the largest timber structure yet attempted in the Colony, a short description may be of interest:—The bridge consists of six timber trusses, resting on iron cylinder piers and concrete abutments, forming three spans each of 110ft. 3in. centres, also nine approach spans each of 35ft. The trusses stand 27ft. 1in. apart, centre to centre, and are connected by a top and bottom system of lateral bracing, angle and portal brackets being introduced in the top system. Each truss contains seven panels of 15ft. 9in., and, being 21ft. deep between centres of triangulations, enables full provision to be made for a loaded wool wagon, which requires 17ft. 6in. head room. The truss spans are designed to carry a distributed live load of 1·2 tons per foot run, or a concentrated load of 16 tons. The carriageway is 24ft. 4in., whilst one 4ft. 6in. footway is arranged for, so that the requirements of the wool traffic will be fully met, a wool wagon measuring 11ft. 6in. when loaded and 6ft. 6in. when empty. The wind pressure allowed for is 56 lb. per square foot, on the exposed surfaces of kerbs, stringers, and ends of planking, and on twice the area of the handrails, ends of girders, top and bottom chords, braces, and verticals, the whole being taken as an uniform moving load.

Whilst the author is aware that on the occasion of the Dandenong gale, September, 1876, the wind is recorded at the Sydney Observatory to have attained a velocity of 153 miles per hour, equal to a pressure of 115 lb. per square foot, yet the author considers there would be no justification for assuming that such a phenomenal pressure would extend over such a large area as that occupied by such a bridge as that under consideration, and in support of this opinion, points to the existing structures throughout the Colony, few if any of which would be now standing if ever subjected to anything approaching even the pressure allowed for in the Wagga Wagga bridge.

The minimum factor of safety adopted for timber in the trusses is 7 for the stresses due to combined dead and live loads. Although this factor may appear to be somewhat liberal, yet it must be borne in mind that the ultimate strength of ironbark has been taken from tests made on small specimens of picked timber, and that a reduction in strength is only to be anticipated in large scantlings. Again, the flitches being sawn, the grain will run more or less across the line of the sticks, and as defects in timber are so liable to escape even the most severe inspection, it is necessary, in the opinion of the author, to make a liberal allowance to cover such contingencies.

The floor system adopted in this bridge presents some novel features, which, so far as the author is aware, have not previously been adopted in any structure in any part of the world —Fig. 4. The main points kept in view were:—(1) The necessity of having a camber in deck to permit of the quick escape of water. (2) The desirability of having a low lateral system of wind bracing, so arranged that the triangulation lines of the wind bracing and the triangulation lines of the truss members would intersect at a common point in the bottom chord. (3) The distribution of the load, so as to get each pair of the floor beams to act as one. (4) The necessity of concentrating the loads at the apices, as, with the section employed, two 14in. by 7in. timbers, no additional stress was permissible in the bottom chords.

The deck consists of 4in. transverse planking spiked to 12in. by 6in. longitudinal stringers, seated on the lower lateral struts. The lower lateral strut is 12in. wide by 8in. deep at centre, adzed down on top surface to 6in. at ends—to give camber in deck—the centre line of strut being placed in the same plane as the centre line of the bottom chord. The ends of the lateral strut are secured to bottom chords by wrought iron brackets, and to these brackets are attached the diagonal tie rods, the centre lines of which, if produced, would intersect at the centre of bottom chord; the triangulation lines of the wind-bracing and truss members thus intersecting at a common point and avoiding all bending stress. The lateral struts are tightly lapped one inch over nine 12in. by 4in. sawn packing blocks 2ft. 5in. long, resting on the floor beams. These blocks not only pack the lateral struts up to the same plane as the centre line of chord, but what is of just as much importance, equally distribute the whole load over the pair of floor beams. With a panel length of 15ft. 9in., and a span of 27ft., the resulting load is so great as to necessitate the use of two floor beams, each 14in. wide by 16in. deep, spaced 1in. apart—to permit of a current of air and avoid boring for stringer bolts, and connected together with eleven ⅞in. bolts passing through 1in. cast iron distance washers.

As the overall width of these two floor beams is 2ft. 5in., it was impracticable, without fouling the braces and suspension rods, to rest them on the upper edge of the chord. They are therefore suspended from the chords by sixteen beam hangers 1⅛in. diameter passing on either side of the flitches of chords. The author is of opinion that for timber railway bridges of large span, the floor [system above described offers some advantages, inasmuch as shock from trains would be reduced by the lateral strut and distributing blocks acting as a cushion; whilst the beam hangers being so short, a large allowance could economically be made for dynamic action, which action would be materially lessened by the time the main suspension rods were reached. In connection with the construction of timber bridges, the financial aspect of the question is of the utmost importance. Like all engineers, the author would prefer—if economy had not to be considered —to construct metal bridges, but in a new Colony where the trend of the traffic is likely to be diverted by many circumstances, difficult, if not impossible, to anticipate, it would seem preferable in such localities to construct timber structures with a small capital outlay, rather than spend large sums on works of a more permanent character.

For many years there has been a disinclination in this Colony to build other than permanent traffic bridges out of loan funds, yet as harbour works and railway works, in which timber structures, sleepers, fencing, &c., represent no inconsiderable portion, are built out of loan funds, the author submits there is no reason why traffic bridges should not also be constructed out of borrowed capital, provided it can be shown, first, that they are more economical not only in prime cost but in annual charge, and secondly, that provision be made for their renewal or repayment out of revenue. It may be urged, in these days of cheap steel, that it is against the practice of other parts of the world to construct timber bridges, but in what other country could be found timber with a tensile strength of eight tons per square inch, a crushing strength of 4¾ tons per square inch, and a shearing strength along the grain of one ton per square inch; or bridges totally unprotected from the weather with a life approaching anything like, amongst others, the following:—Bridge over Cox's River, at Glenroy, 28 years old; bridge over Bell River, 32 years old; bridge over Macquarie River, at Dubbo, 32 years old; bridge over Murrumbidgee River, at Wagga, 33 years old; bridge over Duck River at Paramatta, 34 years old; bridge over Cudgegong River, at Rylstone, 34 years old; bridge at Berrima, 35 years old; bridge over Murray River, at Albury, 36 years old.

The first metal bridge in the world is said to have been erected over the Severn at Colebrook Dale in 1779. This bridge consists of a cast iron arch of 100ft. span, the structure being thus 116 years old. Wrought iron and steel bridges are, however, of a much later date, and the fixing of the life of such structures is to a great extent only a matter of conjecture. In connection with this matter Waddell says: "There is no reason why a well-designed iron highway bridge—when properly cared for—should not last for ever. Under loads which are light and slowly moving compared with those of railway bridges, the iron cannot possibly wear out, and when properly protected from the weather cannot rust." The author, therefore, to make everything favourable to the metal bridge, in a comparison of its cost with that of a timber bridge, has assumed the life of the former as infinity, whilst the timber bridge has been taken at only twenty-five years—a life, it is only reasonable to expect, will be much exceeded with the better type of structure, the more careful inspection of timber, and the greater care in erection that now obtains.

The whole of the timber for the Wagga Wagga bridge was brought from the Northern Rivers to Darling Harbour, about 150 miles by sea, thence by railway to Wagga Wagga—310 miles—or a total carriage of 460 miles. The contract cost for one timber truss span at Wagga Wagga is £1300, and the estimated cost of one span of the iron lattice girder design, complete on bearings, was £2800—Colonial manufacture. Now, to compare the relative cost of these two bridges on the basis that the planking in each bridge will require renewal every 12½ years, the remaining timber work every twenty-five years, and that the ironwork is everlasting, it is necessary to ascertain how much per annum it will take to keep these bridges "trafficable" for ever; in other words, to ascertain how much per annum it will cost in each case for interest on the prime cost—tarring, painting, removal of old material, and renewing of each portion as it wears out.

Having obtained the annual charge for each bridge, the difference represents the saving effected. The comparison is as follows:—

Annual Charge for Iron Design.

Item.	Prime cost.	Interest.		Renewals.	Sinking fund to provide for removal and renewal of timber.		Maintenance.	Total.
		Rate.	Amount		Life.	Amount		
	£		£ s. d.	£		£ s. d.	£ s. d.	£ s. d.
Planking ..	180	4 p.c.	7 4 0	220	12½ yrs.	13 18 2	—	21 2 2
Stringers ..	130	4 p.c.	5 4 0	170	25 "	4 1 8	—	9 5 8
Ironwork ..	2490	4 p.c.	99 12 0	Nil	Infinity	Nil	—	99 12 0
Painting ..	—	—	—	—	—	—	60 0 2	60 0 2
£	2800				Total annual charge	..		£190 0 0

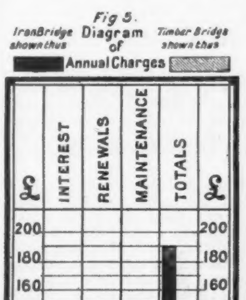
Annual Charge for Timber Design.

Item.	Prime cost.	Interest.		Renewals.	Sinking fund to provide for removal and renewal of timber.		Maintenance.	Total.
		Rate.	Amount		Life.	Amount		
	£		£ s. d.	£		£ s. d.	£ s. d.	£ s. d.
Planking ..	180	4 p.c.	7 4 0	220	12½ yrs.	13 18 2	—	21 2 2
Stringers, trusses, floor-beams and remainder of timber in superstructure	630	4 p.c.	25 4 0	950	25 "	22 16 8	—	48 0 3
Ironwork ..	490	4 p.c.	19 12 0	Nil	Infinity	Nil	—	19 12 0
Painting ..	—	—	—	—	—	—	51 5 7	51 5 7
£	1300				Total annual charge	..		£140 0 0

Thus it will be seen that there is a saving of £50 per annum in favour of the timber bridge, which has, at 4 per cent. interest, a capital value of £1250. See Fig. 5.

The author has also designed timber trusses for spans of 130ft. and 153ft. The latter truss altogether differs from the Wagga Wagga bridge, four flitches instead of two being placed in the top and bottom chords, and as for purposes of renewal a larger sectional area is provided than is actually required for direct tension, the floor beams can in this case be seated directly on the upper edge of the bottom chord. The flitches of chords being spaced only 3in. apart, whilst allowing of a free current of air and room for painting, permits of the adoption of channel iron gib-plates for suspension rods in lieu of the heavy forgings used at Wagga Wagga, whilst the castings are, from the same cause, much lightened. Again, in the lower lateral system diagonal timbers and transverse tie-rods have been arranged for, which is somewhat more economical than the diagonal tie-rods used at Wagga Wagga. In conclusion, the author desires to record his acknowledgments to Mr. Hickson, M.I.C.E., for his courtesy in lending models, plans, and photographs to illustrate the several works mentioned in the foregoing paper.

Fig 5.



The Colony of New South Wales is fortunate in possessing an almost unlimited supply of hardwood of exceptional durability and strength, the most favoured for engineering purposes being "ironbark," which in bridges totally unprotected from the weather has a life in many structures exceeding twenty-five years, whilst the average of a number of tests gives its tensile and crushing strength as 8 tons and 4½ tons respectively. Full advantage has been taken of this valuable natural product, no less a sum than £634,000 having been expended in the Colony of New South Wales during the last ten years in the construction of 680 timber bridges. The Glennies Creek, New South Wales, designed by Mr. Percy Allan, Assoc. M. Inst. C.E., acting under Mr. Hickson, M.I.C.E., Engineer-in-Chief for Public Works, has been adopted as a standard type throughout the Colony for spans of 70ft. and 90ft. Sixteen bridges have been erected of a total length of 4300ft. 1in., containing twenty-six truss spans of this type, which have proved both economical and suitable to the requirements of the traffic. The loads allowed for are a traction engine of 16 tons on a 10ft. wheel base, with 9½ tons on the leading wheel and a distributed live load of 84 lb. per square foot, equal to 18·8 cwt. per foot run of bridge. The timber in the trusses is cut free of heart, and is so placed as to be always accessible to the brush, whilst at the same time permitting of any member being replaced without staging from below.

LETTERS TO THE EDITOR.

(*Continued from page* 518.)

THE JENNY LIND: A LINK IN LOCOMOTIVE HISTORY.

SIR,—In THE ENGINEER for January 10th in the present year you published an engraving of the Jenny Lind of the Midland Railway, and an account of how the Jenny Lind type came into existence. The special feature of it is that the driving wheels have only inside bearings, and the leading and trailing wheels outside bearings. It has been considered by some persons that I have advanced claims in regard to the design of this type which are not in accordance with the facts. Will you favour me with space to deal with these charges, and to add a link, not without interest, to the history of the locomotive engine?

I would gladly have kept out of a discussion if it had been possible, as any part I may have to take in it must be personal, and may appear to be egotistical; but my readers will excuse me, if I am forced into this, as it will be necessary in the nature of the evidence I must give to meet the objections which have been raised, and therefore cannot be helped. Again, as a reason for the delay, which has been unavoidable, I have been so busy with practical work as not to have had the time at my disposal necessary to treat the question with the attention due to the importance it has assumed as a question of locomotive history, involving on my part the hunting up of old records, drawings, tracings, &c., as well as other collateral matter to prove my position, as I shall not bring into the case any haphazard accounts or remarks, but only such records as I have notes or drawings to prove.

First, I think I should say an explanatory word about an article which appeared in THE ENGINEER of the 10th of January, 1896, from which all this correspondence has arisen. Asked by you, Sir, for anything I could tell about the Jenny Lind, to save myself trouble, without much thought I offered you my diaries. These diaries were, of course, originally written without the idea of any one seeing them, and were records kept only for my own information. No wonder then that in selecting information from my journal, my name should have come out prominently—this had not struck me at the time, as it was the engine I was thinking of rather than myself in connection with it.

Next I will answer the question often asked, why I have not spoken earlier. When the Jenny Lind came out, it was the custom that the heads of a works or manufactory had the credit of all that was done there. This was perhaps a necessary result of the circumstances, and it is so more or less still in every walk of life—the expert who perhaps really does the work not coming to the front at all—and I, of course, never for a moment thought of interfering with usual custom. As an instance of this custom, the link motion has always and is still called and quoted for as "Stevenson's link gear." Meanwhile everyone knows who invented it. In this sense then, as Mr. Tomlinson puts it in his address, Mr. Wilson and Mr. Fenton "produced" the Jenny Lind.

Then it is asked why I did not come forward when Mr. Tomlinson gave his presidential address, which he used to speak of as his "recollections." This address—contrary to my usual custom—I had not seen. I heard it before the meeting of members, and then I still accepted the ruling of the old custom, that the heads got the credit, for, to say the least, it would have been very bad taste to burst out then. But, further, I did not care to claim the honour from an old and very much respected and esteemed master and friend, such as Mr. Fenton had always been to me, and perhaps to more young engineers coming forward than any other man in the profession, and I am glad here to bear this testimony. Besides, I felt that from that gathering of brother engineers I had already received such unstinted goodwill, credit, and kindness for advances in engineering science and practice distinctly my own, that I should have felt it a graceless thing to seem to snatch at the laurels worn by another, that I was well content to let the matter rest as it was; and it has been the hue and cry raised by only partially informed correspondents that has now forced me into the matter.

Before going into facts, and as clearing away, as I think I can, all the objections, I may be perhaps allowed to say a word or two on the many letters which have appeared on the subject, and I think by answering the objections raised in one or two I can cover the whole of what requires notice, and by massing the rest without specially naming any, I shall get at the most simple treatment of a subject which has become pretty well confused.

The bulk of the ordinary letters in all the papers appear to be written by those who have only a very partial and often after knowledge of the matter, and in most cases only hearsay, so some of the intended facts are mixed up in amusing confusion. Many speak of the "Jenny" as originally built for the Midland Railway in 1848. This was not so. The first order was given by the Brighton Company, and the engine was designed for that company, and the first went there. Then others speak of 1848 as the date of the type. The design of the first 800ft. surface engine was made in 1846, and the first engine was finished in May, 1847.

Referring to the correspondence, the main question has been treated by one correspondent thus: having first admitted—as he has done—that he had had "to rely on books and statements, and the report of others;" on such very unreliable evidence he thinks fit to lay down the law for your readers and to say positively, "Mr. Joy did not design the Jenny Lind." This statement may stand for what it is worth, after the admission of the source from which its authority comes, but it must bear the test of the facts; and as to designing—what is designing? Call it what you will; I will give a simple statement of the events which is not founded on the report of others, but all from personal knowledge, such as in every point and date can be proved by my diaries, drawings, and tracings. I can then well afford to leave the decision with your unbiassed readers as to my share in the matter; but for those who are determined only to believe what they wish, let them do so if it pleases them, but no amount of this sort of assertion will make it true, or will destroy the facts or alter history, but will only give more prominence to the facts.

Another correspondent quotes what he calls a "very full statement" professing to be a very clear account of the origin of the Jenny Lind—this has also been copied into other papers. He says of it, that it formed part of the address of Mr. Tomlinson to the Institution of Mechanical Engineers, May, 1890. As a member of that Institution I have examined my own authorised copy of these "minutes," which I have, further, the secretary's sanction for saying contains everything that was included in that address. Yet there is not a syllable of this "full statement" in it. Mr. Tomlinson is also further made responsible for a very strange remark, "that the Jenny Lind was the result of an accident." Not a word of this either appears in the address or in the few remarks, not amounting to a discussion, which followed. Wishing to trace the authority of the publisher of this "very full statement," I sought for his name in the list of the members of the Institution, without finding it. I was present at the reading of the presidential address. I heard nothing of all this, and there is nothing of it in the "minutes," the only official, and so reliable authority on the subject. So it seems to me that your readers must conclude with me that the "statement" and the "accident" dissolve together into only an ingenious invention. No doubt such an accident has happened at some time, and forms the basis of this tale, but not to a Railway Foundry engine of that date, and not with the result ascribed.

And it is utterly useless to make any fresh or explanatory statements to build up this theory, as neither the "full statement," so much relied on, nor the accident theory, appears in the authorised copy of Mr. Tomlinson's address, or in any copy; so there's an end to it. This can be proved by any one by reference to the minutes, at the rooms of the Institution, 19, Victoria-street, Westminster. I will now turn to the facts, and go on to relate what did transpire at Railway Foundry during that eventful year of 1846, and so prove how this apparently plausible "statement" could not have happened; that the accident described could not have occurred, and so that the "Jenny" could not have been the result of an accident. Then I will show by the continued narrative of the circumstances, how the Jenny Lind did come to be what she was.

"In 1846 E. B. Wilson and Co., of Leeds," *certainly did not build* "a number of standard engines with single driving wheels, 6ft. diameter, and double frames." I say this of my own personal knowledge, as I was there to see. First, because they had no such standard engines at that time or at all; and, secondly, because during the years of 1845 and 1846 the works were fully occupied in building other engines to order, all of the long boiler type, which was then the favourite engine. Nor were any such engines with double frames to drivers built at Railway Foundry in Mr. Wilson's time at all, since January, 1845, when he took the works, nor before that, in Sheppherd and Todd's time, back as far as June, 1843. Through all this time I was there, first as pupil, then as chief of the drawing-office, and everything had to pass through my hands, and if these engines had been built during the time assigned to them I should have had to make the drawings for them, or to superintend them, and this certainly was not the case; so I can say positively they were not built, nor were there drawings of this class of engine in the drawers before that time, or we pupils were certain to have found them. Again, if the accident had happened, as a mechanical question, the details would have been brought to the drawing-office to be reported there, as the proper place where all such matters were recorded. I have not the smallest recollection of this at the time, nor afterwards, when classifying the records for use; and an event so important, even controlling the design of an engine, could not so have sunk into oblivion.

When Mr. Wilson came to the foundry in 1845, the productive power could not at most have been over ten or twelve engines per annum, but he found no work of moment going on. This, however, he soon remedied. To begin with, he took an order early in the year for six engines for the Manchester, Bury, and Rossendale Railway Company, Mr. Cawley being engineer. These were long boilers. By August he took another order for six engines for the York, Newcastle, and Berwick Railway, Mr. Thos. Cabry. These also were long boilers. Thus the productive power of the place was already considerably over-crowded for the year, and proving that I have not over-stated this, the first engine of the first order was not finished till March 1st, 1846, so that 1846 began very full of work, and another little order dropped in in spring for a contractor's engine. Then by summer Mr. Wilson was bringing in more orders, this time it was six passenger engines and six goods for the Leeds, Dewsbury, and Manchester Railway, the line on which Mr. Fenton had been engineer. These engines had some of the features of the long boilers, and the outside cylinders combined—see Fig. 1—but the whole of these engines for 1845 and 1846 had inside bearings only; indeed they were the ordinary style most in favour there, but among all there was not one outside bearing to twist off, and to give the possibility of "the accident." Thus the Railway Foundry was kept full of work, and no room, and no time left for building the "standard engines," on which so much has been made to rest; indeed, if the Railway Foundry had a standard then, it was for long boilers and inside frames only. I have typical tracings of all the above engines, but not a vestige of the so-called "standard."

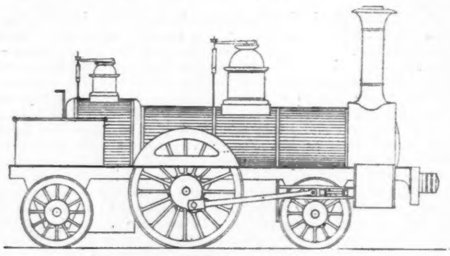


Fig. 1—L. D. M. RAILWAY, 1845

So having now proved, on the one hand, that the "Jenny" could not have been the result of an accident, I will next show some of the causes which brought her about, and made her what she was. To do this I must proceed with my narrative, and so next come to the Brighton Company's order towards the end of autumn, 1846. This was for ten passenger engines, to be built to the drawings of their superintendent, Mr. Gray; ten others had already been ordered from Messrs. Hackworth and Co.; these engines were all to be fitted with the Gray expansion gear, and throughout in accordance with Mr. Gray's really advanced ideas. From my position as chief in the drawing-office, I was sent for, and received my instructions from Mr. Wilson to go at once to Brighton, to take drawings and all particulars from Mr. Gray.

Mr. Gray being very much engaged during the day, sent me out with an engine pass, to see what I could on the line, working all the evenings when he could be present to see that his instructions were recorded. Another draughtsman was there also for Messrs. Stothert and Slaughter. With such freedom on the line, there was hardly a class of engine I did not have a run on. One of the Gray's engines—Fig. 2—had come from Hackworth's, and I did not fail to make a very intimate acquaintance with her. She was, though a heavy and lumbering engine to look at, a fine engine to pull, and she could run, and was very steady and very easy.

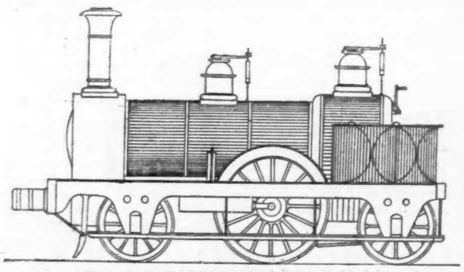


Fig. 2—L. B. AND S. C. RAILWAY, 1846

I spent three weeks taking particulars of these engines, but on my return to Leeds at the end of October, I had hardly got to work on the drawings when orders came to stop the engines, and to furnish a design of our own. This work, of course, naturally fell to my lot. And Mr. Wilson and Mr. Fenton, who was now general manager, met in my office over the drawing-board, and it was decided to go to work, naturally, on an engine of the class we were then building, and so to work out some combination of the long boiler and outside-cylinder type. The last of these we had under construction were the six passenger engines for the Leeds and Dewsbury Railway. These were outside-cylinder engines, 6ft. single drivers, with inside bearings only, and inside frames running the whole length of the engine, crowding up the fire-box so that little more than 60ft. of surface could be got in. I worked on these lines for about a week at the office, twisting the design into every possible form, and had made about ten general designs, when on Saturday about noon Mr. Fenton came into the drawing-office, and said we would try an inside-cylinder, 15in. by 20in., with 6ft. single driver, and as much heating surface as I could get in. These were all the directions I received. I was pretty sick by this of scheming engines to no good, and, as everyone else had gone, I left, too, for was it not Saturday afternoon, and a holiday? And from that hour till nine o'clock on Monday morning I saw no more of the Railway Foundry or anyone connected with it.

But on arriving at home, where I always had a sheet of drawing paper stretched ready for anything that might turn up, I took the fancy to try what I could make of the engine with such a "free hand" to work with, and the bias of my old Sheppherd and Todd training, including my familiarity with the engines Ariel and Orion, as well as my recent very satisfactory experience of the new engine at Brighton. Without throwing aside the type of the engine I had so recently been working at—the long boiler—I naturally associated the older predilections revived by the newer engine at Brighton, and the shortened inside frame allowing the wider fire-box, by which 80ft. of surface was easily got in, carrying on this frame the inside bearings only for the driving wheels, and adding an outside frame for the leading and trailing wheels to give ample ground surface to get steadiness. Then getting the boiler as low as possible—the "fad" then believed in to get steadiness—a very neat-looking engine came out without any great changes, and no invention, but really the result of the survival, or rather the selection, of the fittest elements of the various types of engines worked at from the first, the best points of each combining to form one harmonious whole. See Fig. 3. So she came out also with a smart compact "go" about her, partly picked up from the "long boilers," which had that virtue, at least, that they were about the cleanest and simplest looking job ever made of a locomotive. The result quite satisfied me, and I cut off the drawing and took it to the office on Monday morning, where it was submitted to the usual criticism, and was at once approved in almost every particular; and I was instructed to go on with ordering boiler plates and working out details. This drawing I have, now faded with age, but the original, and it can be inspected and compared with the early tracings of the "Jenny," dated 1847, and with the engravings which appeared in THE ENGINEER on the 10th January, 1896, and after, and which are reproductions of old engravings from *The Practical Mechanic*, the tracings for which were furnished by Messrs. E. B. Wilson and Co. at the time; thus the originals are very old prints, and are authentic.

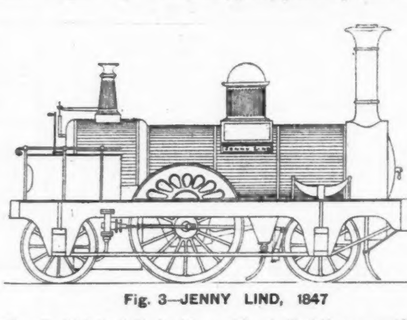


Fig. 3—JENNY LIND, 1847

Very soon the interest gathered around the new engine, she was so different from anything that was under construction in the works. Mr. Wilson was often at my board to see how matters progressed, but he had much higher and more profitable work to do than to design engines. Those who have raised the hue and cry on this subject might as well have said that he made his own balance sheets, but that was not the system at the Railway Foundry under his government; each department had its own work to do and did it, and did not interfere around, and in the establishment and organisation of the concern the Railway Foundry soon became, raising its power of production from ten to twelve engines per annum to a capacity of one engine a week, was a big thing in those days, and this was accomplished within a year; and beyond this work was found to keep the place fully going, and this, too, was no small matter. But Mr. Wilson's power of control over others, especially in a case of securing an order, was marvellous—it was magnetic. I was present at the settlement of the order for the ten big engines for the Manchester, Sheffield and Lincolnshire Railway, and often else I saw this.

Mr. Fenton also was often round, and left his impress on the engines as work went on. I had seen on the engines building at Railway Foundry when I first went there, the steam pressure raised from the usual 60 lb. to 90 lb., and I found this still further raised in the Brighton engine to 100 lb., and I, of course, adopted this pressure for the new engine, though the usual pressure around us was 80 lb. This Mr. Fenton, with his well-known tendency to go ahead, ordered to be lifted to 120 lb. And this, as a fact, was one of the main causes of the success of these engines. This feature, recognised and utilised by the next superintendent of the Brighton Company, Mr. J. C. Craven, enabled him with these comparatively small engines to run the Brighton trains quite up to the highest speeds then attained, and on, also, by far the lowest consumption of fuel burnt. I have an authorised copy of a coke list, soon after the Jenny Linds got fairly to work, where the lowest consumption on the list of main line engines was 16·75 lb. per mile, and the highest 19·47 lb.

The first engine was completed for trial in May, 1847, and was finished regardless of cost. The boiler and fire-box were lagged with polished mahogany, and bound with bright brass hoops and brass furnishings, the dome and safety-valve tops were bright copper, and there was other bright work about that made of her a very smart-looking engine.

The first run was made from Leeds to Wakefield and back, and was not accompanied either by Mr. Wilson or Mr. Fenton, only by us heads of departments—Willis and myself and others—and we had the bad luck nearly to fall in for a collision on the return.

Immediately after this the new erecting shop was completed, and was opened with a big banquet and a dance, and the next morning the first boiler was over a pit ready to begin work, and soon after the delivery of an engine a week began, and the rush came, every railway company wanting these engines, they became so immediately popular, as from the pressure carried they could both pull and run.

So I have shown that the origin of the Jenny Lind was no more an accident than was the introduction on our railways of the compound system, or any other great advance in railway practice, but the fulfilment of the need for an engine, both to pull and to run, and to do both economically, when locomotive practice, as THE ENGINEER said in that article, was in a very chaotic condition, and schemes of extraordinary design and daring were being brought out.

And to summarise, I have proved four things:—

First, that the "full statement" of an accident described as the origin of the Jenny Lind was not in Mr. Tomlinson's presidential address of 1890. Secondly, that the standard engines said to have been built by Messrs. E. B. Wilson and Co., at the Railway Foundry in 1846 could not have been built. Thirdly, that therefore the accident described could not have happened, as no Railway Foundry engines of that year had any outside bearings to twist off, so the Jenny Lind could not depend on that for her general design. Fourthly, that the drawing which settled the general design of the Jenny Lind was made as and where I have described.

As I have hinted, the Jenny Lind was not by any means the only interesting engine of the day brought out by Messrs. E. B. Wilson and Co., from Railway Foundry, in those early days of progress. Some of the early Cramptons, the Lablache, the Double Boiler, the Little Mails, and other engines built for higher pressures, and suggesting rapid advance in constructive design, with histories even more interesting from an experimental point of view, came out from Railway Foundry shortly after. DAVID JOY.

17, Victoria-street, Westminster,
May 11th.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

IN finished iron the marked bar houses are this week fairly well situated for orders, and continue to quote the £7 basis. In merchant bar iron there is a steady inquiry going on, and quotations are £6 to £6 5s. The manufacturers of common bars are also in possession of some good orders at £5 5s. to £5 10s. Increased demand is registered for black sheets, and makers quote £6 10s. to £6 15s. for doubles. The hoop and tube strip manufacturers report a favourable amount of new business, and continue to realise £6 7s. 6d. There are fair inquiries for angles, and the quotation is £5 15s. Galvanised sheets are in good demand at £10 2s. 6d. to £10 5s. for 24 gauge at Liverpool.

Steel makers are doing a brisk trade at £4 5s. for Bessemer billets and blooms, but some North-county and Welsh steel may be had at £4 2s. 6d.; Siemens, £4 12s. 6d.; £5 12s. 6d. to £5 17s. 6d. for angles and boiler plates, £7 5s. to £7 10s. for sheets, and £5 15s. for bars.

The pig iron manufacturers are in receipt of moderate orders for forge, and a regular demand exists for foundry. Quotations are maintained at recent levels. Cold blast pig, 90s.; Staffordshire all-mine, 55s.; part mine, 40s. to 42s. 6d.; and 35s. 6d. for cinder. Northamptonshire forge is 39s. to 40s.; North Staffordshire and Derbyshire, 41s.; and Lincolnshire, 42s.

The tender of Mr. G. Law, of Kidderminster, has been accepted for the carrying out of the important sewage scheme recently determined upon by the Town Council of Shrewsbury. The following are the tenders sent in. They were as follows:—A. Krauss, Bristol, £26,747; H. Weldon, Birmingham, £34,412; C. Harris, Shrewsbury, £31,640; John Jackson, Plaistow, E., £30,000; Enoch Tempest, Rawtenstall, £27,987 3s.; A. Skellett, Manchester, £27,025; Geo. Law, Kidderminster, £22,978; Ed. Iles, Mitcham Common, £29,339; Bentley, Son, and Partington, Bury, £32,067 14s. 6d.; J. Mowlem and Co., London, £55,155; G. Bell, Tottenham, N., £28,960; Currall, Lewis, and Martin, Birmingham, £28,936 3s. 7d.; Jones and Fitzmaurice, Birmingham, £33,000; Jas. Dickson, St. Albans, £28,567; W. Cunliffe, Kingston-on-Thames, £24,998; G. Osenton, Westerham, £29,863; James Nuttall, Manchester, £29,444 9s.; and John Weston, Chester, £42,448.

The boom in cycle engineering continues unabated. Further additions are almost daily being made to the crop of new cycle tube and cycle companies which are just now constantly appearing in the Midlands, and which have now reached a total of seventeen since November. The total capital of the nine such companies floated since my last letter amounts to £1,164,000. Six of them have each a capital of £100,000, or more, and one is for a quarter of a million. Many establishments are working double shifts night and day, and are yet in arrear. All this means a correspondingly large demand for tube drawing and other sorts of machinery, and is looked upon consequently by the mechanical engineers of the district with the greatest satisfaction. As much as £15 15s. is being paid for Swedish steel blooms of best quality, or £3 15s. per ton more than last year. It is estimated that the American make of cycles for the current season up to July next will amount to 1,000,000 machines, and English steel tube is, it is believed, being used for about two-thirds of these. Tube prices are rising. Discounts a year ago in the Midlands were as much as 77 per cent.; to-day they vary from 57 to 35 per cent. Among the new companies announced during the past few days are the Coventry Cross Cycle Company, capital £100,000 (to acquire the business of Warman and Hazlewood); Premier Tube Company, capital £15,000 (to acquire the business of Mr. Alfred Smallwood, Premier Tube Mills, Birmingham); Auto Tube Company, £30,000 (to take over the business of C. Hudson and Collier, Seamless Tube Works, Ashton); Metallic Seamless Tube Company, £85,000 (to acquire the business of the Metallic Tube and Flask Company, Wiggin-street, Birmingham); Trent Cycle Company, £100,000 (to take over the business of the old company of the same name and its works at Long Eaton, Nottingham); the Endurance Tube and Engineering Company, £190,000 (to acquire the works and business of the Endurance Seamless Tube and Vial Company, of King's Norton, who put down an excellent plant about six months ago); the New Hudson Cycle Company, £20,000, Birmingham. In most of these cases considerable extensions of plant and machinery are contemplated.

An extraordinary general meeting of shareholders of the Coventry Machinists Company, Cheylesmore, Coventry, the parent company of cycle manufacturers, is to be held to consider an offer made by a syndicate for the purchase of the undertaking, with a view to its further development. The exact terms of the offer are not made known, but it is stated with some show of authority that the price will enable £20 to be paid for each share, which is of the nominal value of £4 10s. It is also stated that negotiations have been completed for the sale of the Premier Cycle Works, &c.—Messrs. Hillman, Herbert, and Cooper—for the sum of £450,000, and that negotiations are nearly completed for the sale of the Rudge-Whitworth Company. The Singer Company's purchase price is fixed at £750,000.

A syndicate of Canadian capitalists have offered to purchase the whole of the Birmingham tramways undertakings, and a somewhat similar scheme is also in hand with regard to the South Staffordshire tramways. The would-be purchasers are Mr. William MacKenzie, president of the Toronto Street Railway, and Mr. James Ross, managing director of the Montreal Street Railways. They propose to abolish steam and substitute electricity for some other power. The tramways directors, in a circular just issued to the shareholders, recommend the acceptance of this extraordinary offer. The present authorised capital is £300,000, and the number of shareholders is about 1500.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The continued lull as regards new buying in the iron market here has necessarily a depressing tendency, and in some quarters there is an uneasy sort of feeling as to the possible course of prices, which is resulting in very low figures being quoted to effect clearances of iron already bought, whilst merchants and dealers are here and there showing a disposition to enter into speculative "bear" operations for forward delivery. The downward tendency in prices is still chiefly confined to pig iron, and is partly due to makers pressing for specifications from merchants and dealers who have overbought, and are consequently realising as best they can, rather than run the risk of low-priced contracts being cancelled. In the finished iron trade the position is also weak, but so far prices are generally being steadily maintained. The steel trade continues strong, and although merchants undersell, makers are apparently not at all influenced in their quotations, which continue firm at full rates.

Business on the Manchester Iron Market continues generally extremely slow, with prices steadily tending downwards, especially for pig iron. For local foundry brands makers hold firmly to late rates; in forge numbers there is nothing stirring to really test prices, but these could scarcely now be fully maintained. Lincolnshire makers have during the week been compelled to further give way in their list rates for forge iron, which is now quoted 40s. 6d., but foundry qualities remain at 43s.; Derbyshire foundry, however, is easier, and does not average above 45s. 6d. net, delivered Manchester. In outside brands there is some very low cutting on the part of merchants. Ordinary G.M.B. Middlesbrough has in some cases been obtainable at 45s. 4d. to 45s. 7d. net cash, delivered by rail Manchester, although makers do not quote under 46s. 4d., whilst the docks price is 44s. net cash. For Glengarnock the official quotations are 49s. 9d., delivered Ship Canal, Manchester, 48s. 6d. at Preston, and 47s. 6d. other Lancashire ports, but there are ready sellers in the market here at 9d. less, whilst Eglinton can be bought at 46s. to 46s. 3d. delivered ports, and 48s. 6d. delivered Dock Quays, Manchester.

Manufactured iron is without quotable change, except that one large firm, who, as I reported last week, have had to close a portion of their works on account of the falling off in shipping trade, are rather low sellers. New work generally is, however, not coming forward very freely, and forges are not so well employed as they have been. Quotations remain as given last week.

In the steel trade a strong tone is maintained, and although in raw and manufactured material merchants undersell, makers show no disposition to give way on their quoted rates. For hematite makers still quote 58s., less 2½, for No. 3 foundry, delivered Manchester, but merchants are sellers at 6d. to 9d. under this figure. A fair amount of activity is reported in some classes of manufactured goods, prices for which are hardening, £6 to £6 2s. 6d. being now quoted for bars, but steel boiler plates remain at £6 5s. to £6 7s. 6d., delivered in this district.

Activity continues to be fully maintained throughout the engineering industries of this district, all branches being well employed, and in most cases reporting new work coming forward freely. Fairly large orders are being booked by locomotive builders, and the Vulcan Foundry Co., Newton le Willows, has just secured an order for sixteen engines for the Eastern Bengal Railway, of the type recently illustrated in THE ENGINEER. The firm has also received another order from the North-Western Railway of India for twenty goods engines of a similar type to a number they have already in hand for the same company. The improvement recently reported in the boiler-making trade is also being fully sustained, and machine tool makers report a large weight of inquiry, with orders both for light and heavy machine tools coming forward freely, whilst stationary engine builders continue in the same satisfactory position that has been reported for some time past.

Visiting the Ordsal Works, Salford, of Messrs. Hulse and Co., this week, I had an opportunity of seeing an exceptionally massive and powerful vertical shaping and slotting machine they had just completed for dealing with the heaviest armour plates that are now being constructed. This machine, which weighs upwards of 120 tons, will admit 14ft. between the uprights, and has a table 17ft. in length, whilst the slotting stroke can cut through a thickness of 30in. A special feature of the machine is that it will slot at an angle of 45 deg. out of the vertical plane, either transversely or longitudinally. The tool slide is self-acting, and there are power motions for adjusting the table carrying the armour plates along the bed, and also for the swivelling slotting slide, whilst the feed is variable over a wide range. The firm had also in hand five large lathes, and several gun boring machines, which are to be driven electrically, with motors self-contained.

Mr. J. K. Broadbent, of Islington-square, Salford, has recently patented an improved forced draught arrangement for undergrate blowers, which is applicable to all classes of steam boiler furnaces. The arrangement consists essentially of a mouthpiece of trumpet form, which is supplied with a very small jet of steam, under one-sixteenth, which carries in a large quantity of air, and increases the draught through the fire bars. The steam which is used for producing the draught assists in keeping the bars cool, and, after passing over the fire, is finally converted into water gas and burned, thus giving back to the boiler the same amount of heat which was required to produce the steam, and the increased draught causes the fire to burn much brighter and clearer than would be the case with a defective draught through the fire. By this means the combustion in the furnace is rendered perfectly satisfactory, even where the chimney draught is defective, whilst another advantage is the great saving in the coal bill, as any inferior kind of fuel can be used where the Broadbent forced draught is applied. No special class of furnace bars are requisite to admit of the application of this arrangement, nor is it necessary to enclose the ashpits. The method is already in operation at a number of works in this district, and very satisfactory results have been obtained in the direction of increased steaming capacity.

The coal trade remains without improvement, and, in many cases, collieries are not working more than three to four days per week, whilst those which are kept going four to five days are, as a rule, putting into stock. For all descriptions of round coal, the demand continues only of very limited weight, and even in anticipation of the holiday stoppages of the pits, which, in most cases, will extend over a week, there is very little extra buying going on. The better qualities suitable for house fire consumption are without quotable change; but there is an easier tone in prices, and representatives of collieries are in most cases prepared with concessions to effect sales of any weight. Only in exceptional cases is best Wigan Arley fetching more than 9s. 6d.; with seconds qualities of Arley and Pemberton 4ft. averaging about 8s., and common house coal 6s. 6d. to 7s. at the pit mouth. Supplies of steam and forge coals continue largely in excess of requirements, and very low prices are ruling, good average qualities not fetching above 6s. per ton at the pit mouth. Engine fuel meets with a ready sale, with rather higher prices obtainable; but supplies are fairly plentiful, owing to increasing quantities coming in from other districts. At the pit best sorts average 4s. 3d. to 4s. 9d., and common slack from 3s. to 3s. 6d. per ton.

For shipment prices show no sign of any upward move, and steam coal, delivered Mersey ports, is still readily obtainable at 6s. 9d. to 7s. 3d. per ton.

Barrow.—The hematite pig iron trade has, so far as prices are concerned, shown a somewhat weaker tone this week, but this is accounted for by speculative reasons, and not by any falling off in the demand. Makers, in fact, are in daily receipt of inquiries for heavy forward deliveries. Some iron went into stock last week, delivery of which is not required for some time, and this influenced timid holders, who sold at 47s. 2d. net cash, buyers offering 47s. 1½d. The normal value of hematite pig iron is still quoted at 49s. to 50s. per ton, net f.o.b., but business is generally done at a shade over warrant prices. Stocks show an increase of 295 tons, and now represent 308,647 tons, or 19,472 tons increase since the beginning of the year.

Iron ore is selling well, and the native mines are well employed, and some recent discoveries of metal have led to a better prospect for the iron mining industry in the future. Prices show no change, native qualities being at 10s. per ton for ordinary sorts, and from 12s. 6d. to 14s. 6d. for best descriptions, net at mines. A steady business is doing in Spanish iron ore, many cargoes of which are imported weekly.

Steel makers are fully at work, and the demand for rails is especially active. Makers keep their mills regularly employed, and they have orders in hand which will maintain general activity for several months to come. The continuance of brisk trade is, in fact, assured for the year, not only in the rail, but in all other heavy branches of the trade. Prices are very steady, and there is an all-round fair margin of profit.

The only note of interest in reference to the shipbuilding and engineering trades is that H.M.S. Powerful, first-class cruiser of 14,200 tons, is ready to take her steam dock trials at Barrow next week. This monster cruiser, ordered January 1st, 1895, will be ready to hand over to the Admiralty some time during June.

In the coal and coke trades there is a brisk business, and the consumption is fuller than it has been for some time past, but prices are unchanged, though firm.

Shipping shows a marked improvement. During the week 9921 tons of pig iron and 17,931 tons of steel were exported from West Coast ports, as compared with 3125 tons of pig iron and 4389 tons of steel in the corresponding week of last year, an increase of 6796 tons of pig iron and 13,542 tons of steel. The aggregate shipments this year up to now represent 120,695 tons of pig iron and 177,200 tons of steel, as compared with 99,542 tons of pig iron and 131,556 tons of steel in the corresponding period of last year, making an increase of 21,153 tons of pig iron and of 45,644 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

CONSIDERING the state of the weather there is hardly any business doing in the house coal trade. The metropolis is taking but a limited quantity. Merchants refuse to purchase forward supplies, and while owners require only a small tonnage, and sea-borne coal is sold at very low rates, inland coalowners continue badly off for orders. Prices are at present very low, and purchasers in a position to place orders for fair tonnages obtain easy terms. Quotations remain about the same, and are not likely to be changed. Silkstone, best, is at 8s. 3d. to 9s.; ordinary, 6s. 9d.; Barnsley house, 7s. 3d. to 8s.; secondary sorts, 6s. 9d.; Flockton, 7s. to 7s. 6d.; and thin seam, 6s. per ton. There is an active demand for steam coal, the tonnage at present leaving the district being very considerable. A large quantity is going to Hull, and a similar remark applies to Grimsby. Everything points to a satisfactory export trade, so far as the local collieries are concerned. A moderate tonnage is being taken by the railway companies, and the general demand is fairly good. Heavy supplies are on the market, and the prices consequently are hardly equal to previous quotations. Barnsley hards are at 6s. 6d. to 7s. per ton; seconds from 6s. per ton. Gas coal is in moderate demand. Manufacturing fuel is fairly active, and values are fully maintained. Small nuts, 4s. 3d. to 5s. 3d. per ton; screened slack, 3s. 3d. per ton; pit slack, 2s. 6d. per ton; smudge, from 1s. to 1s. 6d. per ton. Coke is increasingly called for at from 8s. 6d. to 10s. 6d. per ton for ordinary sorts; best washed coke realising 12s. per ton. A considerable tonnage is being sent to Derbyshire and North Lincolnshire.

The demand for railway material, both on home and foreign account, has largely increased during the last four weeks. Most of the British companies had allowed their stores and stocks to get very low, and the sudden accession of better business put an end to the reluctance to give out orders for wagons, carriages, and other railway goods, both in the rolling stock and permanent way departments. A good deal of work will be found in the erection of the new locomotive shed for the Manchester, Sheffield, and Lincolnshire Railway at Woodburn junction, which is to accommodate over two hundred engines. This is one of the changes necessitated by the extension to London, the old place at Neepsend, west of Sheffield, being altogether inadequate for the increased requirements. All our makers of tires, axles, buffers, springs, &c., are full of work. There is also a good deal more doing in marine material, the specialities recently introduced being an increasing request for ocean-going steamers. The values of iron and steel have, of course, been affected by the betterment in trade. Lincolnshire forge iron is now at 39s. per ton; Bessemer billets, of special carbon, range from £5 12s. 6d. to £6; Siemens-Martin steel, from £7 to £10 10s.; bar iron, £5 10s. at makers' works; hematite irons, 54s. 6d. to 57s. 6d., delivered in Sheffield.

The extraordinary demand for bicycle steel already noted is more than maintained, with the usual result of causing values to stiffen. Some of our manufacturers, believing that this department is certain to furnish abundant work for a considerable time, have laid themselves out to meet the pressure. Should next season's demand be at all equal to what it has been during the last month or two, the extended arrangements for coping with it will enable the wants of Coventry, Wolverhampton, Beeston, and other parts to be more rapidly met. The local firms who recently commenced the production of bicycles in Sheffield—which, it is held here, really ought to have been the home of the cycle industry—are doing very well, their make steadily advancing on the market.

In the lighter trades of the city there is a gratifying improvement reported from the Australasian markets, and much more is doing with South America, the better understanding between Argentina and Peru being a favourable factor in the commercial situation. On the other hand, there is less doing in cutlery for the United States. The leading houses in cutlery, electro-plate, and silver are generally well employed, but the lesser firms could do with more business. The order for cutlery, electro, &c., for the Hotel Cecil—said to be the largest of its kind yet given out—has been divided between Birmingham and Sheffield, Birmingham taking the largest share.

Much better business is reported with Turkey, Egypt, and the Soudan. The Turkish market has latterly yielded some very good orders. The occupation of Egypt by England has led to more trade with the home country, and the quality of the goods ordered has also improved. It is hoped that the operations now proceeding will lead to the reopening of the Soudan, which was closed after the retreat following the former expedition. If the country is again opened to Sheffield goods, the benefit felt here will be most acceptable.

The *Sheffield Daily Telegraph* has initiated a vigorous campaign against excessive smoke. After a series of special articles by an engineering expert, showing that smoke abatement was not only possible, but was already being carried out most satisfactorily in many of the large works, the proprietors of that journal established a Pure Air Fund, heading the subscriptions with £50, the object being to undertake firm and impartial prosecution of all who unnecessarily pollute the air. The intention is to join the Manchester Smoke Abatement League, which is now on a material basis, and undertakes prosecutions in any part of the country.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE week opened badly, business being very languid in nearly all branches of the iron and steel industries in this district; but the engineers' strike having ended, the stumbling block in the way of local trade was removed on Tuesday, and the market at once showed improvement, and consumers who have been holding back, owing to the uncertainty, are now manifesting a disposition to operate again. The strike only lasted a fortnight; and fortunately was confined to narrower proportions than were at first threatened, only the men on Tees-side and the Hartlepools coming out. They have gained their point, however, and work was resumed at some establishments on Wednesday, while at other places operations will not be re-commenced until after the Whitsuntide holidays. The dispute, it will be remembered, arose because the employers in the engineering establishments in the Stockton district intimated that they could not see their way to give, in September, the full 1s. per week advance to such members of the Engineers' Society as were receiving less than 30s. per week. When in March it was agreed to give this second 1s. per week advance to the members of the Amalgamated Society of Engineers, the employers were not aware that any of them were being paid less than 30s. per week; they did not know that the constitution of the Society had been altered so as to admit unskilled men, such as machinemen, planers, &c., and they thus promised the advance to men of this class under a misapprehension. In all other departments they had arranged that the men earning less than 30s. per week should have 1s. advance early in April, but only 6d. advance in September, instead of 1s. to be paid to the more skilled men. This was only just seeing that the wages of such men were not reduced to the same extent as those earning over 30s. a week. The engineers at Stockton objected and struck work, refusing the offer of the employers to submit the dispute to arbitration, as they said there was nothing to arbitrate upon. They had promised all the members of the Society, without distinction, 1s. per week advance, and they would hold them to that promise. They contended for the literal carrying out of the agreement. The Middlesbrough men came out in support of Stockton, and afterwards the Hartlepool engineers, after the masters resolved to discharge 25 per cent. of the men weekly. On Monday and Tuesday conferences between the employers and the representatives of the men took place, and on the latter day the difficulty was removed by the masters agreeing to carry out the arrangement made in March literally, paying every member of the Society the 1s. in September whatever his rate of remuneration. The actual amount in dispute was very small, there being really very few men in the Amalgamated Society that are receiving less than 30s. per week, but the question was fought as a matter of principle. Certainly a large amount of money has been sacrificed in support of it, but now that they know of the alteration in the constitution of the Engineers' Society the employers can guard against a similar arrangement in future agreements.

A stronger pig iron market has been shown since Tuesday, inquiries have increased, and sales have become more numerous, but not till after the Whitsuntide holidays is anything of importance likely to be done. Nevertheless, the outlook may be described as more satisfactory, though a time is at hand when business is often slack, for there is generally only a small amount of buying in June and July. Probably there may not be anything approaching activity until the autumn demand sets in in August, and consumers are not in any hurry to operate. Exports of pig iron, so far this month, from the Cleveland district, have been good, though they fall short of those of April, and as the local consumption will be curtailed on account of the holidays, it is probable that the decrease in the stock of Cleveland pig iron will be very small, if there is not an increase. Last month, with a larger shipment, the decrease was only 5558 tons, and very little has been done to reduce the production of Cleveland pig iron this month. It would be well if some of the makers would blow out, say, three or four furnaces; the production would then be brought below the consumption over the quiet summer months, and the market would be considerably strengthened. The exports of pig iron from the Cleveland district this month up to Wednesday night were 63,243 tons, as compared with 68,304 tons in April, and 64,899 tons in May, 1895, to 20th. The stock of Cleveland pig iron in Connal's warrant stores on Wednesday night was 197,603 tons, or 3847 tons increase this month, the bulk of the increase accumulating in the early part of the month, as very little has been added during the past week.

Quotations for pig iron have been somewhat stiffer this week. No. 3 Cleveland pig iron has been obtainable at 37s. 3d. per ton for prompt f.o.b. delivery, both from makers and merchants, but since the engineers' settlement all the sellers have put up their rate to 37s. 6d., and some makers will not take less than 38s. There was, early in the week, some business at 37s. 6d. for June deliveries, but more than that is asked now. Cleveland warrants have been quoted this week as low as 37s. 1d. cash, but on Tuesday they rose to 37s. 3½d, and on Wednesday the influence of the termination of the strike making itself felt there was a further rise to 37s. 9d. No. 1 Cleveland pig prices have ranged between 38s. 3d. and 39s., the general quotation having been 38s. 6d. No. 4 Cleveland foundry pig iron is at 36s. 9d., and grey forge at 36s. 3d., but business was done at less early in the week. Mixed numbers of Cleveland hematite pig iron have been sold at 45s. 9d., but 46s. is generally quoted, which is considerably more than is being offered for hematite warrants, but practically no one cares to buy the latter, as they are not sure of the brand that will be supplied to them when they purchase warrants, and they may get a brand which they do not care for. Rubio ore is at 12s. 7½d. per ton, delivered at wharves on the Tees.

Except for rails, the demand for finished iron and steel has become slack, and prices are 2s. 6d. per ton easier than last week. Most manufacturers, however, are still well supplied with orders, and works are regularly employed. There is great activity at the rail mills, and makers have all they can do to keep up with the orders. For heavy steel rails they quote £4 10s. per ton at works, and this they have been able to realise. The demand for plates, angles, and bars is quieter than for some time past. Steel ship-plates are reduced to £5; steel ship angles to £4 17s. 6d.; iron ship-plates to £4 17s. 6d.; iron angles to £4 15s.; common iron bars to £4 17s. 6d.; and best bars to £5 7s. 6d., all less 2½ per cent. and f.o.t. Puddled bars are at £3 5s. net at works.

Shipbuilders are very well occupied, and appear to be booking orders as quickly as contracts are completed. Sir Raylton Dixon and Co., Middlesbrough, are building a series of steel towing vessels, which are intended for a new method of coal-carrying across the North Sea. The vessels are for the Schupvart Steenkolen Maatschappij, of Rotterdam, and the first was launched a few days ago. It is 170ft. long, 32ft. beam, and 13ft. 7in. deep, and the deadweight cargo capacity is 1000 tons. These vessels will be towed by screw colliers, which themselves will carry 1700 tons of coal between the coal ports of the North of England and Rotterdam. They will be fitted with sails and heavy chains and anchors, so as to be quite independent and seaworthy, should the steamers have to cast them off at any time through stress of weather. Sir R. Dixon and Co. have secured an order for a steamer of 5000 tons carrying capacity, for Messrs. Cory and Sons, of London, and Messrs. Short Brothers, of Sunderland, will build a large steamer for the Nitrate Producers Co., and similar to the Juanita North launched for the same owners a few days ago. The Tyne Pontoon Company is enlarging its dry dock at Wallsend, and when completed, it is said, will be the largest on the North-East Coast. It will be 550ft. long, and have a depth of 26ft. of water on the sill. Messrs. R. Cragg and Sons a few days ago launched the first vessel which they have built at their new yard at Middlesbrough.

The executive council of the United Society of Boilermakers and Iron Shipbuilders have decided to present to Mr. Robert Knight a memento of the esteem and goodwill of the members, and are raising voluntary subscriptions for that purpose. The proposal is warmly supported in all parts of the country. Mr. Knight has been twenty-five years the secretary of the organisation, and is as highly esteemed by the employers as by the men themselves. If all trades union officials were as reasonable as Mr. Knight there would be few strikes. Mr. Knight has been long an ardent advocate of arbitration and conciliation in trade disputes.

The first sod of the North Sunderland Railway, which will run from the Chathill station on the North-Eastern between Newcastle and Berwick to the place named, was cut on the 14th inst.

On Tuesday electric trams commenced to run at Hartlepool, the overhead trolly system being adopted.

The coal trade is improving, more especially the steam coal branch, and the Northumberland pits are profiting the most by this. The price of best steam coal is stiffer, 8s. 3d. per ton f.o.b. being the figure. It is to be regretted that the Durham miners continue to display such hostility to the Conciliation Board, in spite of the good advice given to them by their Executive Council. The second ballot has been as adverse as the first, and the Board will, therefore, come to an end on August 4th. Only 17,556 voted in favour of the continuation of the Board, 33,114 voted against, and 13,631 were neutral, but all the collieries did not vote. The Earl of Durham has concluded the agreement to transfer all his collieries to Messrs. James Joicey and Co., of Newcastle-on-Tyne, who are already amongst the largest colliery proprietors in Durham. The Earl's collieries are fourteen in number, produce over 2,000,000 tons of coal per annum, of gas, house, and steam coal, and employ 8000 men and boys. Included in the purchase are the Earl's nineteen steam colliers, the railways and railway plant connected with the collieries, thirty locomotives, and the coal shipping station at Sunderland. Messrs. Joicey previously had 13 collieries, 300 coke ovens, and 30 steam colliers. Now, therefore, they will own twenty-seven of the best collieries in Durham, with a production of 4,500,000 tons per annum, and they will own forty-nine steam colliers. They will thus be the largest firm of coalowners in this country, if not in the world.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has been a firmer feeling in the iron market during the past week. An impression has become general that the dispute in the engineering branch of the shipbuilding trade is likely to be arranged without resort to a strike, and this has had a favourable effect. Consumers are also found to have been purchasing more freely, while "bears" are reported to have been covering their over-sales. All this has tended to strengthen the tone of business, and to prevent a decline in prices. Indeed, some kinds of iron have been selling at a little more money.

In the warrant market there was a considerable business early in the week, mainly between dealers, the public holding aloof from investment in iron. At the same time, there is a pretty general belief among those most intimately acquainted with the trade, that prices are likely to be well maintained, so long as the manufacturing branches continue busy. Business was done in Scotch warrants from 45s. 11d. to 46s. 3d. cash, and 46s. 2½d. to 46s. 4½d. one month, the quantity of iron changing hands being considerable. In Cleveland warrants business was quiet, transactions taking place from 37s. 1d. to 37s. 3d. cash, and at 37s. 5d. one month. For hematite warrants there was only a limited demand, and that was mainly for delivery a month hence. Cumberland warrants sold at 47s. to 47s. 1d. cash, and 47s. 2d. to 47s. 4½d. one month.

The output of Scotch pig iron is fully maintained. Indeed, since last report an additional furnace has been put in blast. There are now 40 furnaces producing ordinary, 30 hematite, and three basic iron, the total of 82 comparing with 77 at this time last year.

Prices of makers' iron have been steady:—Govan, Monkland and Carnbroe, Nos. 1, are quoted 47s.; Nos. 3, 45s. 6d.; Clyde, No. 1, 50s.; No. 3, 47s.; Summerlee, Calder, and Gartsherrie, Nos. 1, 50s. 6d.; Nos. 3, 48s.; Coltness, No. 1. 53s.; No. 3, 48s. 6d.; Glengarnock at Ardrossan, No. 1, 50s.; No. 3, 46s.; Eglinton, No. 1, 47s.; No. 3, 45s.; Dalmellington at Ayr, No. 1, 46s. 6d.; No. 3, 44s. 6d.; Shotts at Leith, No. 1, 52s.; No. 3, 48s. 6d.; Carron at Grangemouth, No. 1, 52s. 6d.; No. 3, 48s. 6d.

Stocks of pig iron in the public stores in Glasgow remain practically as they were a week ago, the total being about 73,000 tons larger than at this time last year.

The pig iron shipments are light, amounting to only 4690 tons, against 7848 in the corresponding week of last year. There is no improvement in the inquiry from abroad, but the home consumption of pig iron just now is fortunately so good that the smallness of the reports is less felt than it would be in other circumstances.

In the finished iron department a steady business is being done, with scarcely any change in prices. Sheets are in good request, and the tube makers are for the most part actively employed.

Locomotive engineers are full of work and marine engineers are fairly supplied, while founders and ironworkers generally are obtaining a fair market for their goods.

All departments of the steel trade are busy, and makers of shipbuilding material are taking a less serious and apprehensive view of the labour question than they did a week or two ago.

The coal trade does not exhibit any change for the better. The shipment from Scottish ports in the past week amounted to 153,733 tons, against 182,105 in the preceding week, and 167,501 in the corresponding week of last year. Prices f.o.b. at Glasgow are, for main coal, 5s. 9d.; splint, 6s. 3d. to 6s. 6d.; ell, 6s. 3d. to 6s. 9d.; and steam, 7s. 6d. per ton.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

EXPECTATIONS at Cardiff last week were not fully realised as to the shipments of coal, tonnage coming in rather slowly, but as it was the export of the week exceeded 36,000 tons, and several notable cargoes were included. This week one steamer left Cardiff for Batavia with 5000 tons, and several large ones for Malta, Monte Video, &c.

Swansea coal business last week was very slack, nothing like the average being reached, and Newport totals were under the mark.

These matters are only regarded as temporary, and good business is anticipated generally, in front of the public holidays, after which some degree of lull is tolerably certain. On 'Change, Cardiff, this week, the tendency has not been to book freely, as a hope of better prices prevails, and a good sign is visible that best seconds are in capital demand. More business is being done in dry coals, and the coal of the Monmouthshire valleys continues to be inquired after. The energy shown by railway speculators in pressing forward their schemes to get into these valleys, indicates a hopeful view of the future of that great coal district. The Tredegar and Rhymney Iron and Coal Companies, with their respective fine areas of excellent coal, may be expected soon to figure even more extensively than at present.

In the Glamorganshire districts Dowlais-Cardiff is beginning to figure, and the character of the coal is well sampled at the Cardiff Exhibition, where it comes in for close scrutiny at the hands of experts.

I see that a contract for 45,000 tons of South Wales coal for the Portuguese Railway Company has been secured by O. Herold and Co., of Lisbon. The Government of Surinam figures also for 2000 tons of Cardiff steam coal. Swansea continues its despatch of anthracite to the States, but last week it was under 2500 tons.

A slight improvement has begun to characterise the Rhondda Valley output, where, at the upper part in particular, there has not been the weakness which has characterised the lower districts. Ynysyfero is working regularly, but at the Bute trade is slack, and the dispute at the Bwllfa, which is one of the Ocean collieries, remains unsettled. The stoppage of that colliery and a part of the Ton pit is estimated to have been a loss to the district of £80,000. There is a dispute also on at the Mardy, Rhondda Fach, and a large number of working places have been stopped in consequence of the colliers refusing to do certain work at the rates offered. There is also a fear of a rupture at the Tylorstown collieries, if the management presses its contention about ripping the top without powder. My final item of labour difficulties is the Plymouth arbitration, which is to be given at the end of the week.

One of the events of the week at the docks, Cardiff, has been the presence of the twin screw steamer America, one of the finest ships owned by the West India and Pacific Steamship Company, Liverpool. She is in the Roath Basin, taking in 3500 tons bunker coal, and will proceed to Cape Town *viâ* New York. Her dimensions are interesting:—476ft. long, 55ft. beam, 40ft. depth, net register, 5407 tons; carrying capacity, 12,000 tons. Bunkers supplied by the Powell Duffryn Co.

Mid-week coal prices Exchange, Cardiff, were as follows:—Best steam coal, 10s. to 10s. 3d.; best seconds, 9s. 9d. to 10s.; ordinary seconds, 9s. 3d. to 9s. 6d.; dry coal, 8s. 7½d. to 9s. Monmouthshire coal as follows:—Western Valley, 8s. 3d. to 8s. 6d.; Eastern Valley, 7s. 9d. to 8s. House coal continues dull. Some of the weather prophets say that a slight improvement in price is likely before the really summer weather sets in, as some continuance of rain and colder weather at Whitsuntide is likely. Prices remain, subject to special arrangement, best household, 9s. 9d. to 10s. 3d.; No. 3 Rhondda, 9s. 6d.; brush, 7s. 9d. to 8s.; small, 6s. 3d. to 6s. 6d.; No. 2 Rhondda, 7s. 6d. to 7s. 9d.; through, 6s. to 6s. 3d.; small, 4s. 3d. to 4s. 6d.

Swansea coal prices are:—Anthracite, best, 11s. to 11s. 6d.; seconds, 9s. to 10s.; ordinary, 8s. to 8s. 9d.; culm, 4s. to 4s. 6d.; steam, 9s. to 10s.; seconds, 8s. 3d. to 9s.; No. 3 Rhondda, 9s. 6d. to 10s.; No. 2, 8s. 6d. to 9s. 6d.

Coke at Cardiff is in good demand. Furnace, 13s. to 14s. 9d.; foundry, 15s. 6d. to 16s. 6d.; special, 19s. 6d. Patent fuel, Cardiff and Swansea, is in moderate demand at last prices.

Pitwood at Cardiff has experienced a slight relapse, and prices are about 1½d. less than at the beginning of the week.

In iron and steel a fair amount of business is being done, and works in the Swansea district are busy. A moderate make is going on at Blaenavon and Dowlais, and Cyfarthfa is busier with steel bar and crop ends, and its revived steel rail industry.

I note that pig iron is coming in extensively from Millom and Middlesbrough, Swansea receiving 800 tons last week. Cargoes of ore, too, are numerous to Blaenavon, Dowlais, Cyfarthfa, Ebbw Vale, and Swansea. The last-named received 2000 tons last week. Swansea Hematite and the Newport Patent Nut and Bolt Company figure well.

Briton Ferry Ironworks are arranging for a new movement, calculated, it is thought, to affect foreign competition. This is to run steel ingots into moulds fresh from the blast furnaces, thus obviating re-smelting. This is expected to lessen considerably the cost of production. A good deal of pig iron is being turned out at these works, and it is satisfactory to note that the demand is in excess of supply.

In tin-plate prices are slightly better, and more work is being turned out. If this should be followed by an increased demand, the hopes of tin-plate manufacturers and men would soon be revived. Unfortunately, though some small cases of improvement are recorded, the general character of the trade remains much about the same, and will continue until wages have been reduced to a point enabling manufacturers to turn out plates without loss, and to compete.

Taking a survey over the district, I find that the Western Tin-plate Works Llanelly will start in a few days, on a 15 per cent. reduction, for six months. These works have been idle ten weeks. The Ashburnham men stopped on Saturday, but resumed for a week on the 15 per cent. reduction. At Pontardulais the Teilo, Cambrian, and Clayton, and also the Glamorgan, are working at the same rate. This limit seems to hit the mark, and it is expected that all works now going at higher figures will have to adopt the same.

At the Villers Tin-plate Works on Saturday Messrs. Davy, Sims, and Taylor, directors, who had resigned, were unanimously re-elected.

Reports from the Exchange, Swansea, record a large attendance of members this week to hear Mr. Stanley's speech on opening out Africa to the tin-plate industry. This speech may be briefly summarised as an able investigation into the decline of the tin-plate trade, coupled with promptings to the Welsh to emulate Germany in its canvassing the world for business. Africa, he cogently showed, would be a grand market.

Iron and steel quotations this week are as follows:—Glasgow pig, 46s. 0½d.; Middlesbrough, No. 3, 37s. 2d.; hematite, 44s. 6½d.; Welsh bars from £5 10s. Iron plates, £6 15s. to £6 17s.; steel, £6 10s. to £6 12s. 6d.; Bessemer steel bars, £3 17s. 6d.; Siemens, £3 18s. Steel rails, heavy, £4 10s. to £4 12s. 6d.; light, £4 15s. to £5 5s. Tin-plates: Bessemer steel cokes, 9s. to 9s. 3d.; Siemens, 9s. 3d.; ternes, per double box, 16s. to 17s. 6d.; best charcoal, 12s. 6d. to 12s. 9d. Block tin, £60 6s. 3d. to £60 7s. 6d

The water supply of various districts in Wales is meeting with close attention, and the public interest in this has been increased of late, on account of the extraordinary dryness of the season. At Llanelly it was reported last week that the reservoir was failing rapidly, a million gallons a day going to waste. Stringent measures were adopted. At Merthyr the new reservoir is now being formed, and is to be pressed forward. Llanidloes is going in for a water-supply. The London scheme for acquiring a great watershed in Wales is again to the front. Mr. J. A. B. Williams, who engineered the Cardiff scheme at Taff Vaur, is in consultation; and Mr. R. Middleton, of London, an engineer of eminence, has the affair well in hand. A few figures will show the vastness of the scheme. The estimated expenditure is 10 millions sterling. It is proposed that the head reservoir shall be on the Usk, near Trecastle, and to contain 4,538,000,000 gallons. The average of the gathering grounds is about 122 square miles, namely, 61 square miles in the Usk Valley, 18 in the Irfon Valley, and 43 in the Towy Valley. Welsh opposition threatens to be strong. One of the objections named is a practical one, namely, that Wales will urgently need its own water sheds. Another is one of sentiment, that the London scheme will obliterate a number of places associated with the events of past history, and the lives of memorable men.

Lord Clinton's Committee of the House of Lords, which has kept the coal and railway works of Wales lately pleasantly exercised, with alternate winnings of the Bute, Barry, and Taff Vale companies, has decided that clause 25 of the Taff Vale Bill, by which promoters sought to be relieved of certain obligations under which they render services at the Bute Docks, should be struck out.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

ACTIVITY in the various departments of the iron and steel trade has further increased, and there was also a marked improvement to be perceived in the tendency of quotations. Exports have been, on the whole, pretty heavy during the past week.

Silesian iron masters describe the business doing as altogether satisfactory. The different branches are all very busy, numerous orders coming in almost daily, which, though often of small weight, will keep the establishments briskly engaged for a considerable time. Prices are firm and paying, generally; further advances are not expected to take place in the immediate future. Production of pig iron in Silesia was, for the first quarter of present year, 145,232 tons, against 125,496 tons for the corresponding period the year before.

In Austria-Hungary the market for iron and steel continues brisk, inland consumption being pretty large. Offers from foreign houses have of late been a trifle less numerous, and this is having a good influence on prices. Sheets have already been slightly raised, and for several other articles an official advance is expected during this week or the next. The railway and engineering departments are likely to be busily occupied for some time ahead. List rates are: For common forge pig, 45 to 46 fl.; grey do., 47 to 51 fl.; Bessemer, 49 to 51 fl.; ingots, 76 to 80 fl.; Styrian bars, 115 to 120 fl.; girders, 107 to 110 fl.; heavy plates, 180 fl.; tank do., 135 fl.; sheets, 140 to 160 fl.; galvanised sheets, 205 fl.; all per ton free Vienna. Tin sheets cost 26 fl. per box. Austro-Hungarian export trade has been, all things considered, rather dull for some time past. In the export trade to Roumania, for instance, Austria-Hungary only took a small part, principal supplies coming from England, Germany, and Belgium. This is due to the unfavourable condition of prices. Basis quotation for Silesian bars was, for 1895, M. 100 p.t., free Gleiwitz, while Styrian bars stood at 100 fl. p.t., free Donawitz. In 1895 one of the leading Silesian firms sent more than 2000 t. plates to Roumania at M. 221 p.t., free Galatz, while the price for Styrian plates would have been M. 240 p.t., free Galatz.

Concerning the French iron market, extremely good accounts are given. A very lively business is doing in the raw and in the finished iron and steel trade, and prospects for further employment are bright, producers having their books well filled with orders for home and for foreign consumption. Quotations are favourable on the whole. Merchant bars stand on 145f. p.t. free at works, and when orders for immediate delivery are in question, M. 150 p.t. is generally asked. In the Haute-Marne the works have been vigorously engaged since March, and though output is large, makers are hardly able to meet the active demand that has of late been experienced. In Paris prices are steadily maintained on 155f. p.t. for merchant bars, and 165f. p.t. for girders, the latter being in particularly good request on account of the briskness in the building line. In the Departement Nord there has been quite a "rush" on the iron market. Export prices have again shown a rising tendency; basis quotation for bars is at present 145f. p.t., but 150f. p.t. will soon be asked and obtained. A fair number of orders has been secured at the construction shops. In the Maas and Moselle district pig iron is exceedingly scarce, stocks, which were rather low when the revival set in, having now almost entirely disappeared. Forge pig has been offered at 50f. p.t., foundry No. 3 fetching 60f. p.t. Quotations for nearly all articles of finished iron are exceedingly firm.

On the Belgian iron market a fair weight of business continues to be reported, and prices are moving upwards. Export orders have been pretty plentiful.

Increasing animation is reported in the Rhenish-Westphalian iron industry. The works are now all fully employed, and have excellent prospects. Stocks are very low, as the iron produced goes into immediate consumption, and the fact that makers have in several instances refused to accept orders at long terms of delivery, shows that work is plentiful.

Current list rates are, on the whole, satisfactory, leaving a fair profit; further advances in quotations will most likely take place in June or July. There is nothing of special interest to be reported with regard to the pig iron trade. All through last week much life has been stirring, and the different sorts meet with a very good demand at firm prices. Export orders, though increasing in weight and in number, have still to be accepted at comparatively low figures. The malleable iron market shows a bright physiognomy; the occupation at the mills and foundries is as good as can be, and there is a strong inclination on the part of makers to practice a certain reserve with regard to the booking of fresh work, some of the mills finding it almost impossible to execute the orders already booked within the time stipulated. At a meeting held on the 9th inst. the Rhenish-Westphalian rolling mills agreed to raise bars M. 2·50 p.t.; at the same time the Convention of Rolling Mills was prolonged till 1st of May, 1897. The building line is unusually active, and at date structural ironwork is in very brisk request; but in the matter of prices there is not much alteration, only a considerable stiffness is noticeable.

Producers of plates and sheets are well off for contracts, and the indications are all in the direction of a further improvement. Here and there rather more business is reported to be stirring in the wire trade, the steadily rising demand on foreign account being likely to improve the condition of prices, which are very low at present. Rivets sell briskly at firm quotations. The railway and engineering industries show improvement in that the works are more fully employed, but, unfortunately, the contracts in many instances have to be taken at prices that leave only the smallest profit, so keen is competition, both foreign and inland. The situation of the tube mills has perceptibly improved, and stocks are decreasing.

Output of coal in the Saar districts was, for April of present year, 467,200 t. against 40,718 t. for the same month last year: in Silesia 1,080,870 t. were produced, against 922,050 t.; in the Ruhr district 2,885,820 t. against 2,630,100 t., and in the three districts together 4,433,890 t., against 3,959,330 t. during the same month in 1895. Total output of coal during the first four months of the present year was in the Saar district 1,937,270 t., against 1,690,270 t.; in Silesia, 4,572,340 t., against 4,039,160 t; in the Ruhr district, 12,003,950 t., against 10,974,200 t., which shows an increase of 14·7f. per cent. for the Saar district, 13·6 per cent. for Silesia, and 10·3 per cent. for the Ruhr district, against the same period in the previous year.

Production of brown coal in Prussia is stated to have been 5,424,171 t. during the first quarter of present year, increase against the same period last year amounting to 407,844 t.; consumption was 4,369,408 t., or 529,817 t. more than during the first quarter in 1895. The number of men employed was 31,019, or 1305 more than during the corresponding period in 1895.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

GOOD attendance on 'Change. There is a fair demand for steam coal, and prices remain without any change. House coal shipments are good, with prices steady. Tin-plates in improved demand. The iron and steel works are fully employed.

Coal: Best steam, 8s. 3d. to 9s. 6d.; seconds, 7s. 9d. to 8s.; house coal, best, 10s.; dock screenings, 5s.; colliery small, 4s. 3d. to 4s. 9d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 46s. 6d.; hematite warrants, 47s. 5d. f.o.b. Cumberland; Middlesbrough No. 3, 37s. 5d. prompt; Middlesbrough hematite, 45s. 1d. Iron ore: Rubio, 12s.; Tafna, 11s. 3d. Steel: Rails, heavy sections, £4 12s. 6d.; light ditto, £5 f.o.b.; Bessemer steel tin-plate bars, £4; Siemens' tin-plate bars, best, £4 7s. 6d.; all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel, coke, 9s. to 9s. 3d.; Siemens, coke finish, 9s. 3d. to 9s. 6d.; ternes, per double box, 28 by 20 C, 18s. 6d. to 20s. Pitwood: 15s. 3d. to 15s. 6d. London Exchange Telegram: Copper, £46 12s. 6d.; Straits tin, £60 10s. Freights are firm, bot home and outwards

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, May 14th.

THE industrial situation is governed to-day by the same causes which existed three months ago. Mills are generally working to two-thirds capacity, excepting in the Pittsburgh district, where there is greater activity than elsewhere. As a result of the recent steel billet combination, certain concerns are considering the advisability of selling their allotment to the Carnegie people. There are possibilities behind this talked-of purchase of allotments—viz., the control of the steel works themselves by the Carnegie interests. The spirit of combination is rife. Manufacturers are huddling together in and with agreements which are intended substantially to keep prices above the level which competition would naturally determine. The railroads are neither building nor buying up to their average. The plate and structural mills are in sight of a vast amount of work, and it is likely to show itself in a few weeks. There is a greater abundance of engine building and shop work, of equipment and tool work, and of pipe line work. Contractors and engineers have specifications pigeon-holed for a great deal of new summer and autumn work, and manufacturers discount it, anticipating harder prices during the midsummer months. The protection cyclone that is sweeping over the country represents the accumulated indignation of the people over four years of free trade, or the closest approach to it we have had. Prices for almost all commodities are lower than for months. The banks are well supplied with money. Gold exports are large, and business men and bankers are anxiously awaiting the announcement in favour of an unequivocal gold basis at the St. Louis presidential convention to be held June 16th to 20th.

LAUNCHES AND TRIAL TRIPS.

On Thursday, 14th inst., Messrs. Lobnitz and Co. launched from their yard at Renfrew a powerful screw steamer for the United Steamship Company, of Copenhagen. The vessel is built under special survey of Bureau Veritas, and has large accommodation for first-class passengers and emigrants. The owners were represented by Mr. L. C. Caspersen, superintending engineer, under whose supervision the vessel has been built, assisted by Captain Thomsen and Mr. Fricke. On leaving the ways she was named N. J. Fjord by Mrs. Morris, of Ramsey Lodge, Trinity.

On Thursday, the 14th inst., the Tyne Iron Shipbuilding Company, Willington Quay-on-Tyne, launched a large steamer to carry oil in bulk, which has been built to the order of Messrs. Hunting and Son, of Newcastle-on-Tyne. The vessel is of the following dimensions:—Length, 356ft.; breadth, 47ft.; depth, 30ft. 3in. To class 100 A1 at Lloyd's on the spar deck principle for carrying petroleum in bulk, and is to have engines with cylinders 27in., 44in., 77in., by 48in. stroke. These will be supplied by the Wallsend Slipway and Engineering Co., of Wallsend-on-Tyne. Her outfit includes the very latest developments and appliances for the trade that she is intended to be engaged in. The sub-division of the tanks is in accordance with the requirements for carrying oil in bulk through the Suez Canal. On leaving the ways the vessel was named the Oilfield by Miss Arthur, of Glenariff, London.

On the 14th inst. Messrs. Ropner and Son, of Stockton, launched a steel screw steamer of the following dimensions, viz.: — Length between perpendiculars, 270ft.; breadth, 39ft. 6in.; moulded depth, 17ft. 6in.; which they have built for a West Hartlepool firm. The steamer is built off the part awning decked rule, having poop and raised quarter deck, her deadweight carrying capacity being 2600 tons on 16½ft. The saloon and cabins for the captain and officers are fitted in the poop, whilst the engineers are accommodated in iron houses placed on the awning deck near the entrance to engine-room. She is built on the web frame principle, leaving the holds entirely clear for cargo, and carries her water ballast in a cellular bottom and in the after peak; all labour-saving appliances are fitted for the economical working of the steamer, and also for the expeditious loading and unloading of cargoes. She has steam steering gear amidships and screw gear aft, four powerful steam winches, two large donkey boilers working at the same pressure as the main boilers, patent windlass, stockless anchors, &c. The engines will work up to about 700 effective horse-power, and are by Messrs. Blair and Co., having cylinders 19½in., 32½in., and 52½in. by 36in. stroke, steam being supplied by two large steel boilers working at 160 lb. pressure. The steamer was named Ashby by Mrs. J. W. Ropner, of West Hartlepool.

On Thursday, May 14th, Messrs. Furness, Withy and Co. launched from their yard, at Hartlepool, a large steel screw steamer, built to the order of Messrs. The Thompson Steam Shipping Company, Sunderland. She is a fine type of a modern cargo boat, measuring over 320ft. in length, and built throughout of Siemens-Martin steel, with a large measurement and deadweight capacity, and built to the highest class at British Corporation. The vessel is of the single deck type with poop bridge and top-gallant forecastle. The holds are fitted with iron grain divisions, and all decks, deck erections, skylights, bulwarks, bulkheads, &c., are constructed of steel and iron. Cellular bottom fitted all fore and aft for water ballast. The greater portion of the plates are in 24ft. lengths, making the structure of the ship very strong. Four steam winches, donkey boiler, patent steam steering gear amidships, screw gear aft, direct steam patent windlass, stockless anchors hauling into hawse pipes, and other modern appliances are fitted for the handy working of the vessel. The saloon and cabin, providing accommodation for the captain, &c., are handsomely finished in polished hardwood with painted panels. The steamer will be rigged as a two-masted fore and aft schooner, and has been constructed under the supervision of Mr. C. Potts, on behalf of the owners. She will be fitted with triple-expansion engines by Messrs. W. Allan and Co., Sunderland, of massive design, with every provision for the economical working of the vessel. On leaving the ways she was named Carham, by Miss Potts, of Sunderland.

There were launched on the 14th inst., at the yard of Messrs. Sir Raylton Dixon and Co., two steel coal barges, built to the order of the Steam Coal Company, of Rotterdam. These barges have been specially designed by Messrs. Flannery and Tritton, of Liverpool and London, for the transit of coal at sea, the intention being to tow them by steam tugs or by collier steamers. The system of towage by steamer for long distances at sea as an economical means of cargo transit is much in use in America, and is believed to compare favourably with the cost of conveyance in the ordinary way. The barges are each 170ft. long, with a breadth of 32ft. 6in. and 13ft. 7in. depth, and the design includes forecastle and poop decks raised 3ft. above the main deck, and running fore and aft between these two decks are continuous hatch coamings to the same height, the barge being closed in with bulwarks 3ft. 6in. high. The vessel is divided by a collision bulkhead at each end, forming peak water ballast tanks, and with two further water-tight bulkheads, forming a water ballast tank amidships, the latter compartment being further divided longitudinally. Each vessel is provided with two steam winches and a donkey boiler, together with hand steering gear and windlass, and the two masts are arranged to be lowered. The rudder is so arranged that a special movable portion may be added, and the rudder so lowered below the keel line when at sea. The decks are of steel, and the centre ballast compartment continued up to the top of the hatch coaming is also covered with a steel deck, together with a short length of the hatch top at the fore end of each hold, and on these steel covered portions are fitted the masts and winches. The portion over the centre tank is provided with two water-tight hatchways for the access of cargo. Each barge has accommodation for a crew of six hands.

Messrs. J. T. Thompson and Sons, of the North Sands Shipbuilding Yard, Sunderland, launched on the 12th inst. the steel screw steamer Howick Hall, built to the order of the Globe Shipping Company, of Liverpool, of which Messrs. C. G. Dunn and Co. are the managing owners. The principal dimensions are:—Length between perpendiculars, 356ft.; breadth, extreme, 48ft. 6in.; depth moulded, 27ft. 4in. The vessel is built on the spar-deck rules to Lloyd's 100 A1 Class, under special survey, and is a fine example of a modern cargo vessel, with all the latest improvements. Water ballast is carried in a cellular double bottom, right fore and aft, and in the after peak. The whole of the officers' and engineers' accommodation is arranged in the bridge amidships, with a limited number of spare berths for the accommodation of passengers. The crew, firemen, and petty officers are berthed in the top-gallant forecastle. The vessel is rigged as a two-masted fore and aft schooner, with telescopic top-masts to suit the Manchester Ship Canal. A large house is placed at the forward end of the bridge, used as an entrance hall to the saloon, steering-room, and chart-room, the steering gear itself being placed in the aft end of the engine casing. A powerful screw gear is fitted at the after end of the vessel. A large galley, bath-rooms, and other sanitary requirements are placed in the bridge. There are four large cargo hatches, worked by five powerful steam winches, and forward is a patent steam windlass for the working of the stockless anchors. The steamer is replete with every requirement for the comfortable accommodation of the crew, and for the rapid handling of cargoes. The engines are by Messrs. Blair and Co., Stockton-on-Tees, the size of the cylinders being 25in., 42in., and 68in., with a stroke of 45in. Steam is supplied by three large cylindrical multitubular boilers, working at 160 lb. pressure. The vessel was launched by means of hydraulic power by Miss Dunn, sister of the managing owner. The vessel was named by Miss Edith Dunn, of Clare Mount, Wallasley, daughter of the managing owner.

Messrs. David J. Dunlop and Co., engineers and shipbuilders, Inch Works, Port Glasgow, launched from their yard on Saturday a handsomely modelled steel twin screw steamer, of the following dimensions, viz.:—Length between perpendiculars, 205ft.; breadth moulded, 30ft.; depth moulded, 15ft. 9in. The steamer has been built for the New Zealand Government, and is specially designed for cable laying and repairing purposes, two large circular cable tanks being fitted, one forward and one abaft of machinery space. The cable machinery and all fittings for paying out and lifting cables have been supplied by Messrs. Johnson and Phillips, Old Charlton, London. The builders are fitting two sets of triple-expansion engines to the vessel, having cylinders 15½in., 25in., and 40in. diameter, with a stroke of 30in., and two main boilers 13ft. 1in. diameter by 10ft. 6in. long; a large auxiliary boiler is also being supplied. The whole of the machinery has been designed for a working pressure of 170 lb. The outfit of the steamer includes Napier's steam capstan, windlass, and screw steering gear; Clarke, Chapman, and Co.'s steam winches; Davis and Co.'s steam steering gear, and a complete installation of electric lighting and bells by Messrs. W. and J. Robinson, of Liverpool and London. Spacious state-room accommodation, dining saloon, and apartments for navigating and cable officers is provided amidships, whilst the petty officers' rooms and dining saloon are fitted up aft under raised quarter deck; the lighthouse keeper's quarters and crew's accommodation being placed in the forward part of the steamer. The construction of the vessel has been under the direct superintendence of Mr. W. H. Preece, C.B.; Mr. W. R. Culley, having also taken an active interest in the general arrangements and the various details, his large experience in this class of work rendering his advice of great advantage. The steamer was named Tutanekai by Miss Taylor, daughter of the late Dr. John William Taylor, Port Glasgow; and amongst those present who met in the builder's private office were Mr. W. R. Culley, Professor Jamieson and Mrs. Jamieson; Mr. Braid, Postmaster, Glasgow, and Mrs. Braid; Miss Baird, Miss Wylie, Miss Dunlop, Misses Jamieson, &c.

On Thursday, May 14th, there was launched from the shipyard of Messrs. John Readhead and Sons, South Shields, a large handsomely-modelled steamer of about 5000 tons capacity, which has been built for the Prince Line of steamers, of Newcastle-on-Tyne, and is the third vessel built and engined by Messrs. Readhead for this fleet of steamers. The directors of the Prince Line have given the composition of their fleet very careful consideration, and in common with the policy adopted by most large steamship companies, during the past year have disposed of several of the old and small steamers which have become obsolete and quite unable to compete with the greatly improved and larger vessels that, during the past few years, have been put into nearly all trades, and they are now steadily replacing them with steamers of the most modern type, of greatly augmented speed, and specially designed to meet the particular requirements of the various services worked by the vessels of the line. In pursuance of this policy, the Trojan Prince has been built more particularly for the River Plate trade, and will, no doubt, greatly enhance the reputation of the service. She is a somewhat similar vessel to the well-known Tartar Prince, which steamer at present holds the record passage to Argentina of 21 days 1 hour, and has earned for herself a very high reputation among passengers for her great steadiness at sea. The Trojan Prince is somewhat longer, has finer lines, and more powerful machinery, and is expected to attain a speed of thirteen knots fully laden, and make the passage from this country to Argentina —calling at Madeira and Teneriffe with passengers—under twenty days. Very superior passenger accommodation is provided under the bridge deck, with a large airy saloon and music room above, and there is a comfortable smoking saloon on the after part of the bridge deck. Particular attention has also been paid to the ventilation of the saloon and state-rooms, and electric fans have been fitted. The ship will be lighted throughout by electricity. The vessel is built to the highest class of Lloyd's Register, and has been specially strongly constructed. The 'tween decks are very high and available for emigrants, and she has also a large poop suitable for second-class passengers. Special attention has also been paid to the machinery and gear for the expeditious handling of mixed cargoes and heavy weights, and all the deck and other fittings are of the most recent and improved type. The Trojan Prince is expected to leave London in July for Argentina, landing passengers at Madeira and Teneriffe on her way down. She will be under the command of Captain John Hesketh, late of the s.s. Tartar Prince. The propelling machinery has been built under the inspection of Mr. John Trail, and the ship has been constructed under the supervision of Mr. M. C. James. As the vessel left the ways she was named by Miss Scott, daughter of Mr. C. H. Scott, of West Bank, Heaton Mersey, Manchester, chairman of the Prince Line.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

***** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.**

7th May, 1896.

9667. Lamps, W. Fox, Lancashire.
9668. Electric Arc Lamps and Projectors, W. Fox, Lancashire.
9669. Automatic Bread-cutting Machine, J. G. Pike, Norwich.
9670. Bookmark, E. H. Shorey.—(*W. H. Shorey, West Indies.*)
9671. Combined Hollow Brased Forks, A. Bayliss, Birmingham.
9672. Construction of Door Handles, H. S. Stewart, London.
9673. Bed Hammock for Army Tent, F. E. Wood, London.
9674. Obtaining a Level Surface, W. C. Hart, London.
9675. Pneumatic Tires, J. R. Hunt, Sheffield.
9676. Treatment of Brewing Materials, J. A. Fawcett, Doncaster.
9677. Self-propelled Carriages, J. Roots, London.
9678. Sight-protecting Curlers and Wavers, W. H. Platt and E. J. Richards, London.
9679. Feed Heater, Hot Well, &c., Baron Barreto, Brandon.
9680. Dress Suspender, W. J. Fox, Manchester.
9681. Street Lighting by Glow Lamps, H. L. P. Boot, Tunbridge Wells.
96 2. Spinning and Twisting Machinery, J. M. Hetherington, Manchester.
9683. Child's Chair, Swing, and Stool, J. Mitchell, Aston.
9684. Clothes' Props, H. and E. Whittaker, Manchester.
9685. Gas and Steam Engine, E. Hoyle, Todmorden.
9686. Tennis Ball Tire, S. F. Keating, Brighton.
9687. Bicycles, F. Wynne, London.
9688. Velocipede Steadying Device, R. J. Symonds, Liverpool
9689. Making Pressed Articles, R. Bradshaw, Liverpool.
9690. Fire-escapes, I. Knapke and A. C. Robnett, London.
9691. Saw Filing Machines, J. L. McDougall, London.
9692. Ramming Vessels, T. F. Drew, London.
9693. Home Training with Velocipedes, G. Beard, Manchester.
9694. Wheels, J. Burtinshaw, W. Moores, and M. Conlan, Manchester.
9695. Cycle Gear Cases, V. Dugmore, Birmingham.
9696. Cycles, E. M. Carter, London.
9697. Driving Gear, S. G. Mason, R. F. Goyne, and J. Tonry, London.
9698. Puzzle Box, T. H. Saunders and J. H. Brindley, Birmingham.
9699. Decanting Apparatus, C. W. Rands-Allen and W. Boby, London.
9700. Bicycles, Tricycles, &c., W. Madigan, Manchester.
9701. Bicycles and Velocipedes, F. Alexander, Jersey.
9702. Blotters, O. R. Fischer, Germany.
9703. Combined Furniture, W. O. Weddle, Newcastle-on-Tyne.
9704. Feeding Appliances for Animals, P. J. Skill, Nottingham.
9705. Ladies' Dress Pockets, J. Wollman, Rotherham.
9706. Brake Apparatus for Cycles, W. J. Simmons, Bristol.
9707. Platen Printing Machines, C. Butterfield, Nottingham.
9708. Tires for Wheels, W. H. W. and E. P. Furrell, London.
9709. Removing Solids from Vacuum Pans, R. H. F. Finlay, Belfast.
9710. Brakes, &c., D. Tindall and J. Dunbar, Glasgow.
9711. Perpetual Calendars, A. Glendinning, Glasgow.
9712. Stays for Boilers, J. A. McKie and P. M. Baxter, Glasgow.
9713. Signal Indicator for Locomotives, D. Foulis, Glasgow.
9714. Driving Belt Coupling, R. Breckenridge, Glasgow.
9715. Valves, J. Y. Johnson.—(*Redway Manufacturing Co., United States.*)
9716. Waste or Slop Water-closets, T. Dawber, London.
9717. Manufacture of Toy Balloons, J. Harris, Manchester.
9718. Folding Tables, Stands, &c., J. Robertson, Glasgow.
9719. Patent Cyclist Toilet Compactum, J. Cook, London.
9720. Burglar Alarm, J. A. Kelman and H. Yuill, London.
9721. Means for Projecting Boxes, J. M. Banks, London.
9722. Wheel Tires for Bicycles, &c., F. Duffett, Acton.
9723. Corner Mounts for Fenders, G. E. Lancelott, Birmingham.
9724. Pneumatic Tires, E. G. Edmands and R. Edlin, Birmingham.
9725. Rims for Bicycles and Carriages, J. C. Cole, London.
9726. Bill Head Hooks, F. G. Fender and W. E. Coleman, London.
9727. Corset, G. P. Festa, London.
9728. Corset, G. P. Festa, London.
9729. Raising and Lowering Boats, J. Griffin, London.
9730. Tire, S. M. Frankenstein, London.
9731. Coin-freed Game, E. G. Matthewson, London.
9732. Explosion Motor, C. A. de Dion and G. Bouton, London.
9733. Brake Mechanism, C. A. de Dion and G. Bouton, London.
9734. Steering Carriages, C. A. de Dion and G. Bouton, London.
9735. Cycle Handles, G. S. Wallis, London.
9736. Spoons, T. Edge, London.
9737. Pneumatic Tires for Velocipedes, E. M. Payne, London.
9738. Sky Signs, W. C. Barns, London.
9739. Hair Retainer, E. Coombs, Southampton.
9740. Preventing Escape of Acids, H. Gronwald, London.
9741. Thermometric Alarm Apparatus, J. J. Hicks London.
9742. Pianoforte Action, W. Yarrow and L. Courtice, London.
9743. Switching Device, W. P. Thompson.—(*J. Csasznek and M. Kollmann, Austria.*)
9744. Bicycle Lantern, C. M. Bump, London.
9745. Pickers for Looms, J. M. Rose, Manchester.
9746. Packing Lobsters, W. M. Simpson.—(*F. Roberts, Canada.*)
9747. Locking Bicycles and Tricycles, J. C. Grant, London.
9748. Warp Tension, J. Poyser and G. W. Barrows, London.
9749. Treating Refractory Ores, F. Ellershausen, London.
9750. Handle Bars, J. Galt, A. P. Rankin, P. R. Wright, and M. E. Wright, London.
9751. Boat Propelling Apparatus, A. C. C. Asenar, London.
9752. Gum Bottles, G. Musgrove, London.
9753. Grates, H. J. Bickley, jun., London.
9754. Buffers for Railway Locomotives, J. Cowen, London.
9755. Device for Cutting Oranges, H. T. Mylan, London.
9756. Gearing for Cycles, T. A. G. Frost, London.
9757. Inflatable or Pneumatic Tires, H. S. Maxim, London.
9758. Floorcloths or Carpets, &c., F. Fanta, London.
9759. Motor Vehicles, A. J. Boult.—(*La Société Justin Landry and G. Beyroux, France.*)
9760. Transparent Enamels, W. H. Forester and G. Bland, London.
9761. Fastenings for Coffins, A. Smith, London.
9762. Engine Governors, A. S. F. Robinson, London.
9763. Raw Hide and other Belting, S. Schreiber, London.
9764. Letter Boxes, F. Freegard, London.
9765. Indicating or Signalling Apparatus, A. Friis, London.
9766. Bicycles and Tricycles, &c., C. T. Mitchell, London.
9767. Dyeing Fabrics, J. Reixach and F. Bamford, London.
9768. Double Shuttle Looms and Weaves, J. Reixach, London.
9769. Tire Rim for Cycles, G. Fellowes, London.
9770. Gas Engines, J. A. Hockett, Missouri, U.S.A.
9771. Pneumatic Brakes for Cycles, J. J. Eckert, Strood.

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9772. Separating Metals from Ores, &c., J. Lyle, London.
9773. Machinery for Separating Purposes, A. S. F. Robinson, London.
9774. Wheels of Cycles and Vehicles, S. Greenwood, Liverpool.
9775. Filter Funnel, E. E. Heyliss and C. G. Oppermann, Henley-on-Thames.
9776. Ventilator for Carriages, C. E. P. Gabriel, Birmingham.
9777. Boot and Shoe Fastener, J. P. Furlong, Youghal.
9778. Carding Engines, W. Hopkinson and R. Tyack, Accrington.
9779. Construction of Cue Cases, W. J. Peall, London.
9780. Rulers, R. W. Hodgson, Newcastle-on-Tyne.
9781. Wall Bracket for Photographs, W. J. Robinson, Bristol.
9782. Strainers for Baking Pans, &c., L. W. Lee, Bilston.
9783. Beverage for Invalids, J. C. Harvey, Wolverhampton.
9784. Pumping Water, J. Hughes and C. Lancaster, Liverpool.
9785. Machines for Washing Clothes, A. Barrett, Keighley.
9786. Cigars, A. E. Smith, Huddersfield.
9787. Moulding Boot Stiffeners, W. H. Dorman, Stafford.
9788. Connections, &c., for Pipes, H. P. Lavender, Walsall.
9789. Superphosphates, F. M. Mooney and A. Dickson, Dublin.
9790. Stop Indicator for Road Cars, E. Causon, Bristol.
9791. Preventing Puncture in Tires, E. T. Morland-Johnson, Blaenau Festiniog.
9792. Dish for Photographic Purposes, W. S. Wain, Ripley.
9793. Protector for Chest and Lungs, W. Brown, Swansea.
9794. Brushes, &c., W. L. Byers, Sunderland.
9795. Operating Cash Tills, S. Mason and W. Snelgrove, Birmingham.
9796. Tobacco Pipes, F. Page, London.
9797. Bottles, H. B. Lowe and P. Harris and Co., Birmingham.
9798. Game, H. O. and J. O. Roberts, Gloucester.
9799. Photographic Printing Frames, E. Marlow, jun., and T. Marlow, Birmingham.
9800. Cycles, J. Darling, Glasgow.
9801. Locks for Railway Carriage Doors, D. Maxwell, Dundee.
9802. Spectacles, A. Marshall, Glasgow.
9803. Filtering Presses, J. Williamson, Glasgow.
9804. Wheel Tires, W. H. Luther and J. Cockburn, Glasgow.
9805. Scrubbing Brushes, H. Rowlands, Liverpool.
9806. Starting, &c., Electro-motors, H. Pieper, fils, London.
9807. Sleeve Links and Solitaires, J. Cheshire, Birmingham.
9808. Adapting Books for Postage, F. Richmond, London.
9809. Animal Traps, E. C. Waldurf and F. T. Reynolds, London.
9810. Guard, &c., for Carving Forks, J. Forbes, London.
9811. Folding Cots, T. Bass and C. M. Römpler, London.
9812. Cycle and other Oil Lamps, H. Salsbury, London.
9813. Velocipedes and Rolling Stock, A. Squire, London.
9814. Manufacture of Roofing Tiles, C. Wicke, London.
9815. Safety Revolving Window Frame, W. Tomlin, London.
9816. Coin-operated Gas Meter, W. Britain, jun., London.
9817. Electric Lamps, E. Bach, H. S. Lewis, and A. B. Saunders, London.
9818. Tools for Making Boots, &c., C. W. Harvey, London.
9819. Puzzles, H. Marles, Brighton.
9820. Coupling-boxes for Electric Circuits, M. Binswanger and F. G. Bell, London.
9821. Saddle for Velocipedes, H. P. de Lastelle, London.
9822. Anti-friction Ball Guide, C. H. Worley, London.
9823. Pneumatic Tires and Rims therefor, P. Mercier, London.
9824. Holder for Legs of Mutton, A. Mention, London.
9825. Manuacture of Needles, A. Schoeneweiss, London.
9826. Cork-drawing Machines, A. Whitfield, London.
9827. Velocipedes, W. H. Williams, London.
9828. Polishing Apparatus, N. W. Russ, London.
9829. Producing Designs upon Paper, G. R. Hildyard, London.
9830. Preventing Skirts from Sagging, C. G. Mackay, London.
9831. Tires for Wheels of Bicycles, J. C. F. Johnson, London.
9832. Exchange Telephone Systems, J. E. Kingsbury. —(*The Western Electric Company, United States.*)

9833. Reproducing Pictures, &c., J. H. Player, London.
9834. Window Sashes for Carriages, E. Cunningham, Liverpool.
9835. Measuring, &c., Liquids, T. Saccaentz, Manchester.
9836. Boots and Shoes, W. Ward, Birmingham.
9837. Velocipedes and Road Vehicles, H. D. Dance, London.
9838. Compositions for Building Purposes, J. Wilkinson, London.
9839. Carrying-off Liquid Deposits, E. de Brabander, London.
9840. Protecting Travellers' Boxes, J. M. Banks, London.
9841. Incandescent Gas Lighter, C. Weston, London.
9842. Preparing Milk Sugar from Milk, H. Edwards, jun., London.
9843. Electric Current Meters, &c., R. P. Wilson, London.
9844. Feed-water Purifying Apparatus, J. Bruun, London.
9845. Hat Grip, J. N. Spence, London.
9846. Bedsteads, J. H. Morley, London.
9847. Sinking and Lining Mining Shafts, C. Walker, London.
9848. Embroidering Machines, E. and R. Cornely, London.
9849. Looms for Weaving, J. A. Bannister, London.
9850. Spring Clutch Mechanism, A. Brancher, London.
9851. Swath-turners, E. C. Blackstone, London.
9852. India-rubber Printing Stamps, F. R. Houten, London.
9853. Electric Belts and Appliances, E. S. Col icott, London.
9854. Nosebag Support, D. Black, London.
9855. Boots and Shoes, G. T. Mackley, London.
9856. Bottle Capsules and Labels, E. M. Llewellyn, London.
9857. Taps, H. Hatton, T. W. Nayler, and G. Nayler, London.
9858. Ejector Mechanism of Linotype Machines, The Linotype Co., Ld.—(*The National Typographic Company, United States.*)
9859. Distributing Mechanism of Linotype Machines, The Linotype Co., Ld.—(*The National Typographic Company, United States.*)
9860. Drawing Implement, G. Grund, London.
9861. Burners for Acetylene Gas, E. Hütter, London.
9862. Liquefying Acetylene Gases, E. Hütter, London.
9863. Card Cases, A. J. Needham and W. C. Needham, London.

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9364. Wristband Cuff Attachment, M. A. Alger, London.
9865. Clip for Trousers, &c., E. de V. du Boulay, Isle of Wight.
9866. Saddles for Treadle Machines, A. W. Murray, Dublin.
9867. Earthenware Pipe Joints, &c., R. Ewing, London.
9868. Saddles for Bicycles, &c., W. G. Manwaring, Banbury.
9869. Machines Driven by a Crank, R. Ewing, London.
9870. Screw, C. Leigh, London.
9871. Pickers for Underpick Looms, J. Curtis, Manchester.
9872. Rollers for Dyeing Apparatus, H. D. Halstead, Manchester.
9873. Golf Clubs, C. D. McLachlan and P. S. Grant, Glasgow.
9874. Thermometers, G. Bennett, London.
9875. Game of Cards, G. Chalmers, London.
9876. Apparatus for Balling Warps, J. Rhodes, Bradford.
9877. Stopping Shrinkage of Fabrics, T. Illingworth, Bradford.
9878. Music Stools and the like, A. Plant, Glasgow.
9879. Railway Brakes, J. W. White, Liverpool.
9880. Tennis Balls, W. P. Wethered, Liverpool.
9881. Dregs Guard for Teacups, &c., H. Britten, Sheffield.
9882. Closing Water-tight Doors, J. A. Crawford and T. A. Crawford, Newcastle-on-Tyne.
9883. Check Registers, A. Cotgreave and W. Morgan, Birmingham.
9884. Cycle Prop, J. Reynolds and J. Reynolds, jun., Nottingham.
9885. Gearing of Bicycles, J. Plummer, Midlothian.
9886. Cases for Holding Cutlery, &c., J. C. Wain, Sheffield.
9887. Raising Nap on Fabrics, J. Tomlinson, Manchester
9888. Menstrual Pad, F. W. Cates and G. Graham, London.
9889. Brakes for Railway Trucks, T. W. Mayos, Trewaugh.
9890. Kinoscopic Apparatus, W. Hunt and J. Trotter, Bothwell.
9891. Leather Skiving Machine, E. E. Bartlett, United States.
9892. Adjustment of Seats and Saddles, E. J. Byrne, Dublin.
9893. Carrying Bag, W. M. Storrar and W. Maconachie, Dundee.
9894. Fire-grates and Stoves, S. H. Crocker, London.
9895. Cup Stands, Mansell, Hunt, Catty, and Co., Ld., and F. H. Taylor, London.
9896. Registering Safety Till and Box, M. Bliss, London.
9897. Basket for Market Produce, W. C. Mullett, London.
9898. Cycle Rest or Supports, H. Howland, London.
9899. Wheels, F. Klingelhöfer, London.
9900. Fixing Collars, J. W. Vose and J. Parkinson, London.
9901. Glass Etching Plates for Copying, T. Löhler, Berlin.
9902. Crank Driving Gear, A. E. G. Birkbeck, London.
9903. Locks, W. Ferdinand and E. Lyon, London.
9904. Saddles for Cycles, M. de Laski, London.
9905. Binders or Files for Music, G. W. Owen, London.
9906. Moistening Device, The Rapid Damper Company, Ld., and J. Parker, London.
9907. Chimneys, M. G. J. Bate and F. W. Collins, London.
9908. Compressed Bakers' Yeast, M. P. Hatschek, London.
9909. Hair Curlers, A. Rowe, London.
9910. Secondary Batteries, A. Schanschieff, London.
9911. Stands to Exhibit Cut Flowers, W. B. Press, Leytonstone.
9912. Black Azo Dyestuffs, E. R. von Portheim, London.
9913. Tires and Wheels for Vehicles, H. Hicks, London.
9914. Stylographic Paper, L. Capazza, London.
9915. Showcards, Tablets, &c., J. R. Phelps, London.
9916. Connecting the Pedals of Cycles, A. E. Payne, Barnes.
9917. Cycle Stands, W. P. Thompson.—(*J. B. Fondu, Belgium.*)
9918. Fastener for Boots and Shoes, W. Kretschmann, Liverpool.
9919. Electrical Exhausted Tubes, W. Friese-Greene, London.
9920. Supplying Currents of Air, G. R. Hildyard, London.
9921. Carding Engines, J. Y. Johnson.—(*Maschinenfabrik O. Schimmel and Co., Germany.*)
9922. Making, Lighting and Heating Gas, J. Sibley, London.
9923. Increasing Stability of Beer, H. Gronwald, London.
9924. Cartridge Clips, H. H. Lake.—(*The Lee Arms Company, United States.*)
9925. Magazine Fire-arms, H. H. Lake.—(*The Lee Arms Company, United States.*)
9926. Match-boxes, J. H. Iredale, London.
9927. Uniting Broken Shafts, A. C. Sheppard, London.
9928. Furnaces for Heating and Drying, L. Richard, London.
9929. Self-returning Bell Indicator, R. W. Lane, London.
9930. Regulating Motion for Twiners, J. Battersby, Bolton.
9931. Pedals, H. Gstirner, London.
9932. Bicycles, G. E. Wade, London.
9933. Sleeve Links or Fastenings, J. Gordon, Birmingham.
9934. Roller Blind Ends or Fittings, F. W. Nicholls, Birmingham.

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9935. Developing Photographic Plates, &c., J. G. Williams, Manchester.
9936. Tubular Knitted Fabrics, O. Tabberer, A. Lorrimer, G. O. Tabberer, M. Lorrimer, and F. S. Shipp, Leicester.
9937. Revolving Link Ladder, C. W. G. Aldridge, Feltham.
9938. Mustard Plasters, J. Millard, London.
9939. Cycles, C. Merington, London.
9940. Four-way Valves for Furnaces, C. Wood and A. C. Caddick, Sheffield.
9941. Woollen Bleaching, T. Parry-Jones, Montgomeryshire.
9942. Mechanically-operated Vehicles, J. Southall, Worcester.
9943. Steel Shape for Soft Felt Hats, W. J. Clarke, Great Yarmouth.
9944. Vertical Retorts, A. C. Thomson, Cobbinshaw, near Edinburgh.
9945. Ball Valve, R. and G. Harding, London.
9946. Pie-making Machinery, J. S. Smith, Bradford.
9947. Covers for Tobacco Pipes, A. A. Percy, London.
9948. Feeding Water into Steam Boilers, W. Burns, Glasgow.
9949. Staff-notation Music, J. Findlay, Glasgow.
9950. Means for Disinfecting Purposes, R. S. Brownlow, Manchester.
9951. Toy or Race Game, P. Pownall, Manchester.
9952. Railway Carriage Windows, W. Wright, Manchester.
9953. Brakes for Cycles, T. Crowther, Bradford.
9954. Tire and Rim for Cycles, &c., R. Willington, London.
9955. "Swathing" for Mowing Machines, G. Farris, Salisbury.
9956. Automatic Mudgards for Bicycles, E. and E. Hodgson, Manchester.
9957. Metallic Packings, W. P. Thompson.—(*T. Lister, South Africa.*)
9958. Multiplying Power of Steam, &c., J. Davies, Pembrokeshire.
9959. Electrical Arc Lamps, W. H. Lauder, Dublin.
9960. Electric Bell Communication, F. Helman and J. Carroll, Liverpool.
9961. Camp Bedstead and Bed, B. Burleigh, London.
9962. Portable Shower Bath Ring, W. H. Slade, Bristol.
9963. Game and Pieces for Playing Same, J. E. and H. J. Griffiths, London.
9964. Electric Cables, G. H. Nisbett, Liverpool.
9965. Scavenger Brushes, S. Mann, London.
9966. Loom Shuttles, T. Walker, London.
9967. Finger Plates for Doors, W. H. Richardson-Jones, London.
9968. Match-boxes, &c., E. H. Levi, London.
9969. Machine for Cleaning Boots, A. R. Bowcher, London.
9970. Adjustable Picture Hoist and Hanger, C. Hamlyn, London.
9971. Pneumatic Tire, T. M. Down, London.
9972. Wheels for Cycles, F. W. Jones, Kingston-on-Thames.
9973. Screw-winged Flying Machines, H. Middleton, Slough.
9974. Electrical Switches, M. Binswanger and F. G. Bell, London.
9975. Conduits for Electrical Conductors, F. Bathurst, London.
9976. Hand Telephones, M. Binswanger and F. G. Bell, London.
9977. Covering Pianoforte Hammer Heads, A. J. Harrison, Wealdstone.
9978. Communicating Motion, C. Frost-Foster and H. W. Seager, London.
9979. Ball Tire, W. Meadows, London.
9980. Self-adjusting Packing Ring, J. A. Magill, London.
9981. Lamps, H. Lane, London.
9982. Internal Combustion Engines, H. Lane, London.
9983. Pen for Birds, W. E. B. Macaulay, London.
9984. Winding Yarn, A. B. Morse, London.
9985. Elastic Tires, H. Smith, Harrow-on-the-Hill.
9986. Cigar Holders, E. Savor, London.
9987. Court Plaster, H. H. Lake.—(*Boston Curative Company, United States.*)
9988. Automatic Liquid Level Indicator, F. A. Morse, London.
9989. Cycle Saddles, A. Baxter, London.
9990. Driving Gear for Cycles, J. P. C. Rigby, London.
9991. Cycle Handles, F. W. Gunton, London.
9992. Electric Traction, H. J. Allen, London.
9993. Hoisting Goods, A. G. Hadcock and C. W. Hutchinson, London.
9994. Automatic Clutches, A. W. Peust and E. Tewis, Liverpool.
9995. Automatic Punkahs and Fans, W. Turvey, London.
9996. Tires for Cycles, G. V. de Luca and S. Hill, London.
9997. Traps for Condensed Steam, G. Fletcher.—(*E. Y. Connell, West Indies.*)
9998. Producing Motive Power, E. B. Badcock, jun., London.
9999. Bicycles, C. F. Pfeiffer, London.
10,000. Fresco Painting, O. Matthiesen, London.
10,001. Wheels, W. Aves, London.
10,002. Transmitting Power, Count A. de Dion and G. Bouton, London.
10,003. Cinnamic Aldehyde, J. Y. Johnson.—(*C. F. Boehringer and Soehne, Germany.*)
10,004. Making Derivatives of Xanthine, E. Fischer, London.
10,005. Preparing Alkylated Uric Acids, E. Fischer, London.
10,006. Receiving Photographic Images, A. F. Parnaland, London.
10,007. Wheels, W. A. Konemann, London.
10,008. Securing Objects to Cycles, O. Imray.—(*C. Schilbers, Austria.*)
10,009. Machine for Shaping Metals, C. Nube, London.
10,010. Rasps, W. Shaw, H. A. Parkin, and B. C. McRae, London.
10,011. Car Coupler, W. R. Fine, London.
10,012. Dress Shields, M. F. P. Miles, London.
10,013. Air Regulating Device, W. H. A. Sieverts, London.
10,014. Ball Bearings, N. Rousselle, London.
10,015. Writing Telegraphs, R. J. Crowley and A. B. Hutchings, London.
10,016. Eyes for Fastening Dresses, E. N. W. Madigan, London.
10,017. Arc Lamps, W. J. Davy, London.
10,018. Constructing Motive Power Apparatus, H. Lane, London.
10,019. Stays for Steam Boilers, R. T. Preston and J. Holden, London.
10,020. Driving Gear for Bicycles, W. Woodman, London.
10,021. Speaking Tubes or Voice Pipes, H. A. Cutmore, London.

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10,022. Ladies' Pillion Bicycle Saddle, R. Harper, High Wycombe.
10,023. Nursery Chairs, O. Townsend, London.
10,024. Back to Cycle Saddles, J. Reynolds, sen., Nottingham.
10,025. Rock Boring Machines, P. H. Parkyn and W. Evans, Plymouth.
10,026. Miniature Ammunition Cartridge, M. Mullineux, Manchester.
10,027. Magnet Washing, &c., Machine, J. Johnson, Bilston.
10,028. Flanged Stench Trap, &c., J. Johnson, Bilston.
10,029. Inserting Timber in Trenches, H. Collison, King's Lynn.
10,030. Indicator for Dark Slides, J. B. Sincock, Bridgwater.
10,031. Stoppering of Bottles and Jars, C. Henry, Glasgow.
10,032. Cases for Holding Papers, S. Learoyd, Huddersfield.
10,033. Reproduction of Moving Objects, S. D. Williams, Newport, Mon.
10,034. Valve, N. Dakin, Leeds.
10,035. The Cleanser Washing Machine, E. Scott, Bristol.
10,036. Brake Attachments for Cycles, M. Lintine, Birmingham.
10,037. Gully Traps, J. Richards, Bristol.
10,038. Fireproof Doors, T. C. Fawcett, Halifax.
10,039. Pocket-knives and Corkscrews, C. H. Müller, Manchester.
10,040. Cycle Saddles, J. B. Brooks, Birmingham.
10,041. Match Strikers for Boxes, H. Allday, Birmingham.
10,042. Castor for Chairs, W. U. Coates, Falfield.
10,043. Delivering Liquid Matter, E. C. Matson, Dublin.
10,044. Steam Engines, C. Devine, Glasgow.
10,045. Moistening Gummed Labels, W. Weir, Milngavie.
10,046. Shuttles for Weaving, J. Wilson and J. Lumb, Leeds.
10,047. Electrical Transportation, P. K. Stern, London.
10,048. An Improved Puzzle, W. Johnson, Liverpool.
10,049. Pneumatic Inflating, H. F. Easton, Middlesex.
10,050. Automatic Brake for Bassinettes, J. Taylor, Bacup.
10,051. Spoons, A. Nicol, Middlesex.
10,052. Elastic Tires for Velocipedes, E. P. Allam, London.
10,053. Pressure Generator, J. Anderson, C. Dickie, and R. Dickie, Glasgow.
10,054. Golfette, A. G. Porteous, Stirling.
10,055. Multitubular Tyre, G. Ramsay, London.
10,056. Hygienic Boot, F. H. Nicolai, Berlin.
10,057. Cash Registers, J. R. Ward, London.
10,058. Change-giving Apparatus, J. R. Ward, London.
10,059. Cigar and Cigarette Holders, T. Dawber, London.
10,060. Stopping Machinery, G. Edgar and Tasker, Sons, and Co., Sheffield.
10,061. Charging Blast Furnaces, T. Lewis, Birmingham.
10,062. Power Crank for Cycles, H. L. Todd and W. Wright, London.
10,063. Railway Car or Vehicle, A. Bierstadt, London.
10,064. Portable Cycle Rest, N. Pogose, London.
10,065. Shoemakers' Tools, I. Golfarelli, P. Buob, and T. Banchi, London.
10,066. Duplicating Graphophone Records, J. Y. Johnson.—(*The American Graphophone Company, United States.*)
10,067. Disinfecting with Chlorine, R. N. Lennox, London.
10,068. Making Tires for Vehicle Wheels, J. C. Cole, London.
10,069. Electrically Controlling Guns, M. Pfatischer, London.
10,070. Bicycle and Carriage Frames, W. H. Price, London.
10,071. The Chepstow Aneroid, H. J. R. Lowe, London.
10,072. Photo Negatives, A. Hill and the Cresco Fylma Company, London.
10,073. Files for Letters and other Papers, I. N. Adrian, London.
10,074. Detachable Tires for Wheels, M. Bliss, London.
10,075. Automatic Fog Signal Apparatus, C. H. Fox, London.
10,076. Metal Canisters or Packing Tins, J. D. Falk, London.
10,077. Galvanised Hot-water Tanks, W. Skaiff, London.
10,078. Locomotive Tires, H. H. Lake.—(*H. A. Harvey, United States.*)
10,079. Locomotive Tires, H. H. Lake.—(*H. A. Harvey, United States.*)
10,080. Hat Shaping Flanges, F. L. F. Butterworth, London.
10,081. Speed Countershafts, H. H. Lake.—(*M. White, United States.*)
10,082. Kettles, J. Beale, London.
10,083. Repairing Tires, A. R. Mallard, E. C. Toller, and H. A. Slade, London.
10,084. Web Printing, &c., Machines, R. C. Annand, London.
10,085. Pipe Coupling, A. W. F. Bennik, London.
10,086. Non-refillable Bottles, F. Coirin, London.
10,087. Paper Cutting Machines, P. M. Justice.—(*The Seybold Machine Company, United States.*)
10,088. Water-closet Valves, J. W. Bragger, London.
10,089. Manufacture of Wheel Tires, H. J. Doughty, London.
10,090. Brakes or Supports for Cycles, H. A. Lazarus, London.
10,091. Flue Cleaners, R. Haddan.—(*M. G. Cook, United States.*)
10,092. Transmitting Motive Power, W. Kneen, Manchester.
10,093. Driving Gear for Velocipedes, J. H. Keeble, London.
10,094. Garters, B. Dreyfus, London.
10,095. Electric Batteries, P. Schmidt, London.
10,096. Arc Electric Lamps, A. O. Mackin, London.
10,097. Treatment of Gold Bearing Ores, J. Jones, London.
10,098. Gauge Glasses for Steam Boilers, J. E. L. Ogden, London.
10,099. Support for Cans and Cases, T. W. Hickson, London.
10,100. Knitting Machines, G. C. Marks.—(*E. Spear, F. L. Middleton, W. E. Richards, and W. W. White, United States.*)
10,101. Valves for Rock Drills, A. W. and Z. W. Daw, London.
10,102. Regulating Gas, R. T. and J. G. Glover, London.
10,103. Steering Handles for Cycles, F. W. Oliver, London.
10,104. Material for Belting, &c., F. W. Oliver, London.
10,105. Making Water-proof Fabrics, F. W. Oliver, London.
10,106. Step-by-step Printing Telegraphs, W. S Steljes, London.
10,107. Machines for Driving Hoops, A. Lieber, London.
10,108. Speed Gearing for Cycles, J. E. Preston, London.
10,109. Improved Artificial Manure, O. G. Blunden, London.
10,110. Stretcher for Boots, &c., C. W. Braithwaite, London.
10,111. Protectite Sole for Boots, &c., W. Jeggle, London.
10,112. Oil Lamps, W. F. Broomhead, Liverpool.
10,113. Cycle Tire Covers, J. Griffiths and J. Fitzsimins, Liverpool.
10,114. Pneumatic Tires, F. S. Bellhouse, G. R. Bellhouse, and F. R. Clarke, Birmingham.
10,115. Driving Gear for Cycles, T. E. Nightingale, Liverpool.
10,116. Pneumatic Tires for Velocipedes, A. Willis, London.
10,117. Cowls for Ventilating Shafts, &c., L. Pitsch, Liverpool.
10,118. Obtaining Photographic Maps, A. V. Newton.—(*A. Nobel, France.*)
10,119. Electrical Thief Alarm, J. Pearson and W. Gooding, London.
10,120. Dust Bags, D. Hunt, London.
10,121. Soldering Lamps and Soldering Irons, J. Fouilloud, London.
10,122. Sinking Wells, A. Lengauer, London.
10,123. Lever Carving Fork Attachment, J. S. Lockeyear, London.
10,124. Distribution of Electric Currents, J. Devonshire.—(*C. P. Steinmetz, United States.*)
10,125. Pneumatic Tubes, J. L. Hancock, London.
10,126. Gas Generators, W. Jordan.—(*The Morley Acetylene Gas Company, United States.*)
10,127. Electric Tram Trolleys, A. H. Leigh.—(*H. R Keithley, United States.*)
10,128. Hydrocarbon Motor Engines, J. Y. Johnson.—(*A. and C. Janet, France.*)
10,129. Brakes for Velocipedes, H. R. Newburgh-Stewart, London.
10,130. Motor Wheel, J. P. E. Proud, London.
10,131. Manufacture of Bread, &c., W. W. Macadam, London.
10,132. Straw Caps, H. L. Dixon and C. Wright, London.
10,133. Apparatus for Playing a New Game, I. Sulzbacher, London.
10,134. System for Collection of Electricity, W. J. Brewer, London.
10,135. Typewriters, J. C. Fell.—(*The Densmore Typewriter Co., United States.*)

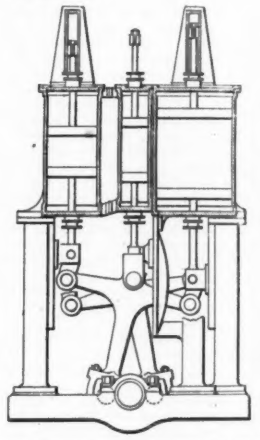
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

554,966. Steam Engine, *E. E. Wigzell, London, England.—Filed July 31st*, 1895.

Claim.—(1) A triple-expansion steam engine having two pistons working in opposite directions in each of its three cylinders, a three-throw crank shaft, a central triangular connection interposed between the rods of one set of pistons, and the middle crank of said crank shaft, and like triangular connections, together with connecting rods and crossheads, connecting the rods of the other set of pistons with the outer cranks of said crank shaft, substantially as hereinbefore specified. (2) In a steam engine, the combination with a three-throw crank shaft and cylinders placed in a line at right angles to said crank shaft, of two pistons working in opposite directions in each cylinder, a central triangular connection interposed between the rods of one set of pistons and the middle crank of said crank shaft, and like triangular connections, together with connecting rods and crossheads, connecting the rods of the other set of pistons with the outer cranks of said crankshaft, substantially as hereinbefore specified.

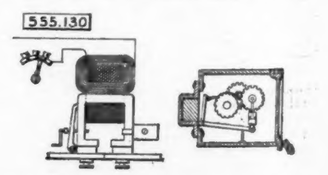
554.966



555,130. Electric Welding Indicator, *E. Thomson, Lynn, Mass.—Filed July 23rd*, 1888.

Claim.—(1) The combination with an electric welding, forging, brazing, or other electric metal working apparatus, of a register or counter, a reciprocating actuating or controlling device therefor responsive to the flow of an electric current accompanying the heating of the work, and a retarding device connected to the said reciprocating mechanism, as and for the purpose described. (2) The combination with the conductor and the register operated or controlled by the current in said conductor, of the iron bar or strap M, fastened transverse to said conductor, and an armature arranged to be attracted to said strap, as and for the purpose described.

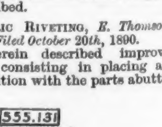
555.130



555,131. Electric Riveting, *E. Thomson, Swampscott, Mass.—Filed October 20th*, 1890.

Claim.—The herein described improvement in electric riveting, consisting in placing a two part rivet blank in position with the parts abutting within the pieces to be fastened together, passing an electric current through such abutting portions, and then subjecting the same to endwise pressure so as to weld the two parts together to complete the rivet and at the same time form a head or enlargement to give increased resistance against shearing strain.

555.131



ISLINGTON ELECTRIC LIGHT STATION.

ISLINGTON has now followed the lead of other metropolitan parishes, such as St. Pancras and St. John, Hampstead, and the Vestry of St. Mary, Islington, has undertaken the work of public supply of electricity. The parish is very large, having a rateable value of £1,771,420 and nearly 45,000 hereditaments; it covers an area of 3109 acres, and has 120 miles of streets.

Without describing the various abortive attempts made by the Vestry in former years to obtain a public supply of electricity, we may say that a committee was appointed to examine the question, and it presented a preliminary report in July, 1892, reccmmending that application should be made to the Board of Trade for a provisional order. The committee then visited a large number of electric light stations in the country, with a view of selecting the most suitable system, and submitted a report, which was laid before the Vestry in March, 1893. In the report they pointed out that, in view of the fact that the area to be supplied was a very large one, and that the mains would be of great length, they considered that the alternating system with transformers would be most suitable for private lighting and the high tension continuous current system for public lighting.

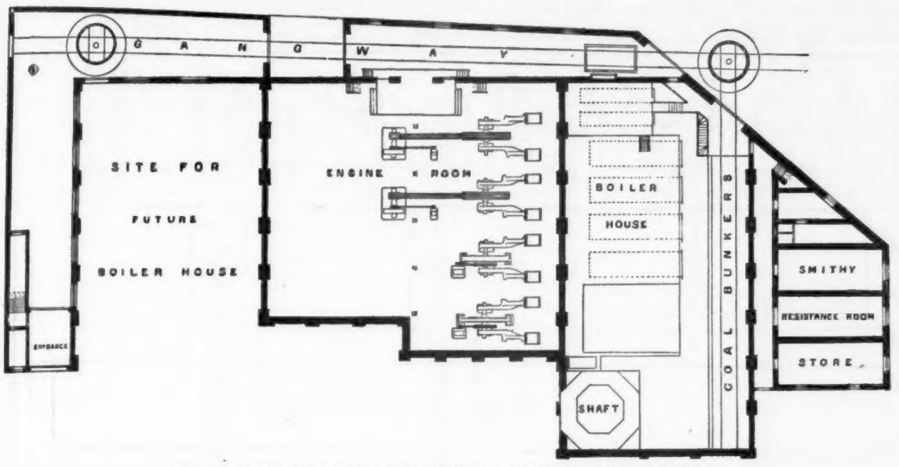


Fig. 1—GENERAL PLAN OF ISLINGTON ELECTRIC LIGHT STATION

The report was accepted, and instead of retaining a purely consulting engineer, the Vestry appointed in public competition Mr. Albert Gay, M.I.E.E., as electrical engineer, to prepare the necessary plans and specifications, to superintend the works while in progress, and to take over the whole undertaking as manager on completion. The work was taken up in October, 1893, and soon after this a site in the centre of the area was selected and bought, and Mr. A. Hessel Tiltman, F.R.I.B.A., was appointed architect to the Vestry. The work of pipe-laying began in October, 1894, and the foundation stone of the building was laid in December, 1894, by Mr. Lambert, the chairman of the Electric Lighting Committee.

In order to give some idea of the amount of public lighting which may eventually be required, we may state that on Lady-day, 1895, the number of public street lamps was 4648, and the gas supplied to them cost 2s. 3d. per 1000 cubic feet, making a total cost for the year of £13,916, exclusive of fittings. The site acquired for the generating station is about three-quarters of an acre in extent, and it is bounded on two sides by the Great Northern Railway, these having great facilities for the delivery of coals and other materials. It is freehold, and was bought by the Vestry from the Great Northern Railway Company; at the same time some adjoining cottages were bought, with a view to the possibility of future extension, and also to avoid any possibility of an injunction being obtained against them for vibration caused to the property of adjacent owners. During last year the work of construction was in full progress, and in our issue of the 6th March we gave a short account of the opening ceremony, which took place on March 4th of this year.

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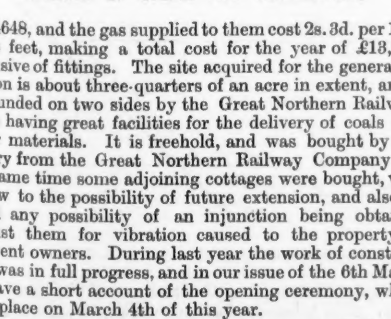
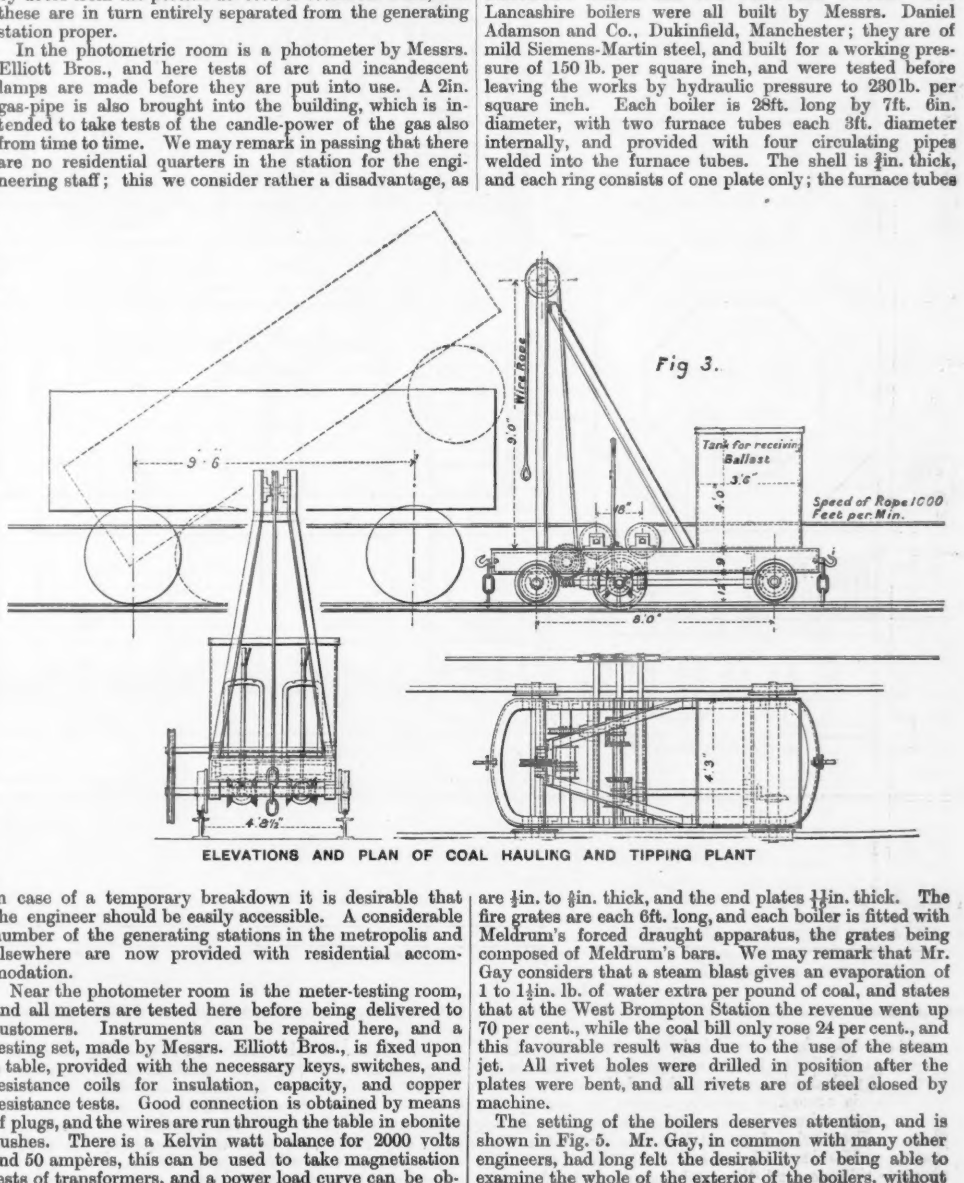


DIAGRAM OF STEAM PIPE CONNECTIONS

The generating station itself is in Eden-grove, Holloway-road, near the Holloway Station of the Great Northern Railway, and it has been so designed that extensions can easily be made. In Fig. 1 we give a sketch plan of the buildings, in order to show the relative positions of the plant. It will be seen that the engine-room is placed in the centre, and the boilers at present installed occupy the space to the right, and the large chimney shaft is placed so that it will serve for a greatly increased station. Vibration should be avoided by this arrangement, as the space occupied by the moving plant does not abut directly upon adjoining inhabited premises. When it is considered desirable to enlarge the station, the whole of the buildings can be extended towards Holloway-road upon the land belonging to the Vestry, and now occupied, as previously stated, by cottages. The Great Northern Railway passes the back of the building, affording facilities for the delivery of coals, and a siding is carried direct into the works. Turntables are fixed so that wagons can be brought into the boiler-house directly over the coal bunkers.

At the entrance to the works there is a large space for carts to be unloaded, and goods are taken up direct to the stores by means of a crane, the goods themselves never being exposed to the weather. Oil is pumped direct from the barrels on the carts to the storage reservoirs in the building, and this is found to effect a very important saving in trouble of unloading. The offices themselves are well laid out, and are reached directly from Eden-grove. The commercial portion of the rooms is separated by doors from the portion devoted to technical work, and these are in turn entirely separated from the generating station proper.

In the photometric room is a photometer by Messrs. Elliott Bros., and here tests of arc and incandescent lamps are made before they are put into use. A 2in. gas-pipe is also brought into the building, which is intended to take tests of the candle-power of the gas also from time to time. We may remark in passing that there are no residential quarters in the station for the engineering staff; this we consider rather a disadvantage, as in case of a temporary breakdown it is desirable that the engineer should be easily accessible. A considerable number of the generating stations in the metropolis and elsewhere are now provided with residential accommodation.



ELEVATIONS AND PLAN OF COAL HAULING AND TIPPING PLANT

Near the photometer room is the meter-testing room, and all meters are tested here before being delivered to customers. Instruments can be repaired here, and a testing set, made by Messrs. Elliott Bros., is fixed upon a table, provided with the necessary keys, switches, and resistance coils for insulation, capacity, and copper resistance tests. Good connection is obtained by means of plugs, and the wires are run through the table in ebonite bushes. There is a Kelvin watt balance for 2000 volts and 50 ampères, this can be used to take magnetisation tests of transformers, and a power load curve can be obtained instead of an ampère curve; the other standard is a 100-volt Kelvin electrostatic voltmeter. The horizontal scale type of multicellular Kelvin voltmeter is preferred to that with the vertical scale. A mirror galvanometer of the Kelvin astatic type is used with the test table, and a testing set of 200 Leclanché cells is mounted upon oil insulators placed upon shelves. The meters used for the customers are of the Chamberlain and Hookham type, and the charge for current is regulated by the Wright demand meters. The latter instruments are largely in use at Brighton, and the instruments were supplied by the Reason Manufacturing Company.

Next to the meter test-room is the arc lamps and transformer store, and this room is provided with special racks for arc lamp testing, and no lamp is allowed to be connected on to the circuit by a customer until it has previously been tested by the Supply Company. This room is also used for storing transformers and thoroughly drying them previous to use by passing a current through their coils.

The oil store adjoins the lamp room, and contains three galvanised iron tanks, two of which are of 1000 gallons capacity each, for engine and dynamo oil respectively, and the third holds 500 gallons, and is used for cylinder oil. Passing now to the generating plant, we illustrate the general arrangement in plan, Fig. 2. Coal is brought in 10-ton end-tip wagons, and is shunted on to the works private siding; here it passes on to the Avery weighbridge, where the weight is registered; the truck then passes on to the turntable and is dealt with by the hauling and tipping apparatus, shown in Fig. 3. The power is obtained from a rope driven by a small vertical engine, and the gear is of the worm and worm wheel type, so that there is no possibility of danger from slipping or overrunning. The motions are readily controlled by hand levers, placed so as to be conveniently handled by the attendant. The truck is first drawn into the building, the winch is then anchored, as shown, and the truck is then lifted at one end, and the load of coal is shot into the bunker below. The apparatus works very satisfactorily, and saves all the expense of manual labour and cartage. The bunkers are provided with sliding doors below of a peculiar pattern, whereby the door is not jammed fast by the direct pressure of the mass of coal. We have on various occasions described arrangements for dealing with coal, notably that at the Great Northern Railway Company's generating station, but the present arrangement has not previously been applied so far as we are aware. This apparatus was built by Messrs. Craven Brothers, of Manchester, who also built the overhead travellers used in the station.

The boiler power at present installed consists of four Lancashire boilers and two water-tube boilers. The Lancashire boilers were all built by Messrs. Daniel Adamson and Co., Dukinfield, Manchester; they are of mild Siemens-Martin steel, and built for a working pressure of 150 lb. per square inch, and were tested before leaving the works by hydraulic pressure to 230 lb. per square inch. Each boiler is 28ft. long by 7ft. 6in. diameter, with two furnace tubes each 3ft. diameter internally, and provided with four circulating pipes welded into the furnace tubes. The shell is $\frac{3}{4}$in. thick, and each ring consists of one plate only; the furnace tubes are $\frac{1}{2}$in. to $\frac{5}{8}$in. thick, and the end plates $\frac{11}{16}$in. thick. The fire grates are each 6ft. long, and each boiler is fitted with Meldrum's forced draught apparatus, the grates being composed of Meldrum's bars. We may remark that Mr. Gay considers that a steam blast gives an evaporation of 1 to 1$\frac{1}{2}$in. lb. of water extra per pound of coal, and states that at the West Brompton Station the revenue went up 70 per cent., while the coal bill only rose 24 per cent., and this favourable result was due to the use of the steam jet. All rivet holes were drilled in position after the plates were bent, and all rivets are of steel closed by machine.

The setting of the boilers deserves attention, and is shown in Fig. 5. Mr. Gay, in common with many other engineers, had long felt the desirability of being able to examine the whole of the exterior of the boilers, without disturbing the setting, and for this purpose, instead of putting insulating material directly upon the top of the boiler, he has built a chamber above composed of a roof of iron plates supported upon tee irons. The upper surface of these plates is thickly covered with non-conducting composition. Access is obtained to this chamber by means of a manhole. The division between adjacent boilers consists of two brick walls, each 9in. thick, with a 8in. air-space between; this makes a good non-conducting screen, and it is found possible to attend to repairs in any boiler, even while the boilers on each side of it are in full work. It will also be seen that the whole of the shell of the boiler is accessible outside, except, of course, the narrow strip where the shell rests upon the setting blocks. The whole of the fittings are by Messrs. Hopkinson, of Huddersfield, and each boiler has a feed valve at each side, so that the feed supply is in duplicate throughout.

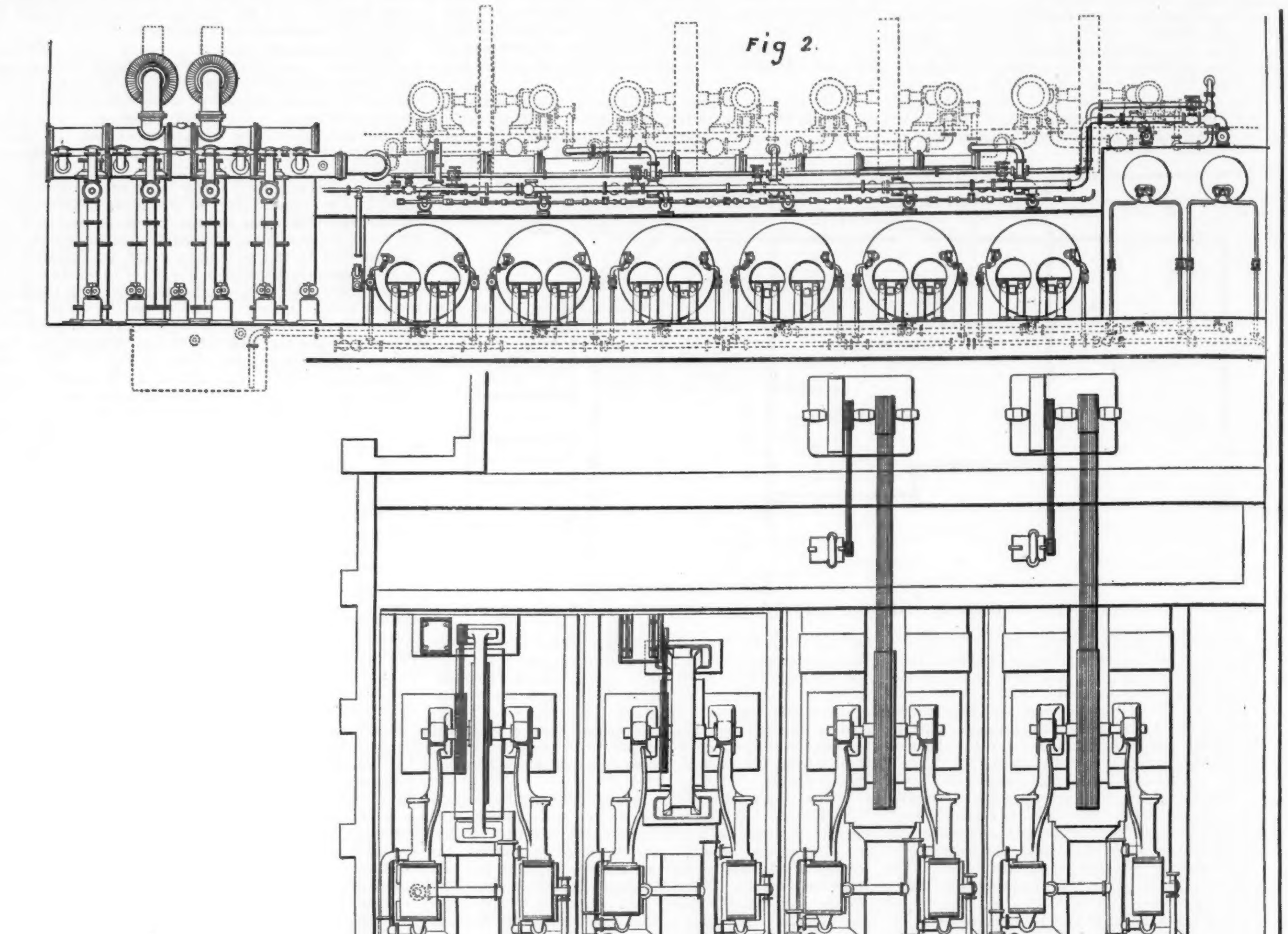


Fig 2.

PLAN AND SECTIONAL ELEVATION OF ENGINE AND BOILER HOUSE, ISLINGTON ELECTRIC LIGHT STATION

The boilers are set 11ft. centre to centre, and the stokehold floor is 11ft. below the railway level. The dampers are not worked by the usual arrangement of weights and chains over pulleys, but by a new method shown in Fig. 4, from which it will be seen that the dampers do not slide but turn on pivots, those of the Lancashire boilers being like doors hinged at one side, while those of the water-tube boilers are of the butterfly-valve type, pivoted in the middle. Each damper is controlled by means of a long rod, and a pair of bevel wheels actuated by means of a lever at the front of the boiler, and this lever can be locked in any position by a locking handle. The whole arrangement gives absolute control over the damper, with exactitude said to be unattainable by the ordinary arrangement, even with a system of marks on the wall. We were informed that the surface of the non-conducting composition above the boilers never rises to a temperature above 20 deg. Fah. in excess of the temperature of the air, and as the boiler-house is very lofty it is much pleasanter than the similar part of many other electric-lighting stations. The evaporation of each boiler with natural draught is given as 5000 lb. of water per hour from and at 212 deg. Fah.; but this is considerably exceeded with the forced draught.

The water-tube boilers were supplied by Messrs. Babcock, Willcox, and Co., and are of the most recent type. The tubes are made according to ordinary locomotive practice; that is, expanded for a short distance at one end; so that the holes in one tube plate are larger than in the other. This allows the tube to be got out, even although covered with scale. We understand that this is the first time this method has been adopted to this type of boiler. All the headers are of pressed steel, instead of cast iron, and there is far better means of access to inspect the tubes. Mr. Gay's past experience has led him to make suggestions which led to these variations. Each boiler has 1600 square feet of heating surface, and 30 square feet of grate surface; and the evaporative capacity of each is about the same as quoted above for the Lancashire boiler.

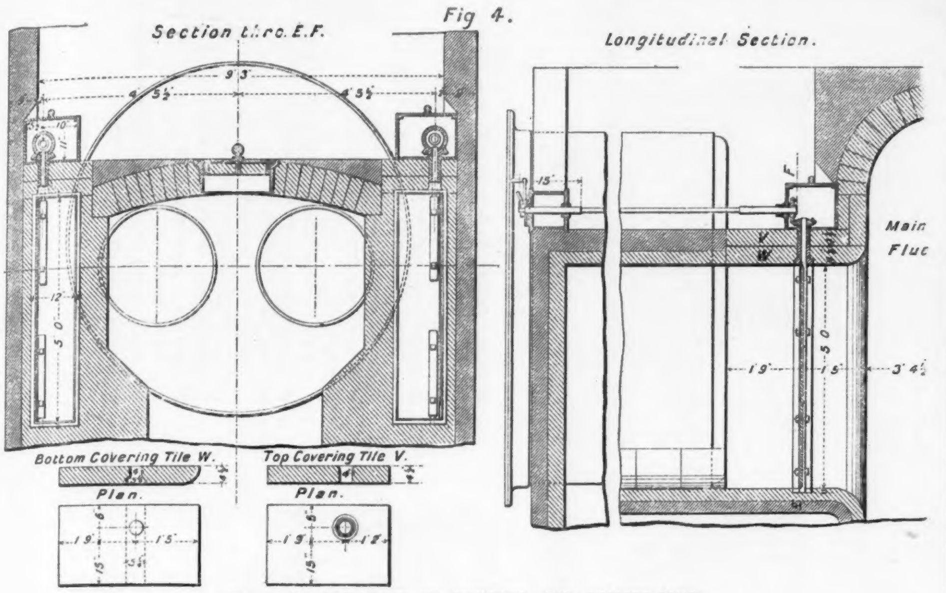


Fig 4—ARRANGEMENT OF DAMPERS AND DAMPER GEAR

Besides the boilers, Messrs. Adamson also supplied the whole of the steam pipes, exhaust pipes, pumps, injectors, feed-water heaters, and water connections. The arrangement of steam pipes is clearly shown in Fig. 1A, the ordinary ring main has not been adopted. Primarily, each boiler feeds one engine, but there is an equalising pipe which connects all these steam pipes together. A diagram of the arrangement is shown in Fig. 1A, the crosses representing stop valves. The actual arrangement is shown in Fig. 2; it will thus be seen that in ordinary work each engine is supplied by its own boiler, and there is little flow of steam along the equalising pipe, but if desired any engine can be supplied by any boiler. All the steam pipes and connections are of steel, with copper U bends to allow of free expansion; these bends are placed in the horizontal plane, and therefore there is no chance of water collecting in them as is the case when they are placed vertically. The exhaust pipes are of wrought iron, with riveted seams and cast iron flanges, the latter appear somewhat heavy, but we understand that the arrangement has been made with a view to a possible future use of condensing apparatus. In one corner of the boiler-house is placed a tank which will be of use for measuring feed-water for experimental purposes, and also for injecting compositions to prevent incrustation.

Mr. Gay has paid the very greatest attention to the question of feed supply. The whole apparatus is in duplicate, so that it seems impossible that any serious breakdown should occur. The feed-water is obtained from the mains of the New River Company, and passes along a main below the future boiler-house, and supplies two large tanks placed on the roof of the stores. Each tank holds about 20,000 gallons, and the water is delivered to the boilers by three Worthington pumps; besides these there are two of Körting's injectors, and the feed pipes are arranged on the ring system. Near the pumps are placed two exhaust steam feed-water heaters of the Withinshaw type, built by Messrs. Lupton, of Coventry, and bye-passes are provided, so that the exhaust steam can be carried direct to the chimney if so desired. The pressure of water in the supply water mains is about 100 lb. per square inch, and relief valves are to be put on the feed pipes and loaded to 155 lb. per square inch.

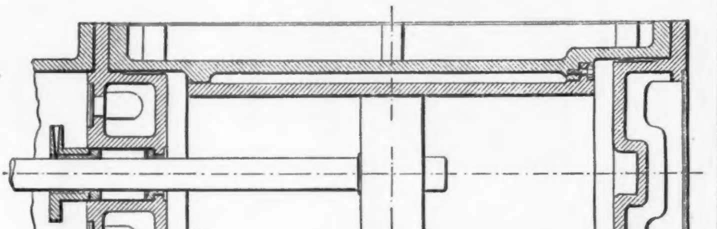


Fig. 7—IMPROVED WHEELOCK VALVE GEAR

The boilers can be blown off into a closed blow-off pit, the outlet of which is provided with a back-pressure valve to prevent the contents of the drain coming back into the pit.

The chimney stack is of ample size for future extensions, and is intended to suffice for sixteen boilers of similar size to those already installed. Eight of these will be placed in the present boiler-house, where there are at present six, and the remaining eight will be placed in the new boiler-house not yet built. The shaft is 180ft. high, of octagonal section, 14ft. diameter at the bottom, and 12ft. diameter at the top, while the external dimensions are 24ft. diameter at the bottom, and 14ft. 3in. at the top. It is built upon a solid bed of Portland cement concrete, 40ft. square by 9ft. thick.

Passing now to the engine-house, we find a fine spacious building, well lighted from above, and having walls faced with glazed bricks, giving the whole a very clean appearance. There are at present installed four complete sets of engines and dynamos, placed as shown in Fig. 2; two of the engines drive their alternators by ropes, and the other two have fly-wheel alternators. All four engines were built by Messrs. Daniel Adamson and Co., of Dukinfield, Manchester, and are of interest as showing the tendency to the use of slow-speed engines instead of high-speed engines direct coupled. In Fig. 6, page 544, we give an illustration of one of the engines, from a photograph; they are compound, horizontal high-pressure engines working non-condensing, and are fitted with Wheelock's expansion gear.

Each engine will develope 250 indicated horse-power, and the makers gave a guarantee that the consumption of steam should not exceed 20 lb. per indicated horse-power per hour. At present we are not able to state what the exact figures are in actual working, but a premium of 5 per cent. upon the agreed price will be paid for every pound below 20 lb. which it is found is consumed by the engines. The principal dimensions are as follows:—

High-pressure cylinder diameter	15in.
Low-pressure cylinder diameter	24in.
Stroke	36in.
Shaft bearings	8in. diameter by 1ft. 6¼in. long.
Shaft body	12in. diameter.
Centres of engines	10ft. 9in.
Crank pin	6in. diameter by 6in. long.
Connecting-rod centres	8ft. 3in. long.
Connecting-rod diameter at crank ends	4½in.
Connecting-rod diameter at crosshead	3⅝in.
Connecting-rod diameter at one-third its length from crank pin	5in.
Crosshead pin	3½in. diameter by 5in. long.
Piston-rod	3¼in. diameter.
Crosshead bore of guide	19½in. diameter.
Crosshead slipper blocks	16in. by 11½in.
Rope pulleys	14ft. diameter; weight 10 tons; 10 ropes 1¼in. diameter.
Speed	95 revolutions per minute.
Piston speed	570ft. per minute.

In Fig. 7 we give sections of the cylinder showing the valves; these are of the most recently improved type, of which Messrs. Daniel Adamson and Co. are the sole makers in this country. The whole of the valves of each pair of cylinders are driven by one excentric, the same excentric being used for driving both the steam and exhaust valves, and fitted with improved gear for giving automatic control of the expansion from zero to 75 per cent. of the stroke of the piston, whilst retaining complete control of the periods of release and compression. The valves are driven by means of levers keyed upon the valve spindles, and they have a vibrating motion, as in the earlier type of "Wheelock" gear, the levers being keyed to the rocking levers and excentrics by adjustable coupling rods in the usual manner; the steam valves are driven from the exhaust valve levers by means of latch links, which engage with hardened steel trip blocks, pivotted to the ends of the steam valve levers; the disengagement of the latch link and trip block is effected by means of cam levers, controlled by the governor or regulated by hand, as the case may be.

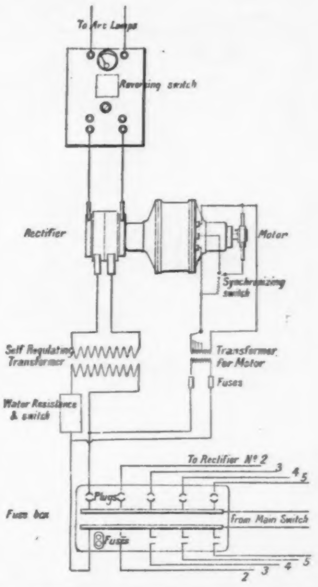


Fig. 8a—FUSE-BOX AND RECTIFIER CONNECTIONS

When disengagement takes place the valves are instantaneously closed by means of helical springs working in a dashpot with a noiseless air-compression cushion. The cams for disengaging the latch links have a defined positive travel obtained by suitable connection with the excentric rod, which is used for driving the valves. The timing of the travel is varied, and controlled by the governor, a resultant action being thereby obtained capable of tripping or disengaging the latch link in any position of the gear, whether it is moving in a forward or backward direction, thus giving complete automatic control of the expansion. The valves and seats are of the flat grid type, giving large openings with small travel and small surfaces for friction to act upon. A toggle joint between the valve grids and spindles gives almost instantaneous opening and closing, with great ease of action under extreme pressures

By this arrangement the valves are allowed to dwell or rest during the periods of exhaust or admission respectively. It will be seen that both the steam and exhaust valves are contained in one chest or port at each end of the cylinder. The seats of the valves are in the form of a plug, which is turned a little taper to fit the bored seats in the cylinders, the valve seats being thus entirely independent of the cylinder casting, enabling spare valves and seats to be kept in stock, and entirely dispensing with wear in the cylinder casting itself. The valve spindles are

BOILERS AND BOILER SETTING—ISLINGTON ELECTRIC LIGHT STATION

(*For description see page 533*)

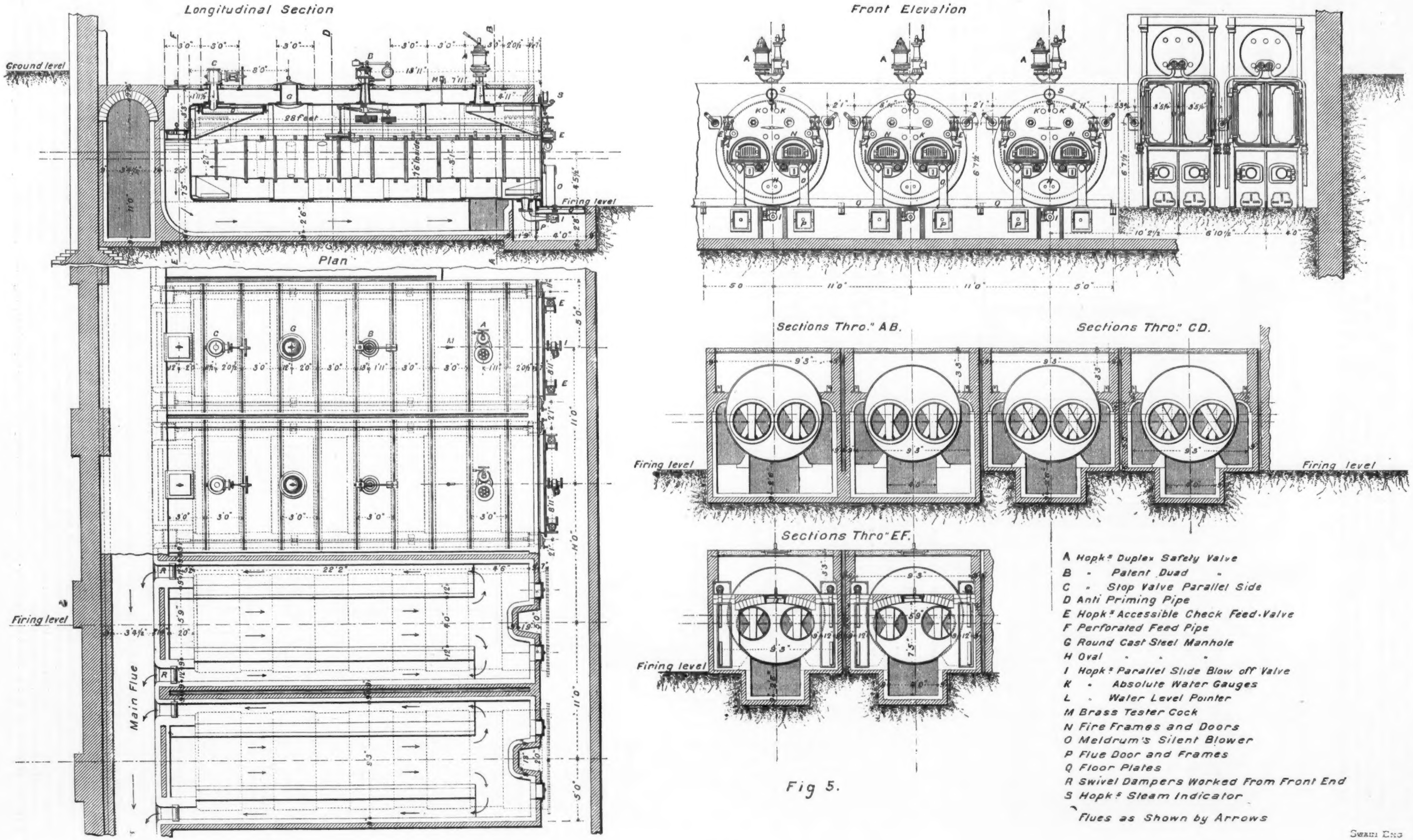

Longitudinal Section
Front Elevation
Plan
Sections Thro." AB.
Sections Thro." CD.
Sections Thro." EF.
Ground level
Firing level
Main Flue
28 Feet
16' inside
A Hopk.s Duplex Safety Valve
B " Patent Duad "
C " Stop Valve Parallel Side
D Anti Priming Pipe
E Hopk.s Accessible Check Feed-Valve
F Perforated Feed Pipe
G Round Cast Steel Manhole
H Oval " " "
I Hopk.s Parallel Slide Blow off Valve
K " Absolute Water Gauges
L " Water Level Pointer
M Brass Tester Cock
N Fire Frames and Doors
O Meldrum's Silent Blower
P Flue Door and Frames
Q Floor Plates
R Swivel Dampers Worked From Front End
S Hopk.s Steam Indicator
Flues as Shown by Arrows

Fig 5.

"The Engineer"

Swain Eng

of the Wheelock self-packing type, dispensing entirely with the usual stuffing-boxes and glands. We are informed by the makers that some of these engines have given in regular work one indicated horse-power for 1·251 lb. of coal, and this result is taken from actual work over an extended period, and not from a special test of a few hours only.

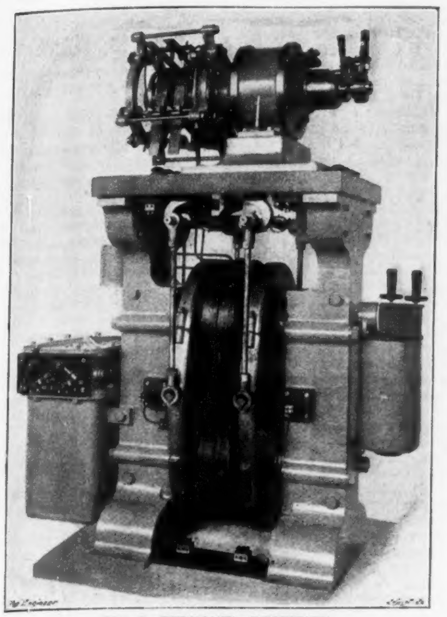


Fig. 8—FERRANTI RECTIFIER

The arrangements for lubrication are very complete, and the oil, after having passed through the bearings, is conveyed by pipes to a well below the floor of the engine-room, whence it is pumped by hand to the filters and used over again. All the steam, exhaust, and drain pipes are carried below the floor level, and each engine rests upon a separate massive block of concrete. The floor girders are bedded upon thick india-rubber pads, and on the occasion of our visit we noticed no vibration. Two of the alternators are rope-driven; these have been built by Messrs. John Fowler and Co., of Leeds, under Mr. Hall's patents, and each has an output of 100 kilowatts, at a speed of 375 revolutions per minute, and will easily maintain a pressure of 2000 volts at full load at that speed. The mean speed at which the armature conductors are passed by the field magnets is about 6000ft. per minute, and the frequency is fifty complete phases per second.

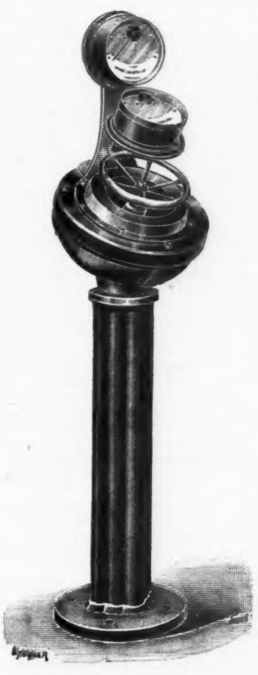


Fig. 10—REGULATOR

The armature is stationary, with an iron core of large section composed of best charcoal iron sheets bolted rigidly between two heavy cast iron clamps, the sheets being insulated from each other, and arranged longitudinally in the same plane with the magnetic fields. The conductor, when at full load, carries not more than about 1710 ampères per square inch of section, and it is composed of copper ribbon of 98 per cent. conductivity, well insulated, taped and fixed in such a way as to present the edge of the strip only to the field magnets, thus rendering the coil quite rigid. The ends of the coil are passed through porcelain insulators in the cast iron clamps, and are fixed to terminals mounted on ebonite, and are readily accessible on the removal of the wood lagging. The entire armature consists of eight segments, held in position around the field by a heavy cast iron frame. The high-pressure terminals are placed under lock and key. The field magnets are the moving parts of the machine, and consist of laminated charcoal iron, this arrangement enabling the best iron to be used without introducing a magnetic joint. There are sixteen poles, and each has its own exciting coil, composed of well insulated copper wire.

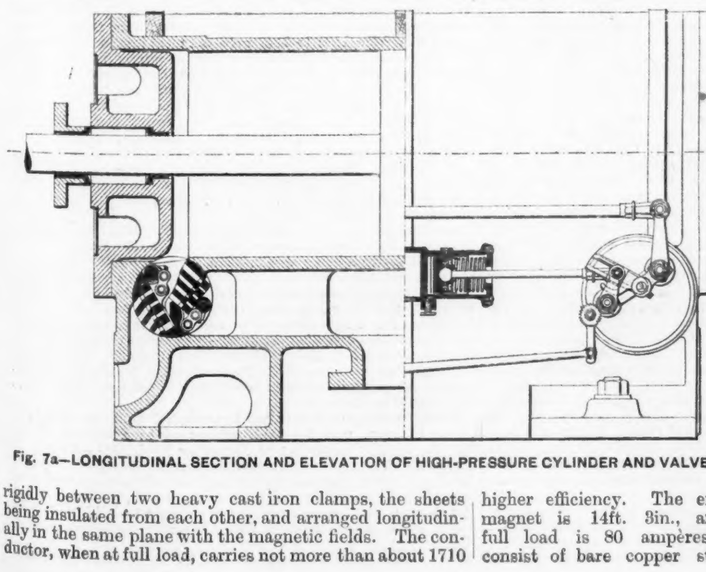


Fig. 7a—LONGITUDINAL SECTION AND ELEVATION OF HIGH-PRESSURE CYLINDER AND VALVE GEAR

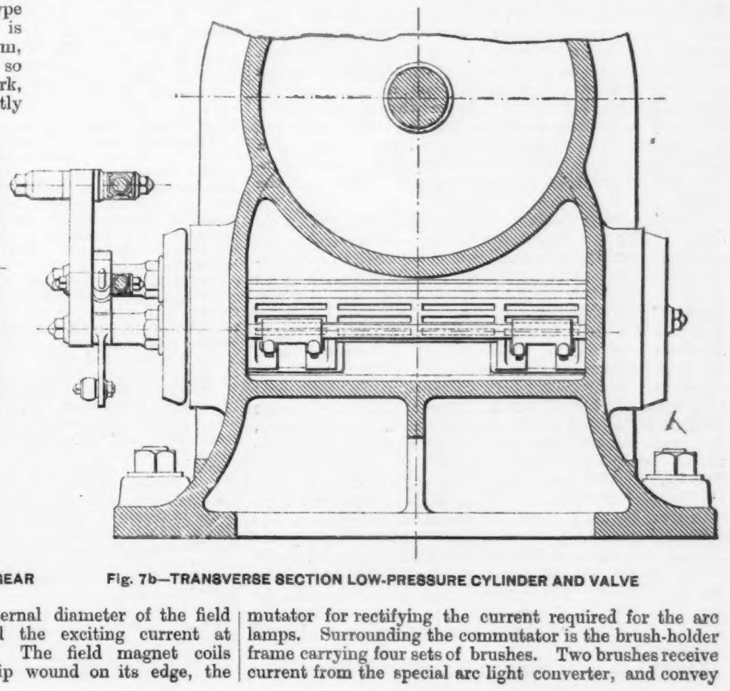


Fig. 7b—TRANSVERSE SECTION LOW-PRESSURE CYLINDER AND VALVE

The above construction is adopted to avoid the eddy currents usual with solid magnets, and the current density is about 720 ampères per square inch of section. Each collector ring is provided with two sets of brushes. The insulator resistance between the conductor and the laminated iron core is 15 megohms, and between the armature and body 10 megohms.

The next machine is a Fowler fly-wheel alternator, similar in construction to those just described; the fly-wheel forms the supporting part of the field magnets, around which the stationary laminated charcoal iron armature is built. The current density is as follows: Armature, about 1800 ampères per square inch, field magnets about 750 ampères per square inch; the speed is ninety-five revolutions per minute and there are sixty-four poles in the field and thirty-two segments in the armature, each having its own coil. We understand that a machine of similar type is now at work at Reading. The guaranteed commercial efficiency is 92 per cent., and the excitation is not to exceed 2 per cent. of the output. Each machine drives its own exciter, which is a simple shunt wound machine giving 50 to 60 volts and 50 to 60 ampères. They were also built by Messrs. Fowler and Co.

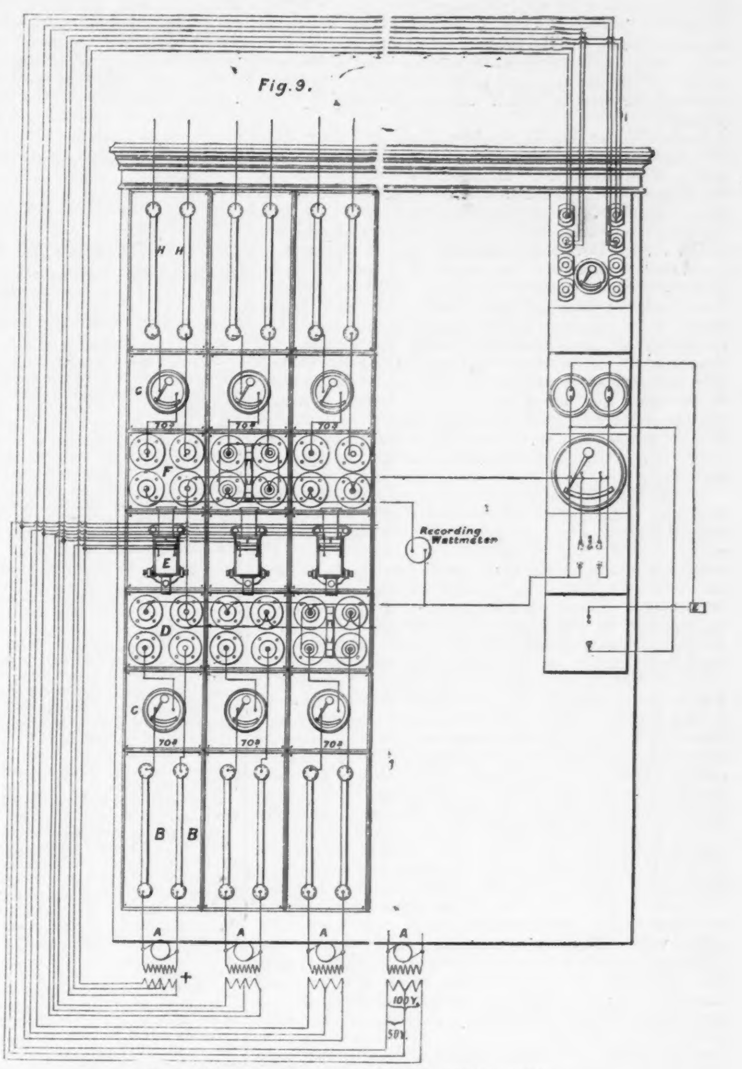


Fig. 9—DIAGRAM OF SWITCHBOARD CONNECTIONS

The fourth machine is a fly-wheel alternator by Messrs. Z. D. Ferranti and Co., and is of the revolving magnet type. It gives an output of 125 kilowatts at 2000 volts when running at ninety-five revolutions per minute. It has sixty-four field magnets and thirty-two armature coils. It is of the same type as was used at Portsmouth and Southport, and we may point out that a type with revolving armature is also built by the same firm, but was not considered so suitable for the Islington work, although it gives a slightly higher efficiency. The external diameter of the field magnet is 14ft. 3in., and the exciting current at full load is 80 ampères. The field magnet coils consist of bare copper strip wound on its edge, the adjacent layers being separated by paper rings covered with shellac and pressed into position, the coils themselves being insulated by heavy fibre washers. We are informed by the makers that there is little fear of short circuiting by water or dirty oil, and the construction would permit of the machine being cleaned if desired with a hose pipe. The exciter for this machine is of the single shunt type, and was built by the Electric Construction Corporation.

With a station supplying arc lights for public lighting, and also private consumers, it was of course possible to employ rectifiers for the public lighting, and these apparatus have been supplied by Messrs. Z. D. Ferranti and Co. We illustrate one of the five rectifiers in Fig. 8, and they are of somewhat similar type to those used at Portsmouth; each consists of a synchronous self-starting alternate current motor, fitted with the necessary commutator for rectifying the current required to excite its own field magnets, and also with a special form of commutator for rectifying the current required for the arc lamps. Surrounding the commutator is the brush-holder frame carrying four sets of brushes. Two brushes receive current from the special arc light converter, and convey it to the commutator, and the other two take up the rectified current when it passes to the switchboard.

The special converter gives a practically fixed current in its secondary circuit, with an electro-motive force varying according to the load on the secondary, so that it is the exact reverse of the ordinary transformer. The primary coils are arranged so that they balance one another on the rocking levers, and move equally towards or away from the fixed secondary coils. Others are so weighted that they are just clear of the secondary coils, when a current of 12 ampères passes through the latter. When the secondary current increases the repulsion becomes greater, and the primary coils move away, and so reduce the secondary current by causing more of the lines of force of the primary coil to be diverted. There is a counterpoise weight which can be adjusted by the attendant.

In the diagram, Fig. 8A, we show a fuse-box arranged for five rectifiers, but the connections for only one rectifier are given. This fuse-box is arranged so that any set can be plugged through a Ferranti oil-type fuse on to the station bus-bars. In putting the plant to work, the fuse and plug are inserted in the fuse-box, the motor, which is of the Brown-Boveri synchronous type, is then run to speed and synchronised, the arc circuit is then put on by slowly closing the water-break switch, and this, by introducing a heavy water resistance, allows the load due to the arc circuit to come gradually on to the bus-bars. The method avoids any variation in the bus-bar voltage. On the arc light distribution board a reversing switch and pole indicator are provided, so as to ensure the running of the lamps may never be reversed. Messrs. Ferranti and Co. claim very great advantages for this system, and it is in general use at Portsmouth, Edinburgh, Cardiff, Tunbridge Wells, and elsewhere, besides the present station.

The main switchboard is placed upon a gallery at the end of the engine-house, whence the whole of the plant can be perfectly seen, and signals are transmitted to the engine and dynamo attendants by means of a ship's telegraph of the Willis type, made by Messrs. Elliott Brothers. We give in Fig. 9 a diagram of the switchboard connections. It consists of nine sets of slate panels, and is arranged on the Lowrie-Hall system, consisting of double-pole double-break switches of the plug type, the fuses being also of the Lowrie-Hall pattern, as used at West Brompton, and many other places. Referring to Fig. 9, the alternator is shown at A; the lowest slate panel carries the fuses B B in the alternator circuit. Above these is the alternator ampèremeter C, above that is the alternator switch D, which is connected with the main omnibus bars behind the board; above this is the alternator pilot voltmeter—one of Lord Kelvin's multicellular vertical instruments — supplied with current from the special transformer T below. Above the voltmeter is the circuit switch F connected to the omnibus bars at the back of the board, then the circuit ampèremeter G, and at the top the circuit fuses H H. The panel which is used for synchronising is shown to the right separately, and synchronising is effected by the use of two lamps in the usual way. There is a separate board, which is not illustrated, used for the arc lights alone, and this enables any particular circuit of lamps to be fed from any machine. The potential is regulated through the exciters from pillars in the gallery, and one of the pillars is shown in Fig. 10.

Considering the whole station, it no doubt looks very large for the power already installed; the approximate cost, inclusive of the site, which will accommodate plant of three times the capacity, was £85,000. This, therefore, means a high capital cost per kilowatt installed, but this will speedily become normal when more plant is put down. Space will not permit of a description of the outdoor work, such as cable laying, but we hope to deal with this on a future occasion.

THE BATH AND WEST OF ENGLAND AGRICULTURAL SHOW.

THE annual exhibition of the Bath and West and Southern Counties Society, which is being held this year at St. Albans, was opened on Wednesday last in charming weather, and will remain open to the public until Monday. The implement and machinery department occupies about the same area as in recent years, although in point of numbers the implements fall somewhat short of those exhibited at the shows of 1893, 1894, and 1895, reports of the last of which we published last June. Taken as a whole, however, this department is thoroughly representative, and forms one of the most attractive features of the show.

Traction and portable engines are exhibited by Messrs. John Fowler and Co., Leeds; Messrs. Ruston, Proctor, and Co., Lincoln; Aveling and Porter, Rochester; J. and H. McLaren, Leeds; Hornsby and Sons, Grantham; William Allchin, Northampton; Ransome, Sims, and Jeffries, Ipswich; Marshall, Sons, and Co., Gainsborough; Barrows and Co., Banbury; Charles Burrell and Sons, Thetford; Robinson and Auden, Wantage; W. Tasker and Sons, Andover; Richard Garrett and Sons, Suffolk; Wallis and Steevens, Basingstoke; E. T. Humphries, Pershore; Clayton and Shuttleworth, Lincoln. Most of these exhibits are of well known standard patterns. We may, however, call attention to a 10-horse power road locomotive with 5-ton crane attached, shown by Messrs. Fowler, which has been constructed for Messrs. Cattermole, of Islington. This engine, which we hope to illustrate next week, is mounted on springs, has specially wide tires on the front wheels to carry the load on the crane, and is provided with a powerful screw brake to act on the inner surface of the rim of the driving wheels. These wheels are provided with the usual crossbars, but holes have also been drilled in the rim for affixing wood blocks when the engine is required on paved roads.

Oil and gas engines are exhibited by, amongst other firms, Messrs. Crossley Brothers, Messrs. Tangyes Limited, T. Green and Sons, Holmes and Sons, Norwich, Clayton and Shuttleworth, Hornsby and Sons, Fielding and Platt, James and Frederick Howard, Bedford, and the Campbell Gas Engine Company. The Central Cyclone Company, London, has an extensive exhibit of its well-known "Cyclone" pulverisers and disintegrators, one of the latter of which is said to be the largest attrition mill yet constructed and is capable of dealing with as much as 10 tons of material per hour. Messrs. J. and H. MacLaren show an 8-ton traction wagon, mounted on springs, having a screw brake which can be actuated by a handle at the side. Amongst the dairy machinery department some new machines are shown, and plenty of evidence given of the growing importance attached in the United Kingdom to this class of mechanical methods of carrying out old processes which are now inferior to and dearer than the new. To these and to other exhibits we must refer in another impression.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

THE ORIGIN OF THE BESSEMER PROCESS.

SIR,—I have delayed answering the criticisms on my address, as President of the American Institute of Mining Engineers, on the "Invention of the Bessemer Process," until I could carefully consider the objections urged against the claims of William Kelly, and especially until the "argument by abuse" had been exhausted. The question at issue is one of fact, to be settled by the rules of evidence, and not by abuse or denunciation or the demolishing of "claims" that were not advanced by me. I have carefully read every written and published word in reply that has come to my attention, and have as carefully reconsidered all the evidence offered, as well as other that has been brought to my notice. This has only served to strengthen the conviction, reached after careful investigation more than twenty years ago, a conclusion in which I was at one with many of the most prominent steel and iron makers of the United States at that time, viz., that William Kelly was the inventor of what Holley described as the essential feature of the Bessemer process, which was for many years known in this country among many steel and iron makers as the pneumatic or Kelly process.

And as so many things have been disputed which I did not assert, may I state just what I did claim in my address?

(1) Accepting the definition of Holley, I claimed that the essential feature of the Bessemer process was "the decarburisation of crude cast iron by the air blast in a vessel independent from the blast furnace or furnace in which it was melted, and without the application of external heat."

(2) That the invention set forth in the patents under consideration of both Bessemer and Kelly was covered substantially by this definition.

(3) That Kelly, and not Bessemer, was the original inventor of the process so far as it is covered by this definition.

In proof of this claim I adduced:

(1) The statements under oath of twenty-two persons taken in the interference case between Kelly and Bessemer in 1856-57, who testified of their own knowledge that in 1847 and 1851, and later, Kelly described and practised this invention.

(2) Decisions of the Commissioner of Patents of the United States in at least two cases, in which it was decided, after extended hearings and investigations, that Kelly, not Bessemer, was the original inventor.

(3) The statement under oath of A. L. Holley that he considered Kelly's invention the first practical development of the process.

It will be noted that all of this evidence is either the decisions of sworn officials, or is given under oath at legal hearing, when false swearing would be both moral and legal perjury. In discussing Kelly's claim to be the original inventor, I purposely and vigorously confined myself to this evidence, all of which is a matter of record and not of memory.

Just here let me say that I have no desire, nor have I attempted, to "whittle down the Bessemer process," nor to sum it up in the words "blowing air into iron." If the question of the invention in its entirety of the Bessemer process as it is understood to-day were the point at issue, Sir Henry Bessemer is certainly not its sole inventor. He did not invent the Mushet feature, the use of the triple compound; and the production in the United States of as much as 4,160,072 tons of cast steel ingots in 1892—not 1872, as Sir Henry states—would have been impossible without Holley's inventions for quick working. I purposely and properly confined my claim for Kelly to what has been called the pneumatic feature, and which Holley characterised as the essential feature of the process.

What is the answer of my critics to my claims? To the first it is that these men did not know what they were talking about; that they were unworthy of belief; that their testimony was "vague" and has been discredited.

I reply that on no single statement of fact has the testimony of one of these men been impeached or discredited, though the opportunity was afforded Bessemer so to impeach this testimony, both when the patent was originally granted to Kelly in 1857, and when the application for the re-issue of his patent was before the Patent-office fourteen years afterwards, in 1871.

In the interference suit in the Patent-office between Kelly and Bessemer in 1856-57, Bessemer was represented by the late Mr. R. H. Eddy, the attorney who secured his patent. This attorney, in a letter dated February 26th, 1857, professed his ability to show that "Kelly did not make the invention." The only evidence submitted in Bessemer's behalf to justify this assertion, so far as I have been able to ascertain, was a copy of the *Artisan* of September 1st, 1856; of the London *Times* of August 14th, 1856; and of Bessemer's English patent of October 17th, 1855, No. 2321. The only claim made for this evidence was that it proved that Bessemer made his invention before October 17th, 1855. There is not in the files at Washington, so far as I can discover, one word of testimony to show that "Kelly did not make the invention." There is not a word of testimony, and never has been, to impeach the veracity of Kelly's witnesses, and when on April 13th, 1857, the Commissioner of the United States Patent-office decided the question of priority of invention in favour of Kelly, and ordered a patent to issue to him unless an appeal was taken by Bessemer within sixty days, no appeal was taken, and Bessemer allowed the decision of the Patent-office in favour of Kelly to stand unchallenged, at least in the only legal way in which it could at that time be questioned.

In a word, the testimony of these men as to the facts set forth in their affidavits was uncontradicted by competent testimony at the time, and is to this day, after forty years. It is not vague, and if the testimony is one-sided, as Sir Henry asserts, it is his fault. He had his day in court, his privilege to cross-examine, and his right of appeal, and he exercised none of them. Under such conditions it is simple justice, and strictly in accord with the rules of evidence to assume that these men told the truth. If they did, Kelly invented this process in 1847, at least seven or eight years before Bessemer's earliest date.

My second line of proof was the decisions of the United States Commissioner of Patents: first, in the interference suit in 1856-57; second, in Kelly's application for an extension of his patent in 1871.

The wording of these decisions, so far as relates to the point in question, was as follows:—In 1857 the Commissioner said: "It appears that by the concurrent testimony of numerous witnesses Kelly made this invention and showed it by drawings and experiments as early as 1847, and this testimony appears to be reliable in every respect. . . . Priority of invention in this case is awarded to said Kelly." In 1871 the Examiner reported: "Kelly's own statement of the history of his invention is full and clear, and when taken in connection with the statement of the witnesses, seems to be both intelligible and truthful." These two cases are, so far as I am aware, the only times when priority of invention has ever been directly or indirectly submitted in the United States to a legal or quasi-legal decision, and the decision was against Mr. Bessemer in both cases.

The answer by my critics, when they meet this point at all, is that they have but little respect for the decision of our Patent-office and judges; that is, these critics not only abuse the plaintiff, his counsel and witnesses, but the court as well. In such cases it is generally regarded that the defendant has a very bad case. I am aware that the decisions of our Patent-office and courts do not run in Great Britain, but they do here, and have force. Under these decisions the patent of Bessemer having been superseded and made invalid, so far as the Patent-office was concerned, by the Kelly patent, it may be said that in a certain sense not one ton of steel made in the United States was ever made under the Bessemer patent in question. It was made under Kelly's patent, which the Patent-office had decided to be the valid one, and after the extension of 1871, Bessemer's patent having expired, and Kelly's being extended and being the only one in existence, all steel was made under it until it expired in 1878, and Kelly was paid royalty.

(3) In answer to my claim that A. L. Holley regarded Kelly as the original inventor, the answer is that this is not true, and that in making the assertion I am "throwing mud" upon the reputation of Alexander Lyman Holley. Extracts from letters of Holley are quoted against me.

In the appendix to my address before the American Institute of Mining Engineers I give in full an affidavit of Holley's made in 1871. Question 9 in the affidavit and the answer were as follows:

"(9) What do you consider the value of the invention of Mr. Kelly in its relation to the pneumatic or Bessemer process as at present practised?"

Answer:—"I consider Kelly's invention the first practical development of the pneumatic process, and it has been so recognised by the owners of the combined patents covering this process."

If any man in the world knew both sides of this controversy Alexander L. Holley was that man. He knew all the facts; he was fully competent to give an intelligent decision on the merits of the case; he was an able engineer, he was an honest man. He declared under oath in 1871, when the subject was fresh in his mind, that he considered Kelly's invention the first practical development of the pneumatic or Bessemer process. If Holley was competent to decide this question, and if he knew the facts, and no one dare deny either, there is no escape from the conclusion that Kelly's invention was the first practical development of this process.

A correspondent quotes in *Engineering* a letter of Holley's to show, "what he had to say on the claims of Kelly as a first inventor." There is not one word in that letter that contradicts the position I have assumed. Indeed, it confirms my position. Mr. Holley says, for example: "The patent of William Kelly, of Kentucky—controlled by Mr. Ward and his associates—for refining crude iron by blasts of air, antedates the Bessemer patent in this country." It was this patent that covered the invention which Holley declared to be "the first practical development of the pneumatic process."

In this letter of Holley, Bessemer is nowhere described as the inventor of the process, but as the "perfecter and introducer." "It is proper to remark here," said Mr. Holley, and the correspondent puts it in italics, "that to Mr. Bessemer is awarded in this country the chief credit for perfecting and introducing the process that bears his name here, and all over the world." This does not say the "inventor;" nor does it give him the "entire credit," but the "chief credit," for perfecting and introducing the process. He even shares this with others in Holley's mind. There is nothing in this letter of Holley to even throw a doubt on the statement in Holley's affidavit, that he considered "Kelly's invention the first practical development of the pneumatic process."

I might rest my case here. Indeed, I have been strongly urged to do so as a "matter of courtesy" by some of the most prominent metallurgists and steel makers of this country, who are aware of the strength of certain evidence in my possession to which I have not even referred. Simply as a matter of courtesy, and not that I have no answer, I have concluded to take this advice and not answer in detail Sir Henry Bessemer's letter, except briefly on two points.

(1) The "one-tuyere-vertical-blowing-downward" converter, of which Sir Henry makes so much as the "first converter," was not Kelly's first converter, but the first built at Cambria Ironworks, and was so described by me. Mr. Kelly describes his first converter as follows:—

"The first converter used at the Suwanee furnace was a square brick structure about 4ft. high. Inside, the converter was cylindrical, about 15in. in diameter, with a concave bottom, in the centre of which was a tile perforated with small holes for tuyeres. In this tile was a small air chamber into which the blast pipe entered." Mr. Kelly states that the converter charges in this vessel were 100 lb., but he was troubled with weak blast, as he was in the six or seven other converters he built on a somewhat similar design, the metal clogging the tuyeres, and he was led to place tuyeres in the side near the bottom. He also had the self-same trouble with his iron that Bessemer had.

(2) The impression is conveyed in the replies to my address that mine is the only discordant note that has ever been heard in this chime of universal praise to Bessemer. I have already quoted what Holley and the owners of the combined patents in the United States thought and said. If one acquainted with the facts had been asked who from 1860 to 1870 were the most intelligent and most prominent metallurgists and iron manufacturers in the United States, among the first dozen would have been named Jas. Park, jun., of the Black Diamond Steel Works, Pittsburgh; Capt. E. B. Ward, of Detroit, Michigan; D. J. Morrell, of the Cambria Ironworks; Bernard Lauth, the inventor of cold rolled shafting; and Wm. M. Lyon, of the Sligo Ironworks, Pittsburgh. Each of these is on record as expressing the belief that Kelly, not Bessemer, was the inventor of the process. Mr. Park, in a lecture in 1872, said, "To Mr. Kelly, of Pittsburg, justly belongs the honour of having been the first to discover . . . . the great principle of the pneumatic or Bessemer process."

All through the years since 1857 Kelly's claim has not been allowed to slumber, but has again and again been restated.

As this letter is being written, Mr. Wm. Metcalf, formerly of the Crescent Steel Works, a gentleman who has been president both of the American Society of Civil Engineers and the American Institute of Mining Engineers, has published a work on "Steel," in which, after briefly referring to Bessemer's desire to make steel for guns and his invention, he says:—"At about the same time or a little earlier Mr. Kelly, of the United States, devised and patented the same method. Both of these gentlemen demonstrated the potencies of their invention, and neither brought it to a successful issue.

In this connection it may not be amiss if I quote the words of Zerah Colburn, who has been summoned as a witness by my critics. In THE ENGINEER of December 23rd, 1864—I quote at second-hand, as I have no copy of the original—he says, "It should be stated here that the first experiments in the conversion of melted cast iron into malleable steel by blowing air jets through the mass in fusion appear to have been made in 1847 by William Kelly, an ironmaster at the Suwanee Furnaces, Lyon County, Ky., United States.

"It is notorious that the conversion of iron in this manner at first required great experimental knowledge to make it successful, and Kelly, no doubt, soon found what difficulties were in his path. In June, 1857, however, after Mr. Bessemer had obtained an American patent, Kelly, having conclusively proved his priority of invention, also received a patent, in a form which virtually annulled that held by Mr. Bessemer for the States. It would be natural to say that there was an evident injustice in ranking an abandoned experiment before an invention which, now at least, has become successful."

It is but just to Mr. Kelly to state that he denied abandoning his experiment.

Let me say, in conclusion, that I have no desire to detract in the least from the credit that is justly due to Sir Henry Bessemer. Holley was right when he gave such generous praise to him as the "perfecter and introducer" of this process. His mechanical appliances for the working of the process are deserving of the highest praise, as are the persistence and intelligence with which he set himself to work to make the process a success, when, as he and Longsden so graphically state, the process was "pronounced by the iron trade a complete failure," and when the largest iron manufacturers in Great Britain "who had already negotiated terms for the use of the process, joined in its condemnation and abandoned all ideas of experimenting therewith." Indeed, it was not until 1863 that the first royalty was paid by John Brown and Co., the first licensees who got to work successfully in England. It is to this persistence and intelligence that much, not all, of the final success of this process in the world was due. JOS. D. WEEKS.

Pittsburgh, May 14th.

PERMANENT WAY.

SIR,—The "giant" referred to by your correspondent "Four-foot," in last week's ENGINEER, happens to be an old acquaintance of mine, and I am able to tell you some little about him also. The poor fellow has too often found out that "ordinary men's heads" do "wobble about," and that their understandings are not always to be depended on either, and so far from feeling now "a security he never enjoyed before," as "Four-foot" says, he hardly ever goes through any unusual performance without a feeling of great trepidation.

At one of the "giant's" performances he carried me also, as well as his clubs, when, unfortunately, "the heels of his boots"—although "deep"—managed to slip over the smooth heads of his supporters, and we all came to grief. I was not much the worse for the mishap when I came to myself again; but, Mr. Editor, you should have seen the giant as he lay overturned, and ignominiously kicking his heels high in the air. I lived to tell of this accident, as I could also of many others, some of which happened only very lately.

Mr. "Four-foot" must bear in mind that our "giant," although near a hundred years old, is still growing and waxing in strength, and, in response to the calls of an exacting public, is getting more and more presumptuous every day, although he confesses to feeling some little anxiety in executing unusual feats all the same. I may tell you, then, that he does not consider—as "Four-foot" would have you believe—that he is so ably supported by his assistants now as formerly. On another occasion of an extraordinary exhibition of his, applauded to the echo by his numerous patrons, all of a sudden both himself and his assistants, together with the chairs upon which they sat—cushions and all—and even the very floor of the stage upon which they were planted, were sent right and left pell-mell in all directions, and such a commotion produced that Goliath of old, or Samson at his best, would have been quite unequal to producing anything so disastrous.

Now, Mr. Editor, it is very plain that our "giant" must stop growing in bulk, and curb his disposition for exhibiting his increasing strength, and rather take to his business more quietly, or his assistants and supporters—chairs, cushions, and all will have to give place to others better able to withstand his antics. If not, he will surely kill somebody "as *is* somebody," yet; and it may happen to be the bishop that "Mr. Punch" once suggested might possibly become involved in such a disaster, when, as he supposed, the matter would be considered as it ought to be, and accidents on railways prevented.

Just a word in another direction, Mr. Editor, if you please. I agree with Mr. Fforde that mechanical work is rapidly supplanting hand labour, and this is all in the right direction; but a line will have to be drawn where a "cheap and nasty" result comes in; especially where it may affect the lives of human beings. In the column headed "Railway Matters," in last week's ENGINEER, I read that out of fifty-seven derailments of trains, of permanent way origin, occurring in the U. S A. during one month, thirty, or more than 50 per cent. of them remained "unexplained." A machine "depositor, &c.," would be charitable enough to cover up a multitude of imperfections and faults, which would otherwise be discovered, and go a long way toward reducing a not very creditable result of unknown causes. The mere deposition, spreading and trimming of ballast, is not of itself sufficient to ensure immunity from accident, and is only of use when the contending forces brought into play are, unfortunately, from whatever cause, allowed to be so equally balanced, that a pound or two more or less of resistance would be acceptable to turn the scale in favour of safety. This value of that part of ballasting is of universally unwritten acceptance, and it follows that even the little help it would be on such occasions as I have above described, is—more's the pity—not much thought of. In all I say about this, I have as much the interest of my own precious self at stake as the life of any other person.

I learned the practice of platelaying in my youth from a good navvy, on the first mile of the first branch that was ever made from the old London and Birmingham line, and that, too, as a pastime, before cricket and football became such popular means of letting off the superfluous steam of muscular Christianity. Since that time I have performed every operation pertaining to it with my own hands, over and over again, instructing numerous gangs of unskilled labour to do the same work effectually. Beside this, I have laid the whole matter in its naked truth to heart, and therefore I feel that if, as Mr. Fforde suggests, my "exposition" should be taken by anyone as a reflection upon himself, instead of seeing in it a something to be inwardly digested, to get what possible good there may be in it out of it, I can only say that I am very sorry for that individual. Mr. Editor, I would not afford as much ink as would dot an "i" upon this paper on any subject that affected the pocket only; but the meanest life—which might even be my own, or one near and dear to me—to be sacrificed to a "practice" which is avoidable, and which, on due consideration, ought never to have existed at all, and besides is roundly condemned by a responsible Government engineer, justifies me or anyone in coming forward with any honest suggestion which can be shown to be the result of experience and considerable thought.

I was greatly pleased with the observations contained in Mr. W. M. Acworth's letter last week, recording a very important and interesting interview between that gentleman and some American railroad magnates; and I wish to refer to that account, as far as it may be taken in relation to the elasticity and rigidity of a permanent way. One of your correspondents, a little while ago, suggested the advantages of solidity, when soon afterward another endeavoured to show that any approach to such a condition was undesirable, and that the nearer a solid and rigid construction was obtained the worse for the road itself, and the rolling stock too.

Upon this head I might say a great deal which possibly would be interesting to some of your readers, and with your permission, Mr. Editor, I may do so some day, but now it would lead me too far from the subject in hand. I will content myself, therefore, with saying that I have always advocated the abundant sleepering of the permanent way, and that only the facility offered for packing should put any limit to it; and that the rail as well should be so heavy and so formed as to be liable only to the least possible amount of depression between sleeper and sleeper. I have long considered, too, that ballasting should take a new departure, and that the additional expense of adding even a hundredweight of iron per yard to the rail would be the best paying outlay of capital ever contemplated among all the many improvements proposed for permanent way.

Now, Mr. Editor, I do not for a moment think that rails will in our day—at all events in my time—ever be rolled of 202 lb. per yard; but I do think that it will soon be found advantageous to stiffen them very considerably, and that this will be effected by adding to the number of sleepers, or increasing the weight of and altering the form of the rail itself, or both together; for which improvements—or I may call them innovations—I declare there is no end to the advantages which might be adduced.

As I have inferred in my recent letters, so I say now, this is not a matter of inspectorship as toward the public, but involves another direction of the profession. And in conclusion, I will say that a consideration of it would be found to pay; and that, after all, is something in its favour. J. W. WILKINS.

May 26th.

SIR,—The rough sketch of the dialogue given by Mr. W. M. Acworth, page 518, is especially interesting to me, as it so exactly agrees with several conversations which I had with American railroad officials when travelling on their lines in 1893.

On each occasion upon which the subject of permanent way was discussed, I was informed that "the English system of rails and chairs would not do for their heavy and fast traffic," and on one occasion I was shown a heap of the English pattern of rails and chairs which had been tried experimentally and afterwards taken up, and there was no overcoming the fact that many of the chairs and some of the rails were broken, which was stated to be the reason for their being removed from the track.

In consequence of these conversations, I took especial notice of the running of the American trains, and of their permanent way. The majority of the rails were 60ft. in length, 90 lb. and 100 lb. per yard, and were supported by no less than thirty large cross sleepers; in some instances there were even more sleepers, and the permanent way almost amounted to a continuous bed of sleepers, having very little ballast between each one. The "riding" on the engines, and also in cars, over the American tracks was most remarkably steady and smooth, and there could be no question that their system of permanent way gave far more elasticity, and caused far less noise than is experienced in this country.

In England it is the general opinion of railway engineers that "a first-class road cannot be made with flanged rails spiked to cross sleepers." It is not to be expected that English practice will be changed for many years to come; but during the past three years I have several times suggested that it would be a great advantage if one of the large English companies would lay down at least one mile of American track upon one of the fastest and hardest worked portions of railway in England; the practical results obtained would very soon prove the advantages or disadvantages of the two systems.

American trains carried on bogies and provided with central buffers, weight for weight, have less resistance per ton than English carriages with rigid wheel base and side buffers. No doubt, to a great extent this accounts for some of the work performed by their engines.

We hear from America what their engines can do with their trains of a certain weight, but there is no means of ascertaining what the same engines would do with an English train of similar weight, but having more resistance.

CLEMENT E. STRETTON.

Saxe-Coburg House, Leicester, May 23rd.

SIR,—It is much to be regretted that Mr. Acworth seems to have lost his presence of mind. Possibly he was overawed by a president and a vice-president. Had he kept his head he would have asked these gentlemen to explain why it is that on the splendid American roads of which they spoke it is so difficult to keep a train. The derailments which take place in the United States—after making allowance for augmented mileage—are enormously more numerous than in this country. C. TRENAIL.

Ipswich, May 26th.

SIR,—As Mr. Acworth condemns the English system of railway chairs, and deems much better the American plan of placing the rails directly on wooden sleepers, will he explain why some of the best of the American lines are now interposing steel plates between the rails and the sleepers? See letter of "Railbed" in THE ENGINEER of January 17th? ANGLO.

Leeds, May 25th.

THE PROBLEM OF SPEED.

SIR,—I beg to offer you my best thanks for the publication in your last number of a translation of my paper "The Problem of Speed," and for your kind remarks thereon.

Allow me, at the same time, to take exception to a phrase in your editorial, "It is noteworthy that the speeds of his—Normand's—torpedo vessels, at the beginning of the series, fall far below those which were being obtained in this country at the same time."

That such is the case for trials made in England under unspecified conditions of weights I am quite ready to admit, since you say so, but it is equally true that ever since I began to build torpedo boats their speed was always superior to that of foreign ones, when tried on the same measured mile, and under the same conditions.

It was so as early as 1878, and the superiority found on trial—about 1 knot—was more than doubled on service, on account of the much smaller consumption of coals.

In the Spanish trials of 1888, a small boat of mine, the Barcelo, delivered two years before at the very modest speed of 19·50 knots, had to compete with seven larger English-built boats, of which two had an official speed of 26·3 knots, two of 23·03 knots, one of 20·5 knots, and two of 20·16 knots. The Barcelo gave the greatest speed in a sea run of 68 miles, see *Engineering*, vol. xlvii., page 381.

Some Russian experiments gave the same results. The Avant-Garde to which you allude carried very heavy weights, more than double of those of the Coureur—an improved Ariete. Now the speed of the Coureur was not 26 knots, but 23·53 knots. One of the boats mentioned in the table at the end of my paper, the Lancier, carried a weight of artillery, torpedoes, coals, men, stores, &c., equal to $\frac{1}{3\cdot8}$ of her displacement, more than double the proportion in the destroyers. Taking this, and also the small displacement of the Lancier into account, is not the speed of 25·79 knots proportionally higher than those of 27 and 28 knots attained two years later by the destroyers.

But nothing better than the Forban shows the immense influence of lightness on speed. There, the French Admiralty, by way of experiment, reduced the extra weights on trial to the same proportion as in the destroyers, about $\frac{1}{7\cdot8}$ of the displacement, and the result, in spite of the small displacement and the low revolutions, was over 31 knots. She still holds the record. Now, for many years, the trials are made in France with a weight of coals corresponding to a certain steaming distance, this weight being deduced from one or two preliminary trials of long duration. For instance, the weight carried by the Lancier corresponds to 2000 nautical miles at 10 knots—the consumption speed is now increased to 14 knots. It will be most interesting to see the result of the adoption of the same very reasonable measure by your Admiralty.

The object of this letter, Sir, is not to cast any shade on the very high and duly deserved reputation of English builders of high speed vessels. Some of them are very good friends of mine, and I do not forget that the real inventor of those high speeds is an Englishman, Mr. Thornycroft. I only wish to prove that it is not only recently that we have been able to compete with English engineers. A. NORMAND.

Havre, May 25th.

THE JENNY LIND: A LINK IN LOCOMOTIVE HISTORY.

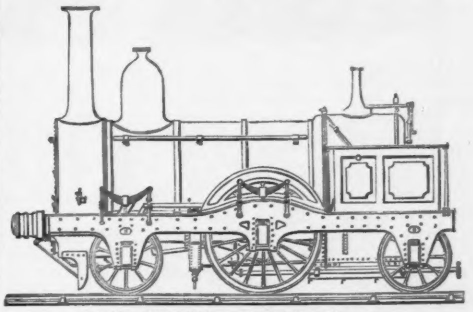
SIR,—In the interests of correct locomotive history it certainly is very greatly to be regretted that, at the conclusion of Mr. Tomlinson's presidential address, Mr. David Joy did not make any mention whatever of the record which he gives in his letter, page 527.

Turning to the printed copy of the excerpt minutes of the meeting, it will be found that on page 195 Mr. Tomlinson stated:—"E. B. Wilson and Co., of Leeds, produced an engine which was called 'Jenny Lind,' Plate 60. Of this class many scores were built; they had 15in. by 20in. cylinders, with 6ft. driving wheels. The drivers had inside bearings only, and the leading and trailing were 4ft. wheels, with outside bearings. They were largely used in the north, and as far south as Rugby on the Midland. These engines were principally designed by the late Mr. James Fenton."

Upon turning to Plate 60 a diagram of Jenny Lind is given, headed:—"By James Fenton, at E. B. Wilson and Co., Leeds."

If Mr. Joy had spoken at the time there would have been the advantage that Mr. Tomlinson would have been able to state his reasons for giving the credit to Mr. Fenton, whereas now, of course, his death has rendered it impossible for his reasons ever to be known.

Mr. Joy in his letter states that "Mr. Fenton came into the drawing-office and said we would try an inside cylinder, 15in. by 20in., with 6ft. cylinder driver." Those are the leading dimensions of the Jenny Lind, and were undoubtedly given by Mr. Fenton. Six-wheeled passenger engines were first constructed by R. Stephenson and Co. as early as 1834, the Patentee being the first built.



MIDLAND RAILWAY—ENGINE No. 60

Cranked axles with inside bearings only had been used by Hackworth in 1830, and by Bury in 1831; and the diagram given by Mr. Joy—Fig. 2—shows that the general design of the Jenny Lind follows very closely the engine of Mr. Gray; in fact, the whole of the evidence brought forward relating to the Jenny Lind question tends to confirm the opinion that during the past fifty years Mr. Gray has not received the full credit which should belong to him for the design of the engine built by Hackworth and Co. for the Brighton Railway.

In THE ENGINEER, page 25 of the present volume, reference was made to trials which took place upon the Midland Railway in May, 1848, between engines built by Wilson and those by Sharp Brothers and Co., of Manchester. As no drawing has been given of the latter engines, I enclose one for publication.

In 1847 the Midland Railway Company gave an order to Messrs. Sharp for six passenger engines, and they were delivered in April and May, 1848. They had no names, but were numbered 60 to 65 in the railway list. These engines had cylinders 16in. by 20in., and driving wheels 5ft. 6in. diameter. The two Sharp's engines, which took part at the trial in May, 1848, were Nos. 60 and 61, being Nos. 494 and 497 in the books of the makers. The six above-mentioned engines worked till 1870. It may not be generally known that in 1848-9 Messrs. Sharp constructed four broad or 7ft. gauge engines for the Midland Railway Company, to work between Gloucester and Bristol. They were Nos. 66 to 69, and had cylinders 16in. by 20in., and driving wheels 6ft. 6in.; having been ultimately changed to narrow gauge, these four engines continued at work till 1873-74. CLEMENT E. STRETTON.

Leicester, May 23rd.

PUFFING BILLY.

SIR,—With reference to the letter of Mr. G. S. Pardoe, page 518 "Locomotion" was built by Stephenson and Co. in 1825 for the Stockton and Darlington Railway, and is preserved at the Darlington Station. "Billy" was built in 1830 by the same firm, for the Killingworth Colliery line; it is now upon the High Level Bridge, but is about to be placed in Newcastle Station. "Puffing Billy" was built by Blackett and Hedley in 1813 for the Wylam line; it is at South Kensington Museum. Trevithick's engine of 1803 had smooth wheels and smooth rails.

Leicester, May 22nd. CLEMENT E. STRETTON.

SIR,—The celebrated original locomotive, "Puffing Billy," which is referred to in THE ENGINEER of May 22nd, page 518, is now preserved in the South Kensington Patent Museum. The locomotive that is upon the High Level Bridge at Newcastle, and now being removed into the Newcastle station for better protection, is "Billy," not "Puffing Billy," and was one of Stephenson's Killingworth engines, the first of which began running in 1815.

"Puffing Billy" was made by Hedley in 1813, for the Wylam Colliery line near Newcastle, and was the first practically successful engine with smooth driving wheels, and the father of the locomotive engine. It ran for fifty years on the line from Wylam Colliery to Lemington on the river Tyne, a few miles above Newcastle. W.

May 25th.

TRACTION ENGINES.

SIR,—Has anyone noticed the peculiar way in which the "Select Committee on Traction Engines" are working? They appear to have gone to the separate authorities and asked them if they are in favour of having someone above them to whom they could refer their imaginary grievances about traction engines. Of course with one accord they have said "No." I wonder if the Committee expected them to agree with it.

Why don't the Committee go to the traction engine makers and owners and see what is wanted, and give it to them—viz., higher speeds, and one licence of not more than £10 for the whole country, with the free use of any part of the day or night, instead of consulting these traction engine haters? Speed in towns and cities should not be less than four miles per hour, except in exceedingly busy places, and for the country it might be as fast as the engines can go with their loads.

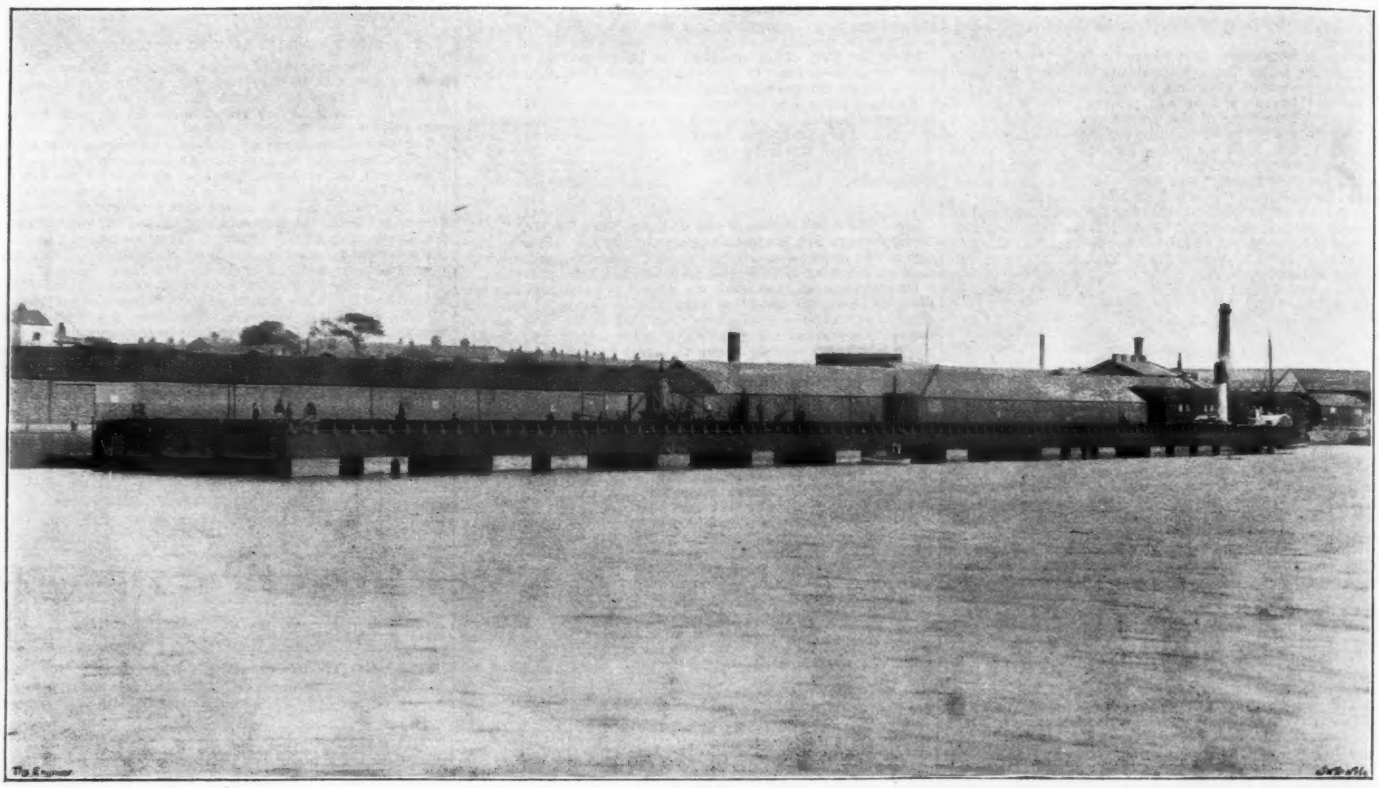
TRACTION ENGINE ADMIRER.

Smethwick, May 17th.

(*For continuation of Letters see page* 550.)

THE NEW LIVERPOOL LANDING STAGE

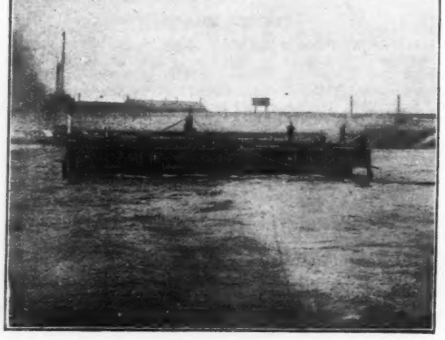
MR. A. G. LYSTER, M. INST. C.E., ENGINEER



LIVERPOOL LANDING-STAGE.

Liverpool has, as our readers are aware, been improving her position as a port, both as regards the reception of deep-draughted vessels and the convenience afforded to passengers. Following upon increased facilities, we find an increased traffic, and naturally, the demand for increased station accommodation. This must have been foreseen by the authorities of the Mersey Dock and Harbour Board, and the result has been that the landing-stage has been lengthened 400ft., that is, an addition of one-fourth to the already marvellous structure at which the passenger traffic of the port is conducted. This landing-stage has been the resort of visitors for many years; it is probably the largest and most frequented marine promenade in the world, and forms one of the principal features of Liverpool.

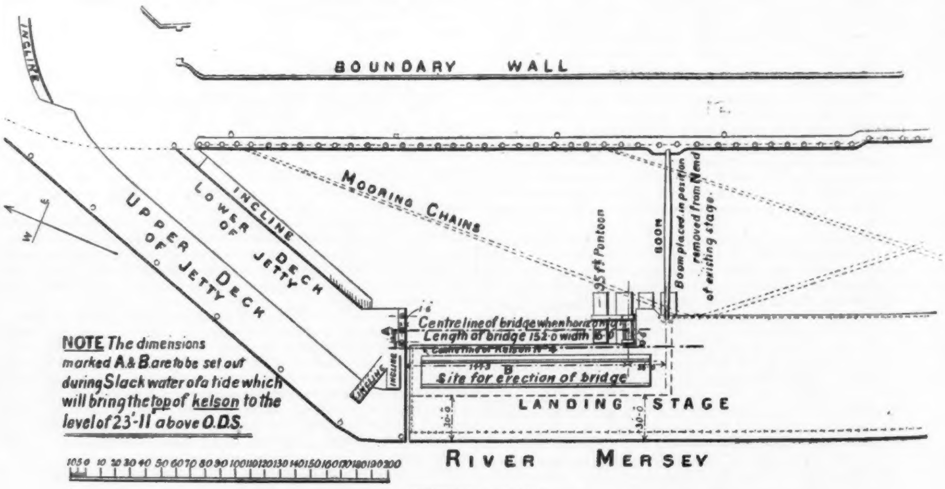
The first stage, opened to the public in 1847, was comparatively small, but with the growth of the cross-river and coasting traffic, additions were found necessary. In 1871 the Harbour Board obtained parliamentary powers, and in the course of three years constructed a landing-stage 2000ft. long. Unfortunately this was accidentally destroyed by fire shortly after it was opened for traffic; the damage, according to a local contemporary, amounted to £250,000. When replaced, the George's and Prince's stages became one.



THE STAGE IN MID STREAM.

The existing stage, with its recent addition, is 2460ft. long and 80ft. wide. It is floated on iron pontoons 80ft. long by 10ft. wide, spaced 15ft. from centre to centre. On these are riveted five box girders 4ft. 4in. deep by 3ft. wide, evenly divided between the centre and ends of the pontoons. The box girders are surmounted by cross girders to carry the flooring; they are hog-backed plate girders 26in. deep at the centre and 14in. at the ends, and are spaced 4ft. from centre to centre. Upon these 4in. creosoted timber is laid, and a second layer of 4in. greenheart planking, surmounted by a layer of asphalte, completes the flooring. The completed stage will be approached from the shore by eight wrought iron bridges; one end rests on the quay wall, the other end on the landing-stage, and these provide access to the stage. The stage rises and falls with the tide, the extreme range being 30ft. There is also a floating bridge 550ft. long and 35ft. wide, which enables heavily laden vehicles to be dealt with, affording an easy incline at all times of the tide.

The new length of 400ft. was constructed by Messrs. Pearson and Knowles, the iron being rolled and prepared at their works, Dallam Forge, near Warrington, and put together in the Wallasey Dock near Birkenhead, on pontoons supplied by the Phœnix Co., of Derby, to the design of Mr. A. G. Lyster, Engineer to the Mersey Dock and Harbour Board. Nineteen pontoons were in place at the beginning of this month; by this time the ironwork of the superstructure was completed, and it was determined to remove the stage from Birkenhead to Liverpool. The illustration shows the stage in dock, ready for removal, with steam tugs attached. As will be seen, it is an unwieldy structure. It weighs 1475 tons, and is not calculated to steer well, as the pontoons lay athwart the centre line; the responsibility of floating it across the Mersey to Liverpool was, therefore, very great. This, we were glad to see, was most successfully accomplished on the 3rd inst. The day suited admirably for the operation—a low neap tide was ebbing comparatively slowly, and a light northerly breeze produced scarcely a ripple on the surface. Under less fortunate conditions the work of the contractors would have been very different. Four steam tugs were employed, two in line ahead to drag the stage, and one on each corner aft to steer it. In little over half an hour from the time of starting at Birkenhead the stage was alongside the quay at Liverpool. The Teutonic lay in the track from the Alfred Dock to the north end of the existing stage; the tow was dropped deftly under her stern and brought across without a hitch. It was then necessary to place it in position, and to join the plates of the old and new work together. The measurements, both as to width, depth, and floating level of the stage—the accuracy of every item being essential to success—were so perfect, that the top and bottom plates and angle irons of the box girders were fitted at once, and temporary bolts and drifts were passed through holes, one-half of which were in new and the other half in old work. The start was made about two hours before low water, and it was necessary that the junction should be effected before the turn of the tide, for even at neap tides the run in the narrows at Liverpool is somewhere about three miles an hour. The stage was secured by timber moorings, until the permanent mooring chains could be got into position, and by a ponderous iron boom from the quay wall.


INCLINE
BOUNDARY WALL
MOORING CHAINS
INCLINE
LOWER DECK OF JETTY
UPPER DECK OF JETTY DECK
W
E
95 ft Pontoon
BOOM
Boom placed in position removed from N end of existing stage.
Centre line of bridge when horizontal
Length of bridge 152·0 width 16·0
Centre line of Kelson No 4
B
Site for erection of bridge
INCLINE
INCLINE
LANDING STAGE
30·0
30·0
NOTE The dimensions marked A & B are to be set out during Slack water of a tide which will bring the top of kelson to the level of 23'-11" above O.D.S.
105 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
RIVER MERSEY

GENERAL PLAN

The stage now extends from the centre of George's to the north end of Prince's Dock. From the entrance of the latter a timber jetty 250ft. long has been projected in the direction of the landing stage, and a bridge, 152ft. long and 14ft. wide, will open communication between the two. This jetty has an upper and a lower deck, and is also provided with inclines to facilitate communication.

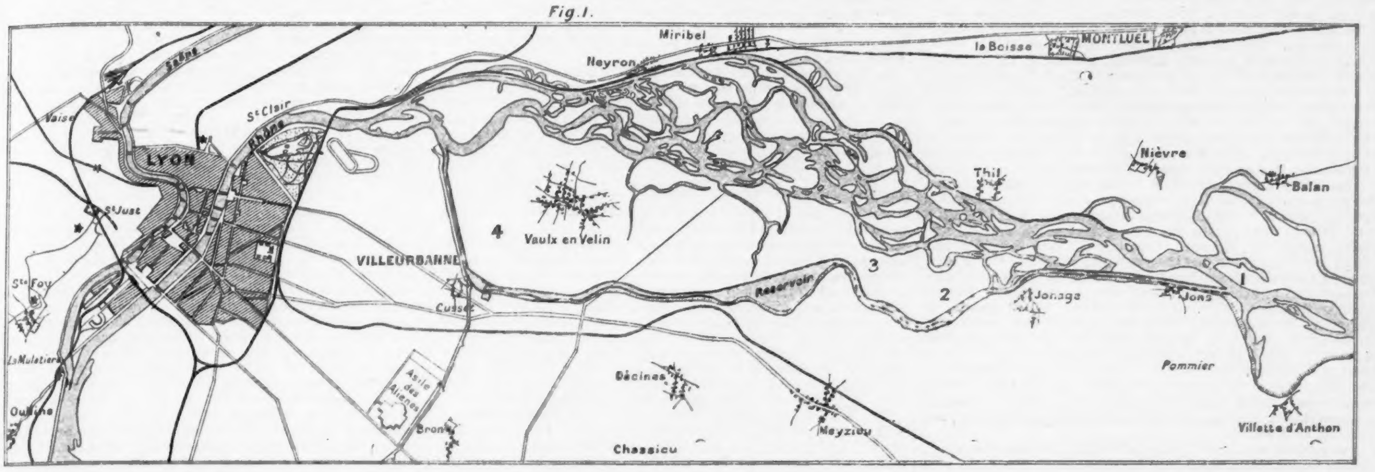
The traffic carried on at the Liverpool landing-stage is of considerable interest. Until recently it was confined to a comparatively small class of steamers, and not long since the water at the south end was so shallowed by the advance of Pluckington Bank in that direction that the ferry steamers were obliged to change their berths at low water. This alarmed the authorities and inconvenienced the public, and led to the construction of a system of sluices in the quay wall, through which the water in the dock was discharged at low water. This, assisted by dredging, maintained a sufficient depth of water for the ferry boats alongside the stage. No less than nine ferries are accommodated at this stage, and many of them run four times an hour.

On the August Bank Holiday last year, 263,000 persons passed through the turnstiles and used the landing-stage. Until recently only small craft, such as ply between Liverpool and the Isle of Man, Ireland, and Scotland, came alongside. The traffic by these boats, however, is considerable, and amounts at times to forty to fifty a day, as many as thirteen steamers occasionally going to and coming from the Isle of Man in a single day.

The Dock Board, having improved the access by dredging the bar, then turned their attention to dredging in the river, The depth alongside the stage may be taken as 11ft. at the commencement of 1895, when dredging commenced, some of the older dredgers being employed. During last summer the sand pump dredger Brancker was also sent there, and up to the beginning of this month 1,200,000 tons had been removed. There is now 30ft. alongside the stage at low-water spring tides. The Lucania inward bound, drawing 26ft. 6in., has

INLAND NAVIGATION IN FRANCE—THE JONAGE CANAL

Fig. 1.



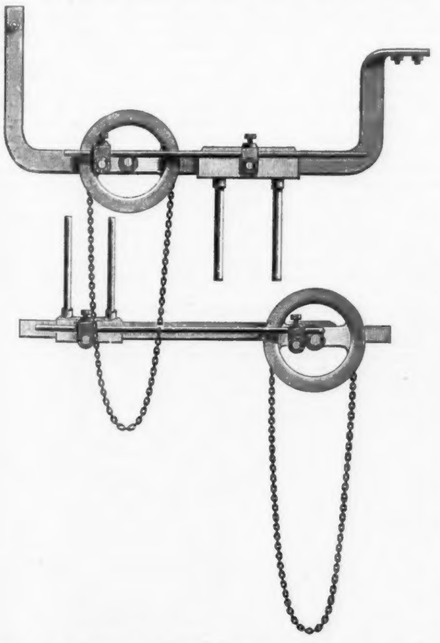
berthed at the landing-stage at dead low water, and liners, loaded to their maximum draught of 29ft. 6in., have left it. The Germanic, White Star, and Cephalonia Cunarder were the first American liners to use the stage on June 12th of last year. During eleven months 250 vessels of this description have been accommodated at the stage. It is therefore evident that the extension has not been made a day before it was wanted.

We must consider the riverside railway station opened last summer as being largely responsible for the extension of the landing-stage. This station was rapidly built. The roof, which is 800ft. long and 87ft. 6in. wide, contains 400 tons of iron. The iron was rolled and erected by Messrs. Pearson and Knowles in three months. The expedition with which the work was carried out was mainly due to the simplicity of the design. By arrangement the requirements of the engineer were limited to sections easily rolled and easily worked. Forgings were avoided—practically the roof consists of flat bars and angle irons connected by gusset plates.

At present the London and North-Western Railway are the sole users of the station, but provision has been made for the Midland Railway and its allies. From this station the journey to and from Euston by special train *viâ* Edghill is made in a little over four hours. The Atlantic liners lie at the landing stage within a stone's throw of the railway carriage, quick despatch is secured, and the discomfort inseparable from the use of tenders between a big ship and the shore is avoided.

SIMPLEX DEAD-LOCK BELT SHIFTER.

THE accompanying engraving illustrates a simple and very ingenious belt shifter, brought out by Mr. E. S. Ratcliffe, of the Ceres Ironworks, Kingston. The engraving shows it in two forms. As will be seen, it consists of an iron bar which is bolted to the underside of the beams carrying the shafting. On this slides a small casting carrying two forks through which the belt to be shifted runs. To this casting is attached, by means of a stud, a rod which serves as connecting rod, which at its outer end is attached to a crank on a small cast iron chain pulley. The weight of the rod and the big end of stud are sufficient to keep the belt in either position, either on the fast or loose pulley as may be desired. To shift it all that is necessary is to pull at the chain until the crank passes the top centre, when it will fall through of its own accord and remain there. These belt shifters are produced at a very moderate price, and will be very useful in the turnery and machine shops.



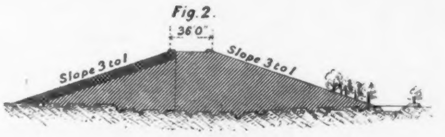
A TELEGRAPHIC message was dispatched from the Electrical Exhibition now being held at New York, and, after making a double circuit of the globe, it returned to its starting-place, the time occupied being 50 minutes. *The Electrician* says, President Chandler, of the Postal Telegraph Department, sent off the message, and Mr. Edison, sitting at the same table, received it.

THE JONAGE CANAL.

IN our impression of June 7th of last year we described and illustrated some of the principal works of engineering construction belonging to this important undertaking, which is intimately connected with the inland navigation of France. Since that period the execution of the whole project has made very considerable progress, and some further particulars are newly to hand which may not be uninteresting to our readers, and will bring the whole subject well up to date. It cannot be truthfully said that our neighbours have ignored the many advantages which accrue to a country from an extensive development of its inland water communication, for witness the scheme for making Paris a seaport, also that of the Canal des deux Mers, and not to mention others, the great enterprise of bringing to the walls of the capital the waters of Lake Leman. But none of these vast projects has as yet exchanged the ideal for the real, while in other parts of the world, in striking contrast, are the recent utilisation of the Falls of Niagara, the Corinth Canal, the new water route which has unquestionably converted Manchester into a *port de mer;* the Baltic and North Sea Canal, and the great hydraulic engineering works undertaken for improving the navigation of the Iron Gates of the Danube.

It will be seen on reference to the accompanying plan—for which we are indebted to our contemporary, *La Revue Technique*—in Fig. 1, that the canal commences at the point 1, in the vicinity of the town of Jons. Here the river Rhône makes a very perceptible bend, which, combined with the strength of the current, causes it to dredge out its own channel along its left bank. The consequence of this automatic scouring action is that the bed of the canal will always be a good deal higher than that of the river, and consequently be in no danger of silting up—an evil to which all works of this description are liable, and from which very few are exempt. At the point 2 in the plan, where is situated the dam with the twenty-two sluice gates, forming one of the works referred to at the commencement of our article, this first part of the canal, which is in direct communication with the Rhône, and may be termed the supply section of it, terminates. The second portion of the canal extends to Cusset-Villeurbranne, where the hydraulic works and the double-chambered lock are situated. After passing point 3, the canal skirts a large tract of marshy ground, forming a naturally impermeable reservoir, which can be utilised as a regulator for the level of the water of the canal, and would, by a skilful system of impounding, raise the power available from 12,000 to 20,000-horse power. In a total length of ten miles, there are six miles of straight reaches, and eighteen curves of radii varying from 330ft. to 6600ft. Besides serving as the creator of hydraulic power of great magnitude, the Jonage Canal will be essentially a canal of navigation, and will, moreover, enjoy the somewhat exceptional privilege of being entirely free and open to the public, without payment of dues, taxes, rates, charges or imposts of any description whatever. Its normal width will be 200ft., with a depth at low water of 8½ft. For a length of about five miles from its take-off, the canal is in cutting, and elsewhere partly in cutting and partly in embankment, with slopes in both instances of not less than two to one. Wherever necessary, puddle has been used to render the sides and channel watertight. This precaution was not necessary in the construction of the outlet canal, which has a length of two miles before it ultimately falls into the Rhône, since it is altogether in cutting. As the force of the current is exceedingly feeble, the inclination of the bed being uniformly about 1in. in every dozen miles, no fear need be entertained respecting the wear and tear of the banks, and so the Société des Forces Motrices du Rhône has been spared the expense of protecting walls of masonry.

Fig. 2.



Although the level of the canal can always be regulated by the sluices erected at the take-off, the additional precaution has been adopted of constructing, near the point 3 in the plan, a bywash which will allow any sudden and accidental rush or flood of water to find its way into the river, without occasioning an undue rise at the hydraulic and electric installations. In reality, an overflow in the strict sense of the term, and in constant and uniform operation, was not required here, but simply a trench or cut, from 300ft. to 600ft. in length, made in the embankment at the level of high water in the canal. At about two miles further up the canal, in the direction of Lyons, a compensating reservoir has been built which deserves a word of notice. Its volume or capacity is 54,000,000 cubic feet, and owing to the favourable character of the contours of the ground, its cost was restricted to the price of the acquisition of the necessary area and of the accompanying sluice gates, which are of a simple and comparatively economical construction, since they are subjected to a head of water not much exceeding 3ft. The advantage of this compensating reservoir is thus very considerable for the hydraulic department of the whole undertaking. The object of the sluice gates is, in cases of necessity, to enable the reservoir to be closed—that is, cut off completely from the canal—and also to maintain the water level of the canal at a uniform height. It is evident, therefore, that if the consumption of water by the turbines should lower the water level of the canal, the deficiency would at once be made good by a fresh supply coming in from the compensating reservoir. If, again, on the other hand, the supply to the turbines should be more than they required—a condition obtaining during the night time—the surplus water would be diverted to maintain the water level of the compensating reservoir. The conclusion to be drawn from this *va-et-vient* arrangement is that the compensating reservoir will impound the surplus water not required by the turbines at certain times, and restore it again to them when they require it, by maintaining the water level of the canal at a constant height, whatever may be the demand for supply drawn upon it by the working of the turbines.

A section of the canal in embankment is shown in Fig. 2, from which it appears that the old puddle wall type of construction is abandoned, and the puddling transferred to the inner or waterside of the bank, as indicated by the dark shading on one of the slopes. The general dimensions of the bank are as follows:—Height, 30ft.; width at top, 36ft.; and as the slopes are 3 to 1 on each side of the bank, the width at base becomes equal to 250ft., which ought to be ample for the comparatively small height. This embankment, which forms the right bank of the whole length of the supply canal, was made up partly from the excavated material of the canal itself, and partly from that from the outlet canal, which, as already stated, is wholly in cutting. It is confidently expected, and the present progress of the works certainly seems to warrant the anticipation, that the whole undertaking will be completed before the end of next year.

"INVENTION"—THE INDEFINABLE REQUIREMENT OF THE PATENT LAW.

THE subject of a patent must be not only new and useful, but must also be an invention. The courts hold that an improvement is not patentable, if there is no invention. With regard to the first two requirements but little difficulty has been experienced, or is to be anticipated; they relate to matters of fact and evidence. Questions involving them would be decided on the ordinary rules which apply to such matters. A thing must be considered new if no similar co-ordination of mechanical or other elements is on record. So, too, if it does not appear that a device is hurtful, it may for the purposes of the patent law be considered useful. Contrivances which are absolutely negative and inert are sufficiently rare to be left out of consideration; besides, a more positive or active interpretation of this word must presuppose not only a universal range of information, but prophetic insight on the part of those whose duty it is to determine the issue. Further, the patenting of such devices, did they exist, could work no more serious injury than the encumbering of the records. With regard to the third requirement, a very different state of things presents itself.

It is my intention to show that though the third requirement has always been in the statute, and its meaning substantially the same as the present interpretation, until recently it has practically been a dead letter. Further, that it is not by any means axiomatic that the third requirement is in any case possible of fulfilment, but, on the contrary, there are many cogent reasons for questioning whether "invention," like "spontaneous generation," is not a metaphysical myth. That, even if it be in fact a real quality, it has never been defined, nor is it of such a character that its presence can in any case be determined beyond doubt. All authorities agree that "questions of invention proceed upon fine and subtle metaphysical distinctions." Strangest of all, the law and practice relating to patents, which provides this requirement involving metaphysical distinctions, also provides that decisions relative to these philosophical subtleties shall be rendered by mechanics, chemists, lawyers, &c., but never by expert metaphysicians. That in effect the Patent-office examiners and judges decide these questions arbitrarily. So the third requirement works injustice in all cases, but particularly in those involving the results of the highest and best form of mental industry, which the patent law was particularly designed to foster. And that it should be removed from the statute, and the idea eliminated from the practice both in the Patent-office and courts.

The phrases descriptive of invention used by the courts are very few, viz.: "Inventive genius," "the genius of an inventor," "the inventive faculty," "invention as distinguished from mechanical skill," "invention as distinguished from construction," "ingenuity as contrasted with the judgment of a skilled workman." These, of course, are not definitions, but simply phrases supposed to be descriptive. Though the term "invention" has never been defined, legally or otherwise, either as a mental process or product, attempts to describe it have not been lacking. The following will, I think, suffice to show the inextricable confusion and difficulty arising from these attempts. I quote from Merwin's "Patentability of Inventions," a good authority, though on this point one is as good as another, each being simply a summary of legal decisions :—"An idea is not an invention if it be in the nature of an inference. It is true, of course, that what is plain inference to one man is a sealed book to another. But the inference here spoken of is that which is natural to a man of ordinary intellect, possessing the ordinary skill and knowledge of the art in respect to the inference drawn." This is under the head of "Test of Invention," page 18. Would not such a test simply shift the inquiry from the invention to the inventor? Then, too, the most striking characteristic of men's minds is the vast difference between them in this very matter of drawing inferences. This it is which makes the difference between the thousand a year and the thousand a month man. Again (page 22), "Invention is imagination, it is the very opposite of reason or inference. . . . . It is not a sort of elevated reason, it is a faculty, which differs in kind from reason, which often in truth is free to act only when reason has been thrust aside, and its conclusions ignored, nay, denied." Certainly this is to the point, and ought to serve as a guide, but later we come upon this ". . . . In the last analysis reasoning and imagination are both perception of likeness, and reasoning shades off into imagination." Here is another suggestion :—". . . . When the mind invents, it starts with the conclusion. The conclusion flashes, so to say, upon the mind . . . . an instance is the case of the barbed wire fence." This does not appeal to the mind as axiomatic or even beyond question, nor does the illustration necessarily fit the stated conditions. Is it not much more easy to think of the "barbed wire" as the result of inference from direct or reminiscent observation, than as a conclusion flashed upon the mind, out of nothing, as it were?

Let us suppose a case :—A man is walking through the woods searching for his cattle which have broken through the plain wire fence of their paddock. Suddenly he is brought forcibly, painfully, to a halt by an aggressive blackberry bramble which has grown across the path and attached itself to a tree. Is it, I ask, necessary to endow that man's mind with an "inventive faculty," "inventive genius," with, in fact, anything other than ordinary reason, that he should be enabled to draw the inference from his own experience with the bramble. That, were it as strong as his plain wire, it would be more efficient as a fence; or in other form, had his wire been armed as the bramble, his cows would not have pushed against it.

These quotations illustrate how vague and misty are the criteria of "invention," and Mr. Merwin says in his preface, "His aim has been to make the book essentially practical." And this, undoubtedly, he has done, so far as the subject would permit. Judge Shepley says: "No more difficult task is imposed upon the court in patent cases than that of determining what constitutes invention, and of drawing the line of distinction between the work of the inventor and constructor." A careful reading of the decisions involving invention, the summaries of Robinson, Merwin, and others, show that to distinguish between so-called "invention" and the results of other normal mental practices which, according to these same authorities, are "foreign to invention," if not absolutely impossible, is a task of the most abstruse, subtle, and difficult character.

After forty-five pages of such an attempt, Mr. Merwin says, under the head of "Conclusion":—"We are far from thinking that our suggestions are equal to the difficulty of the subject, neither do we fancy that the most thorough and correct analysis would render it easy henceforth to decide upon the presence or absence of it—invention—in any given case." This is but repeating in other words the remarks of Justice Brown, in the Supreme Court, in McClain *v.* Ortmeyer, 141 U. S. 419, who, after speaking of the impossibility of defining invention, calls it "that impalpable something which distinguishes invention frome simple mechanical skill."

Up to comparatively recent times the workers in the field of mechanical improvement were few, and the results scattering and disconnected, but withal great and surprising. It is not, therefore, to be wondered at that to those not directly connected with the day-by-day preparation these results should appear as the work of persons differently endowed to themselves, to whom both process and result alike appeared mysterious. It is the normal action of the human mind to ascribe to occult sources results beyond its present comprehension. Owing to the comparative fewness and lack of connection between patentable devices at the time referred to, novelty frequently, if accompanied by complication of parts, was considered sufficient evidence of invention, so that, practically speaking, though on the statute books, the present idea of invention as a vital principle in patentability has been a dead letter.

The history of invention and the current decisions make the conclusion almost inevitable that, though theoretically a suppositious "something" other than novelty and utility was and is required, the practical working and effect has always been that apparent novelty in a high degree served to prove the presence of "invention," and a low degree of novelty to show its absence. This course is pursued deliberately by some judges. Merwin says, page 17:—"Certain judges do not even ask if a new function or effect has been produced. They assert that the statute requires only that the thing to be patented shall be new and useful." This apparently rough-and-ready, though really scientific, method, whether employed deliberately or not, served excellently, and carried out the undoubted intention of the patent statute, viz., to reward the producers of devices of a high degree of novelty and utility, the result of unusual intelligence or industry. Open and continued practice on the same lines would doubtless continue to prove equally effective in carrying out the spirit of the statute.

In recent years the scope and ramification of mechanical and other industrial processes have become world-wide, affecting every act of life. Consequently the points of contact and coincidence of new devices have become more numerous, and opportunities for striking novelties have become fewer and fewer. It is under these circumstances that this subtle metaphysical—one is tempted to say occult—idea of invention has been given prominence, and the patentability of devices determined by fallible personal opinions, instead of facts and evidence. The legal text-book writers, with every intention of rendering assistance to work-a-day men on a subject of practical importance, in dealing with the accepted idea of invention are irresistibly forced in the mazes of metaphysical and philosophical abstrucities. But admitting what the text-book writers and the courts say on this subject, that invention does exist, though indefinable; that it is an "impalpable something" wholly within the domain of metaphysics and philosophy, does it not seem utterly illogical that the determination of these subtleties should be left to mechanics, chemists, and lawyers. Would it not be more reasonable that the examiners in the Patent-office, instead of being versed in the arts of their departments, be metaphysicians trained to determine mental principles and operations. And above all, would it not be more logical to try patent cases involving these issues before this same kind of experts, than as at present before judges who are neither specialists in the art involved nor metaphysicians, but simply men trained to determine and discriminate in matters of fact. "The mental process of invention, in most cases, is very similar to that of discovery. . . . . . The distinction between them is almost always overlooked, sometimes its existence is denied by the courts."—Merwin.

There is, as has been hinted at, still another phase of this question, namely, that "invention," instead of being the result of a peculiar, unique, and altogether exceptional mental process, is simply the result of conscious or unconscious reasoning on data supplied by observation, and in all respects similar to other mental processes in which observation, memory, and reason take part. This view was set forth at some length in a recent number of the *Engineering Magazine*, under the title, "Is the Inventive Faculty a Myth?" by the present writer. It is not necessary to the present argument, and is simply referred to as offering a possible reason for the difficulty of defining wherein invention differs from other rational processes, also as suggesting the justice and advisability of determining, first, the existence of "invention," as interpreted by the courts, beyond question. Before demanding its presence as a statutory requirement to a common contract. "The statute demands a peculiar process of mind as the characteristic of invention. . . . The statute is so interpreted by the courts. . . . It is impossible to arrive at the patentability of an improvement in any other way."—Merwin.

As illustrating how this demand for the presence of "invention" works in practice, take this case:—The Patent-office refuses to grant a patent, not on account of lack of novelty, for no anticipating device can be found; it is admittedly of great practical importance, but it is refused simply on the ground of want of invention. After exhausting argument, the applicant finally says: "Surely we must be quibbling about words. What does the office mean by 'invention?' What has the examiner in mind which he says this device lacks?" To this there is no reply except the arbitrary exercise of power. This is not a supposititious case, for of late years it is becoming of frequent occurrence.

Before drawing conclusions from all the foregoing, I desire to make some remarks, which, while they do not bear directly on the present argument, do bear on the subject of invention in general, and will probably serve to give point even to the present matter. The courts and authorities are agreed that "invention involves the spontaneous conception of some idea not previously present to the mind of the inventor" (Robinson), but that wise judgment in selecting and combining ideas already there has no part therein, and that "reasoning is not invention."—Merwin. It is justly inferable, therefore, that inventive ideas do not depend upon other ideas, or they would not be spontaneous, but simply inferences.

This being so, it logically follows that a mind devoid of ideas, if such were conceivable, would be as fertile a field for invention as one rich and full of ideas, concepts, and observations. Or, to put it in another form, that in a mind stored wholly with, say, legal concepts and ideas, a mechanical invention is as logically probable as in a mind filled with observations of every variety of mechanical elements and combinations. The born blind should invent new colours, and the born deaf compose music.

At the risk of opening the door to a metaphysical argument, which I would avoid, being a mechanic and not a philosopher, and my present object being the wholly practical one of suggesting a way of taking patents out of the misty region of metaphysics into the domain of facts, where they belong, still, I cannot refrain from suggesting that when the first sentient atom perceived inert matter, the concept of resistance originated, the first embryonic idea, with and from which all others have risen in continuous and unbroken sequence.

In every attempt to disentangle "invention" from other forms of thought much stress is laid upon the idea of its instantaneousness of operation. This, I take it, is a relic of ignorance, for we now know that even thought is not instantaneous. Rapidity is characteristic of all thought. Is it not possible that behind this question of time lurks hidden the solution of many of the difficulties of "invention" as interpreted by the courts? The phonograph is frequently cited as one of the most perfect illustrations of inventive genius. In this I fully concur, and, further, I hold it to be an equally beautiful example of pure inductive reasoning, and that the idea of the phonograph being "spontaneously conceived" is simply unthinkable. For its conception a distinguished line of ancestry was required, among which, as near kinsfolk, were very sturdy ideas of sound waves, elasticity of diaphragms, and whole troops of mechanical ideas. And for a birthplace a mind furnished with every achievement of modern science and lighted by logic as clear as noonday. Spontaneously conceived, forsooth!

In contrast to this may be mentioned the illogical unreasoning and unmechanical attempts of Von Kempelen, and later of Faber, to make a talking machine by copying the human speech organs, ignorantly overlooking what simple observation should have taught, that the human mouth, with other functions, is a tasting device, a grinding apparatus, and a fighting machine, and only last and least of all, and incidentally, is used for talking; for which purpose, by the way, it is so ill-adapted that it takes years of adjustment to do in the way of talking what the phonograph does instantly it is made. "Reason is unravelling and invention is weaving of thought. Reason is analytic, invention is synthetic."—Merwin. The error of this lies in the fact that reason is both analytic and synthetic. Illustrations, both analytic and synthetic, of convincing character could readily be given, but they would be out of place in this article. In the class under consideration—viz., inventions in which reasoning appears to be solely employed—reasoning is, indeed, the faculty most conspicuously used; but imagination must be employed before the reasoning begins, and in order that it may begin. For in these cases invention—imagination—is exercised. . . in selecting out of a great many possible elements, the particular element to accomplish the result desired."—Merwin.

A pertinent inquiry is here suggested: "Invention"—imagination—being unreasoning, how is it possible for it to select? The quotation in effect concedes my whole contention. The courts and text-book writers first eliminate reason, and then immediately proceed to endow imagination with a power of intelligent selection, which is reason.

The better idea of imagination—I avoid the word "invention" as being misleading—is just what the word implies, mentally seeing images, that is, a sort of mental pictorial scrap book, in which is stored past visual observations—leaving out of consideration those who derive their principal impressions through other senses. The imagination is just as inert and as incapable of conception, spontaneous or otherwise, as the physical scrap book used as illustration. The circumstances of life and man's contact with nature disclose wants, deficiencies, and lack of adjustment between him and his environment, which reason sometimes supplies by selecting directly from physical nature or by recourse to the scrap book of reminiscent observations, *i.e.*, imagination, image memory, *alias* visual memory, *alias* visualisation, *alias*—though wrongly—invention. A patentable combination, no matter how involved or complicated, is simply an aggregation of co-ordinating individual wants or deficiencies which have been individually supplied.

It would be an entirely erroneous impression to derive from my remarks, that because I question the existence of "Invention" as interpreted by the courts, I also discredit "Genius" or believe that poets are made, not born. I hold in the profoundest reverence those giants of intellect, both past and present, to whom the world owes its masterpieces, and I do not fear that an intelligent inquiry into the causes of their greatness, no matter how searching, will detract from their glory or tend to diminish their number in the future.

It may possibly be urged by some, that tribunals of law when they adjudge the existence of the "inventive faculty" simply adjudge the existence in certain individuals of capabilities, which enable those so gifted to accomplish results superior to anything which might reasonably be expected from the best minds and skill at present engaged in the cognate arts or callings; and when the same tribunals adjudge that a certain thing is an invention, they simply adjudge that it is distinctly superior to and different from anything that might reasonably be expected from the skill of the best minds versed in the arts involved.

If what has gone before is not considered to meet this objection, then a complete answer is to be found in the decisions of the United States Supreme Court, in which it has been held time after time that simple superiority, or superiority accompanied by novelty, either in device or result, does not entitle it to be considered an invention, or entitled to the benefit of the patent statute. On this point I refer to the following cases taken at random:—Union Edge Setter Co. *v.* Keith, 139 U.S. 530. It was decided that the claim lacked invention, though the result was a more perfect machine. Bussel Trimming Co. *v.* Stevens, 137 U.S. 423. Patent performed the work it was designed to accomplish in a better and more workmanlike manner, and yet was held to lack invention as being improvement only in degree. Consolidated Roller Mill Co. *v.* Walker, 138 U.S. 124. Conceded that the peculiar arrangement of patentee is attended with better results than previously, still this would not necessarily sustain patent. Aaron *v.* Manhattan Railway Co., 132 U.S. 84. Though patentee was entitled to the merit of being the first to conceive the convenience and utility of a gate opening and closing mechanism which could be operated efficiently by an attendant in a new situation, still this merit might not sanction patent. Though taken at random, these serve to show that superiority is not a criterion of invention, nor is novelty, nor yet superiority and novelty, though they may indicate it; but the statute as interpreted by the courts demands something else, which is not simply superiority nor novelty, nor even a combination of these qualities.

It may, of course, be said that the devices in question did not disclose the degree of these qualities contemplated by the statute, but this simply carries the question back again to the original difficulty not a whit simplified. The determination of that degree would still be left to the arbitrary decision of individual opinion. But this line of argument is futile anyway, for it is not in accordance with the facts of the case. The statute as interpreted does demand a prescribed character of mental operation or evidence of it in the device as a condition on the part of the produce to entitle him to the provisions of the statute.

It is urged that the law being practical simply attaches to words it employs—the meaning as nearly as possible given to them by common consent—and does not inquire if the words correctly interpret facts, or whether there is any real foundation for them in fact. It simply uses them as the best means available to convey a meaning. Even this does not help the matter if that meaning be erroneous or confusing and a source of continued and increasing trouble, tending to thwart the very end for which the statute was formed. That this is the case with the words invention, inventor, and invented, is thoroughly appreciated by both the producers of new devices and lawyers whose business brings them into close acquaintance with matters relating to patents and patent litigation. And it is with this practical difficulty that the writer as a mechanic is interested at this time, and not with any fine-drawn metaphysical distinctions or modes of mental action. It does not follow, of course, that because the present interpretation of a word in the statute works confusion and difficulty, that therefore the statute is based upon a wrong idea, and ought to be abolished. This paper has gone far wide of its intention if such an idea is deducible therefrom.

The patent statute stands a monument of human wisdom which has few rivals either in honesty of purpose or grandeur of result, and the writer would be the last to suggest anything which in his judgment would tend to weaken or cripple its beneficent working. The very opposite of this is the intention, which is simply to suggest the elimination of those elements which tend to obscure the meaning and balk the evident purport of the statute.

The object of the patent law was undoubtedly to encourage and reward industry and intelligence when directed in channels beneficial to the commonweal. There certainly was no idea of rewarding certain supposed freaks of nature for the possession of a peculiarity they could not help. Therefore, putting aside any metaphysical controversy, inasmuch as the criteria of one of the requirements to the patent contract are so utterly indefinite and the determination so impossible, does it seem the part of the practical common sense and business-like procedure to eliminate the element of confusion? All other matters which have been found by practice to be good and desirable would remain unaffected.

In fact, the substitution of the idea conveyed by such words as discovered, produced, thought out, reasoned out, for that which now attaches to the third requirement of the patent contract, would work no change whatever in the spirit of the statute to reward intelligent industry, but would sweep away the cobwebs of mysticism which festoon the ideas supposed to underlie the word "Invention."—*W. H. Smyth in the Mining and Scientific Press (San Francisco).*

THE FEDERATED INSTITUTION OF MINING ENGINEERS.

A GENERAL meeting of the members of the Federated Institution of Mining Engineers will be held in London on Thursday, June 4th, at 12 noon, and on Friday, June 5th, at 12 noon, in the rooms of the Institution of Civil Engineers, 25, Great George-street, Westminster, London, S.W.

Arrangements have been made for visits to the works of the Electric Welding Company, the Deptford Station of the London Electric Supply Corporation, on Friday, June 5th; and to the works of the Waterloo and City Railway Company, on Saturday, June 6th, 1896. The following programme has been issued:—

Thursday, June 4th: 12 noon.—General meeting in the rooms of the Institution of Civil Engineers, 25, Great George-street, Westminster, London, S.W. An adjournment will be made for luncheon from 1.30 to 2.30 p.m. The following papers will be read, or taken as read:—"Presidential Address," by Mr. Geo. A. Mitchell; "The Causes of Death in Colliery Explosions," by Dr. J. S. Haldane; "Road Engines," by Mr. John McLaren; "The Gobert Freezing Process of Shaft-sinking," by Mr. A. Gobert; "Precautions necessary in the Use of Electricity in Coal-mines," by Mr. H. W. Ravenshaw. The following papers will be open for discussion:—"Photography in the Technology of Explosives," by Mr. Alfred Siersch; ("Trans.," vol. xi., page 2. "Coal-washing Plant at the Wirral Colliery, Neston, Cheshire, by Mr. J. Platt; "Trans.," vol. xi., page 55;) "Lead and Lap of Winding, and other Engines;" by Mr. Hargrave Walters; ("Trans.," vol. xi., page 64.;) 4.0 p.m.—General Meeting will be closed.

Friday, June 5th.—Excursion No. 1:—9.30 a.m.—Visit the works of the Electric Welding Company, 21, Hindon-street, Pimlico, S.W., and inspect the Thompson electric welding process. The visitors will be received by Mr. R. J. Wallis-Jones. Take train or omnibus to the Victoria Station, and walk to the works, which are closely adjacent. 12 noon.—General meeting in the rooms of the Institution of Civil Engineers, 25, Great George-street, Westminster, London, S.W. The following papers will be read, or taken as read:—"Powdered Coal Firing," by Mr. Bryan Donkin; "The Southern Limit of the Nottinghamshire Coalfield," by Mr. G. E. Coke; "The Indian Goldfields," by Mr. A. G. Charleton; "The Witwatersrand Goldfields," by Professor L. de Launay; "Mechanical Roasting of Ores," by Mr. Horace F. Brown; "Lake Superior Mining Ore Region, with Special Reference to the Masabi Range," by Mr. Horace V. Winchell. The following papers will be open for discussion:—"The Eastern Limits of the Midland Coalfield," by Professor Ed. Hull, F.R.S. ("Trans.," vol. xi., page 9); "The Goldfields of Matabeleland," by Mr. F. G. Shaw ("Trans.," vol. xi., page 29); "Electric Welding," by Mr. T. Scott-Anderson ("Trans.," vol. xi., page 40). The Müller smoke and gas mask will be exhibited. 4 p.m.—General meeting will be closed. Excursion No. 2:—4.30 p.m.—Visit the Deptford Station of the London Electric Supply Corporation.

Saturday, June 6th.—Excursion No. 3:—9.30 a.m.—Members may visit the works of the Waterloo and City Railway, and are desired to assemble at the shaft sunk in the river Thames, near Blackfriars Bridge. The party will be received by Mr. Dalrymple-Hay, resident engineer; Messrs. Wales and McDonnell, assistants; Mr. Wm. Rowell, contractors' agent; and Mr. Chas. Campbell, contractors' engineer.

TRADE AND BUSINESS ANNOUNCEMENTS.—Mr. James S. Gaskell, M.I.C.E., has been appointed resident engineer to the Surrey Commercial Dock Company, in succession to the late Mr. James Adair McConnochie.—The Hamburger Metall-Walzwerk von George Dittmann and Co., have appointed Messrs. Weager and Funck, 1, Whittington-avenue, London, E.C., sole agents for the United Kingdom for the sale of their yellow metal and copper sheets and sheathing, and other manufactures.

RAILWAY MATTERS.

The Light Railways Bill is down for Monday next, and the occasion will be seized for obtaining promises concerning the passenger duty and carriage tax.

In connection with the Royal Agricultural Society's show at Leicester, the Midland Railway Company is making arrangements for visitors to take tickets to and from Derby, and accommodation at the company's hotel at Derby, for the several days of the Show week.

Travellers on the Great Western Railway propose to present a testimonial to Benjamin Jeans, the oldest guard on the line, who will retire from the company's service at the end of the present month, after fifty-three years' work. A fund is being raised for this purpose.

Through trains over the Brooklyn Bridge are again proposed by the Brooklyn elevated railways. They propose to have the engines fitted with cable grips. The weight of a train is estimated at 48,000 lb. for the engine, 125,000 lb. for five cars, and 65,000 lb. for 500 passengers, or 238,000 lb. in all, the length of the train being 258·95ft. The weight of the cable trains is given by *Engineering News* as 56,000 lb. for a car equipped with electric motors for switching, 120,000 lb. for three cars, and 65,000 lb. for 500 passengers, or 241,000 lb., the length of the four-car train being 200ft.

The position of general manager of the Victorian Railways has been offered to Mr. J. Mathieson, the present Commissioner for Queensland Railways, who has accepted same, at a salary of £3500 per annum, for a term of five years. It is understood that in making the choice of this gentleman, his successful colonial experience in railway matters specially befits him for the position. The successor to Mr. Mathieson for the position he vacates in the Queensland Railways is to be filled either by Mr. Gray, a former commissioner, or Mr. C. E. Norman, the present Engineer-in-Chief for Queensland Railways.

A pre-arranged railway collision is to be one of the attractions at the opening of Buckeye Park, a pleasure resort twenty-five miles south of Columbus, O. The Columbus, Hocking Valley, and Toledo Railway has assigned two 35-ton locomotives, which have outlived their usefulness for economical service, and to each of these will be attached three old gondola cars and a caboose. A siding 1000ft. long has been laid, connected at each end with the main track, and the trains will be started from points about half or three-quarters of a mile from the middle of the siding. A trial trip has showed that a speed of forty-five to fifty miles per hour may be expected. The engines are to carry 120 lb. boiler pressure, and are to have the throttles wide open. What means will be taken to protect the spectators in case of the possibility of a boiler explosion we do not know. The above particulars have been given to the *Engineering News* by Mr. W. H. Fisher, general passenger agent, who is arranging for a large excursion traffic to this novel attraction.

In the report of the trial tests of Victorian coal made on one of the Government locomotives, Mr. Price-Williams, who has recently returned from Australia, says:—"I consider, therefore, that having regard to these exceedingly severe trial tests, carried out as they have been under exactly similar conditions of load, locomotive power, and upon the same portion of the Victorian railways, with the results verified by the independent observations of the officials of the Government railway department, the fact is conclusively established that this great Colony has the good fortune to possess, amongst its other great natural resources, an abundant supply—the extent of which I gather from Mr. Stirling, Assistant Government Geologist, has not yet even been thoroughly ascertained—of coal of a very high class, not only well suited for steam purposes, but which, from independent tests of it which I made at home, I can certify produces very good coke, and from its bituminous character, ought to prove of great value as a gas producer. It is scarcely necessary, I should add, that this coal has all the best qualities for domestic use."

The sale of the Guatemala Central Road, owned by Mr. C. P. Huntingdon, to an English syndicate, has been completed. The price is said to be 7,400,000 dols. in gold. A road is now being built in the northern portion of the State, from Guatemala City, to reach Port Barrios on the Atlantic Coast. This line may divert traffic now going to San Francisco to New York. This road is being built by the Government. The entire distance between the two towns is 180 miles; 65 miles of this, from the Atlantic side, is now in operation. Besides this, 50 more miles are under contract. There is also a 45-mile section from the Guatemala City end to be let to contract shortly. When these two contracts are completed freight can be transferred between the terminals. The coffee shipments then may be made to New York. Another important project by the Guatemalan Government is the spending of 57,000,000 dols. at the new port of Estrapa, nine miles below San Jose. It is at the mouth of a river and dockage will be there furnished for large ships. Over 7,000,000ft. of lumber have been sent from San Fransisco during the last few months. The *Railway News* says the harbour is to become the important one for the Pacific coast in Guatemala.

On March 6th a description was given in The Engineer of the first of the Dunalastairs, a new and powerful class of locomotives built by the Caledonian Railway from designs by Mr. M'Intosh, its locomotive superintendent, for working the heavy main line expresses. The whole fifteen engines of the class have now been running for a period long enough to judge of their working capacity. From the statistics of their work up to the end of April, it is found that with the exception of one instance, where two minutes were lost on account of very stormy weather with a heavy train of twenty vehicles, the whole of the trains have either been worked to booked time, or from ten to twenty minutes made up on the journey. The engines have been put to do single-handed work usually performed by two engines, and have frequently, without the aid of the usual pilot, made up time with trains of from nineteen to twenty-two vehicles over such bad gradients as on the main lines from Glasgow to Carlisle and from Perth to the south. It is intended to gradually conform all the old main line locomotives to this new class by replacing their boilers by large ones of the same dimensions, with 1403 square feet of heating surface.

Cast iron car wheels are not permitted to be used in any country of continental Europe with the exception of Austria, the laws to this effect having originated at a time when such wheels were very imperfect. This arbitrary action, *Engineering News* says, of course prevented any improvement in such wheels, while their general use in the United States has led to great improvements in the design and manufacture of the wheels, and the establishment of a large and important industry. During the past year Mr. Fr. von Emperger, consulting engineer, of New York city, representative of the Austrian Government, was requested to investigate and report upon American practice. As a result of this, the Austrian Government Railways placed an order with the New York Car Wheel Works, of Buffalo, N.Y., for 120 standard cast iron Griffin car wheels for use on freight cars fitted with brakes. These have been delivered, but the cars cannot be used beyond the Austrian frontiers, in consequence of a rule of the German Railway Union—which comprises all the States adjoining Austria—which forbids the use of brakes with cast iron wheels. Should this experience on Austrian railways lead to the abolition of this rule there would be a good prospect for an export trade in this country, as the experience, machinery, and skilled labour necessary for the construction of high grade cast iron wheels cannot be had anywhere in Europe.

NOTES AND MEMORANDA.

A new flour mill is to be built at Fort Saskatchewan, Alberta, the owners of which propose to give 35 lb. of flour, 10 lb. of bran, and 3 lb. of shorts in exchange for a bushel of sound clean wheat.

The deaths registered last week in 33 great towns of England and Wales corresponded to an annual rate of 18·1 per 1000 of their aggregate population, which is estimated at 10,846,508 persons in the middle of this year. In London the rate was 17·8.

The population of registration London at the recent census enumeration was 4,411,271. The population of London in the middle of this year, estimated on the basis of the rate of increase between the censuses of 1891 and 1896, is 4,421,492, which is 14,463 less than the estimate hitherto in use, based on the enumerations of 1881 and 1891.

At a recent meeting of the Paris Academy of Sciences, a paper was read on the *rôle* of the induction ring of iron in dynamo-electric machines, by M. Marcel-Deprez. A discussion as to the cause of the effect produced by the ring of iron in dynamos of the Pacinotti type. Some experiments are cited which tend to show that the explanations usually given in text-books are insufficient. The complete theory will be given in a future paper.

Mr. W. J. Humphreys has examined quantitatively the solution and diffusion of tin, lead, bismuth, zinc, copper, and silver in mercury with a view to determining the extent to which these phenomena differ, if at all, from the solution and diffusion of non-metallic solids in liquids. Pieces of metal were placed on the upper surface of a column of pure mercury, and samples of the liquid were taken at definite depths below the surface, and the amount of foreign metal estimated. As far as the experiments go, the author concludes that the solution and diffusion of metals in mercury do not essentially differ from those of non-metallic solids in liquids. Copper and silver dissolve in mercury to a very small extent at ordinary temperatures, but diffuse very rapidly.

At a recent meeting of the Physical Society, Mr. Campbell read a paper on "New Instruments for the Direct Measurement of the Frequency of Alternating or Pulsating Electric Currents." The author employs two arrangements, in one of which a steel wire, the tension on which is variable, and the other a steel spring of variable length clamped at one end, are acted upon by an electro-magnet through which the periodic current is passed. The tension or length, as the case may be, is varied till maximum resonance is obtained, a small contact piece being employed to detect when this occurs. The instrument exhibited was capable of measuring the frequency of periodic currents of from 40 to 150 double vibrations per second. Mr. Watson said he thought that in the case of the steel spring there would be a considerable temperature correction, and he suggested a method by which this might be compensated.

At the last meeting of the Physical Society, Mr. R. Appleyard read a paper on "Dielectrics." The author has particularly investigated the effect of temperature on the dielectric resistance. He has employed for this purpose condensers insulated with mica and paraffined paper. In order to eliminate some of the effects of surface leakage, Price's guard-ring arrangement was made use of in all the experiments. The author finds that the capacity of a paraffin condenser varies irregularly with the temperature, but that to within the accuracy attainable with his instruments—1 per cent.—the capacity of a mica condenser is constant between 33 deg. Fah. and 110 deg. Fah. If the resistance of paraffin at a temperature t is represented by $R_t = R\,a^t$ the mean value for log. a deduced from all the author's measurements is $\bar{1}\cdot96344$. Experiments made with a parallel plate condenser, with paraffin as the dielectric, show that when the temperature reaches within about 20 deg. of the melting point, the resistance rapidly falls; when melting commences there is a rapid drop, but while melting is in progress the resistance remains constant.

Another method of treating wood, with a view to preserving and colouring it, is described in a recent English patent specification. Although the lighter paraffin oils are said to protect timber, they disappear after a time through rain and climatic influences, leaving only the heavier oils in the wood, and these are sufficient to protect the timber from decay. The new method consists in taking the heavier oils or waxes of the distillation of mineral, animal, or vegetable oils and mixing them under pressure and at an elevated temperature with naphtha or other solvent. The solution is then forced into the wood in the same way as when creosoting is adopted, after which the naphtha is recovered from the wood by distillation, leaving the heavy oil in the timber to protect it from decay. By this means a small amount of heavy oil will thoroughly preserve wood, whilst the latter will be clean to work and handle, and remain light and elastic. It is claimed that only one-fifth the weight of heavy oil is required compared with creosote. For colouring the wood, such dyes are used as are soluble in the solvent employed to dissolve the oils, with which the wood is being treated.

In a paper in the *Journal* of the American Chemical Society, on "Coals, Determination of their Heating Effects," by W. A. Noyes, J. R. McTaggart, and H. W. Craven, references are given to the recorded discrepancies found by Scheurer-Kestner and others to exist between the calculated and the determined calorific powers of coals. The authors have tested six specimens of representative Indiana coals by the Hempel calorimeter, by Berthier's test, and by analysis; two of these coals—Brazil and Lancaster—are non-caking, and are known as block coals, whilst the other four are bituminous caking coals. Anthracite could not be compressed into cylinders for the calorimeter, and could not be burned as a powder; it was therefore not tested. The moisture was found by drying at 105 deg. Cent. for an hour in a toluene bath, and the fixed carbon by heating one gramme of the coal in a covered platinum crucible with the full flame of a Bunsen burner for seven minutes; the oxygen was estimated by difference, after adding to the weight of ash found, five-eighths of the weight of sulphur present, as the sulphur generally occurs in the form of pyrites, which is assumed to be burned to Fe_2O_3 and SO_2. The calorific power is calculated from the formula $8080\,C + 28{,}800\,(H - \frac{1}{8}O) + 1582\,Fe + 2168\,S$, the symbols standing for the weight of the corresponding element present, and hydrogen being supposed burnt to vapour of water.

According to the statement made by Mr. H. Schweitzer, of New York, some of the refiners of American petroleum have a new way of adulterating their products. This consists in making up oil from a mixture of "top and bottoms"—*i.e.*, naphtha and the last boiling, or heavy oil. It is stated that these mixtures can be made to show the same flash-point and specific gravity as the best burning oils; and as the boiling point is also the same, only an exact fractional distillation would furnish means for detecting the adulteration. For this purpose, Mr. Schweitzer advises the use of the solidifying test generally, which also shows the amount of solid paraffins present in the oil. Upon this the *American Manufacturer* says:—Herr R. Kissling remarks that he has used the solidifying test daily for at least twenty years, not because of its supposed value as a test of the burning and illuminating power of the oil, but because the separating out of the paraffins in cold weather might give rise to great inconvenience. For applying the test, Mr. Kissling makes use of an appliance consisting of a couple of concentric tin cylinders, containing a mixture of ice and salt. Into this, standing upon a cork plug, is inserted the oil in a glass tube which also contains a thermometer. According to Mr. Schweitzer, one of the large American railways companies demands that oil flashing at 150 deg. to 175 deg. shall remain clear when cooled and kept for ten minutes at 1 deg. Fah.; and 300 deg. oil must remain clear when cooled to 32 deg. Fah.

MISCELLANEA.

The directors of the Brush Electrical Engineering Company have decided to make a large extension of their works at Loughborough for building the Raworth Universal steam engine. The new tool shop, which will be devoted entirely to the engine trade, is to be 160ft. long by 48ft. wide. Building operations have already commenced, and it is hoped that delay in the execution of orders will now be avoided.

At Klausthal, in Germany, according to *Machinery*, a lightning stroke struck the wooden post of a house and fused two nails four millimetres thick. Messrs. Siemens and Halske, of Berlin, afterward carried on a series of experiments to ascertain the force required to melt this quantity of iron. Assuming one second as the time standard, it required a current of 200 ampères and 20,000 volts, representing 7000-horse power. Assuming that the lightning occupied one-tenth of a second to fuse the two nails, the horse-power required would be 70 000.

Considerable inconvenience was lately caused to the Howrah public through the bursting of a main of the recently opened Howrah water supply in the Grand Trunk Road, near Bally. So great was the rush of water that it literally cut through the road, rendering wheeled traffic altogether impracticable, while considerable inconvenience was caused to foot passengers. Some of the villagers of Bally regarded the accident as most opportune, as two or three dried-up tanks were replenished with the much coveted filtered water. The damage was quickly repaired and traffic was resumed.

The Port Orchard dry dock, built for the U.S. navy at Seattle, Wash., was formally opened on April 23rd by the entrance of the monitor Monterey. The dock is of timber construction. The contract for the work was awarded in October, 1892, to Byron, Barlow, and Co. The general dimensions are as follows:—Length over all, 749ft. 8in.; length over coping, 650ft. 5in.; length on floor, 573ft. 7in.; width over coping at middle, 130ft. 1in.; width on floor, 67ft. 1in.; width of entrance, 92ft. 8in.; height from floor to coping, 39ft. 3in.; height from sill to high-water line, 30ft.; height from keel blocks to high-water line, 28ft. 2in.

On the 17th ult. a converter in the American Glucose Company's works at Peoria, Ill., exploded with terrible effect, two men being instantly killed and several others being dangerously injured. The converter, which was of copper, 5ft. in diameter and 14ft. long, was used to convert liquid starch into glucose, steam being used in the process. When the accident occurred, it is said that there was no way of shutting off the steam outside of the room in which the explosion occurred, and the converter-room could not be entered to remove the injured until the fire had been drawn from the boilers, and the latter cooled down. The *Peoria Journal* stated that the copper shell of the converter was ⅜in. in thickness originally, but it was worn down to ⅛in. by the corrosive action of the acids.

In the United States, during the year 1895, occurred 355 boiler explosions. This, says the *American Miller*, is the number tabulated by the *Locomotive*, and is probably short of the true number. By these explosions 374 people were killed and 519 injured. The property loss is not stated. In the preceding year the number of explosions was 361, and in 1893, 316. Inspection of boilers and examination of engineers is not general, and even where the law requires both politics is an ever potent factor. So long as inspection fails to inspect, so long will carelessness and ignorance continue the work of destruction, ably supported by the short-sighted economy of a large percentage of plant owners. Time will press home the importance of inspection and supervision; no doubt of it; but meantime the sacrifice of life and property will continue.

A most sensible order has been issued by the Commissioner of Public Works Collis, of New York City, who has directed that whenever an application for a permit to open a street is filed, all other parties having conduits in that street shall be notified to apply for permits to do any work they have in contemplation, so that the street may be blocked for as short a time as possible. After repaving, on completion of such work, the street will not be torn up again for a year except in great emergencies. Gas companies laying mains in streets will hereafter be required to lay service pipes to all properties abutting on the street while the main is being laid, and no permits for service pipes will be issued afterwards. Many hundreds of thousands of pounds would be saved annually, to say nothing of the great saving of annoyance, if a similar order were observed in London.

The Arrogant, a new second-class cruiser of 5750 tons, was successfully launched on Tuesday, at Devonport Dockyard, in the presence of a large concourse of spectators. The christening ceremony was performed by Lady Forestier Walker, wife of the General Commanding the Western District. The building of the Arrogant was commenced in June, 1895, and another twelve months must elapse before she is ready to hoist the pennant, by which time she will have cost nearly £270,000, more than half of which sum has been already expended on her. The Arrogant was designed by Sir William White, is 320ft. long and 57½ft. broad. Earle's Company, Hull, are the contractors for the engines, which are expected to develope a mean speed of 18·5 knots. The vessel's armament will comprise altogether twenty-seven quick-firing and machine guns, and two submerged torpedo tubes.

In 1895 a total of 3434 vessels, with a tonnage of 8,448,383 tons, traversed the Suez Canal, paying tolls amounting to 75,934,357f. The toll for the 216,938 passengers produced 2,169,385f., and the accessory earnings 322,367f., making a total for transit of 78,426,110f. The number of vessels in 1895 that used the canal for the first time was 250. Three thousand two hundred and sixty-six vessels, or 95·1 per cent. of the total shipping, used the electric light, enabling them to continue their passage through the canal during the night. In 1894 the proportion was 94·9 per cent. The average time occupied by vessels in the canal during 1895 was 19 hours 18 min., and the average duration of steaming through the canal 16 hours 18 min. Compared with 1894, that represents a diminution of 37 min. in the time occupied by vessels in the canal, and of 23 min. in the actual steaming through it. In 1895 the number of vessels drawing over 7 m. of water that passed through the canal was 1250, and among those vessels there were 228 that drew from 2 m. 51 cm. to 7 m. 80 cm., the maximum permitted by the regulations of navigation. The average tonnage of vessels using the canal increased from 2398 tons in 1894 to 2460 tons in 1895.

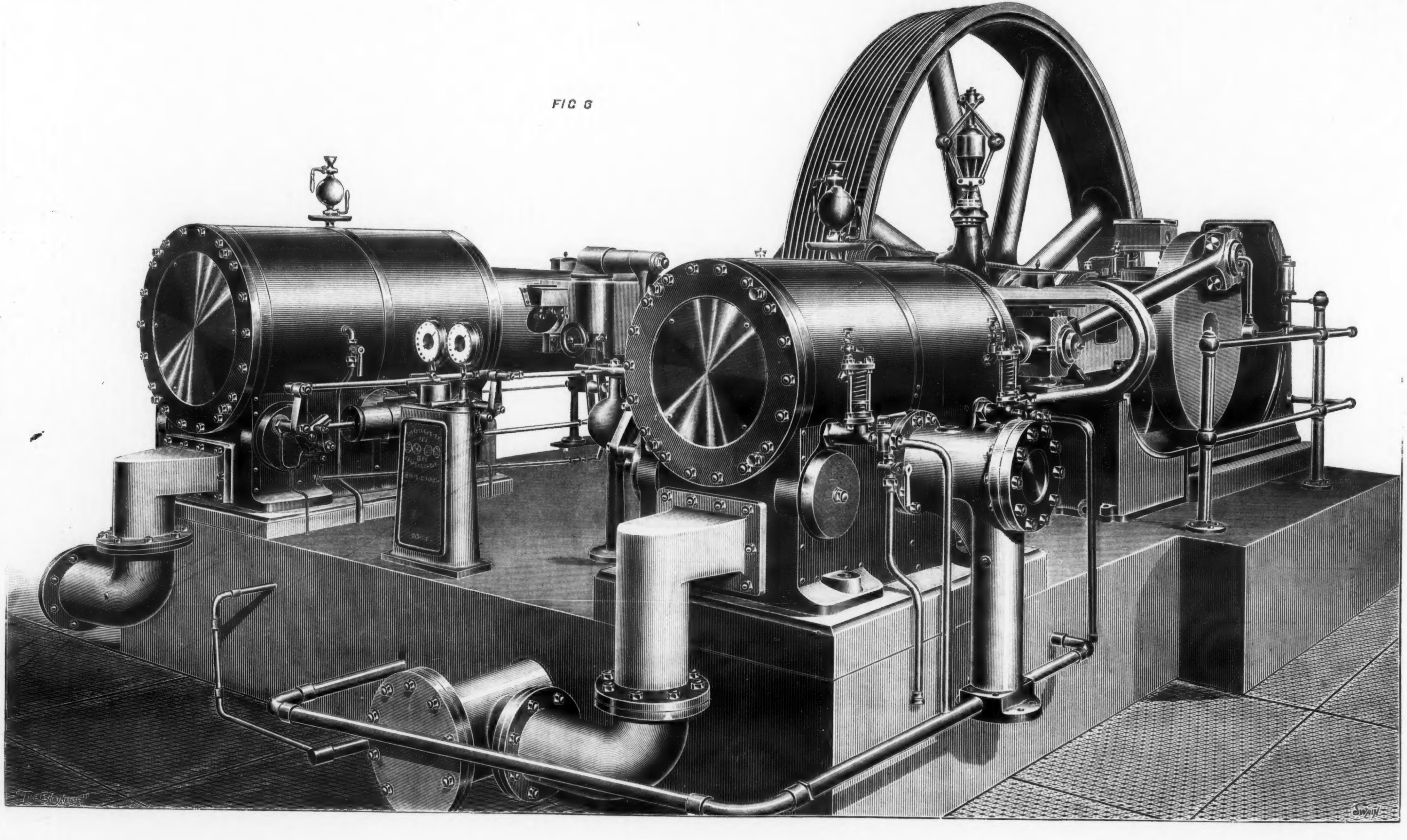
The German Hygienic Association offers a prize of 1200 dols. for a research essay on the efficiency of electric heaters. The programme is as follows:—"The heat given out in heating installations by heaters in their various forms and modes of use is to be ascertained. The investigations are to be described in detail in respect to the arrangement of the heaters, the nature of the heating agents, and the observations made; and they are to be illustrated by drawings. The heating values obtained are to be stated in units of heat given off per hour per unit of surface. In the case of heat given out to air, the investigations must be conducted with currents of air at speeds as different as possible. The heaters are to be described in detail as regards form and measurement, and the relation of their heating efficiency to their weight is also to be ascertained." Essays are to be written in German, and sent, with a motto and sealed envelope, to Prof. Konrad Hartmann, Charlottenburg, Fasannstrasse, 18, before the 1st of July. The essay will remain the property of the successful competitor, but he is required to publish it within six months, and to give the prize offerers gratuitously 300 copies. The offerers reserve the right to divide or withhold the prize

HORIZONTAL COMPOUND ENGINES—ISLINGTON ELECTRIC LIGHTING STATION

MESSRS. DANIEL ADAMSON AND CO., MANCHESTER, ENGINEERS

(For description see page 534)

FIG 6



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H. A.—*Thanks for the cutting. We agree with you that the invention does not deserve the encomiums heaped upon it. If, however, it provides a satisfactory method of getting rid of coke at a fair price, the gas companies will regard it with much favour.*

MARINE GOVERNORS.

(*To the Editor of The Engineer.*)

SIR,—I shall be obliged for name and address of maker of Smith and Pinkney's Pendulum Governor for Marine Engines, or if not now made by any one, about the date when patent was taken out for it.

Newcastle-on-Tyne, May 27th, 1896. C. W. F.

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, June 2nd, at 8 p.m.: Annual General Meeting of Corporate Members only, to receive the Report of the Council, and to elect the Council and Auditors for the ensuing year.

GEOLOGISTS' ASSOCIATION.—Friday, June 5th, at 8 p.m.: Lecture, "Bradyseisms, Earthquakes, and other movements of the Earth's Crust"—Geodynamics—by Professor John Milne, F.R.S. Saturday, June 6th: Excursion to the Crag District of Suffolk. Leave Liverpool-street—G.E.R.—10 a.m., arrive Bentley Station 11.45. Excursion Secretary, A. C. Young, 64, Tyrwhitt-road, St., Johns, S.E.

SOCIETY OF ENGINEERS.—Monday, June 1st, at 7.30.: Paper to be read, "Examples of Railway Bridges for Branch Lines," by Mr. M. A. Pollard-Urquhart, M. Inst., C.E. Synopsis:—Cost and number of railway bridges—Investigation as to the cheapest form—Public road bridges over railway—Wing walls—Economy of brick arch over girders for single line—Three arch bridges—Public road bridges under railway—Types of flooring—Occupation road bridges—Timber bridges for farm traffic—Structures over watercourses—Examples of three different types—Conclusion.

ROYAL INSTITUTION OF GREAT BRITAIN.—Tuesday, June 2nd, at 3 p.m.: Lectures: "The Building and Sculpture of Western Europe," by Professor T. G. Bonney, D. Sc., LL.D., F.R.S. Wednesday, June 3rd.: "The Vault of the Sixtine Chapel," by Professor W. B. Richmond, R.A. Thursday, June 4th.: "Lake Dwellings," by Mr. Robert Munro, M.D., M.A. Friday, June 5th, at 9 p.m.: Discourse, "Electric and Magnetic Research at Low Temperatures," by Professor J. A. Fleming, M.A., D. Sc., F.R.S., M.R.I. Saturday, June 6th, at 3 p.m.: Lecture, "The Moral and Religious Literature of Ancient Egypt," by Dr. E. A. Wallis Budge, M.A., Litt. D., F.S.A.

"THE ENGINEER"
HORSELESS CARRIAGE COMPETITION.

WE have recently received suggestions from many quarters that it would be expedient that our Competition should be postponed until the spring of next year, for the reason that the date already fixed does not allow sufficient time to competitors to produce really satisfactory vehicles for trial, and, further, that until the Bill now pending in Parliament has been passed, designers cannot be quite sure that they are working on the right lines. So far as we are concerned, we are perfectly ready and willing to abide strictly by the conditions which we have already published, but we shall be glad to have the views of those who are interested, so that we may decide upon a course which will lead to the best results for all.

THE ENGINEER.

MAY 29, 1896.

THE PNEUMATIC PROCESS.

WE have recently published two long communications from Sir Henry Bessemer intended to refute certain statements made by Mr. Weeks in the course of a presidential address to the American Institute of Mining Engineers in February last. Mr. Weeks gave a Mr. Kelly the credit of inventing something which he regards as an anticipation of the inventions of Sir Henry Bessemer. We use the word "something" advisedly. The term is vague, and we intend it to be vague, for reasons which will, we think, be made sufficiently obvious before we have done. We may say that with the controversy we have hitherto had nothing whatever to do. We did not publish Mr. Weeks' address; we did not give currency to any attack on Sir Henry Bessemer. We have published his letters out of deference to the wishes of the veteran inventor, feeling certain the while that they would prove more or less puzzling to the greater number of our readers, dealing as they do with the facts of a long-forgotten episode. Mr. Weeks has now sent us a statement of his views, which will be found in another place, and the time has come when the matters at issue must be stated in a form more intelligible than that adopted by our correspondents. Fortunately the thing is very simple. Mr. Kelly many years ago carried out experiments in the purification of iron by blowing air into a small vessel containing molten cast iron. Mr. Weeks and many other persons before and since have claimed that this was an anticipation of the Bessemer process. No one, however, so far as we are aware, has asserted that Sir Henry knew anything of Kelly or his experiments when he took out his first patent.

The first thing to strike the dispassionate reader who has a competent knowledge of metallurgy is that the contest has, in the first place, no practical value or significance whatever. How, indeed, it may be asked, were Kelly's operations an anticipation of the Bessemer process? In the second place, it will appear to him that the something fought about is not worth the paper and ink spent in the dispute. It is beyond all question that Kelly's experiments ended in absolute failure. No one asserts that he ever produced a ton of marketable steel. At the bottom of a little fixed cupola he put a hollow fire tile. The top or uppermost wall of this tile was pierced with small holes. A tuyere led air into the hollow tile, and the air escaped or was intended to escape up through melted iron in the cupola. It may be said that this was the Bessemer process. It was also said that Bessemer was anticipated by Martien, because he proposed that air should be made to pass up through molten iron running in "sows." It was also said that he was anticipated by some one who had dipped a tuyere below the level of melted metal in a ladle. The Catalan hearth and the Welsh refinery fire have all been cited as anticipations, and they have all been very properly brushed aside. A statement contained in Mandilso's Travels in Japan has been adduced to prove that the Japanese practised the process in 1669. Parry's abortive experiment at Ebbw Vale was far more to the purpose than anything Kelly did. Probably, if credit is to be given to any inventor before Bessemer, it is due to Henry Cort, who invented the puddling furnace, in which oxygen obtained from the oxides with which the hearth is fettled rises through the molten metal, and aids in burning out the carbon and silicon. But all arguments and citations of this kind are beside the mark. The Bessemer process, as it has come to be called, is not *a* thing. It is made up of a dozen things. Kelly most certainly did not invent all these things; neither did Sir Henry Bessemer. Kelly invented a process that was of no value whatever. The mere blowing of air through molten iron approaches very nearly to the nature of a principle, and a principle cannot be made the subject of a patent. But Kelly did not stand alone. Dozens, if not hundreds, of attempts have been made to free iron of its impurities. These are forgotten, simply because they were utter failures. Why should Kelly's utter failure be singled out from the host? Simply because there appears at first sight to be a close connection between the principle of his apparatus and the inventions of Sir Henry Bessemer. But the radical difference remains that, whereas Bessemer was successful, Kelly was not. It has been abundantly proved that the mere blowing of air into melted cast iron will not now and never has produced satisfactory commercial steel; and it is not easy to see why, on the one hand, Mr. Week's should have taken the trouble to rake up Kelly's long-forgotten existence; or, on the other, why Sir Henry Bessemer should so earnestly maintain that he was the original inventor of a method of treating cast iron which, standing alone, is absolutely worthless. It is indisputable that Kelly did such and such things, but what if he did? Sir Henry breaks a butterfly on the wheel when he disputes with Mr. Weeks. Besides the whole matter is ancient. It is some forty years since Kelly made his experiments. It is at least as many since Bessemer tried his hand at the same work. His reputation has lasted too long to be affected one way or the other now by experiments which ended in total failure.

A noteworthy feature of the controversy is the action taken by the United States patent tribunal, and the facts stated by Mr. Weeks are interesting. At first sight it seems that the decisions cited by Mr. Weeks are conclusive evidence that the claims advanced for Kelly were substantial and substantiated. But it must be remembered that the limitations of patent law are very rigid in one sense though very vague in another. There is beyond all question what may be termed "technical anticipation," and it constitutes one of the terrors of United States patent law. In the eyes of the examiner, things apparently alike are not infrequently really alike. Even in this country it has been possible to find what was little more than a published suggestion regarded as an anticipation, and a paragraph in a newspaper has ere now been regarded as sufficient to invalidate a patent; but newspaper paragraphs neither make nor mar a reputation, albeit nothing is more vexatious than the manner in which words have been used to establish priority claims. The reputations of great inventors are fortunately not measured and determined by patent law; they rest on a far wider basis. The world has never given either honours or money to an inventor who did nothing but file a specification. After all, the honours and the money go to the man who does, not to him who merely suggests. Sir Henry Bessemer's claims to honour and fortune are entirely unaffected by the fact, be it true or false, that Kelly or any one else tried to blow air through cast iron to purify it. Bessemer did that, and a great deal more. It is often urged by his detractors that without the aid of Mushet he could have attained no success. But even that statement is only true within very strict limits. Regard the case how we may, award credit with no stinting hand, as we do, to a number of inventors and workers, the broad great fact remains that to Henry Bessemer the world is indebted for the art and science of purifying iron by blowing air through it. His work extended over years, and ultimately it was his good fortune to gather round his standard a group of metallurgists and engineers by whom the multiplex manipulations which go by the general name of the Bessemer process were suggested or improved, and the apparatus for carrying them on produced. It is only necessary to go into any great modern steel works, see the huge blowing engines, listen to the roar of the converter, and watch the cascade of fiery white metal falling into the ingot moulds to see how vast is the difference separating Bessemer from Kelly. The Bessemer process is not a theory, it is an art. It is not one invention but fifty. Kelly's cupola did not anticipate the Bessemer converter as fully as Newcomen's engine did the modern triple-expansion engine. For Newcomen's engine could work; it had an economical value; it revolutionised the practice of mining. But Kelly's experiment possessed no value whatever; it rather tended to retard than to facilitate progress, as is the way with experiments which fail.

WHAT IS AN INVENTION?

IN THE ENGINEER for August 16th, 1895, will be found an article entitled, "What is Invention?" We commented at length on the views advanced by Mr. W. H. Smyth, mechanical expert and consulting engineer, living in Berkeley, California. Mr. Smyth has read what we have said, and still holds to his original views. He has favoured us with copies of the *Mining and Scientific Press*, containing a paper from his pen entitled, "Invention: the Indispensable Requirements of the Patent Law." We reproduce the paper, because it gives some useful information concerning the legal aspect of patents in the United States. Mr. Smyth's argument is not very clear to us, and we hope that he will forgive us if we do not fully grasp his meaning. We understand him to say that the word "invention" should be eliminated from patent law, and that in its place should be used the words "discovered," "produced," "thought," or "reasoned out."

Very recently we took occasion to point out that, in a certain sense, every invention is in the nature of a discovery. A discovery cannot be patented; but the means by which the discovery can be made useful can. Thus, for example, it was discovered that the electric current could deflect a magnetised needle. But the apparatus by which this discovery was utilised in the telegraph was invented. The discovery was common property as soon as it was announced. It remained open to each inventor of apparatus to choose a different method of utilisation. There are, however, cases in which a discovery is kept secret and utilised. An instance is furnished by the well-known Bessemer "gold" paint. Sir Henry, then Mr., Bessemer, in trying to make "gold" and "bronze" paint from Dutch metal, discovered a fact and utilised it. The whole story is extremely interesting. We hope the inventor will record it in his forthcoming autobiography. He kept the secret, and made his paints; and the object of thus keeping the secret is very suggestive. The whole success of the paint turned on one point. A certain result had to be produced at one stage of the process. Now this result might have been got in more ways than one, and Mr. Bessemer must, to protect himself, have taken out either a number of patents, or one combination patent. In either case it would be impossible to be sure that he had covered the whole ground and left no loophole for another inventor. Fortunately the manufacture was of such a nature, and the trade in gold and bronze paints so concentrated, that he had no difficulty in keeping the secret and supplying the demand. But however near to discovery invention may come, it is not invention. We think that the weakness about Mr. Smyth's argument lies in the circumstance that he mixes up two distinct things, namely, invention and an invention. So far as we can see, a judge is not called upon to define invention in any direct way; but he may be called upon to say whether a particular machine, or process, or thing, is, in the legal sense, an invention or not. The United States Patent-office, says Mr. Smyth, "refuses to grant a patent, not on account of lack of novelty, for no anticipatory device can be found. It is admittedly of great practical importance, but it is refused simply on the ground of want of invention." That is to say, the Patent-office holds that some device is not an invention. In this country the law is administered in a different way, and we have no hesitation in saying that Mr. Smyth has only told half the truth about the American system. Certain novel wants are called into existence as civilisation progresses. These wants are daily supplied by individuals who are not aware that they are doing anything unusual. The method of supply is simple, and obvious not only to one man but to hundreds of men, and the result is novel and satisfactory, but there is nothing to patent. Take, for example, the shafts of a dog cart. It was found that these, if made of wood only, broke, so a strap of iron was put under each to strengthen it. The addition of an iron plate in this way is obvious, and required no inventive effort, and would not form a good subject for a patent; and notwithstanding Mr. Smyth, we suspect that the United States Patent-office authorities find no practical difficulty whatever in defining what is and is not a patentable invention, although they may be quite at a loss to define "invention."

We have on a previous occasion said that Mr. Smyth's mode of reasoning leads us to believe that he has himself never invented anything. If he had, we venture to think that he would not have experienced the incredible difficulties under which he seems to labour in defining the meaning of the word. We have so fully dealt with the question in our issue of August 16th last year, that we shall not now say much concerning invention; but it is, no doubt, worth while to consider what is the essence of an invention—the something that distinguishes it from more or less well-known machines, instruments, appliances, or processes. Confining ourselves to machines, an invention, so far as it is capable of definition at all in this connection, may perhaps be said to be a combination of parts arrived at by an individual, and apparently, or as far as is known, not likely to be conceived by others. Put into other words, all machines are combinations of well-known parts. The particular combination in question must not be an obvious combination. It must be more or less occult, and the more occult the more deserving of a patent. Very many cases might be cited in illustration; indeed, they are multitudinous. Yet it may be useful to name one. Blake's stone breaker will do as well as another. It is composed of well-known parts, an excentric, a couple of toggle joints, a swinging jaw, a spring to pull the jaw back, loose plates to do the chewing, which can be renewed at will. The world had been breaking stones for thousands and thousands of years. But until Mr. Blake came on the scene, no one ever thought of combining the parts we have named in one harmonious and disintegrating whole. We have heard it said that the entire device was so transparently simple and obvious that it did not constitute an invention at all. No such reasoning, however, could have weight for a moment in the face of the fact that, as we have said, millions of individuals must have broken stones, and blistered their hands, and used bad language for century after century, and yet had not hit upon the combination which, in a sense, rendered Mr. Blake immortal.

In this country the views we express are very generally held, and an invention is generally defined as a combination of parts, not only useful, not only novel, but occult or not obvious. How or by what means the arrangement has been schemed, effected, or worked out, has nothing to do with the subject in hand. That affects the validity of a patent in quite another way. No doubt in this country, as well as in the United States, obvious combinations are not good subjects for a patent. The question has repeatedly been raised in our law courts. It has been urged that certain combinations were so obvious as to need no invention to produce them, so that they were not inventions. But without going into legal subtleties of definition, common sense teaches us that if a machine which has been wanted for some time, either positively or vaguely, at last appears, the combination is not obvious; because had it been obvious the want would have been satisfied long before. The cases cited by Mr. Smyth may or may not prove his case. We are unable to say whether they do or not, because we know nothing about the facts; but we venture to think that in all of them the combination patented, or tried to be patented, was obvious, and did not constitute an invention.

We think we hear it urged that, after all, we have defined a new combination of parts as a good subject for a patent, although the combination might demand no inventive effort whatever. Our reply is simply that it remains to be proved that any new combination of parts can be effected without invention. There are many kinds of invention. There is the happy idea, the inspiration, the thought, which comes quickly as a flash of lightning; and there is the result slowly arrived at by the painful mental process of trial and error; and between these extremes is a field of mental work, indefinable; now with, now without law and order. It is a vain thing to attempt to say what is and what is not invention. But it is by comparison very easy to say what is and what is not an invention; yet the decision is reached, and our minds made up on a basis which has very little to do with explanations of the nature of the inventive faculty. And so we hold that the words "an invention" are good and expressive, and that Mr. Smyth has failed to make out a case for their suppression. It seems to us that to substitute "discovered" or "thought out" for "invented," as Mr. Smyth proposes, would carry us no further. All the old familiar arguments would apply to the substituted words as forcibly as they have been used in respect of "invention."

THE ENGINEERING SETTLEMENT.

It is with much satisfaction that we observe the close of the Whitsuntide holidays, is accompanied, as usual, by a return to work on the part of the operative engineers of the North-east Coast, instead of, as was at one time feared, by empty benches and silent machinery. Fortunately, a considerate and wise policy of concession on the part of the employers has obviated the idleness of from 10,000 to 12,000 members of the Amalgamated Society of Engineers, and the idleness also of 15,000 members of the subsidiary trades. The employers have been advised that the construction of the agreement for the advance of wages to the members of the Amalgamated Society of Engineers should rest upon the literal interpretation of the written terms, irrespective of any verbal explanation given at the time of signature. They have therefore decided to give operation to the agreement as it stands, and to give a general advance of 1s. in September next. It is distinctly understood that an amnesty is declared on both sides. Under this agreement the whole of the members of the Amalgamated Society of Engineers, including metal placers, drillers, borers, and other machine workers, will receive another shilling a week advance in September next, in addition to the one they obtained last month. The men who have been on strike at Stockton, Hartlepool, and Middlesbrough have returned to work. The men on the Tyne and Wear have also withdrawn the notices they had handed in to cease work, so that there will be no interruption of employment whatever on these two rivers. The settlement means that the arrangement as to wages made on the 31st March is to stand in its entirety. That is to say, it is to apply to all the members of the Society—to those who are in receipt of wages below 30s. as well as to the others. We think the men may consider themselves fortunate to have obtained such a termination to the dispute as this. The employers might easily have argued that in a question of this kind it ought not to be a matter of rigid and literal rendering of an agreement, apart from its spirit and intention. At the same time, considering in any case that the dispute was about a matter that will not take effect for several months, that it is in its essence a comparatively small point, and that, on the other hand, a stoppage of work at this time would certainly be disastrous to all concerned, we think the employers have done well and wisely in yielding the point rather than involve the district in a labour war. If the men will not consider themselves or others, the employers must consider both.

THE COST OF A GREAT FROST.

Sheffield was the city which suffered most severely of all provincial places of first-class importance from the great frost of 1894-95. Our Sheffield correspondent, writing at the time, estimated the cost to the Corporation Water Department in repairing burst pipes and arrangements for making supplies by water-carts and other means at a sum certainly not less than £10,000. The accounts of the Water Committee for the year ending March 25th, 1896, have just been published. They exhibit a total cost of £10,620, "extra expenditure caused by the severe frost." This sum is considerably in excess of what was officially thought of at the end of 1894, but the water manager explained that the damage done to the distributing pipes and other apparatus was only partially disclosed prior to March 25th last year. In the accounts, indeed, up to that date, the exceptional expenditure then ascertained was only £1156 5s. 10d., the larger portion of that amount having been incurred in repairing fractured mains, &c. It was after 1895 commenced that the real magnitude of the calamity became apparent. Lengthy pipes were taken out, only to be succeeded by fresh bursts within a few yards of where the repairs had been completed. The enormous extent of the damage may be gathered from the fact that the mains thus repaired or relaid amounted to an aggregate length of 31,519 lineal yards, or 17¾ miles. The number of applications made direct to the department by consumers whose pipes were frozen or burst, or otherwise deprived of water, was over 16,000, in addition to which 10,925 applications were received from plumbers requiring water to be shut off for repairs where stop taps were not fixed. Notwithstanding that the resources of the department were principally devoted to restoring the permanent supply of water to the consumer at the earliest possible moment, the department repaired upwards of 7000 lead communication pipes belonging to owners or occupiers of property. The draught upon the system caused, of course, by these fractured pipes, reached a maximum of 16,000,000 gallons per day, as compared with the normal daily consumption of about 7,500,000 gallons. It was not until the second week in August, 1895, that the normal consumption was restored. While £10,620 15s. 3d. was the cost to the Corporation Water Departments, the consumers had further losses inflicted upon them. Many works were altogether stopped, artisans thrown out of employment, and business dislocated. The indirect loss caused by the frost would not be over-stated at nine times the direct damage done to the Corporation system.

MORE LIGHT.

According to telegrams in the pages of our daily contemporaries, Mr. Edison has made important discoveries in connection with the Röntgen rays. By coating a Crookes' tube on the inside with fluorescent crystals, a pure white glow resembling sunlight is produced. We are too much accustomed to vague comments of this kind concerning Edison's work to attach much importance to this. More interesting is the statement that Tesla has at last discovered that of which he has so long been in search — a method of inducing millions of etheric vibrations per second within a vacuum tube—without using any direct electrical connection. An ordinary 16-candle bulb gives by this method, we are told, a light equal to 250-candles, which is sufficient to light very pleasantly a large room. It is rapidly becoming obvious that the received theories of light are quite inadequate to explain new discoveries. It may yet be found that there exist means of transmission of energy of which we have no mechanical analogue, no mechanism, in fact, which is understood. Dr. Lodge hinted at this some years ago when he said, after dealing with certain aspects of the vibratory theory, "Perhaps, after all, there is no motion."

LITERATURE.

The Progress of Artillery—Naval Guns. By James Atkinson Longridge. London: E. and F. N. Spon. 1896.

There has been growing during the last few years a feeling in the minds of ordnance engineers that the length of guns has reached the practical limit, and that a reversion in favour of shorter guns is to be expected at no great distance of time. The curve has reached the highest point, so to speak, and will probably begin soon to start down hill. Mr. Longridge is the champion of short guns, and in the pamphlet which we have before us he advocates a revolution in the construction of ordnance. If the system he indicates was at once adopted we should have, instead of a gradually descending curve, an almost straight drop from guns of forty calibres and upwards to guns of half that length and less, and a corresponding rise in maximum powder pressure from, say, 15 or 20 tons to about 30 tons per square inch. We are not only too conservative to wish to see so sudden a change, but we are at the same time not convinced in spite of Mr. Longridge's sensational figures, that the modification suggested would be one of unqualified good. It is not enough by any means to show that an increase of pressure means an increase of muzzle energy or a reduction in the length of the piece. There are so many factors to be considered that it would be unwise in the absence of experimental data to insist that what on paper appears best would in practice be so. Mr. Longridge probably recognises this quite well, and we do not quarrel with him for stating his case in the brightest and most forcible terms; what we wish to insist on is that as we are practically without experience in the use of high pressures in guns, it would be unwise to accept the conclusion at which he arrives, that such pressures must be efficient, until exhaustive experiments have been conducted. For ourselves, whilst we are distinctly in favour of the shortening of ordnance, we think it better to maintain the energy by a more efficient consumption of the explosive employed than by greatly increasing the pressure. By this we mean that the direction of investigation at present should be towards the discovery of a method by which a maximum pressure of, say, 15 or 18 tons would be maintained for at least half the length of the gun, and thence drop to such a pressure at the muzzle that the velocity of the gases through the mouth should just equal, or slightly exceed, the velocity of the projectile. By this means a great efficiency would be obtained from an explosive charge, and a gun of moderate length would be as effective as the present very long pieces. The difficulties here are to be faced, as Lord Armstrong said many years ago, by the chemist and the physicist, rather than by the engineer.

It will be well, perhaps, before we enter more fully into a discussion of Mr. Longridge's paper, to lay briefly before our readers the objections to very long guns, that they may appreciate more fully the advantages that would be gained by reducing the length of future pieces. It must be understood that our remarks apply chiefly to guns of large calibre, and to none of less than 4in. These objections are twofold, and can be classed as:—(1) Constructional; and (2) manipulative difficulties. Under the first head the greatest trouble is found in keeping a very long gun perfectly straight; indeed, we may safely say that now-a-days no gun of over 4in. calibre is quite straight. Bending occurs not only because the weight of the gun itself is more than the gun is able to support, but because the contraction of long hoops on to a barrel sets up unequal strains which pull an originally straight tube into all sorts of shapes. The greatest care in construction is not competent to prevent these unbalanced effects. Another cause is that after the first round has been fired from a gun, a totally new lot of strains is set up; the various hoops, or the wire, as the case may be, readjust themselves under the extension of the piece longitudinally and transversely, and under the high temperature of the explosion. We merely hint at these things. Then it will be easily comprehended that every foot added on to a tube or barrel increases the difficulty of turning and boring it as exactly as is required in the construction of guns, and at the same time the difficulty of forging is greatly increased. All these things combined add enormously to the cost of construction. The manipulative difficulties will probably be sufficiently obvious to every one. The longer and heavier a gun, the stronger must be its emplacement and mounting; the evil effects of unequal heating increase as the length of the gun increases; and the awkwardness of housing and other minor points must not be overlooked. All these objections are balanced by an economical consumption of powder and great muzzle energy.

Let us now turn to Mr. Longridge's pamphlet. The author begins by comparing the ballistic results of the old and the new powders in the old and the new guns, and shows that whereas the increase in muzzle energy due to the length of piece alone, supposing everything else the same, is only about 22 per cent.—a result, by the way, which we have checked independently and found approximately correct, though a slip occurs in Mr. Longridge's figures—whilst the increase in power per pound of powder from old to new is nearly 284 per cent.; from which, of course, is derived the evident conclusion that "the real cause of the great increase in ballistic effect is chiefly the change of the powder." But he opposes the belief that any great improvement in sustaining power has been gained by the adoption of the so-called slow-burning powders, and seeks to support this view by a diagram which "represents the actual pressures obtained from a 6in. gun by Sir Andrew Noble, with a charge of 27 lb. of cordite." This diagram, however, as it stands alone is worthless; it is only by comparing it with a diagram taken from a similar gun using quick-burning powder that the great improvement gained by the use of the new powders can be appreciated. With the old powders the pressure rose to a maximum in about 1⅓ calibres; with the new powders the maximum is not reached till, say, 4½ calibres travel of projectile, and thence the curve falls at about an angle of 40 deg. to the horizontal in an approximately straight line, finally sweeping off at a very small inclination to the horizontal. The curve with the old powders is much steeper. A fair comparison should be made by subtracting the area of one diagram from that of the other, and the increase of power would then be seen. In the next section the author shows that the increase of muzzle energy is not directly proportional to the length of the gun, but is a continually decreasing quantity. Thus lengthening the 6in. gun from 20ft. to 40ft. adds only 54 per cent. to the energy, and putting on another 20ft. adds only a further 16 per cent. to the energy. "It is therefore obvious that guns of extreme length do not give increase of power in anything like the proportion of their length; and taking into consideration their unhandiness and liability to damage due to their excessive length, we cannot look to any improvement of ballistic power by still further lengthening the guns. In fact, they are already too long." And "there remains for consideration the question of increase of ballistic power by altering the conditions under which the powder is used, and this at once raises the question of an increase of the maximum pressure." Mr. Longridge then goes on to show that only about 10 per cent. of the possible maximum pressure from cordite is now used, and this is because up to the present guns have not been constructed strong enough to withstand a higher pressure. He considers, however, that with the system of wire construction, there is no reason why pressures of from 30 tons or 40 tons per square inch should not be used "*with as great a margin of safety* [the italics are the author's] as the forged steel gun previously in use under a pressure of 17 tons per square inch, and with far greater security as regards defects of material and workmanship." This is true to a large extent, but still the wire gun is not wholly without disadvantages, and though these drawbacks would be greatly minimised by shortening the gun, it is not after all a perfect system. However, the greatest objection to the use of these high pressures is, as Mr. Longridge admits, the high temperatures which it involves, and the consequent injurious effect upon the barrel; it is also not improbable that if the gun became very hot the value of the wire winding would be considerably decreased by expansion under that heat. Another objection which is brought forward is the difficulty of obturation, which Mr. Longridge considers can be obviated by the use of the De Bange obturator. To this it may be replied, that even under the moderate pressure now used, the pad occasionally is compressed so firmly against the sides of the gun that considerable force is required to withdraw the screw, and that as it is impossible to put the steel of the vent plug or obturator face in initial compression in the same way that the rest of the gun is compressed to allow a larger ultimate limit of expansion, it would be necessary to use a very high steel, as the steel ordinarily used is deformed by a pressure of between 30 and 40 tons per square inch. Allowing a factor of safety of two, the steel used for the face of the obturator, or breech screw, would have to be safe at a pressure of 60 tons, and the use of such high steel is not to be advocated at present, as such material is highly treacherous. The objection, that the firing mechanism is damaged or deranged by high pressures no longer exists; whether firing is done either electrically or by percussion, it takes place now-a-days close to the cartridge, and there is no long passage in which a sudden increase of pressure, due to high-velocity gases, can occur. How it comes about that the author has overlooked the advantage that would be gained to the system he advocates by the use of cartridge cases, or cartridge case ends for obturation, we do not know. It seems to us the only feasible way of making the breech secure against leakage; still, it does not get over the difficulty of the pressure on the breech screw, and the necessary doubling in length or diameter of the screw, in order to present enough surface of thread to stand the total pressure. In connection with the temperature of explosion, Mr. Longridge thinks much of the consequent trouble by erosion, &c., due to high temperature, can be avoided by the use of ammonium nitrate powder, of which he gives authority for stating that "the whole charge is probably converted into gaseous matter of comparatively low temperature immediately after the starting of the projectile, and a short gun would be the right thing for it."

There is very much more to be said on this subject which, doubtless, will be said in time, but we feel that we are drawing this review out to too great a length, and will, therefore, conclude with a few of the estimated results from high-pressure guns. If the chamber of 12in. guns now making or made for our new battleships was reduced so as to give a maximum pressure of 27 tons per square inch, using the charge of 148 lb. of cordite, the muzzle energy would be increased from 31,800 foot-tons, as at present, to 42,741 foot-tons; but if the pressure be raised to the same degree by merely increasing the charge to 207 lb. of cordite, the energy becomes 49,032 foot-tons. But the same effect as at present obtained can be produced by using a 10in. gun of about 24 tons weight and 23ft. 6in. total length, with a maximum pressure of 30 tons per square inch, and a sketch of this gun is given in comparison with one of the present 12in guns.

The advantages claimed are that the proposed gun "(1) would be much handier in action; (2) and less vulnerable owing to its less length; (3) it would be loaded and fired more rapidly, since the weight of projectile and charge would be only 634 lb., as against 998 lb. in the case of the 12in. gun; (4) it would cost less than the 12in. gun, in the proportion of 24 to 46"—this conclusion is, as to the weights, very doubtful—"(5) the gun with 100 rounds of ammunition would weigh 52 tons, against 91 tons as in the case of the 12in. gun." It is not improbable, however, that the weight of the carriage would have to be increased, but this is a point with which Mr. Longridge has not dealt at all; yet, nevertheless, the whole of the recoil arrangements for high-pressure guns will need very considerable modification on those at present employed.

In conclusion, we wish to record that, though we have made several observations in disfavour of high pressures, we do not wish it to be supposed that we consider the difficulties by any means insurmountable, and we are entirely in favour of shortening ordnance by whatever means that end may be attained.

Mechanism of Men of War. By R. C. Oldknow, Fleet Engineer, R.N. (Retired). Royal Navy Handbooks. George Bell and Sons, London. 1896.

It is interesting to hear from time to time from members of the Royal Navy opinions of the service, and in the series of volumes edited by Commander C. N. Robinson, R N., of which the present volume forms part, we shall have, when complete, let us hope, a very fair expression of opinion from persons who are intimately connected with the subjects of their respective volumes. The present book would be as good a pill as one could desire to deliver as a corrective to any of those persons who suffer from pessimism with regard to her Majesty's Navy. It is written by a retired fleet engineer, and we may, therefore, take it as worthy of an unguarded reception, except for the allowances which must necessarily be made for a little not unnatural pride, and a large amount of *esprit de corps*. Mr. Oldknow has practically no complaints to make about the Navy. It seems to him, judging only from his book, to be the strongest, the fastest, the best manned, and the best machined Navy in the wide world. This is quite as it should be, from him; from us civilians, who have no practical connection with H.M. ships, a little criticism, a little cold water throwing is, of course, to be expected. Personally, we have never entertained those unhappy opinions with regard to the British Fleet which some people are so fond of vigorously reiterating. Like Mr. Oldknow, we entirely believe her Majesty's Navy not only to be the biggest, but the best that sails the seas; but at the same time we admit there are many faults which need correcting. It cannot be said that it is the best of all possible navies, as the volume before us would lead one to suppose. Probably Mr. Oldknow knows its faults better than we do, and it is only an excess of affection that leads him to view them so leniently that he can say, that breakdowns are practically unknown; greater speeds are obtained after several years' commission than on the official trials; the trouble with boilers is a thing entirely of the past; the steering gear has been practically brought to perfection, and so on, and so on. It is very pleasant reading this sort of thing, even when discounted. and Mr. Oldknow is to be congratulated on having produced a very charming book, written easily and gracefully, and containing a large mass of information served up in a form suitable for the general reader. His is not a technical work, it is a popular account of the propelling and auxiliary mechanism of ships of war, and is written with the object of meeting the wants of the average British subject who takes the interest which is due in the welfare and protection of his country. It is very largely compiled from the contemporary press, standard technical works, and the invaluable publications of the American Intelligence Department, to which all Englishmen go when they want to find any statistics about their own ships of war. The book is well and profusely illustrated with reproductions from photographs and drawings of engines and boilers of all the different types of ships in the Navy. There is nothing essentially new in it, but a good many facts and controversial topics are conveniently collected, as, for example, chiefly in the chapter on the "Battle of the Boilers," in which a candid review of that memorable tussle is brought before us. The book is well printed, contains sixty-one illustrations and some 280 pages, and is sold at the moderate figure of 5s. We can confidently recommend it as easy and interesting reading.

An Elementary Treatise on Rigid Dynamics. By W. J. Loudon, B.A., Demonstrator in Physics in the University of Toronto. New York: Macmillan and Co. 1896. 10s. 6d.

A book of this kind has long been wanted, justifying the Greek motto μηδὲν ἄγαν of the title page, to serve as an introduction, and in most cases, as a supplanter of Dr. Routh's colossal treatise. Professor Pirie has not persevered with his elegant little elementary Lectures on Rigid Dynamics, so that Routh has been left without a rival for many years. The present work is excellent in not following the continental method, which persists in going back to the origin of all dynamical knowledge, so that the reader is halfway through the book before arriving at the real subject. Our author starts with the assumption of the requisite amount of previous foundation, and proceeds at once to the notion of a Moment of Inertia, without which it is impossible to treat the motion of a body which turns as well as advances, like a wheel, or which swings, like a clock pendulum, a bell, or a ship. The part which treats of plane motion, constituting what Maxwell called the gentlemanly knowledge of the subject, is hurried over too rapidly, and the author, in our opinion, is too anxious to get on to motion in space, where the difficulties are nearly trebled. In fact, his main object appears to be the introduction to junior students of the motion of the top or gyrostat, a subject which bristles with analytical difficulties if treated with any pretence of completeness, requiring, as it does, all the various elliptic functions; these elliptic functions are defined in a note at the end of the book.

The only method of obtaining a real grasp of this subject is by working through a number of exercises. The author has carefully ransacked all sources, and has brought together some three or four hundred examples of the most recent type; this forms a most important feature of the book, but the author should have edited away such obscure academic phrases as "tendency to break," "perfectly rough," &c. A word of praise must be added for the diagrams, which are large, bold, and plentiful, and drawn to resemble the objects they are intended to represent.

BOOKS RECEIVED.

Institution of Mechanical Engineers "Proceedings," July, 1895: *Glasgow Meeting.* London, S.W.: Published by the Institution.

Society of Engineers. "Transactions" for 1895 *and General Index,* 1857 *to* 1895. Edited by G. A. Pryce Cuxson, Secretary. London: E. and F. N. Spon. 1896.

Cassell's Natural History. Edited by P. Martin Duncan, M.B. (Lond.), F.R.S., F.G.S. Part I. Price 6d. To be completed in 26 weekly parts. London: Cassell and Co., Ld. 1896.

The Student's Lyell. A Manual of Elementary Geology. Edited by John W. Judd, C.B., LL.D., F.R.S. With a geological map and 736 illustrations in the text. London: John Murray. 1896. Price 9s.

The Application of Graphic Methods to the Design of Structures, Specially Prepared for the use of Engineers. By William W. F. Pullen. Manchester: The Technical Publishing Company, Ld. 1896. Price 6s. net.

Miscellaneous Papers. By Heinrich Hertz. With an Introduction by Professor Philipp Lenard. Authorised English Translation by D. E. Jones, B.Sc., and G. A. Schott, B.A., B.Sc. London: Macmillan and Co., Ld. 1896. Price 10s. net.

Practical Tunnelling. By Frederick Walter Simms, F.G.S., M. Inst. C.E. Fourth Edition, revised and greatly extended, with additional chapters illustrating recent practice. By D. Kinnear Clark. With 36 plates and other illustrations. London: Crosby Lockwood and Son. 1896. Price £2 2s.

Electric Lighting. A Practical Exposition of the Art for the use of Engineers, Students, and Others Interested in the Installation or Operation of Electrical Plants. Volume I.: The Generating Plant. By Francis B. Crocker, E.M., Ph.D. New York: D. van Nostrand Company. London: E. and F. N. Spon. 1896.

Press-working of Metals. A Treatise upon the Principles and Practice of Shaping Metals in Dies by the Action of Presses, together with a Description of the Construction of such Implements in their Various Forms, and of the Materials Worked in them. By Oberlin Smith. Illustrated with 433 engravings. First Edition, First Thousand. New York: John Wiley and Sons. London: Chapman and Hall, Ld. 1896. Price 12s. 6d. net.

SHORT NOTICES.

A Practical Hand-book on the Care and Management of Gas Engines. By G. Lieckfeld, C.E. Authorised translation by G. Richmond, M.E., with instructions for running oil engines. London: E. and F. N. Spon. 1896.—The instructions given in this book with respect to gas engines are based upon the construction and working of the Otto engine, and may thus be taken as pertaining to nearly all the gas engines now made. The man who, on being placed in charge of a gas engine, takes the trouble to read this little book will be the better off, even although 25 per cent. of it is occupied with a description of friction-brake dynamometers and how to use them. These instructions do not, however, refer to the simplest and best brake, and they are wrong in attributing to Professor Brauer the first band brake as now used for dynamometric purposes. The book does, however, present a very well-considered collection of practical suggestions as to the choice of an engine, its examination, power, cost, arrangement of connections, running, and precautions. The chapter on oil engines will not be of much use, as it relates to only one type of engine, and that is one the cycle of which is adopted by only one maker and only partly by one other.

Year-book of the Scientific and Learned Societies of Great Britain and Ireland: Comprising Lists of Papers read during 1895, *before Societies engaged in fourteen departments of research, with the names of their Authors. Compiled from official sources.* Thirteenth annual issue. London: Chas. Griffin and Co. 1896. Price 7s. 6d.—The value of this book has been increased very greatly by the addition of the lists of papers read before the various societies during the previous year. It is not too much to say now, that no one engaged in scientific or literary work can afford to dispense with it. It is one of the most valuable of books of reference.

Compressed Air. Practical Information upon Air Compression and the Transmission and Application of Compressed Air. By Frank Richards, Mem. A.S.M.E. New York: John Wiley and Son. London: Chapman and Hall. 1895.—If this book did no more than renew attention to the use of compressed air as an economical means of power transmission and as an exceedingly useful thing in the workshop and manufactory, it would have served a useful purpose. It does, however, more than this, as in a comparatively simple manner it conveys a great deal of most useful information on air compression, air conveyance, economical and wasteful pumps, and processes and rules and data. It has been written by the author, and bears the impress of originality of treatment. The failure in this country, as at Birmingham, to establish air transmission supply for power and workshop purposes is more to our loss than our credit, and the growing number of successful compressed air supply installations in the States affords some proof of its possible commercial value. Compressed air offers many advantages over any other means of power transmission, the air being useful for so many purposes in the arts, and the possible economy, as Professor Unwin long ago pointed out, is very great. Mr. Richard's book is not only useful from the mechanical point of view, but as drawing attention to the oft quoted and fallacial opinions as to losses attending the use of compressed air, which are not losses at all, but only part of the cost of what is in many respects a very cheap and efficient tool.

INSTITUTION OF ELECTRICAL ENGINEERS.

THE UTILISATION OF WATER POWER, ESPECIALLY WITH A SMALL FALL, WITH SOME EXAMPLES OF PLANTS FOR THE GENERATION OF ELECTRICAL ENERGY.

THE following paper, by Mr. Alph. Steiger, was read at the meeting of the Institution held on Thursday, May 28th.

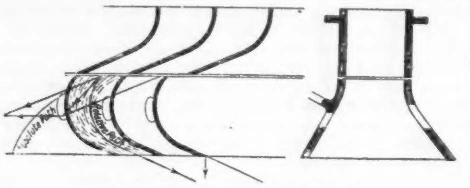


Fig. 1.—Vanes of "Action" Turbine.

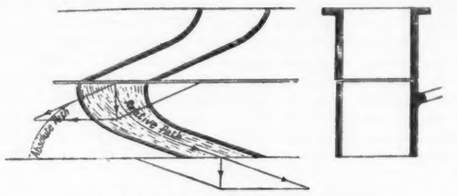


Fig. 2.—Vanes of "Reaction" Turbine.

The cheap production of electrical energy is generally recognised to be one of the chief aims of modern engineering science. Nature has provided us in water power with one of the best possible agents for realising this object; and I trust that, in bringing the subject of the utilisation of this free gift of Nature before the members of the Institution of Electrical Engineers, I shall be able to convince them that the water powers of this country, if judiciously utilised, are capable of rendering them great service. In my own country—Switzerland—the electrical engineer is co-operating cordially with the water power engineer, and electrical installations are rapidly increasing in number. The successful electrical transmission of power to points far distant from its source has been the chief factor in this development. The idea prevails that considerable fall is required to obtain water power, but it is my desire to show and to prove in the following remarks that excellent results are obtainable also with a very low fall—a fall of even less than 3ft. Small falls are more frequently met with in this country than high falls, and will, therefore, have more particular attention in this paper than the high falls found in mountainous districts. The description of a few turbine plants under low falls, some of which are applied to the generation of electrical energy, will be of special interest.

During a long experience in constructing turbines and designing complete plants, I have found that the most difficult were always those connected with the utilisation of a low fall. These difficulties consist chiefly in the variation within very wide limits of both the quantity of water and the fall, while a constant power, and in most cases a constant speed, is of great importance. Generally speaking, the real agent in water power is gravity, and the water is simply the medium to transmit the action of gravity on to the motor which converts it into mechanical work. The action of gravity can take either the form of deadweight, or of pressure, or of velocity, sometines called kinetic energy. A very high efficiency is obtained from motors in which the water acts by deadweight or by pressure, but the slow speed of the water-wheels and the complicated mechanism of the pressure engines render them unsuitable for the purpose of generating electricity; moreover, motors worked by weight or by pressure are only advantageous when working under a high fall. The kinetic energy is the only form in which the gravity can be applied advantageously to the performance of mechanical work under a small fall. The motors using it in this form are the common undershot wheel, the Poncelet water-wheel, and the turbines.

It will be sufficient for the purpose of this paper to give the efficiency of the various types of water motors for any fall, without going into a detailed description of those which are unsuitable for driving dynamos. The efficiency of the motors, with the fall for which they are adapted, is as follows:—

Fall. Feet.	Efficiency of water-wheel.	Per cent.	Efficiency of Turbine. Per cent.
1 to 5 ..	Ordinary undershot ..	25 to 30	.. 70 to 75
	Poncelet	65 to 70	
	Sagebien	65 to 75	
5 to 8 ..	Low breast	30 to 50	.. 75 to 80
8 to 15 ..	High breast	60 to 75	.. 75 to 80
15 to 50 ..	Overshot wheel	65 to 75	.. 75 to 80
Above 50 ..	Pressure engine ..	75 to 85	.. 75 to 80

These figures show the interesting fact that, the smaller the fall is the greater is the gain in power over the old-fashioned water-wheels. Although the smallest fall which would reasonably be utilised by a turbine is at least 2ft. 6in., I will show by some examples that, by a turbine suitably constructed and carefully adapted, useful power is still obtained under a fall of only 1ft. or a little over. The great variety of fall, water supply, local conditions, and special requirements, of necessity demands a variety of types of turbines.

Turbines are classified, according to the manner in which the water acts in them, into (*a*) "impulse" or "action" turbines, and (*b*) "reaction" turbines; and according to their construction, into (*a*) parallel flow turbines; (*b*) radial flow turbines; (*c*) mixed flow turbines. There is an essential difference between the "impulse" turbine and the "reaction" turbine, as indicated by the form of vanes illustrated in the diagrams Figs. 1 and 2.

The "impulse" turbine, as usually constructed, must run clear of the tail water, its buckets being only partially filled with water. It requires a constant fall, with constant level of the water in the head and tail race, but its efficiency is not affected by the greatest variation of the water supply. On account of this quality, it can be built as partial injection turbine, to utilise high falls with a very

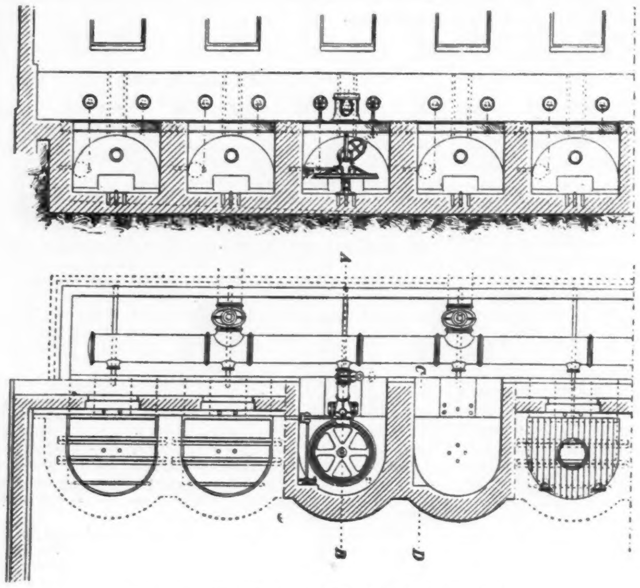


Fig 3 a.—Turbines at the Falls of Foyers, Scotland.

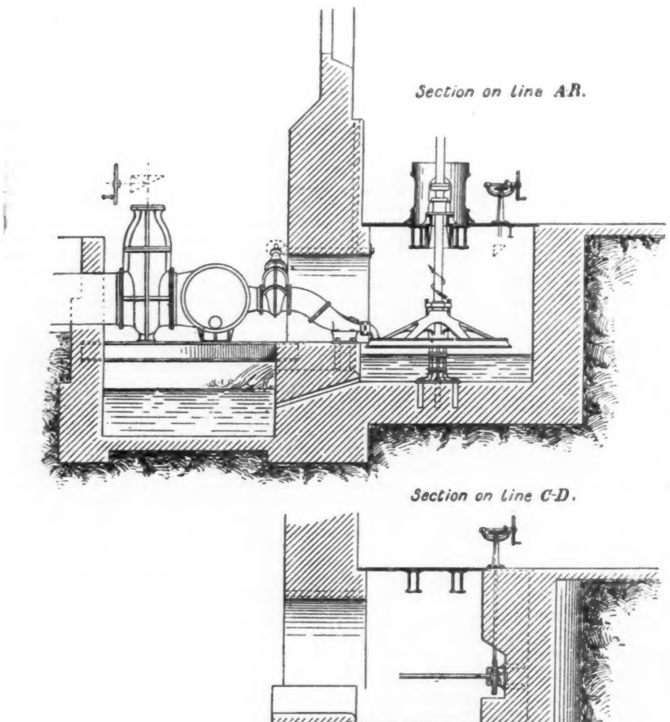


Fig. 3 b.—Turbines at the Falls of Foyers, Scotland.

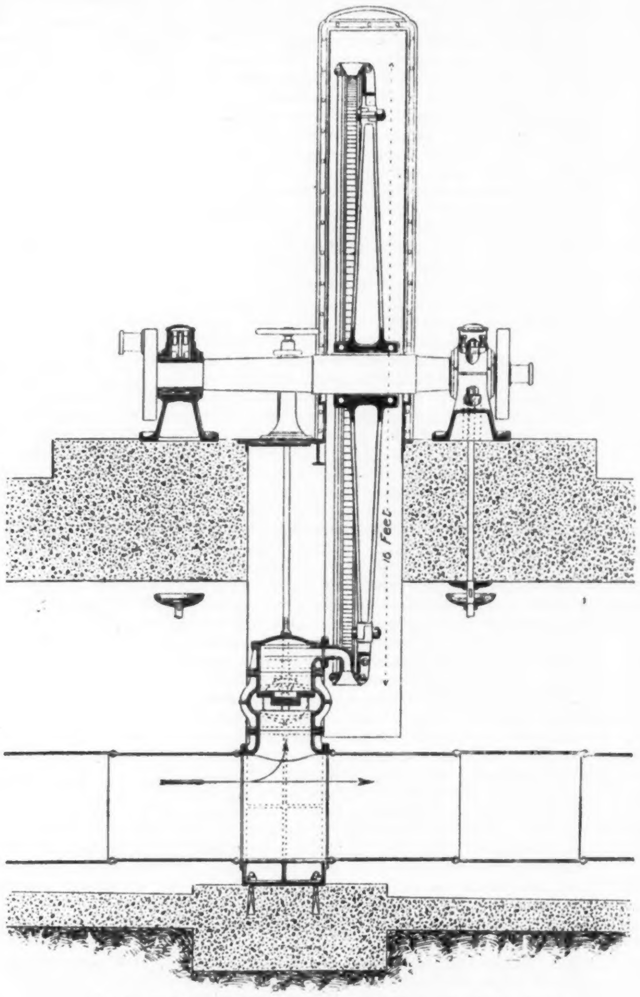


Fig. 4.—Turbines of the Chauxdefonds Waterworks Switzerland.

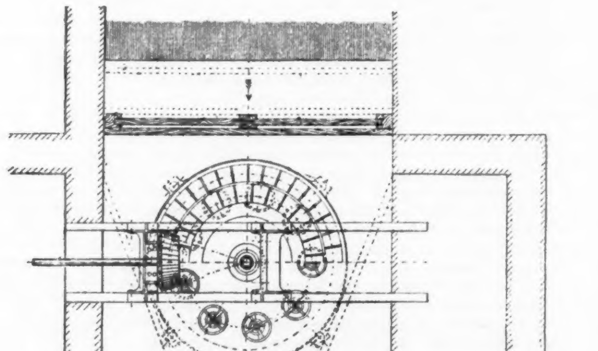


Fig. 5 b.—Turbine at Brantham Mills, Essex—Ground Plan.

small water supply. If constructed as "partial injection turbine," its diameter can be chosen so as to give just the desired number of revolutions. This is extremely convenient for driving dynamos, which can thus be connected direct with the shaft of the turbine, doing away with intermediate gearing or belt drives. An instance of this kind is the turbine plant now being erected by Messrs. Escher, Wyss, and Co., of Zurich, at the Falls of Foyers, for the British Aluminium Company. This plant consists of five "impulse" turbines with vertical shaft, with partial injection, each giving 700 brake horse-power, working under a fall of 350ft. The dynamos are required to run at 140 revolutions per minute, and to obtain this speed the turbines were given a diameter of a little over 9ft. Partial injection turbines under a high fall are sometimes fixed on a horizontal shaft, and can thus be coupled direct to the armature spindle of a dynamo by means of an isolating coupling. This mode has been adopted, amongst numerous other plants, for the electric lighting installation of Davos, in Switzerland, which consists of three horizontal patent turbines of 200 brake horse-power each, working under a fall of 330ft., and running at 400 revolutions per minute. The turbines have a diameter of 40in. As a contrast to these turbines of large power and small diameter, and to show the adaptability of the partial injection turbine to special requirements, the 140-horse power turbines of the waterworks in Chauxdefonds may be mentioned. These work under a fall of only 170ft., but as they are driving pumps at the low speed of 60 revolutions, they had to be made of a diameter of 15ft. Great as the advantages of the "impulse" turbines are under the conditions above mentioned, their use under very low falls is limited, firstly, owing to the reason already given that they must run clear of the tail water—a condition which can seldom be realised in a flat country like this; and, secondly, because they run at a slower speed than a "reaction" turbine under the same fall. Although "impulse" turbines are now built to run in the tail water without considerable loss of efficiency, the reduction of power in proportion to the reduced fall, and the quantity of water accordingly reduced, together with the reduced speed, excludes them in the majority of low and varying falls.

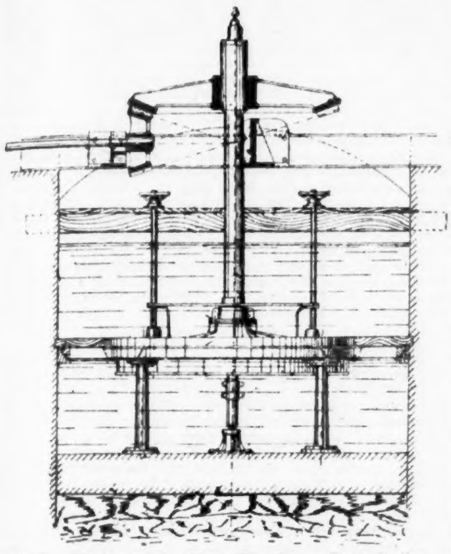


Fig. 5 a.—Turbine at Brantham Mills, Essex—Cross Section.

The ideal turbines for low and varying falls are the "reaction" turbines. They are generally placed in a level with the tail water, or, if local conditions require them to be placed above tail water, connected with it by a suction tube. They run at a higher speed for the same fall, or the same diameter, than an "impulse" turbine, and their efficiency is not affected by the immersion in the tail water. The principal objection raised against "reaction" turbines in general is that their efficiency is greatly reduced when working at part gate. This is, indeed, the case with many of the reaction turbines known in this country, which give a very poor efficiency at part gate, especially at less than half gate. The continuity of flow of the water through the buckets is essential to a good efficiency. Only in a few reaction turbines is this condition fulfilled to such an extent that within very wide limits of the water supply the efficiency is not perceptibly reduced. The utilisation of a small and varying fall, with a varying quantity of water, is a very difficult problem for the water-power engineer. The turbine for a given power under a low fall is larger and runs slower than one of the same power under a higher fall; it is, therefore, heavier and more costly, and requires heavier gearing, entailing a greater loss of power through friction. A high speed is desirable, especially for driving dynamos; but attempts to increase the speed of the turbine by reducing its diameter may easily result in an inferior efficiency. The efficiency should be as high as possible in consideration of the greater cost of a water-power plant with a low fall; but the proportions within which such a fall and the quantity of water varies is mostly so great that it is almost impossible to obtain the highest efficiency when the water supply is diminished, *i.e.*, when a high efficiency is most wanted. The maintenance of a constant power with a constant speed under variation of fall and quantity of water in large proportion can, if at all, only be attained by sacrificing some efficiency. The hydraulic losses must be reduced to a minimum by the most careful construction of the turbine in its essential parts, and it is needless to say that no standard size or type of turbine will fulfil all these conditions by simply consuming all the available water.

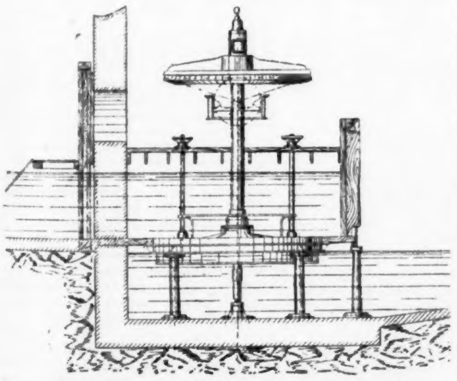


Fig. 5 c.—Turbine at Brantham Mills, Essex—Longitudinal Section

Even the arrangement of the turbine chamber is of influence on the results, and requires special attention. On a careful judgment of the local conditions depend the economy and the success of a plant. Unsatisfactory results in water power plants are caused just as much, or oftener, by bad judgment of the local conditions than by the inferiority of the turbine. In by far the most cases of low falls, incidental to flat countries, an abundance of water corresponds with a reduction of the fall. The power of a turbine calculated for the normal fall would be reduced, for the time, when an abundance of water reduces it, and, as a consequence, water would be wasted, while the power obtained is insufficient. These cases are, unfortunately, of frequent occurrence. On the other hand, if the turbine is constructed to give off the required power under the reduced fall, it must be partially closed for the diminished water supply with the normal fall, whereby the efficiency would be reduced just when it should be highest if economy is at all the chief object of a turbine plant.

The manner in which a high efficiency can be maintained for a diminished water supply is to subdivide the turbine into several compartments, each of which represents a complete turbine. This arrangement has been adopted by Fourneyron for his well-known outward flow turbine, and in the modern Jonval turbine. The Fourneyron turbine is provided with a cylindrical gate, which is moved vertically, whereby each compartment is opened or closed. This type has been adopted for the large-power plant on the Niagara Falls, but on the European Continent they are seldom used. Their efficiency is very good, but, owing to the narrowness of the buckets, they are easily choked. The Jonval turbine is a parallel flow turbine, and is, for large variations of the fall and quantity of water, subdivided into two or more concentric compartments. A subdivision in this manner renders it possible to maintain not only the power, but also the speed, under a varying fall within very wide limits.

The description of a Jonval turbine installation which I supplied for the Brantham Mills, near Manningtree, in Essex, here illustrated, will show that a very small and varying fall can be utilised with great advantage to obtain nearly a constant power. The local conditions and requirements are most remarkable and interesting. The power is used to drive a modern flour mill, in which the maintenance of a regular speed is of equally great importance as for driving an electrical plant. The river Stour is a tidal river, with a maximum fall at ebb tide of 4ft. 10in., while at high tide the fall is nil. The water is supplied partly by the river itself coming down from the hills of Cambridgeshire, and partly by the rising tide filling the river bed above the mill for a considerable length. The power required is 40 actual horse-power, and it was stipulated that this power should be maintained down to a fall of 40in. On starting the turbine, it was shown, however, that it drove the mill at full capacity and at full speed under a fall reduced to 32in. The full power is available during sixteen hours of each day, while during six further hours the power corresponding to a fall reduced down to about 1ft. is still utilised for driving a part of the machinery. Comparing the useful power obtained from this varying fall by the new turbine during twenty-four hours with that obtained by the undershot water wheel previously working, it is nearly six times larger. The turbine consists of only two concentric rows of buckets; the inner one is provided with gates, which are opened or closed by hand wheels, an automatic governor not being generally used in flour mills. The outer row of buckets is just large enough to give the full power required under the maximum fall. As the fall is decreasing by the rising tide, the gates of the inner row of buckets are gradually opened to make up the power by an increased quantity of water, and the more water is passing through the buckets of the inner row the more it acts on a reduced mean diameter, thus maintaining also the proper speed without perceptible loss of efficiency.[*] The power is transmitted from the turbine on to a horizontal main shaft by means of a pair of bevel wheels. This horizontal shaft is made to run at 75 revolutions, and is provided with a clutch by means of which the turbine is connected with the steam engine if the mill is required to work continuously. When the fall is reduced to more than 32in., the mill is, however, driven separately by the steam engine, and the power of the turbine is used to drive the wheat-cleaning machinery, and eventually some pairs of millstones which can work independent of the automatic roller mill plant. When the fall is reduced to 15in., the power that is still obtained from this turbine is 7-horse power, the turbine naturally running slower; but still this power is quite sufficient to be profitably utilised.

(*To be continued.*)

HORSELESS CARRIAGE NOTES.

WE learn from our American correspondent that the State Fair Association of Rhode Island has decided to arrange for a series of races of horseless vehicles as well as of horses, at the State Fair, which will be held at Providence in September. It is expected that a large number of the carriages will be exhibited and entered for the races, and the Association has offered £1000 in prizes.

SINCE our issue of the 15th inst., when we published the regulations for the competitive trials for the four prizes, two of £100 and two of £50, offered by the Royal Agricultural Society in connection with its Manchester meeting next year, the regulations have been separately issued by the Society. They are as published on page 497 *ante*, with the addition that the entries for these prizes must be made on or before Thursday, 1st April, 1897, and must be accompanied by a deposit of £10 for each entry, the deposit to be forfeited if the "machine" is not submitted for competition at the time appointed for the trials. It will be noted that the Society only stipulates as to weights; that of the loads to be carried are either a maximum of two tons or of five tons, but the weight of the vehicle is to be considered by the judges. Nothing is said as to the passage of the Bill at present before the House of Commons; this is taken as a matter of course.

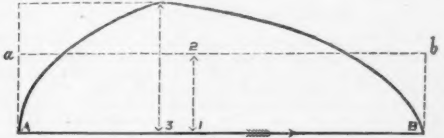
WRITING from Clifton Park, Kelso, N.B., on a defect in the Horseless Carriage Bill, as relating to Scotland, Mr. T. R. B. Elliott says:—"As an owner of a horseless carriage, and being much interested—in no way financially—in the new movement, I trust you will allow me to draw the attention of the Scottish members of Parliament and of the Scottish people in general to a serious defect, as far as Scotland is concerned, in the Locomotives on Highways Bill, which has recently been read a second time in the Lords, and which, if it becomes law, will allow England to avail herself of an easy, cheap, and safe form of road locomotion, practically free from restriction, while Scotland and Ireland will be so hampered by local regulations that they will be quite out of the field. The Bill now before the House, says, 'Section 25 (c), so much of Section 6 of the Locomotives Amendment (Scotland) Act, 1878, and of Section 6 of the Public Health (Ireland) Amendment Act, 1879, as gives power to regulate the use of locomotives, shall apply to light locomotives—*i.e.*, horseless carriages—under two tons." The section referred to in the Act of 1878 runs as follows:—'Be it enacted that the road authority of any county or burgh may make byelaws as to the hours during which locomotives are not to pass over the highways situated within the areas respectively above-mentioned, the hours being in all cases consecutive hours, and no more than eight out of the twenty-four, and for regulating the use of locomotives upon any highway, or preventing or regulating such use upon every bridge, where such authority is satisfied that such use would be attended with damage to the public from the narrowness, inclination, or imperfect construction of such highway or bridge respectively.' Thus, while in England a horseless carriage will be able to go anywhere unmolested, in Scotland and Ireland its owner will be at the mercy of every local authority, everyone of whom will have different opinions on the subject; and as a horseless carriage does not tire, it will be impossible to go 100 miles in any direction in Scotland without being stopped by some local regulations as to hours, roads, bridges, &c. The new limit of weight ought not to be too much for any bridge over which heavily-laden carts are allowed to pass, and as to hours and roads, it may interest sceptics to know that I have recently completed 740 miles, chiefly in Scotland, on almost all kinds of roads, narrow and otherwise, and also at all hours, and I have never caused an accident of any kind. Why, then, should Scotland be handicapped in this way, and England given a free hand in this new venture? It is not fair play, and the only remedy is for those interested in Scotland to approach their members, with a view to having an amendment made to this one-sided Bill before it is too late; and, if this amendment is opposed, why, then, let Scotland and Ireland oppose the whole Bill, for it is of no use to any of the three kingdoms—except England—in its present form." This is further evidence of the necessity for freeing the Bill as far as possible from all restrictions that do not pertain to all ordinary vehicles.

A RAPID TRANSIT PROBLEM.

THE following, by G. Leverich, is from the *Railroad Gazette*:—

Given two stations A and B, on a level, straight railroad track, separated by a space S—required, in what time a train starting at A and stopping at B, may traverse this space.

In a diagram, A and B are the stations; the space between them is S, and A 4 B are curves indicating the speed between these stations, A 4 the acceleration from A the starting point, and 4 B the retardation to the stopping point; hence the normal 3, 4, from the intersection of these curves 4, to the base S, represents the maximum speed attained. Also the area of the parallelogram A*a*, *b*B, equal to the area enclosed by the two curves and the base S, divided by the base S, namely 1, 2, represents the mean speed attained.



It will be noticed that the retardation curve is practically constant—its elements being determined by the conditions of stopping a train safely and without inconvenience to passengers: the acceleration curve, if similar conditions are disregarded, may range from A B, representing no speed, to A5, representing infinite speed. Should the latter be possible—that is, the train at starting, immediately move at maximum speed—the increase of mean speed between the two stations, over that represented by 1, 2, in the diagram, would only be that represented by area A4, 5, *a*, divided by the space S—quite small as compared with area A*a* *b*B divided by the same space.

Simple formulæ indicate the trend of these two curves—acceleration and retardation, and consequently the maximum and mean speeds possible—the constants in each formulæ being determined by the operation of trains, subject to conditions similar to those under consideration.

As perhaps is reasonable—and surely tending to the reduction of time of transit—it has been assumed that the acceleratien of speed may be thrice the retardation; that is, a train leaving a station may acquire maximum speed in one-third the space between that station and the one at which it is to stop. Also it is assumed that the trains shall stop one minute at each station.

From the formulæ and subject to the conditions mentioned, the following table has been computed, showing the spaces required between stations, that trains may be moved at the speeds indicated:—

Speed—Miles per hour.			Between stations.	
Mean.		Maximum.	Space—Miles.	Time.
Over the entire line.	Between stations.			
				hrs. min.
5	12·2	18·2	0·14	1 42
10	19·1	28·6	0·35	2 6
15	25·3	38·	0·61	2 27
20	31·2	46·7	0·93	2 48
25	36·8	55·2	1·3	3 7
30	42·3	63·5	1·72	3 26
35	47·7	71·6	2·18	3 44
40	53·1	79·6	2·7	4 3
45	58·4	87·6	3·27	4 22
50	63·7	95·5	3·89	4 40
55	68·9	103·3	4·55	4 58
60	74·	111·1	5·26	5 16

From this it appears that, for a mean speed over the entire line of 15 miles per hour, the maximum speed between stations shall be 38 miles, and these stations shall be nearly five-eighths of a mile apart; that for a mean speed of 30 miles the maximum speed shall be 63½ miles, and these stations shall be nearly 1¾ miles apart, and that for a mean speed of 45 miles the maximum speed shall be nearly 88 miles and the stations shall be over 3¼ miles apart.

WILLANS AND ROBINSON, LIMITED.—It will be seen from our advertising pages that Messrs. Willans and Robinson, Limited, are issuing £100,000 worth of debenture stock, for the purpose of completing the company's works at Rugby, wherein the manufacture of the Niclausse water-tube boiler will be carried on.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Chief engineer: Samuel Aston, to the Scylla, to date May 28th. Engineers: W. H. W. Stewart, to the Vivid, for the Opossum; Joseph N. Crowle, to the Vivid, for the Shark; B. J. Watkins, to the Vivid, for the Rocket; E. W. Rodet, to the Victory, for the Hart; J. G. Liversidge, to the Wildfire, for the Snapper; T. S. Guyer, to the Victory, for the Starfish, to date May 7th; and Henry E. Tregenna, to the Scylla, to date May 28th. Assistant-engineers: Edward J. Rosevere, to the Bellona, and George H. Fletcher, temporary, to the Scylla, to date May 28th.

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[*] The outside diameter of this turbine is about 10ft., and it runs with 24 revolutions per minute.

LETTERS TO THE EDITOR.

(*Continued from page* 539.)

UNDERGROUND STEAM PIPING AND INSULATING.

SIR,—I was much pleased to see in your issue of February 21st a full report, with drawings, of a paper read by R. C. Carpenter, at the annual meeting of the Society of Heating and Ventilating Engineers of New York. I think, Sir, you will agree with me in saying that the work, as carried out according to those drawings, can be much improved upon. I enclose a rough tracing of a plan which I tried to bring out in 1874, which I named the universal steam supply. My idea did not meet with favour when submitted to one or two gentlemen of distinction. It was said to be of too great magnitude, and too far ahead of the times. The Americans, under the guidance of Mr. Holley, soon after this commenced the system of laying down services of steam supplies on a large scale. It has been a great wonder to me that no steps have been taken to adopt the system in London or other large towns. To my thinking London especially should have an underground steam supply. It would minimise the fog nuisance by supplying heat to thousands of houses which now have to use open fires, by taking steam into your house from the street mains, and using it for culinary purposes first, and then let it ascend through pipes and radiators to all rooms in the house, or any special room as required. What a great benefit it would be in winter. Imagine the pleasure of having the whole of your house kept at one uniform heat in winter. There are numbers of warehouses and places in and about the City which would readily use steam for heating purposes, and at no extra rate for fire insurance. On the other hand, steam as an extinguisher of fire is equal, if not superior, to water. Take, for instance, a warehouse fitted up with a steam service, and should a fire occur in any particular room, it would only be necessary to open an outlet tap and shut the door; the steam would choke out the fire without flooding the place as with water. The uses to which steam can be applied are many—for driving engines in small workshops, for hoists, &c.; the exhaust steam, after being used by the engine, is sufficient to warm a large area of space. The only care in fitting up an exhaust system is to have the pipes of ample size, so as not to cause back pressure on the engine. Hotels, restaurants, coffee-houses, would find a steam supply of inestimable benefit, and at no risk of fire, as at present with gas. My plan is also to have plugs in the streets, for the purpose of melting away snow and supplying steam to fire engines. Some people run away with the idea that by loss of heat by radiation the steam would lose its effect. I contend, by having the pipes laid in a suitable trench, and properly covered or insulated, and the boilers at suitable distances apart, so that the steam is always circulating from one boiler to another, the system is thoroughly practical. I think, Sir, a little fair discussion in your valuable paper upon the merits or demerits of this subject would benefit the community at large.

H. GRAY, Engineer.

Alten-road, Auckland, N.Z., April 15th.

MR. BAYARD AND H.M.S. CALLIOPE.

SIR,—I beg to be permitted to record and to refer to the remarks a few days ago of the American Ambassador, who, in a very interesting speech and graceful reference, said: "A while ago, in a very remote part of the world, there was a great catastrophe. Away down in Polynesia there came a tornado in the Samoan Islands. A cyclone swept the armed ships of three nations into destruction. The Americans were lost, and part of the British were lost; Germany was stranded, and one ship alone survived the disaster. It was a British ship, the Calliope, commanded by an honest, brave British seaman, Captain Kane. He fought the tempest, and inch by inch gained his way against it."

May I be once more permitted to remind your readers that the Calliope—2770 tons, 4020-horse power—was fitted at the time with a two-bladed "feathering" propeller with movable blades, for the purpose of placing the said blades in a line with the keel, to save resistance when sailing. The fact that such a screw carried her to safety out to sea establishes beyond a doubt the sufficiency and safety of outboard movable blade holding gear. I may add to this the many and long-continued trials during the last five years, and under all conditions, of reversing screws, gears, and direct-acting system and attachments operated while running by non-reversing engines, thus proving that the great advantages of non-reversing engines and reversing propellers are attained without any disadvantages.

ROBERT MCGLASSON.

Selhurst, S.E., May 16th.

THE JOULE EFFECT.

SIR,—In connection with the interesting correspondence on the liquefaction of gases, which is being carried on in your columns, perhaps the following short account of Joule and Thomson's experiments "On the Thermal Effects of Fluids in Motion," by which the existence of what is now know as the "Joule effect" was indicated, may be acceptable.

In a communication to the British Association in September, 1852, Joule and Kelvin gave an account of certain preliminary experiments they had jointly carried out earlier in the same year. The object of these experiments was to test Mayer's hypothesis, by which he obtained a numerical relation between quantities of heat and mechanical work. This hypothesis had been adopted by Clausius, Holtzman, and others, and had been verified as at least approximately true by Joule, for air at ordinary temperatures. But Kelvin, in his mathematical investigations on the dynamical theory of heat, &c., arrived at conclusions which led him to doubt the accuracy of the hypothesis. Mayer's hypothesis is briefly this: The heat evolved from air compressed, and kept at a constant temperature, is mechanically equivalent to the work spent in effecting the compression.

The principle of the method employed to test this hypothesis is given by the authors in the following words:—"Let air be forced continuously and as uniformly as possible, by means of a forcing pump, through a long tube open to the atmosphere at the far end, and merely stopped in one place, so as to leave for a short space only an extremely narrow passage, on each side of which, and in every other part of the tube, the passage is comparatively very wide; and let us suppose, first, that the air in rushing through the narrow passage is not allowed to gain any heat from, nor—if it had any tendency to do so—to part with any to the surrounding matter. Then, if Mayer's hypothesis were true, the air, after leaving the narrow passage, would have exactly the same temperature as it had before reaching it. If, on the contrary, the air experiences either a cooling or a heating effect in the circumstances, we may infer that the heat produced by the fluid friction in the rapids, or, which is the same, the thermal equivalent of the work done by the air in expanding from its state of high pressure on one side of the narrow passage to the state of atmospheric pressure which it has after passing the rapids, is in one case less, and in the other more than sufficient to compensate the cold due to expansion; and the hypothesis in question would be disproved" (*Phil. Mag.*, 1852, page 482).

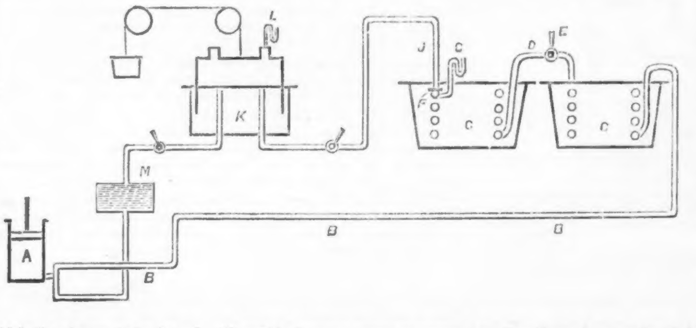
The apparatus employed consisted of a hand forcing pump adapted to pump air into a strong copper vessel of 136 cubic inches capacity, used for the purpose of equalising the pressure of the air, and from this into a spiral leaden pipe 24ft. long and $\frac{5}{16}$in. in diameter, provided with a stop-cock at its other end, the spiral being immersed in a large water bath during the experiments.

The water of the bath was kept at a uniform temperature throughout by constant stirring. In the first series of experiments the narrow orifice was made by simply nearly closing the stop-cock. Afterwards, in another set of experiments, the narrow passage was formed by fixing a narrow india-rubber tube to the stop-cock, which was kept fully open, and squeezing the end of the tube with a pair of wooden pincers. This change was made to diminish the effect arising from the conduction of heat through the metal of the stop-cock. It was found in both cases that, the pump being worked uniformly, a thermometer placed in the current of air flowing from the narrow passage showed a lower temperature than the air on the other side, which was assumed to be the same as that of the bath in which the spiral was immersed. The temperature of the bath was kept in the first series of experiments as nearly as possible the same as that of the surrounding atmosphere. In the second series, in addition, the effect of increasing the temperature of the bath to 150 deg. Fah. was tried. A cooling effect was still obtained, though the amount was less in this case than when the temperature of the bath was lower. The pressures were made to vary during these experiments from two to five atmospheres. The authors next attempted to determine the whole thermal effect by means of a calorimetrical apparatus applied externally, for it was considered possible that the observed cooling of the air might be due wholly or partly to its reaching the thermometer bulb before it had lost all the *vis viva* produced by the expansion in the narrow passage, and consequently before the full equivalent of heat had been produced by the friction. It is, however, unnecessary to give an account of these experiments, as the results were not very conclusive; though, on the whole, the authors considered that a cooling effect due to the air rushing through the narrow passage was indicated, if not satisfactorily proved.

After the completion of these experiments by Joule and Kelvin, the former made some additional ones to obtain a decisive test of the discrepancy from Mayer's hypothesis indicated by the experiments already described, and to determine its amount for different temperatures. For this purpose he soldered a piece of brass piping to the end of the leaden spiral, and having fastened a piece of calf-skin leather over its mouth, found that the natural pores of the leather were sufficient to allow a uniform and conveniently rapid flow of air from the receiver. The end, over which the leather diaphragm was bound, was protected with a vulcanised india-rubber tube, so that it could be immersed in the water bath to a depth of about 2in. A small thermometer was placed within this tube, the bulb being allowed, for convenience, to rest on the centre part of the leather diaphragm. It was ascertained that the effects were not perceptibly diminished when the thermometer was raised a quarter of an inch above the diaphragm. This was the first introduction of a porous plug into the experiments, and it was this apparatus that was used two years afterwards by Joule and Kelvin in their experiments with hydrogen. On this occasion—1852—during the first series of experiments, the temperature of the bath was kept at 61 deg. Fah., and pressures varying from 1·79 to 4·11 atmospheres were employed. The observed cooling effect was 0·5 deg. Fah. with the lower pressure, and 1·7 deg. Fah. with the higher pressure.

In the second series, consisting of six different experiments, the bath was kept at a temperature of 160 deg. Fah., and the pressure at 2·64 atmospheres, the cooling effect varied from 0·264 deg. to 0·66 deg. Fah. The variation being considered as probably due to alterations in the copiousness of the stream of air in passing through the plug—for, the more copious the stream the less of the cooling effect would be lost by conduction of heat from without—in all the subsequent experiments the quantity of air pumped through per second was observed. In the first five experiments of the third series 5·6 cubic inches of air were pumped through per second, and in the next two 8·4 cubic inches; the temperature of the bath was 170·8 deg. Fah. In three of these experiments the pressures were 4·11 atmospheres, and the cooling effects were 0·528 deg., 0·66 deg., and 0·726 deg. Fah. In all the subsequent experiments similar discrepancies occurred; due, in the opinion of the authors, to the want of a sufficiently copious current, showing, they state, how much uncertainty there must be in the results on account of purely accidental circumstances. But they consider it is perfectly established that there is a final cooling effect produced by air rushing through a small aperture at any temperature up to 170 deg. Fah., and that the amount of this cooling effect decreases as the temperature is augmented.

With the aid of a grant from the Royal Society, Joule and Kelvin carried out in the following year experiments on a far larger scale; a full account of which is given in the *Phil. Trans.* of the Royal Society for 1853. The accompanying figure, roughly copied from a drawing given in the report above referred to, will give a sufficient idea of the apparatus employed. It consisted of a single-acting pump *a*, worked by a steam engine. The pump cylinder was 6in. in diameter, and the stroke of the piston 22in. The air entered at the bottom of the cylinder during the up stroke and was expelled into the receiving tubes on the down stroke. The number of strokes per minute was limited by the governor of the steam engine to twenty-seven. Both the cylinder and valves of the pump were immersed in water. Forty-seven feet of wrought iron tubing *b b b*, of 2in. internal diameter, conducted the compressed air to the coils *c c* of copper tubing immersed in two wooden tubs filled with water. The copper tubing was of the same internal diameter as the iron, and had a total length of 74ft. A stop-cock *e* was placed between the coils, with the object of letting a portion of the air escape when it was wanted to reduce the pressure. The terminal coil had a flange *f*, to which could be attached any required nozzle containing the porous plug through which the air was to be forced. Near this flange a mercury gauge *g* was placed to indicate the pressure. A pipe *j* conveyed the air issuing from the nozzle to a calibrated gas meter *k*, having a capacity of 40 cubic feet. A pressure gauge *l* connected with the meter indicated any slight difference that might exist between the pressure in the meter and the external atmosphere. From the meter the air could be made to pass through a desiccating apparatus *m*, and thence to the pump, so as to circulate through the entire apparatus. In addition to the above it was found necessary during the course of the experiments to prevent the considerable oscillations in pressure due to the action of the pump, to place a diaphragm of copper, pierced with a hole ¼in. in diameter at the junction between the iron and copper pipes. With this addition to the apparatus the oscillations in pressure were hardly perceptible. To prevent any of the lubricating oil from the pump being carried to the porous plug at the far end of the copper coils, a box with perforated cups filled with cotton-wool was afterwards substituted for the copper diaphragm, which was equally effective in keeping the pressure uniform. The porous plug used for these experiments was composed of 251 grs. of cotton compressed into a space 1½in. in diameter and 1·9in. long. It was contained in a metal cylinder with flange to bolt to the end of the copper tube. Contact between the metal and cotton-wool plug was prevented by a piece of india-rubber tubing.



It is unnecessary to give the entire tabulated accounts of the experiments made under the different conditions above described. The following table gives the mean results of the last four observations in each series:—

Series.	Pressure in lb. on the sq. in.	Atmospheric pressure.	Temperature of bath. Fah.	Temperature of issuing air. Fah.	Cubic inches of air passing each minute reduced to atmospheric pressure.	Cooling effect. Deg.
			Deg.	Deg.		
1. Without diaphragm	35·866	14·695	65·0381	64·4198	12,703	0·6183
2. With diaphragm ..	35·9	14·755	66·5636	65·937	11,796	0·626
3. With box	34·279	14·71	58·2926	57·7328	11,784	0·5598

Finally, a number of experiments were made with reduced pressures, obtained by partially opening the stop-cock *e* between the coils, and thus permitting some of the air to escape into the surrounding atmosphere, and consequently diminishing the quantity arriving at the nozzle. The results obtained on this occasion were apparently anomalous, and need not be given here.

In a communication to the Royal Society in the following year—*Phil. Trans.*, 1854, page 321—Joule and Kelvin gave an account of a series of very elaborate and most interesting experiments by which, in the first place, they were able to account for the apparently anomalous results obtained under the conditions above referred to. It was shown that these were due to considerable fluctuations in temperature, occasioned by the sudden opening or closing of the stop-cock *e*—see Fig. The cause of these fluctuations, which continued for a considerable time, was explained, and it was found that the only precaution required to prevent their injurious effect on the accuracy of the results was simply to keep the action of the pump as uniform as possible, and only to commence the record of the experiments after the fluctuations had died away, viz., from an hour and a-half to two hours after the starting of the pump. The nozzle containing the porous plug used during these experiments was made of boxwood instead of brass, and was placed in a tin can filled with cotton-wool to keep the water of the bath from coming in contact with the wood.

In the first set of experiments made on this occasion the cotton-wool plug weighed 191 grains. The quantity of air passed through the nozzle varied from 10,998 to 10,769 cubic inches per minute. The mean results were as follows:—

Pressure in pounds on the square inch	20·969
Atmospheric pressure	14·624
Temperature of bath, Fah.	62·6108 deg.
Temperature of the issuing air	62·4164 deg.
Cooling effect	0·1944 deg.

Under almost precisely the same conditions as regards pressure and temperature in Series 7 of the preliminary experiments with a hand pump, the mean cooling effect was found to be 0·42 deg. (*Phil. Mag.* 1852, page 489) a result apparently exactly contrary to that anticipated by the authors, who considered that in these preliminary experiments, "very much of the cooling effect must be lost on account of the insufficiency of the current of air" (*Phil. Mag.* 1852, page 490).

In the next series of experiments a cotton-wool plug of 382 grains was used, and the stop-cock was kept partially open so that the pressures might not widely differ from those in the above series. The quantities of air passing through the nozzle on three occasions when they were observed, were 3865, 3960, and 3125 cubic inches per minute, and the mean results were:—

Pressure in pounds on the square inch	22·678
Atmospheric pressure	14·540
Temperature of bath Fah.	68·225 deg.
Temperature of issuing air	67·9842 deg.
Cooling effect	0·2408 deg.

In the next series the entire quantity of air propelled by the pump, which amounted to 11,766 cubic inches a minute, was passed through the plug, the mean results being:—

Pressure in pounds on the square inch	35·993
Atmospheric pressure	14·577
Temperature of bath Fah.	63 9892 deg.
Temperature of issuing air	63·302 deg.
Cooling effect	0·6372

For the sake of comparison the following mean results of Series 8 of the preliminary experiments are given below (*Phil. Mag.* 1852, page 490):

Quantity of air in cubic inches passing through the plug.	Temperature of bath Fah.	Pressure of air in atmospheres.	Cooling effect.
168	deg. 64·48	2·41 about 35·4 lb. on the square inch	deg. 0·56

Afterwards a number of similar experiments were made with silk instead of cotton plugs, the results of which were in accordance with those already given. The effect on carbonic acid and on hydrogen was also determined; it was much greater than air with the former, and only one-thirteenth of the cooling effect observed with common air with the latter. The apparatus employed on this occasion in the experiments with hydrogen was the small one used in the preliminary experiments. In experimenting some years later on a larger scale with hydrogen, a heating instead of a cooling effect was obtained (*Phil. Trans.*, 1862.) On this occasion, for the convenience of experimenting with hydrogen, and other gases not so easily procurable in large quantities as air or carbonic acid, a porous plug of smaller dimensions, enclosed in a nozzle of less capacity for heat, was used. A smaller air pump was also used, but it was a double instead of a single-acting one.

It is impossible to read the original accounts given by Joule and Kelvin of their experiments, without being struck by the remarkable skill, patience, and inventive resources they displayed during their investigations. But I must admit that it appears to me not a little remarkable—considering that the express object of the investigation was to determine whether the gas experimented with was at different temperatures on opposite sides of the porous plug—that it seems never to have occurred to the experimentalists to settle this matter beyond question by testing the temperature of the gas on both sides of the plug with thermometers—a not very difficult operation, one would suppose—instead of assuming that the gas on the high-pressure side of the plug was at the same temperature as the bath in which the copper coil containing it was immersed. It seems to me that this might very well not have been the case, for the following reason. Each time the valve between the pump and coil was closed, the gas in the pipes would continue to be forced through the porous plug by expansion only. Obviously, as work is being done, a cooling effect on the gas within the coil would take place. This cooling effect would be modified by two causes:—(1) By the heat conducted inwards from the bath; and (2) by the heat due to compression each time a fresh supply of gas was forced into the pipes by the action of the pump. Regarding this second action, Joule and Kelvin state in their report (*Phil. Trans.*, 1853, page 363):—"There was also another source of interference with the accuracy of the results owing to a considerable oscillation of pressure arising from the action of the pump. We had remarked that when the number of strokes of the engine was suddenly reduced from twenty-seven to twenty-five per minute, a depression of the thermometer equal to some hundredth of a degree Cent. took place, a circumstance evidently owing to the entire mass of air in the coils and cotton plugs suffering dilatation, without allowing time for the escape of the consequent thermal effect. Hence it was found absolutely essential to keep the pump working at a perfectly uniform rate. For a similar reason it was also most important to prevent the oscillations in pressure due to the action of the pump, particularly as it appeared obvious that the heat evolved by the sudden increase of pressure, on the admission of a fresh supply of air from the pump, would arrive at the thermometer in a larger proportion than the cold produced by the subsequent gradual dilatation." It was for this reason that a perforated copper diaphragm, replaced afterwards by a box with perforated cups, was placed between the iron pipe and copper coil, which it is said reduced the oscillations so as to be hardly perceptible. But this could only apply to the oscillations in pressure in the copper coil. The oscillations in pressure in the iron pipe must obviously have been increased by these measures. Hence it is only reasonable to suppose that the stream of air issuing through the narrow passage from the high-pressure pipe, that is, the iron pipe, to the medium pressure or copper pipe, must have been colder owing to dilatation than when there was no such obstruction in its passage from one pipe to the other. And the temperature of this stream may very well have been so much colder, on the average, between each oscillation in temperature than the water in the bath, that it reached the porous plug before being raised to that temperature.

It would occupy too much space, and, without further experiments, be perhaps of little use to discuss the question here raised more fully. But I think enough has been said to show that Joule and Kelvin's experiments can hardly be considered to have established that there was a fall in temperature in the case of air, carbonic acid, &c., due to molecular attraction; or a rise in temperature during expansion in the case of hydrogen, due, I suppose, to molecular repulsion. With regard to this latter gas, it would pass the obstruction between the iron and copper pipes with so much greater facility than air or any other gas, that it is quite possible that it had little, if any, effect upon it. If so, since on one occasion a heating effect was obtained, even with air, before the introduction of the obstruction between the iron and copper pipes (*Phil. Trans.*, 1853, page 363), it may be that during the final experiments in 1862, with hydrogen, when a heating effect was obtained, instead of a cooling effect, as had been previously obtained with the small hand pump apparatus, the gas reached the porous plug before it had lost all the heat derived from compression in the pump cylinder. So far, then, it seems to me that Mayer's hypothesis has neither been proved nor disproved by experiment. If, hereafter, it should turn out to be true for ordinary temperatures, all uncertainty regarding the exact value of the mechanical equivalent of heat would be removed, which would be as calculated by Tyndall, 771·4 foot-pounds ("Tyndall's Heat," fourth edition, pages 70 to 72).

It will be readily seen from the foregoing that the liquefaction of gases in the exceedingly ingenious machines of Dr. Linde and Dr. Hampson is quite independent, as stated by "X." in his able article in January this year, of what is called the "Joule effect"; that is, if we mean by the "Joule effect" a fall in temperature during the expansion of a gas due to internal work being performed in overcoming molecular attraction; although, if this attraction exist, it will no doubt aid in reducing the temperature. The theory of the action of these machines seems to me to be as follows, supposing Mayer's hypothesis to be true. When the valves between the pump and pipes are closed—which must take place periodically, whether a single or double-acting pump is used—the gas in the pipes expands against external pressure, and consequently falls in temperature. The admission of the next fresh supply of gas forced in by the pump at atmospheric temperature is sufficient to warm up the gas in the pipes on the high-pressure side of the narrow orifice to its former temperature, but not sufficient to do this and in addition to warm up the gas which has escaped through the orifice in the interval between the supplies. Now, since in these machines the gas forced through the narrow orifice is made to pass back along the exterior of the pipes containing the high-pressure gas, it must tend to prevent the rise in temperature within these pipes due to the incoming gas. Hence there will be on the whole a cooling effect on each successive stroke made by the pump—slightly reduced in amount by each fresh supply of gas being warmer than that in the high-pressure pipes. Consequently as the pumping action is continued, the gas within the high-pressure pipes, and also the gas surrounding them, will continue to fall in temperature until liquefaction sets in. C. E. BASEVI.

8, Norfolk-square, W., May 19th.

CIRCULATION IN WATER-TUBE BOILERS.

SIR,—I have read with a great deal of interest the correspondence which has appeared in the engineering journals relating to the circulation in water-tube boilers. I believe I was the first to point out that the heating of the downcomers did not in any way diminish the rapidity of circulation. This statement, at first, was looked upon by some engineers as being absurd and ridiculous in the extreme. However, the experiments so ably conducted by Professor Lambert and Mr. Yarrow amply demonstrated that my theory was correct; in fact, these experiments showed that the circulation, rather than being diminished by the heating of the downcomers, was actually increased. In other words, my theory was a little more than correct.

As there still seems to be much misunderstanding in regard to what the actual cause of circulation is, and as a good deal of the reasoning which has appeared is founded on a mistaken hypothesis, I think I shall be able to simplify matters by pointing out exactly what takes place in a U-shaped tube, and why the water circulates.

If one limb of a U-shaped tube should be filled with a liquid which would weigh 15 oz., and the other with a liquid which would only weigh 10 oz., it is very evident that the heavier liquid would flow into the other limb and expel the lighter liquid, and that the flow would be just in proportion to the difference in the specific gravities of the two liquids. Suppose that the heavier liquid should consist of pure water and the lighter liquid should be composed of water mixed with some lighter substance, no matter what this substance may be, so long as it is held in suspension in the water, the circulation would take place always exactly in the degree that the one liquid was lighter specifically than the other. If this lighter material should consist of air bubbles, or steam bubbles and water, it would not make the least difference whether the bubbles were so small as to give the solution a milk-like appearance, or whether they were so large as to nearly fill the tube, the result would be the same, because it is the specific gravity of the whole mass that we have to consider. The circulation is due altogether to the difference in the specific gravities of the fluids, or fluid-like substances, in the two limbs of the tube, and to no other cause whatsoever.

It has been asserted by some writers that, so long as a continuous thread of water extends from the top to the bottom of the up-tube, the pressure in this up-tube must be identical with the pressure in the downcomer; and this mistaken hypothesis has, to my mind, been the cause of a great deal of the misunderstanding which has taken place. If a series of cork balls were strung together on a light thread, secured to the bottom of the up-tube, we should then have a continuous thread of water extending through the whole length of the tube, and the pressure would be the same as in the downcomer at all corresponding points. If these cork balls were each loaded with sufficient lead to make them exactly as heavy as the surrounding water, there would be no tension on the thread, and the result would be exactly the same. But suppose that these cork balls only weigh one-tenth part as much as a corresponding volume of water, and that they were so numerous as to occupy a third part of the volume of the tube. Suppose, now, that the thread should be cut, the balls would instantly commence to ascend the tube, and the pressure at all points in this tube would instantly fall below the pressure in the downcomer. If there were a very large communication to the downcomer, the difference in pressure would not be very great; only sufficient, of course, to cause the water to flow in and occupy the space previously occupied by the cork balls. However, if the communication between the two tubes should be restricted, it would be found that as soon as the cord was cut the pressure in the up-tube would be considerably diminished.

Some correspondents have assumed that the water circulates by an entraining action of the bubbles, believing that the bubbles move by some inherent power of their own, and in doing so take the water along with them. This is called an entraining action. When a canal boat is drawn through a canal, the water is drawn in the same direction, but at a much less velocity. In this case the canal boat moves the water and not the water the boat. But the bubbles do not move by any force inherent in themselves. Every steam or air bubble weighs something, and is drawn towards the earth exactly like any other body. These bubbles do not rise in a tube by any inherent force of their own, but because the water flows down between them, or through another tube, as the case may be, and produces a pressure on their underneath side greater than on the top side. The bubbles are therefore moved upward by the water, and not the water by the bubbles, as has been supposed by some correspondents.

The truth of all that I have said is easily demonstrated by a simple and inexpensive experiment, and if I have not made myself sufficiently clear, I propose to demonstrate the truth of what I have written by actual experiment. HIRAM S. MAXIM.

32, Victoria-street, London, S.W., May 21st.

[If Mr. Maxim tries the experiment with the cork balls, he will find that no circulation worth the name takes place. Water will descend the downcomer, and take the place of the cork in the way and for the purpose fully explained in our impression for May 15th, but not for the reason stated by Mr. Maxim in his third paragraph.—ED. E.]

THE THAMES TUNNELS.

SIR,—My attention has been called to a letter from Mr. A. Scott, which appeared in your issue of the 1st of May, in which he states that the Thames Tunnel is an obstruction with only 12ft. at low water and suggests the necessity of its removal. As one of those employed in its construction, I beg to state that the top of the tunnel is more than 36ft. below low water of spring tides. As to his complaint that the Conservators have done so little towards deepening the river, I desire to bear my testimony to the very great amount of work which they have effected in that direction with the very inadequate means at their disposal.

17, Victoria-street, May 22nd. HENRY LAW.

NEW TRAINS FOR THE FLYING SCOTSMAN SERVICE.

THERE will shortly be put into service on the East Coast route two complete trains for the through working—in the day time—between London and Edinburgh, Glasgow, Aberdeen, Dundee, and Perth, which make a distinct advance on anything hitherto designed for use in this country, or indeed in Europe, approximating as they do to the American ideal of luxury and safety. In a case like this, where a train divides into a number of portions at Edinburgh for different places, it is difficult to design a "complete" train in the full sense of the word, but it will be readily admitted that while the coaches for the different Scottish centres are complete in themselves, that yet both in outward appearance and internal arrangements the trains on the section between Edinburgh and London will show the care which has been bestowed on the designs. The coaches are all East Coast joint stock; that is to say, they are the property of the three companies—the Great Northern, the North-Eastern, and the North British—and are built from designs agreed upon by the officers of the three companies, and used for the joint service only. Each train consists of eight coaches, carried on a pair of six-wheeled bogies—*i.e.*, twelve wheels under each coach—and having an extreme height of 13ft. 5in. from the rails, clerestory roofs, patent torpedo ventilators, double gas lights, Gold's patent steam heating apparatus, and a complete arrangement of electric bells from each compartment by which the attendant can be called if required. Externally the coaches are finished in selected teak, varnished, picked out with gold lines and with large gold lettering, and ornamented with the East Coast joint arms in the centre, and at either end the old coats of arms of England and Scotland respectively, from special designs, which give the exterior a very handsome appearance. The public will fully appreciate the long scarlet destination boards, with bold gold letters conveying all information necessary to the easy finding of the right through coach. In the long corridors are ingenious skeleton route maps showing the principal stations, branch lines, and junctions, the mileage, &c., which will be of interest to the traveller who is unfamiliar with the route, and who wants to know "Where we are now," and which with the large maps placed at intervals on the doors in the corridors, and the fold-up seats also fitted therein, make the long promenade from end to end of the train a pleasant place in which to pass away the time. The whole of the floors in the train are laid with thick Kork matting, a material both noiseless and warm. In the meantime the first and last vehicle of each train will be a standard East Coast six-wheeled van, but as soon as the present pressure in the shops allows, a long twelve-wheeled "van and third composite" coach will be built for the front and tail of the train. Two entire novelties, so far as this country is concerned, which will add much to the safety and comfort of the passengers, are introduced in these trains—namely, the patent Gould combined vestibule, automatic coupler, buffer, and continuous platform, and the quick-action Westinghouse brake. The system of side buffers and screw-up couplings, which is universal in this country, has never been used in America, and the gradual abolition of so unsatisfactory a system means a great increase in the haulage capacity of the locomotives, as it is evident that on a curve a considerable amount of the power of the engine is employed in compressing the inner buffers. The Gould centre coupler and buffer is a very powerful steel apparatus like a gigantic mark of interrogation (?) on its side, and is the kind most favoured in America. It is automatic in its action; that is to say, when the coaches are pressed together the two couplers engage at once, and all the usual dangers which arise where shunters have to work between moving carriages are dispensed with, as it is only necessary to couple up the brake and steam heating pipes and the electric communication wires after the coaches are at rest, and are practically one. The coupler is held in position by springs of enormous strength, which, while they allow the coupler to act like a great hinge on curves, in the case of a collision act with great resistance in absorbing the dangerous forces which result in telescoping. The coaches are fitted also with the standard British side buffers, so that when necessary vehicles not fitted with Gould couplers may be added to the train; but these side buffers are kept quite out of play, so as not to interfere with the gain in haulage which results from the flexibility of centre buffers—at the same time these side buffers will be a great help if the coaches begin to crush together in a collision, as they will act as additional springs, throwing the stresses on to the outer frames. But the greatest gain of all in the way of safety is in the adoption of the Gould continuous platform and solid vestibule, which make the train practically one vehicle from end to end. The end of the coach sweeps out in a semicircle like the stern of a ship, forming an enclosed and covered platform which almost meets the corresponding one on the next coach, the intervening space being bridged over by the Gould vestibule, which is an ample steel gangway, 3ft. wide and 6½ft. high, which automatically interlocks, without bolts or clamps, when the coaches meet. Telescoping, which is the cause of most of the deaths in collisions, is practically unknown where centre couplers are combined with solid vestibules, which throw part of the terrible crushing force on to the sides and roof of the carriages, instead of on to the frame alone.

Every wheel of the train is fitted with quick-action Westinghouse brakes, an improved form of brake which is practically instantaneous in its action, and which stops a train at full speed in less than half the distance required by the brakes now in use in this country; this brake has been generally adopted in America, Australia, Belgium, &c., for some years both for coaches and goods trucks, but hitherto this country has been backward in such matters. The Gould couplers, vestibules, &c., and the quick-action Westinghouse will in future be fitted on all East Coast joint stock, on which the automatic vacuum brake is also fitted. On each train there is one third-class open carriage, entered by doors at the ends only, thereby abolishing the draughts and general discomfort inseparable from side doors, and having a passage right down the centre; it is divided into three sections, holding twenty-three, sixteen, and fifteen passengers, or fifty-four in all, and at one end are the lavatories, a large luggage compartment, and the attendant's room. The introduction of an attendant who will have the sole duty of waiting on the passengers, who can call him by the bell in each compartment, will be much appreciated, especially when it is known that he has arrangements for supplying tea, coffee, and light refreshments *en route*. The passenger compartments are trimmed with combination velvet in crimson and black, with silk laces, &c., to match. This coach is 66ft. 10in. long and 9ft. wide, and, with its light and airy feeling of freedom, should be very popular. There is also one third-class corridor carriage, 66ft. 10in. long and 8ft. 6in. wide, having nine separate compartments, seating fifty-four passengers, and the usual lavatories. In the centre of the train are four composite corridor carriages, each 65ft. 10in. long and 8ft. 6in. wide; for the Glasgow, Perth, and Aberdeen service each is complete in itself, containing three first-class and four third-class compartments, ample luggage room, and separate lavatories for each class, the first-class compartments being trimmed in fine blue cloth, crimson laces, holder lace, &c., and provided with mirrors; the third-class in crimson and black combination velvet, and lace to match. The composite carriage brakes for the ends of the trains will be 62ft. 7in. long and 8ft. wide—with side inspection projections for the guard—and uniform with the rest of the train, and will accommodate four third-class compartments and a lavatory, besides a luggage van 32ft. long. Each train will be over 530ft. long, will weigh about 270 tons, and carry exactly 300 passengers, and from these statistics and general notes it will be seen that the whole arrangements have been made with the intention of producing trains which will not only be very luxurious, but present a handsome appearance, and afford a highly-paying accommodation space, a happy combination both for the public and the companies. The trains have been built at the Great Northern works at Doncaster, and the chief work of the designing, as well as the complete construction, has been carried out by Mr. E. F. Howlden, the carriage superintendent, in a most satisfactory manner.—*The Scotsman, May 25th*, 1896.

THE INSTITUTION OF CIVIL ENGINEERS.

MAGNETIC PROPERTIES OF IRON AND STEEL.

AT the ordinary meeting on Tuesday, May 19th, Sir Benjamin Baker, K.C.M.G., the President, in the chair, two communications dealing with the magnetic properties of iron and steel were considered.

The first paper was entitled, "The Magnetic Testing of Iron and Steel," by Professor J. A. Ewing, F.R.S., M. Inst. C.E. The author referred to the practical importance which now attached to the magnetic testing of iron and steel in relation to the manufacture of dynamos and transformers. From being a mere laboratory experiment, interesting only to students of physics, it had passed into the rank of an engineering operation. Ironmakers now supplied material greatly superior, from the magnetic point of view, to that which could be obtained even two or three years ago. In dynamo construction the introduction of permeable steel castings for the field magnets had given greater latitude as to form without loss of efficiency, the best steel castings being indeed somewhat better magnetically than most forged iron. In stampings of sheet metal for transformers the main consideration was absence of hysteresis, and so great had been the advance in this respect that iron was now readily obtainable with only half the amount of hysteresis which was considered possible a few years ago. This had brought about a notable increase in the efficiency of alternate-current distribution, by reducing the large element of loss which occurred through the hysteresis of transformed cores during the hours of light load as well as of heavy load. The author recalled the conventions according to which the magnetic quality of iron was expressed. The most usual test was one to determine the relation of the magnetic induction to the magnetising force, the ratio of B to H being the permeability. To enable H to be determined with accuracy, the specimen was arranged as a closed ring, or as an ellipsoid, or as a bar or bars rendered practically endless by the use of a yoke. Ballistic methods of testing were described, and it was shown how in the use of a yoke a proper correction might be experimentally found, to deduce the true magnetising force, by allowing for the magnetic resistance of the yoke itself. For this purpose the author used a pair of bars, joined by two short yokes at their ends, the yokes being shifted so as to include either the whole length or half the length of the bars in the magnetic circuit. Reference was made to various forms of apparatus designed to measure the magnetic induction by observing the force required to separate surfaces in the magnetised piece, and a form used by the author was described, in which a yoke piece was simultaneously drawn away from polar extensions at both ends of the bar. A novel apparatus was shown in detail for measuring permeability by comparing the magnetising force required to produce a given induction with the force required to produce equal induction in a standard bar. This apparatus, which the author terms a magnetic bridge, from its analogy to the Wheatstone bridge for the measurement of resistance, reduced the operation of testing to a comparison between the specimen and a bar the magnetic quality of which had been determined once for all by the instrument maker. The two bars were connected by end yokes, and by varying the number of turns in the magnetising coil on one of them, the yokes were brought to the same magnetic potential. The relative number of turns on the two thus gave the relative magnetising forces required to produce the same induction in both. A simple form of magnetic detector showed when the two yokes were brought to the same potential. The manipulation consisted in varying the number of turns acting on one bar by means of dial switches, while the magnetising current was from time to time reversed. This permeability tester was intended for workshop use, and might take its place alongside of the author's hysteresis tester, which was also described. The methods of directly measuring hysteresis were briefly referred to.

A number of representative examples were given of permeability tests of forged wrought iron, forged steel and cast steel for dynamo magnets; also of hysteresis tests of transformer plate rolled from

Swedish wrought iron and from ingot metal. The results were shown by means of numerical tables and also in curves.

The second paper, on "Magnetic Data of Iron and Steel," was by Mr. H. F. Parshall, Assoc. M. Inst. C.E. Magnetic tests of iron and steel might be conducted to determine such properties as permeability, maximum magnetisation, residual magnetism, and permanent magnetism, and the relation they bore to tempering, annealing, internal stresses, composition, and processes of manufacture. The loss of energy through hysteresis might be determined either magnetically by determining the area of the loop formed by plotting the flux densities as ordinates, and magnetic force as abscissæ, or mechanically by suitable power-measuring apparatus. A study of the magnetic results and of the chemical analysis showed a more or less intimate relationship according to the degree with which the modifying physical conditions might be controlled. In general, a greater degree of purity was an indication of high permeability, but as the different qualities of iron and steel merged into each other by insensible degrees, owing to variations in the processes of manufacture, chemical analysis might be taken only as an approximate indication of the magnetic properties. Carbon was the most important element entering into the composition of commercial iron, and within the limits that chemical analysis might serve as an indication of the physical structure, the permeability was inversely as the amount of carbon present. The limitation as to the state of physical structure was greatly affected by the state of the carbon, that was, whether free or combined; in cast iron as well as in steel, the effect of graphite was second to that of the carbide, commonly known as fixed or combined carbon.

Beyond a certain degree of purity, as in wrought iron and carbon steels, the treatment as to annealing and tempering became of first importance. The magnetic properties of some of the alloys of iron, nickel, or manganese were such as to show that the physical structure was the ultimate determining factor. The hysteresis loss was in general inversely as the degree of purity, but in comparatively pure irons it was determined principally by its treatment as to annealing, heating, and mechanical straining.

LAUNCHES AND TRIAL TRIPS.

THE transport steamer Sir Evelyn Wood, recently built and engined by Messrs. Fleming and Ferguson, Paisley, went down the Firth on her trial a few days ago, attaining, on a six hours' run, a speed of 10 knots, being in excess of guaranteed speed, and everything working smoothly and to the complete satisfaction of the Government officials on Board.

The twin-screw steamer Barcellos, built by Messrs. A. Rodgers and Co., Port Glasgow, and engined by Messrs. Hall, Brown, Buttery, and Co., Govan, was successfully tried on the measured mile in the Gareloch on the 21st inst., when a speed of 10½ knots was easily obtained. This vessel is a sister ship to the Sapucaia, both being owned by the Amazon Steam Navigation Company, London, and built under the superintendence of James Pollock, their engineer. The vessels are fitted with all the latest improvements for the special trade in which they will be engaged. The dimensions are 170ft. by 28ft. by 10ft. 6in., and in trial the vessels were fully loaded with coal. The engines are on the triple-expansion principle, working at a pressure of 165 lb. Both vessels were ordered early in February, so that they have been handed over within three and a-half months from the date of order.

On Tuesday, the 26th inst., Messrs. Wigham, Richardson, and Co. launched from their Neptune Shipyard a steamer named the Innisfallen, which they are building to the order of the City of Cork Steam Packet Company, of Cork. The Innisfallen is the third steamer built for this company by Wigham, Richardson, and Co. The vessel is built of steel, with very fine lines, and is intended for the passenger service between Milford and Cork, in conjunction with a special service of fast trains from London. She is 283ft. in length by 35½ft. beam, and will have luxurious accommodation for a large number of first and second-class passengers. She will also be fitted up for carrying a large number of cattle, besides being able to be converted into a troopship should occasion arise. The propelling machinery is also being constructed by Messrs. Wigham, Richardson and Co., the engines being of the four-crank triple expansion type, working at 160 lb. pressure, and balanced on the well-known Yarrow, Schlick, and Tweedy system, which, owing to the entire absence of vibrations, is peculiarly suitable for passenger steamers. Amongst the company who viewed the launch were Major Lyons, chairman of the City of Cork Steam Packet Company, Mr. Christie, and Mr. Tweedy, of the builders' firm. The christening ceremony was performed by Miss Hicks, daughter of the Rev. Canon Hicks, of Tynemouth.

On Saturday, the 23rd inst., the new steamer Loongmoon, which has been built and engined by Messrs. Wigham, Richardson, and Co., of Newcastle-on-Tyne, for the Chinesische Kustenfahrt Gesellschaft, of Hamburg, completed a very satisfactory trial trip. The vessel is built of steel, 310ft. in length by 38½ft. beam, rigged as a two-masted schooner, and has been built to take the highest classes in the registries of the Bureau Veritas and Germanischer Lloyd. She has been specially constructed for the Eastern Coasting Service of this company, and is well supplied with all the most modern appliances for working both the cargo and the vessel. She has also handsome, well-ventilated and convenient accommodation for a large number of native and European passengers. The engines and boilers have also been constructed by Messrs. Wigham, Richardson, and Co., the former being of the quadruple type, self-balanced on the Yarrow, Schlick, and Tweedy system. During the trial trip they worked most satisfactorily, driving the vessel at a speed of 12⅝ knots. Amongst the company on board the vessel were Mr. John Tweedy, of the builders' firm; Mr. Hubbe, director of the Chinesische Gesellschaft, and Mr. Schlick, the technical adviser of the company; and Captain Kohler, who has taken command of the vessel, Mr. Muir, and representatives of the Board of Trade, the Bureau Veritas, and other gentlemen. The Loongmoon is the fifth vessel built by Messrs. Wigham, Richardson, and Co. for the coasting passenger trade of this company, and is a very handsome addition to their fleet.

The steel screw steamer Carlow, built and engined by Messrs. Blackwood and Gordon, Castle Building-yard, Port Glasgow, for the City of Dublin Steam Packet Company, Dublin, went down the Firth on the 19th inst. on her official trial, in favourable weather. Her dimensions are:—Length, 260ft.; breadth, 34ft.; depth to main deck, 16ft. 9in.; with full poop, long bridge and forecastle, having short breaks filled in with planking, which gives a continuous upper deck; gross tonnage, 1284 tons. The vessel has been built very much in excess of Lloyd's scantlings in view of the particular trade for which she is intended—*i.e.*, Dublin to Liverpool—and has also been fitted with deep rolling chocks to minimise the rolling motion in heavy weather. In the holds water ballast tanks are placed, which can be separately filled and emptied, being connected by pipes to ballast engines in the engine-room. The machinery, which has also been constructed by Messrs. Blackwood and Gordon, is of the triple-expansion type, of fully 3000-horse power, and is supplied with steam from two large double-ended boilers working up to 170 lb. pressure. The vessel and her machinery has been constructed under the superintendence of Mr. E. G. Ferber, of Liverpool, the engineering superintendent of the City of Dublin Steam Packet Company. The speed attained was fully 15¼ knots on a four hours' run. The distance between Dublin and Liverpool is 120 knots, and Mr. W. Watson said they were constantly doing the passage under eight hours, which was a speed of 15 knots. Proposing "The City of Dublin Steam Packet Company," owners of the Carlow, the chairman said this company was the oldest steamship company in this country, having been founded in 1823. This company had for nearly sixty years had the honour and privilege of carrying her Majesty's mails between Ireland and England, and they had recently entered into a new contract with her Majesty's Government, to fulfil which they were building four new twin-screw steamers, to attain a speed of 23 knots, and when they came to occupy the station they would shorten the passages between Kingstown and Holyhead by half an hour.

AUSTRALIAN NOTES.

THE information concerning the particulars of the mineral resources of New South Wales, as published by the Mines Department, is not yet officially before the public for the year 1895, the delay being caused in consequence of the reports being held over until Parliament meets However, the principal statistics have been submitted for press review. The total value of all the mineral products for the year 1895 was £4,552,018, being a decrease of £504,118 on the value won in 1894. The following are the values of the principal items:—Gold, £1,315,929; silver, £81,858; silver, lead, and ores, £1,560,813; coal, £1,095,327; shale, £75,218; coke, £24,683; tin, £138,623; copper, £140,885; iron, £15,620; antimony, £7251; chrome, £13,048; limestone (flux), £68,160; the noble opal, £6000. The increases for 1895 were:—Gold, £159,211; shale, £43,437; copper, £67,404; chrome, £712. The principal decreases were:—Silver, £12,292; silver, lead, and ores, £634,526. The decrease in the value of the output of silver is evidently due to a greater quantity of lower grade ores being produced during the past year, the tonnage being nearly 40,000 tons in excess of 1894.

Coal shows a decrease of £60,426, notwithstanding there being an increase in quantity of 66,500 tons. This is considered to be due to the low price prevailing.

The prospects for gold mining are very encouraging, as, notwithstanding the adverse circumstances met with on account of the drought, the returns show a substantial increase. The impetus given to gold mining in this Colony is due in a great measure to the scheme of sending the unemployed throughout the Colony to "fossick."

The Broken Hill Proprietary Company are still saving gold in connection with their silver mining operations, the quantity last year being 4650 oz., valued at £18,600. The report gives a table showing the yields and value of the quartz mines in the various districts as under:—

District.	Tons.	Yield.	Average.		
		oz.	oz.	dwt.	gr.
Bathurst	17,541	83,958	4	15	17
Tambaroora	3,784	2,749	0	14	12
Lachlan	19,223	27,202	1	8	7
Southern	6,007	3,278	0	10	21
Tumut	5,488	5,210	0	18	23
Peel	43,137	28,878	0	13	9
Hunter	449	336	0	14	23
Clarence	3,068	2,652	0	17	7
Mudgee	15,088	9,169	0	12	7
Cobar	12,507	6,601	0	10	13
New England	2,139	3,769	1	15	5

A strike is again contemplated throughout the Newcastle coalfields against a further reduction of pay. It is to be deplored that some arrangement cannot be agreed upon amongst the colliery proprietors for a fixed rate for coal, so as to place the miners on a better footing. According to the official returns of the Government, the ruling price of coal for the past year was the lowest on record since the commencement of coal mining in the Colony.

A deal of consternation has lately been caused among coal shippers in consequence of heated coal cargoes; hitherto it was considered perfectly safe to ship the Newcastle coal in any weather, but within the last two months three coal-laden ships have had to get their cargo broached in consequence of over-heating, one vessel, the Knight of St. Michael, having to return to port after being several days out. The absence of gases in the pits was thought to be a safeguard against any over-heating. From investigations that have since been made it has been considered that the causes of the over-heating have been through the friction of shooting the coal from a great height into the holds of the ships, and also through loading in wet weather.

In addition to the smelting works now being erected in the Illawarra district, under the management of Mr. J. Howell, it is understood a company is about to erect a smelting works for the treatment of sulphide ores in the Newcastle district, at a cost of between £50,000 and £60,000.

Since the inauguration of the Public Service Commission for New South Wales—a body to fulfil duties similar to those of the Civil Service Commission in London, but with greater powers—several important changes have already taken place, one of the principal ones being the retirement from the chairmanship of the Metropolitan Water Supply and Sewage Board of Mr. C. W. Darley, who becomes Engineer-in-Chief in the Works Department.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, May 20th.

STEEL makers are making additional slight concessions this week to stimulate the placing of orders for finished products, particularly in plates and shapes, but without success in any degree. While there is admittedly a great deal of bridge building to be done, and that too before the approach of cold weather, there is an indifference on the part of railway managers and others to inaugurate work. There is also a large amount of elevated railroad work, terminal work, track repairing and extension, and so on, that railway people say must be attended to, but the attractions of extremely low quotations and arguments that prices may advance later on do not have any effect.

Our Pennsylvania mills are monopolising the cream of the trade, and especially in Western Pennsylvania. Some mills have two months' work secured. Pig iron production does not decline, but prices weaken. Even at shaded quotations it is no easy matter to move lots of 5000 tons for mills. Charcoal iron is doing better, but Bessemer pig is neglected almost completely. The steel billet people loaded up a big gun, but the middleman kept them from firing it off. There will be no change until July, when all authorities agree business will improve. Steel rails are picking up in the West, where a great many roads are doing repairs. Some are building small extensions. All need more rolling stock, but have to get along as best they can. The bar mills are slack, but to-day's report from Pennsylvania sheet mills assures us there is a steady demand for sheets. Wrought iron pipe mills have many recent inquiries. Merchant steel is also in better demand. Summing up the entire situation, it must be admitted business in iron and steel is below its normal level. The one needed factor, as before said, is railroad building. Of late nearly all our railroad building is on paper. Should capital turn in this direction, nothing could prevent or long check a general rise in values in furnace and mill products. There is activity in the Lake ore regions, and in the coal and coke regions, but the requirements do not permit very remunerative quotations.

The people are thinking more of the Protection sweep they are to make this autumn.

THE costliness of wooden petroleum barrels, which have advanced in the last few years from 1·50 to 4·50 florins in Austria-Hungary, besides requiring repairs after long use, has induced Consul Schwimmer, in Budapest, to erect, under assistance of other capitalists, large works for the manufacture of iron barrels, welded by electricity after the latest process. These barrels will cheapen the price of petroleum, and the usual loss attending the use of wooden barrels is avoided.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

THE attendance at to-day's Birmingham market was of a holiday character, and the business done was of a perfunctory nature, and insufficient to base quotations upon, which it is understood remain unaltered since last week. Most of the works, what with holidays, repairs, stock taking, &c., will not restart till the beginning of next week.

Increased local attention is being paid to phosphorus. When the basic steel process was adopted it was found that the phosphorus in the basic pig could be used as a heat producer in place of the silicon formerly employed with the old Bessemer process, but which, if used in the basic process, rapidly, by its acid action, destroyed the basic lining of the connection. For some time a large quantity of puddled tap cinder was bought up in South Staffordshire by continental ironmasters and shipped from this country for use in their own blast furnaces, the result of which is that phosphoric puddled cinder, which ten years ago could frequently be had almost for the asking, has risen in South Staffordshire to over 5s. per ton, and appears likely to touch as much as 10s. per ton. The effect has been a considerable increase in the cost of the charges for the local makes of basic pig iron. Under these circumstances other methods of obtaining phosphorus have been adopted on the Continent, especially in the Luxemburg and Lorraine districts, such as adding some portion of the basic slag from previous blow to the blast furnace, and ores richer in phosphorus are imported from other countries, to give the phosphorus required in the pig. As much of this ore has to be brought long distances, it is obviously important to keep down the total quantity carried to the lowest possible limit. We have, therefore, the remarkable result that the higher the content of phosphorus which some of these ores contain the better the price the continental ironmaster can afford to pay, so that in some instances ore is actually being purchased and valued at the present time in proportion to its phosphorus contents. Had anyone been bold enough to predict such a state of things some years previously he would have been considered out of his mind; so greatly has the basic process altered our opinions on the subject of phosphorus, which has ceased to be a terror to the steel maker. Some of the ores used on the Continent as an alternative to the employment of Staffordshire tap cinder are imported from long distances—for instance, from Gellivara, in the north of Sweden, where some of the ore is very rich in phosphorus, pig iron having positively been made from it containing as much as 10 to 13 per cent. of phosphorus, with as little as 0·1 per cent. of silicon, which latter, to the Bessemer basic steel maker, is almost the same bugbear that phosphorus was to the old Bessemer acid steel maker.

G. Kynoch and Co., the noted ammunition makers, recommend a dividend of 10 per cent. on the preference and 13 per cent. on the ordinary shares. They have made a profit on the year of more than £29,000, and to this they add a favourable balance brought over from last year of £12,500. They carry £18,400 to next account. The Lion Works at Wilton, and the Rolling Mills at Lodge-road, have been fully employed during the past year; and the directors have wisely taken advantage of this state of prosperity to repair or replace a large proportion of the engines and machinery. The Black Powder Mills at Worsborough Dale have been continuously employed day and night, at remunerative prices. The Arklow Nitro-Explosives Works have been completed, and the output raised to nearly double the contemplated amount. The Government is being supplied to the full extent of its requirements, and orders from the private trade are coming in satisfactorily.

With regard to the boom in cycle engineering, holiday influences have caused a lull in speculation; one or two recent issues of new companies were not, in fact, quite covered, but there is no reason to suppose that company promoters have yet done with the cycle trade, or that we have reached the end of the list of new undertakings due to their enterprise. Several additional ventures are known to be on the stocks, and are only waiting an opportune moment to be launched. It is estimated that during the past two months some twenty-four new companies have been floated—chiefly in the Midlands—with an aggregate capital of nearly £7,500,000, and of this large amount £4,000,000 is absorbed by a single company, the Dunlop Pneumatic. The cycle engineering industry and its tributaries must indeed be in a wonderfully prosperous state to justify this extensive diversion of capital from private pockets, more especially when it is remembered that a large proportion of these issues have come upon the market at high premiums, ranging from ten or twenty to several hundreds per cent.

Light railway engineers have received with much satisfaction the opinions just expressed by Lord Winchilsea at a public meeting held at the Council House, Birmingham, under the auspices of the Warwickshire Chamber of Agriculture and Midland Farmers' Club, for the purpose of considering how home producers may hold their own against foreign competition by organisation and combination. The Earl thinks we require a better system of collecting agricultural produce in rural districts, so that advantage may be taken of the cheap through rates offered by the railway companies; combination in different branches or departments of the industry, with a view to economy and equality of production; and central depôts, from which the produce received in bulk could be economically and advantageously distributed to consumers. Birmingham, owing to its central position, is certainly well fitted to co-operate in such a work, and though its traditions and associations are connected with the hammer and the anvil rather than the plough, there is no reason why it should not give a cordial response to Lord Winchilsea's invitation. The freer use of road locomotives, the introduction of light railways, the use of agricultural forms of mechanical carriage—these are all methods in which the Earl's idea might usefully be carried out, and it need hardly be pointed out that they are methods also which would considerably assist Midland manufacturers. Dairy engineers were also pleased to find on the same occasion in Lord Winchilsea a strong advocate of the factory system of dairy farming which has been adopted with such success in the Colonies and on the Continent, and that is only possible, of course, by organised co-operation on a large scale.

The North Staffordshire Chamber of Commerce in its annual report regrets that no substantial progress has been made regarding railway rates on earthenware, and trusts it will not be necessary to carry the matter to the Railway Commissioners.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—During the past week there has been the customary stoppage of operations throughout the iron, engineering, and coal trades of this district. Most of the principal engineering works have been closed over the whole of the week; and collieries in the immediate neighbourhood of Manchester, which closed about noon on Tuesday, will scarcely get into full operation again until about Wednesday in next week; whilst in other Lancashire districts, even where Whitsuntide is not so fully observed, there have also been more or less general partial stoppages of the pits. For the time being there is consequently very little to report with regard to actual trade operations; but with engineering establishments all through, and most of the iron-using industries well supplied with orders, a healthy position is maintained so far as prospective requirements are concerned, and although for the time being prices for both raw and manufactured iron continue weak for immediate delivery, the outlook generally is regarded hopefully.

Although Tuesday was the only 'Change meeting at Manchester for the iron market, there was but a very thin attendance, and scarcely anything doing to really test prices. For local and district brands of pig iron makers hold to late rates, averaging 46s. 6d., less 2½, for No. 3 foundry Lancashire; 40s. 6d. for forge to 43s. for foundry Lincolnshire; and 45s. 6d. to 46s. for foundry Derbyshire, net cash, delivered Manchester, with, however, low sellers of Lincolnshire in the open market. Outside brands offering here show some irregularity in price, the tendency being, if anything, to harden, but business is scarcely possible except at very low cut figures. Makers scarcely quote under 45s. 10d. to 46s. 4d. for good-named foundry Middlesbrough, delivered Manchester, but through second-hands ordinary brands are obtainable at quite 6d. less, whilst for delivery Manchester Docks about 44s. remains the average figure for good brands. Eglinton ranges from 46s. to 46s. 6d., and Glengarnock is quoted 47s. net prompt cash, delivered Lancashire ports, and 48s. 6d. for Eglinton, to 49s. for Glengarnock, are the average figures for delivery Dock Quays, Manchester.

With regard to finished iron a fairly steady tone is maintained generally. Local makers do not, as a rule, quote under £5 10s. for bars, and North Staffordshire qualities range from £5 10s. to £5 15s., delivered here; but one of the largest Lancashire makers are rather anxious sellers, and this tends to weaken the market. Sheets and hoops are unchanged, averaging £6 17s. 6d. to £7 2s. 6d., and £7 5s. for sheets, according to quality, and £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths of hoops, delivered Manchester district, with 2s. 6d. less for shipment.

In the steel trade there is an active demand for forgings, and also for some descriptions of manufactured goods, and prices generally are very firm at late rates. Makers still hold to 58s., less 2½, for good foundry hematites, although merchants would take 6d. less, with steel billets averaging £4 7s. 6d. net cash. Steel bars are still quoted very low, but are steady at £6 to £6 2s. 6d.; boiler plates also show no appreciable improvement, £6 5s. to £6 7s. 6d. remaining the average figures for delivery in this district.

An improved spoke bending machine, for dealing with the wrought iron spokes of railway carriage and wagon wheels, has just been constructed to special designs by Messrs. Cunliffe and Croom, of the Broughton Ironworks, Manchester. In this machine the power of the gearing and the strength of the machine throughout have been largely increased, as compared with previous machines of the same class, in order that it may be capable of bending and blocking effectually the largest sizes of thickened-back spokes, which are now in so general demand. The machine is driven by an engine attached to it, and a special arrangement is introduced whereby the stopping and starting is controlled by friction cones, which can be instantly put in or out of operation, so that there is no necessity to stop and start the steam engine, whilst this device also removes any risk of breakage. The machine will bend the spokes at the rate of six per minute, and block them to the exact shape required, an automatic attachment being provided for raising the spokes out of the dies after they have been operated upon. The firm has also in hand, besides ordinary work, a large number of machine tools, specially designed for the motors now being introduced for horseless carriages, &c., and also for cycle manufacturing operations.

Messrs. Statham and Sons, Windsor Bridge, Salford, have introduced a new hearth boxing—Moore's patent—constructed of steel or iron, to take the place of the usual brick or trimmer arches, which are frequently very difficult to fix firmly in position. This boxing, which, I understand, is being adopted by many builders and architects, consists of an arched steel plate ⅛in. to $\frac{3}{16}$in. thick, at one end of which is a 1½in. flange and at the other a back-plate containing two screw-holes. In fixing the boxing, the small flange is let into the chimney breast, and the back-plate is bolted to the trimmer joist, after which the space between the floor-line and the plate is filled in with concrete, or any other incombustible material.

In the coal trade there has been some pressure to get in extra supplies, just prior to the holiday stoppages of the pits, but this has fallen chiefly upon the lower class fuels suitable for engine purposes. The better qualities of round coal continue only in slow request. Although there is nominally no quotable change in list rates, prices are very irregular, and even where concessions are made, it is difficult to effect sales. Apart from one or two special qualities 10s. is a full average figure for best Wigan Arley; 8s. to 8s. 6d. for Pemberton 4ft. and seconds Arley; and about 6s. 9d. to 7s. 3d. for common households. Common round coals, for steam and forge purposes, also continue difficult to move, and extremely low in price, 5s. 6d. to 6s. at the pit mouth being about the average figures. The restricted production of slack, owing to the very limited demand upon round coals, is causing rather a scarcity of engine fuel on the market, and the pressure for extra supplies during the past week has given a hardening tendency to prices, but no general advance is being got, and at the pit mouth common ordinary slacks remain at 3s. to 3s. 6d., and best qualities 4s. 6d. to 5s. per ton.

For shipment, business shows no improvement, and prices are quite as low as ever, common steam coal being obtainable, delivered Lancashire ports, at 6s. 9d. to 7s., and delivered free of toll at the Partington tips, Manchester Ship Canal, at 7s. per ton.

Barrow.—The demand for hematite qualities of pig iron is steady, although during the week the amount of business doing has been necessarily limited on account of two or three days having been taken for the holidays. The inquiry, however, is well maintained on home as well as on foreign and continental account, and makers being already well sold forward have a good outlook for the future. There are thirty-nine furnaces in blast as compared with twenty-eight in the corresponding week of last year, and the fact that all the iron produced is going into consumption is shown in the steadiness of stocks, which remain as last week at 308,647 tons, being an increase of 19,472 tons since the beginning of the year. Prices are steady at 49s. for mixed Bessemer Nos., net f.o.b. Warrant iron is at 47s. 4½d. net cash sellers, 47s. 4d. buyers.

Iron ore is in steady request, and average qualities are quoted at 10s., and best descriptions at 12s. 6d. to 14s. 6d. per ton net at mines. These quotations have been steadily held now for some months. Spanish ore is in brisk demand, and is largely imported to local smelters. Prices are quoted at 12s. to 12s. 6d. per ton net at West Coast ports.

The steel trade is brisk, and makers have plenty of orders in hand. Rails are especially busy, and all classes of shipbuilding material are in brisk request. All other branches of the steel trade are busy, with the solitary exception of tin bars, and the trade in these is checked by the action of the American tariff.

Shipbuilders and marine engineers do not report any new orders, but the inquiry for new tonnage in the open market is more pronounced than it has been, and it is evident some large orders will soon be placed with British builders, of which Barrow builders hope to get a fair share. Much interest has been taken this week in the dock steam trials of H.M.S. Powerful, first-class cruiser, which have passed off very satisfactorily.

The coal and coke trades are busy and the demand is maintained all round, and especially so by manufacturers. Prices, however, do not show much improvement or even change, although it is expected there will be an advance in the price of coke now that more furnaces are going into blast.

Shipments of pig iron from West Coast ports during last week reached 2510 tons, and of steel 12,551 tons, as compared with 6080 tons of pig iron and 13,013 tons of steel in the corresponding week of last year, a decrease of 3570 tons of pig iron and 462 tons of steel. The aggregate shipments this year to date have reached 123,205 tons of pig iron and 189,751 tons of steel, as compared with 105,622 tons of pig iron and 144,569 tons of steel in the corresponding period of last year, an increase of 17,583 tons of pig iron and 45,182 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THIS has largely been a holiday week. The exceptionally fine weather on Whitsun-Monday caused an enormous exodus from all the working districts. In the larger establishments where work is pressing the holidays have been limited to the half of the week, but no great volume of work will be turned out. Whitsuntide and Christmas are the two seasons when advantage is offered for repairs to machinery and alterations. These are being vigorously proceeded with while this is written, and the boiler makers and repairers are excessively busy in work of this kind.

Very little change has taken place in the house and other departments of the coal industry of late, nor is there the slightest likelihood of much alteration at present. Four to five days a week have formed the maximum of weekly employment, and even with this restricted labour the output still continues considerably in advance of the demand. Reports from agents in the metropolis show that the competition is largely in favour of seaborne fuel, on account of the rates of carriage being so much less. The decision of London merchants to declare lowest summer prices from June 1st may have the effect of causing consumers to lay in stocks. A very poor tonnage is being sent to London, both of Silkstone and Barnsley house coal, and a similar remark applies to the Eastern Counties. No improvement has taken place in the values of house coal, and considering the number of new collieries being opened out, it is difficult to see when an advance will take place. One interesting item has been the placing of Midland Railway Company's contracts for the supply of hard steam coal for the next twelve months. Tenders have been accepted at 7s. per ton from Barnsley, and 6s. 3d. from the Parkgate bed. These quotations are on the basis of existing contracts, and quite equal to the prices quoted in the open market.

Quotations in the Barnsley district range as follows:—Silkstone coal, 8s. to 8s. 3d. per ton for the best; 7s. to 7s. 6d. for secondary qualities; Barnsley house coal makes 7s. to 7s. 6d. per ton, while thin seam coal can be bought at 6s. to 6s. 3d. per ton at the pits. Gas coal is again in poor demand, and there is very little business doing outside contracts. Prices range from 7s to 7s. 3d., whilst 6s. to 6s. 3d. is all that can be obtained for Parkgate and similar thin seam qualities. A large tonnage of the best South Yorkshire "hards" is going to Hull to be shipped to Sweden, Norway, North Russia, and Germany. Yorkshire trade with Grimsby is on the mend, notwithstanding the keen competition of Derbyshire coal. Only a moderate business is being transacted by South Yorkshire pits with Goole, the bulk of the trade being done by the West Yorkshire collieries. Railway companies have drawn a large quantity of coal under contracts owing to increased traffic caused by the Whitsuntide holidays. An advance in the demand for coke has materially assisted the consumption of small coal and slack, and prices have slightly increased. Best screened slack is making from 3s. 3d. to 3s. 6d.; ordinary pit slack, 2s. 6d. to 2s. 9d. per ton; smudge is easily sold at 1s. 6d. to 2s. per ton. An average tonnage has been sent to the manufacturing districts. Coke is in good demand. A large tonnage is being sent to North Lincolnshire, Derbyshire, and other places. Prices range from 8s. 6d. to 11s., and in a few instances 12s. is obtained for best washed coke.

The heavy industries continue to be fully employed. All the large works are full of employment. Some good orders for railway material have recently come in from India and the Argentine Republic. State carriages for the Royal Railway Department, Siam, are being completed. The marine departments are very much busier on account of an expansion of the shipbuilding industry. One of the most encouraging features of the trade is the steadiness of the values of iron and the finished material. Pig iron has been steady for three months now. Bessemer billets realise £5 12s. 6d. to £6; Lincolnshire forge iron, 39s. to 40s.; ditto foundry, 41s. to 42s.; bar iron, £5 10s.; hematites as quoted last week.

The dispute in the file trade has now been brought to a conclusion, for a period of six months at least. The masters have plenty of orders in hand, but what they are complaining about is the lowness of prices. Now-a-days, from 50 to 67½ per cent. discount is allowed out of Sheffield, according to the size of the files and the quality of steel used. In the opinion of the men the employers ought to knock 2½ per cent. off the discounts, and in this manner compensate themselves for the advance in wages. The masters look at it this way. There are a number of manufacturers who are not members of the union, and those who are in the association must consider before raising their prices, while their rivals continue to allow the old discounts. Efforts having failed to secure uniformity of action in the way of improving prices, there is no doubt that more machinery for producing files will be put down, and the number of file workers gradually decreased.

The cutlery trade is in a fairly active condition. The home demand for table cutlery of the best and medium sorts is well up to the average. Many houses are able to find their men full employment. There is an excellent call for pocket and table cutlery from the continental and colonial markets. Very little business is being transacted with America. A few lines have come in this week, but they are very trifling. This is generally the time of the year when the American business is in full swing; but the fact is being steadily forced upon local houses that the United States market is less and less to be relied upon. In the higher grades of goods, one or two houses can command important work from customers with whom price is no object. In the secondary classes, however, where the lines are the heaviest, the English makers are completely underquoted by the American and German makers.

The Manchester, Sheffield, and Lincolnshire Railway Company is making some extensive alterations to its Victoria Station at Sheffield, in view of the completion of the London extension. The citizens have complained for a long time of the need of another entrance to this station. Some time ago a deputation waited on the directors, and received assurances that the station would be enlarged and improved before long. The management have now decided to make a new entrance in Sussex-street. There will be an inclined way from the street, up to which vehicles may drive. A double subway is to be built—one division for passengers and the other for luggage, connected with the platforms by flights of steps and hoists for the luggage. Access to the new approach from the north-east will be easy, but the intervention of the river Don between Sussex-street and the Wicker will be very awkward for citizens who live on the north-west side. It is proposed to build a bridge over the Don, and several other alterations will have to be made before the new approach can be fully used. The internal improvements at the station include the provision of a new platform, a new line for passenger traffic, and the extension of the existing bays. The aggregate result will be that the platform area will be increased from 3980 square yards to 7598 square yards. The cost of the enlargement will be about £65,000, without taking into account the value of property and interests which will be absorbed by the scheme.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE Whitsuntide holidays have curtailed business a good deal this week, and nearly all the works, except those producing pig iron, have been idle for one and, in many cases, two days. Though there is still plenty of work on the books of manufacturers, it does not seem to be pressing, and the men, having done well of late, have been ready enough to take the holiday. The tone of the market is satisfactory, and a more active demand is reported by producers in most branches. The situation is more encouraging, and producers and consumers are both more disposed to operate now that labour difficulties have apparently been settled for some time to come. The adjustment of the engineers' dispute has cleared the way, and the market quickly responded when the settlement was announced.

The employers in the engineering industry have been very generous in their treatment of their workmen. Having agreed with the Engineers' Society to abide by the literal wording of their arrangement with the men as to the advance to be given in September, and to pay all the lower class men the same rate of advance as the higher paid men, giving all alike 1s. advance whatever the standard wage, the employers have decided to grant the same privilege to the lower classes of other societies and to non-unionists, giving them 1s. instead of the 6d. heretofore agreed upon. It is stated that while the extra 6d. per week, for which the Amalgamated Society of Engineers contended on behalf of their less skilled men, would not have exceeded £4 per week, taking the whole of the North-east Coast, the present action will involve them in a large extra expenditure; but they felt they were not doing justice to give extra wages to the members of the Engineers' Society, and leave out others occupying a similar status, although these latter were pledged to accept 6d. in September, with the understanding that there should be no further change of wages before March, 1897.

The pig iron trade is somewhat stronger than it has hitherto been this month, and neither sellers nor buyers are so reluctant as they were to enter into contracts. Usually towards the end of the month weak speculators offer cheap lots of iron which they are forced to sell, and this eases the prices, but this month there is little of that, and the tendency of prices is rather towards firmness. As exports of pig iron have not been so brisk this month as they were last month, and local consumption has been reduced by the holidays, it is believed that the consumption for May will barely exceed the production, and there is a probability that there may be an increase in stocks. It would strengthen the position of makers considerably if they blew out three or four furnaces, and especially those producing hematite pig iron. There is a belief that the output of hematite pig iron is much in excess of the requirements, but this cannot be verified, as no record of stock of hematite pig is issued, or even collected. It would be well if the hematite pig iron makers could follow the example of those producing Cleveland iron, and have included in the monthly statistics the stock held of hematite pig. A step towards this has been attained, for Connal's make known what quantity of hematite iron they have in stock. The large make prevents producers from securing the prices they might obtain with a smaller output. Besides this it keeps up their cost of production, as it enables the coke manufacturers to maintain their high prices. Coke is now relatively dearer than pig iron; formerly the Cleveland ironmaster had to pay out for fuel one-third of the price he realised for his pig iron; now the proportion is greater, for while he has to give 13s. 9d. per ton for the coke delivered at his furnaces, he can only get 37s. 6d. for his No. 3 pig iron.

This week the general quotation for No. 3 Cleveland pig iron has been 37s. 6d. per ton for prompt f.o.b. delivery, and in many cases this would also be accepted for June deliveries. Some of the makers are also getting 38s. for next month. Cleveland warrants, which at the end of last week were quoted at 37s. 9d. cash by holders, and which buyers would purchase at 37s. 8d. cash, could on Tuesday be bought at 37s. 4½d., and Wednesday's closing price was at 37s. 2d. The stock of Cleveland pig iron held by Messrs. Connal and Co., on Wednesday night was 198,124 tons, or 4368 tons increase this month. No. 1 Cleveland pig iron has been bought more freely this month, but nevertheless compared with No. 3 it is at a low price. It was 2s. 6d. per ton dearer than No. 3, now not more than 1s. 3d. parts them, and continental consumers, who used to be the chief buyers of it, take comparatively little now, as they find that No. 3 answers their requirements equally as well. No. 4 foundry pig iron is at 36s. 9d., grey forge at 36s. 3d., and white at 36s. M. Nos. of Cleveland hematite pig iron are to be bought at 45s. 9d. per ton for early delivery, though the leading makers hold out for 46s. This is a good deal more than the nominal price of Cleveland hematite warrants, but no one seems to care to buy the latter, as a purchaser does not know what brands he may get, and he prefers to have a known brand, the analysis of which is guaranteed to him.

The finished iron mills and forges are fairly well off for work, but almost all were idle on Monday and Tuesday. Just now the demand is generally slack, but on the whole prospects are more favourable than they were, now that the engineers' strikes are over, and trade is likely to be less uncertain. The shareholders of the Darlington Steel and Iron Company, whose works have been idle since October, 1894, and who formerly were occupied chiefly in producing steel rails, hold their annual meeting this week, and are called upon to discuss whether the works are to be reopened or the company is to be wound up. The directors have consulted Mr. Kean, who was formerly engineer to the company, and he states that before the works could be restarted at least £27,905 would have to be spent upon extensions and improvements. A new cogging mill would be needed with engine, live roller gear, &c.; a new 12in. mill for fish-plates; new engine for 15in. mill; new boilers over furnaces, to utilise the waste heat; new cold sawing machine, &c. The directors think that to provide for contingencies, £30,000 should be taken for these improvements, &c. Then £11,000 should be found for working capital, and £14,000 to pay off the mortgage on the works; altogether, £55,000 would have to be provided by the shareholders to reopen the works. If the shareholders decide on the realisation of all the company's assets, it is estimated that the cash investments, movable stocks, and debts, would be sufficient to pay off all the liabilities of the company, leaving the proceeds of the land, buildings, fixed plant, and machinery, together with the tap cinder still lying in the ground available for distribution among the shareholders.

The statistics supplied by Mr. Waterhouse to the Board of Conciliation and Arbitration for the Manufactured Iron and Steel Trades of the North of England, showing the deliveries and average realised prices of finished iron in the district during March and April, are not satisfactory, seeing that a decrease in the realised price is reported where an increase was expected, as quoted prices were higher than in the previous two months. It is evident from the returns that the improvement has benefited the manufacturers in giving them more work but not any better prices; in fact, they have generally not got the higher prices which they asked, and especially is this the case with bars, which form 46 per cent. of the production. The net average realised price for all kinds of manufactured iron was £4 16s. 0·21d. per ton, this being 7·68d. per ton below the previous return, and 2·48d. below the figure for the last two months of last year. The wages at the mills and forges in the North of England will therefore remain unaltered for June and July. Iron rails, which form about 2 per cent. of the production, declined 9·46d. in value; and bars fell 1s. 6·65d., which is rather surprising. Angles went up 2·12d., and plates 0·19d. The deliveries, however, were better by 20 per cent. than in the previous two months, and this notwithstanding that the Easter holidays occurred in the last two months. The following is the official return for the two months:—

Description.	Weight invoiced.				Percentage of total.	Average net selling price per ton.		
	tons	cwt.	qr.	lb.		£	s.	d.
Rails..	533	17	3	9	2·18	4	8	6·47
Plates	9,492	2	1	20	38·72	4	13	7·18
Bars	11,347	7	1	14	46·29	4	18	10 74
Angles	3,140	15	2	22	12·81	4	14	2·39
	24,514	3	1	9	100 00	4	16	0 21

Considerable activity is reported in the demand for castings, and ironfounders and engineers are as a rule doing well as regards the number of orders they secure, but they have not been able to raise prices materially as yet. It is reported that Messrs. Head, Wrightson, and Co., Teesdale Iron and Engineering Works, Thornaby-on-Tees, have found that with their present plant they are not able to overtake their orders, and they have therefore leased the Eaglescliffe Foundry, near Stockton, which was established by Messrs. Smith and Stoker, but has been idle for several years.

The coal trade is comparatively quiet in all branches, partly because of the holidays, but in addition the rush of demand from the Continent for steam coal has subsided, and some firms will sell best Northumberland steam coal at 8s. per ton f.o.b., whereas 8s. 3d. was the regular price last week. Best Durham gas coals are at 6s. 6d. per ton f.o.b. The supply of coke is no longer short of the requirements, and 14s. per ton delivered at Middlesbrough furnaces can no longer be got, except for the "tip-top" qualities; the regular price being 13s. 9d. Nearly every available coke oven in Durham is at work.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE pig iron market was closed on Monday as well as several days last week, and since its re-opening the tone has been weak, with a considerable quantity of iron being offered, the result being that prices have receded. It is usual after a holiday that the market prices up, and the fact that it has not done so on this occasion is regarded as evidence that consumers had already secured pretty large supplies, and are not very apprehensive of a rise in prices. Business has been done in Scotch warrants from 46s. 11d. to 46s. 5d. cash, and 47s. 0½d. to 46s. 7½d. one month. The transactions in Cleveland iron were for the most part for future delivery, and the prices have been from 37s. 10d. to 37s. 6d. one month. Hematite iron has been quiet and easier in the open market. Cumberland warrants have varied from 47s. 8½d. to 47s. 4d. cash, and 47s. 11d. to 47s. 6d. for one month.

The output of Scotch pig iron is well maintained. There are 40 furnaces producing ordinary, 38 hematite, and 3 basic iron, the total of 81 comparing with 82 in the preceding week, and 76 at this time last year. The consumption of Scotch-made hematite pigs is greater than at any former time, notwithstanding that the imports of English iron of this district are much larger than the average. In order to provide for an increased continuous supply of hematite ore, some large contracts have been entered into with merchants in the Spanish trade, while ironmasters who have mines of their own in Spain are chartering considerable numbers of steamers to bring ore into the Clyde. The present rate of freight is about 5s. 4½d. per ton.

Since last week there has been comparatively little change in stocks of pig. They have not been increasing, it is thought, to any appreciable extent. Indeed, the pig iron in Glasgow warrant stores show a slight decrease compared with the preceding week.

The prices of Scotch makers' pig iron are as follows:—Govan, Monkland, and Carnbroe, Nos. 1, 47s. 6d.; Nos. 3, 46s.; Clyde, No. 1, 50s.; No. 3, 47s.; Gartsherrie, Calder, and Summerlee, Nos. 1, 50s. 6d.; Nos. 3, 48s.; Coltness, No. 1, 53s.; No. 3, 48s. 6d.; Glengarnock at Ardrossan, No. 1, 50s.; No. 3, 45s. 6d.; Eglinton, No. 1, 47s.; No. 3, 45s.; Dalmellington at Ayr, No. 1, 46s. 6d.; No. 3, 44s. 6d.; Shotts at Leith, No. 1, 52s.; No. 3, 48s. 6d.; Carron at Grangemouth, No. 1, 52s. 6d.; No. 3, 48s. 6d.

The shipments of pig iron from Scottish ports in the past week amounted to 5023 tons, against 4712 in the corresponding week of last year. There was despatched to Germany 600 tons, United States 220, South America 375, India 122, Australia 111, France 25, Italy 190, Belgium 980, Spain and Portugal 70, China and Japan 100, other countries 25, the coastwise shipments being 2205 tons, compared with 1902 in the same week of last year.

The finished iron department is well employed, and prices are fairly steady. In the steel trade there is a continuance of the great activity so frequently noticed already. The locomotive engineers are full of work, having contracts on hand that will keep them going for a long time to come. Numerous other branches, among them being the cycle industry, which is exceptionally active, are now experiencing a period of improved trade.

There is little change in the position of the coal trade, but such as there is appears to be in a favourable direction. The coal shipments at the Scottish ports amount to 167,647 tons for the week, against 153,733 in the preceding week, and 146,288 in the corresponding week of last year. There is a fairly good market for household coals of the better qualities, and furnace coals and dross are in good request, but the supply is still more than equal to all requirements. Main coal is quoted f.o.b. at Glasgow 5s. 9d.; splint, 6s. 3d. to 6s. 6d.; ell, 6s. 3d. to 6s. 9d.; steam, 7s. 6d. per ton.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

A GOOD bulk of work was done in the coal trade in the week previous to the holidays, but since then the usual Whitsuntide slackness at docks and on the Exchange has been very perceptible. Even by mid-week the attendance was of a very lukewarm character, and the week promises to be of the old type—little work, with a good deal of holiday and excursion character about it.

As indicating the pressure of last week, I may note that Cardiff coal exports totalled the high figures of 355,000 tons, or 26,000 tons more than the total of the previous week. Newport total was 68,339 tons coastwise and foreign, and Swansea 35,971 tons. The total dock business at Swansea exceeded that of the previous week by 20,000 tons. The Swansea coal shipments included 12,625 tons to France, 1570 tons to Germany, 2500 tons to Cape Town, 2710 tons to Portland (O.), 4000 tons to San Francisco, and 1050 tons to Australia. The item to Germany is somewhat of a comment upon recent suggestions that Germany contemplates flooding the London market with Westphalian coals. In Welsh coal circles it is contended that, even if the German collier works at 40 per cent. less wages than the Welsh collier, there is no fear of successful competition with Wales so long as the Welsh labour market is tranquil. With pits closed in Wales will come the German opportunity.

The colliery questions of the Aberdare, Hirwain, and Merthyr districts are taking more hopeful form. Bwllfa has acquired the Nantmelin Colliery, and will work it in conjunction with that of Pwll Alse. As regards Aberdare—Merthyr, at Hirwain, this is a trifold royalty, the Bute, Crawshay, and Gwyn Holford. It is thought that this may be acquired and worked by the Bute. The Plymouth Colliery question has now been before the arbitrator, and is progressing satisfactorily.

Mid-week's quotations, Cardiff Exchange, showed little or no change; and the business done was only formal. Prices remain much about the same: Best steam, 10s. 3d. to 10s. 6d.; best seconds, 9s. 9d. to 10s.; ordinary seconds, 9s. 3d. to 9s. 6d.; dry, 8s. 7½d. to 8s. 10½d.; best Monmouthshire, 8s. 3d. to 8s. 6d., seconds, 7s. 9d. to 8s., shipment at Cardiff, but when shipped at Newport, Mon., 3d. per ton less. Best small steam, 4s. 9d.; next best, 4s. 3d. to 4s. 6d.; seconds, 4s.; drys, from 3s. 6d. House coal is, as usual, quiet. Prices:—9s. 6d. to 10s.; No. 3 Rhondda, 9s. 6d. to 9s. 7½d.; brush, 7s. 9d. to 8s.; small, 6s. 3d. to 6s. 6d.; No. 2, Rhondda, 7s. 3d. to 7s. 9d.; through, 6s. to 6s. 3d.; small, 4s. 3d. to 4s. 6d.

Swansea prices:—Best anthracite, 11s. to 11s. 6d.; second quality, 9s. to 10s.; ordinary large, according to quality and selection, 8s. to 8s. 9d.; small supply culm, 4s. to 4s. 6d. Steam coals, 9s. to 10s.; seconds, 8s. 3d. to 9s.; bunkers, 7s. to 9s.; small, 4s. 3d. to 4s. 6d., f.o.b. Swansea, cash thirty days, less 2½. Bituminous coals, No. 3 Rhondda, 9s. 6d. to 10s.; No. 2 Rhondda, from 8s. 6d.

Coke not only maintains past quotations, but makers are adding a few pence more per ton. Last prices are furnace, 13s. to 14s. 9d.; foundry, 15s. 6d. to 16s. 9d.; special foundry, 19s. 6d., Cardiff. Increased vitality is showing itself in the pitwood trade, and quotations are firm at 16s. to 16s. 3d. Patent fuel, 9s. 9d. to 10s. 3d.; moderate demand, Cardiff and Swansea.

At Briton Ferry Cambrian coke is reported in great demand.

As might be anticipated, there is very little moving in the freight market. At Cardiff, mid-week, the only outward fixtures negotiated were two for Genoa at 6s. 6d. clean, and a homeward fixture from Bilbao to Newport, Mon., at 4s. 7½d.

The revival of the steel rail trade at Cyfarthfa is progressing, one of the first orders being for a rail with wide flange, similar to the rail used on the Rhymney Railway, which requires no sleepers. This is a very difficult article to turn out, compared with the bull-headed pattern, but the Cyfarthfa Company, having attained the front rank in steel, is not likely to raise any objection to the form it takes.

The rail clearances of the past week and the early part of this include 800 tons for Santos from Cardiff, and 500 tons for Freemantle from Swansea.

The principal demand is for steel rails, bars, and small goods, and Swansea works are reported full of orders. I am also glad to note that generally there is better demand for steel bar.

The report from the tin-plate works last week showed an increased make of tin-plate. About half the mills are at work, and makers say that if more are started the result will be depression again, as cost is not even now covered by price. I give the iron and steel and tin-plate quotations ruling at Swansea this week.

Glasgow pig, 46s. 8d.; Middlesbrough, 37s. 6d.; hematite, 45s. 5d.; Welsh bars, £5 10s. to £5 12s. 6d.; iron plates, £6 to £6 17s. 6d. at works. Steel plates, £6 to £6 7s. 6d.; steel rails, £4 10s. to £4 12s. 6d. for heavy; light rails, £5 to £5 10s.; Bessemer steel bars, £3 17s. 6d.; Siemens, £3 18s. Tin-plates, Bessemer coke, 9s. 3d. to 9s. 4½d.; Siemens, 9s. 6d. to 10s.; ternes, 16s. 6d. to 21s. 6d.; best charcoal, 12s. 9d. to 13s.; block tin, £60 7s. 6d. to £60 10s.

Tin-plate still keeps to the front in a large part of the district, and discussions abound as to the ways and means for improving the trade. The advice of Mr. Stanley to "drum up orders in Africa" was simply a re-echo of the capital idea and effort made by the Associated Tin-plate Owners some time ago to find new markets. That failed from a lack of unanimity between makers, and, in some parts, from a dislike to sink money on the artesian well plan, "letting water down to get water up." It is feared that merchants having business centres in Africa would oppose the action of tin-plate manufacturers to find trade themselves—so runs present opinion. In the meanwhile, the trade has not so gloomy an appearance in some districts. Good reports come from Briton Ferry.

An alternative water scheme, which promises most satisfactory results, has been submitted to the Council, Newport, Mon., and a resolution that it should be reported upon was carried. The long drought is beginning to cause a good deal of concern, and pumping back into the Merthyr reservoir is in daily operation. The mountain rivers in many parts of Wales are simply rocky beds. The Wye in many places is drier than I have known it. The Usk river, Brecon, is moderately full. The Taff between Merthyr and Cardiff is only an excuse for a river. Considering that great quantities of water are in the deep coal pits, a systematic pumping in aid of sanitation by keeping a good body of water in the rivers is recommended.

Iron ore has been coming in at a great rate this week, arousing an impression at docks and on lines of route that a boom was on in iron and steel. This is not so, but prospects are more assuring. On Tuesday the imports at Newport from Bilbao included 1900 tons ore for Ebbw Vale and 1800 tons for Blaenavon. The same day Cyfarthfa received three cargoes from Bilbao, Almeria, and Seville, and Dowlais Company three from Bilbao.

One of the principal events of the week has been the announcement that the Bute Docks Company invite subscriptions for £500,000 4 per cent. Preferred Ordinary Stock, this amount being required for making the new dock now in course of construction. The announcement is regarded with peculiar satisfaction, as it is the first time the public have been invited to take shares in the undertaking, the public subscriptions hitherto invited having been confined to the debenture issue. The subscription is fixed at £110 per £100.

Mr. Phillips, M.E., of Pretoria, an old pupil of Sir W. T. Lewis, Bart., died lately.

The Great Western Railway Company has deposited a petition, praying to be heard against the Llanelly Harbour Bill when it comes before the Select Committee.

It is likely that Mr. Clarke, present assistant-secretary Taff Vale, will be the permanent secretary, vice Mr. J. Jones deceased.

Some interesting figures are recorded of Newport trade in '95:—6904 steamers and ships cleared. Only ninety of these were foreign vessels. Their united tonnage was 1,298,085. Italy was Newport's best customer, France second, Spain third.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

ACTIVITY continues to increase on the continental iron markets. Since last week no material changes have taken place with regard to prices, which are as a rule tending upwards.

The iron trade in Silesia is in a most satisfactory condition, and promises to be even more active in a few weeks. All round the outlook is bright, and an exceedingly firm tone prevails in the various departments; the volume of business is gradually swelling, and the mills and forges are all full of work.

On the Austro-Hungarian iron market only a moderate weight of new business is reported to have come forward during the past week, but makers, having their order books pretty well filled, hold firmly to their prices. Only foundry pig has of late been a trifle weak in demand, and quotations were fluctuating. For plates, and also for various articles of finished iron, a regular, healthy inquiry has been experiened.

Satisfaction is universally expressed with regard to the present state of the French iron industry, most of the establishments being as full of work as they can well be. Makers have resolved to desist from a further rise in prices for the present, bars standing on 145f. p.t., and girders on 155f. to 160f. p.t. There is talk of several new conventions that are about to be formed; one will be a syndicate of the tube mills. French import in coal during the first quarter of 1896 was 2,163,490 t., against 2,205,470 t. for the same period the year before, 1,182,620 t. coming from England, against 1,095,650 t. in 1895; 824,510 t. from Belgium, against 998,750 t.; 155,210 t. from Germany, against 109,440 t.; while imports from other countries amounted to 1150 t., against 1630 t. in 1895. Imports in coke were 334,830 t., against 359,390 t.; 126,330 t. came from Belgium, against 105,040 t.; 206,020 t. from Germany, against 247,310 t., and 2480 t. were imported from different countries, against 7010 t. in 1895. Exports in coal were 212,280 t., against 185,130 t. in the year before; of these 104,690 t. were sent to Belgium, against 97,980 t.; 61,030 t. went to Switzerland, against 49,800 t.; 3460 t. were exported to Italy, against 3690 t.; 3208 t. to Algiers, against 210 t.; 820 t. to Turkey, against 2670 t., and 38,810 t. to other countries, against 28,880 t. in the same quarter last year. French export in coke amounted to 14,340 t., against 31,810 t. in 1895.

Reports from the Belgian iron market are such as to create a favourable impression with regard to the future condition of the iron and steel industries. Especially the business that is done on home account must be considered as good. Export trade is less satisfactory, although an improvement in demand has certainly taken place; but makers find it exceedingly difficult to sell their articles at the official rates. Prices in April were, for foundry pig No. 3, 53f. p.t.; forge pig, 49f. to 50f. p.t.; bars, No. 2 f.B.t., stood on 137·50f. p.t. on May 1st, against 132·50f. on April 1st; No. 3 fetches 142·50f. p.t., against 137·50f. p.t.; girders No. 2, for home demand, rose from 130f. p.t. on 135f. p.t.; angles, from 137·50f. p.t. on 145f. p.t.; plates No. 4, for export, advanced from 180f. on 185f. p.t.; No. 2, for inland demand, rose from 145f. p.t. on 147·50f p.t.; No. 3, from 155f. on 157·50f. p.t.; steel plates rose from 155f. on 157f. p.t. Sheets advanced from 165f. on 167·50f. p.t. For export steel plates are now quoted 150f. p.t., against 145 in the beginning of April. The number of blast furnaces in Belgium has considerably increased in April. On May 1st there were thirty-one furnaces in blow, out of forty-two built, eleven producing forge pig, four foundry pig, and sixteen basic. Output of pig iron in Belgium was for April of present year, and during the first four months of 1896 and 1895, as under:—

	April.		January 1st till May 1st.	
	1896.	1895.	1896.	1895.
	Tons.	Tons.	Tons.	Tons.
Forge pig ..	25,350	38,595	101,145	148,395
Foundry pig	6,900	8,990	28,225	35,090
Basic	34,500	33,790	139,150	120,690
Total ..	66,750	81,375	268,520	304,175

The Belgian coal market has not in any way changed since previous reports, nor is there likely to be an improvement in the immediate future, prices being firm at date; but there are only very few contracts offering. Engine classes of fuel are specially languid. Best steam coal is sold at 10f. to 11·25f. p.t.; dry kinds, 6·75f. p.t.; seconds, 8f. to 9f. p.t. Here and there inquiries for house coal have already been coming in for next winter, and stocks are very low, chiefly on account of the cool weather that has prevailed in March and April. Last year's prices are, almost without questioning, accepted for next season, the different sorts of house coal standing on 12f., 15f., 18f., and 22f. p.t.

A steady demand is experienced for coke, prices for next quarter having been fixed on 15f. p.t., and for the remainder of the year 16f. p.t. will be asked. However, producers will have to wait till the beginning or end of next month ere they can ascertain whether these prices can be accepted.

With regard to Belgian business in coal and coke during the first quarter of the present year, there were 401,711 t. coal imported, against 334,261 t. in the year before; 228,499 t. coming from Germany, against 158,622 t. in the previous year. In coke, 51,079 t. were imported, against 92,545 t. last year; 47,142 t. coming from Germany, against 91,055 t. during the corresponding period last year. Export in coal amounted to 1,009,112 t., against 1,196,127 t. Of these 49,410 t. were sent to Germany, against 71,305 t.; to France 759,146 t. were exported, against 938,766 t. during the same period the year before. Export in coke was 205,941 t., against 221,229 t., of which 23,720 t. were sent to Germany, against 38,841 t., while to France 122,367 t. were exported, against 94,754 t. for the corresponding period last year.

There is no abatement of activity in the producing and manufacturing branches of the Rhenish-Westphalian iron and steel industry. A comparatively large amount of new work has been offering, and prices have gained in firmness, but are officially the same as during former weeks. Iron ore continues strongly inquired for, especially the Siegerland sorts are brisk of sale, while the demand for Nassau iron ore has been just a trifle less active than formerly. Quotations are, for spathose iron ore, M. 9 to 9·60 p.t.; roasted ditto, M. 12 to 13 p.t.; calcined iron ore, M. 12 to 14 p.t. at mines. Nassau red iron ore, 50 per cent. contents, M. 9·70 p.t., free Dollenburg. Luxemburg and Lorraine minette has of late been a trifle more weak in quotations; as a rule M. 2·40, 2·70, and 3·20 p.t. is asked, At the blast furnace works a good activity continues, and prices are satisfactory on the whole. Spiegeleisen, 10 to 12 per cent. grade, is offering at M. 59 p.t.; forge pig, No. 1, M. 53 to 55 p.t.; No. 3, M. 42 p.t.; hematite, M. 65 p.t.; foundry pig, N. 1, M. 65 p.t.; No. 3, 57 p.t.; basic, M. 56 p.t. at works; Bessemer, M. 60 p.t.; iron for steel making, M. 54 to 56 p.t. at works. Luxemburg foundry is quoted 56f. p.t., free Luxemburg. Output of pig iron in the Saar district was, for April and during the first four months of present year, as under:—

April.		January 1st till May 1st.	
1896.	1895.	1896.	1895.
99,836 t.	93,878 t.	395,987 t.	367,529 t.

In the manufactured iron industry trade continues in the satisfactory condition previously reported. Bars are actively called for, and so are girders, quotations showing much firmness. Plates of all descriptions are also readily consumed, and the employment of the sheet mills is improving from week to week. The condition of the wire trade is unmistakeably better than it was a month ago, and if prices do not rise, they are, at least, exceedingly firm. Foundries, machine, and wagon factories are all in good occupations.

Present list prices, per ton at works, are as follows:—Good merchant bars, M. 120; angles, M. 130; girders, M. 94 to 97; hoops, M. 120 to 125; billets in basic and Bessemer, M. 85 to 86; heavy plates, for boiler-making purposes, M. 160 to 165; tank plates, M. 135 to 140; steel plates, M. 145; tank plates, M. 120 to 125; sheets, M. 155 to 160; iron wire rods, common quality, M. 125 to 130; drawn wire in iron or steel, M. 118 to 138; wire nails, M. 127 to 130; rivet iron, M. 138; rivets, M. 180; complete sets of wheels and axles, M. 280 to 290; axles, M. 220; steel tires, M. 200; steel rails, M. 118; steel sleepers, M. 110; fish-plates, M. 120 to 130; light section rails, M. 100.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

THE shipments of steam coal for the past week were fully up to the average, and the present demand is good, with quotations unchanged. The house coal trade is good for this season of the year. Tin-plates without alteration in prices or demand. The iron and steel works continue well employed.

Coal: Best steam, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s.; house coal, best, 9s. 9d. to 10s.; dock screenings, 5s.; colliery small, 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 46s. 5d.; hematite warrants, 47s. 3d. f.o.b. Cumberland; Middlesbrough No. 3, 37s. 2d. prompt; Middlesbrough hematite, 44s. 10d. Iron ore: Rubio, 12s.; Tafna, 11s. 3d. Steel: Rails, heavy sections, £4 12s. 6d.; light ditto, £5 f.o.b.; Bessemer steel tin-plate bars, £4; Siemens tin-plate bars, best, £4 2s. 6d.; all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel, coke, 9s. to 9s. 3d.; Siemens, coke finish, 9s. 3d. to 9s. 6d.; ternes, per double box, 28 by 20 C, 18s. 6d. to 20s. Pitwood: 15s. 9d. to 16s. London Exchange Telegram: Copper, £47 8s. 9d.; Straits tin, £60 10s. Freights firm.

KING'S COLLEGE ENGINEERING SOCIETY.—At a general meeting, with the president in the chair, Mr. Simpson read a paper on "The Blackwall Tunnel." The author pointed out the various causes which culminated in "the origin of the scheme." He then went on to describe the shafts sunk, enumerating them, and the different strata encountered in sinking them. The difficulties met with due to loose sandy and water bearing strata, especially in shafts 3 and 2, and the methods resorted to in order to overcome such difficulties, were all clearly explained. The next prominent feature dealt with was the shield, which, with hydraulic fittings, use, strength, method of working, and pressure required in this case to work it, formed an exceedingly instructive part of the paper. The way in which the shield was got on the scene of action at the foot of the shaft—by filling the shaft with water and floating shield down by pumping out the water; the costly and fatal accident to the cutting edge of the shield and the manner in which this was repaired, were all well explained. The author then considered the manner in which the external face of the cast iron segments of the arch were cased with cement—by grouting, the pneumatic arrangement for forcing the grout behind being illustrated by a diagram. The part worked under compressed air, the air locks, and arrangements for preserving the workmen in case of the heading flooding, were thoroughly and clearly dealt with. Messrs. Fletcher, Standen, Strutt, Mowat, and Bailey joined in the discussion which followed. The meeting terminated with a vote of thanks to Mr. Simpson for his exceedingly interesting paper.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

12th May, 1896.

10,136. Paper Toys, E. T. Gibson, London.
10,137. Boxes for Cigarettes, G. Gould, London.
10,138. Valves for Water Cisterns, A. J. Boult.—(*F. Wangelin, Germany.*)
10,139. Flushing Apparatus, A. J. Boult.—(*F. Wangelin, Germany.*)
10,140. Cycle Supports, T. E. Liddiard, London.
10,141. Self-propelled Vehicles, E. P. L. Mors, London.
10,142. Cycles, J. M. Gilbert, London.
10,143. Locks, G. C. Bateman, London.
10,144. Safety Envelopes, R. Schaellibaum, London.
10,145. Folding Frames for Cycles, F. A. Reynolds, London.
10,146. Foot Rests, R. D. Brown, London.
10,147. Advertising Desks, J. Garretson, T. Eyck, and D. I. Garretson, London.
10,148. Bottles, C. P. Behrens, London.
10,149. Brakes for Tramway Cars, J. B. Payne, London.
10,150. Machines for Cleaning Windows, C. Kinkel, London.
10,151. Pointers for Interest Tables, C. E. Locke, London.
10,152. Music Holders and Turners, F. M. Stacy, London.
10,153. Station Indicators, F. Johnson, London.
10,154. Supports for Cycles, C. C. Mueller, London.
10,155. Wave Power Devices, F. C. Little, London.
10,156. Toilette Requisites, L. Silberstein, London.

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10,157. Distribution of Solutions, F. C. Briggs and L. M. Isaacs, London.
10,158. Globe or Shade for Lamps, R. D. Bailey, London.
10,159. Skipping Rope, R. D. Bailey, London.
10,160. Apparatus for the Use of Blind People, T. Dawber, Pemberton.
10,161. Tires for Cycles or other Vehicles, R. Brown, Brentford.
10,162. Ventilator, J. Webster and J. T. Woodhouse, Sheffield.
10,163. Cycles and other Vehicles, W. Tarrant, Glasgow.
10,164. Driving of Light Vehicles, A. Duncan, Glasgow.
10,165. Cooking Ranges, R. Nisbet and J. Campbell, Glasgow.
10,166. Construction of Tires, H. O. Lanyon, Belfast.
10,167. The Invincible Tooth Gearing, J. Marsh, Blackburn.
10,168. Starting of Tramway Cars, W. Stewart, Glasgow.
10,169. Signs for Advertising, W. Dollin and G. H. Richmond, Manchester.
10,170. Combs, W. Whalley, A. Clegg, T. W. Benson, W. Parratt, and J. Robinson, Halifax.
10,171. Circuit Closers for Electric Fire Alarms, F. Dresser, Liverpool.
10,172. Bottles, J. Waugh.—(*M. Schreiber, Germany.*)
10,173. Chains and Driving Wheels of Cycles, J. J. Green, Halifax.
10,174. Cycles, W. Crofts, Nottingham.
10,175. Keeping the Front Wheels of Cycles Straight, T. H. Simmonds, London.
10,176. Brake for Safety Bicycles, L. Warwick, Manchester.
10,177. Retort for Engendering Gases, J. E. Tolson, Dewsbury.
10,178. Driving Gear for Cycles, J. J. Baggaley, Manchester.
10,179. Ale Regulator, M. Parsons, Stockton-on-Tees.
10,180. Breast Protector, K. P. Gardner, Kent.
10,181. Manufacture of Colours, H. Rudge, Lancashire.
10,182. Securing Chambers to Rims, J. C. and M. C. Hall, London.
10,183. Hoop Fasteners for Casks, W. Thorne, Burton-on-Trent.
10,184. Cast Steel Wheels, B. A. Firth and G. N. Cook, Sheffield.
10,185. Protectors for Foot Coverings, G. Wood, London.
10,186. Bows, R. Coates and E. Holme, Manchester.
10,187. Saddles, H. L. Lowdell and F. Eastmead, London.
10,188. Doors, J. O'Brien, Manchester.
10,189. Brush Holders, F. H. Royce and E. A. Claremont, Manchester.
10,190. Ball Bearings, F. H. Royce and E. A. Claremont, Manchester.
10,191. Manufacture of Piled Fabrics, J. Grey and W. Taylor, Manchester.
10,192. Harness, P. Robinson, Manchester.
10,193. Tires, B. Fox, Manchester.
10,194. Optical Lanterns, J. and W. Riley and H. Dalby, Bradford.
10,195. Tires, J. Fearon and W. Tinto, Glasgow.
10,196. Dress Lining, W. Carsley.—(*W. D. Woodruff, Canada.*)
10,197. Humidifying and Spraying Apparatus, O. Hoffmann, Manchester.
10,198. Gassing Frames, G. Swindells and Son and F. Jackson, Manchester.
10,199. Roller Blind Fittings, T. Allchin, Essex.
10,200. Arc Piston Stroke, &c., J. T. Towlson, Somerset.
10,201. Stapler, A. Wright, London.
10,202. Making Roses, R. T. Grocott and A. P. Dickinson, Stoke-on-Trent.
10,203. Covers for Hot-water Jugs, J. Gordon, Birmingham.
10,204. Interchangeable Chain Wheel, A. Allen, Nottingham.
10,205. Tumbler, F. W. Heaton, H. Smith and A. Lindley, Manchester.
10,206. Mysterious Shadow Scope, R. Symons, Sheffield.
10,207. Tires, J. Jackson, London.
10,208. Attaching Spherical Bodies to Wheels, W. J. Fleming and F. W. Exley, London.
10,209. Spindle Studs, W. Howarth and W. R. Robinson, London.
10,210. Venetian Blinds, W. H. Elliot, London.
10,211. Golf Clubs, G. Young, Glasgow.
10,212. Reels for Hose Pipes, J. C. Merryweather, London.
10,213. Bicycle Support, J. Clegg, London.
10,214. Rolling Spittoon, W. Richards, F. G. Gould, G. H. Smith, and T. W. Rees, ——.
10,215. Can Openers, P. C. O. Stephansky, London.
10,216. Baths, J. Cocks, London.
10,217. Frames for Photographic Films, F. Andreae, London.
10,218. Penholders and Erasers, G. M. McBride, London.
10,219. Keys, C. Billet, London.
10,220. Rulers, A. M. Kone, London.
10,221. Compounds, C. S. Gilbert and J. F. Thompson, London.
10,222. Folding Bicycle Rest, H. S. King, London.
10,223. Metallic Packing for Piston-rods, R. Archer, London.
10,224. Safety Stirrups, V. Bridgman and D. Bridgeman-Metchim, London.
10,225. Boring Wells, P. Tarabini and C. Silvestri, London.
10,226. Device for Cycles, A. Haworth, London.
10,227. Construction of Match-boxes, F. W. Mullon, London.
10,228. Producing Mosaic-like Embroidery, A. A. Krüger, London.
10,229. Paper for Use with Typewriters, W. Morgan, London.
10,230. Machine for Cutting Plate-iron, E. Bauer, London.
10,231. Cartridge Holder for Fire-arms, H. Pieper, London.
10,232. Manufacture of Leggings, M. Frankenburg, Manchester.
10,233. Belts for Power Transmission, J. H. Bek, London.
10,234. Valves for Tires, J. A. Prestwich, London.
10,235. Brakes for Vehicles, W. P. Thompson.—(*Schmidt, Langkutt, and Co., Germany.*)
10,236. Safety Appliance for Lamps, H. Rickards, London.
10,237. Axle-bearings for Carts, &c., J. M. Horne, Liverpool.
10,238. Nails or Tacks, G. W. Holland, Liverpool.
10,239. Trees for Keeping Boots in Shape, G. H. Ormsby, Liverpool.
10,240. Tires for Bicycles and Vehicles, F. Alcock, Liverpool.
10,241. Typewriting Machines, O. F. Mayer, Liverpool.
10,242. Photo - chromatic Plates, W. Hayward, London.
10,243. Wood Pavements, T. R. Roscoe, London.
10,244. Charging Balls with Liquid, C. G. Mancha-Bennett, London.
10,245. Horse - imitating Mechanism, P. B. Leroy, London.
10,246. Guards for Wounds or Sores, H. Weber, London.
10,247. Folding Boats, C. M. Douglas, London.
10,248. Internal Combustion Engines, E. J. Clubbe and A. W. Southey, London.
10,249. Links or Couplings for Harness, J. Rhodes, London.
10,250. Fire Extinguishers, H. Kaserer, London.
10,251. Wood-carving Machines, W. W. Ratcliff and J. Kershaw, London.
10,252. Extracting Caustic Alkalies, D. A. Péniakoff, London.
10,253. Cutting Edges of Wall-paper, H. P. Demmel, London.
10,254. New Musical Instrument, F. T. Stokes, London.
10,255. Cuffs and Wristbands, &c., H. Manning, London.
10,256. Tires for Bicycle, &c., Wheels, R. Wilson, London.
10,257. Wheels for Velocipedes, J. F. Duke, London.
10,258. Candlesticks, D. Richards, Birmingham.
10,259. Intercepting Ash in Tobacco Pipes, E. J. Ford, London.
10,260. Cleaning Chains of Bicycles, H. S. Grant, London.
10,261. Brakes, A. J. Boult.—(*V. Brancovitch, France.*)
10,262. Pneumatic Tires, W. A. C. Birkin, London.
10,263. Tanning, A. Levinstein, London.
10,264. Bending of Ship Frames, M. H. C. and R. E. C. Shann, London.
10,265. Ship Frames, M. H. C. and R. E. C. Shann, London.
10,266. Internal Combustion Engines, S. O. Cowper-Coles, London.
10,267. Electrodes for Galvanic Batteries, C. Hoepfner, London.
10,268. Pneumatic Tires, G. Nivet, London.
10,269. Self-propelling Cycles, &c., R. O. Allsop, London.
10,270. Collars, V. Drew, London.
10,271. Removing Dust from Cushions, J. E. Howard and J. C. Taite, London.
10,272. Dynamo-electric Machines, H. T. Harrison, London.
10,273. Catamenial Bandages, S. Drucker, London.
10,274. Device for Cleaning Slates, W. G. Hill, London.
10,275. Candlesticks, C. Cox, London.
10,276. Book Forms of Kinetoscopes, H. W. Short, London.
10,277. Cycle Pneumatic Tire Ball, W. Meadows, London.

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10,278. Rain-water Separator, S. Skinner, Hastings.
10,279. Cycle Tires, C. E. Taylor, L. B. Taylor, and C. F. Gray, Birmingham.
10,280. Horizontal Windmills, J. W. Cooper, Southampton.
10,281. Axles for Driving Cycles, W. G. Armstrong, London.
10,282. An Oscillating Tower, A. H. Tyler, London.
10,283. Road Locomotive Engines, H. Knowles, Liverpool.
10,284. Glow Lamps for Electrical Lighting, G. W. Pridmore, T. J. Sturgeon, and E. Yorke, London.
10,285. Lavatory Basins and Baths, F. C. Lynde, Manchester.
10,286. Rotary Engines, G. W. Hart, Nottingham.
10,287. Luggage Carrier for Cycles, T. Rosethorn, Manchester.
10,288. Straight Swell for Looms, R. Wilde, Stalyridge.
10,289. Cycle Lamps, J. Parker, C. Hudson, and J. H. Smith, Birmingham.
10,290. Penholder and Ink Container, E. A. O. Leeds, Birmingham.
10,291. Draw Plate for Fire-grates, E. A. O. Leeds, Birmingham.
10,292. Sweeping Chimneys, M. H. Barlow-Massicks, London.
10,293. Fire-bricks, J. G., T. E. W., and R. O. Henry, Newcastle-on-Tyne.
10,294. Heating Feed-water, D. Rushworth, Stockport.
10,295. Lids of Saucepans, &c., E. Eyre, Sheffield.
10,296. Bolts for Doors, E. Harrison and W. A. Lathbury, Birmingham.
10,297. Box for Potted Meat, A. Gruner and W. Cooby, London.
10,298. Music Stands or Desks, J. McL. Whitfield, Huddersfield.
10,299. Tipping Soap Dish or Holder, J. Harrison, Leeds.
10,300. Golf Clubs, J. Leigh and J. A. Penny, Manchester.
10,301. Buffers, &c., for Windows, G. Cotton, Nantwich.
10,302. Dye Sticks of Dyeing Machines, B. L. and E. Fletcher, Halifax.
10,303. Self-propelled Vehicles, J. H. Hamilton and A. Rollason, Nottingham.
10,304. Leather Tires for Cycles, J. B. Fenby, Birmingham.
10,305. Grinding Chalk, T. C. Fawcett, Ltd., T. C. Fawcett, and J. D. Fawcett, Halifax.
10,306. Cycles, J. Wallace, jun., Belfast.
10,307. Gas Engines, J. P. Binns and H. G. Binns, Luddenden.
10,308. Reflector for Affixing to Educational Blackboard, W. T. Tutton, Shrewsbury.
10,309. Frames of Cycles, &c., G. Barker, Sutton Coldfield.
10,310. Wheel Tires for Cycles, J. M. Meech, Brighton.
10,311. Greasing the Axles of Coal Tubs, F. A. Murphy, Oldham.
10,312. Automatic Feed-water Regulators, R. B. Smith, Birkenhead.
10,313. Metallic Packings, J. Butterworth and R. F. C. Tonge, Manchester.
10,314. Bands for Driving Machinery, J. Wetherill and W. J. Armitage, London.
10,315. Floor Coverings, J. Wetherill and W. J. Armitage, London.
10,316. Windows of Vehicles, W. Perrins, Birmingham.
10,317. Toy, C. W. Hunter, Hull.
10,318. "The Hare Axle Cushion" for Cycles, G. F. Hare, Limerick.
10,319. Nut Lock for Bolts in Wood, J. T. Sanders and W. H. Nott, London.
10,320. Nut Lock for Bolts, J. T. Sanders and W. H. Nott, London.
10,321. Nut Lock and Bolt, J. T. Sanders and W. H. Nott, London.
10,322. Nut Lock and Bolt, J. T. Sanders and W. H. Nott, London.
10,323. Boots, F. and C. F. Mobbs, London.
10,324. Carriage and Cycle Tire, W. Merritt, London.
10,325. Velocipedes and other Vehicles, J. J. Rowley, London.
10,326. Sewing Machines, J. Thomas, London.
10,327. Watch Chains and Guards, E. G. Johnson, London.
10,328. Rubber Tires for Cycles, J. Hamilton, London.
10,329. Elastic Tires, H. de Laspée, London.
10,330. Extracting Starch, C. Friedheim and A. Rosenheim, London.
10,331. Wenham Gas Lamps, S. H. Robinson, London.
10,332. Skirt Holder for Lady Cyclist, E. C. Woolmer, London.
10,333. Can Packer, G. A. Farini, London.
10,334. Can Lifter, G. A. Farini, London.
10.335. Box Filler, G. A. Farini, London.
10,336. Flying Toy Bird, J. Nesbit and A. Behrend, London.
10,337. Cycle Adjustable Handle Bars, T. H. Burton, London.
10,338. Tube or Vaporising Element, V. C. J. Ortmans, London.
10,339. Boots, R. McKay, London.
10,340. Cycle Tires, A. E. Mavor and W. Jones, London.
10,341. Cycle Tires, A. E. Mavor and W. Jones, London.
10,342. Disintegration of Quartz, &c., A. Gutensohn, London.
10,343. Packing Tea in Packets, A. V. Smith, London.
10,344. Spring Seats and Backs for Chairs, J. Compin, London.
10,345. Stopping Apparatus for Road Carriages, W. Woolidge, Southampton.
10,346. Dwarf Portable Music Receptacle, R. J. King, London.
10,347. Gear, G. Dallison and C. Pardoe, London.
10,348. Applying Adhesive Substances to Paper, H. E. Smyser, London.
10,349. Preparing Metals for Galvanic Purposes, A. M. Clark, London.
10,350. Elastic Tires, T. E. Wheeler and G. F. Baker, London.
10,351. Checking the Receipts of Bills, A. E. Hodder and J. B. G. Lester, London.
10,352. Corsets, H. Bendy, London.
10,353. Manufacture of Tubes for Cycle Frames, C. Binks, London.
10,354. Chain Geared Cycles, W. W. Ward, Liverpool.
10,355. Velocipedes, W. Hall and P. Leonard, Liverpool.
10,356. Curtain Hooks, E. Blossom, Liverpool.
10,357. Packing and Measuring Embroidery, L. Reichenbach, Liverpool.
10,358. Registering Electric Currents, H. Carbonnellf, Liverpool.
10,359. Fastenings for Retort Lids, &c., W. W. Box, London.
10,360. Bicycles, N. A. Aubertin and C. E. Haverly, London.
10,361. Bicycles, J. L. Souhami, London.
10,362. Wheel Tires, A. H. Bogle, London.
10,363. Box for Containing Paper, H. A. Péraut, London.
10,364. Ticket Pin, H. A. Péraut, London.
10,365. Checking, &c., Apparatus for Billiards, J. G. Dixon, London.
10,366. Books for Cigarette Papers, J. O. Schweitzer, London.
10,367. Boot Trees or Stretchers, P. J. Parmiter, London.
10,368. Surveying Instruments, Elliott Brothers, London.
10,369. Driving Chains for Cycles, J. W. Deans and W. D. and R. J. Foster, London.
10,370. Supports for Attachment to Bicycles, F. C. Yeo, London.
10,371. Boots, C. W. Braithwaite, London.
10,372. Apparatus for Production of Ozone, E. Andreoli, London.
10,373. Fore-carriages, F. J. J. Gibbons, London.
10,374. Star Wheels of Linotype Machines, The Linotype Company, Ld., and J. Place, London.
10,375. Threading Needles, A. and R. Schlagintweit, London.
10,376. Handles for Cycles, J. McRae, London.
10,377. Shoes, R. Hertzberg, London.
10,378. Musical Instrument, A. R. Breinl, London.
10,379. Attaching Venetian Blind Tapes, A. Cameron and H. E. Skinner, London.
10,380. Air Pump for Cycle Tire Tubes, F. E. Bunting, London.
10,381. Horse Provender Receptacles, L. Giese, London.
10,382. Hat Cord Attachments, C. Scheidereiter. London.
10,383. Wheels for Cycles, A. Walter, London.
10,384. Cooling the Cylinders of Engines, F. R. Simms, London.
10,385. Cooling the Explosion Cylinders of Engines, F. R. Simms, London.
10,386. Combined Steering Handles, &c., F. R. Simms, London.
10,387. Pneumatic-tired Wheels, H. Jelley and H. J. Lawson, London.
10,388. Calendars, M. M. Dessau, London.
10,389. Steam Engines, W. B. Crichton, London.
10,390. Tanning Apparatus, A. Levinstein, London.

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10,391. Producing Motive Power, D. Cook, London.
10,392. Inflated Tires of Wheels, J. Adair, Waterford.
10,393. Driving Velocipedes, H. T. Scowcroft, Manchester.
10,394. Loom Pickers, J. C. Cartwright, Bradford.
10,395. Supplying Disinfecting Fluids to Water-closets, W. Giddie, Bristol.
10,396. Hat Fastener, W. J. Fox, Manchester.
10,397. Starting Valveless Syphons, L. W. Waechter, Manchester.
10,398. Gear Wheels for Cycles, G. Moore, jun., Birmingham.
10,399. Gas Engines, T. J. Bennett and W. F. Thomas, Birmingham.
10,400. Oil Lamps, J. and A. L. Undy, Derby.
10,401. Billiard Tables, G. Cummings, Blyth.
10,402. Rims and Tires for Wheels, S. Bunting, Birmingham.
10,403. New Explosive, H. Boyd, Birmingham.
10,404. Window Fasteners, T. A. Langhorne and J. Tillotson, Keighley.
10,405. Metallic Lathing, A. R. Fordyce, Manchester.
10,406. Top-pressing Rollers, J. Knowles and J. Robertshaw, Bradford.
10,407. Portable Lamp Standard, R. Goodwin, Dublin.
10,408. Pneumatic Tire Inflators, R. W. Leftwich, London.
10,409. Lubricating Heavy Bearings, J. Lumb, Halifax.
10,410. Guard to Prevent Puncturing of Tires, W. Fletcher, Birmingham.
10,411. Laying Yarns in the Form of Warps, A. Leach, Manchester.
10,412. Velocipede Wheels, J. W. Myers, Whitehaven.
10,413. Compound Fluid Pressure Engines, R. E. Bradford, London.
10,414. Electric Hoists, W. H. Scott, Norwich.
10,415. Electrical Collecting Apparatus, W. Sillery, Wrexham.
10,416. Wheels for Vehicles, F. and A. Mousley, Birmingham.
10,417. Steam Merry-go-round, G. Smith and A. J. Davis, Leicester.
10,418. Door Latch and Lock Combined, E. Hentsch, Nottingham.
10,419. Removing Harness from Carts, S. Cadman, Oldham.
10,420. Draught Preventer for Doors, S. Cadman, Oldham.
10,421. Handle-bars for Cycles, &c., O. Ward, London.
10,422. Pneumatic Tires, H. Jelley and J. Jelley, London.
17,423. Rims for Vehicle Wheels, &c., H. Jelley, London.
10,424. Cooling Surfaces of Cylinders, F. R. Simms, London.
10,425. Independent Washstand, W. H. Wearing, Liverpool.
10,426. Cycle Heads, A. Haskins and C. R. Garrard, London.
10,427. Swaging Machines, W. B. Challen and Taylor and Challen, Ld., London.
10,428. Cycle Parts, C. R. Garrard, London.
10,429. Holders for Electric Lamps, T. R. Kenny, Bradford.
10,430. Cycles, W. J. Giblin, Glasgow.
10,431. Apparatus for Drying Wool, J. Fielden, Rochdale.
10,432. Ladders, J. Malton, Scarborough.
10,433. Propelling and Compressing Fluids, E. Hunt, Glasgow.
10,434. Potato Diggers, T. S. Bisset, Glasgow.
10,435. Combining Oil and Air for Engines, G. Johnston, Glasgow.
10,436. Metallic Packing for Engines, J. Cuthill, Dundee.
10,437. Treating Water, J. T. Norman, London.
10,438. Looms, W. E. Simpson, Birmingham.
10,439. Securing Bottoms of Boxes, M. Heinemann, Birmingham.
10,440. Tires of Cycles and Vehicles, K. Tullis, Glasgow.
10,441. Nursery Safety Pin, K. W. Frost, Birmingham.
10,442. Arc Lamps, W. R. Ridings, Birmingham.
10,443. Pianoforte Practice Board, J. B. Baylis, Southend-on-Sea.
10,444. Constructing Bicycle Frames, F. H. Terry, Birmingham.
10,445. Mandril for Carrying Rollers, H. Meller, Manchester.
10,446. Ships' Rudders, J. M. Ramsay, Glasgow.
10,447. Walking Stick and Field Glass, J. M. Brown, Glasgow.
10,448. Sharpening Reaping Knives, W. French, Glasgow.
10,449. Bicycle Tires, F. Sheridan and A. E. Hodder, London.
10,450. Type-writing Machines, E. W. Hearn, London.
10,451. Velocipedes, A. G. Meeze and S. H. Burchell, Painswick.
10,452. Method of Ringing Cycle Bells, I. Davis, London.
10,453. Pneumatic Tires, O. C. Jones and T. Birkett, Birmingham.
10,454. Bicycles and Tricycles, F. Cooper, Manchester.
10,455. Electric Motors, R. Norman, Eastbourne.
10,456. Electric Motors, R. Norman, Eastbourne.
10,457. Tiles for Roofing Purposes, A. W. Evans, London.
10,458. Protecting Thumb or Finger Nails, E. Nash, London.
10,459. Umbrella Case, J. F. H. V. Hoop, London.
10,460. Cap for Wheels of Road Vehicles, H. Job, Torquay.
10,461. Preventing Tires Puncturing, J. E. Howard, London.
10,462. Manufacture of White Lead, A. Sandiland, London.
10,463. Chain and Wheel, C. Pardoe, London.
10,464. Stretching Hides or Skins, R. Spitz.—(*G. Feith, Austria.*)
10,465. Automotor Carriages, E. Fessard, London.
10,466. Valves for Bottles, T. H. Walker and G. Soar, London.
10,467. Inking Letterpress Rollers, W. Whittaker, Manchester.
10,468. Cycle Saddles, S. Pattisson and F. Mousley, London.
10,469. Button Fasteners, D. Bridgeman-Metchim, London.
10,470. Shaping Nuts, K. Banks and E. N. Banks, London.
10,471. Moulded Clay Articles, &c., W. West, London.
10,472. Material for Secondary Batteries, G. A. Grindle, London.
10,473. Automatic Supply of Water, E. B. Ellington, London.
10,474. Pneumatic Tires for Cycles, J. Brandenberg, London.
10,475. Surgical and Medical Syringes, E. Krüning, London.
10,476. Billiard Cues, A. L. H. Spencer and W. Date, London.
10,477. Metallic Tubing for Bicycles, J. V. Pugh, London.
10,478. Motor Cars, J. C. Merryweather and C. J. W. Jakeman, London.
10,479. Stuffing-box, B. J. B. Mills.—(*H. Rostagnat, France.*)
10,480. Generating Acetylene Gas, P. C. Frewin, London.
10,481. Adjusting Fanlights, G. Deacon, London.
10,482. Attaching Tires to Rims, H. P. Ranger and H. D. Earnes, London.
10,483. Ears for Chamber Pails, &c., J. Fellows, jun., London.
10,484. Tool Holder, H. M. Judd and G. Rushworth, London.
10,485. Oil Feeders, J. Watson and F. G. Brown, London.
10,486. Piston Rings, G. Henderson and T. Hindson, London.
10,487. Smoking Carriages, &c., J. Edwards, London.
10,488. Sand Machines, H. W. Clarke and J. Emery, London.
10,489. Brake for Velocipedes, N. A. Aubertin, London.
10,490. Bottles, R. S. Seaman, London.
10,491. Devices for Holding Cards, H. A. Sieghörtner, London.
10,492. Supports for Trolley Cars, &c., O. Holz, London.
10,493. Tires, H. F. Lange and F. von Leicht, London.
10,494. Extraction of Zinc, J. R. Wylde, J. W. Kynaston, and J. Brock, London.
10,495. Lenses for Photographing, W. Friese-Greene, London.
10,496. Envelopes, W. P. Thompson.—(*D. Conrad, United States.*)
10,497. Electric Traction, J. Perry and T. Tomlinson, London.
10,498. Brakes for Soft Tired Wheels, W. H. Hallett, Liverpool.
10,499. Chain Wheel Mechanism, J. W. Brereton, Birmingham.
10,500. Devices for Velocipedes, H. D. Martin, London.
10,501. Central Buffers and Couplings, G. Johnston, Liverpool.

10,502. Wickless Cooking Lamp, C. E. Ostlund, London.
10,503. Driving Gear for Cycles, T. E. Nightingale, Liverpool.
10,504. Pianofortes, H. J. Brinsmead, London.
10,505. Metallic Packings, W. A. Bennett, London.
10,506. Pneumatic Tires, G. J. Stevens and J. Hix, London.
10,507. Lathe Motion for Looms, G. Schwaabe, London.
10,508. Temperature of Fluids, F. Lamplough and the Automatic Heat Regulator Company Limited, London.
10,509. Reamer, J. A. Little, London.
10,510. Ventilators and Chimney Cowl, J. G. Jennings, London.
10,511. Loading Trucks, W. H. Munns.—(*G. T. Dixon and A. Jamieson, United States.*)
10,512. Leather Belting Apparatus, E. F. Sargeant, London.
10,513. Paving Floors, Landings, &c., P. Stuart, London.
10,514. Seats, J. W. Wightman, London.
10,515. Railway Vehicles, E. J. Pennington, London.
10,516. Bottles, J. G. Henrich, London.
10,517. Bicycles, E. Murray, London.
10,518. Lenses for Photographic Purposes, R. Krügener, London.
10,519. Cushion Noiseless Tire, &c., J. H. Glew, London.

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10,520. Fastening Pneumatic Tires, L. O. Michael, Birmingham.
10,521. Sewing Machines, J. Forbes, Tyrone.
10,522. Regulating the Infusion of Tea, T. M. S. Bloxam, Gloucester.
10,523. Transmitting Rotary Motion, E. K. Dutton, Harrowgate.
10,524. Manœuvring of Ships, F. H. and F. H. Pellew, Bristol.
10,525. Bicycle, S. Cooper, Oldham.
10,526. Rims for Wheels of Vehicles, J. Birtwisle, Manchester.
10,527. Preparing Propulsive Powders for Cartridge Cases, C. O. Lundholm, Glasgow.
10,528. Producing Effects, S. Tozer and W. C. Bearder, Nottingham.
10,529. Transverse Mechanism, A. Kay.—(*W. R. Parkin, United States.*)
10,530. Repairing Pneumatic Tires, W. J. Walford, Bristol.
10,531. Securing Pneumatic Tires, A. Hamilton, Dublin.
10,532. Kilns for Burning Cement, P. J. Neate, Rochester.
10,533. Manufacture of Slippers, H. F. Sexton, Norwich.
10,534. A Self-righting Spur, &c., J. Maddock, Burslem.
10,535. Dressing Machine for Yarn, W. B. Soman, Manchester.
10,536. Rulers, R. W. Hodgson, Newcastle-on-Tyne.
10,537. Forming Bodies of Metal Cans, H. Austin, Wolverhampton.
10,538. Air Pumping Apparatus, J. Woodley and W. B. Griffiths, Cardiff.
10,539. Car Couplings, R. C. Sayer, Bristol.
10,540. Air Pump Receiver, A. R. Bennett and C. F. Casella, London.
10,541. Glass Fronts for Buildings, F. S. Rippingille, London.
10,542. Tip Carts or Vehicles, J. and G. Smith, London.
10,543. Fastening Bale Ties and Bands, W. Hayward, sen., Wolverhampton.
10,544. Shoe for Animals, H. J. Tremellen, Newport, Mon.
10,545. Earthenware Scale Plates, G. Herbert, London.
10,546. Pneumatic Tires for Cycles, W. Briscall, Liverpool.
10,547. Disc Valves for Gases, &c., C. H. C. Rudd, Newcastle-on-Tyne.
10,548. Bicycles, J. Price, H. W. Fisher, and N. Collier, Derby.
10,549. File, A. E. Walker, London.
10,550. Filling Oil Tins, D. S. Cargill.—(*The Burmah Oil Co., Burmah.*)
10,551. Picture Suspender, A. V. Ingall, Birmingham.
10,552. Additions to Urinals, T. W. Twyford, Birmingham.
10,553. Furnace Grate-bars, W. Furness and W. J. Bell, Halifax.
10,554. Billiard Cues, H. Externest, jun., Liverpool.
10,555. Purifying Material for Beer, W. P. Knight and E. Cave, London.
10,556. Connecting Cranks to Axles of Cycles, J. Gibson, Manchester.
10,557. Connecting Straps to Vehicles, F. T. Burgess, Bristol.
10,558. Fastenings for Garments, T. P. Taylor, Bristol.
10,559. Pneumatic Billiard Cushions, A. Sydenham and E. J. White, Birmingham.
10,560. Music Stands for Pianofortes, H. G. Millier, London.
10,561. Indicating the Amount of Fluid in a Barrel, T. B. Burns, Bristol.
10,562. Mounting Window Sashes, R. A. Brackenbury, London.
10,563. Distributing Powders, A. A. Furst and F. Becker, London.
10,564. Frost-proof Pipe, T. B. Burns, Bristol.
10,565. Tires for Vehicles, H. Lindsay - Bucknall, London.
10,566. Canvas Grips and Appliances, H. Marles, Brighton.
10,567. Hospital Tables and Cases, R. F. Reynolds, Leeds.
10,568. Gas-producing Apparatus, V. I. Feeny.—(*P. Carmien, A. Yvonnet, and M. Billion, France.*)
10,569. Rapid Timber Dryer, J. Black and R. Black, Liverpool.
10,570. Bodkin, T. W. Johnson and C. Charman, Redditch.
10,571. Dust and Draught Excluders, E. Pollard, Bradford.
10,572. Carrier Pigeon Message Holder, F. W. A. Mylius, Manchester.
10,573. Bicycles, W. F. Woods, Liverpool.
10,574. Phosphate Ore Utilising Process, E. Cuylits, Brussels.
10,575. Motor, E. M. Foot, London.
10,576. Driving Chains, &c., of Cycles, P. A. Craven, London.
10,577. Making Chlorates of Sodium, A. Wolf and W. S. Blythe, Manchester.
10,578. Mowing and Reaping Machines, A. McGregor, Manchester.
10,579. Spring Ambulance Hammock, H. W. Williamson, London.
10,580. Quick Return Motion for Drilling Machines, C. H. and C. H. Clifton, and C. W. B. Crossley, Johnstone.
10,581. Tires, G. C. Nesbitt, London.
10,582. Track Brakes for Railway Cars, L. Kneedler, E. Vorpe, and J. S. Everitt, London.
10,583. Teeth of Rakes, W. Goldsworth, Stony Stratford.
10,584. Coffins, J. Ursell, Cologne.
10,585. Oilers or Portable Lubricators, J. C. Chandler, London.
10,586. Tiled Hearths or Flooring, J. Simpson, London.
10,587. Steam, Oil, and Gas Engines, R. J. Eke, London.
10,588. Manufacture of Cycles, &c., G. Shrewsbury, London.
10,589. Pneumatic Tires for Cycles, &c., H. Mead, London.
10,590. Making Pneumatic Tires, J. A. Calantarients, London.
10,591. Toothed Parts of Machinery, F. Ludewig, London.
10,592. Toothed Parts of Machinery, F. Ludewig, London.
10,593. Hat Pins, R. Bürgemeister, London.
10,594. Picture and Curtain Rods, J. J. Bate, Liverpool.
10,595. Cycle Saddles, J. J. Bate, Liverpool.
10,596. Railway Keys, A. G. Sidwell, Birmingham.
10,597. Cycles, E. Hale, Liverpool.
10,598. Mounting Carriage Bodies, D. L. Salomons, London.
10,599. Cycle Riding Appliances, W. C. Dyer and G. H. Rayner, London.
10,600. Stands or Receptacles for Olives, K. M. Barber, Birmingham.
10,601. Body Rollers for Horses, &c., J. J. Wilson, Birmingham.
10,602. Capstan or Turret Lathes, A. Herbert, London.
10,603. Thrashing Machines, M. Dornwald, London.
10,604. Construction of Cycle Wheels, J. Davidson, London.
10,605. Tire for Cycles and Vehicles, W. H. Simmonds, London.
10,606. Breech-loading Guns and their Mountings, D. Vickers, A. T. Dawson, and G. T. Buckham, London.
10,607. Purifiers for Middlings, &c., H. Simon, London.
10,608. Tumler Electric Switches, The Edison and Swan United Electric Light Company and C. F. Proctor, London.
10,609. Pipe Coating Material, F. Espir.—(*W. C. Jack, Tonkin.*)
10,610. Pneumatic Tires, G. W. C. and A. E. Noble, London.
10,611. Wheels and Tires, W. H. and J. R. Caldecourt, London.
10,612. Baths, J. Ott and B. W. Conti, London.
10,613. Covers for Pneumatic Tires, R. Kitchen, London.
10,614. Rim for Cycle, &c., Wheels, R. Kitchen, London.
10,615. Vapour Burners and Lamps, J. S. Wood, London.
10,616. Displaying Wall Papers, H. H. Lake.—(*J. J. Reid, United States.*)
10,617. Elastic Wheel Tires, A. G. Bessemer, jun., London.
10,618. Preventing Accumulation of Coal Dust in Mines, H. Bell, A. L. Steavenson and R. Harle, London.
10,619. Lamps for Cycles and Vehicles, P. H. Emanuel, London.
10,620. Roofing Plates or Sheets, A. J. P. Whitaker, London.
10,621. Papermakers' Beating Engines, W. H. Caldwell, London.
10,622. Engines, R. L. Weighton and D. B. Morison, London.
10,623. Manufacture of Woven Fabrics, H. Spiegler, London.

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10,624. Stoppers for Bottles, E. Hurry, Newcastle-on-Tyne.
10,625. Cooking Eggs, T. H. Simmonds, London.
13,626. Brakes for Cycles, J. E. Blackledge, Manchester.
10,627. Testing Butter and Margarine, R. Wells, Scarborough.
10,628. Audible Signals or Alarms, G. Rydill, Dewsbury.
10,629. Lavatory Basins, Baths, &c., F. C. Lynde, Manchester.
10,630. Cycles, J. Whitehead and J. A. Crane, Birmingham.
10,631. Tires, W. F. Gedye, London.
10,632. Liberating the Hands in Bicycle Riding, J. J. Jonas, London.
10,633. Mouthpieces of Tobacco Pipes, A. E. Gilbert, Newcastle-on-Tyne.
10,634. Tire, W. Meadows, London.
10,635. Balling Gun for Animals, J. A. Bosworth, jun., Leicester.
10,636. Automatic Saddle, J. McKenny and P. Redmond, Dublin.
10,637. Screw-neck Gully for Drains, J. W. Mearns, Sunderland.
10,638. Bicycle Brakes, I. Trolley, Grantham.
10,639. India-rubber and Vulcanite, A. Hobbs, Newport.
10,640. Horseshoe, K. Tucker, Chard.
10,641. Automatic Machine, A. W. Cutting and G. Roberts, London.
10,642. Driving Gear for Cycles, J. M. Davies, Dublin.
10,643. Coupling Attachment for Bicycles, W. P. Kelly, Dublin.
10,644. Cord Clutches or Grips, G. Leadbetter, Ledbury.
10,645. "Byron" Bicycle Brush, H. E. Dolphin, Liverpool.
10,646. Drums or Vessels for Petroleum, D. Caird and the Iron and Steel Plant Company, Limited, London.
10,647. Beams, H. Laing and W. Hök, Newcastle-on-Tyne.
10,648. Ladies' Shirts, M. E. Carrington, Manchester.
10,649. Cycles, J. A. Crane and J. Whitehead, Birmingham.
10,650. Buffer Tube Saddle Spring, J. Lane, Nottingham.
10,651. Rims for Cycles, A. Maltby, London.
10,652. Air Chambers for Pneumatic Tires, A. Maltby, London.
10,653. Pneumatic Tires, A. Maltby, London.
10,654. Non-slipping Bands for Tires, A. Maltby, London.
10,655. Stamping Blocks of Butter, J. C. Lawson, London.
10,656. Shaping Leather Loops, E. R. Royston.—(*E. Spear and F. L. Middleton, United States.*)
10,657. Machinery for Slitting Leather, E. R. Royston.—(*E. Spear and F. L. Middleton, United States.*)
10,658. Machinery for Cutting Pockets, E. R. Royston.—(*E. Spear and F. L. Middleton, United States.*)
10,659. Machinery for Making Loops, E. R. Royston.—(*E. Spear and F. L. Middleton, United States.*)
10,660. Means for Inflating Toy Balloons, J. Harris, Manchester.
10,661. Construction of Bottles, L. E. Keegan, Dublin.
10,662. Bicycle and other Tires, E. W. Hughes, London.
10,663. Sand Box for Use on Golf Courses, C. Playfair, Glasgow.
10,664. Means of Raising Water, &c., C. J. Eyre, Brighton.
10,665. Tires, J. Murray and C. R. Alexander, London.
10,666. Manufacture of Cycle Frames, C. Binks, York.
10,667. Driving Gear for Cycles, A. E. Hodder and F. Sheridan, London.
10,668. Protector against Rain, J. Gilbert and H. O. Box, London.
10,669. Electrical Variable Speed Gear, A. G. New, Surrey.
10,670. Electrical Variable Speed Gear, A. G. New, Surrey.
10,671. Lamps, A. E. Purrott and E. W. Willard, London.
10,672. Tubular Tire for Wheels, E. A. Tavernier, London.
10,673. Regulating Gas, C. A. Finch and H. J. Ingle, London.
10,674. "Careful" Cuff, G. Care and T. Tabrar, London.
10,675. Lamps for Burning off Paint, C. Phillips, London.
10,676. Lasts, B. Toone and J. W. Black, London.
10,677. Combined Dress Skirt Band, A. Bradbury, London.
10,678. Devices for Curling Hair, A. E. Roberts, London.
10,679. Easy Chair, H. Burgess, London.
10,680. Attachment to Travelling Caps, C. W. Shepherd, London.
10,681. Soaps, J. Ascough, London.
10,682. Storing and Delivering Address Cards, &c., H. Schenk, London.
10,683. Shearing Textile Fabrics, A. Sykes and W. E. Yates, Ltd., London.
10,684. Ball Bearings, E. Rother, London.
10,685. Velocipedes, C. Chambers, London.
10,686. Combined Set Square and Ruler, J. Lohmeyer, London.
10,687. Utilising the Tidal Flow, J. Lohymeyer, London.
10,688. Frames of Bicycles, O. Imray.—(*E. Béranger and A. Chobert, Belgium.*)
10,689. Aromatic Aldehydes, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
10,690. Mechanism for Stopping Machinery, Tangyes Limited, and J. Robson, jun., London.
10,691. Wheels for Cycles, J. G. Ferguson, London.
10,692. Holdfast Excentric Grip, J. Gardner and J. Such, Cheltenham.
10,693. Hooks and Chains Combined, H. S. Woodd and T. Crisp, London.
10,694. Sprocket Chains, F. Myers, London.
10,695. Tire for Wheels of Cycles, A. R. Richards, London.
10,696. Lubrication of Bearings, H. H. Lake.—(*Todtenhaupt and Helms, Germany.*)
10,697. Wheels for Velocipedes, &c., W. J. Ingram, London.
10,698. Electric Alarm Apparatus, H. C. Bird, London.
10,699. Pneumatic Tires, J. Slee, Liverpool.
10,700. Elastic Tires for Cycles, &c., E. Gerard and A. Picon, London.
10,701. Pedals of Cycles for Racing Purposes, O. Taylor, London.
10,702. Ventilating Fur Garments, H. W. Lane and W. H. and H. M. Smith, London.
10,703. Gunpowder, J. House and A. Gillingham, London.
10,704. Bicycles, W. Atkinson, London.
10,705. Tires of Cycles, A. A. Furst, London.
10,706. Adjustable Support for Bicycles, G. Woolley, London.
10,707. Cycle Saddles, L. Houghton, London.
10,708. Railway Signal Indicating Appliances, A. H. S. Daniell, London.
10,709. Rotary Pumps and Engines, L. S. d'Iszoro, London.
10,710. Incandescence Spirit Lamps, E. Berker, London.
10,711. Mechanism for Marine Propulsion, L. Lawrence, London.
10,712. Mechanical Organs, &c., A. A. M. Gavioli, London.
10,713. Machines for Vanning Ores, T. H. Tregoning, London.
10,714. Pneumatic Tires, I. Nasch, London.
10,715. Manufacture of Manures, F. W. Saatmann, London.
10,716. Fishing, F. W. Saatmann, London.
10,717. Tubes, A. Racic, London.
10,718. Positive Lead Electrodes, H. O. Tudor, London.
10,719. Weighing Machines, C. Ingrey, London.
10,720. Braking Vehicles, I. A. Timmis, London.
10,721. Lighting Cigars, L. Huttenbach, London.
10,722. Pneumatic Tires, W. Maddock, London.
10,723. Apparatus for Unchaining Cattle, J. Vietheer, London.
10,724. Tires of Wheels for Bicycles, C. M. Glen, London.
10,725. Generating Gas, G. Webb, jun., and J. W. Kelly, London.
10,726. Toasting Forks, F. Hutchins, London.

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10,727. Lever Crank for Bicycles, R. Wilcox, London.
10,728. Generating Acetylene, J. Swinburne, London.
10,729. Cycles, K. Gengnagel, St. Leonards-on-Sea.
10,730. Tires of Wheels for Carriages, J. Hayes, Lincoln.
10,731. Velocipedes, C. C. Hopkins, Birmingham.
10,732. Securing Cycle Pumps, W. H. Henser, Birmingham.
10,733. Cycle Parcel Carrier, W. H. Henser, Birmingham.
10,734. Holders for Pipe Cleaners, G. H. Hill, Birmingham.
10,735. Raking Hay into "Hacks," S. H. Ody, Bristol.
10,736. Winding Fabrics upon Rollers, L. Schreiner, Manchester.
10,737. Disinfector for Water-closets, W. Preston, Leeds.
10,738. Tires for Bicycles and other Vehicles, G. S. Ram, Coventry.
10,739. The Presto Bottle Lock, J. Dudley, Southsea.
10,740. Egg-cutter Guides, H. B. Everest, London.
10,741. Manufacture of Boot Heels, B. Seimert, London.
10,742. Fastening Inflated Tires, C. Merington, Penge.
10,743. Brass Cornice Pole Ring, F. P. Cochrane, Leith.
10,744. Combining Solid and Cushion Tires with Pneumatic, J. A. Bonds, L. Dawes, and S. Dawes, London.
10,745. Pneumatic Tires, D. Young.—(*The Self-healing Pneumatic Tire Company, United States.*)
10,746. Pneumatic or Solid Wheel Tires, J. H. Evans, London.
10,747. Hydraulic Pumps, A. G. Browning, Manchester.
10,748. Nails and Spikes, H. E. Fuller, Birmingham.
10,749. Stowing Heavy Plates in Ships, T. Banks, Glasgow.
10,750. Cycle Pneumatic Tires, R. J. Hamilton, Glasgow.
10,751. Voting Machines, A. O. Abbott, Glasgow.
10,752. Degreasing Leather, G. E. Wright and W. Monk, Manchester.
10,753. Scouring Textile Fabrics, J. D. Asquith, Bradford.
10,754. Folding Arm to Cranks of Cycles, W. H. Havers, Norwick
10,755. Wheels of Pit Corves, S. Shepherd, jun., and E. Shepherd, Sheffield.
10,756. Self-opening Umbrella Frames, C. W. Bremshey, Glasgow.
10,757. Cycle Felloes, R. Turnbull, sen., and R. Turnbull, jun., Newcastle-on-Tyne.
10,758. Measuring Taps, J. H. Airey, Sunderland.
10,759. Chain Protector for Cycles, F. Lott, Liverpool.
10,760. Detachable Mud Guards for Cycles, F. Lott, Liverpool.
10,761. Stoppers for Glass Bottles, J. H. Trinder, London.
10,762. Ornamental Sheet Belts, C. F. Gaunt, Birmingham.
10,763. Siemens' Regenerative Furnaces, F. Svoboda, Glasgow.
10,764. Ladies' Cycling Skirt, F. H. and L. H. Stirling, Edinburgh.
10,765. Automatic Gear for Brakes, J. S. Hainsworth, London.
10,766. Coal-dust Mixing Apparatus, &c., F. Forst, London.
10,767. Bicycle Stand, F. Forst, London.
10,768. Folding and Collapsible Boxes, J. Thompson, London.
10,769. Valves for Pneumatic Tires, J. Shipway, London.
10,770. Wheels for Cycles and Carriages, F. Jones, Long Ditton.
10,771. Automatic Matchbox, A. Minter, London.
10,772. Elevators, Otis Elevator Co., Ld.—(*Otis Bros. and Co., United States.*)
10,773. Tires, T. and C. Colls, Barnt Green.
10,774. Water-tube Boiler, J. P. Hall, London.
10,775. Wheels, S. H. James, London.
10,776. Tires and Rims for Cycles, &c., T. Fenwick, London.
10,777. Bridge Rim and India-rubber Tire, F. Ochs, Reigate.
10,778. Exhibiting Photographic Pictures, A. N. Petit, London.
10,779. Tire, A. Hone, London.
10,780. Wheel, J. J. Ney, London.
10,781. Applying Electricity to Vehicles, H. J. Dowsing, London.
10,782. Ruler and Blotter, R. B. Whiteside and W. Tuck, London.
10,783. Engines for Pumping-up Beer, A. E. Hart, London.
10,784. Washing Granular Substances, R. Moodie, London.
10,785. Pneumatic Tires, J. Dunkley and E. Harber, London.
10,786. Sash Fasteners, A. E. Bray, London.
10,787. Tire Protectors, A. E. Cooper, London.

SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

555,190. Alternating Motor, *N. Tesla, New York.—Filed May 15th*, 1888.

Claim.—(1) In an electro-magnetic motor, the combination of independent energising circuits, one adapted to be connected with a source of alternating current, the other arranged in inductive relation to the said first circuit whereby the motor will be operated by the resultant action of the two circuits, as set forth. (2) The combination in an electro-magnetic motor, with an alternating coil or conductor and a closed circuit conductor in inductive relation thereto, of an armature mounted so as to be within the field produced by the coil and closed conductor, as set forth. (3) The combination in an electro-magnetic motor, with energising coils adapted to be connected with the generator of induced coils and independent energising coils in circuit therewith and arranged to produce a shifting movement of the points of maximum magnetic effect of the motor, as set forth. (4) The combination in an electro-magnetic motor of a series of independent energising coils or sets of coils and induced coils wound on all the energising coils or sets of coils but the last of the series, the first energising coil or set of coils being included in circuit with a generator and each succeeding energising coil or set of coils being in circuit with the induced coils of the next preceding energising coils of the series. (5) In a system for the electrical transmission of power the combination of an alternating current generator, a motor with an energising coil or coils connected with the generator, secondary coils in inductive relation to said energising coils, and energising coils in circuit therewith arranged in substantially the manner set forth to produce a movement or rotation of the points of maximum magnetic effect of the motor, as set forth. (6) In an electro-magnetic motor the combination of independent energising circuits, one for connection with a source of alternating currents, the other in inductive relation to the first, whereby a rotary movement or projection of the field poles will be produced by the conjoint action of the two and an armature mounted within the influence of the field produced by the energising circuits and containing closed coils or circuits, as set forth.

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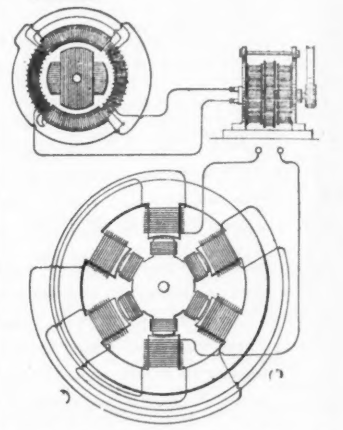
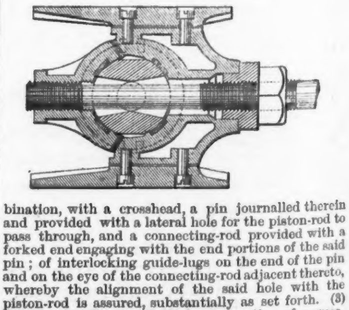


555,296. Crosshead, *G. A. Anderson, Waynesborough, Pa.—Filed August, 13th*, 1895.

Claim.—(1) The combination, with a crosshead, a hollow pin journalled therein and provided with tapering end portions and a lateral hole for the piston-rod to pass through, and a connecting-rod provided with a forked end engaging with the tapering end portions of the pin; of a plate bearing against the connecting-rod over the smaller end of the pin, a nut let into the said pin in front of its said lateral hole, and a pin passing through a hole in the said plate and screwed into the said nut, substantially as set forth. (2) The combination, with a crosshead, a pin journalled therein and provided with a lateral hole for the piston-rod to pass through, and a connecting-rod provided with a forked end engaging with the end portions of the said pin; of interlocking guide-lugs on the end of the pin and on the eye of the connecting-rod adjacent thereto, whereby the alignment of the said hole with the piston-rod is assured, substantially as set forth. (3) The combination, with the main portion of a crosshead, a cap, and a crosshead pin journalled in the said main portion and cap; of thin liners, and covers of soft material enclosing the said liners and interposed between the said cap and main portion, and means for drawing together the said cap and main portion, substantially as set forth.

555.296



WAGES IN THE ENGINEERING TRADE.

By J. STAFFORD RANSOME.

III.—THE CAUSES OF THE VARIATION IN THE RATES.

WITH a view of showing as nearly as possible the actual difference between the rates of wages in the various branches of the trade, I give below a list of them, together with the localities where the maximum and minimum rates obtain.

In explanation of this table, which is somewhat full and as up to date as can be, I would say that it is possible that, in a few instances, there may be districts in which wages exceeding those recorded as the maximum and minimum are paid. But if such is the case, I have been unable to obtain data with respect to them. With this reserve, it is merely necessary to point out that, as far as my particulars go, the variations given in the table represent the extremes between the maximum and minimum rates. In other words, the figures in the fourth column indicate the amount per cent. which would have to be deducted from the maximum rates, to bring them down to the level of the minimum.

It is as well to mention that in some of the towns a variety of rates are paid to men who are classed under the same trade. Consequently it does not follow that some of the towns in the minimum column do not pay a portion of their men at higher rates, nor that some of the towns in the maximum column do not pay a portion of their men below the maximum rate. The most extreme instances of this are afforded in the case of the West Hartlepool and Tees districts, where the wages of "felters" are both lower and higher than anywhere else in the country; and, with regard to the wages of millwrights, Birmingham will be found to figure in both the minimum and maximum columns.

I quote no figures of the actual wages paid in any case, as much of the information given me on the subject is of a more or less confidential nature. The percentage method, however, affords a clear means of showing at a glance the comparison of the standards. Then, again, the actual wages are continually changing, whereas the portions between the rates do not vary nearly so much.

Table showing the Extremes of Rates of Wages in various Districts, and the Amount of Variation between Maximum and Minimum Rates in each Section of the Trade.

Sections of the trade.	Localities where the minimum wage is paid.	Localities where the maximun wage is paid.	*Amounts of variation in rates. p.c.
Angle iron smiths	Glasgow	London	30
Angle iron strikers	Glasgow	London	79
Boat builders	Dartmouth	Newcastle-on-Tyne	80
Boiler men	Belfast	Newcastle-on-Tyne	46
Brassfinishers	Lincolnshire	London	42
Brass moulders	Birmingham, Leeds	London, Bolton	31
Cabinet makers	Sunderland	Newcastle-on-Tyne	4
Caulkers	Glasgow	Tees, Hartlepool	18
Chippers	Lincolnshire	Tees, Hartlepool	51
Coppersmiths	Belfast	Cardiff	31
Crane men	Dundee	Tees, Hartlepool	42
Engine men	Bedford, Bolton	Bolton	57
Dressers	Belfast	Tees, Hartlepool	67
Erectors	Dundee	London	34
Felters	Tees, Hartlepool	Tees, Hartlepool	37
Fettlers	Belfast	Tees, Hartlepool	69
Firemen	Stroud	Lincolnshire	50
Fitters	Barnsley, Dundee	London	37
Fitters' labourers	Dundee	London	37
Flangers	Southampton	Birmingham	6
Foundry labourers	Stroud	Cardiff	48
Furnacemen	Liverpool, Birkenhead	Barrow-in-Furness	32
General labourers	Glasgow	London	66
Grinders	Lincolnshire, Belfast, Manchester	Sunderland	52
Hammermen	Belfast, Newcastle-on-Tyne	London	23
Hand drillers	Belfast	London	48
Holders-up	Glasgow	London	30
Iron moulders	Barnsley	London, Sheffield, Manchester, Liverpool, Bolton	36
Joiners	Dartmouth	London	40
Platers	Leicester	London	33
Platers' helpers	Bradford	Sunderland	53
Machine borers	Belfast	London	61
Machine drillers	Belfast	East of Scotland	51
Machine screwers	Belfast	London, Barrow-in-Furness	51
Millwrights	Birmingham	London, Birmingham	35
Outworks men	Dundee	London	35
Packers	Glasgow	Liverpool, Birkenhead	10
Painters	Belfast	Barrow-in-Furness	65
Patternmakers	Keighley	London	30
Planers	Lincolnshire	London	52
Plumbers	Lincolnshire	Barrow-in-Furness	40
Polishers	Belfast	Newcastle-on-Tyne	10
Punchers	Leeds	Lincolnshire	37
Red-leaders	Belfast	London	38
Riggers	Tees, Hartlepool	Liverpool, Birkenhead	22
Riveters	Bradford, Leicester	London	27
Rivet boys	Southampton	East of Scotland	52
Sail-makers	Newcastle-on-Tyne	London	16
Sawmill men	Belfast	Hull	46
Sawyers	Barrow-in-Furness	Barrow-in-Furness	47
Shapers	Dundee	London	47
Shipwrights	Hull	London	20
Slingers	Manchester	Newcastle-on-Tyne	29
Slotters	Lincolnshire	London	52
Smiths	Bedford, Huddersfield, Leicester, Lincolnshire, Stroud	London, Sheffield	40
Smiths' finishers	Belfast, Tees, Hartlepool	Belfast	18
Smiths' strikers	Portland	London, Cardiff	40
Spar-makers	Tees, Hartlepool	Liverpool, Birkenhead	16
Strappers	Glasgow	Liverpool, Birkenhead	10
Turners	Barnsley	London	47

* The percentages given in this column represent the extent to which the minimum rate is lower than the maximum.

On reference to the above table, it will be seen that the amounts of variation differ greatly in the various sections of the trade; the smallest difference being 4 per cent., and the highest 79 per cent. In the more important trades such as erectors, fitters, iron moulders, millwrights, patternmakers, platers, and riveters, the extremes are not so great, the minimum, speaking roughly, amounting to about two-thirds of the maximum. The above sections, with the smiths and machine hands, such as turners, slotters, planers, and so on, may be said to form the chief trades followed in ordinary engineering works; but the variation in the rates of pay of smiths and machine men is naturally greater than in the trades first named, as the degrees of skill brought to bear in them is very much more marked. A "smith" may mean anything, from a man doing rough routine work of a very simple nature to an extremely high-skilled man, who is working intelligently to elaborate and complicated drawings. Then, again, some "machine men" draw as much as 50s. a-week, while boys and labourers are largely employed on the commoner class of work, and come under the heading of "machine men." In some of the cases where the table shows a very great discrepancy of rates, this is to be partially attributed to the very different class of engineering work carried on in different districts. For undoubtedly a certain class of work will often attach itself to an individual district. It does not, however, in the least follow that the quality of work turned out by two firms in opposing districts, where the wages standards are quite different, should not be equally good.

In looking into the causes of the great difference in wages, one really ought to put London on one side and deal with it separately. It is so immensely larger than any other district, its population being nearly ten times as great as that of any of the provincial centres; and, as the metropolis of the world, the conditions of the work carried on there, and the surroundings of the workers, are entirely different from those of any provincial town. To deal with London first, the great difference between London and provincial wages is to be attributed to a variety of causes. Of these, perhaps the most obvious lies in the fact that the metropolis is the wrong place in which to attempt to make ordinary machinery. Engineers have found out that it does not pay to manufacture a cheap or inferior class of machine in London, owing to the very high cost of raw materials, and the excessive expenditure entailed in handling goods and putting them on board ship. Then, again, high rentals and limited space tend to handicap the London manufacturer in turning out common machinery. There are, however, many very successful and important manufacturing engineering firms in London, but they may be divided into two classes: (1) Those who never attempt to do anything but a very high quality of work, and (2) those who confine themselves to manufacturing special or patented articles which cannot be made elsewhere. Such firms require only first-rate men, and can afford to pay them high wages. But in no case would it answer the purpose of men to take work in London at provincial prices; for apart from the fact that their living expenses are heavier in the metropolis, the hours of work are, as a rule, longer—fifty-four hours a week as against fifty-one, and sometimes forty-eight—and shop discipline as to timekeeping and so on is generally more strictly adhered to.

There is another class of London firm who occupy men in the engineering trade. I refer to the very large number of very small firms whose work is more accurately described as millwrighting than anything else, and whose business is essentially local. The *raison d'étre* of such firms is, of course, brought about by the enormous capacity of the London district and the vast sums of money annually expended there to keep its factories, ships, docks, &c. in repair. Much of this money is of necessity expended locally, and a very great deal of it finds its way into the little repairing shops. Such firms have, of course, to pay the local rate of wages, although the work turned out by them is often quite inferior; for, owing to the large number of petty employers, and the hand-to-mouth manner in which many of them carry on their trade, they are unable effectually to combine for the purpose of reducing wages.

Another great cause of the high wages of London is to be found in political influence. For many years past the labour question has been one of the accepted matters for politicians on both sides of the House to juggle with; for to accord something or other, good or bad, to the working man has often served to bring into notoriety public men of various shades of opinion. The Government factories have naturally formed the happy hunting-ground of these gentlemen, and as London and the district abound in this class of institution, the metropolitan wages have been subjected to a far greater political pressure than those of any other centre. In the engineering and shipbuilding trades, the influence of Woolwich, Enfield, Sheerness, and even Chatham are felt, and the influence is one which hampers metropolitan engineers by unduly lifting wages. In a Government shop the wages are always high, but they are surrounded by so many other advantages to the men, that private firms, who do not offer these advantages to their men, are forced to pay still higher rates. The advantages to the men, apart from the question of wages, in Government workshops where piece work is not the rule are:—

(1) That they need not work at all hard, as Government departments not being worked commercially, the cost of articles produced there is practically immaterial.

(2) Shop discipline is at a low ebb, as owing to the continual interference of politicians who are temporarily in power, the hands of the permanent managing staff are tied, and they are consequently unable to exercise a business-like control over the working arrangements.

(3) There is a greater chance for inefficient men to retain permanent employment, than is the case in private works.

(4) A considerable number of the permanent hands become, in the course of time, what is known as "privileged," and, among other things, become entitled to a pension.

There can be no sort of doubt that the existence of factories carried on under these conditions must materially influence the rates of wages paid by private firms in the neighbourhood, and, bearing in mind the influences which are constantly at work for keeping up the price of labour and keeping down the efficiency of the men employed in Government shops, one cannot be altogether surprised at the line adopted by certain London employers, who recently complained bitterly of so little Government shipbuilding being given out to firms in the metropolis. No doubt, if Government is largely instrumental in unduly keeping up the wages of the metropolis, it may be contended that it should be under some sort of a moral obligation with regard to the private firms who suffer from its action, to give them work at a higher price than would be paid to other firms more fortunately situated. But I am unaware that any Government in any country is in the habit of recognising moral obligations of any sort, and my personal opinion is that any endeavour to enforce a moral claim of this sort would prove a very arduous and profitless undertaking.

Reverting to the question of engineering wages generally throughout the country, the four chief influences which directly determine and control the rates are undoubtedly:—

(1) The degree of local competition for work between the men.

(2) The degree of local importance of the industry; or, in other words, the proportion of the men in the trade to the total local population.

(3) The size of the local firms employing the men.

(4) The local cost of raw materials.

There are two other influences which occasionally, and in a strictly limited manner, may be considered to have some direct effect on wages. These are:—

(5) The cost of living.

(6) The quality of the work turned out.

To deal with the last two points first, I am bound to say that, with the exception of London, I cannot find any important centre where the rates of wages seem to be proportionate to the cost of living, as compared with other towns. The only other marked instances of this rule holding good are to be found in little out-of-the-way places, where there is no doubt that wages and living are often both extremely low. In the long run the increased cost of living, or, in other words, the advance of civilisation, is undoubtedly the main cause of the steady rise in wages; but, speaking locally, I do not find that one can with any accuracy say, in comparing the big provincial centres, that the engineering wages are proportionate to the cost of living.

With regard to wages corresponding to quality of work, this is extremely limited in the engineering trade. As explained in a previous article, by far the greater part of the trade union energies in this industry have for years been devoted to endeavouring to level up the wages of the inferior men, and leaving the better class of men to shift for themselves; and it is only natural that the great pressure brought by the trade unions, while failing to raise wages all round, should show some results in the way of distorting the pay sheet in favour of the inefficient workman. Consequently we see, over and over again, factories working side by side where the wages are the same, but the quality of the work entirely different.

It is only when we find whole districts devoted to one particular class of engineering work, and are able to compare them with other whole districts which are devoted to another class—higher or lower—of engineering work, that we can see that occasionally the wages in the districts where the rough work is done are lower than those of the other districts. But even this rule is not a very safe one, all along the line.

The first four influences mentioned in the above list afford really the important, or at all events the palpable reasons for the variations; and as they are all more or less dependent on each other and run together, they may be considered simultaneously. Most people are agreed that where there is an abundance of labour, there will be a tendency for wages to be cheap. That is so obviously a truism, that no argument is necessary to enforce the statement.

The supply of labour in a given industry is greatest in localities where such industry is large in proportion to the size of the district. The reason for this is, that a considerable proportion of the inhabitants are born and bred to that industry, and from father to son learn the trade as a matter of course. In fact, the inhabitants of those centres live in an atmosphere of that industry, and it is an effort rather than otherwise to emancipate themselves from it and learn another trade. In short, it is the natural industry of the place. The neighbourhood itself has a great hold on the men and their families. They are born there, and their social surroundings are there, and only such of them as cannot get on, or are tempted by higher wages elsewhere, trouble to leave the place.

It will be found that in measure as an industry becomes important locally, so the firms, who find employment for the men in it, become large and powerful. Such firms are in a far better position to afford continual work to a large number of hands; and in many other ways large firms are preferable to small ones from the point of view of those employed. Where firms are large, it will, in nine cases out of ten, be found that raw materials are cheap in the district, for it is only in such places that firms develope into colossal proportions, unless they are kept going by artificial or extraneous influences. For it naturally does not pay under ordinary circumstances to employ thousands of men in making machinery in districts where every pound of coal and iron costs more than it does elsewhere.

Thus in London there are very few large firms, but an enormous number of medium and small ones. Raw materials are high, the proportion which the engineering industry bears to the total population is insignificant, the labour supply spasmodic, living is more expensive than elsewhere, and as a rule nothing but high-class work is turned out in the metropolis; consequently wages arehigh—the highest in the country. The next four centres where wages are highest—Sheffield, Manchester, Birmingham, and Liverpool—are all better off as regards raw material, but the engineering firms, with the exception of some in the Manchester district, are mostly comparatively small. The labour supply is small in proportion to the population, Sheffield and Birmingham having as their staple industries their cutlery and hardware trades, and as engineering centres they are not very important. Liverpool is more a shipping port than an engineering centre, and Manchester, though a big engineering centre, has cotton and dry goods as its overwhelming industry. Perhaps the quality of the Manchester work has something to do with its high wages; but, in any case, the labour question there has had to submit to be handled from time to time by local politicians and faddists.

Newcastle, Sunderland, and Glasgow, are examples of centres where an excellent quality of work is turned out, but where wages are low. They are natural engineering and shipbuilding centres, and very large ones. Raw materials are cheap, and plenty of labour is forthcoming.

Belfast, where a precisely similar work is carried on, and where living is certainly no more expensive, pays higher wages, for the reason that the proportion of the engineering element to the total population is not so great. Belfast wages are, however, cheaper than those of Bolton, Liverpool, Birmingham, Manchester, Sheffield, and London, because the trade in that town is mainly in the hands of a few large firms.

To sum the whole matter up, it would appear that wages are low in such districts as by their position and surroundings may be termed the natural homes of the industry, and high where that industry is carried on under artificial or forced circumstances. One can readily understand, however, that for one reason or another a great deal of manufacturing engineering must be carried on in the "unnatural" districts, but when such is the case the employers have to depend either on the nature or the quality of their work to bring them in better prices and recoup them for their heavier outlay.

Going a little further back into the general question, I would say that nature and the railway companies have a great deal more to do, primarily speaking, with fixing the localities and wages in the engineering industry than have either master, man, trade union, or politician. For nature points out the localities where the work can be carried on cheapest, and the railway companies determine how far other districts may be artificially brought in to serve the same purpose, and the rates of local wages are as a matter of course dependent on these considerations.

RAILWAYS IN ASIATIC TURKEY.

A far-reaching interest attaches to the report furnished to the Foreign-office by Major E. Fitzgerald Law, and published as a parliamentary paper, treating of the railways in Asiatic Turkey. In compliance with the instructions received by him from Sir Philip Currie, the British Ambassador at Constantinople, Major Law, prior to the preparation of his report, went over all the railways which have been established in that part of the Sultan's dominions, with the exception of the short line between Jaffa and Jerusalem. It is a singular fact, and one which Major Law says is not very easily to be accounted for, that whereas at the outset railway enterprise in Asia Minor was entirely in English hands, only one line—the Smyrna-Aidin Railway—continues so at the present time. The circumstance is obviously important as regards the general interests of British trade. Not only has the supply of large quantities of railway material been obtained from other countries than Great Britain, but the diminution in the number of Englishmen employed also operates adversely.

Respecting the future, Major Law does not expect any important extension of the railway system in Asiatic Turkey at an early date, beyond the completion of railways already commenced. But although there is no immediate prospect of the construction of the Euphrates Valley Railroad, Major Law admits "the practical certainty that such a road will sooner or later be built." He speaks of the Euphrates Valley and the Persian Gulf as "the inevitable mail route to India." This, however, waits on the construction of direct rail communication between Bussorah and Western Europe *viâ* Constantinople. Until such direct communication is established, Major Law is of opinion that the idea of a route to India through Turkey, even for mails, is little better than a dream. With regard to the general use of such a line, Major Law is doubtful if forty-eight hours could be saved, as compared with the Suez Canal, in taking this route to Bombay. If this be all, he "cannot believe" that such a comparatively small saving of time would be found an adequate compensation for the trouble and expense involved in two transhipments, one at Haifa on the Mediterranean coast, and the other at Bussorah.

The Haifa-Damascus-Hauran Railway, with its authorised branches, is described as one of the most important of existing or proposed railways in Asiatic Turkey. At present it belongs mainly to the projected class. It has been thought that this line was destined to become the terminal of the "much talked-of" Euphrates Valley Railway, which, by connecting the Mediterranean with the Persian Gulf, would, it is assumed, become the great highway to our Indian Empire. On this point Major Law says, "Whatever may be the importance of a railway from Haifa to Damascus, it seems to me improbable that this line will ever form part of an important route to India." When all existing conditions are fully considered, it seems clear, according to Major Law's judgment, that the Suez Canal must remain the proper route from Central and Western Europe to India for goods, troops, "and all passengers who are not careless of money, and who are not under pressing necessity to try and save one or two days on their journey." Among the varied proposals for railway construction which are still *in nubibus*, two are specified as worthy of consideration, and one of these has its bearing on the question of a route to India. This is the proposal to make a railway between Bagdad and Khannikin, on the Persian frontier. The special value of such a line, we are told, lies in the fact that ultimately it would almost certainly become an important section of a great trunk line connecting Teheran, Bagdad, and the Bosphorus, "perhaps reaching India by a branch from Kermanshah, through Ispahan and Yezd, eastward." The present road from Bagdad through Khannikin into Persia is described as the only one which presents no serious physical difficulties for communication between the Persian Gulf and the great central plateau of Persia—the most populous and fertile portion of the country. All heavy merchandise from India, for Ispahan or Teheran, now takes the route of the Persian Gulf to Bussorah, thence by the Tigris to Bagdad, and by Khannikin into Persia. Physical conditions appear to point out that "the great caravan road of the past" will become "the great railway highway of the future." With such prospects, there appears fair reason to suppose that a Bagdad-Khannikin railway would at once pay its way, and would stand in no need of a Government guarantee.

Financial difficulties have delayed the construction of the railway from Haifa to Damascus, so that up to the end of last September only five miles of permanent way had been completed, and there was no sign of any early renewal of the work. A recent letter in the *Times* is still further discouraging. The situation is rendered the more critical by the circumstance that the term of the original concession is expiring, and its renewal to the same parties is certain to be strenuously opposed by those interested in the rival railway already working from Beyrout *viâ* Damascus, to Mezerib in the Hauran, and proposed to be extended towards Djebel-el-Druz. The Beyrout Railway is throughout a narrow gauge line, a metre wide, and the several gradients encountered in crossing the Lebanon and Anti-Lebanon ranges have rendered it necessary to adopt the Abt system, with a third or rack rail, for the greater portion of the distance between Beyrout and Damascus. On the Lebanon range the railway attains an altitude of 4895ft., with an abrupt fall into the valley between the two ranges. With regard to proposals for extending the Beyrout-Damascus line northward, Major Law says it would seem impossible for a tortuous and narrow gauge railway passing over great altitudes to serve as a satisfactory terminal to an important trunk line. The Beyrout Railway is said to labour under the disadvantage of a defective harbour, whereas Haifa is described as being "by far the best natural port for large ships on the Syrian coast," and as capable of being improved at comparatively small cost. If such improvement is effected judiciously, it is thought that Haifa will become the most important commercial port south of Smyrna. The Damascus-Mezerib line commenced working in July, 1894, and the Beyrout-Damascus section has been opened quite recently.

The Jaffa-Jerusalem line, fifty-two miles in length, opened towards the close of 1892, has not yet proved very profitable in its working. A prolongation to the sea may improve its goods traffic, and an important increase of production for export may be expected to result from the establishment of the Jewish colonies in Palestine. The concession includes the right to make branches to Nablouz and Gaza. The railways so far described, and having their termini on the sea coast at Beyrout, Haifa, and Jaffa, are the only lines in Syria which have been to some extent constructed, or on which any serious work has been done. But a concession has been given for another line, from Damascus to Biredjik, on the Euphrates, proceeding by Homs, Hama, and Aleppo. This line would be about 280 miles long, and the concession has been taken over by the same company which owns the Beyrout-Damascus-Hauran Railway. Major Law remarks that at one time the project assumed great importance, on the supposition that the Anatolian Railway would be rapidly pushed forward to the head of the Euphrates, and that, by a junction on that river, Damascus and Aleppo would be placed in communication with a grand trunk line from Constantinople to Bagdad. But Major Law says, from all he can learn, it seems unlikely that the Damascus-Biredjik Railway will be proceeded with immediately. The concessionaires have been endeavouring to get the track of their line altered, so as to turn off at Homs and proceed to Baalbek, to join the Beyrout-Damascus line in the Lebanon Valley. This would deprive Damascus of a direct line to Aleppo. A project for a narrow-gauge railway along the Syrian Coast from Tripoli southward is one of the two proposals already referred to as worthy of consideration.

There are five railways working in Anatolia. These are the Anatolian line, the Smyrna-Aidin, the Smyrna-Cassaba, the Mersina-Adana, and the Moudania-Broussa. The first of these is the most important railway in Asiatic Turkey, the conceded mileage being, approximately, 875 miles. The lines from Haidar Pasha, near Scutari, to Angora, and from Eskishehr to Akshehr, a total of 528 miles, were open at the close of last year, and the final section of the Koniah branch, about 105 miles in length, will be working by the end of the present year. The remaining 242 miles which have been conceded represent the prolongation from Angora to Cæsarea, but it is unlikely that this portion of the undertaking will be open for some years to come. The construction of a railway meets with a somewhat peculiar difficulty in Turkey, owing to the circumstance that the Government allows no explosives to be used for blasting purposes, except the gunpowder which it furnishes itself, and which is apt to be none of the best. The Anatolian line is single throughout, but of the ordinary gauge, called by Major Law "broad," in distinction from "narrow." The rails and sleepers are of steel, and have been supplied exclusively from Germany, by the Essen and other large establishments. The orders for metal work for bridges were distributed in France, Belgium, and Germany. The last-named country furnished all the rolling stock.

In contrast with the Anatolian railway, the Smyrna-Aidin is a purely English undertaking. Major Law accordingly says it is satisfactory to note that so far this is "the only railway in Asiatic Turkey which, on its own merits and without Government assistance, has proved a profitable concern." The original length of the line to Aidin only was about 81 miles, but frequent extensions, including branches, have brought up the total to 318½ miles. A further prolongation of the line, so as to bring it to Tchai, where a junction could be effected with the Anatolian railway, is pronounced necessary, and must some day be made. The course of the Aidin Railway to Diner, with its projected extension to Tchai, marks the route by which the famous ancient cities of Asia Minor conducted their important commerce with the interior of Anatolia, "and pushed their trade eastward to the Euphrates and the Persian frontier." But the concession for extending the Aidin line to Tchai is held back, under influences doubtless operating at Constantinople. The Smyrna-Cassaba line, running parallel with the Smyrna-Aidin, at an average distance of about 40 miles, finds favour with the Turkish Government, and is expected to compete with the Aidin line. If the only flourishing railway in Asiatic Turkey can be damaged, we may presume there will be rejoicing somewhere. The present length of the Cassaba system is 165½ miles, but an extension to Karahissar will add 154 miles. The other two railways situated in Anatolia are of minor importance. The Mersina-Adana is only 41¾ miles in length, but would undergo great development if extended to Marash and Biredjik, supposing Biredjik to be connected with Damascus. The Moudania-Broussa Railway is still shorter, being only 26½ miles in length. It connects the ancient Ottoman capital Broussa with Moudania on the Gulf of Isnik, in the Sea of Marmora.

The history of railways in Asiatic Turkey is not satisfactory, either for England or for Turkey herself. Of four railways in Asia Minor built with English capital and English material, under English management, only one remains as an English undertaking, neither has there been any English participation in the great enterprises of the Anatolian Railway, or the reconstruction and extension of the Smyrna-Cassaba. The Aidin scheme was clearly founded on a commercial basis, and has prospered. Other projects have been bolstered up by Government guarantees, and the lines have followed the routes which the Government desired, the question of traffic development being thus treated as a secondary consideration. The new railways in Turkey have been financed by French and German banks, more speculative than those of England, and as a result British influence has been overborne. To the Turkish Government the guarantee system is working in a manner little less than disastrous. The conditions are so singular as to give the railway companies—to use Major Law's expressive phrase—"a direct interest in discouraging traffic." The companies are guaranteed a certain return, and the less they earn in the shape of gross receipts the more they get from the Government. To develope their traffic the companies must necessarily increase their working expenses. But for this they get no compensation. Hence such expenditure is a dead loss. The system seems too absurd to last; but it exists, and is eminently Turkish. The Smyrna-Aidin Company has no guarantee, and as it benefits by every increase in the traffic of its line it exhibits an exceptional prosperity. The Turkish Government is burdened by its guarantee system, and is supposed to have learned sufficient wisdom to abstain from giving any more guarantees, at least for a long time to come. For the present Turkey may be congratulated on having 1211¼ completed miles of railway in its Asiatic territory, out of 2285¼ miles for which concessions have been granted.

MUNICIPAL ELECTRICAL ASSOCIATION.

The first annual Convention will be held in London on the 10th, 11th, and 12th inst. The following programme has been issued :—

Wednesday, June 10th.—General meeting for the discussion of papers: Royal United Service Institution, Whitehall, S.W., 10.15 a.m. President's Address: "The Municipal Electrical Association and its Objects." Papers for discussion: (1) "Electricity Supply at 220 Volts," by A. S. Barnard, borough electrical engineer, Hull; (2) "Alternating Current Stations and High-voltage Lamps," by Harold W. Couzens, borough electrical engineer, Taunton; (N.B.—Papers Nos. 1 and 2 will be taken together for discussion); (3) "The Control by Municipal Authorities of Consuming Devices and the Wiring connecting them to the Mains," by C. H. Wordingham, city electrical engineer, Manchester; (4) "Electricity Works Records," by A. B. Mountain, borough electrical engineer, Huddersfield. Adjournment, 1 p.m. Visit of inspection to the works of the London Electric Supply Corporation, Deptford—chief engineer, Mr. P. W. D'Alton—4 p.m.

Thursday, June 11th.—General meeting for the discussion of papers: Royal United Service Institution, Whitehall, S.W., 10.15 a.m. Papers for discussion: (5) "The Cost of Electricity Supply," by Arthur Wright, borough electrical engineer, Brighton; (6) "Cable Specifications and Tests," by Joseph A. Jeckell, borough electrical engineer, South Shields; (7) "The Organisation of an Electricity Works Staff," by E. T. Ruthven-Murray, city electrical engineer, Worcester. Adjournment, 1 p.m. Reception by the Electric Lighting Committee of the Islington Vestry, Vestry Hall, Upper-street, Islington, 3.30 p.m. The Vestry Hall is within a few minutes' walk of the Agricultural Hall and of the Angel, at Islington. It is best reached from Charing Cross by cab or 'bus. Chairman of Electric Light Committee, Mr. S. Lambert. Discussion on paper: (8) "Combined Electric Lighting and Traction Plants," by John Hesketh, electrical engineer to the Government of Queensland, late borough electrical engineer, Blackpool, and John H. Rider, borough electrical engineer, Plymouth. Visit of inspection to the Islington Electricity Works, Eden-grove—within a few minutes' walk of the Vestry Hall—5 p.m.

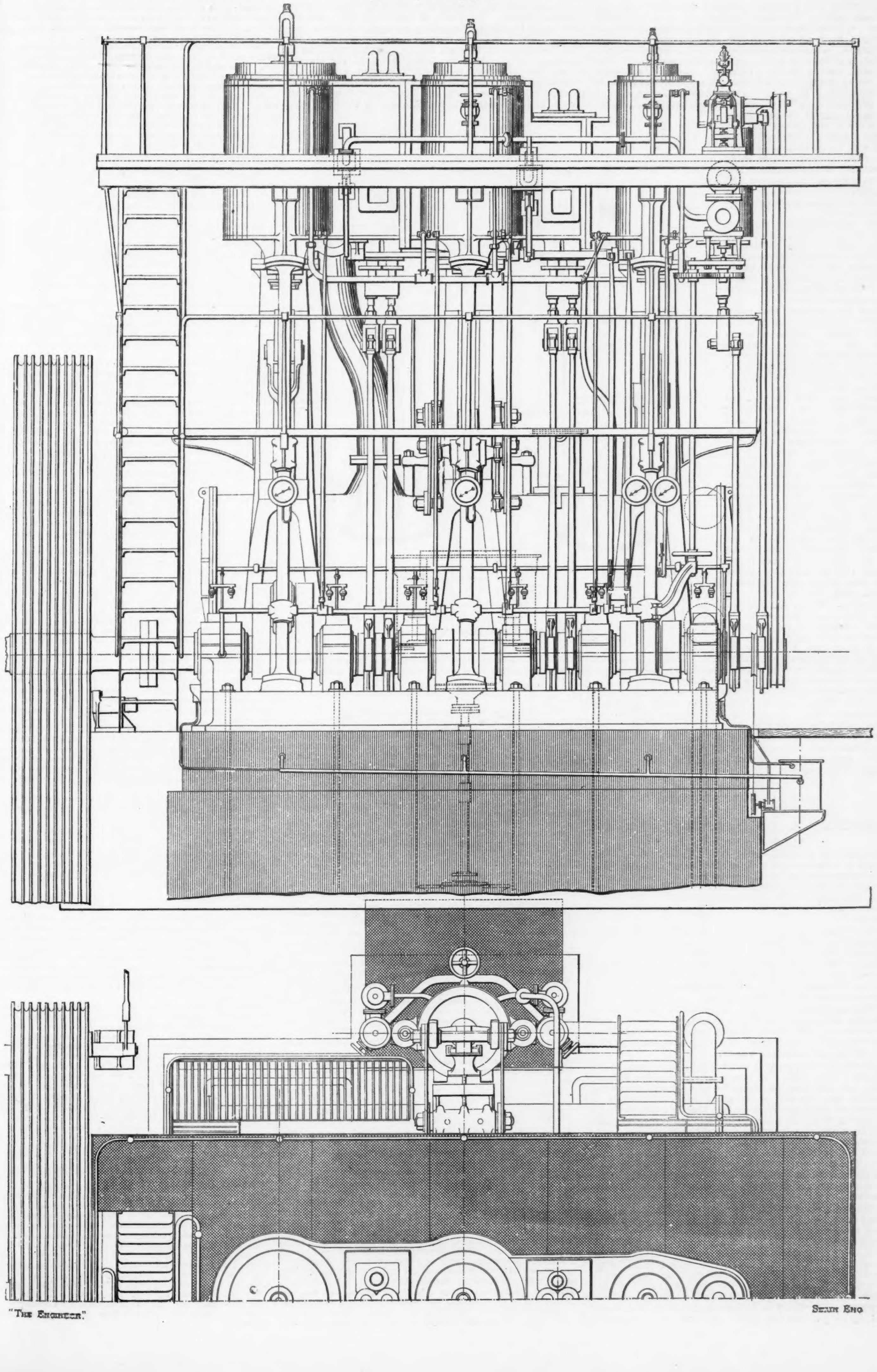
Friday, June 12th.—General meeting, for members and associates only: Royal United Service Institution, Whitehall, S.W., 10.15 a.m. Election of president, vice-presidents, three members of committee, officers, and place of meeting for the Convention of 1897; general business. Adjournment, 12 noon. Visit to Brighton by the 1.50 p.m. from Victoria or the 2 p.m. from London Bridge, arriving at Brighton at 3.15 p.m. and 3.20 p.m. respectively. Reception by the Electric Lighting Committee of the Corporation of Brighton at the Royal Pavilion, 4 p.m. The Mayor of Brighton, Alderman Blaker; the Chairman of the Electric Lighting Committee, Alderman Stafford. Discussion on paper: (9) "Extensions to Outlying Districts," by A. H. Gibbings, borough electrical engineer, Bradford. Visit of inspection to the Brighton Electricity Works, North-road, near the Pavilion, 5 p.m.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty. Engineers: Walter May, to the Alexandra, additional for the Spanker and Edwin Bell, to the Vivid, to the Salamander. Assistant Engineers: Arthur P. L. Dupen, for the Alexandra, additional, for the Spanker.

300-I.H.P. TRIPLE-EXPANSION MILL ENGINES

MESSRS. J. COCHRANE AND CO., BARRHEAD, SCOTLAND, ENGINEERS

(*For description see page* 560)



"The Engineer." Swain Eng.

300-I.H.P. TRIPLE EXPANSION ENGINE.

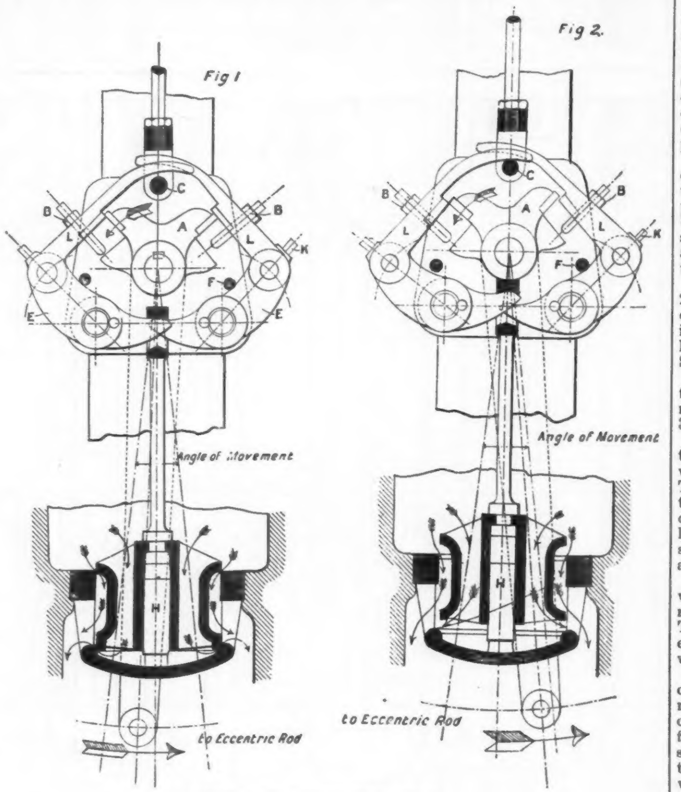
THE illustrations on pages 559 and 561 show a triple-expansion vertical mill engine made by Messrs. J. Cochrane, for a mill in the East.

It is fitted with a surface condenser, from which the back columns spring. The front columns are of polished mild steel. A piston valve is used for the high-pressure cylinder giving a fixed cut-off. To give an automatic cut-off the "Cameron" expansion apparatus is used, arranged to give a variation of speed of 1 per cent. from the mean speed. The essential features in the "Cameron" expansion apparatus are shown in Figs. 1 and 2; these clearly show the action of the apparatus. In order to put as little work as possible on the governor, stops B B are provided, which limit the amount of engagement of the steel faces on A and L, and prevent the end of the fingers L L coming in contact with the governor pin C until the valve is open, when it is practically in equilibrium. The valves of the intermediate and low-pressure cylinders are slide valves fitted with expansion plates having a fixed cut-off.

The usual practice of this firm is to fit such engines with Corliss valves and trip gear, at least on the high-pressure and intermediate cylinders, but it was particularly specified in the engine illustrated that the valves should be of the type described above.

The high-pressure and intermediate cylinders are jacketed with steam at boiler pressure, and are efficiently trapped. Metallic packing is used throughout. The low-pressure and intermediate cylinders are fitted with starting valves. The air, circulating, and feed pumps are worked from the intermediate cylinder by heavy mild steel levers. The circulating pump is placed immediately below the air pump, to which it is secured by three wrought iron stays. The level of the source of the circulating water determines the position of the circulating pump. The circulating water is forced through the lower set of brass condenser tubes, then through the upper set to the outlet. The power is transmitted to the mill by a grooved flywheel 15ft. in diameter, grooved for nine ropes 1¾in. diameter, fitted with barring gear. All accessories are most complete. The lubricant is pumped to the main bearings by an oil pump driven from the main shaft; the oil is drawn from a tank, the excess being returned thereto and filtered. Access to the various parts is obtained by middle and upper stages, which are protected by polished wrought iron hand-railing and columns. The boiler pressure is 160 lb. per square inch; revolutions ninety; cylinders 11½in., 18¼in. and 30in. by 36in. stroke; indicated horse-power 300. This engine has been working now for three years with excellent results.

Two Lancashire boilers 30ft. by 7ft. 6in., for 160 lb. pressure per square inch, complete with all steam pipes and economiser, were supplied with this engine and set to work by Messrs. J. Cochrane.



CAMERON'S EXPANSION GEAR

MARITIME CANAL OF THE LOWER LOIRE.

ACCORDING to a recent report of the United States Vice-Consul at Nantes on the trade of that port, notwithstanding unfavourable circumstances and the general crisis for some time in maritime commerce, transit by the canal has from the commencement caused an increased activity which seems destined to make Nantes one of the principal ports of France.

The object of the canal was to take the place for heavy navigation of that section of the river comprised between the extremity of the dykes—*à la Martiniere*—and Paimbœuf, in which are the highest banks and the most difficult channels to keep open. Work was commenced on the canal in 1882, and on September 1st, 1892, it was delivered over to navigation and completed the following year.

The canal proper is 9 miles 635 yards in length, and is closed at each end by locks 328ft. long, 122ft. wide, and with an entrance of 59ft. width. Close to each of these locks there is a basin 1148ft. 4in. long by 492ft. 1½in. wide, which permits the waiting and passing of vessels.

The width of the canal at water level is 180ft., and at the bottom or floor 90ft. At points one-third of the distance from each end there are docks for the passage of meeting vessels. On each side of the canal there is a towpath of broken and roller pressed stone, and also numerous stocks for embarking or disembarking agricultural produce or animals. The draught of vessels passing through the canal is constantly increasing, and although in its normal state the canal is supposed to furnish largely 19ft. 8¼in. of depth, a vessel drawing 21ft. 1¾in. has successfully passed, and with the aid of water drawn from the feeder—*l'achenean*—the level can be raised so as to permit during full tide the passage of a vessel drawing 24ft. 6in.

The number and tonnage of vessels passing through the canal have constantly increased from its opening to the present time. In 1892—four months—the figures were 123 vessels and 39,090 tons; in 1893, 595 vessels and 206,313 tons; in 1895, 791 vessels and 334,500 tons. The average tonnage has risen from 325 tons in 1892 to 423 tons in 1895. Although the canal has given satisfaction as to depth of water and its quick, easy, general working, the channel above the canal between Le Pellerin and Nantes is less satisfactory, although dredging has produced an improvement in access to the port. During the past two and a-half years, with very rudimentary machinery, the depth of the channel has been increased nearly 4ft., and with the proposed more powerful dredgers there will be entire satisfaction as to depth.

It was easier than at first anticipated to obtain a depth of 18ft. at low tide and still water, but it has been more difficult to maintain this result at all times of the year and under all circumstances. The means at disposal of the engineers have proved insufficient to remove promptly the sand bars formed by floods or ice, an example being the closing of the river for navigation through ice for nearly a fortnight in February, 1895. After the breaking up of the ice the channel was inaccessible to vessels drawing more than 16ft. of water for several days owing to defective dredging. This proved a salutary lesson, as the Chamber of Commerce of Nantes, in conjunction with the Ministry of Public Works, took steps to procure at once the appliances necessary to keep the channel always open with a 20ft. draught of water.

TESTS OF AMERICAN RIFLES.

THE Legislature of New York State in 1895 passed a law creating a Commission to examine and test such rifles of American invention and manufacture as might be submitted to it, with a view to the selection of a new rifle for the National Guard—militia—and some interesting trials have recently been made by this Commission, which is composed of Dr. R. H. Thurston, the Professor of Mechanical Engineering at Cornell University; Colonel A. D. Shaw, and Mr. E. W. Bliss, a manufacturer of machinery for ordnance and other purposes.

According to the report, the first gun tested was made by the Savage Repeating Arms Company, of Utica, being a hammerless magazine repeating rifle, with 28in. barrel, 0·30in. calibre, weighing 9¼ lb. without the sword bayonet. It is a lever action, the magazine, to hold five cartridges, being in the centre of the frame immediately behind the breech. There is no wide opening through the framework, which is the weak point of the Winchester rifle. The lever operating the breech-block works easily and smoothly. It can be used either as a single loader or as a magazine rifle. The magazine holds five cartridges, in addition to the one in the barrel. When used as a single-loader, an automatic cut-off prevents the magazine cartridges from entering the barrel. In this way the reserve ammunition is ever ready for use when a sudden emergency arises. No clip or case of any kind for the cartridges is used. They are simply slipped in on top, and are automatically ejected. This can be done so rapidly that the entire six are in the air together. The rifle is asserted to have a range of 2000 yards and a point blank range of 500 yards, with a trajectory of only 4ft. It was rejected by the Government when the Krag-Jörgensen rifle was selected for the United States Army, but has been improved upon since then. It holds the record for ten shots, fired at 100 yards in twenty-three seconds. The entire charge of six shots can be fired in less than four seconds, and 700 shots have been fired continuously.

The first test was fifteen shots at 200 yards, as a single-loader, by the manufacturers' expert with the rifle. The scores made were:—

Savage	4	4	3	3	3	5	4	4	4	4	4	3	3	4	4—56
Crane	4	2	3	0	4	3	4	4	4	3	4	4	3	5	3—50
Savage	4	3	4	4	4	4	4	3	3	4	4	4	3	0	4—52
Crane	3	5	4	4	4	4	4	5	4	3	5	0	4	4	4—57

Crane shot off-hand, while Mr. Savage used a rest. The mechanism was then carefully examined and the entire six shells were ejected with so much rapidity that the whole lot were in the air together.

Next came the test of endurance. Four hundred shots were fired at close range into a box filled with sand, the sides being of seasoned birch, 3in. thick. The shots were fired in rounds of fifty shots, with ten minutes' intervals to allow the gun to cool. The first round was fired, single loading, in three minutes; second, three; third, three; fourth, three; fifth, three and a-half; sixth, four; seventh, three; eighth, two and three-quarter minutes. The weapon was then closely examined and pronounced to be as good as at the start. Defective cartridges were then used to see if the block or extractor would jam, but they worked splendidly.

Next came the test of excessive and defective cartridges. The powder used was Wetterau smokeless powder, made at Wetterau in Belgium. The service charge is thirty-six grains, and this test called for a charge of forty grains. When the powder was weighed on the scale provided, it was found to be much more than the shell would hold. Mr. Savage thought the scale was wrong, and, with Private Crane and Secretary Abell, went to a druggist's and had the charge weighed. It was found to be seventy-five grains, enough probably, if it could have been put in the shell, to cause an accident and possibly burst the gun. Three of these charges were fired with a lanyard, the gun remaining uninjured. In one of these the primer was blown out of the shell. The next test was made with defective cartridges, the primers being thinned to a mere shell, so as to allow gas to escape. The shells were badly bulged, but the mechanism remained uninjured. The primers were burst, but the gun was as good as new.

The rifle had then fired over 470 shots, and as it had been cooled with water it was necessary to clean it before applying the sand test. This consists in placing the rifle in a box connected with a large bellows. Midway is a funnel containing fine sand. This is blown with great force into the box and permeates all the working parts of the rifle, the barrel being stopped to avoid injury to the rifling. The idea is to give the arm such a test as it would undergo in a long and dusty march. After each test six shots were fired by Mr. Savage, and the rifle behaved admirably. He was not allowed to clean the weapon except with his hand and by blowing the sand out just as a soldier in action would. The test was a severe one, and was made in these four methods, six shots being fired after each test. Only the first two were used at the Government trials. (*a*) Magazine empty, breech closed; (*b*) magazine full, breech closed; (*c*) magazine empty, breech open; (*d*) magazine full, breech open. One of the great features of this gun is that it is the only lever magazine rifle that can be operated from the shoulder position.

The next to be tested was the Briggs-Kneeland rifle, but several of the cartridges did not explode at the first pull of the trigger, the spring being too weak. The rifle is loaded with five cartridges placed in a metal frame, which is slipped down through the frame behind the slot that takes the cartridge when the gun is used as a single loader. In the magazine test for fifteen shots, Knapp scored 59 and Crane 53. With the exception that some cartridges refused to explode, the gun behaved well.

The cartridge used was the Lee navy, which has a diameter of 23·006, while the Army rifle has a calibre of 30·003. The pressure on the former is said to be something like 60,000 lb. to the square inch; on the latter, between 35,000 lb. and 40,000 lb. This rifle had a much more vicious bang and a far harder recoil than the Savage rifle.

Next came the endurance tests. Each round of fifty shots was fired in the following time, in minutes and seconds, with ten-minute intervals for cooling:—4.00, 4.00, 4.00, 3.20, 3.10, 3.18, 3.20, and 4.00.

The weapon stood the firing of these 400 shots well. The defective cartridge test came next. It was far from satisfactory, and was finally rejected by the Commission, and must be tried again. The idea is to thin down the primer so that the needle shall penetrate it and allow the gases to escape and so damage the mechanism or have a chance to injure the operator. They were fired with a lanyard. In neither case did the primer burst, and the Commissioners held that the requirement had not been fulfilled, and that a new test would be necessary.

The testing with excessive cartridges came next. The shots were fired with a lanyard, the shells, carrying forty grains of rifleite powder instead of the regulation charge of thirty-six grains. They went off with a terrific bang. The first one was difficult of extraction, indicating expansion of some of the parts, but the gun was apparently uninjured.

The Winchester rifle was the next, and closely resembled the ordinary Winchester sporting rifle. It carries five shells in the magazine, loading from the top. When the magazine is full it cannot be used as a single loader unless first one shot is fired from the magazine. If a shell is put in the breech slot, the weapon is at once jammed, unless there is one shell out of the magazine. The movement seems to work hard at two points, where there are apparently dead centres of motion to be overcome, which makes the action hard. There would be no difficulty in altering the gun so that the magazine would hold either six or ten cartridges.

The Winchester tested had a barrel 28in. in length of nickel steel, there being 4½ per cent. of nickel in the composition, and it is said that nothing else would stand the smokeless powder used. This is made at Wilmington. It is a nitro-glycerine powder, and not so smokeless as either the Wetterau or rifleite powders. Being weaker, 39 grains of it were used, as against 36 grains used in the other rifles.

In general appearance the gun exhibited does not differ in its action materially from the sporting rifle of the same makers. The magazine to hold the cartridges is below the breech, not tubular, as in the ordinary gun. The lever has two arms, which pass on each side of the magazine, connecting, of course, above and below. The bolt is the same in appearance as in the old weapon, with a hammer behind it.

The test began as usual by the company's expert firing fifteen shots at the 200-yard target. Then Private Crane followed. The score was:—

Van Dyke	4	3	4	4	4	4	4	4	5	3	4	4	5	4	5—61
Crane	4	5	4	4	5	3	3	4	5	4	5	5	4	5	4—64

This was good shooting, Van Dyke bracing against the rack, Crane shooting offhand. The gun kicked harder, according to Mr. Crane, than any other tried so far. The firing as a magazine gun came next, the score being:—

Van Dyke	4	4	3	4	3	4	5	4	4	5	5	5	5	4	4—63
Crane	4	2	2	4	4	4	2	3	3	3	4	4	5	4	5—53

This was a great falling off in Crane's work, but the gun had become so heated that the radiation absolutely obscured the target. The gun was allowed to cool off in the last string, and his shooting at once came back to his former average. In the fourth shot fired by Crane in the first round the sight was blown out, apparently by an escape of gas from the breech, but it could not be traced.

The endurance test followed. The time in minutes and seconds was:—4.30, 4.00, 5.00, 4.30, 3.45, 4.00, 3.45, 2.35. The gun stood the test well.

The test with defective cartridges came next. Mr. Van Dyke did not use a lanyard, but fired from the shoulder, braced as usual. At each shot, the escaping gas flashed up in a flame from the breech, but the gun and its handler were uninjured.

In the excessive charges test the same powder as used in the other tests was used. The gun was uninjured.

The rifle was then taken apart and assembled again. The same tests were then taken up, and the following scores were made under these conditions:—Fired—six shots after each exposure to dust blast during one minute. (A) Magazine empty, breech closed; (B) magazine full, breech closed; (C) magazine empty, breech open; (D) magazine full, breech open.

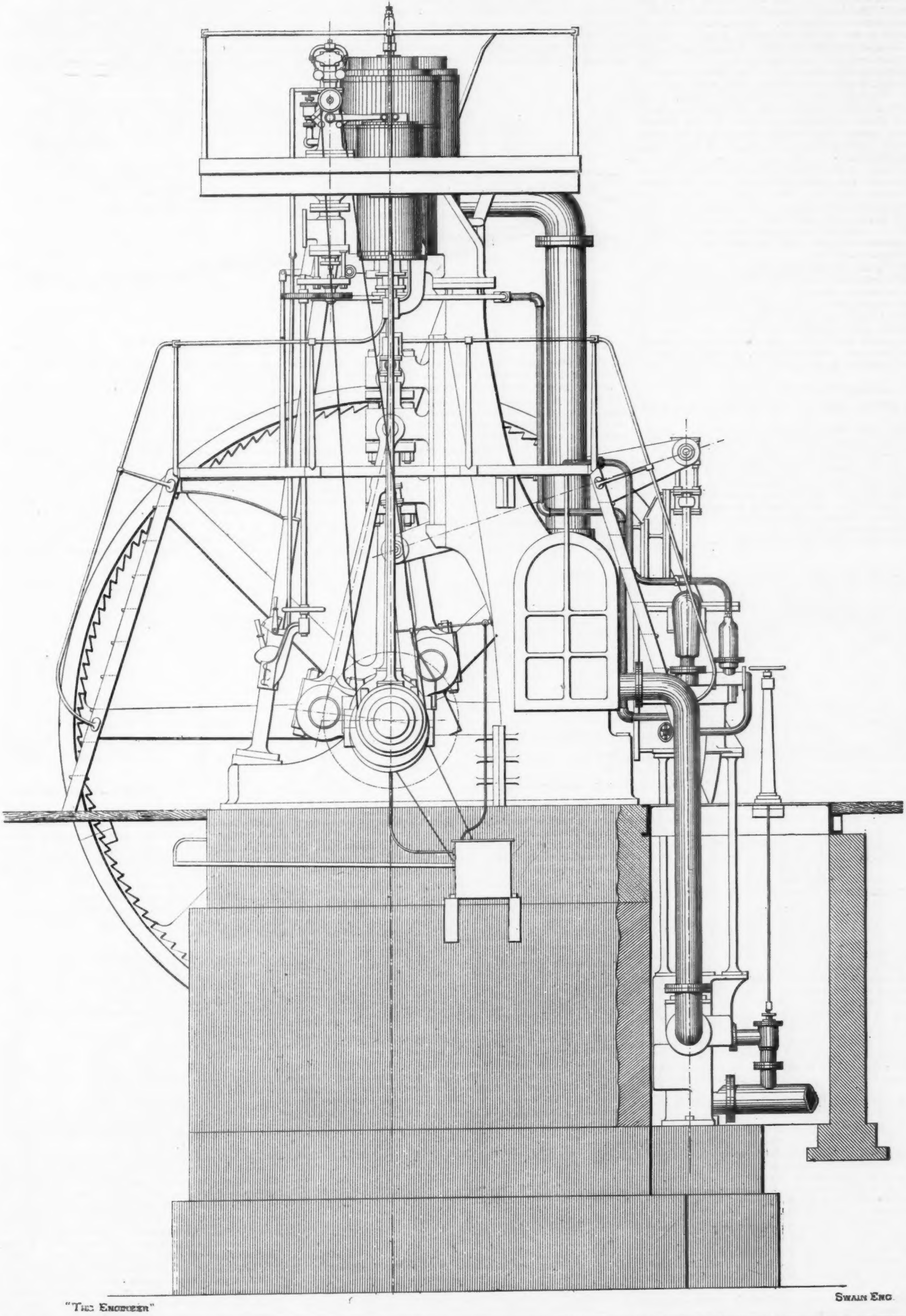
A	4	3	4	4	4	4—23
B	5	4	5	5	5	4—28
C	4	4	4	4	4	4—24
D	3	3	4	4	3	4—21

RAILWAY ACCIDENTS IN AMERICA.—The record of accidents for April includes 21 collisions, 72 derailments, and one other accident, a total of 94 accidents, in which 28 persons were killed and 104 injured. These accidents are classified by the *Railroad Gazette* as follows:—Collisions: Trains breaking in two, 4; misplaced switch, 2; miscellaneous, 10; unexplained, 5; total 21. Derailments: broken rail, 3; loose or spread rail, 6; defective bridge, 5; broken wheel, 1; broken axle, 9; broken truck, 1; fallen brakebeam, 1; failure of drawbar, 1; misplaced switch, 2; bad switching, 2; bad loading, 1; runaway train, 1; derailing switch, 1; animals on track, 1; landslide, 4; washout, 2; wind, 1; accidental obstruction, 3; unexplained, 27; total 72. Other accidents: Tornado, 1. Total number of accidents 94. Thus derailments constituted nearly 77 per cent. of the whole, and of these over 37 per cent. were unexplained.

300-I.H.P. TRIPLE-EXPANSION MILL ENGINES

MESSRS. J. COCHRANE AND CO., BARRHEAD, SCOTLAND, ENGINEERS

(For description see page 560)



THE LIVERPOOL DOCKS.

We last week called attention to the large addition to the landing-stage; we now chronicle the opening of a new branch to the Canada Dock and the widening and deepening of the lock entrance to the same dock. The new dock is almost ready for use throughout its extent, and the little that remains to be done, viz., deepening, is being rapidly executed by one of the Dock Board's powerful dredgers.

The Canada Dock was built about forty years ago by Mr. Jesse Hartley, the Mersey Dock Board engineer, with an entrance lock 500ft. long and 100ft. wide, in order to accommodate paddle-wheel steamers then used for the Trans-Atlantic service. These reached their climax in the famous Cunarder Scotia, which was long commanded by Captain Judkins, was the last of the paddle-wheel steamers so employed. When paddles gave place to the screw propeller it was thought that these wide entrances were no longer necessary, but the enormous increase in the length of ships has necessitated an increase in beam, and 100ft. openings have been built for some years. The draughts now required were unnecessary thirty or forty years ago, and the sill of the Canada Lock, which was for a long time the deepest on the Liverpool side, was laid 7ft. 9in. below O.D.S.; this has now been deepened to 14ft. below O.D.S., making this entrance the deepest on the Dock Estate; deeper by 2ft. than the entrances to the Alexandra group of docks, which were opened by the Prince of Wales in 1881, and which have entrances at the same level as the deep water docks at Birkenhead. It should be stated that the entrances to the Herculaneum, Harrington, and Toxteth Docks, at the south end, have already been deepened to the same level. The water in the group of docks from George's Pier to the south is impounded over low neap tides, and any loss made good by pumping from the river. By this means the effective depth of the docks is maintained at the depth of the lowest sills over which they can be approached, which is, as we have seen, 12ft. below datum. The docks at the north end are excavated below the level of their gate sills, so that pumping for this purpose has hitherto been unnecessary.

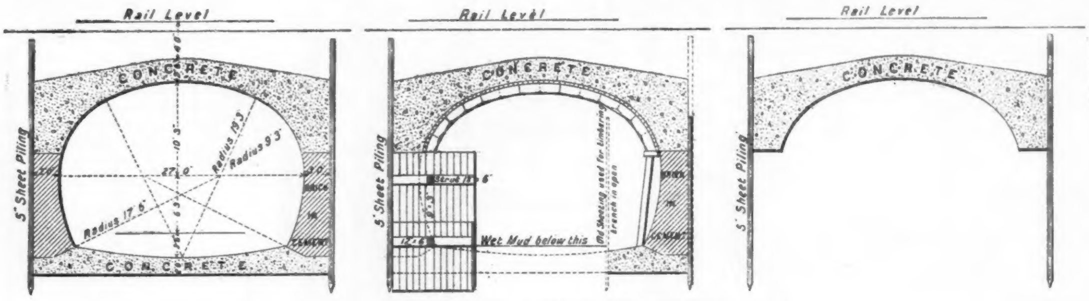
The entrance from the river into the Canada Basin has previously been widened from its original width of 250ft. to 390ft.; the basin has a water area of 9¼ acres. This forms the vestibule of the Alexandra as well as of the Canada group of docks. The Canada Dock has an area of nearly eighteen acres, and the branch will add another twelve or thirteen acres. Along the north side is a single-storey shed, 125ft. wide, while on the south a double-storey fireproof shed, 95ft. wide, has been constructed. At present the dock is entered on the north side only, but a new south entrance to the Huskisson Dock is in hand. When all is complete the water in the Canada and Huskisson systems of docks will be impounded, and there will be entrances to the Mersey for the largest steamers from both north and south.

The value of the new branch dock has been quickly demonstrated, for already the north and south sides are appropriated for the use of the White Star Line of steamers and the west side for Cunard steamers. The increased depth of entrance gives much more freedom of navigation. It provides 29ft. 6in. at mean high water, and with vessels drawing nearly 30ft. constantly plying from the port, the advantage of this extra depth is obvious.

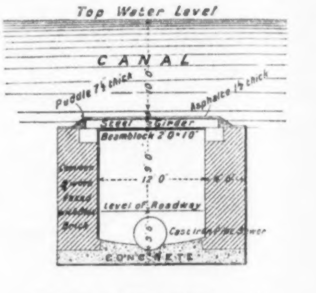
The level of the sills of the deepest docks was until recently about or a little below the level of the Mersey Bar; now the deepest entrance is 10ft. above the Bar, and the berths at the landing-stage are the only ones capable of accommodating deep-draughted vessels on certain tides. This points to deeper entrances being required ere long. These can be obtained by lowering the sills of the Birkenhead Docks or extending the Liverpool Docks to Dingle, a little higher up than the most southerly dock on the Liverpool side of the estuary.

THE DALMUIR AND CLYDEBANK RAILWAY.

Some little time back—The Engineer, August 16th, 1895—we laid before our readers some account of the construction of the tunnel for the passage of the Dalmuir and Clydebank Railway, beneath the North British Railway near Dalmuir, a work which had to be executed under exceptional conditions, which we fully detailed. As the entire line is now rapidly approaching completion, and presents several additional features of interest, we now purpose in brief outline dwelling on the extension as a whole.



COVERED WAY BENEATH THE RAILWAY



TUNNEL UNDER CANAL

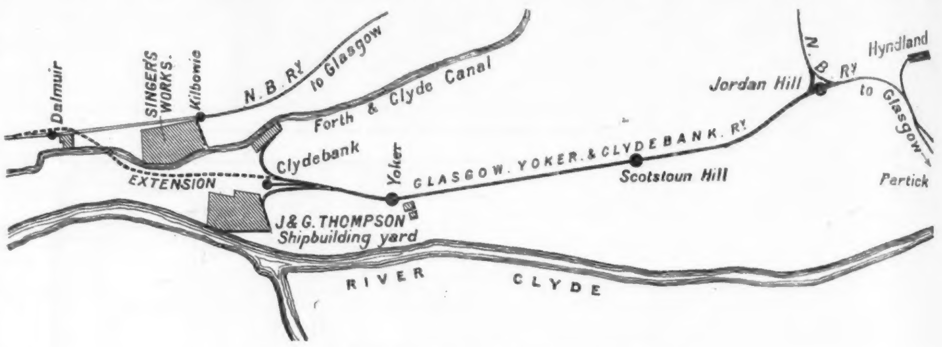
The Glasgow, Yoker, and Clydebank Railway was authorised by Parliament in 1878, and was opened for traffic in 1882, the line being worked by the North British Railway Company. It commences at the Stobcross branch of the North British Railway, about 3½ miles west of Queen-street Station, Glasgow, and passing Yoker, terminates at Clydebank, a distance of some 3¾ miles. The immediate reason for the construction of the line was the removal in 1872 of Messrs. James and George Thomson, the well-known shipbuilders from Govan to Clydebank.

So far back as 1878, the original promoters had purposed carrying the line on to Dalmuir to form junction with the North British Railway, and gain access to the Vale of Leven and the Clyde, but the Caledonian Railway Company, as owners of the Forth and Clyde Canal, raised difficulties, and the promoters had no choice but to make Clydebank their terminus. A year after the opening of the Glasgow, Yoker, and Clydebank Railway—viz., in 1883—efforts were again made to extend on to Dalmuir, but the same opposition being again encountered, the Bill was withdrawn. Seven years later—viz., in 1890—in connection with the passage through Parliament of the Lanarkshire and Dumbartonshire Railway Company's Bill, the Caledonian Railway Company withdrew its opposition, so far as the principle of extension was concerned.

In 1892 the Glasgow, Yoker, and Clydebank Railway sought the requisite powers for extension, but again failed to obtain them, its proposals for passing beneath the canal being deemed defective. In 1893 success was at length secured, the company undertaking to divert the canal, and not to tunnel beneath it by means of air pressure and shields.

The line as now constructed, though only 1 mile 7 furlongs 6 chains in length, presents difficulties of most unusual character, and in this short length a very large amount of arduous and difficult work has been executed. The district has been much built on of late years, whilst the crossings with the Lanarkshire and Dumbartonshire line—to be opened during the current year—have added to the difficulties encountered, amongst which the passages beneath the Forth and Clyde Canal and the North British Railway figured prominently.

Turning now to some short account of the route selected, the extension leaves the existing Glasgow, Yoker, and Clydebank line to the east of Clydebank station, and, passing north of it, ascends by a gradient of 1 in 70 until an elevation is reached sufficient for crossing the Lanarkshire and Dumbartonshire line—occupying the bed of the arm of the canal at this point—and the various streets now encountered, the bridges of which call for no special comment. On approaching the Forth and Clyde Canal, after gradients of 1 in 260, 1 in 160, a short level portion, and a further descending gradient of 1 in 56, passage is made beneath the Lanarkshire and Dumbartonshire Railway, which is carried over by a skew steel girder bridge; after which on a gradient of 1 in 1000, falling to 1 in 80, the canal is passed under on the level, and with ascending gradients of 1 in 88, the North British Railway is reached and tunnelled, junction being made with the North British Railway Company's rails to the west of Dalmuir station by rising gradients of 1 in 260, 1 in 88, and 1 in 487, two roads to the north of Dalmuir station being carried above the new line. The earthwork involved in the undertaking consists of 160,000 cubic yards of cutting and 96,000 cubic yards of banking. The arduous nature of the work may be gauged from the fact that on this short line no less than eighteen bridges occur, including the covered way near Dalmuir, under the North British Railway. Steel plate girders, with either trough flooring or cross girder and buckle plates, and masonry abutments and wing walls, are the type adopted.

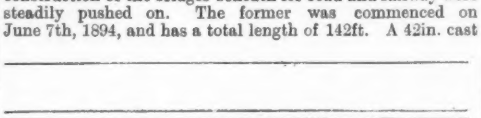


ROUTE OF THE DALMUIR AND CLYDEBANK RAILWAY

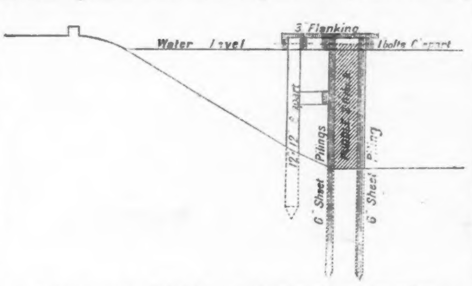
All superstructures were constructed by Messrs. Alexander Findlay and Co., Parkneuk Ironworks, Motherwell, N.B.

Passing now to consider the canal diversion, which forms one of the salient features of interest of the undertaking, and which has a length of 440 yards, two bridges occur, one carrying the canal over the road diversion, the other carrying it over the new railway. The earthwork cutting and banking involved in the diversion was 13,000 cubic yards and 36,000 cubic yards respectively. The puddle walls, which were 3ft. thick, were formed from boulder clay taken from an adjacent cutting, turned over two or three times and kept well watered, being subsequently left for a few days to get properly soured before being taken to the banks as required. The width between the puddled walls is 66ft. 6in., giving a width on water level of 62ft. The canal is 10ft. deep for a width of 27ft. in the centre, making the inclination of the sides 1¾ to 1. Except where the formation is on forced ground, where the puddle is made 2ft. thick it has a uniform depth of 12in. throughout.

Simultaneously with the canal diversion operations, the construction of the bridges beneath for road and railway were steadily pushed on. The former was commenced on June 7th, 1894, and has a total length of 142ft. A 42in. cast iron pipe is laid beneath the roadway and the foundations being in a water-logged alluvial deposit of sand and gravel. The foundations were 18in. thick, and of concrete, the sewers resting on the concrete invert, the abutments, which were 4ft. 6in. thick, being formed of common brick in cement, with blue brick facing. The above illustration gives the leading dimensions—a clear span of 12ft., and a headway of 9ft. The canal is carried on steel girders 1ft. deep, spaced 3ft. apart from centre to centre, and connected by 9in. jack arches of blue brick, having a 3⅝in. rise. The haunches were filled with concrete, and two layers of asphalte, each ¾in. thick, were covered by the puddle already described, and 7½in. thick over the roadway.



GIRDERS CARRYING CANAL

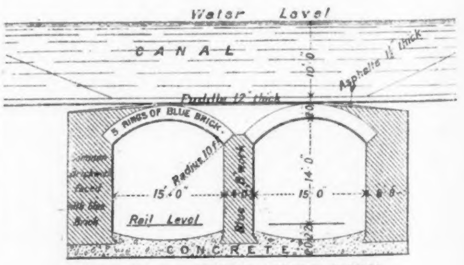


PILING AND PUDDLE WALL CANAL DIVERSION

We pass now to the railway bridge under the canal, which is entirely of brickwork and 260ft. long, consisting of two arches to save headroom, each 15ft. span. Two abutments, each 6ft. thick, and a 4ft. pier, the side walls, whose foundations being in wet mud caused considerable difficulty, were formed in trenches 18ft. deep by some 12ft. in width. The abutments are of common brick with blue brick facing, whilst the centre wall is entirely of blue brick in cement. The arches are formed by five rings of blue brick in cement, giving a thickness of 2ft., the haunches being built up with ordinary brickwork in cement. Two layers of asphalte, each ¾in. thick, completed the structure.

On completion of the bridges the cofferdams were commenced, each being formed of 12in. by 12in. bearing piles 6ft. apart. The piling frame was then carried on planking resting on these piles and on the towing path, and thus two rows of 6in. sheet piling, 15ft. to 20ft. long, were driven, a space of 2ft. being left between them for the puddle. The water was then pumped out, the old banks removed, and connection made with the deviation; the whole of the operations occupying less than a year. Four days after the admission of the water a leak was discovered, due, it was subsequently found, to the puddle having insufficient bottoming on the site of an old hedge—a defect which was speedily remedied. The piles were subsequently withdrawn by a pitch pine lever 12in. by 12in. and 17ft. long, four or five men working a hand winch with a 1in. steel wire rope, led through pulleys to the lever. By this means as much as 15ft. of the dam was removed per day. The covered way under the North British Railway, near Dalmuir station, has been so fully described and illustrated in our columns—The Engineer, August 16th, 1895—that it is unnecessary for us to again describe this salient feature of the new extension railway. Suffice it to add in continuation of our description of last autumn, that the arch stood nine months before the underpinning was commenced and executed in 6ft. lengths, considerable difficulty being experienced with water. It will be seen from the engravings that after the sheet piling was driven, the top earth was excavated, and the concrete arch formed as shown. The sides were afterwards built by partial excavation and underpinning.

The Portland cement used on the undertaking was required to weigh not less than 112 lb. per imperial—striked—bushel, and to bear a tensile strain of not less than 400 lb. per square inch after seven days' immersion in water. The concrete was formed of one portion of Portland cement to one of sand and five of broken stone, the mortar being composed of one part of Portland cement to three parts of sand. Steel rails weighing 84 lb. per yard, with 40 lb. chairs, are employed, there being twelve sleepers to each 30ft. rail. The engineers are Messrs. Simpson and Wilson, C.E., of Glasgow; Mr. James Andrew being resident engineer. The contractors are Messrs. Robert McAlpine and Sons, of Glasgow.



SECTION OF BRIDGE UNDER CANAL

Our illustrations, which deal with the canal and railway crossings, and the more salient features of interest of the undertaking, are self-explanatory, and being fully dimensioned, need no further comment at our hands.

Shipping Facilities at Natal.—Captain Froud, the Secretary to the Shipmasters' Society, writes:—"It may interest the shipping community to know that steamers of 5000 tons gross, 400ft. long, and drawing up to 20ft. of water, have lately entered the harbour of Natal, South Africa. The new dredger has done excellent work since she commenced operations early in February. The greatest difficulty at the port now is want of accommodation inside the harbour to meet the demands of the great increase of trade." The dredger referred to is the Octopus, constructed by Messrs. William Simons and Co., Renfrew.

RAILWAY MATTERS.

The Baldwin Locomotive Works have an order for sixty additional locomotives for Russia.

On Whitsun Monday the Great Eastern Railway Company conveyed, to stations within twenty miles of London, no less than about 132,000 passengers.

In the Chamber of Deputies, Rome, on the May 29th, the Duke of Sermodeta submitted the Italo-Swiss Convention with regard to the projected Simplon Railway.

Some of the famous 8ft. Great Northern single-driver engines will shortly be running with domes. Some new engines are being built with slightly larger fire-boxes. The old form of Great Northern Railway "pull-out" regulator is to be retained.

Five new engines have just been turned out of the Gateshead shops of the North-Eastern Railway, for the Scotch traffic, having four coupled drivers 7ft. 7¼in. diameter, and cylinders 20in. by 26in. We hope to describe these engines more fully later on.

Light rails for Japan are being manufactured at the Bay View Mills of the Illinois Steel Company, near Milwaukee, Wis., and will be sent to New York to be shipped by steamer to Japan. The order comes through the China and Japanese Trading Company The contract price is said to be 21·36 dols. per ton.

It was expected that the contracts for the 5000 cars to be built for the Baltimore and Ohio Railroad will be given out before the first of the month. The company invited bids on 5000 cars, 1800 of which are box, 1800 solid bottom coal, 400 drop bottom coal, and 1000 drop bottom coal with coke racks. It is rumoured that instead of 75 new locomotives the company will purchase 100.

An American contemporary says a street car with pivoted seats is being tried on the Grand-street and Desbrosses-street line in New York city. There are ten chairs on each side, facing towards the front of the car, the seats being supported on brackets. This enables seated passengers to avoid having their feet stepped on by those who are standing on or walking through the car. The seats are reversed at each end of the route by means of a lever. The car was built at the shops of the Dry Dock and East Broadway Railway Company.

The development of Staten Island as a residential district of New York is the purpose of several syndicates, which propose to extend the electric railways, build new roads, put faster ferryboats on the New York line, and establish new ferries to Elizabethport, Bayonne, and Brooklyn. *Engineering News* says two companies are already building electric railways extending back from the towns on the bay shore of the island. One of these is the Midland Electric Railway Company, and the other is the Staten Island Electric Railway Company.

In answer to a question in the House of Commons on Monday by Mr. Massey Mainwaring concerning the Snowdon Railway accident, Mr. Ritchie said the engineers are of opinion that the accident was caused by the locomotive mounting the rack, probably in consequence of a subsidence of the permanent way, caused by the melting of snow in a cutting. As the line was not constructed under any statutory authority, the provisions of the Railways Acts as to inspection do not apply. On the recommendation of the company's engineers, no passenger traffic has been carried since the date of the accident, and none will be carried pending the adoption of certain additional precautions suggested by the engineers to prevent the engine mounting the rack.

Although the East and West Coast Companies have found it advisable to run third class as well as first-class cars, the Great Western Railway is just starting first-class only. Wouldn't it be better, says *Moore's Monthly Magazine*, to once and for all vestibule the cars forming the train, provide a passage along all, and attach a refreshment or dining car on convenient sections of the run, and allow all passengers, irrespective of class, the opportunity of lunching or dining *en route?* With the present restrictive arrangements we are inclined to think the cars cannot be such a financial success as they would be if all limitations were removed. But it is the same with dining cars as with hundreds of other things. The new dining cars of the Great Western Railway are 59ft. 3in. long and 8ft. 6in. wide, on two six-wheeled bogies; weight, 27 tons 14 cwt. Dining accommodation is provided for sixteen people. The new service is between London and Cardiff.

Compressed gas for lighting railway cars is to be carried in 2in. pipes through the streets of Washington, D.C., to connect the works of the Pintsch Compressing Company with the stations of the Baltimore and Ohio Railroad, Baltimore and Potomac Railroad, and Southern Railway, and also to the river front, where it will be used for charging illuminated buoys for the Potomac River navigation. In reporting the Bill, Senator McMillan, of the committee on the District of Columbia, alluded to the project as follows, an American contemporary says: "Pintsch gas is used for lighting railway cars and buoys. The object to be gained is the lighting of the railway mail cars starting from Washington, thus doing away with the oil lamps, so dangerous in railway mail cars especially; also the furnishing of gas for lighted buoys on the Potomac. The Pintsch gas is in use all over the country, and there is no experiment in the matter. Indeed, the Bill simply provides for a commercial necessity."

From statistics just issued in Chicago, it appears that ten years ago there were but four tramway companies in Chicago, capitalised at 11,437,000 dols., and working a street mileage of 90 miles. To-day there are twenty-nine distinct corporations engaged in local transportation business, having an aggregate capitalisation of 187,208,000 dols., and operating 342 miles of street mileage. Of the four systems in existence ten years ago three were worked entirely by horses, the four using both cable and horses. Now the horse car has practically disappeared from Chicago, the motive power at present being:—Surface roads—electric, 255 miles; cable, 42 miles; horse, 18 miles. Elevated roads—electric, 15 miles; steam, 11 miles. In addition to the roads now completed, construction work is rapidly progressing upon five surface and elevated roads, all to be worked by electricity, and which will, when completed, increase the total city mileage to 400 miles. Against these figures, as the *Times* remarks, it is interesting to place the statement that London has less than three miles of mechanically worked tramways, while the total street length of tramways is only 136 miles, all worked by horse power.

A fair and impartial demonstration of the possibilities of compressed air for street car propulsion is yet to be made. In this field compressed air can present no arbitrary claims for its adoption, but must compete on an equal footing with established methods, the basis of comparison being cost of installation and operation. When the inventor, who undertakes to design and construct a compressed air street motor, is able to convince street railroad capitalists, by an actual demonstration, that his system can be installed and successfully operated at a reduced cost per car run, then, and then only, will compressed air be used in this service. The history of the various compressed air motors which have been exploited from time to time is a chequered one, but the fact that compressed air yet lacks a thorough demonstration is due either to incompetent efforts, or to causes entirely foreign and beyond the control of those interested. Compressed air locomotives for mine service, *Cassier's Magazine* says, are used extensively, and, at their present state of development, run anywhere from one to three miles with one charge of air, hauling loads which may vary from 50 to 100 tons, and surmounting any gradients that steam locomotives can travel with economy.

NOTES AND MEMORANDA.

A new apparatus for electrolysis was recently described to the Paris Academy of Sciences by M. D. Tommasi. In the apparatus described the advantages claimed are the suppression of polarisation, that the deposited metal is removed from the oxidising action of the bath, and that the electrical resistance of the bath is considerably reduced.

Another powerful illustration of the constant tendency of the mountains to take a lower seat was afforded on the 30th ult., when the village of Vienholz, near Brienz, in the Bernese Oberland, was partly destroyed by subsidence and landslips, caused by natural springs. The roads were destroyed, and railway communication has been interrupted.

Mr. A. E. Hunt, in the March number of the *Aluminium World*, estimates the minimum cost of electrical horse-power in the United States at £4—5 per annum, using water power, or £12—20 by the aid of coal. In their paper on "The Manufacture of Calcium Carbide," in the *Journal* of the American Chemical Society, Messrs. Morehead and De Chalmot mention that the water in the race-ways is offered to the Willson Aluminium Company at a rate of 25s. per horse-power per annum.

A series of comparative tests of Portland cement made by American, English, German, Belgian, and Danish manufacturers, published by *Engineering News*, shows that no nation has a monopoly of the manufacture of good Portland cement; on the contrary, the reputable brands of cement appear to be of about the same quality in one country as in another. This is after all what should be expected. Portland cement is made from certain well-known constituents, and if those are combined in proper proportions and the process of manufacture is correctly conducted, the product should be about the same, no matter where the manufacture is carried on. There has been, and still is, a large amount of "superstition" concerning cement among engineers; and we even now hear it said that this or that or the other country is the only one that can produce "genuine" Portland cement. The diagrams published by our contemporary appear to show how little foundation there is for such statement; and "the fallacy of the still too common impression that American Portland cements are inferior to that of foreign countries."

To avoid the dangers which result from the use of kerosene (commonly in this country inaccurately called paraffin, for it is a mixture of naphtha and heavy oil) and to prevent some of the lamp accidents, it has been proposed to exclude cheap foreign lamps and alter the oil flash-point. Instead of this the *Chemical Trades Journal* says:—"Instead of the 'simple exclusion of the lamp,' exclude neither lamp nor oil; but, simpler far, inspect them both. Send back the really defective lamps and take in the naphtha as naphtha and the petroleum as petroleum. Make the legal standard the same as the trade. Either define the percentage of naphtha that petroleum is to contain or take the existing written testimony of experts and class only as petroleum the product distilling from crude oil between 150 deg. and 300 deg. Cent. For convenience sake, check the percentage of naphtha by the Abel flash-point, though this will not prevent completely the substitution of prepared oils. It will, however, prevent the loss of 300 out of the 365 lives a year that are lost by the use of the 'stuff' that the Government practically sanctions as safe for use as burning oil. That is the spirit of all we want, or that public safety demands. This is all we want, and this is all the oil companies do not want."

An electric process of converting emery into corundum by means of the alternate current arc has recently been patented, says the *Trade Journal Review*. As heat, and not decomposition, is aimed at, continuous currents would be unsuitable. This furnace is made of firebricks and stands on two bridges; the hollow underneath serves as receptacle for the fused mass, there being a small hole in the bottom of the furnace. This hole is covered with a glass plate. The electrodes—carbon rods—are approached to within 1in. to 2in., the space between being packed with lumps of carbon. The emery, the finest dust, of little use otherwise, is mixed with powdered coal, the amount depending upon the iron oxide in the emery; for 25 per cent. of oxide 5 per cent. of carbon is reckoned. The coal is soon burned by the oxygen of the iron oxide and the arc forms. The inner mass begins to melt, the glass plate gives way, and a stream of fused corundum flows out. The hard outer crust is then broken with iron rods, and new material thus fed to the arc. This addition stops the flow, which starts again after ten or fifteen minutes. The baseplate is strewn with fine emery powder to protect it from the intense heat of the fused mass. The resulting corundum is almost free of water, of which the emery contains about 5 per cent.

In their investigations into the possibility of transforming carbon into graphite, MM. Girard and Street have devised several modifications of the electric furnace. These, together with the results of their experiments, form the subject of a paper in *L'Eclairage Electrique*, iv., page 454, and there is an abstract of the paper in the "Proceedings" of the Institute of Civil Engineers, cxxiii., page 78. The furnace consists of the usual block of refractory material, through which passes vertically into an inner cavity the rod of carbon to be converted into graphite, and another rod to meet it at right angles. At the junction, of course, an arc is maintained. The first carbon passes into the furnace at a speed which depends upon the temperature of the furnace. In the case of carbons for arc lighting, the rod is also given a rotary movement as well as a translatory movement. The effect is stated to be as follows:—The effect of the arc is to leave a spiral trace on the carbon to be converted, this tracing indicating the path of the conversion into graphite. Obviously, the whole surface of the carbon can thus be graphitised. The *Electrical Review* says the result upon the physical properties of the carbon is, that both the conductivity for heat and that for electricity is increased fourfold, whilst the density is also enhanced—these being advantages by no means to be despised.

Various substances and mixtures have been proposed for replacing gutta-percha as an insulating material for cables, but although many of them are effectual in other particulars, none have, so far, rivalled it in point of durability under prolonged exposure to the action of sea-water. Paraffin alone is too brittle, but the plastic products of the incorporation of ozokerite with small quantities of caoutchouc form a medium which in insulating power and durability almost rival the latter substance in its pure state. The degree of insulation attained by Henly's cable, which is coated externally with ozokerite, is 5000 megohms per knot. Nigrite, prepared by kneading together caoutchouc and the residue from the distillation of ozokerite, is far superior, both mechanically and as an insulator, to gutta-percha, and is less susceptible to heat than caoutchouc. The composition, consisting of a mixture of resin and heavy resin oils, used for the Brooks cable has a high insulating power, several samples having indicated regularly 19,000 megohms per mile. Wray's composition, made from caoutchouc, silica, powdered alum, and gutta-percha, is largely used in climates too hot for gutta-percha by itself, but is quickly attacked by sea-water. Latterly, attention has been directed to balata as a substitute for caoutchouc. This gum is obtained by tapping the balata tree, of which there are large forests in British Guiana and other parts of South America. There are two varieties—the red or "bullet tree," and the white, or true balata; they grow to a height of 90ft. to 100ft., and can yield about 2½ lb. of gum in a year without overtaxing their strength. The liquid gum soon hardens on the surface, which is then removed, and this continues till the whole has solidified. For insulating purposes balata gum is, says the *Journal* Society Chemical Industry, inferior to caoutchouc, but it makes a good waterproofing material, and is highly suitable for driving-belts.

MISCELLANEA.

The armoured cruiser Terrible is to commence her preliminary trials at Greenock on the 14th June.

The third Congress of Chambers of Commerce of the Empire takes place June 8th to 13th, in the hall of the Grocers' Company.

It is proposed to import crude petroleum on a large scale into this country and to refine it here as it is done in some other countries. The oil in this case would have to be Galician or Russian, and it would not pay so long as no duty is enforced on imported refined oil.

The ninth Milling Congress will be held in Paris on the 7th, 8th, and 9th of July, at the Champs de Mars, in the Central Dome and Long Gallery. The exhibition of milling, bakery, and agriculture will be opened from the 6th to the 16th of July. The secretary is M. L. Corun, 6, Place du Louvre, Paris.

An Exhibition of Manufactures, Appliances, and Inventions for the Saving of Life is to be held at the Central Hall, Holborn, from July 9th to 18th next, in aid of the Guy's Hospital Fund. Demonstrations by members of the St. John's Ambulance and the Life-Saving Society will be given, and many other attractions will be offered.

In a recent book on "Mechanism in Men-of-War," by R. C. Oldknow, R.N., the author considers it probable that steel will in future be superseded by aluminium; slightly alloyed, it is the ideal metal for all castings where great strength is not required. *Aluminium* is told also that the German Government has decided, after the teachings of the Chino-Japanese war, that no more wooden furniture is to be carried, but aluminium ware is to be substituted.

The Isle of Man Steam Packet Company have placed with the Fairfield Shipbuilding Company, of Govan, an order for a new paddle steamer which, for size and speed, is intended to eclipse any vessel of the description afloat. The ship is to be 350ft. long and 42ft. wide, and will have engines of 10,000-horse power. She will have four decks, the upper one of which will be for promenade purposes. The accommodation will be for 2000 passengers, and the cabins and saloons are to be luxuriously fitted. The steamer will be placed on the Liverpool and Douglas station for the carriage of the mails and passengers early next summer.

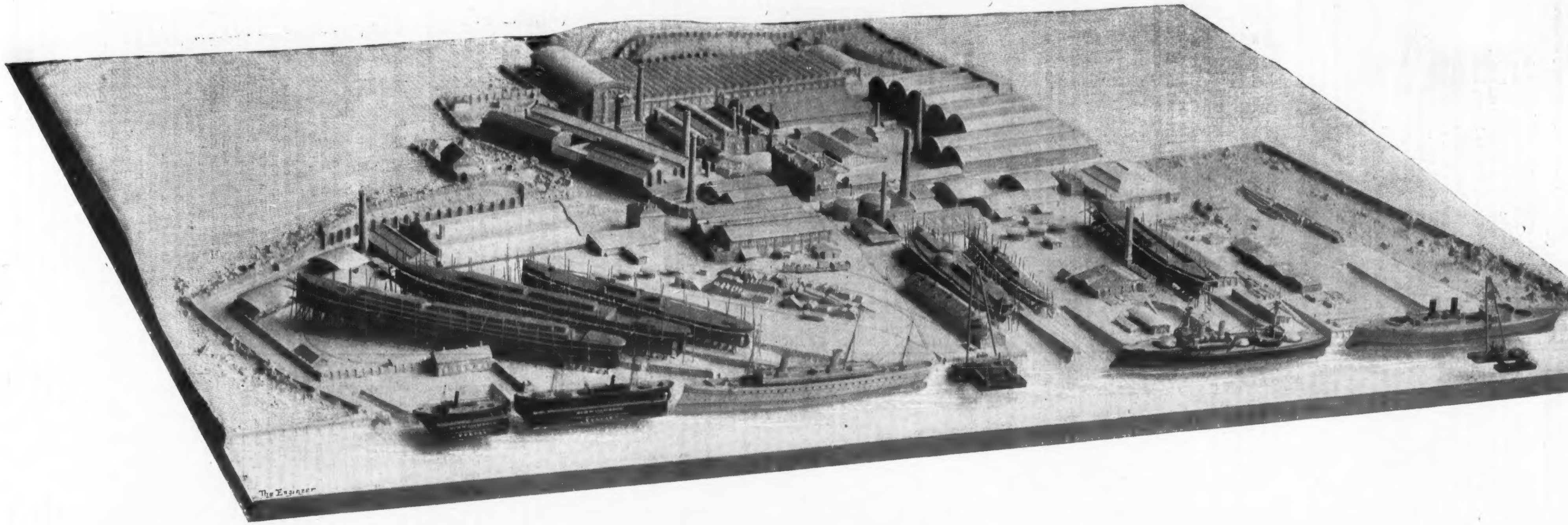
It was reported on the 30th ult. that two distinct earthquake shocks were experienced, one in the south-west of Scotland and the other in the west of England. At a quarter to five o'clock an earthquake shock occurred in Dumfriesshire, the noise resembling a distant peal of thunder. Furniture and crockery were agitated by the shock, which lasted a few seconds, but was not attended by any damage of consequence. The seismic disturbance travelled in a north-easterly direction, the same line as the shock experienced a few days previously. Shortly before seven o'clock a slight shock of earthquake was felt in West Cornwall. The men on their way to work at the Camborne mines noticed the vibrations distinctly.

Undeterred, apparently, by the movement in Congress to have steam yachts which are built outside the States debarred from flying the Stars and Stripes, and from sharing in the privileges and exemptions which that distinction confers, Mr. Robert Goelet, of New York, brother of Mr. Ogden Goelet, for whom a similar yacht is at present well under way in the yard of Messrs. J. and G. Thomson, Clydebank, has just commissioned that firm to build him a twin-screw steam yacht of 1750 tons yacht measurement. Like his brother's vessel, the later boat will be most sumptuously fitted, and will be propelled by triple-expansion engines, capable of giving a speed of 18 knots. Mr. R. Goelet at present owns the steam yacht Beatrice, of Boston build, so that from all points of view the new order is a compliment to British designers and builders. In this connection, however, it may be added that a splendid new twin-screw steam yacht has just been launched from an American yard, the designer of which is Mr. J. Beaver Webb, an Englishman who married an American lady, and is now a resident of New York City. The new vessel, named the Sovereign, has been built by the Erie Basin Shipbuilding Company, New York, and is 260ft. length over all, 212ft. on water line, 28½ft. beam, and 18½ft. draught. The owner is Mr. C. D. Borden, of the New York Yacht Club.

The bursting of a fly-wheel is almost unheard of in England, notwithstanding the high-speed engines we now have running, yet in the United States the fly-wheel "casualties that have become a matter of weekly report," as *Cassier's Magazine* says, "are evidence of slow evolution in providing for known wants." In England we have many thousands of high-speed cast iron fly-wheels and very large wheels up to 60 tons weight running with very high periphery speed, and they all run safely, and yet in the States they say, "The sudden advent of electrical apparatus and its high speeds found people making fly-wheels of cast iron, with a narrow factor of safety, or, indeed, no factor of safety at all, if we consider the impossibility of detecting inherent strains and imperfections in this material. No one can know the value of material moulded into form at a temperature of 2000 degrees and then cooled down to a fortieth of this temperature, nor can they judge internal structure by surface indications. The fact is that cast iron is not suitable material for fly-wheels that are to be driven at high speed, nor is it necessary to make them of this material. There is not even the claim of cheapness in their favour, if the methods of making such wheels of wrought iron and steel were once worked out. Twenty years ago a Scotch firm, who had to make a large fly-wheel for a spinning mill, riveted up a box rim, made from rolled plates, and filled it with cemented masonry or 'grout,' and did a very sensible thing."

The brick-making industry at Peterborough seems to have made great strides in the last few years. On Saturday a large company, including many strangers, were present at the Great Northern Hotel, where Messrs. Fox and Vergette offered for sale an estate of 88 acres, situate in the midst of the Fletton and Yaxley brickfield. From a small concern, giving employment to perhaps twenty hands, the brickyards have developed into a great centre of activity, in which there are sixteen large Hoffman kilns, and fully as many Dutch, Suffolk, and other kilns at work, turning out every year bricks enough to build a small town, and employing hundreds of men; one railway alone carrying about a quarter of a million tons a year. The bed of workable clay extends along the line of the Great Northern Railway about two miles, and the brick-makers of the district have bought up the greater part of the land having a railway frontage. The pressed bricks are general favourites in the trade, because of their cheapness, soundness, evenness of size and quality, their sharp and well-defined arris, and their suitability for heavy work. They have, it is said, when tested, withstood a pressure of nearly 200 tons per square foot. It has been claimed for them that "they are cheaper and better than stocks, taking less labour, less mortar, and at the same time making stronger work, with greater resistance to fire and water." The clay is of a dry nature, and is clean and easily worked. At a recent meeting of the Society of Architects, Mr. Ellis Marshall, hon. sec., read a paper on "Bricks and Brickmaking," in which he referred to the Peterborough bricks, and said, "The clay of Peterborough is of a remarkable nature. It contains a large amount of shale oil, which assists the bricks in burning in somewhat similar way as the breeze assists the stock brick. The bricks are made either plastic or semiplastic." In the course of recent sinkings another substance differing from the clay was found in large quantity, and is supposed to be applicable to various purpose

THE VULCAN WORKS, STETTIN



THE VULCAN WORKS, STETTIN.

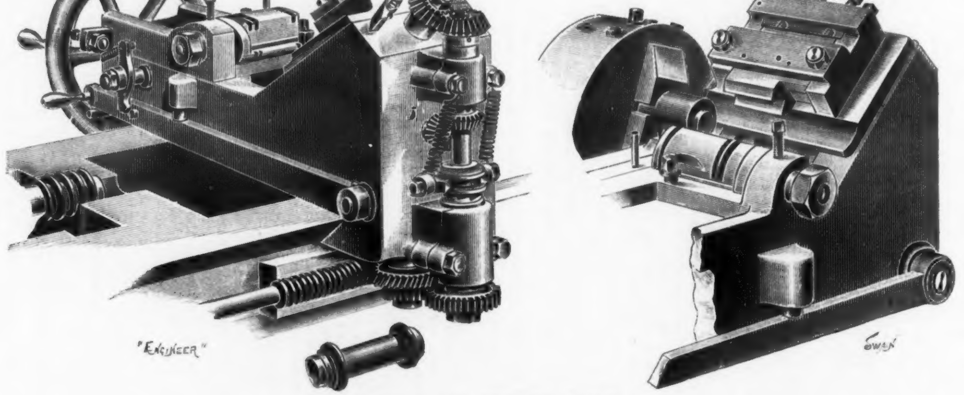
The Vulcan Works near Stettin, to be visited by the Institution of Naval Architects this year, have a brisk and interesting record of shipbuilding and engine manufacture since their commencement. We engrave a plan of the works and building slips, from photograph taken from a very fine model in the possession of the company.

This company—the Vulcan Engineering Company of Stettin—was founded in the year 1857. The creation of the works originated so far back as the year 1851, in which Messrs. Früchtenicht and Brock erected, in a small space, a wharf for iron ships, with a machine shop at the same spot. The original plan had perhaps one-fifth of its present extent, which now embraces twenty-five acres.

Almost simultaneously with the establishment of the new company shipbuilding was inaugurated, and the manufacture of locomotives was also commenced; so that, by the beginning of the year 1859, the first locomotive actually constructed at the works had been already delivered. In 1866 the first small war vessels built by the company were completed, and in 1869 the first set of large marine engines for the armoured frigate Hansa. The first order for a large armoured ship—the Preussen, for the German Navy—was given to the Vulcan Company in the same year. Up to the present date 235 ships and more than 1500 locomotives have been built by the Vulcan Company for home and abroad. These 235 ships included, besides various small war vessels and merchant vessels of all classes, seventeen great battleships and cruisers for the German Navy, also six large war vessels for the Chinese Navy, and a considerable number of torpedo boats. Amongst the numerous vessels built for the merchant navy, many of the largest fast steamers and cargo boats for the Transatlantic trade may be mentioned. At this moment the following ships are in course of construction:—One twin-screw fast steamer of 20,000 tons displacement, and 28,000 indicated horse-power; two twin-screw cargo and passenger steamers of 17,600 tons displacement, and 7000 indicated horse-power; two cruisers for the Imperial German Navy, each of 5600 tons displacement.

With the exception of large rolled material, heavy shafting, and other heavy forgings, all parts of ships and propelling machinery can be completed by the Vulcan Company in its own workshops.

The average number of workmen employed amounts to about 4500. The value of the works is now 16,500,000 marks, whilst the subscribed capital of the company only amounts to 8,000,000 marks. A mark is worth nearly a shilling. By the courtesy of the company further photographs of the works have reached us, which will appear in our pages in due course.



BICYCLE HUB FORMING LATHE

BICYCLE HUB FORMING LATHE.

This is a very substantial tool, having the headstock cast solid with bed, the spindle being driven by a two-step cone for 5in. belts and has friction back gear, which is so proportioned that the cone gives the correct boring speed, while by throwing in the back gear the speed is right for forming. The spindle has a 2in. hole, and can be supplied with a stockfeeding mechanism if desired. The turret is of solid design, gibbed directly to bed, and is fed by a screw under the turret, as near the line of strain as possible; two changes of power feed are provided. The hand motion is operated by a pilot wheel having long handles.

The hub-forming slide, of which we show details, is an interesting feature, and is made in box form, gibbed to the bed so as to be rigidly held in position. But one forming cutter is used, of the round type, as can be seen in the illustration, this being easy to set, and held in exact alignment with the spindle.

The back slide moves in dovetailed ways at an angle of 45 deg. from the plane of the cutter slides; the two slides being geared together so as to feed exactly together as the stock is removed, thus supporting the hub with the greatest nicety against the action of the cutter. The back jaws are made of high-grade tool steel, hardened, ground true, and polished. They are held in the slide by a steel clamp and bolts, and both upper and lower jaws are independently adjustable, by means of set screws. A pump is furnished with each machine, which is driven at constant speed by separate pulleys on the countershaft. This supplies an abundance of oil to a manifold oiling device—not shown in cuts—and which is so arranged as to oil both the cutter and the back jaws independently. Power feed for the cutter and back slide is furnished, operated by worm and gearing from the rear feed shaft, which also feeds the turret. An automatic stop mechanism is also provided, which stops the feed at any predetermined point.

This method of forming produces very smooth work, as it holds the stock very steadily against all tendency to spring away from the cut, and at the same time is rapid in action, because the hubs can also be bored while the forming cutter is at work, and then, when the forming operation is completed, the lathe may be run at the cone speed to finish the drilling. A cutting-off tool with adjustable blade is pivoted on the cutter slide, which cuts down the stock after the forming, so that the drill itself removes the hub from the bar.

They are made by the Niles Tool Works, Hamilton, Ohio.—*Machinery.*

EXPRESS ENGINE, MIDLAND RAILWAY.

On December 13th, 1895, we published as a supplement an external elevation of an express engine on the Midland Railway. Through the courtesy of Mr. Johnson we are now enabled to publish a working drawing of the same engine, which supplies information for which we have been asked by many of our readers. In our impression for January 31st, will be found cross sections of the same engine.

THE TELAUTOGRAPH

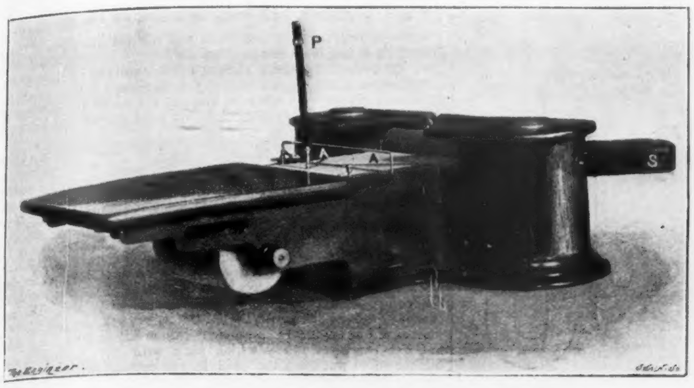


Fig. 1—TRANSMITTER—EXTERNAL VIEW

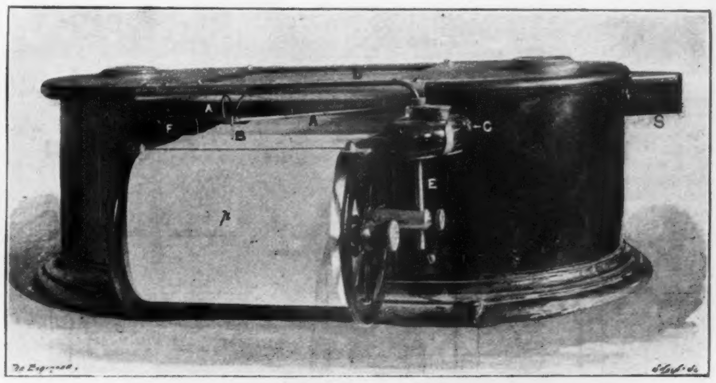


Fig. 2—RECEIVER—EXTERNAL VIEW

PROFESSOR ELISHA GRAY'S TELAUTOGRAPH.

In the year 1891 the new instrument to which the inventor, Professor Elisha Gray, of Lake County, Illinois, U.S.A., has given the name of the Telautograph, was exhibited in the Chicago Exhibition, and was referred to by our Special Commissioner. At that time, however, we were not able to describe the details of the apparatus, the chief reason being that changes and improvements were still being made which were not protected by patents. In June, 1894, the instruments were exhibited at the conversazione of the Royal Society, and recently the actual work of supplying the apparatus in Great Britain has been undertaken by the Telautograph Company, Limited, of 97, Gresham-street, E.C., to whom we are indebted for the photographs used for illustration, and also for the details of the construction o the instruments.

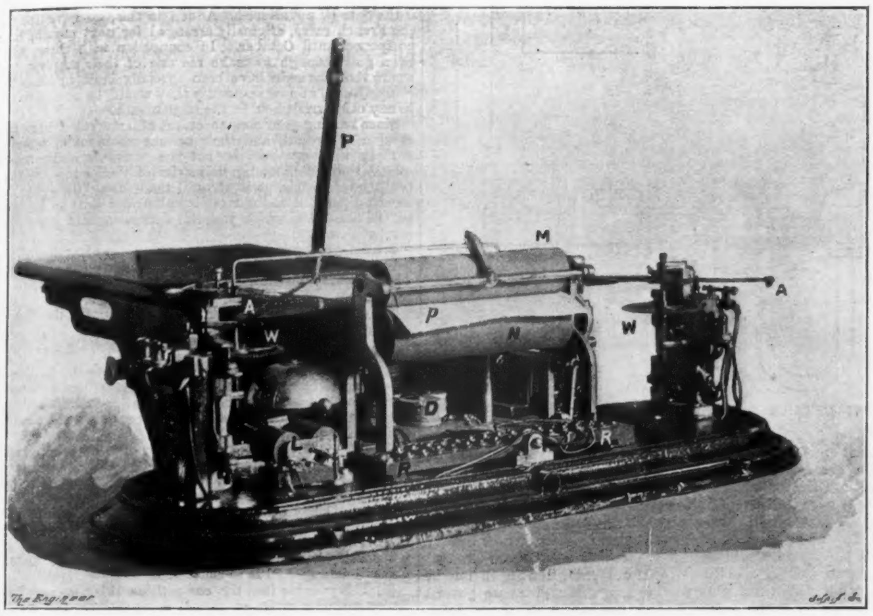


Fig. 3—TRANSMITTER WITH COVER REMOVED

The apparatus we examined consisted of two stations, each provided with a transmitter and receiver, these being separate instruments. The line consisted of four wires, and its resistance was about 25 ohms, but it is merely a question of different winding of the electro-magnets to be able to transmit the messages to different distances, and we understand that the apparatus has given very satisfactory results when used upon the London-Paris telephone line. Since its appearance at Chicago Exhibition the mechanism of the instrument has been much improved and simplified, and we are told that further improvements are in progress which will combine transmitter and receiver into one single instrument, and enable connection to be made between two stations by means of two wires instead of four. These machines have, however, not yet arrived in this country, and our description, therefore, refers to the type now being put upon the market, and let out on hire here.

In Figs. 1 and 2 we give views of the exterior of the transmitter and receiver respectively. Upon the transmitter an ordinary lead pencil P is used, near the point of which light rods A A are fastened at right angles to each other. These rods are connected to the instrument, and following the motions of the pencil regulate the current impulses which control the receiving pen at the distant station. The writing is done upon ordinary paper *p*, 5in. wide, conveniently arranged upon a roll attached to the instrument, and passing over the table T. A lever to the left is so moved by hand as to shift the paper forward mechanically at the transmitter and electrically at the receiver.

At the receiver the pen B is a capillary glass tube placed at the junction of two aluminium arms A A. This glass pen is supplied with ink, which flows from a reservoir C, supported on a bracket E, through a small rubber tube D, Fig. 4, connected to the joint of the arms at B. The arms are supported by the horizontal rod F. The electrical impulses coming over the wire move the pen of the receiver simultaneously with the movements of the pencil in the hand of the sender. As the pen passes over the paper an ink tracing is left, which is always a fac-simile of the writing done by the sender, whether in the formation of letters, words, figures, signs, or sketches.

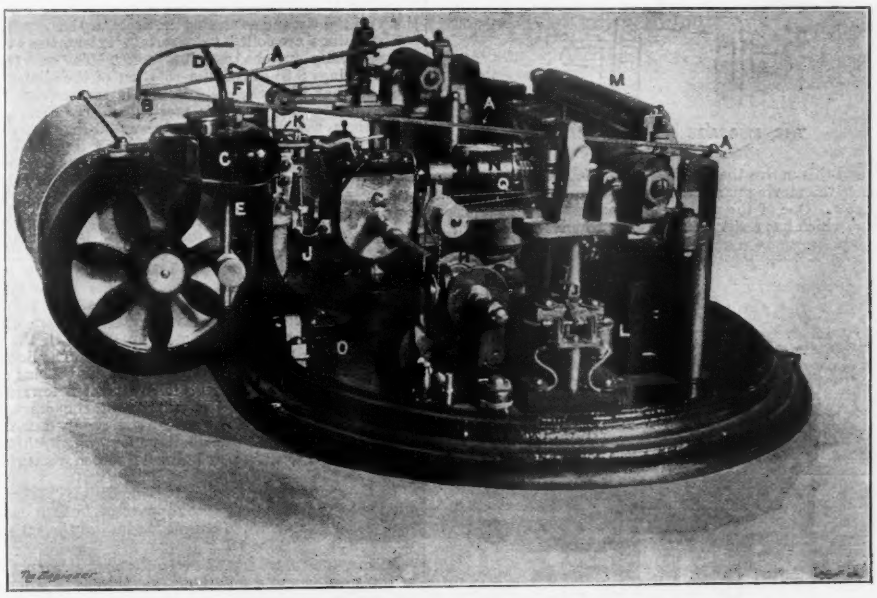


Fig. 4—RECEIVER WITH COVER REMOVED

On lifting the covers of the instruments the mechanism is seen to be somewhat complicated, and we shall now endeavour to describe the chief features as clearly as possible. Figs. 3 and 4 are taken from photographs of the transmitter and receiver respectively, with the covers removed.

The mechanism may be divided into four parts as follows:—Pen-lifting gear, paper-shifting gear, pen-directing gear, and prime mover. The power which works the whole apparatus is obtained from two batteries of small lithanode secondary cells, each battery consisting of six cells, so that 12 volts are obtained from each battery, and they can be put in series to obtain 24 volts.

Pen-lifting gear.—The action of this gear is shown diagrammatically in Fig. 5. The pencil P is not exerting any pressure upon the platform B, and therefore the lever C is held against the top contact D by the spring E. Current flows in from the battery to L^1, and as the resistance coil G^1 is short circuited, it passes direct to the bobbin H^1 of the electro-magnet, at the same time current from L passes through the resistance coil G, and energises the magnet pole H; the pole H^1 is therefore now the stronger, and attracts the ends of the lever J, free to rock upon the fulcrum K, and the pen support F holds the pen pipe M out of contact, with the paper at the receiver. So soon as the pencil presses the platen B in the act of writing, the lever C descends on to the bottom contact D^1, and the pole H at the receiver becomes stronger than the pole H^1 the lever J rocks over, the pen support F descends and the bent end of the pen pipe M touches the paper, the ink flows, and writing begins.

The same electro-magnet H H^1 is used for the paper shifter in the following manner. A stronger current than that used for the pen gear is sent through both the bobbins H and H^1, and as the fulcrum K is free to move vertically, and is only controlled by the spring N, the result is that the armature J is attracted to both poles at once, and the centre pin O makes contact with O^1 and a current is passed to the paper shifter P S, which will be described in detail afterwards.

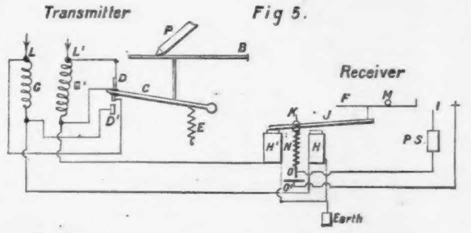
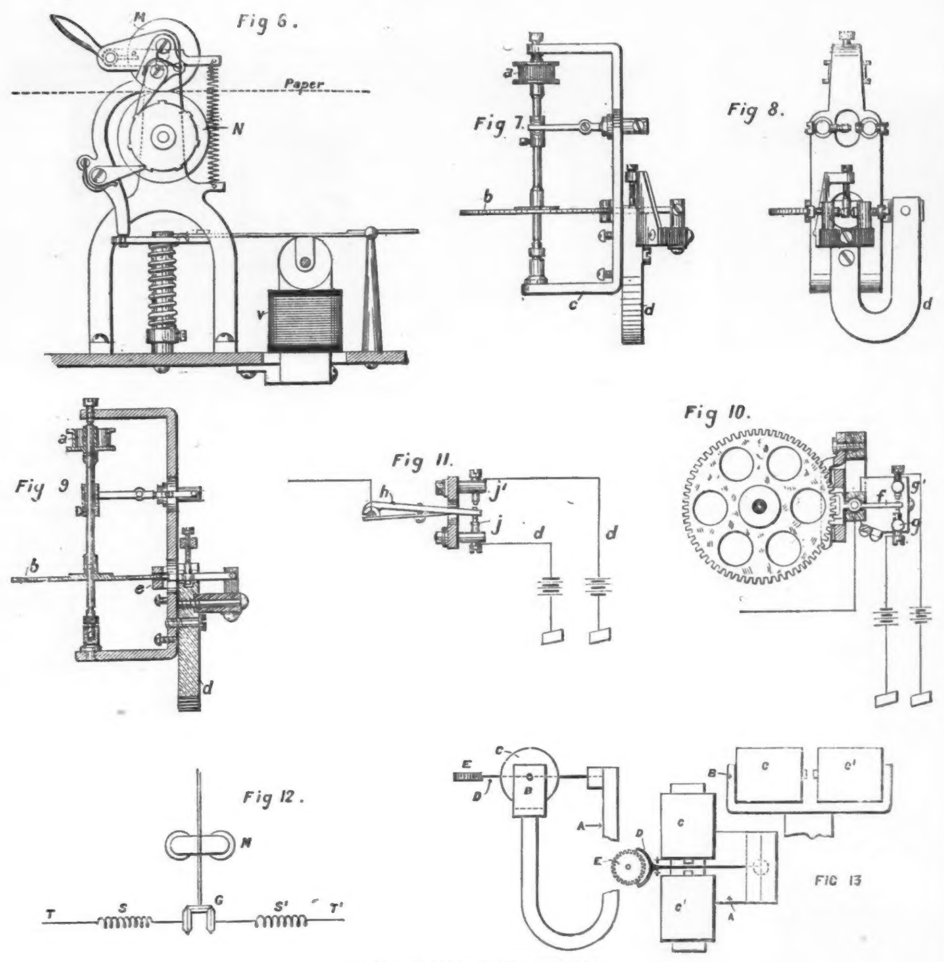


Fig 5.

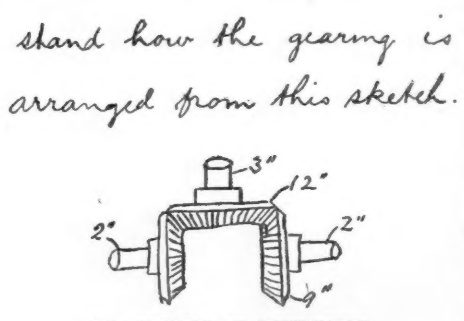
Paper-shifting gear.—At the transmitter the roll of paper is placed inside the instrument, and the end *p* is carried out through a slit over a guide roller, then over the platen upon which the pencil works, and thence between a pair of rollers M and N. The paper is moved forward mechanically at the transmitter, the used portion being rolled upon the roller at the back of the machine. The action of moving the paper at the transmitter causes the electro-magnet H H^1, Fig. 5, to be energised, as already explained, and the mechanism shown in Fig. 6 is actuated at the receiver. It will be seen that the paper passes off the roll inside the apparatus as already described, and as soon as current is sent through the electro-magnet V the paper is gripped between the rollers M and N, and is pulled forward a distance corresponding to that by which it is moved at the transmitter. We are now prepared to deal with the actual writing mechanism.

Writing mechanism.—As we previously stated, the pencil P on the transmitter has attached to it two light rods A at right angles to one another, and both moving in the same



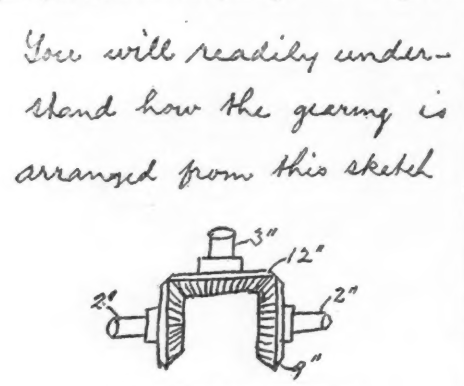
THE TELAUTOGRAPH—DETAILS

plane. Each rod acts in a similar way to the bow of a fiddle drill, for it has a light cord attached to it at two points, and the slack of this cord is wound several times round a small pulley, so giving motion to the part of the apparatus called the interrupter W, Fig. 3; each arm actuates one interrupter, and these two interrupters allow current impulses to pass into the line wires. One of the interrupters is shown in Figs. 7 to 11. Here *a* is the pulley actuated by the fiddle bow, and this moves the toothed wheel *b*. A light frame *c* supports the moving parts, and to it is fixed the horseshoe magnet *d*. One of the poles of this magnet has an extension piece *e*, which has a slit in it, through which the edge of the toothed wheel passes. The edge is, therefore, of north polarity, let us say, while the south pole of the magnet is provided with a rocking tongue *f*, working between the contact screws *g g*. The teeth are so spaced with relation to the forked end of the tongue *f* that one prong of the fork is opposite a space, while the other is opposite a tooth.



You will readily understand how the gearing is arranged from this sketch.

THE MESSAGE AS TRANSMITTED



You will readily understand how the gearing is arranged from this sketch

THE MESSAGE AS RECEIVED

In Fig. 10 it will be seen that the lower prong is attracted to the tooth of the wheel and closes the magnetic circuit, or at least causes the lines of force from tooth to prong to be much greater in number than for the upper prong; the result is that the tongue *f* closes the bottom contact *g*, and current goes to line. If the wheel *b* rotates still further, the opposite action will take place, and the top contact g^1 will be closed. Seen in plan in Fig. 11 the rocking lever *h* lightly grips the spindle, and therefore changes contact on the two terminals $j\,j^1$. These interrupted currents, flowing in one or the other direction, pass to the receiver, and there govern the direction of the pen. Before dealing with these, however, it will be necessary to examine another part of the receiver.

Prime motor.—The interrupted currents on the line play merely the same part as the pendulum of a clock—that is to say, they work the escapement, but the power to actuate the pen of the receiver is provided by an electro-motor N, Fig. 4, arranged as shown in Fig. 12. Current is obtained from the two secondary batteries in series, giving 24 volts, and the motor shaft drives the equalising bevel gear G—also marked G in Fig. 4—and thence the spiral springs S and S^1 coiling them up tightly, and so storing the necessary energy. As soon as the springs are coiled to a certain extent the current is automatically switched off the motor. The energy of the coiled springs S S^1 causes the rotation of the shafts T T^1 as soon as they are released. Power is transmitted through T and T^1 to the reversing mechanism H, Fig. 4, which determines the direction of motion. From the reversing mechanism power is transmitted through light silk cords to the escapement shaft, these cords being wound several times round their respective pulleys. These shafts are, therefore, always tending to turn in one or other direction, but the amount of movement is controlled by the escapement.

Escapement.—There are two similar escapements, one for each arm of the pen, and one is illustrated in Fig. 13; *a* is a horseshoe magnet carrying a bracket *b*, to which are fixed two bobbins *c* and c^1. To the other pole of the magnet is hinged a kind of anchor movement *d*, which acts as the escapement. Holding or releasing the escapement wheel, which has teeth corresponding in number with the teeth of the interrupter wheels, in the transmitter. The line current from the interrupter flowing through the bobbins *c* and c^1, causes the escapement pawl *d* to be attracted toward one or the other according to the polarity of the current—thus releasing the wheel *e*. The wheel *e* is rigidly attached to a spindle which carries the small pulley, which, through the fiddle-bow gear, drives and directs the movements of the pen.

In the space at our disposal it is impossible to trace out the whole of the connections of the apparatus, but our description will, we believe, suffice to give a clear idea of the action of the instrument.

In conclusion, we reproduce in the next column a message as transmitted and received, and we think this will appeal to our readers, as it shows the practical use to which the apparatus may be put by engineers. The originals are about twice as large. It will be seen that the reproduction is practically a *fac simile*.

We are informed that the Telautograph Company has made arrangements with the National Telephone Company, and the latter company will permit its lines to be used for the new instruments, which can be hired at yearly rentals as telephones are now obtained.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

"THE ENGINEER" HORSELESS CARRIAGE COMPETITION.

SIR,—In your issue of last week you ask for the views of those interested in the horseless carriage industry, regarding the date of THE ENGINEER Horseless Carriage Competition. I beg leave, therefore, to offer you not only my own view, but the unanimous opinion of those who come to consult me as to the position of affairs generally concerning common road mechanical vehicular propulsion.

My own great desire in taking upon my shoulders to a large extent the responsibility of an exhibition, the primary object of which was to bring to the notice of the British public a matter which I think, with you, in the very near future, will constitute an industry of great national importance, was that I might be of some service to the engineers and carriage builders of my own country, and to prevent as much as possible the importation of ill-designed, badly constructed, and unsatisfactory foreign built self-propelling carriages. My efforts will be very small in comparison with the good work you have initiated, provided the time at which the competition is to take place be an apposite one. The concensus of opinion, however, is that October is considerably too soon.

Even if our engineers had a clear course before them, they could not get carriages ready which they with any degree of confidence could put upon the road in competition with our friends on the other side of the Channel, who have been building them with practically no restriction or hindrance for many years. The course, however, is by no means clear, for legislative restrictions have not yet been removed, and therefore it is impossible to say, at this date, what will, or will not, be allowed upon our highways. Under these circumstances, engineers could hardly be expected to construct carriages which might be subjected to considerable modification on the passing of the proposed new Act.

I am sure, Sir, you will appreciate the fact that English engineers are perfectly willing to enter the lists with any country, and if the prizes, munificently offered by THE ENGINEER, are to be taken to foreign shores, they will accept their beating in true British style. All the same, they would like to have a fair representation at the competitions, which they cannot possibly do if the date be not altered. Added to this, we have the fact that the French races, originally arranged for next month, have been postponed until October. In connection with these, they have been good enough to make me one of their umpires, and I am aware that carriages have been specially built by them for these competitions, and consequently they would be unable to take part in any other trials held in the same month.

Since reading your announcement of last week I have taken the opinion of several, and their unanimous opinion, which accords entirely with my own, is that you would be doing considerable service to the engineering industries of this country if you would postpone the trials, at least until next May. June has been the month suggested as the most suitable, and it is to be hoped will be the one upon which you will decide to hold your interesting competitions.

I trust you may see your way to this postponement, and that your trials may be the cause of putting upon the road vehicles of which we may have reason to be proud.

ALF. R. SENNETT,
Hon. Executive Commissioner for the Exhibition.
Crystal Palace, S.E., May 27th.

SIR,—With reference to your inquiry as to the feeling of those proposing to enter auto-cars for your competition in October, with regard to the postponement of the date for the competition to the following spring, I shall be glad to mention some considerations which occur to me.

(1) Intending competitors may have already taken measures to be in readiness for the competition in October, the expense of which might have been avoided had they known of the possibility of an extension of time.

(2) Competitors may have arranged their business plans and expenditure with a view to availing themselves of the splendid advertisement which your report will give them, and if this were postponed for six months their outlays would be locked up and plans disarranged so as to cause loss.

(3) It is possible that the competition this year may become the forerunner of a series of annual competitions, and its postponement would cause the loss of a year.

Might I suggest that instead of postponing the date of the competition until next spring, you might with advantage to competitors postpone the date of entry from the last day of July to the last day of August, and the competitions to the month of November.

WM. ROSE SMITH, M. Inst. C.E.
3, Laurence Pountney-hill, E.C., May 28th.

P.S.—Further inquiry and consideration since writing above lead me to think that the proposal to postpone the competition till next summer is the more advantageous. Please to add this postscript to my letter of the 28th May.—W. R. S.
June 2nd.

[In response to the questions we have asked in our last two impressions, we have received a number of letters from all parts of the country advocating postponement in the best interests of the horseless carriage. Mr. Sennett's letter may be taken as a type of the rest. Mr. Smith, whose letter we print, held opposite views, and it will be seen from his postscript that on further inquiry he has changed his mind. We have only one letter to the contrary, giving as a reason the probability that the writer would be the only competitor with a heavy oil carriage if the trials were not postponed.—ED. E.]

THE LIQUEFACTION OF GASES.

SIR,—I am disposed to agree with "Zero" as to the futility of further correspondence. His methods are such as to render any real discussion almost impossible. Facts quoted that make against his views he for the most part ignores; if he does notice them it is only to commit the logical fault of *ignoratio elenchi*. At other times he fathers on me statements I have never made. For instance, he accuses me of pointing to the compressing pump in connection with external work. Will he kindly tell me on what page of THE ENGINEER I did anything of the sort? I did say, in opposition to his view, that the compressed gas escaping from the nozzle does external work, at least against the atmosphere. If he attempted to meet that proposition by talking about work in the pump, he merely evaded the point at issue, and should blame himself, not me, for irrelevancy.

Why I insist on the need for the Joule effect is simply because the cold produced by "mere expansion" will give no final cooling effect in the Hampson machine. A thermometer placed in the stream of gas just as it leaves the orifice will indicate a reduction of temperature, but if placed a few inches along the tube it will stand much higher, because the energy of mechanical motion of the issuing gas is reconverted into sensible heat, which neutralises the cold produced by expansion. If "Zero" can meet this statement fairly and squarely, and successfully refute it, there might be some hope for his theory, but unless he can do that his theory plainly cannot stand. Nor can his fundamental erroneous assertion that the "energy in a gas is a function of its temperature and of nothing else." The latter statement would be true only of a 'perfect" gas, which might indeed be passed through Hampson's machine for centuries without liquefaction of a single drop.

The suggestion that Kelvin's arrangement has nothing in common with Hampson's scarcely deserves notice. Obviously, in that in both compressed gas is expanded through a narrow orifice situated in a long tube, they are essentially identical.

"J." must surely know that the existence of the Joule effect does not depend only on a few doubtful experiments, but is a necessary consequence of known laws of gases and of received theory. Perhaps he regards Boyle's law as rigidly accurate, and has not reflected that the deviations of gases from that law are precisely parallel to their behaviour in respect to the Joule effect. I do not know whether the figures I gave are the results of calculation or of direct experiment. But they are Lord Kelvin's, and as such carry more weight, with me at least, than "J.'s" *ipse dixit*, which I imagine is founded neither on experiment nor on calculation.

"Zero," being a law unto himself, will probably have the same indifference for authorities as he has for ascertained fact. It may, however, be worth mentioning that Professor Ohnes, of Leyden, the possessor of one of the few cryogenic laboratories in the world, in a recently issued paper, takes it for granted that a machine like Dewar's or Hampson's depends on the Joule effect. Dewar, too, in his last lectures—which I heard but could not have read, seeing that they are not printed—did the same, and exhibited elaborate tables based on the same supposition.

With regard to the questions asked by your other correspondent, I can tell him that the temperature of the exhaust gas from the Hampson apparatus is distinctly cooler than that of the room. But on entering the compressor it must be simply at the temperature of the surrounding atmosphere, for at Brin's works, at least, no attempt was made at thermal protection of the pipe leading from the machine to the pump. Indeed, during a great part of the time this pipe was disconnected, the oxygen being taken from a reservoir and discharged into the air. A constant circulation of the same body of gas from the pump to the machine and back is, in fact, no essential feature of the design. If "Zero" or anyone else doubts this I refer him to Hampson's specification. CRYOS.

May 26th.

RADIATION AND BOX-COIL CONNECTIONS UNDER THE MILLS SYSTEM.

SIR,—The forms of radiator connection herein described have been used with success by me, and may be of value to others. In the Mills system of heating, steam is taken from boiler direct to top of the building, then piped off to a number of "risers" which drop through the various stories and terminate in return pipe in cellar. Radiators are usually supplied from these risers by single pipe connections. The connections here shown will, however, work equally well on any other one-pipe system.

Fig. 1 shows the usual connection for wall coils. Mr. E. E. Magovern* has pointed out the defects of this form, and recommends connections as in Fig. 2. I can confirm Mr. Magovern's statement that Fig. 1 is very defective; in fact, cannot be made to heat up the whole radiator. I then independently worked out Fig. 2, but it also was found very defective, unless the coils are quite small, and the steam pressure very steady. In case of coils containing 60 to 85 square feet of radiating surface, there would be such violent pounding under ordinary fluctuations of steam pressure that these coils had all to be shut off.

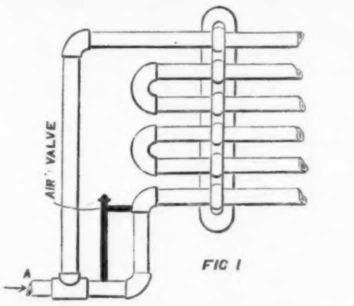


FIG I

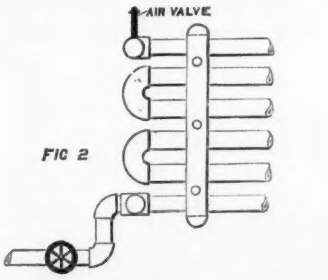


FIG 2

Fig. 3 shows the result of the experiments made to correct this trouble. I am familiar with the use of water seals in heating, and have myself often used them, but the precise arrangements here described are new to me, though doubtless known to others. It is evident that the water seal causes the arrangement to work exactly as in a two-pipe system, except that the return water flows from the top along the bottom of the horizontal connecting pipe. The drawing shows sizes of pipe used for coils two to three pipes deep, eight high, and 8ft. to 11ft. long, all 1¼in. pipe. A 1½in. supply would be better, but in this case 1¼in. was used, owing to size of outlet in the riser.

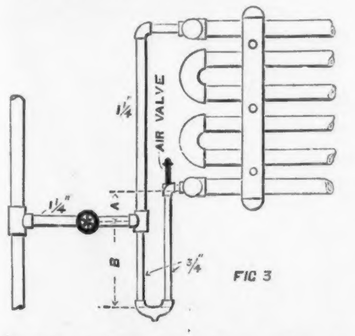


FIG 3

The only precaution to observe in this connection is that the distance *A* must be greater than the head of water equivalent to the maximum drop of pressure between the supply and return pipe of the coil. The writer has found that in all his work 7½in. is ample. Distance *B* should not be less than this; in the work under question it was anything from 7½in. to 14in. Gate valves must be used; globes will not answer. If the fitting is well done, and the supply pipe has a little fall, the radiator will be noiseless under any changes of steam pressure.

I do not like to have steam and water going in opposite directions in horizontal pipes, unless they are very short, hence I have designed connections as in Fig. 4, to be used when the radiator is more than 3ft. from the riser. The dimensions of the trap should, of course, be the same as in Fig. 3. When it is possible to use this design I prefer it to Fig. 3, even when coil is quite near the riser.

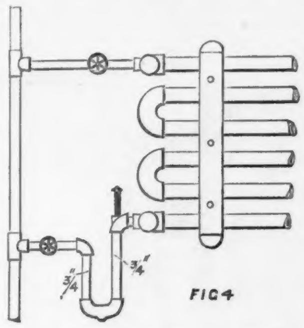


FIG 4

Some object to the one-pipe system because of the pounding when a radiator is turned on, and the boiling or gurgling sound frequently heard when the radiator is in use. I have had to consider cases where such troubles existed, and it was decided to apply the principle underlying Figs. 3 and 4. Fig. 5 shows the result of the experiments, and it completely cures the evils. Everything works as in a two-pipe system; water and steam go in the same way, the circulation is rapid, and the radiator is noiseless. A return bend with ¾in. back outlet was used in the bottom of the traps, and into outlet was screwed a capped nipple, or a bushing and pet-cock. These traps have never given trouble except in one case, where the fitter carelessly left in the pipe enough chips to plug up the bend.

I have given the above connections two years' trial, and found them highly satisfactory if the work is properly done. The scheme is superior to the two-pipe system, in so far as it is impossible to flood the radiator by leaving open the return valve. If this be done in Figs. 4 and 5 the steam pressure will drive the water in the trap up into the radiator, and make a very decided noise before the party who closed the steam side can get very far away, and it thereby gives warning that the return is open. I consider this a valuable feature, as I have seen numerous cases where in a two-pipe system the flooding of radiators, and consequent leakage around valve stems and through air valves, has seriously damaged furnishings in houses, and books and apparatus in schools.

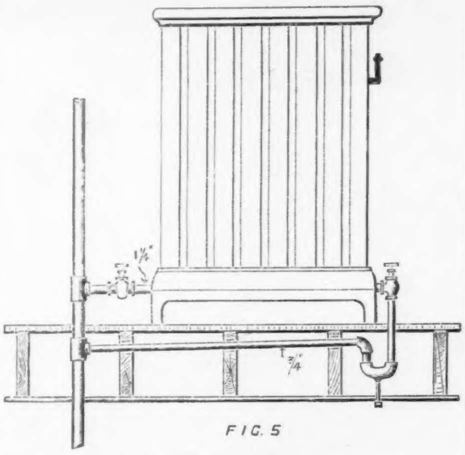


FIG. 5

In the Engineering Hall, Michigan Mining School, cast radiators are used on the second floor, part of them with ordinary one-pipe connections, and part connected as in Fig. 5. On the first floor—shops and lavatories—coils are used, all connected as in Figs. 3 and 4. In the basement—shops—coils with regular two-pipe connections are used. The relative performances of these have been carefully watched, and the connections here described are in this case considered preferable to the others. EDGAR KIDWELL.

Michigan Mining School, Department of Mechanical
Engineering, Houghton, Mich.,
May 20th.

THE PROBLEM OF SPEED.

SIR,—This is largely a question of quality of fuel. Monsieur Normand has doubtlessly constructed the fastest vessel afloat for short runs. Here is a boat only 144ft. long which, on an hour's run, has logged 31 knots. This is a much better performance than that of another boat 210ft. long which does 30 knots, because the square roots of the respective lengths point out the proportionate speed of similarly proportioned vessels with proportionate power, and, consequently, the 210ft. boat should have had a speed of 37 knots, with power in proportion to her tonnage. The Forban required about 4000-horse power, and so the 210ft. boat would have required about 11,000-horse power to go at 37 knots speed. This is probably about double what the 210ft. boat really had to dispose of.

I leave it to naval officers to say of what use such a small vessel as the Forban is likely to be, considering that one half her displacement is taken up with machinery and that her bunkers will only contain about 15 tons of coal. The British Admiralty compels contractors to use ordinary coal on trial-trips, and on low-speed consumption trials the fire-grates must not be materially reduced. Not so in France; there the low-speed consumption trials, which determine the quantity of coal the bunkers must contain may be made with very largely reduced grates, and thereby of course, a considerable economy is attainable. Again, in France contractors are allowed to use a special class of fuel, viz., briquettes made of pulverised coal, out of which the earthy particles have been carefully washed, the coal being then mixed with certain tarry substances to make it cake in the process of hard pressing into briquettes. By such means it is possible to manufacture a fuel which far surpasses Welsh coal in power. It would be very interesting to try what speed could be got out of the Forban on a *three* hours run—not one hour—with ordinary Welsh coal, say Nixon's navigation. I fancy that 28 knots would be more likely than 31, for after a short time the bars would be nicely clinkered over when burning at the rate of probably one hundredweight per square foot of grate per hour. The total duration of the Forban's trial seems to have been about one and a-half hours only. In England a three hours' trial is exacted.

I should consider the Forban as more of a beautiful scientific toy than a practical sea-going vessel. All honour to M. Normand for having schemed out the combination of lightness and power, but I should be sorry to see our naval authorities spending public money on such awfully complicated little machines, which, like racing bicycles, are fast on a track, but useless on the road.

June 1st. PRACTICAL MARINE ENGINEER.

PERMANENT WAY.

SIR,—In all the correspondence on this subject no one, as far as I have seen, has called attention to the fact that in the United States the sleepers are all white oak on good roads like the New York Central. This timber holds the spikes and is hard enough to carry the sole of the rail without crushing. To my mind the American road seems to be superior to the English one, as it is made more directly and of fewer parts. Mr. Whitestone's suggestion of steel sleepers, if adopted, would of course make our roads as simple and as easy to keep in order as the American roads are; but if our roads follow American improvements no faster than our rolling stock has done, I fancy only those who are now lads will see the change carried out.

The fact is the manufacturing monopoly enjoyed by England for fifty years after the invention of the steam engine begat a spirit of ignorant self-sufficiency in the nation at large, too much of which survives to the present time, and some of which is not quite absent in the councils of the powerful corporations which manage our railways. R. R. GUBBINS.

London, S.E., May 30th.

SIR,—Would it be unreasonable to suggest to your correspondent "Anglo" that he should read letters before he criticises them. I have never condemned the English system of chairs; it would be an impertinence for a layman to express positive opinions on engineering matters in a technical journal. The bulk of my letter was merely the report of the opinions of American experts which, as I expressly stated, I heard with surprise. The only opinion I expressed was that our English system could not be the only possible system of constructing a first-class road, seeing that the Americans construct undeniably first-class roads on a different system, which they believe to be actually a better, as it is certainly in America at least, a cheaper one.

To answer "Anglo's" question—"tie-plates" being comparatively thin and light, obviously do not produce the same rigidity as a solid 45 lb. chair. Further, the best roads do not all believe in even tie-plates. The Pennsylvania, I understand, never uses them; and no road, as far as I am aware, employs them when it can get hard wood sleepers.

To your second correspondent, "C. Trenail," I would say that I should need to lose my head pretty completely before I did as he appears to have done, and confused together great trunk lines like the Pennsylvania, the New York Central, the B. and O., &c., and the pioneer lines in unsettled districts of the South and West. If "C. Trenail" can produce evidence that derailments, owing to defective permanent way, are "enormously more numerous" on the Pennsylvania than on the London and North-Western, we can begin to discuss the reason. Till he does it is useless to argue from lines which are no more typical of the best American practice than the Manchester and Midland, or the Central Ireland, are typical of the standard of the great main lines here.

47, St. George's-square, S.W., W. M. ACWORTH.
June 2nd.

TRACTION ENGINES.

SIR,—"Traction Engine Admirer" seems to be only an occasional observer of matters affecting the objects of his admiration. The "Select Committee on Traction Engines" to which he refers began by hearing eight or ten engine users and makers, who gave evidence from all parts of the country in support of the requests put forward by this Association for increased facilities for steam road locomotion. The road authorities are not by any means the traction engine haters your correspondent imagines them to be. All recognise the necessity and utility of steam road locomotion, and many gave most valuable answers to the various questions put to them by the members of the Select Committee, which must help our cause.

The debt of gratitude which the trade owes to the members of the Select Committee for their painstaking efforts will be obvious when the report and evidence are published.

H. R. SUMMERS, Secretary.
National Traction Engine Owners' and Users' Association,
5, Laurence Pountney-lane, Cannon-street, E.C.,
June 3rd.

WOOD PAVING.—At a meeting of the Vestry of the parish of Paddington held on Tuesday, the report was discussed of a special committee appointed to consider the whole subject of wood paving in the parish, more especially in regard to any renewals, being brought within the limits of a specified amount. The report stated that the committee were unanimously agreed as to the imperative importance of hard wood for public thoroughfares, and they entirely endorsed the words of Mr. J. P. Norrington, Assoc. M. C.E., "that it is a wicked waste of public money to pave a line of heavy traffic with soft wood." The committee having seen sections of roadway paved with jarrah, karri, and other hard woods, subjected to most severe traffic, consider that the length of life of these woods have not been over-estimated, and that fifteen years is within the limits of trustworthy probability. The committee state that they entertain very decided views as to the sanitary superiority of the eucalyptus woods and their non-absorbent qualities. As to the first cost of hard wood, they have had clear evidence that its great durability would not only cover the additional expense, but would realise an actual saving in the course of years, as well as make the necessity for renewals far more exceptional than could be possibly attained by the best treatment of the soft woods. This exemption from frequent renewals would be one of the greatest possible boons to shopkeepers in busy thoroughfares.

ENGINEERING SOCIETY, KING'S COLLEGE.—At a general meeting on May 29th, the President—Mr. Mowat—in the chair, Mr. Fletcher read a paper on "Telescopes: their Construction and Revelations." The author dealt briefly with their history, and the theory of lenses. He then went on to detail some of Galileo's experiments to obtain a more efficient instrument. He pointed out the difficulties encountered by Galileo and his contemporaries, owing to chromatic and spherical aberration. After explaining the physical cause of these, Mr. Fletcher indicated some of the earlier attempts to correct these faults in telescopic instruments. He also showed how that in such attempts the length of the telescope greatly increased—finally reaching 123ft.—as it was found by increasing the focal length of the lense, aberration was greatly diminished. The author then discussed Sir Isaac Newton's telescopes, their mechanism, and the way in which achromatism—thought impossible by Newton—was finally obtained by Dollond. He then illustrated several modern forms of astronomical telescopes, and the mechanism by which the object glass of the instrument is made to trace an exactly similar and proportional curve to that described by the star from rising to setting. In describing the clock-work used for this, Mr. Fletcher pointed out how the somewhat jerky action of the pendulum was replaced by that of a vane revolving in a cup of mercury. The bearings on the instrument were also dealt with fully. In dealing with lenses, he showed the increase in size of lenses during recent times, having arrived at as much as 40in.; but Mr. Fletcher pointed out this was probably near the limit, as its great size and weight made it exceedingly susceptible to any stresses due to the mounting, or even unequal heating, and its use required the greatest care and delicacy. Messrs. Mowat, Standen, Tolmé, and Bailey joined in the ensuing discussion.

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[*] "American Steam and Hot-Water Heating Practice," page 261.—The *Engineering Record Company*, New York.

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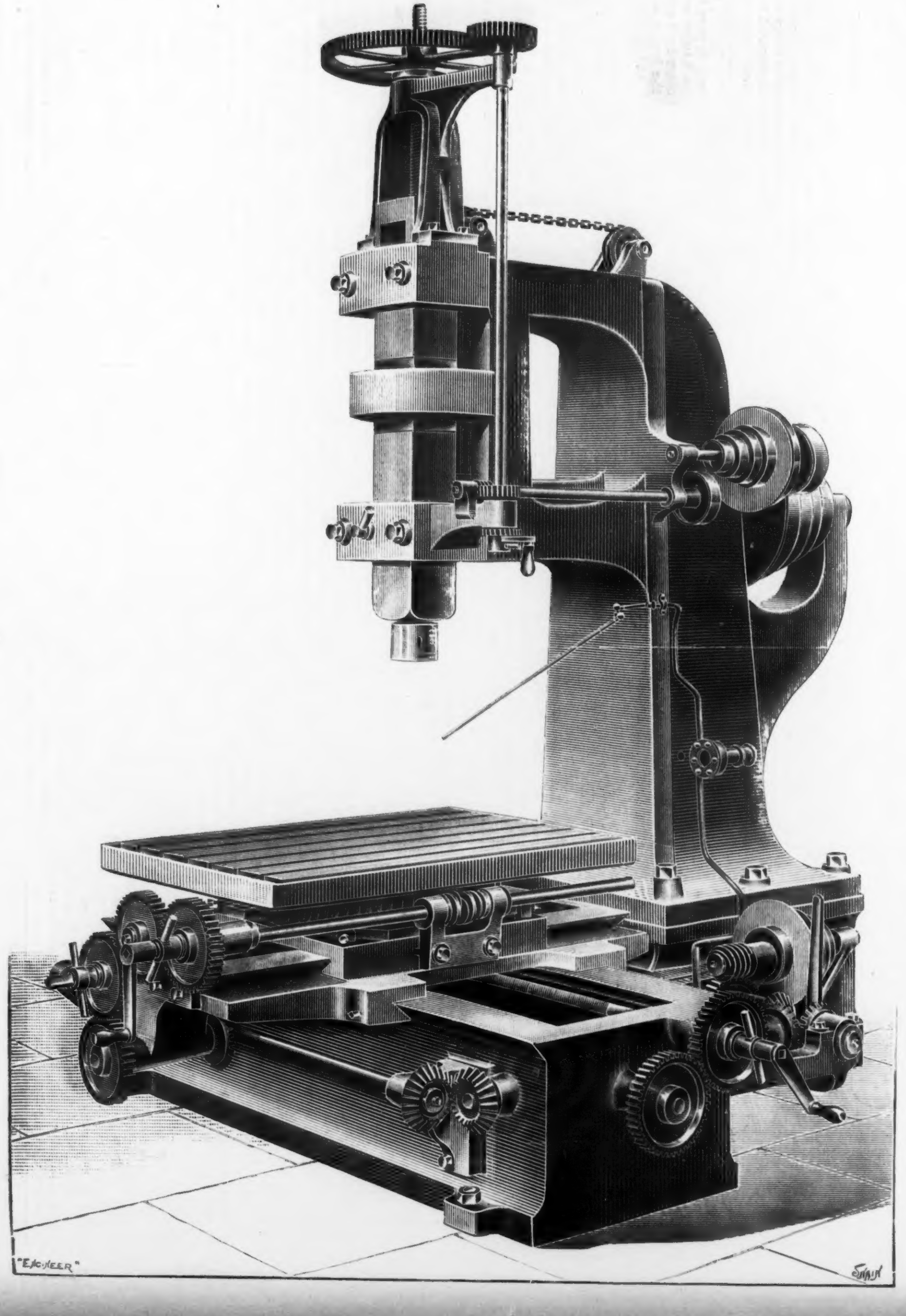
(*For description see page 573*)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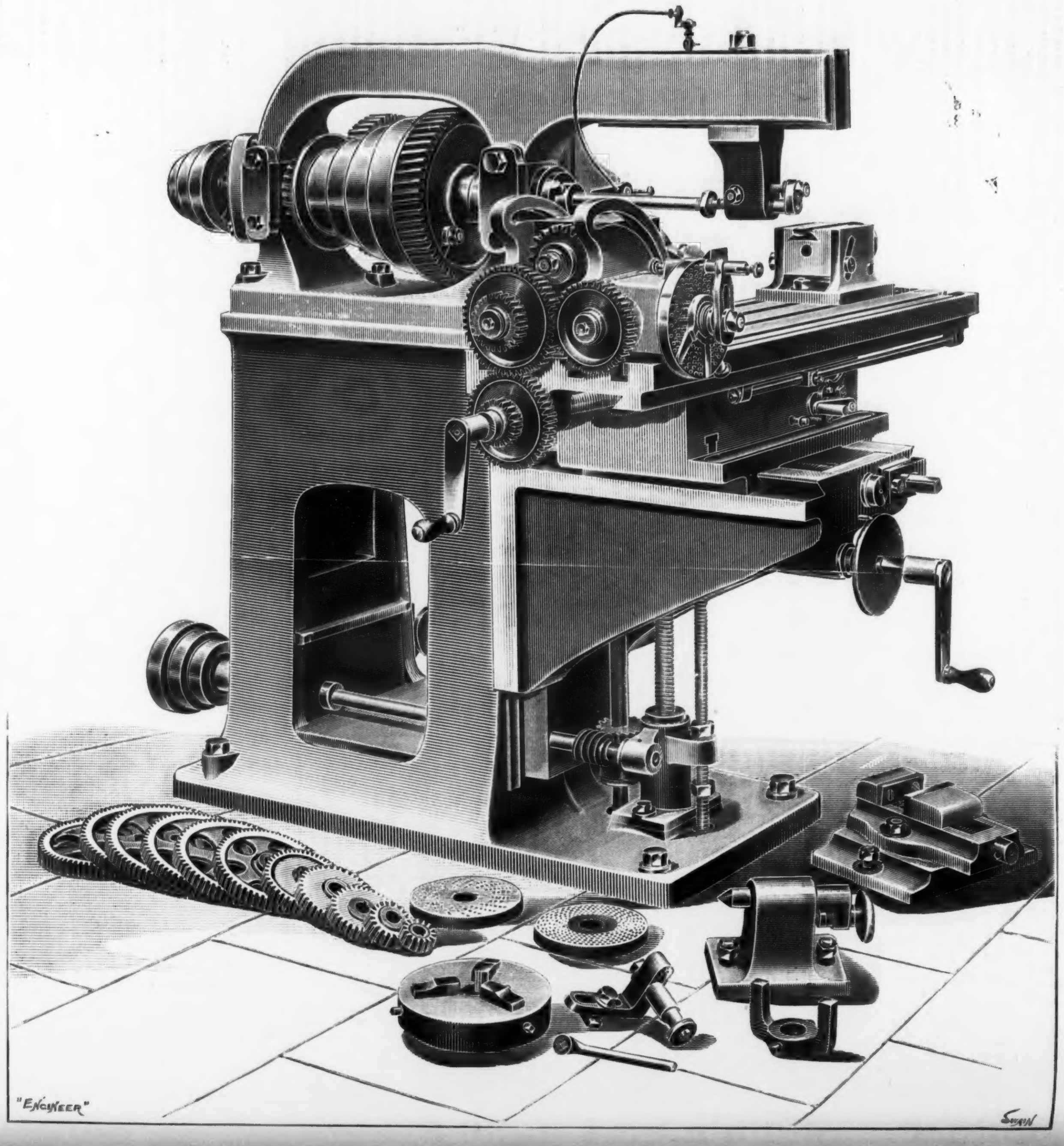
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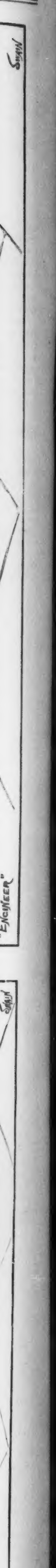
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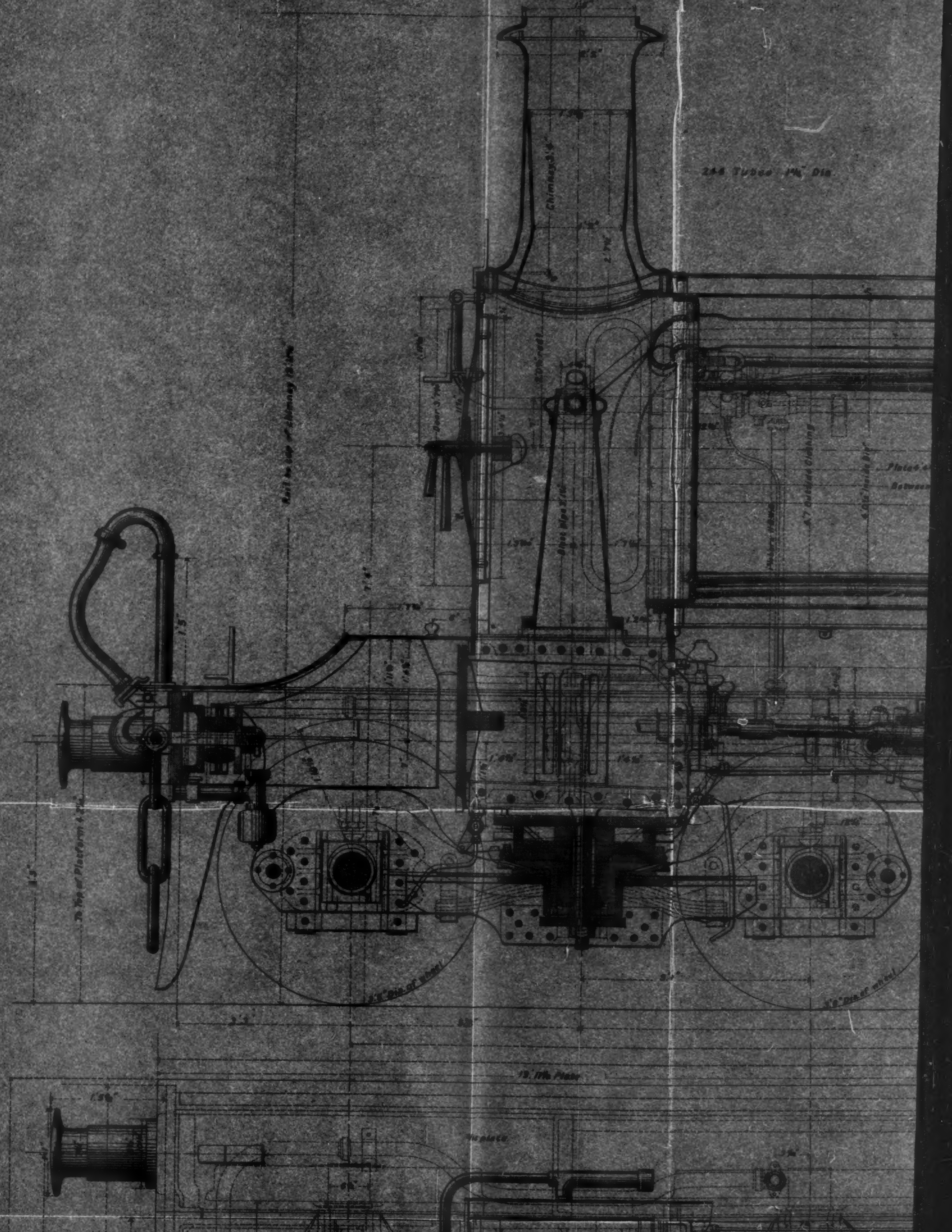
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Chimney
5'6" Dia.
5'6" Dia.

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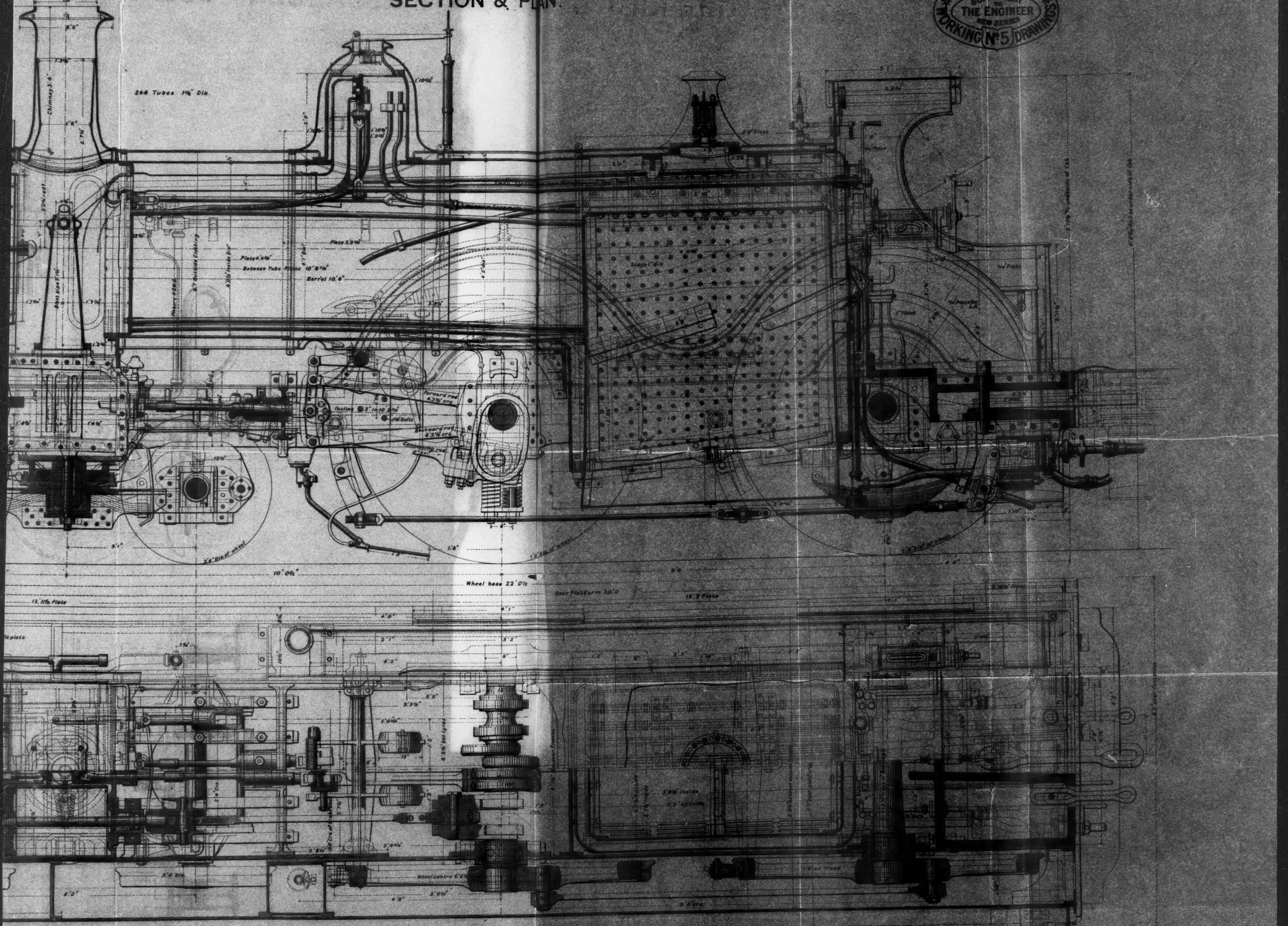

244 Tubes 1⅝" Dia.
Chimney 3'4"
Plate 4' 6½"
Between Tube Plates 10' 8⅛"
Barrel 10' 6"
Plate 3' 9¼"
4'7" Outside Clothing
4'1" Dia
Forward rod 4' 3⅛" crs
Incline 3" in 10' 2½"
1⅛" Bolts
Backward rod 4' 3⅛" crs
Connecting rod
3'6" Dia of wheel
7'0" Dia of wheel
10' 0½"
Wheel base 22' 0½"
Rear Platform 29' 0"
5' 8" Dia
Wheel centre 6' 6"

Saml. W. Johnson

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TO CORRESPONDENTS.

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

ROYAL INSTITUTION OF GREAT BRITAIN.—Friday, June 19th, at 9 p.m.: Paper, "The Utilisation of Niagara," by Mr. Thomas C. Martin.

THE CHAMBERS OF COMMERCE OF THE EMPIRE.—June 9th and following days.

MUNICIPAL ELECTRICAL ASSOCIATION.—June 10th to June 12th, at the Royal United Service Institution.

THE ENGINEER.

JUNE 5, 1896.

OUR HORSELESS CARRIAGE COMPETITION.

WE have offered prizes amounting in value to eleven hundred guineas, in order to promote the establishment and development in this country of an industry which cannot ultimately fail to attain very considerable, if not enormous, proportions. But little reflection is required to make it clear that it would be not only possible, but very easy, to spend this money and yet attain no useful result of any kind. We are not sure that this aspect of our competition has been fully and generally understood, and we think that the time has arrived when we should offer certain explanations to our readers, and direct their attention to facts which they may have overlooked. Our intention, and that of the eminent engineers who have consented to act as judges, is that the competition shall produce not only vehicles of some sort capable of travelling long distances at a moderate speed without accident, but vehicles sufficiently good to satisfy the conditions certain to be laid down by purchasers —that is to say, by the public at large. It forms no part of our purpose to go over old ground. The experiments made in France have left no doubt on the minds of those who have read what we have written concerning them that a very considerable measure of success has been attained. They have proved that light oil engines can be used for the purpose of locomotion. Now our competition is not intended to prove that what has been done on roads in France can equally well be done on English highways. That would be entirely superfluous. What we wish is to see some material advance made, we shall not say on French or American practice, but on what has been accomplished up to the present. We have been careful to keep our readers apprised of all and everything that is being done in the production of horseless carriages. We have ransacked the pages of history; we have dealt with every form of self-propelled vehicle for common roads. The exhibitions at the Crystal Palace and at the Imperial Institute contain, it is believed, the very best horseless carriages in the world. But a careful examination of these vehicles leads to but one conclusion, namely, that nothing nearly suitable to the demands of the English public has yet been produced. On the one hand, so far, no vehicle has been made to run using the heavy oils, without producing a very disagreeable smell. They are more or less imperfect, crude machines; full of promise, full of possibilities, but totally unfit to put into the market. On the other hand, the carriages which run with light oil, petroleum spirit, benzine, or naphtha, although even elegant in design and sumptuous in finish, do not at present comply with the law of Great Britain, and render necessary the storage of a highly inflammable liquid, in a way that would set the insurance companies up in arms. The petroleum spirit must be stored in very small quantities by those who sell it. It can only be purchased in comparatively few places. Anyone using a light oil motor must keep a store of the spirit in his coach-house or near it, and this he could only do by making special arrangements with the insurance companies. Very considerable commercial difficulties stand in the way, and will prevent in this country the light oil carriage from attaining any popularity unless considerable changes are made in the law and improvements are effected in the method of storing petroleum spirit. All which is much to be regretted, because the advantages which it possesses over the heavy oil are at once indisputable and considerable. But this is not all.

We do not think it can be said that any fairly satisfactory carriage has yet been produced. A visit to the Crystal Palace or the Imperial Institute will convince the most enthusiastic that, one and all, the vehicles are noisy, and that, one and all, they leave behind them most objectionable evidence that they have passed. In the matter of vibration, again, some of them are simply intolerable. Now, the general public will not buy carriages, either for pleasure or for business purposes, which are not at once safe, comfortable, odourless, and silent. It is not at all probable that a useful vehicle, say one suitable for carrying a doctor on his daily rounds, will be obtainable for less than £250 or £300. A man who can afford to sink so much capital will demand a certain degree of comfort in return; and he will not be content to ride about the country in a vehicle which will shake him and itself to pieces, or whose running can be heard half a mile off. We know that some thoughtless folk believe that finality has been reached, and that such vehicles as those now to be seen are as good as can be produced. We are quite certain that is not the case, and that in a little time great advances will be made, and vehicles produced which will compare with those now in use much as a Great Northern locomotive does with the Rocket.

The views we have expressed are entertained by a large number of those engineers and others much interested in the development of the horseless carriage. From all parts of the kingdom we have received requests to postpone our competition from next autumn until a convenient season next year, and we confess that the arguments used are very difficult to resist. It is pointed out that the horseless carriage is a new thing with the present generation of engineers. That it is essential that something much better than anything yet made must be produced if a popular demand is to be established; and that to all intents and purposes our prize competition has come too soon—much before anyone is ready to take advantage of it. The result of our inquiries is that there would be no probability of a contest amongst British makers if the competition were held in October; and that all the foreign vehicles are excluded by the nature of the oil they use, from taking part in any portion of the competition but that for the supplemental prize of 100 guineas, which we have offered for vehicles using light oil or petroleum spirit. It is pointed out that the proposed great French race has had to be postponed; and it will be remembered that both the attempts recently made in the United States to bring about a satisfactory competition proved abortive. For ourselves, we have been extremely reluctant to postpone the competition; but, in point of fact, the question has been settled for us. Besides verbal communications, we have received a large number of letters inviting us to postpone the trials. We have printed two, the others are all more or less on the same lines. We have only received one letter the other way. The requests to postpone have, therefore, been practically unanimous, and with the full approval of the judges we accede to it.

There is moreover another factor, which cannot be overlooked. Although Lord Harris's Bill has passed Committee in the House of Lords, there is quite a possibility that it may not become law this session. The Government have their hands full, every moment appears to be pre-engaged, and the chances of the Bill slipping quietly and quickly through are very small. We hear with regret that certain highly injudicious friends have suggested amendments, the introduction of which would be, we have no doubt, opposed. The carrying out or not of our competition depends of course on the passage or non-passage of Lord Harris's Bill. It may be said, and perhaps with reason, that it is too soon to say in the first week of June that a competition cannot take place at the beginning of October. But we hold that the best interests of intending competitors will be considered if we announce at once that the trials will not take place until 1897. We believe that this will satisfy many inventors who are now spending much time, talent, and money, on the production of vehicles which they intend to be superior in every respect to anything yet produced. All they ask for is time. It would be a most unsatisfactory termination to our undertaking if the vehicles winning our prizes were themselves superseded in a few months by something very much better in all respects. It does not appear that anything can be lost by a delay of a few months, and we feel certain that in postponing the competition we shall not only meet the wishes of intending competitors, but promote the best interests of the Horseless Carriage.

THE LIGHT RAILWAYS BILL.

THIS Bill, which has been considered at great length by the Standing Committee on Trade, was made, in the Report stage, the subject of a long and entirely useless debate in the House of Commons on Monday night. Amendment after amendment was moved, and the House divided seven times, the opposition always being beaten by enormous majorities. We do not say that the amendments were invariably frivolous or purely obstructive; but it is useless to expect that any important change will be made in a Bill which has passed the Standing Committee. We have, however, already said that this is in many respects about the worst drawn Bill ever laid before the House of Commons, and before it becomes law it is earnestly to be desired that the Government should give way—the Standing Committee to the contrary notwithstanding—on one most important point, and define the meaning of the words "light railway." What is a light railway? The question will have to be settled every time a scheme is brought before the Commissioners. The theory is that the Commissioners are to say what is and what is not a light railway. No system is more fraught with evil, or causes more waste of money, than that which leaves the meaning of the words of an Act of Parliament open to individual interpretation and discussion. If Parliament is unable to define its own meaning, how is it possible for any judge, commissioner, or lawyer to do it? We have here a Bill which limits the powers of interference of the Board of Trade, and removing a number of rules and restrictions, almost revolutionises Parliamentary procedure as affecting the construction, working, and financing of railways. Evidently it is not the intention of Parliament that the Act should apply to normal lines, and yet no attempt is made to define to what roads it shall and shall not apply. Let us suppose that a scheme is got up for running a line which any one of the existing companies may regard as a competitor. Opposition will be commenced, and the very first step taken by opposing counsel will be to assert that the proposed line is not a light railway within the meaning of the Act, and that the commissioners have no jurisdiction. Here is a splendid opportunity for endless litigation. On the other hand, a so-called light railway is proposed which will, as before, enter into competition with an existing line. Its gauge will be 4ft. 8½in.; the speed allowed unlimited; the weight of the rolling stock just a little less than that of the recognised main line; a 75 lb. rail is used instead of an 84 lb., and other things are in proportion. This is called a light railway by the promoters; and these gentlemen secure advantages in consequence, and enjoy privileges simply in virtue of the name. Can anything be more unfair to existing companies and shareholders? Will any railways be made in future, in Great Britain, which do not come within the four corners of the Act? It seems absurd to suppose that branch lines, at all events, will be made under any other Act of Parliament. Of course Parliament is not supposed to contemplate this.

Some of the members who took part in the debate appeared to think that a light railway must be of less gauge than 4ft. 8½in. As an example, we may cite the argument of Mr. Logan, the member for Harborough, in Leicestershire, who "entered his protest against the removal from light railways of those restrictions and regulations which the Board of Trade had found necessary for the protection of the public. It seemed to him a serious and dangerous new departure, and he hoped the President of the Board of Trade would thoroughly realise this. As to the question of gauge, he hoped it was not too late to insert a clause declaring that all railways constructed under the Act should be of the 4ft. 8½in. gauge, so that they might join up to the existing railways."

At one stroke Mr. Logan would render the Act totally useless for its intended purpose. Sir W. Hart-Dyke, on the other hand, could not imagine anything more destructive to the Bill than the fixing of the gauge. Yet he had no hesitation in suggesting a most impracticable and unpractical definition, namely, that nothing should be deemed a light railway on which a speed was attained greater than 12 miles an hour. There is, of course, no reason whatever why speeds of 25 miles, or even 30 miles an hour should not be attained; and to limit the velocity to 12 miles an hour would go far to render the light railway worthless. It is to us extraordinary that the Act does not contain such words as these: "The words light railway shall mean a railway worked by vehicles which shall not weigh loaded more than four tons for each axle," or "the greatest load that may be carried on a light railway shall be four tons per axle." This definition would be found in practice quite sufficient. No engineer in his senses would construct a heavy line to carry such small loads. A road constructed to carry but two tons per wheel could not possibly come into competition with a normal line, for reasons which it would be sheer waste of time to place before our readers. We do not, of course, pin our faith on four tons per axle, but under no circumstances would we allow the weight to rise above five tons, which is about that of most goods wagons on main lines. We do not refer to coal or mineral trains, which carry much more. A four-coupled engine with eight tons on the driving wheels, or a six-coupled engine weighing twelve tons, is quite heavy enough to work any traffic which would devolve properly on a light railway. In no fit sense of the word can a line of, say, 3ft. gauge, worked by a 30-ton tank engine, be called a light railway, much less a line 4ft. 8½in. gauge, worked by locomotives of the same weight and laid with 60 lb. or 65 lb. rails. Yet it would be very difficult to prove that the Act did not apply to such a line. Indeed, we happen to know that many persons always confound narrow gauge and lightness, holding that a line laid to the normal width must be "heavy," while any line narrower must be "light." It is anticipated that the Commissioners will decide in every case what is and is not a light railway; yet it is certain that they must either prepare some hard-and-fast rule for their own guidance, or their decisions must be mere expressions of opinion. To the average intellect it seems fatuous to pass an Act of Parliament, and to leave it an open question whether it does or not apply to any particular case. No hardship would be inflicted by defining the light railway with sharpness; and even if in a few cases it happened that heavier rolling stock than we have named could have been used to advantage, the loss would be so small that it would be as nothing compared to the advantage gained by removing all doubt from the minds of promoters as to what will and will not be accepted as a light railway by the Commissioners. Fortunately it is not yet too late, and we venture to hope that such representations may be made on this point to the Government as will induce them to give way, and say what they mean by the term "light railway." At present it is quite clear that Parliament has arrived at no conclusion on the subject.

PERMANENT WAY.

Among the numerous correspondents who have written on the construction of permanent way in our pages during the last few months, there is not one who is not qualified to express an opinion based on a competent knowledge of the subject; therefore what they have to say deserves thoughtful consideration. Although they have in many instances withheld their names from the public, it is no breach of faith to say that they include in their ranks the platelayer and the locomotive superintendent, the inventor and the civil engineer. None of these pronounce English permanent way perfect. The general drift of opinion is in favour of a return to the old-fashioned flat-footed rail spiked to cross sleepers, and we are assured that lines made thus are most successful in the United States. It is noteworthy, indeed, that no one seems to have a good word to say for continental lines. The American track first and the English second appears to be the classification most in force. We have on a previous occasion directed attention to what ought to be, but evidently is not, an obvious truth, namely, that the price to be paid for the road and for its maintenance is an important factor to be considered when we are balancing the advantages and disadvantages of various systems of constructing permanent way. We have heard a great deal lately about safety and danger, risk and accident; and we have been told that the English road is a feeble road, and not able to bear the great weights and high speeds now in vogue. No statistics, however, have been produced to prove the proposition. It is true that one or two bad accidents have occurred, presumably for lack of proper or sufficient ballast; but there is no evidence to show that the flat-footed rail on cross sleepers would be better in this respect than the normal track. When we remember that the London and North-Western Railway, for example, has a train mileage of about 40,000,000, or 125 times the distance from the earth to the moon, per annum, while the derailments are practically nil, we think it may be admitted that our roads are really safe. In the United States, on the other hand, derailments are very common, and constitute a very fatal class of accidents. Not much seems to be needed to make our roads absolutely safe. Probably a certain number of anchor plates, as suggested by one correspondent, fixed to sleepers on curves, would supply all that is needed. We fancy that none of our correspondents is prepared to maintain that any system of permanent way can be devised which will be independent of repairs and inspection. However excellent a road may be at first, it will deteriorate unless looked after and maintained in good condition. It would seem, then, that after all, the arguments in favour of the American as compared with the English road, are more matters of opinion than of fact so far. It is admitted that derailments, save at points and crossings, and in yard work, which do not count, are very rare in this country; but we are warned that this will not always be so; and thus, finally, the principal fault found with English track is that its maintenance is costly, that its surface is rough, and that the chairs are bad for the rolling stock.

Two alternative systems of construction are proposed. One is the flat-footed rail and longitudinal sleeper; the other is the flat-footed rail and transverse sleeper. Concerning the first, it is enough to say that it was tried for many years on the Great Western Railway. Everything was done with it that could be done to make it a success. It has all been taken up, and the whole road save a few insignificant bits, has been relaid with chairs and cross sleepers. Some of our correspondents must excuse us if we say that the engineers of the Great Western Railway knew better than anyone else what was the best road. The continuous line has disappeared for very sufficient reasons, and can no longer be regarded as falling within the bounds of practical railway engineering. We have, then, the flange rail laid on cross sleepers. That, too, has had an exhaustive trial in this country. Its great defect is that, weight for weight, it must have less vertical strength than the bull-headed rail. Its advocates cannot get over this fact, and accordingly suggest that instead of using an 80 lb. or an 84 lb. rail, one weighing 100 lb., or even more, per yard should be adopted. They seem to forget, however, that there is in existence already a 100 lb. bull-headed rail, Sandberg's section, which is in turn very much stiffer than the 100 lb. flange rail can be; and they are quite silent on the subject of cost. If our correspondents will try to place an order for 10,000 tons of adequate flange rails, they will very soon find a noteworthy difference in the price. The bull-head and double-headed sections are very easy to roll, and scarcely any wasters are produced; but the rolling of big flange rails is quite another matter. The percentage of wasters is considerable; the weights that can be turned out per week smaller, and the difficulties of rolling increase with the dimensions of the section. The result is that flange rails will cost more per ton by some shillings than the ordinary section. Certain of our readers doubtless recognising this truth, overcome the difficulty by using a flange rail of moderate weight, and increasing the number of sleepers. In short, it is proposed, to all intents and purposes, to construct a timber platform, and carry the rails on this. We are told that in the United States the flange rail is a great success, and in almost the same sentence that nearly twice as much wood is used as we use. Our correspondents omit to add that the United States abound in forests, and that the value of the timber is very small, while we have to import every sleeper we use. The cost of permanent way would be very largely increased if we doubled the number of sleepers; and we have yet to learn what form the return for this outlay would take. In what way would the London and North-Western Railway Company, for example, be reimbursed if it doubled the number of sleepers in every mile of its track?

It has been pertinently asked, Whence came the normal road with chairs? What is the history of the evolution of normal English permanent way? The reply is that, like many other things in engineering, it is a survival of the fittest. Not, be it observed, necessarily a survival of best, but only of that best adapted to the conditions of British railway life. The flange rail has a great defect, overlooked altogether by most of our correspondents. It tends to turn over on its outer edge under the bursting stresses set up by the engines. It eats its way into the sleepers, draws the inside spikes, becomes loose, and gives — especially on curves — an inordinate amount of trouble. This is due to the comparative narrowness of its base. Any attempt to make the rail stiff by adding to its depth aggravates the evil. In the United States the sleepers are mostly of oak or hard wood, the price of which in this country is prohibitive. To get over this difficulty the chair was introduced. It gives a very wide base to the rail, which is therefore secure against turning over. This is the principal reason why chairs were introduced and used; and there is this further and enormous advantage, that no system exists which allows of a rail being removed and replaced with such facility. The flange rail on a cross sleeper road can only be a success when the sleeper is made of hard wood.

While we advance these facts in favour of the normal method of constructing permanent way, we have no intention of asserting that improvements may not be effected on many of our lines; but the direction in which these improvements should proceed has little or nothing to do with the rails The crying defect on some of our roads is bad ballast. In many places the ballast has been worked and worked until it has had "the life taken out of it." It is dust in summer, mud in winter. Bad ballast is a constant source of expense. Packing up has to go on almost day and night if the road is to be kept at all even; engine springs are broken; the engines and rolling stock generally are knocked about, and there is always a certain amount of risk incurred. It is not the sleepers, nor the rails, nor the chairs, against which our correspondents should direct their attack. It is against ballast—worn-out ballast in some cases; bad ballast to begin with in others. We have already said that railway companies are very slow to lead ballast from a distance, and in this they are penny-wise-and-pound-foolish. Engineers, locomotive superintendents, track men, gangers, platelayers, engine drivers, are one and all agreed that good ballast will cover a multitude of defects on the one hand, and that, on the other, nothing can compensate for the injury done by bad ballast. The argument that by having plenty of sleepers any stuff will do for a road bed, is nonsensical. We may have so many sleepers that the road cannot be properly packed, and the remedy becomes worse than the disease. Anyone who has seen, as we have, a close-sleepered road, with half the sleepers hanging from the rail because of the running of the sludge, falsely called "ballast," under them, will be slow to find in wood a substitute for good gravel or broken stone.

Finally, we may say that we do not share in the apprehensions of some of our readers. Speeds, no doubt, augment, and the loads carried are heavier; but as regards the latter, it must not be thought that the locomotive superintendent or the designer of coaches has stood still. Locomotives are provided with means of easing their progress round curves to a far greater extent than was the case twenty years ago. We find the traversing bogie in regular use, or, at least, the traversing axle. We do not think the loads per wheel have augmented. It was said that some of Mr. Sacré's engines on the Manchester, Sheffield, and Lincolnshire Railway carried 21 tons on their single drivers eighteen or twenty years ago. Nothing heavier than that, or indeed as heavy, is running now, so far as we are aware. We do not see any reason, therefore, to think that radical changes of any kind will be needed in English permanent way to enable it to meet the demand which will be made on it in the near future; but we know that much ballasting ought to be, and probably will be, done anew. The cost may be considerable, but no money can possibly be spent on a railway which will bring in so certain a return. In the long run it would pay all our leading railway companies to ballast their lines from end to end with broken stone. The cost would be great, but the return would be great in proportion.

LITERATURE.

The Naval Annual for 1896. By T. A. Brassey. Griffin and Co., Portsmouth.

[First Notice.]

The only feeling of regret that we experience, on opening the *Naval Annual* for 1896, is that its pages no longer contain those crisp and valuable papers upon burning nautical questions that have emanated, for ten years, from the pen of Lord Brassey. Nevertheless, the able compiler of the *Annual* has introduced into it this year a series of novel features and papers upon technical subjects that cannot fail to awaken interest. The excellent engravings, showing side views and deck plans of the Powerful, the Andromeda, or Diadem class, the Buenos Aires, the Carnot, and the disposition of armour upon the Brennus, are of themselves not the smallest of the attractions which the book contains. Whilst writing upon this point, we would make a suggestion which we feel assured would be acceptable to many of the supporters of the *Annual*. We take it for granted that the plates and tables in this work are that which has the main interest for technical readers, and yet it is very difficult to form an accurate estimate, from the plates, of the relative value of the battleships and cruisers of different nations. In the earlier plates it was customary to give a midship cross-section, and sometimes two or three other sections of the various vessels illustrated, showing roughly the position of the propelling machinery and boilers, the magazines, barbette, and turret mechanism, &c.—such, for instance, as were given in the case of the Jauréguiberry. Plates of this character would be of much greater value, if obtainable, than mere side views of ships, which give no insight whatever into the novel characteristics appearing in such vessels as the Diadem and Powerful. Had a midship section of the Powerful been in possession of the public a year ago, the ridiculous rumour that the Admiralty was building docks into which the new cruisers could not be floated would never have arisen. It is clear that if plates of side elevations and plans may be published without injury to the public interests, cross sections may be published too.

Chapters I. and II. deal with the progress of our own and foreign navies. The following brief table, showing, in a few figures, the relative results obtained during the steam trials of the Majestic and Magnificent, as representative of the two great systems of forced and induced draught, show how nearly the systems approximate:—

Eight Hours' Natural Draught.

	Mean draught. ft. in.	Air pressure. in.	Mean revolutions.	I. H. P.	Speed.
Majestic	25 0	—	100·5	10,418	16·9
Magnificent	24 11½	1·4	96	10,301	16·5

Four Hours' Full Power.

	Mean draught. ft. in.	Air pressure. in.	Mean revolutions.	I. H. P.	Speed.
Majestic	Not known	Not known	106	12,497	17·9
Magnificent	24 8½	0·9	100·3	12,157	17·6

Thirty Hours' Coal Consumption Trials.

	Coal consumption. lbs. per I. H. P. per hour.	lbs. of steam.	Revolutions.	I. H. P.
Majestic	1·84	135	85	6075
Magnificent	1·67	133	83	6086

It will be observed that there is an economy of fuel in the case of the Magnificent, with the system of induced draught—taking into consideration the loss of two revolutions—amounting to about 0·15 lb. per indicated horse-power per hour, or about ten tons per diem at this speed.

A good description is given of the Powerful and Terrible, showing some of the constructive features. It is observed that the armoured deck is "composed principally of three thicknesses of steel plating, but at the edges, where it joins the side of the ship, two of the skins of plating are discontinued, so that the extreme edges of the deck, for a width of a foot or two, are only one skin of plating." Should this be a correct description, it cannot but be a matter of regret that the old system of framing and construction has been departed from in the case of these great cruisers. The plan of allowing the thick armoured deck to extend to the skin plating on both sides of the ship, and securing it to the deep bracket-framing beneath, and then building the frames of the main and upper deck portions immediately upon this firm basis, appeared to be a very sound one.

Notice is taken of the very excellent results which have been obtained with the recently renovated battleships, notably with the Monarch and Sultan. The former of these two vessels attained the remarkable speed of 15¾ knots upon her trials, and the latter under natural draught ran for eight hours at a mean speed of 14·6 knots. These ships are now considerably more powerful both in speed and armament than they were originally, the quick-firing 4·7in. guns of the Sultan having added specially to her fighting value; but it does seem a pity that, when so much was undertaken in regard to these and other similar vessels, and so much money spent, the old armament was not replaced altogether. This is being done with renovated vessels in Italy, and there is no reason why it should not have been done in England.

The progress made in the torpedo boat destroyers of the Desperate class is very satisfactory. Before the end of the year we shall have about thirty of these invaluable adjuncts to our torpedo boat flotilla completed and afloat, each of 5400 indicated horse-power, with a speed of 30 knots. When it is remembered that they are expected to overtake and destroy torpedo boats, which are rapidly increasing in power and speed, the importance of each knot beyond 25 per hour may be realised. We understand that Messrs. Laird, of Birkenhead, have several of these 30-knot boats in hand, in addition to the ten ordered for the British Government, so it is clear that other nations are waking up to the importance of the class as well as ourselves.

In France there is not quite so much to record as usual, the difficulties that have been met with by the French naval constructors in securing that their completed battleships shall be sufficiently stable in a seaway having diverted their attention to alterations of superstructures and fighting masts and cutting down upper works rather than to building fresh ships. The extraordinary system of continued modification which prevails in France from the time when a war vessel is originally designed to that when she proceeds upon her first commission, is strikingly seen by a comparison of the plate of the Brennus, which appeared in the *Naval Annual* some six years ago, with that of the finished vessel in the *Annual* for this year. One of the most striking features in regard to nearly all the ships now building and completing in France is to be found in the fact that nearly in every case are they to be fitted, or are already fitted, with water-tube boilers, either of the d'Allest, Belleville, or Normand type. It is a matter for congratulation that our Admiralty, although prepared to make exhaustive trials of the water-tube system, is content to be possessed *of* ideas upon the subject, and not *by* ideas, as in the case of our neighbours across the Channel.

The Jeanne d'Arc will be a vessel emblematic in every way of the name of the heroine after which she is called. She is to be an armoured cruiser of 11,270 tons, with 28,000 indicated horse-power, and maximum speed of 23 knots. Belts of 6in. and 3in. steel extend to the deck above the armoured deck. The armament comprises two 7·5in., eight 5·5in., and twelve 3·9in. quick-firers, as well as smaller weapons.

In Italy the armoured cruiser Vettor-Pisani has been launched at Castellamare. She is only of a displacement between that of the Edgar and Eclipse—6500 tons—but is very powerfully protected, there being a partial nickel steel belt at the water-line, and above this a long redoubt for eight 6in. quick-firers, protected by 6in. plates. The deck, forming the upper portion of this battery, is covered with 2in. plates. Besides this, there is an armoured deck of 1½in. and 1in. plates, extending the whole length of the ship, and 6in. bulkheads at the end of the redoubt. Four 6in. quick-firing guns are on the upper deck, and six 4·7in. quick-firers are mounted in other places. The redoubt has its gun positions isolated by splinter screens. The indicated horse-power is to be 13,000, and speed 20 knots; coal capacity, 1000 tons. This vessel, if a good sea-boat, should be a disagreeable adversary for one of our first-class cruisers to tackle.

The performances of the Sicilia during her natural draught trials were very remarkable. The mean speed run on a base of 100 miles—fifty out and fifty home—was a little over 19·2 knots. This was without any forcing, and the stokeholds were not closed up.

The great armoured cruiser Rossia is now in process of completion afloat. She, like the Jeanne d'Arc, is to have three screws, but the speed will be only 19 knots. The boilers are of the Belleville type, and consist of thirty-two generators, of which the total indicated horse-power is 14,500, the grate surface 140·32 square metres, and the heating surface 4378·56 square metres. The boilers are placed back to back, sixteen on each side, in four compartments. Thus the tubes run athwartships. The armament is enormously powerful.

In the United States considerable interest attaches to the laying down of the Kentucky and Kearsage. Their double turrets, the lower part of which is to contain two 13in. guns—described in THE ENGINEER for the 15th instant, and a drawing of whose breech gear was given—and the upper part two 8in. guns, may be a novelty, but they are not a feature that we should like to see reproduced in our own vessels. One happily directed blow from a heavy projectile striking the base of the turret might disable four guns at once. Cofferdams filled with compressed fire-proofed American corn pith cellulose will be worked the entire length of the vessel in the region of the water-line, behind the armour belt, which has a maximum thickness of 16½in., thinning off towards the stern. We should say that these cellulose compartments would have about as much value as those filled with cork in the Inflexible, Colossus, and Edinburgh, which are religiously emptied and refilled with fresh cork periodically, as their contents decay.

A quantity of space is devoted to Japan. And this is not to be wondered at, for, in the course of six or nine months, the Japanese fleet will comprise five battleships—two of 12,450 tons—and armoured cruisers, fourteen large and powerful deck-protected cruisers, and about the same number of torpedo gunboats of large displacement; whilst two battleships and three other cruisers are either building or about to be laid down. In one sense, therefore, it is unfortunate for the Western Powers who retain large squadrons in the China Seas, that the fleet of China should have been so effectually wiped out. Whilst it existed, under the command of the energetic Ting, Japanese ambition was held in check. Now Japan, as a powerful naval Power in the East, has to be reckoned in the light of a possible enemy, and our force in those waters must be greatly reinforced, unless we are to hold our position in Hong Kong and at the Treaty Ports at the pleasure of Japan.

The three following chapters, Nos. III., IV., and V., upon "Relative Strength, and the Navies of France and Italy," we need not say very much about. It is a large order to deal seriously and satisfactorily with the former, and we should be exceedingly sorry to see any desire amongst the authorities of our Admiralty to create a fleet of small second-rate or coast-defence armoured vessels in order to raise our relative strength in this respect. We agree with a recent writer upon this subject, who said that whatever Great Britain possessed in the shape of war vessels should be "first-rate." Chapter IV. is practically an epitome of "La Flotte de Guerre," brought up to date. That on the Italian Navy is an excellent summary of its present position.

Chapter VI., on "Water-tube Boilers," is a short, popular treatise upon the subject; but though it adds very little to what is already well known in regard to the matter, it is well worth perusal. We fully agree with Mr. Dunell, the writer, that much remains to be learned in regard to the lasting qualities of water-tube boilers; and that "whether, with its long and tortuous steam-generating passages, the Belleville boiler will stand forcing, is a point upon which naval engineers will look to have certain evidence before they pin their faith to the type."

Chapter VII., upon the "Naval Gathering at Kiel," points out the fact that it gave us an exceptional opportunity for studying the relative value of features in the latest warships of various naval Powers. This is precisely the view of the event which we should adopt ourselves, and, having done so, we see but little to imitate in such representative ships of foreign navies as took part in the show.

SHORT NOTICES.

Summer Tours in Scotland, by David MacBrayne's Royal Mail Steamers.—This excellent work is too well known to need more than the statement that the 1896 edition is equal in all respects to its predecessors of former years.

A Summer Holiday in Holland. Scheveningen, the Dutch Brighton, and the Interesting Towns in the Neighbourhood. By Chantrey Churchill. Second edition, with illustrations. London: H. Grube, 12A, Paternoster-row. Price 6d.—This is a guide to Scheveningen, with information as to what to see in excursions from that place as a centre. Visitors to Holland for the first time will find a good deal to interest them in this guide.

Mountain, Moor, and Loch. Illustrated by Pen and Pencil, on the Route to the West Highland Railway. With 230 Illustrations from Original Drawings made on the Spot.—Second edition London: Sir Joseph Causton and Sons. 1895. This is just what it pretends to be—an illustrated guide. The artist has in many cases very fairly caught the spirit of the scene illustrated, but no wash drawing can do justice to Luss or Tarbert. The letterpress is very satisfactory. Altogether it is a little book to be recommended to the tourist.

Le Port D'Anvers au XXme Siécle. Alph. Müllender. Liège: Alph. Müllender, 27, Rue des Guillemins.—This is a long thin book giving a very full and statistical account of Antwerp, its growth, dock, wharf, and railway facilities, and great increase in trading prosperity. It shows the tendency of the old city to spread to the opposite side of the river, and brings forward a new project for an underground railway connecting the centre of Antwerp and the proposed new city on the left bank of the river. It is proposed to construct this railway on lines similar to those of the City and South London, illustrations of which are given. The book also describes at length a project for the construction of a new main line connecting the Antwerps by a new bridge, and running almost direct to Düsseldorf *viâ* Moll and other towns north of the present line, which runs *viâ* Liège. The new line will save about 81 kiloms. in the run between Antwerp and Düsseldorf, out of about 380 kiloms., or a saving of about 21 per cent. of the distance. Certain improvements in the river channel are also proposed. Two short bends, for instance, forming a loop are to be replaced by a new curved cut of large radius, and the old channel would form a dock with large quay frontage.

BOOKS RECEIVED.

Crystallography for Beginners, with an Appendix on the Use of the Blowpipe, and the Determination of Common Minerals (after the method of Dr. Albin Weisbach). By C. J. Woodward, B.Sc. London: Simpkin, Marshall, Hamilton, Kent, and Co. 1896.

Metallic Structures: Corrosion and Fouling, and their Prevention. A Practical Aid-book to the Safety of Works in Iron and Steel, and of Ships, and to the Selection of Paints for them. By John Newman, Assoc. M. Inst. C.E., F. Impl. Inst. London: E. and F. N. Spon. 1896.

HORSELESS CARRIAGE NOTES.

DURING last week a new oil motor carriage was kept running about the country round Horley by the makers, Messrs. Roots and Venables, whose vehicle carries two persons, runs on three india-rubber tired wheels, and is not very heavy. It is propelled by a Roots vertical oil engine, using ordinary lamp oil, and with a new form of ignition tube and vaporiser lamp.

THE differences between the results of trials of motor carriages or any self-mover in a confined space and on the long open country ride are so great that the former is useless until supplemented by the latter. Writing us on this subject, Mr. J. H. Knight, Farnham, says:—"It is extremely unsatisfactory to try a motor carriage in a yard. When the machine comes on to the public road many things will crop up which have been overlooked in a trial in a yard only. If any maker of a light motor carriage wishes to make a trial trip with his carriage on a private road and will communicate with me, I can arrange for him to use a private road for a short time. The road is about 460 yards in length, with space to turn at each end. About half the road has a rise of about 1 in 30; the other half is fairly level. The surface is fair. The nearest railway station is about two miles distant." Although horseless carriages are running here and there about the country without hindrance, and it is possible for owners to find a district in which neither the local authorities nor the public are very strongly prejudiced against them, the offer made by Mr. Knight will no doubt be very acceptable to experimenters.

SOCIETY OF ENGINEERS.

RAILWAY BRIDGES FOR BRANCH LINES.

AT a meeting of the Society of Engineers, held at the Roya United Service Institution, Whitehall, on Monday evening, June 1st, Mr. G. Maxwell Lawford, vice-president, in the chair, a paper was read by Mr. M. A. Pollard-Urquhart, M. Inst. C.E., on "Examples of Railway Bridges for Branch Lines."

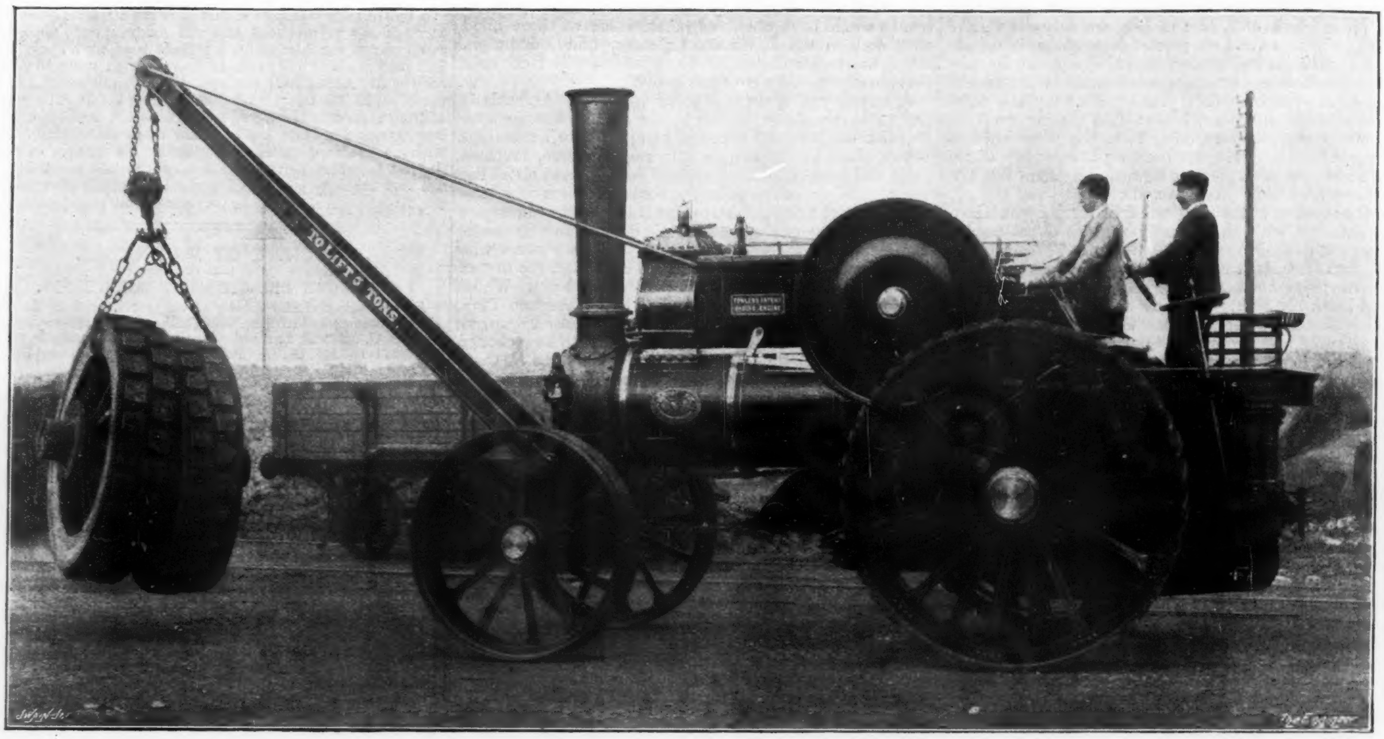
The author first referred to the number and variety of ordinary railway bridges everywhere erected, and proceeded to consider which type was most suitable, as combining economy with efficiency. He pointed out that small branch lines were what chiefly remained to be constructed in this country, and that the bridges under notice were mainly applicable to that class of line. He then drew a comparison between bridges with box wings and those with splayed wings, showing the saving effected by using the latter form. The author then proceeded to show the economy gained by using brick arches instead of girders for bridges carrying roads over the railway, but pointed out that this advantage was chiefly noticeable in single-line bridges, and to a great extent disappeared in double-line structures. The most suitable form of bridge under the railway was then described, and various forms of flooring were referred to. Some examples of bridges for occupation roads were then considered, the author pointing out that when only a small acreage was cut off from a farm, a timber bridge would be sufficient for the moderate traffic that would pass over it. He also alluded to the advantage of using trough girders to carry the railway over small spans, owing to the headway gained. Attention was then drawn to three types of bridges carrying a railway over water-courses, the cost of each of these structures and the time taken in erecting them being given. It was then pointed out that to effect economy, corners and pilasters should be avoided, and the bridge made as simple and easy to build as possible.

NEW INCANDESCENT LAMP.—A new filament for incandescent lamps has been described as made of hygroscopic asbestos paste, which, after being made in sheets ·3 mm. thick, is cut into strips 6 cm. wide, and impregnated with a 30 per cent. solution of platinum chloride. It is then passed through a saturated solution of sal-ammoniac, dried in hot air, and then heated in a Bunsen flame, which converts the platinum solution into a platinum sponge. It is then further impregnated with a 20 per cent. solution of magnesium chloride and heated, which process is repeated until the plate is covered with a uniform coating of magnesia, and it is finally dipped into a 10 per cent. solution of cerite nitrate. The magnesium coating protects the platinum, and as the light-radiating properties of the cerite metals are much greater than those of carbon, the *Electrical Engineer* says it is thought possible that such lamps will take less current.

THE INCORPORATED GAS INSTITUTE.—The thirty-third annual general meeting of the members will be held on Tuesday, Wednesday, and Thursday, June 9th, 10th, and 11th, at the Hall of the Society of Arts, Adelphi, W.C. The chair will be taken by the President, Mr. William R. Chester, M. Inst. C.E. The following programme has been issued:—On Tuesday, June 9th, the chair will be taken at eleven o'clock. Confirmation of minutes of last annual general meeting; appointment of scrutineers to examine the balloting lists for the election of officers, new members, &c.; presentation of annual report of Council; presentation of statement of accounts; presentation of premiums for papers; address by the President. Adjournment for luncheon. Reading and discussion of papers and communications as follows:—"New Details in Gasholder Construction," by E. Lloyd Pease, of Stockton; "Gas Engines as Economical Motors," by J. Holliday, of Scarborough; "A Season's Experience with Incandescent Public Lighting," by F. G. Dexter, of Winchester; "The Popularisation of Gas," by Andrew Dougall, of Tunbridge Wells; "Photometers and Standard Burners," by William Sugg, of Westminster; "Suggestions for a Standard Photometer," by W. J. Dibdin, of London; "The Principles of Transfer of Gas Undertakings from Companies to Local Authorities," by E. Herbert Stevenson, of Westminster; "Letting Gas Apparatus on Hire," by Norton H. Humphrys, of Salisbury. In addition to the above, Professor Frank Clowes, D.Sc., F.I.C., of University College, Nottingham, will on Wednesday, June 10th, deliver a lecture entitled, "Explosive Mixtures of Combustible Gases with Air, and Methods of Detecting and Measuring Minute and Dangerous or Explosive Proportions of such Gases." The annual general meeting of the donors and subscribers to the Benevolent Fund will take place at the close of the sitting, about 5 p.m. It is especially requested that contributors will endeavour to be present. Wednesday, June 10th, the chair will be taken at 10.30 a.m. Reading and discussion of papers and communications. Adjournment for luncheon. Reading and discussion of papers and communications. The sitting will close about 4.30 p.m. Evening: Reception of the members by the President, at the Westminster Town Hall, Caxton-street, Victoria-street, Westminster, at 8 p.m., to be followed by a Conversazione and Dance. Invitations are already in the hands of each member, and it is requested that intimation be sent to the offices, 13, Victoria-street, not later than Wednesday, June 3rd, stating whether it is intended to be present. Evening dress preferred. Thursday, June 11th, the chair will be taken at 10.30 a.m. Reading and discussion of papers and communications. Adjournment for luncheon. Report of the scrutineers; applications for transference; nomination of the President of the Société Technique du Gaz en France as an hon. member; place of next meeting; votes of thanks. Friday, June 12th, Excursion down the Thames, round the Nore Light into Sheerness, and back to London Bridge. 9.30 a m.: Leave Fresh Wharf on board the s.s. Clacton Belle. A tender will start from Westminster Pier at 9 o'clock sharp, calling at Temple Pier at 9.10, and convey the members to the steamer at Fresh Wharf. 12 o'clock: Luncheon on board the Clacton Belle, for all members holding pink tickets. 12.45 p.m.: Luncheon for all members holding white tickets. Members are particularly requested to observe this arrangement, in order that no confusion may arise. Luncheon tickets are transferable amongst those attending the trip, to allow of friends lunching together if desired. 1.30 p.m.: Arrive at Sheerness. Through the courtesy of the captain-superintendent, a pass has been furnished to the Chief Inspector of Police, which will allow members to view the Sheerness Dockyard and Flagship. The Clacton Belle will moor at the pier about 1.30, and members will be conducted round the Dockyard, which is situate about ten minutes' walk from the pier. 3 p.m.: Leave Sheerness. 5 p.m.: The Clacton Belle will call at Gravesend to disembark any members preferring to complete the journey by rail. 6.30 p.m.: Arrive at London Bridge.

COMPOUND ROAD LOCOMOTIVE WITH CRANE

MESSRS J. FOWLER AND CO., LEEDS, ENGINEERS



THE BATH AND WEST OF ENGLAND AGRICULTURAL SHOW.

As promised in the brief notice of this show which we gave last week, we are now enabled to place before our readers full particulars and an illustration—Fig. 1—of the 10-horse power compound road locomotive fitted with crane which Messrs. John Fowler and Co., Leeds, had on view. The leading dimensions of this engine are as follows:—Cylinders, 6¾in. and 11½in. diameter by 12in. stroke; fly-wheel, 4ft. 6in. diameter by 6in. wide; driving wheels, 7ft. diameter by 20in. wide; front wheels, 5ft. diameter by 16in. wide; capacity of water tank, 220 galls.; and capacity of coal bunker, 8 cwt. It is mounted on spring gear having strong locomotive type plate springs under the hind axle, with compensating levers, so arranged that they regulate the motion of the engine always at right angles to the axle, thus obviating any cross action on the spur gearing. The hind axle and third motion shaft-bearings slide in hornblocks, allowing a vertical movement of 2in. The road spur pinion is actuated by a driving frame from the third motion wheel in such a manner as to keep the pitch circles of the two wheels always in contact. The jib crane is designed to lift five tons. It is operated by bevel gear and worm and worm wheel, while the front road wheels of the engine are made of extra width to allow of the carriage of a load on the crane. The cylinders are steam jacketed, the valve chest being placed between them, while to allow of the cylinders being worked together for convenience at starting, a valve operated from the foot-plate, and designed to close automatically, is provided. The slide valve excentrics are cast together and secured on the crank shaft by one large key. The crank shaft and axles are of hammered steel, and carried in malleable iron brackets fitted with gun-metal brasses, the bearings being let into recesses formed in the fire-box shell side plates, which are extended to receive them. The gearing is of crucible cast steel, arranged as far as practicable to work inside the crank-box, and the road motion is designed for two speeds, while the crane gear is placed within convenient reach of the driver, who has thus the power to work the crane both hoisting and lowering. The boiler, made of mild steel plates having the rivet holes drilled *in situ*, is constructed to withstand a pressure of 180 lb. per square inch. The smoke-box is flanged inwards at the front end, and welded at the joint, square corners subject to corrosion being thus avoided. The road wheels are built up of strong tee-iron rings, wrought iron forged spokes, and cast iron bosses, the driving wheels being shod with diagonal cross bars, and having also a number of bolt holes drilled in the rim for affixing a wooden ring or blocks to give additional adhesion, while the front wheels are provided with steel lapping plates. The driving wheels are also fitted with a powerful hand brake, the blocks of which bear upon the inner surfaces of the rims. As will be seen from the illustration, this brake is operated by the driver by means of a hand-wheel and screw.

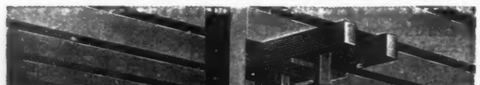


Fig. 2—CARTER'S PENDULUM SIFTER

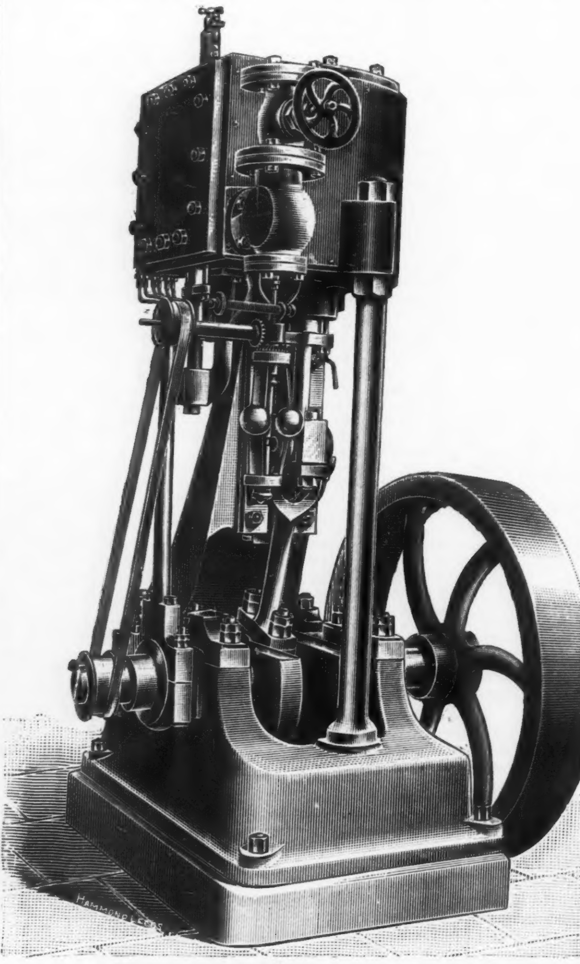
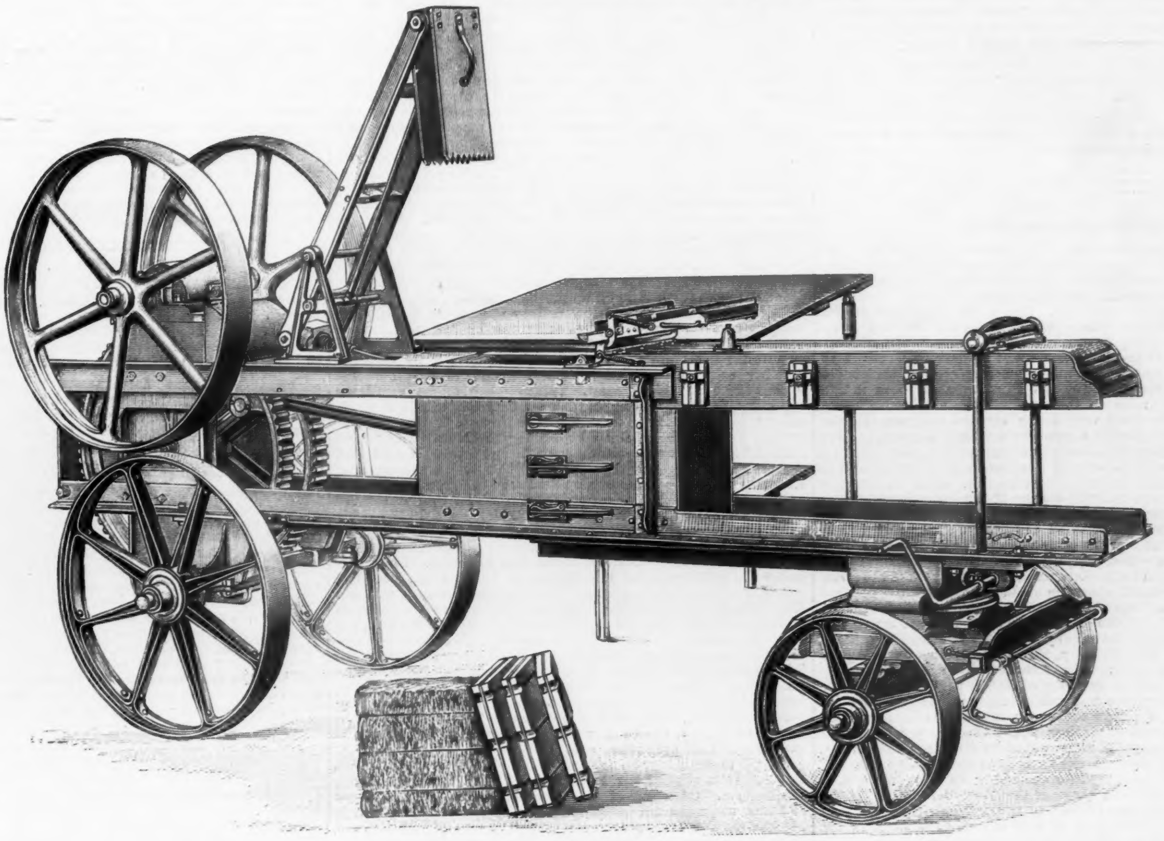


Fig. 4—EASTON AND BESSEMER'S HIGH-SPEED ENGINES

Fig. 2, this page, represents a device called a loose silk pendulum plane sifter, although the loose sifting material is not a plane—for scalping, grading, and dressing flour. This appliance was exhibited by Mr. J. Harrison Carter, of Dunstable, and is said to give better flour while occupying less floor space, and consuming less power than the ordinary centrifugal dressing machine. The pendulum, which is really the body of the machine, is composed of a series of sieves placed one above the other, and the feed entering at the top passes over each of the sieves till the overtails leave at the bottom. The flour—separated from each sieving—falls on to a canvas fixed tightly over the silk of the next lower sieve, and is then by the pendulum or gyratory movement conveyed to openings through which it falls to the tray at the bottom. Thus the flour at the bottom is taken off at the same sleeve. The pendulum is suspended from one point only, a universal ball bearing in the centre of the machine, by which the weight is taken. By the excentric motion of the crank from underneath, its axle moves in the mantle of a cone, and the sieves incline alternately in every direction, thus imitating the hand sieve movement. By securing the silks loosely over the frames, folds or undulatory waves of the fabric are produced by the gyratory movement, and the material being sifted keeps these undulations in constant movement. It is claimed that this feature obviates the necessity of a cleaning device for the silks. The floor space required by this machine is 3ft. 6in. by 3ft. 3in., and the head room 8ft. 6in., while the speed found to give the best results is 175 revolutions per minute. Mr. Carter also exhibits a new wheat heater and steamer for conditioning the grain before grinding. This apparatus consists of two wrought iron concentric cylinders with conical top. In the annular space between these cylinders numerous

SELF-FILLING PERPETUAL BALING PRESS

MESSRS. J. AND F. HOWARD, BEDFORD, ENGINEERS



coils of steam piping are arranged over which the grain passes, its speed being regulated by means of a valve. Steam cocks are fitted at the inlet and outlet ends of the coil, and a third cock fixed on the top of the machine allows the steam to be admitted in direct contact with the wheat. Messrs. Edward Humphries and Co., Atlas Works, Pershore, exhibited portable engines and thrashing machinery, all of which were of their well-known standard patterns.

Our illustration above, Fig. 3, represents a baling press for hay and straw with a new self-feeding arrangement and automatic hinged dropper, made by Messrs. J. and F. Howard, of Bedford. The general arrangement of the machine will be familiar to most readers, who will also be aware of the danger which the operator was formerly exposed to in the old-fashioned hand-fed apparatus. The feed arm, shown in an oblique position in the engraving, is elastically connected to the gearing which drives the ram, so that as the ram is being withdrawn to the end of its travel the feeder arm descends and carries with it the hay or straw into the baling chamber, and whilst the ram advances the feeding arm rises clear above the press. The workman standing at the side of the press has only to push the hay or straw over the open chamber and to place a follower in the dropper frame whilst turned back. The frame then being raised, the feeder arm in descending releases the follower and guides it into position ready for the ram to push it past the retainers. With a 4 or 5-horse power engine a pressure of 25 lb. per cubic foot can be obtained on the material being baled.

Messrs. Christy and Norris, Chelmsford, exhibited their disintegrators, in which improved corrugated sides have been provided. It is stated that these corrugations keep the material under treatment more in the path of the beaters than those formerly employed. This firm is also fitting self-lubricating bearings of the ring type, as successfully used on dynamos, on these machines. On Messrs. Clayton and Shuttleworth's stand a Hett centrifugal pump was at work, being driven by this firm's portable oil engine with a new ignition device. Mr. James Coultas, of Grantham, showed an improved corn drill, in which, by means of a worm and worm-wheel device on the coulter bar stay, the coulters can be moved to any desired angle. Amongst a miscellaneous exhibit Messrs. Easton and Bessemer, Limited, Taunton, showed a well-designed 20-brake horse-power vertical high-speed steam engine, Fig. 4, specially constructed for electric lighting purposes, in which special attention has been given to very accurate balancing of the moving parts. Being very compact, these engines are specially suitable for ship lighting, where space is limited. They are fitted with the well-known Pickering governor, which admits of the speed being altered whilst the engine is running. The lubrication of the working parts is automatic, the necessary quantity of oil being distributed from a common source to each working part through copper pipes. The engine is constructed for a working pressure of 80 lb., and its leading particulars are:—Cylinder, 8½in. diameter by 8in. stroke; diameter of fly-wheel, 3ft. 4in.; extreme height of engine, 5ft.; floor space occupied, 3ft. 11in. by 3ft. 1in.; revolutions per minute, 300; and weight, 1½ tons.

Messrs. Harrison, McGregor, and Co., Limited, Leigh, Lancashire, had a very important exhibit of mowers and reapers, including one of new design with changeable speed gear, which is so arranged that either a fast or slow movement of the knife can be effected by the driver from his seat to suit the material being cut. Messrs. F. C. Southwell and Co., Upper Thames-street, London, showed, amongst other implements, an improved two-horse binder manufactured by the well-known Deering Harvester Company of Chicago, U.S., fitted throughout with hard steel ball and roller bearings. Messrs. G. H. Innes and Co., Hitchin, had on view at their stand an improved lifting attachment for "Bedfordshire" seed drills, by which arrangement the laborious process of lifting the drill by manual labour when turning at the land's end is entirely avoided. The apparatus is extremely simple in action; by simply lifting a lever the drill is raised ready for turning, the lever automatically locking itself in an upright position, leaving the man free to guide the drill in turning, while by again pulling back the lever the drill is instantly lowered ready for work. This attachment is made so that it can be fixed to any existing drill of the "Bedfordshire" type.

Messrs. Sargeant and Co., Northampton, had on view an improved manure distributor, with new reciprocating scraper fitted inside the box, whereby the manure is prevented from "caking" on the chains and clogging up the exits. This scraper is actuated by a cam device from the hub of the wheel, and, being provided with raised bosses along its upper surface, raises and lowers the chains with the object above alluded to.

HORIZONTAL AND VERTICAL MILLING MACHINES.

THE universal horizontal milling machine illustrated on page 568, will in addition to all the ordinary forms of straight milling of which these machines are capable, form the teeth of milling cutters, wheels, reamers, &c., and the flutes of twist drills, taps, and other useful workshop tools. It is a strong and very powerful machine, especially suitable for marine engineering work, and will mill flat surfaces up to 6in. or 8in. wide and 2ft. 6in. long, and when working, a cutter 4in. diameter will admit a maximum depth between it and the table of 14in. Cuts may be taken exceeding ½in. in depth, and the speeds of the "feed" traverse are graduated from under ½in. per minute to a rate exceeding 2in. The fast headstock has double gearing — the wheels being all machine cut—and a four-speed cone pulley, the steps being respectively 13in., 11in. 9in., and 7in. diameter, and 3in. wide. The overhanging arm carrying the outer support for the cutter arbor is cast in one with the headstock, thereby affording great rigidity. The main spindle is of steel, 3in. diameter, carried in hard gun-metal adjustable bearings, so arranged that the "cutting" thrust is against the solid metal. The feed mechanism is carried directly through the centre, around which the table swivels, and serves without alteration for all the varying positions—vertically, angularly, or horizontally—in which the table may be placed. The accessories provided with the machine, which form a very complete set, are clearly shown in the engraving, and are accompanied by a printed tabular form setting forth at a glance the various angular positions and divisions required for the multiplicity of work this truly "universal" machine is destined to cope with.

Our second illustration shows a patent self-acting vertical milling and profiling machine, used chiefly for edge milling, but it is also very efficient for machining flat surfaces. The latter are operated upon by means of "face" cutters, which are made with inserted teeth, when dealing with large surfaces, and are specially applicable for marine engineering work. The machine is very rigidly constructed, with a hollow frame of the slotting machine type, as shown in the illustration, which is taken from a machine measuring 2ft. 2in. from the centre of the spindle to the frame, and 1ft. 9in. from spindle nose to table top—maximum. The spindle is of steel with conical bearings having a diameter of 3½in. at the main neck, and it runs within a 6½in. square bar forming a vertical slide, and rising and falling with it, so as to keep the bearing always close to its work, and give great solidity of action. This bar has a vertical motion of 12in., and is balanced. The table is rectangular, measuring 3ft. 6in. by 2ft. 3in., with tee grooves for securing work, and a trough all round for collecting the lubricant. It is provided with variable self-acting motions, longitudinally, transversely, and circularly, all being reversible; and the circular motion can be readily disengaged to facilitate the rapid concentric setting of the work on the table. When profiling, the longitudinal table slide is disengaged from the screw, and the "former" or model is fixed on the table, directly underneath or alongside the object to be formed, and is held against an adjustable roller, carried by a swinging bracket attached to the main frame of the machine. This attachment is not shown in the illustration. The traverse of the table is 2ft. longitudinally and 3ft. transversely. The rates of feed traverse range from about ½in. per minute to over 2in., and cutters up to 8in. or 10in. in length may be used, in such cases a special support being arranged for the cutter arbor at its lower extremity. A centrifugal pump and the requisite fittings for lubrication are provided, the supply being drawn from a suitable tank formed in the frame of the machine. The driving motions are transmitted from a cone pulley with ample belt surface, through powerful gearing, the teeth of which are all machine cut, and without the intervention of any sliding keys.

THE BLACKWALL TUNNEL.

THIS great undertaking was thrown open to the public on Whitsun Day and Monday for a temporary view. On November 2nd and 3rd it was also shown, and those who availed themselves of Messrs. Pearson and Son's liberality upon both occasions can judge pretty well of the great progress made towards completion. The portion under the river is now quite free from the huge bulkheads which formerly divided it into three sections, and is apparently ready to receive its lining of white glazed bricks. The loose timbers and movable plant of various kinds which made the passage through a matter requiring considerable care are mostly removed, and nothing obstructs the footway save the wooden rollers over which runs the rope for drawing out the earth-laden trucks. Although the portion now excavating is the northern approach, the spoil is led through the tunnel and taken up No. 3 shaft or caisson on the south side. On that side the tunnel itself, and the open part of the cutting leading to it, were bricked and virtually finished some months ago. The entrance is about a mile below Greenwich Hospital, in the flat and cheerless region known under the poetical name of Bugsby's Marshes. A large wooden shed about, over the tunnel, and close to the water's edge on the Greenwich or Kentish shore, contains the boilers and engines of the air-compressing and electric-lighting plant. Close to this shed a temporary steamboat pier was erected for the holidays, and the weather being extremely fine both days, a great many people availed themselves of it. The tunnel is very dry on the whole, though, of course, there are slight "weeps" here and there, which will disappear when the edges of the segments are finally caulked with iron borings and made right and tight. No damp feeling is perceptible in the air, and the atmosphere is remarkably clear and pleasant. Under the river, about 400 yards, the tunnel is quite straight, but going from south to north a slight turn to the left takes place just before going under the water. When we visited the works in November the great shield lay like a stranded whale at the bottom of No. 2 shaft, the one at the water's edge on the Middlesex side having just completed its journey through. Very curious it looked, too, festooned all over with small incandescent lights, and its dark sides glistening with the rain which fell steadily down the shaft. Now it is invisible to strangers, being well on its way up the gradual slope, which will be finished by "cut and cover" and finally come to the surface near the Poplar station of the Great Eastern Railway. Air pressure is still being used, the ground being shingle or Thames ballast full of water. In consequence of this there is a solid brickwork bulkhead just outside the

No. 2 shaft in the rear of the shield, provided with air locks opening into the shaft. Two or three small round windows or peep-holes of thick glass are provided that the proceedings within may be kept under observation. The shield itself is, as is well known, on the Greathead system, with several additions and improvements by Messrs. Pearson and Son, the contractors. It is 27ft. 9¼in. in external diameter, 19ft. 6in. long, and weighs 220 tons. There are twelve working cells in its face, and it is considerably the largest in diameter that has yet been used in such work. Not a single death or any case of serious injury from the use of compressed air has yet taken place, but in this respect, of course, the experience of similar works has been of much service. The tunnel will be quite finished and open to the public, both for foot and vehicular traffic, in a few months.

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

Locomotive and cable traction.—The elevated railways and the electric tramways of Brooklyn have begun negotiations for running through cars and through trains over the Brooklyn Bridge to New York, to avoid the present inconvenient transfer from and to the cable railway trains of the bridge. One of the difficulties in the running of the elevated railway trains would be the very steep grades, which are nearly 4 per cent., and the present steam locomotives used with these trains would not be powerful enough to haul the five-car trains. It was at first suggested that more powerful locomotives, with the weight distributed so as not to impose too severe strains on the structure, should be built, but this would have involved very heavy expense and considerable delay. A more practicable suggestion was that a special power grip should be put on the elevated railway engines, to consist of a modification of the cable-car grip, adapted to train service and to the special features of the bridge construction. Such an arrangement would involve no material change of the cable-driving plant of the bridge as now established. With this grip in position, the engine coming from the elevated railway on either side of the bridge would run out over the cable at about the same speed with it—ten miles an hour—and gripping the cable firmly without injury to it, the train would be hauled over to the other side of the river, where the engine would release its hold on the cable and proceed under its own steam over either of the elevated roads. There has been some trouble with the present grip on the bridge because of the difficulty of setting it firmly by hand. The new grip, though, would present no such difficulty, since the power of the engine could be utilised to set it. It is estimated that with such a traffic arrangement, a carrying capacity of 50,000 passengers an hour over the bridge is within reasonable limits, provided the entire system of trains is placed under one management. Any overcrowding at the terminal stations would then be practically impossible, since the elevated railway stations on either side of the river would be somewhat removed from the bridge terminal stations, the latter being used for passengers reaching the bridge by other approaches than those of the elevated railway. If the electric railways are also allowed to run through cars, a single track will probably be laid on each of the carriage ways of the bridge. At present the cable trains of four cars—weighing 20 tons each, empty—are run at intervals of 1½ minutes, but are entirely unable to deal with the enormous crowds during the rush hours of the morning and evening.

New navy dry docks.—Two new dry docks have recently been completed for the United States Navy, one at Port Royal, on the Atlantic, and the other at Port Orchard, Washington, on the Pacific Coast. The latter dock is on Puget Sound, near Seattle, and was formally opened in April by the entrance of the monitor Monterey. The dock is 650ft. 5in. long between end copings and 573ft. 7in. long on the floor, while the width at the middle is 130ft. 1in. between copings and 67ft. 1in. on the floor. The entrance lock has a width of 92ft. 8in. between copings. The depth from coping to floor is 39ft. 3in., while the depth of water at high-water level is 30ft. on the entrance sill and 28ft. 2in. on the keel blocks. The construction is of timber, as used so successfully in the Simpson docks at other navy yards. The vertical and diagonal piles, sheet piling, and altar brace timbers and altars are heavily braced, and the floor is covered with 3ft. of concrete. The entrance lock is of sandstone and granite, and is closed by a steel caisson, 96ft. long, 25ft. wide, and 39ft. deep. In this caisson are a pumping engine, boiler, and steam capstan; while its sixteen valves, 20in. diameter, are operated by hand wheels on the main deck. The pumping plant for the dock consists of three 42in. centrifugal pumps, each with a capacity of 110,000 gallons per minute, driven by vertical engines with cylinders of 24in. stroke. Steam is supplied by six tubular boilers, externally fired, carrying 150 lb. steam pressure. As the dock contains 14,000,000 gallons when full, it can be emptied in about two hours if necessary. The Navy Department has now ten completed dry docks for large warships, as follows:—

Location.	Material.	Length, feet.	Width floor, feet.	Water, ft.	in.
Boston	Stone	391	30	27	0
Brooklyn	Stone	350	30	25	6
Brooklyn	Timber	530	50	25	6
League Island	Timber	530	50	25	6
Norfolk	Stone	360	30	24	0
Norfolk	Timber	530	50	25	6
Port Royal	Timber	600	50	26	0
Port Orchard	Timber	650	50	26	0
Mare Island	Stone	530	30	28	0

A great suspension bridge.—Work will soon be commenced on the new suspension bridge over the East River to connect New York and Brooklyn. The present bridge, opened in 1883, is greatly overtaxed, in spite of the numerous large steam ferries, and it is hoped to finish the new structure in about four years. It will have a clear span of 1605ft.—10ft. more than the present bridge—and a clear leadway of 135ft. at the middle, and 117ft. at the towers. The width will be 118ft., having two roadways, two foot walks, two tracks for the trains of the elevated railways—which will build connections to the bridge—and four tracks for electric tram cars. The foundations will be sunk by pneumatic caissons of timber, the depth to bed rock being about 60ft. below high water on the New York side, and 80ft. on the Brooklyn side. The masonry of the piers will extend to about 20ft. above the water, and on this will be steel towers rising to a height of 340ft. above the water. The stiffening trusses will be of considerable depth. The shore spans will be formed by continuations of these trusses, resting on the towers and anchorages, and supported by intermediate piers, forming a viaduct, but these spans will not be supported by vertical cables from the shore ends of the main cables. The new terminal stations of the cable railway over the existing bridge are approaching completion and are expected to relieve the overcrowding of the trains, while electric motors on one car of each train are to be used for switching the train at the terminals, thus doing away with the present steam switching or shunting engines. A third bridge over the river is now also under construction, this being some distance further up, where Blackwell's Island affords an opportunity for placing two piers of the great cantilever trusses, which will span the two navigable channels. This bridge is for the Long Island Railroad.

Railway ditching machine.—The Doddridge ditching machine, built for the St. Louis South-Western Railway, is intended specially for use on railways in damp and swampy districts where it is important to keep open good ditches to drain the ballast roadbed. It is a large flat car 46ft. long, carried on two four-wheeled trucks or bogies. It is constructed of longitudinal plate girder sills fastened and braced with angle irons of suitable sizes. To these are fastened the end sills, which are heavy steel castings, and have extended curved ends to receive the chains used in connection with the beams for pulling the plough, scraper, &c. All the machinery and tools used in connection with the ditcher are operated by compressed air, the reservoirs underneath the car carrying a pressure of 80 lb., which is supplied by the air pump on the locomotive used to move the machine. On the car is a steel derrick centrally located, 9ft. high, having a reach of 14ft., and being so arranged that it can describe a complete circle. The tools used in connection with the car are as follows:—A solid cast steel plough weighing 2500 lb., which cuts a furrow 20in. deep by 36in. wide; a triangular shaped scraper, an embankment former, and a scoop excavator of three cubic yards capacity. All of these tools when in use are operated by air from the platform of the car by cocks arranged on a switchboard. Underneath the car are located the air cylinders, which are as follows:—Three reservoirs 22in. in diameter and 10ft. long, which contain the air supply; one cylinder for the derrick hoist, which is 12in. in diameter by 14ft. 7in. long; one cylinder for swinging the derrick, which is 12in. in diameter by 9ft. 5in. long—the piston of this cylinder is arranged with a rack attachment for swinging the mast in a complete circle—four side guide cylinders 8in. in diameter, by 5ft. 4½in. long. All cylinder pistons are air cushioned, taking air from either end. Each tool when in use is slung from the derrick or jib, which regulates its height, chains are led from the corner of the car to the front of the plough, &c., while side braces and the guide cylinders regulate the lateral position. The plough loosens the earth, the scraper draws the loose earth in to fill up the embankment, and the template of the former trims off the earth to the proper slope. The scoop is used for digging and cleaning out the ditches.

Sand cement.—A plant has recently been put in operation for the manufacture of "sand cement," which is formed by grinding together to an impalpable powder a good grade of Portland cement and a clean sharp sand. This not only secures the advantages due to fine grinding of the cement, but effects a much closer and more uniform combination or mixture of the sand and cement than can be obtained by ordinary methods. The "sand cement" is used as a substitute for ordinary Portland cement, and is mixed with unground sand for use. The tensile and crushing strengths are very satisfactory, and material has been largely used in the massive monolithic concrete foundations for the Cathedral of St. John the Divine, in New York, including some 13,000 cubic yards of concrete. The sand and cement are thrown into hoppers with a spout, in which is a measuring device which can be regulated to pass any desired proportions of the two materials. From this meter the mixture is fed into horizontal boiler iron cylindrical grinding mills, which revolve on their longitudinal axes, and are filled with hard flint pebbles. The churning of the revolving mass by these pebbles grinds the sand fine and incorporates it completely with the cement. The cylinders are 4ft. 2in. diameter and 18ft. 9in. long, making twenty-six revolutions per minute. The interior is lined with special glazed bricks laid in cement. The proportions of the mixture are generally one of sand to one of cement, but for special purposes one to six is used. Plain sharp sea sand is used. The finished product, or "sand cement," is so fine as to leave a residuum of only 5 per cent. on a sieve of 180 meshes, or 32,000 per square inch.

United States Navy.—The first trial of the new battleship Massachusetts showed her to be at least equal to her sister-ship the Indiana. On a run of thirty-five hours she averaged over 13 knots, while the maximum speed under natural draught was 14¾ knots. The engines averaged 102 revolutions per minute, and their maximum was 111 revolutions. The Massachusetts averaged 13½ knots at 103¾ revolutions, and a slip of 18 per cent. for the screws. The Indiana on her first trial averaged 13 knots at 103 revolutions, and a slip of 24 per cent. The former made 15·6 knots average, and 15·9 knots maximum on the speed trial, while the contract speed was 15 knots; this was with 125 to 129 revolutions. The Secretary of the Navy has decided in favour of double or superimposed turrets for the two new battleships Kearsarge and Kentucky, which are soon to be contracted for. The plan was so warmly advocated, and so strongly opposed, that special investigations were made. After the Board of Construction had opposed it by a vote of four to one, the Secretary appointed a special board of seven officers, to each of whom were submitted the lengthy written arguments for and against the plan, including those of the chiefs of the Bureaus of Construction and Ordnance, who had respectively opposed and favoured the plan. Five of these officers reported favourably and two adversely, and after due consideration the Secretary decided to adopt the double turret plan for the following reasons:—(1) It permits a better horizontal range of fire. (2) It gives much better protection to the 8in. guns in the upper turret. (3) It permits the establishment of a superior rapid-fire battery. (4) It gives a heavier fire in every direction. (5) It saves the cost and weight of four 8in. gun turrets, with armour, substructures, turning engines, &c., the saving being about 248,000 dols., while the total weight of the double turret emplacement is about 200 tons less than is that of a single emplacement for a 13in. gun. (6) The one valid objection is that if the turning gear of the large turret is disabled it will stop the rotation of four guns, but as this gear is protected by the best armour in the ship, the chances of its injury are reduced to a minimum.

A large railway terminal and port.—The great terminal establishment of the Chesapeake and Ohio Railway at Newport News, near Norfolk, includes a passenger pier, two coal piers, four freight and merchandise piers, a grain elevator of 1,500,000 bushels capacity, and several storage warehouses, located on land owned by the company, with water frontage of 4500ft., extending back 3000ft. The depth of water at piers averages 25ft. to 30ft., and each pier is equipped with well arranged yards, the tracks aggregating 30 miles in length, and having storage capacity for 3000 cars. The eastern entrance extensive receiving yards are located for the reception of incoming trains, and from these the freight cars are drilled to the pier to which they are consigned without interfering with the operations of the main line or of any of the other auxiliary yards. Double passenger tracks enter the yard at the westerly side of the freight yards and piers, extending to the end of the passenger pier No. 1, enabling passengers to remain under cover in passing to and from the company's steamer for Norfolk. The passenger pier and double-deck merchandise pier were built within the last four years. The others have been overhauled, painted, and otherwise put in first-class condition. All are lighted by electricity, and thoroughly equipped with apparatus for fire protection. The passenger station is a three-storey structure located at the shore end of the pier, and has comfortable and convenient arrangements for passengers, with separate provisions for emigrants. The upper floors are used as offices for the Superintendent of Terminals and other local officers of the railway. Piers Nos. 2 and 3 are coal piers, and are 700ft. and 1000ft. long respectively, equipped with two dumping tracks and one return track each. The tracks are arranged on the "gravity" plan, making it unnecessary for locomotives to go upon the piers. The receiving tracks for the loaded cars are on a plane about 20ft. above the lower or empty car tracks. Loaded cars are moved over the upper deck by gravity, passing over the scales, and, when unloaded, run by gravity to the end of the pier, operating trick switches, and return on the lower track to the "empty" car yard, where they are inspected, repairs made, and air-brakes tested before sent out in trains. The two piers have a capacity of about 8000 tons per day. Pier No. 4 is a double-deck merchandise pier, 160ft. wide by 600ft. long having a floor area on the upper deck of 79,000 square feet, and on the lower of 65,000 square feet, with two tracks connected with the yard assigned to it. Vessels can be loaded from either of the decks. The pier is equipped with six automatic elevators, with a capacity of handling from 600 to 700 packages per hour each; two are large enough to take up hogsheads of tobacco. Pier No. 5 is a single deck merchandise pier, 150ft. by 800ft., having a floor area of 82,000 square feet, with two tracks connected with the yard assigned to it. This pier supports on each side an overhead belt way, along which the grain from the elevator is moved, and deposits in the vessel by adjustable down chutes spaced 50ft. apart on each side of the pier. Pier No. 6 is a single-deck merchandise pier 140ft. by 700ft., having a floor area of 61,000 square feet; two tracks connected with the yard assigned to it. Pier No. 7 is a smaller merchandise pier, used for handling staves, ice, &c., and for loading schooners and other small craft. The substructure of all the piers at the port consists of piles creosoted with 16 lb. of dead oil to the cubic foot of timber, to protect them against the ravages of the teredo. A transfer bridge for the transferring of freight cars to and from car floats plying between the port and Norfolk or Portsmouth is located between piers Nos. 6 and 7. The grain elevator stands inland to the rear of pier No. 5. Two unloading tracks, the entire length of the elevator, connect it with the yard assigned to this business. The grain is conveyed to pier No. 5 by belts. The capacity is 300 cars in and out per day. The water is supplied from the city waterworks. These works are some sixteen miles from Newport News, and the main leading to the town is laid along the right-of-way of the Chesapeake and Ohio Railway. A branch railway ten miles in length extends from Newport News to Old Point Comfort—at Fort Monroe—which is the passenger terminus of the line.

A MILLION DOLLARS FOR NEW WATER MAINS IN NEW YORK CITY is authorised by a legislative statute just signed by Governor Morton. It is said that the Bill provides for two mains down Fifth Avenue. At present eight 48in. mains lead down into the city from the new aqueduct, four going to the Central Park reservoir and four connecting with the distributing mains.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.—The Midland Counties District Meeting will be held at Hanley on Saturday, June 13th, 1896. The following programme has been issued:—11.30 a.m., meet at Town Hall; reception by the Mayor (Mr. Councillor Tunnicliffe); paper by Joseph Lobley, M. Inst. C.E., borough engineer and surveyor of Hanley, entitled, "Some of the Public Works carried out in Hanley during the last Ten Years;" discussion. 12.15 p.m., inspect Quarter Sessions Court and Victoria Hall, where light refreshments will be provided by his Worship the Mayor, the Chairman of General Purposes Committee (Mr. Alderman Shirley) and the Chairman of the Works Committee (Mr. Alderman Ridgway). 12.30 p.m., short organ recital by Mr. G. Barlow, borough accountant; after which the members will proceed to view:—12.45 p.m., free library and boys' reading room, technical museum; 1.10 p.m., markets and sub-stations; 1.30 p.m., higher grade school; 2 p.m., the electricity works; 3 p.m., Hanley Park—in course of formation—bridges, lodges, pavilion, terraces, lake, conservatory, &c.; 3.30 p.m., sewage works: inspect sludge presses and Bacillite Sewage Purification Syndicate's experimental works; 4 p.m., Stoke-road electric light cable laying, sub-stations and street improvement; 5 p.m., tea at North Stafford Hotel, near Stoke Station, 2s. each.

THE SECOND BAVARIAN NATIONAL EXHIBITION IN NURNBERG.—For the second time an exhibition of the products of manufacturing industry and the fine arts has been organised by a committee of the Gewerbe Museum—which may probably be rendered as the Bavarian equivalent of South Kensington—to be held in the Municipal Park at Nürnberg. Following the example of its predecessor, the present exhibition is confined to objects originating in Bavaria, and therefore affords a very favourable opportunity for studying the industrial condition of that very active little country. To some extent the division is geographical, the objects being classed according to provinces, but this arrangement does not, of course, apply to the large exhibits and those requiring motive power, which are brought together in a single building. The total area covered by buildings is nearly forty acres; and although a large part of this is devoted to accessory purposes, the main buildings, including those of the railway and education departments and the machinery hall, take up about a quarter of the whole. Among the special features may be mentioned a full display of the supply of the smaller industries for which Nürnberg and the surrounding district are famous—such as toys, optical goods, bronze and tinsel, steatite burners, &c, which are shown in connection with electrical and other small motors. In the larger subjects brewing is well represented, as is also high-speed printing machines, both being Bavarian specialities. In the machinery hall, a three-aisled building, measuring 500ft. by 200ft., and 60ft. high, the leading steam engine makers of the country, including the Nürnberg Joint Stock Company, Messrs. Sulzer, Durgler, and others, contribute examples, both for dynamo and ordinary mill driving, to a total of nearly 3000-horse power. The exhibition will be open from May 15th to October 15th. Those who remember the extremely high quality of the display of 1882 will no doubt be glad to revive their recollections by a comparison with that made on the present occasion should the opportunity occur, and such an opportunity will be readily found by those who intend to visit Buda Pesth, when Nürnberg may be taken as an agreeable break on the road, either coming or going.

ADDITION TO THE AUSTRIA-HUNGARY NAVY.—The principal dimensions of the new coast defence battleship Buda-Pest, launched recently from the Stabilimento Tecnico Triestino at San Rocco, near Trieste, are as follows:—Length, 303ft. 6in.; beam, 55ft. 3in.; displacement, 5550 tons; mean draught, 20ft. 6in. The hull of the ship is constructed of Siemens-Martin steel; divided into the usual cellular and water-tight compartments, while the pumps will be sufficiently powerful to discharge 1500 tons of water hourly in case of necessity. Protection is afforded by an armour belt of 10·8in. nickel steel, made by the Austrian firm of Witkowitz and Co., tapering to 8in. aft and 5in. forward, which runs from the ram for five-sixths the length of the ship, extending from 3ft. 6in. below to 3ft. 6in. above the water-line at normal draught; the after ends being joined by an 8in. armoured-athwartships bulkhead. On the top of the belt runs fore and aft the whole length of the ship a 1·8in. armoured deck, rising above which, and extending from the after end of the armoured belt for about two-thirds of the ship forward, is a citadel protected with 3·3in. armour, with transverse bulkheads of the same thickness of plating. Above, again on the upper deck, is a smaller citadel, also protected with 3·3in. armour, fore and abaft which, but with their bases protected by the armoured lower citadel, are the two barbettes for the heavy guns, plated with 8in. armour, and fitted with 2·5in. steel hoods for the guns. There are further two conning towers, the foremost with 8in. plating, the after with 2·5in. The whole weight of the armour amounts to 1700 tons. The armament consists of four 24 cm. (9·4in.) 40 calibre long Krupp guns, mounted in pairs in the barbettes. Each gun weighs 26 tons, and the mountings for each pair of guns, including the hood, 123 tons. The armour-piercing projectile, which weighs 474 lb., has an initial velocity of 2275ft., and, with an elevation of 25 deg., has a range of 16 kiloms. (10 miles). The secondary battery consists of six 15 cm. (5·8in) quick-firing guns, two 7 cm. Uchatius guns for boat and landing purposes, sixteen 3-pounder quick-firing guns, and two mitrailleuses with two broadside torpedo tubes. The six 15 cm. quick-firing guns are mounted in the citadel on the upper deck, two firing from right ahead to 70 deg. abaft the beam and two from right aft to 70 deg. before the beam; the other two are on the broadside. The guns are separated from each other by steel splinter-proof bulkheads. Ten of the 3-pounder quick-firing guns are mounted on the superstructure over the upper deck citadel. The guns, barbettes, and ammunition hoists are all to be worked by electricity, the ammunition for the heavy guns and secondary battery being provided through separate armoured tubes. The engines are intended to develope 6000 indicated horse-power under natural draught, giving a speed of 16 knots, and 8500 indicated horse-power under forced draught, the corresponding speed being 17·5 knots. The coal capacity is 500 tons, giving a cruising radius of 3000 miles at 10 knots.—*Journal of the Royal United Service Institution.*

INSTITUTION OF ELECTRICAL ENGINEERS.

THE UTILISATION OF WATER POWER, ESPECIALLY WITH A SMALL FALL, WITH SOME EXAMPLES OF PLANTS FOR THE GENERATION OF ELECTRICAL ENERGY.

(*Concluded from page* 549.)

Assuming that the water power available at Brantham Mills were applied for the generation of electric energy, it would, in the first instance, be necessary to obtain a conveniently high speed to drive an electrical generator without much intermediate gearing.

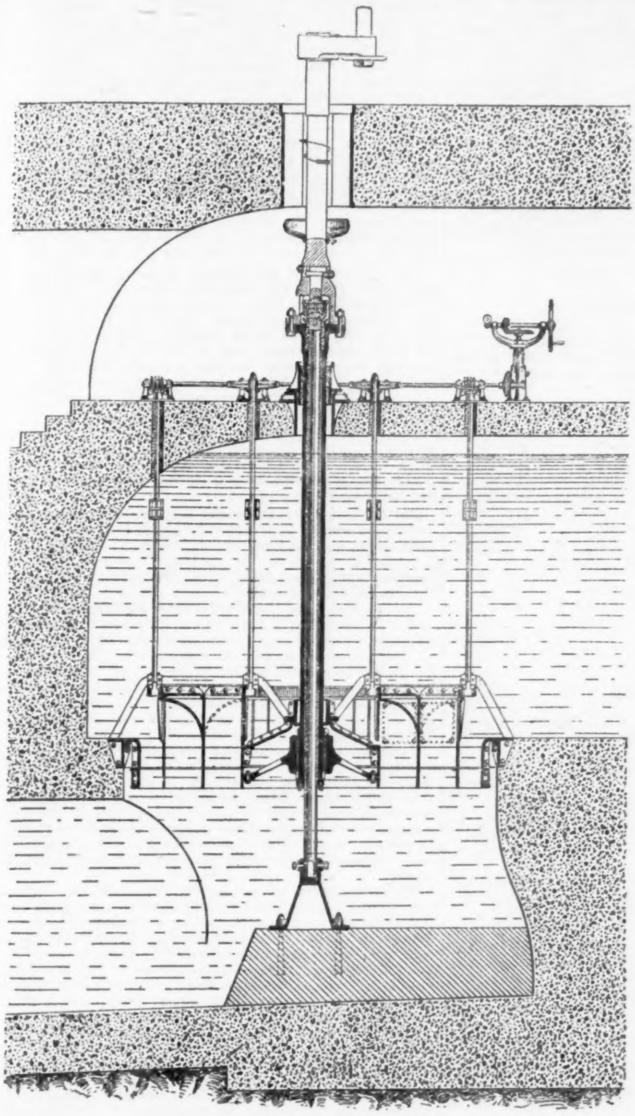


Fig. 6—Turbines of the Waterworks, Geneva

A turbine similar to the one actually working could be made for exactly these conditions, running at 30 revolutions per minute, and a pair of bevel wheels put in of such proportions as to give the first motion shaft a speed of 150 revolutions per minute. This speed would be very suitable to drive a dynamo of 40-horse power by means of a belt or ropes. A higher speed of the turbine than 30 revolutions would, for such a low fall, only be obtainable at the expense of efficiency. As in this special case the fall, and consequently the power, varies with the rise and fall of the tide, the full power of the turbine can, of course, only be relied on during fifteen or sixteen hours every day. The power produced during the time when the fall is diminished beyond the limit at which it is 40-horse power, and at less than the normal speed, could probably be applied to charge electrical accumulators. The construction of the turbine shaft deserves some notice. The space underneath the turbine being always filled with water, and, therefore, inaccessible, the plan for the footstep is placed on top of a column round which the hollow cast iron shaft revolves. The upper part of the turbine shaft is widened, and contains an adjustable steel pin which revolves in the pan or cup, filled with oil. Although a well-constructed footstep will last for years without requiring repairs, an easy access to it is of great advantage.

Similar turbines were erected by me in other mills near Norwich, Reading, and Lewes. In all cases the fall varies between—23in.—2ft. 6in. and 6ft., the reduction of the fall being caused by floods, while the water supply varies in the proportion of about 1 to 4. In each case the local conditions were carefully investigated and the turbine constructed accordingly. The good results obtained in each case are due to the careful adaptation of the turbine to the conditions. The importance of a careful consideration of local conditions is evidenced by several failures which were recently brought under my notice. In one of these instances, the turbine—which in itself is a very good motor—gives very poor results owing to the disregard of the actual conditions of the locality. Even the construction of some details of a turbine depends sometimes on these conditions, and in several cases now under consideration I have had to depart from the general practice of designs of turbines, in order to secure the highest results when most required.

How varied the construction of a Jonval turbine may be, will be shown by the following examples. The turbines of the Geneva Waterworks, built by Messrs. Escher, Wyss, and Co., of Zurich, work under a maximum fall of 12ft. during the winter season, when the water supply is shortest, while during the summer season the water supply stored up in the mountains in the shape of snow and ice is abundant. The large summer supply reduces the fall, however, to 5ft. 7in. The power of each turbine, of which there are now seventeen at work, is 210 actual horse-power, and they run at a uniform speed of thirty-six revolutions per minute, whether the fall is 5ft. 7in. or 12ft. The cost in this case was a secondary question; the turbines have, therefore, been provided with the best possible arrangements to suit the large variations of the fall and quantity of water. The drawing shows three concentric rows of buckets. The outer row alone will develope 210-horse power under the maximum fall of 12ft.—its outside diameter is 14ft. Each of the two inner rows of buckets is provided with a revolving gate, working separately. Each turbine drives a pair of double-acting plunger pumps direct, the crank common to both pumps being fixed on the vertical turbine shaft.

An interesting turbine installation, under a fall varying from 10ft. 9in. to 8ft. 10in., in connection with electrical generators, is that at Baden, in Switzerland. It was described in *Engineering*, November 1st, 1895. This plant was erected to supply the town of Baden with electric light, and the necessary driving power to the new works of Messrs. Brown, Boveri, and Co., the well-known electrical engineering firm. The fall had to be created by a weir, and a canal about 2500ft. long, which added considerably to the cost of the plant. Each of the three turbines is of the Jonval type, giving off 200 brake horse-power. It is impossible to build a turbine of that power for the fall available in this case, which would run with a speed high enough to drive a generator direct. The turbines run at 40 revolutions per minute, which speed is maintained under the varying fall by means of gates for the inner row of buckets. The generators—two-phase dynamos of the horizontal type, made by Messrs. Brown, Boveri, and Co.—run at 200 revolutions per minute, and are driven direct off the turbine shaft by means of a pair of bevel wheels. The exciter dynamos, of which there are three of 10-horse power each, are driven each by a separate turbine. These small-power turbines naturally run at a higher speed—namely, 180 revolutions per minute—and drive, therefore, the exciter dynamos without any intermediate gearing.

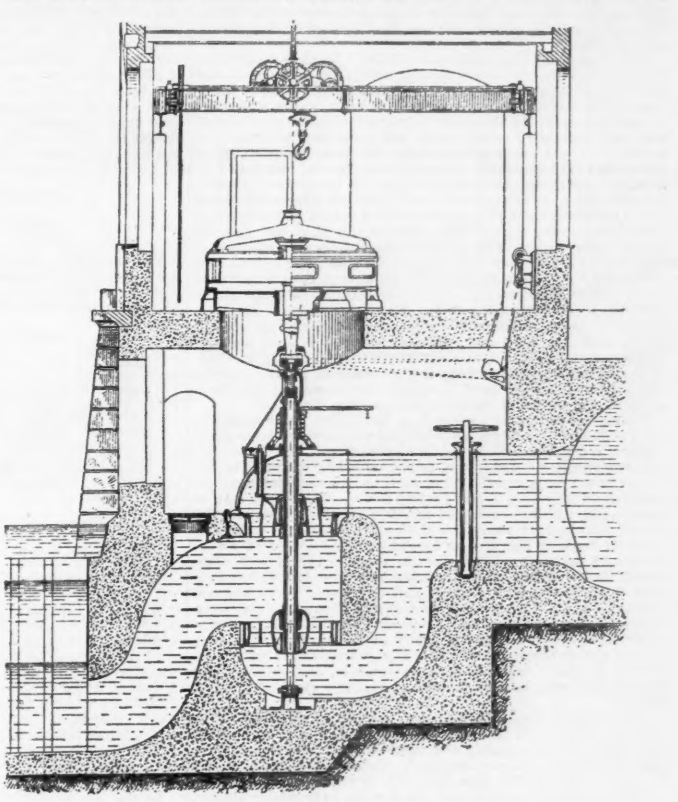


Fig. 8—Turbines at Zufikon-Bremgarten, Switzerland

In most cases in this country where a good water supply is available, the fall will be rather lower than 10ft. or 12ft.; it will, therefore, require intermediate gearing to drive a high-power generator, and it will even not often be possible to connect it direct with the first main shaft driven off the turbine by bevel wheels. Belt drives are very convenient to get up the necessary speed of dynamos, but for large power they are very expensive, and absorb a considerable amount of the power in friction. The ordinary round hemp and cotton rope is objectionable, on account of requiring frequent repairs and re-splicing. During an inspecting tour in Switzerland last summer, I came across a new kind of hemp rope, which seems to supply just what is wanted to drive large power dynamos. A piece of this patent rope is here for inspection. It is a plaited rope of extreme pliability, which does not stretch. I found this rope working at the generating station of Schaffhausen. The power at the generating station is transmitted from the countershafts, driven off two turbines of 300-horse power each by means of bevel wheels, on to the generators by means of ten such ropes, 1¾in. thick. The rope pulleys on the dynamos have a diameter of 5ft., running 300 revolutions per minute. The rope pulleys on the countershaft have a diameter of 13ft. 6in., and the distance between the centres of shafts is 51ft. The power is electrically transmitted to a spinning mill about half a mile distant from the generating station. The secondary station consists of an electro-motor of 200-horse power, coupled directly to a main line shaft, and two electro-motors of 190-horse power each, coupled together. The latter, running at 300 revolutions per minute, carry a rope pulley of 5ft. diameter with fourteen grooves; 100-horse power are transmitted by four such ropes to a shaft 21ft. above the electro-motor, at an angle of 51 deg., while the remaining 250-horse power are transmitted to another shaft on about the same level and 17ft. 8in. distant, running with 130 revolutions per minute. In spite of the unfavourable relative position of the shafts, these ropes work with extreme regularity and easiness, and their adaptation has, according to the manager of the spinning mill, put an end to the trouble and frequent stoppages caused by the breaking of the round ropes which were previously used.

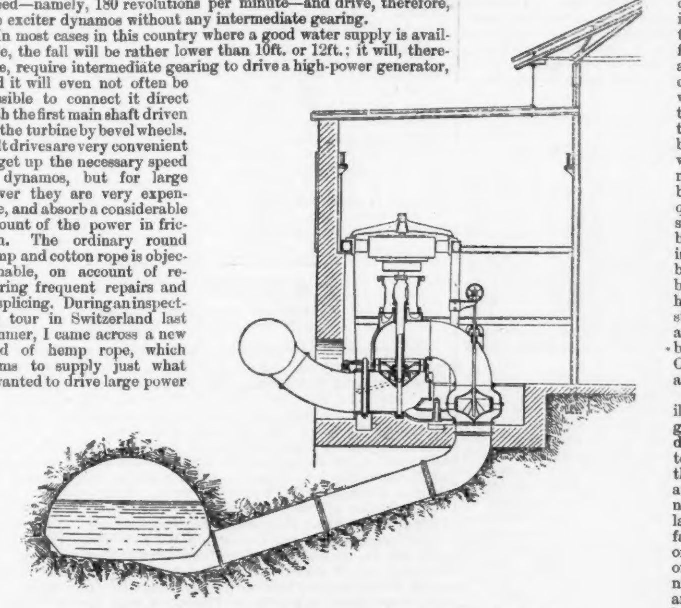


Fig. 7—Turbines at the Aluminium Works at Neuhausen, Switzerland

Returning to the description of water-power plants proper, two more examples in connection with the generation of electricity deserve to be mentioned, showing how certain objects can be attained by a special construction. One of these is the installation of five new turbines for the aluminium works at Neuhausen, on the Rhine Fall, in Switzerland. One of these turbines is here illustrated. Each of these turbines gives off 610 brake horse-power under a fall of 66ft., with a quantity of water of 6500 cubic feet per minute. With the high fall a high speed suitable for driving the dynamo direct is naturally obtained—an arrangement which has also been adopted in this case to economise space. On the other hand, the load on the footstep of a turbine of the power mentioned by the pressure of the water, in addition to the weight of the armature of a generator of corresponding dimensions, is so great that a special arrangement had to be adopted to release the footstep of at least a part of that load. In order to overcome this difficulty, the turbine has been reversed, the water passing through the turbine upwards, acting, therefore, in the opposite direction to the weight of the machinery. The boss of the turbine wheel is, moreover, formed into a piston, working in a cylinder, to which water under the pressure corresponding to the fall is admitted, thus counteracting again the weight of the moving parts of the turbine and dynamo. The water, after passing through the turbine, is conducted to the tail-race through a suction tube, the turbine being placed 15ft. 9in. above the tail water. It runs at 150 revolutions per minute, and is a single Jonval turbine. To regulate its speed, if required, a ring gate is inserted in the suction tube, while it can be stopped by a throttle valve in the wrought iron tube taking the water to the turbine. The total power now utilised by these aluminium works is 4550-horse power. The turbines were constructed by Messrs. Escher, Wyss, and Co., of Zurich, and the dynamos by the well-known electrical works at Oerlikon. Each dynamo is of 7500 ampères and 55 volts.

The last turbine installation here illustrated is that at Zufikon-Bremgarten, also in Switzerland. The drawing shows another arrangement to counteract the weight carried by the footstep, and at the same time an arrangement by means of which the necessary speed to drive a dynamo of large power direct under a medium fall is obtained. The plant consists of four sets of double Jonval turbines of 325 brake horse-power each, running at 115 revolutions per minute, and a smaller Jonval turbine of 34 brake horse-power, driving two exciter dynamos, running with 210 revolutions per minute, and was erected to supply electric light to the neighbouring town of Wohlen, and driving power to the new works of Messrs. Escher, Wyss, and Co., of Zurich, and a large flour mill close by these works. The distance over which this power is transmitted is about eleven miles. The fall is 17ft. 6in., and was obtained by building a dam across the river Reuss, and a tunnel about 1100ft. long across a hill round which the river flows at a rather high speed. The water is divided between two Jonval turbines fixed on one common shaft, so that it passes upwards through the lower wheel and downwards through the upper wheel. By distributing the water in this manner, the diameter of each turbine is reduced, and the speed consequently increased. At the same time the pressure of the water, which would otherwise act on the footstep, is entirely counterbalanced. The central part of the lower wheel is, moreover, formed into a disc, on which the water presses from below, releasing the footstep also partly by the weight of the revolving parts of the turbine and the dynamo. The space between the two turbines on each shaft is connected with the tail-race by a flume formed of concrete, which acts as a suction tube. This turbine plant was also erected by Messrs. Escher, Wyss, and Co., and the dynamos were built by the Oerlikon works. The examples given above of the utilisation of water power may be considered as representative types of successful installations under different conditions. They are sufficient in number and in variety to prove the necessity of a selection from motors which are different in principle, and of the careful adaptation of the turbine selected to the local conditions and requirements.

A turbine installation under a low fall will be more costly than one under a higher fall; it is, consequently, of special importance to obtain the highest possible efficiency, even at an extra expense, under a low fall. The cost of the turbine itself is only a fraction of the total outlay for the plant, including foundations, connection with the machinery to be driven, and sometimes a weir and a canal. The cost of these permanent structures exceeds that of the motor; it is, therefore, a penny wise and pound foolish policy, after putting in the permanent structure, to try and cut expenses by putting in a turbine of insufficient capacity or inferior efficiency. The commercial value of a water power depends rather more on the annual outlay on the same than on the first cost, and the annual outlay for the work obtained from the power is the smaller the higher the efficiency of the plant. The efficiency of a turbine which can be obtained and honestly guaranteed, even if the fall is low, is about 75 per cent. Eighty per cent. and a little over is sometimes obtained under favourable conditions, and has been proved by careful tests made by responsible experts; but an efficiency of 85 and 90 per cent., sometimes claimed, is never reached, if the quantity of water be accurately measured during the test. If the efficiency of the turbine is guaranteed at all, it should be stated not only for the most favourable conditions, but also for a reasonable minimum of the fall or the quantity of water.

In many instances within my own knowledge, water power, in itself sufficient to drive the machinery of a factory, but improperly utilised, is supplemented by artificial power, produced by steam, gas, or oil engines. The loss of money caused by the waste of the cheap power from a running stream in this manner amounts certainly to a big sum in this country alone. The annual cost of such auxiliary power, calculated for 3000 working hours, may be put at three to four times the cost of water power, and calculated for 6000 working hours, four to eight times the cost of water-power. A judicious utilisation of the water power in such cases would not only result in an enormous saving of money, but in a gain of a large amount of power now unutilised. Most factories are closed at night time, when the water is allowed to run away without being made use of. Assuming that the water power is insufficient to drive all the machinery in the daytime, while it is wasted during the night, electrical storage batteries in connection with a generator might very advantageously, and perhaps with greater economy, be used instead of auxiliary steam, gas, or oil engines.

It seems probable that in the near future the electrical transmission of power will take the place of shafting and belt drives in factories, when certainly the waste of water power would be prevented in the manner suggested. Owners of factories driven by water power might even find that by improving their water power they obtain spare power which could be profitably applied by the generation and distribution of electrical energy in the immediate neighbourhood. I may add that the majority of large-power central stations now being erected in Switzerland for the generation and distribution of electrical energy are mostly utilising small or medium falls varying between 10ft. to 30ft. The storage of water in the shape of snow and ice on our mountains provides us with a good water supply during the summer, but the low temperature in winter reduces that water supply very considerably. The water power there is just as variable as in other countries, and those falls which can be advantageously utilised on account of being situated in the inhabited and industrial districts are often not any higher, or much higher, than in this country; the only difference being that such small falls occur more frequently, rendering a concentration of large power in one place easier, and perhaps less costly. Still, it is my conviction that concentration of water power for the distribution of electrical energy, or for the generation of a large amount of electric current, as required for electro-chemical and electro-metallurgical processes, is possible in many places in this country without going into prohibitive expenditure for canals, &c.

In conclusion, I hope to have succeeded in my endeavour to show how water power under low falls can be, and is, very advantageously and economically utilised for the generation of electrical energy; and that a very large amount of water power is now running to waste which could, in conjunction with electrical machinery and apparatus, be turned to profitable account by such a hearty co-operation of the electrical and the water-power engineer as has resulted in such success of commercial enterprise in my native country.

LAUNCHES AND TRIAL TRIPS.

On Thursday, the 21st ult., the s.s. Veva, built by Messrs. Ropner and Son, of Stockton-on-Tees, to the order of Messrs. G. Pyman and Co., of West Hartlepool, made her official trial trip. The steamer proceeded down the river to the Tees Bay, where her compasses were duly adjusted, after which a very pleasant and satisfactory run was made at sea, the engines working very efficiently and steaming easily. The owners were represented by Captain Pyman, who has superintended the building and fitting out of the steamer, and who expressed himself as highly satisfied with the performance of the vessel. At the conclusion of the trial trip the steamer proceeded on her way to Hull, where she loads for the River Plate.

The saloon steamer Talisman, the most recent addition to the fleet of the North British Steam Packet Company, made a trial trip on the river on the 26th ult. The vessel, which is one of the most handsome passenger steamers on the Clyde, was built by Messrs. A. and J. Inglis, and was placed on the passage between Craigendoran and Rothesay. She has been specially designed with a view to rapid sailing and the comfort of her passengers. Her length is 215ft., and she is 23ft. in breadth, by 8ft. in depth, her tonnage being 290 tons. Her engines, which are also by Messrs. Inglis, are of the single diagonal surface condensing type, with a 52in. cylinder and a 6ft. stroke. She has been built to meet the Board of Trade requirements, and is certified to carry 1254 persons. Leaving Craigendoran, in delightful weather, shortly after noon, the ship, which was under the command of Captain M'Kinlay, crossed to the Cloch Lighthouse for the purpose of making a speed trial to the Cumbrae Light. The speed attained was 18·5 knots, equal to 21·3 statute miles an hour, a result which was regarded as highly satisfactory. The Talisman is the fastest steamer of her size ever built at the price.

On the 27th ult. a further addition was made to the fleet owned by Messrs. Houlder Brothers and Co., of London, by the launch of a large screw steamer by Messrs. Workman, Clark, and Co. The vessel was named the Denton Grange by Mrs. Alfred Houlder, of Holmewood, Purley, Surrey, in the presence of a large assemblage. A party, at the invitation of the builders, then proceeded on board the Langton Grange, which proceeded down Belfast Lough on her trial trip. This vessel has been specially designed to suit the requirements of Messrs. Houlder's trade to Australia, South America, and the Cape. The leading dimensions are: Length, 420ft.; breadth, 54ft.; depth, 32ft. 5in.; with a gross tonnage of 5850, and built to Lloyd's highest class, with Board of Trade requirements complied with for carrying passengers. The vessel is divided into eight compartments, and several of the holds are insulated, and the refrigerating machinery fitted up by Messrs. Hall, of Dartford, on the carbonic gas system. Eleven powerful steam winches of a special design, having extended shafts with large barrels and frictional brakes, are provided for working cargo, the derricks being suspended from steel derrick posts. Exceptional good stowage has been secured by dispensing with hold beams and substituting continuous side stringers with a minimum projection. The upper deck is covered with erections for over three-quarters of the length, having on the bridge deck a large deck-house for the passengers and officers. A complete installation of electric lighting has been fitted throughout, including arc lamps. Arrangements have been made for conveying cattle, and upwards of 700 can be carried on the upper decks. During the day the vessel was run on the measured mile, and an average speed of 13½ knots was, we are informed, attained. The machinery has also been constructed at the builders' works, and is capable of developing about 3200 indicated horse-power, with steam supplied from three boilers with Howden's forced draught, the superintendence of this department being carried out by Messrs. Esplen, Son, and Swainston, and the supervision of the ship under Mr. Copeland K. Etheridge, Messrs. Houlder's marine superintendent.

AUSTRALIAN NOTES.

The quarterly report of the Railway Commissioners for New South Wales for the quarter ending 31st March last, together with the particulars for the corresponding period of the previous year, is summarised as under:—

Railways.	Quarter ending 31st Mar., '95.	Quarter ending 31st Mar., '96.
Miles open	2531	2531
Revenue	£647,875	£648,982
Expenditure	£368,959	£372,832
Train miles run	1,867,262	1,890,021
Earnings, per train mile	6s. 11¼d.	6s. 10¼d.
Expenditure, per train mile	3s. 11¼d.	3s. 11¼d.
Percentage, expenditure to earnings	56·95	57·45
Number of passengers	4,846,193	5,236,431
Tonnage of goods traffic	917,152	1,015,538
Tonnage of live stock traffic	40,285	40,790
Tramways.		
Miles open	61	61
Revenue	£73,366	£75,143
Expenditure	£54,221	£53,781
Train miles run	638,930	681,619
Earnings, per train mile	2s. 3¼d.	2s. 2½d
Expenditure, per train mile	1s. 8¼d.	1s. 7d.
Number of fares collected	17,343,232	17,735,940
Percentage, expenditure to earnings	73·90	71·57

The total revenue derived from goods traffic decreased by £11,642, general merchandise, minerals, hay, straw and chaff, and wool showing an aggregate decrease of £20,659, while live stock, coal, and miscellaneous show an increase of £9017. In the coaching traffic the increase of £12,749 was made up by £5188 in first-class, £5360 in second-class, and £2201 in parcels.

The expenditure for the quarter shows an increase of £3873, which is accounted for by the following special debits:—Workshop staff working full time. One day's extra wages included in consequence of leap year. Heavy exceptional expenditure for repairing damage caused by floods on the Bourke and Cobar lines in February last.

In the proposed Overhead Wire Electric Tramway now before the Public Works Committee, to be laid from Circular Quay, Sydney, to the Railway Station and Pyrmont, a length of 3 miles 12 chains of double line, the following shows the particulars of cost.—Cost of permanent way, including alterations of pipes and car shed, £72,000; overhead wires, bonding, telephones, &c., and power cables, £15,000; generating power at engine house, rolling stock, and motors, £36,000; total estimated cost of construction, £123,000. Annual cost:—Interest at 3¼ per cent. on capital cost, £3997; estimated cost of motive power and car repairs, including car drivers, £15,000; estimated cost of permanent way maintenance and repairs, £2500; estimated cost of conducting traffic and general expenses, £11,000; total estimated annual cost, £32,497. Annual revenue:—Estimated value of passenger traffic, £45,000; estimated annual profit, £12,503; or equal to over 10 per cent. on investment.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

Good attendance on 'Change. The holidays affected the shipments of steam coal during the past week; the demand is now good with prices steady. House coal shipments are moderate, with prices weaker. Tin-plates in fair demand, with prices steady. The iron and steel works are all fully employed. Pitwood firmer in price.

Coal: Best steam, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s.; house coal, best, 9s. 9d. to 10s.; dock screenings, 5s.; colliery small, 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 46s. 10d.; hematite warrants, 47s. 5½d. f.o.b. Cumberland; Middlesbrough No. 3, 37s. 6d. prompt; Middlesbrough hematite, 44s. 10d. Iron ore: Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel: Rails, heavy sections, £4 12s. 6d.; light ditto, £5 f.o.b.; Bessemer steel tin-plate bars, £4; Siemens tin-plate bars, best, £4 2s. 6d.; all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel, coke, 9s. 3d.; Siemens, coke finish, 9s. 6d. ternes, per double box, 28 by 20 C, 19s. to 20s. 6d. Pitwood: 16s. 6d. Freights firmer.

AMERICAN NOTES.

(From our own Correspondent.)

New York, May 27th.

Interim capital because of dulness is seeking temporary employment in this city on long time at 4½ per cent. Net earning on 168 railroads for first three months of the year are over 1 per cent. less than same time last year. Business is much depressed all over the Sates because of uncertainty, generated without cause, in the public mind that a political platform of an equivocal character will be formulated at St. Louis on June 18th. There will not be any appreciable expansion of the volume of business until after July 1st. The iron trade holds its own; furnace production averages 190,000 tons per week. Average weekly excess of production above requirements for several months 12,000 tons. Output is now less. Prospective requirements are increasing, and the consumption of pig during the last half of the current year will not be much, if any less, than 200,000 tons per week, and certainly not if construction is begun upon some 2800 miles of road, which railway authorities say must be done soon. The American people are bent on Protection, and the political party that does not "throw up both hands" at the command of eight million votes next November will be given a permanent vacation.

Trade and Business Announcements.—The senior partner, Mr. Stephen Pewtress, in the firm of E. Marlborough and Co., 51, Old Bailey, London, E.C., retires, and his son, Mr. S. Leslie Pewtress, who has long been associated in the management of the business, becomes a partner.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(From our own Correspondent.)

There was an average attendance on 'Change at Birmingham to-day—Thursday—and a healthy business tone prevailed. The trades showed a steadier tone, and orders were given out in many cases when they were postponed on account of the late holidays. Moreover, there was more disposition to do business, and operations in the works have been well resumed, with a good record of orders awaiting execution. The home trade is in a moderately healthy condition, and the foreign demands show a well sustained amount of business to be forthcoming. The general condition is encouraging, thought at present there is no inclination on the part of buyers to give more money. Manufacturers now hold sufficient orders to carry them on through the quarter, and steady inquiries are made for prompt supplies of material. The best marked bar iron houses report a moderate volume of business at £7, with the usual 12s. 6d. extra for the Earl of Dudley's L. W. R. O. brand, and the demand for merchant iron at £6 to £6 5s. keeps up. The common bar iron manufacturers are fairly well booked at £5 5s. to £5 10s. There is a more active trade moving in black sheets at £6 10s. to £6 15s. for doubles, and £7 15s. for lattens, and a fair business is doing in hoops and thin strip at £6 7s. 6d. The tube strip makers report fresh offers for renewing the expiring orders. Angles are £5 15s., stamping sheets £9 10s., and nail rod £6 10s. Galvanised sheets in Liverpool are £10 2s. 6d. to £10 5s. for 24 gauge.

The accountants to the Midland Iron and Steel Wages Board presented to the Sliding Scale Committee, this week at Dudley, their bi-monthly certificate of the average ruling price of manufactured iron for March and April. This was £5 15s. 4d. per ton, compared with £5 16s. 8d. in January and February, £5 15s. 3d. for November and December. It will be perceived that during the first two months of the year the value advanced by about 1s. 5d., nearly all of which is not taken off again. This reduction of 1s. 4d. is insufficient to alter wages, which remain at 7s. 3d. for puddlers, and millmen in proportion.

The steel makers are busy, and further orders are coming to hand at £4 5s. for Bessemer blooms and billets of Staffordshire make, £4 2s. 6d. for similar steel imported from the North, and £4 12s. 6d. for Siemens billets. Girders and angles are £5 10s., and boiler plates £6 5s.

For pig iron a steady record of contracts is announced, and makers are sending their output into consumption, while prices are sustained at cold-blast pig, £4 10s.; South Staffordshire all-mine, 55s.; part-mine, 40s. to 42s. 6d.; and cinder pig, 35s. Northampton forge is 39s. to 40s.; North Staffordshire and Derbyshire, 41s.; and Lincolnshire, 44s.

At a meeting of the Council of the Walsall Chamber of Commerce on the 1st inst., Mr. T. A. Smith announced that the result of the interview with the borough member was that he would take charge of the Council's suggested amendments to the Locomotives on Roads Bill in the House of Commons. The President read a further batch of communications from chambers of commerce, agricultural associations, and private gentlemen approving of the proposed amendments, but in some instances suggesting that the desired end could be better attained by regulations than by an embodiment of the proposed alterations in the Bill. Lord Dartmouth wrote that he considered the amendments fair and reasonable. Sir David Salomons considered them unnecessary, as did the "Self-propelled Traffic Association." The President suggested that, in deference to the views expressed in some of the communications, they might reconsider the question of speed; and on the proposition of Mr. Hill, seconded by Mr. Scott, it was agreed to name six miles as the speed in towns, and twelve miles in the country.

The recent offer by a Canadian Syndicate to purchase the system of the Birmingham Central Tramways Company is still in abeyance, and the Public Works Committee are preparing a report to be presented to the City Council on the matter. The offer made is equivalent to the par value of the shares, plus a bonus of £1 upon the ordinary stock. Some members of the Council favour an alternative suggestion to the effect that the Corporation of Birmingham should follow the example of Glasgow, Leeds, and Huddersfield, and embark itself upon working the tramway traffic.

The West Bromwich and District Miners' Association has been in existence for about thirty years, and during that period there has been paid £33,661 for death claims, £5800 to outside trades, and £22,348 for strikes—making a total of £61,809. At a meeting of that body a resolution has been passed pledging members to continue loyal to the South Staffordshire and East Worcestershire Coal Trade Wages Board, and declaring that its sliding scale system of regulating wages is the best ever instituted in the mining district of the Black Country.

The engines of the South Staffordshire Mines Drainage Commissioners have had to deal during the month with a rainfall of ·37 of an inch only. In the Old Hill district twenty-two of the fifty canal basins agreed to be tested in March last have been dealt with and found more or less defective; and a further number of forty basins are arranged for testing at early dates.

Dairy engineers are expressing satisfaction that this week the Warwickshire Chamber of Agriculture has adopted the following recommendations of a special committee:—"That the principle of combination and co-operation for the sale and distribution of farm produce is a good one. That it is desirable that companies be established at convenient centres, both for the formation of dairy factories and for opening shops for the sale of agricultural produce. That in forming companies it is desirable that preference be given in the allotment of shares to consumers as well as producers, and that all sales be conducted on a cash basis. That the practical details and results of Lord Winchilsea's scheme be carefully watched and considered, and that Lord Winchilsea's invitation to inspect the locality of its operations be accepted." The Chamber also resolved: "That the present commitee be asked to continue its investigations, with power to add to their number."

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—Business in the iron trade here has been resumed after the holidays in a much more satisfactory manner than is usual following the protracted Whitsuntide stoppages. Prices for raw material have shown a hardening tendency, and there has been a considerable weight of buying which fully bears out the anticipations in my previous notes as to the temporary character of the weak depressed tone recently prevailing, and the general feeling of confidence with regard to the future. Operations have, of course, scarcely got into full swing again, the holidays in some of the engineering centres extending until Tuesday, whilst pits in the Manchester district did not make a full start until Wednesday. Although collieries are so short of orders that a protracted stoppage is perhaps rather welcome than otherwise, engineering establishments are in the position that except for the customary repairs, the whitewashing of shops, &c., that are put in hand at Whitsuntide, they could very well have dispensed with any stoppage at all, as in most cases they are pressed to get out in anything like reasonable time the orders they have already on the books, and with regard to new work, of which there is plenty, it is, as a rule, more a question of delivery than of securing orders.

For the opening market after the Whitsuntide holidays, the 'Change meeting at Manchester, on Tuesday, was well attended, and a strong, active tone characterised the market generally. Considerable sales were reported in Lincolnshire pig iron, and in one or two cases makers have put up their list rates 6d. per ton for forge numbers, bringing them back to 41s. net cash, delivered here, and this advance, it is expected, will, at the close of the week, be followed by other concerns, a meeting of the Lincolnshire makers being held to-day, Friday. This will tend materially to strengthen the position of local makers, who owing to the weakening tendency in Lincolnshire, have been doing little or nothing in forge qualities, and have had to regulate their quotations by the low prices ruling for forge numbers coming from the above district. Both local and district foundry qualities remain without quotable change, averaging 46s. 6d., less, 2½ for No. 3 foundry, Lancashire; 43s. net cash for foundry Lincolnshire, and 45s. 6d. to 46s. 6d. for Derbyshire foundry, delivered Manchester, although Derbyshire is, if anything, a trifle easier. As regards outside brands, prices have stiffened up somewhat; good foundry Middlesbrough is not quoted under 45s. 10d. to 46s. 4d. net cash, delivered by rail Manchester, and 44s. delivered Manchester Docks. Scotch iron is still rather irregular so far as immediate delivery is concerned. Eglinton has been offered as low as 46s., delivered ports; and 48s. 3d., dock quays, Manchester; but this is nearly 1s. under makers' quotations and about 6d. under the average market prices. Glengarnock is also irregular, ranging from 46s. 9d. upwards, delivered Lancashire ports. In some special brands of Scotch iron, however, business has been done at much better prices relatively.

A rather unsettled tone prevails in the finished iron trade owing to the continued low cutting of one of the large manufacturing firms, to which I have previously referred, and whose bars, it is reported, are being offered at more than half-a-crown per ton under the general quoted rates. This is naturally being very strongly resented by the other Lancashire makers, who have still sufficient orders on their books to keep them fully going for some time to come, and although just at present they are not booking much new business, they are not attempting to compete with the reduced prices which the firm above referred to are prepared to accept, as they believe that by waiting there will be a strong, steady improvement in the market with the turn of the half-year. For delivery in the Manchester district they consequently remain firm in quoting £5 10s. as the minimum, whilst North Staffordshire bars average £5 10s. to £5 15s., delivered here. Sheets are stronger, and now range from £7 to £7 5s.; hoops remain at £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths, delivered Manchester district, with 2s. 6d. less for shipment.

In the steel trade a steady tone is maintained, and there is no quotable change in prices. For good foundry hematites makers are firm at 58s. to 58s. 6d. less 2½; steel billets are obtainable at £4 7s. 6d. net cash; bars at a trifle under £6, whilst for boiler plates, £6 5s. to £6 7s. 6d. remain about the average figures for delivery in this district.

All descriptions of manufactured metal goods are in brisk demand, and local makers have quite a pressure of orders. The railway companies have been placing a large quantity of work; requirements of general engineers are also heavy, and there has been a considerable demand for the various fittings required in connection with the Government work recently given out. This pressure of work has caused another advance in prices of ¼d. per pound, and delivered Manchester district quotations are now as below:—Solid drawn brass tubes, 6¾d.; brazed copper tubes, 7¾d.; solid drawn copper tubes, 8d.; brass condenser tubes, 8¾d.; brass wire, 6d.; copper wire, 7d. to 7¼d.; and rolled brass 6d. per pound. Yellow metal plates, which were not at first included in the general advance, have since also been put up ¼d. per pound.

Messrs. Nasmyth, Wilson, Limited, of the Bridgwater Foundry, Patricroft, have in hand several special orders for exceptionally powerful presses. One of these, which is being sent out to India, and is constructed for dealing with special material, is to work at a pressure of five tons per square inch. Another order they have in hand is for a very large hydraulic press for Egyptian cotton, the total weight of which, when complete, will be about 180 tons. This press is so arranged that steam is utilised for part of the action, and by means of this combination the press can turn out sixty bales of cotton per hour. The firm are also exceptionally busy with orders for their special steam stamps, which have been largely in demand for bicycle forgings, and in their locomotive department they are also well engaged, the orders including a number of locomotives for the Japanese railways.

Some time back I referred to Mr. Benjamin Goodfellow, of Hyde, having secured the contract from the Manchester Corporation for the engines required for the extension of the electric lighting installation. This contract, which includes eight engines, each of 400-horse power, is now approaching completion, several of the engines having already been put down, and given, I understand, every satisfaction. Six of these engines are of the inverted vertical type, and the two others horizontal, and the whole of them are fitted with Corliss valves, which, I am informed, have been found an improvement upon the slide valves supplied with the engines put down in the section of the electric works first completed.

The only change to notice in the coal trade is, perhaps, a steady weakening in prices. Notwithstanding the protracted stoppages of the pits, all descriptions of round coal hang upon the market. Better qualities, suitable for house-fire purposes, met with only the slowest possible demand, and, apart from small retail orders, list rates are to a large extent little more than nominal. In the lower descriptions of round coal for steam and forge requirements there is continued excessively keen competition, with all sorts of prices taken for contracts or to secure orders for anything like quantities, 5s. 6d. to 6s. being the full average figures at the pit mouth for ordinary qualities. Tenders are now being sent in for the gas coal contracts, and to secure these prices are being cut a shade lower than even last year, especially in the commoner qualities. It is too early as yet to give any definite idea as to the actual prices, as none of the important contracts are yet settled, but from what I can gather they are not likely to be more than about 6s. to 6s. 3d. for ordinary Wigan four-feet, and about 7s. for best screened Wigan Arley gas coals. At the pit mouth, engine fuel, if anything, is rather more plentiful in some quarters, especially where pits have not been closed over so long a period for the Whitsuntide holidays, whilst the mill stoppages in the manufacturing centres have necessarily for the time being restricted requirements for engine purposes. Prices, however, are firm at fully late rates, averaging 3s. to 3s. 6d. for common slack to 4s. 6d. and 5s. for better qualities, at the pit mouth.

No improvement can be reported as regards the shipping trade, and 7s. per ton, delivered Garston Docks or High Level, Liverpool, remains about the average figure for ordinary steam coal.

Barrow.—There is a distinct improvement to note in the hematite pig iron trade this week, and since the holidays business has not only improved but prices as well, and users are in the market for big forward deliveries. The furnaces in blast number 39, and an increase is expected, as makers are more fully sold forward than they have been for some time past. The production is all for immediate consumption, and the stocks are held very firmly. Bessemer qualities of iron are in liberal demand on home as well as on general account, but some assurance of the continuance of activity can be obtained from the fact that local makers of steel are likely from present appearances to remain very good customers for Bessemer qualities of pig iron. Prices are better at 47s. 6½d. net cash sellers, and 47s. 6d. buyers of warrant iron, while makers quote 49s. to 50s. nominally for parcels of mixed Bessemer Nos. net f.o.b.

There is a corresponding improvement in the iron ore trade, and the demand for native qualities has appreciably increased. Prices remain steady, however, at late rates, 10s. for ordinary sorts net at mines. Imports of Spanish ores are still very largely maintained.

Steelmakers are busy on all classes of goods, but more especially on rails and on ship and boiler plates, orders for which are numerous. There is also a good trade doing in all other sorts of steel usually produced in this district, except tin bars, which remain quiet.

Shipbuilders and marine engineers have a fair number of orders on and, but new work is expected and required if the works are to be kept regularly employed. Some good commercial orders are in the market, and some important Admiralty contracts have yet to be given out.

The coal and coke trades are heavier, but while the price of coal remains easy that of coke is firmer, and higher prices are expected.

Stocks of warrant iron have increased 1195 tons during the week. There is now in stock, 309,842 tons, an increase since the beginning of the year of 20,667 tons.

Shipping is fairly employed, 7957 tons pig iron and 7823 tons of steel were shipped from West Coast ports during the week, as compared with 3931 tons of pig iron and 8058 tons of steel in the corresponding week of last year, an increase of 4026 tons of pig iron, and a decrease of 235 tons of steel. The shipments this year so far have been—Pig iron, 131,162 tons; steel, 197,574 tons; as compared with pig iron, 109,553 tons; and steel, 152,627 tons in the corresponding period of last year, an increase of 21,609 tons of pig iron, and 44,947 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

WORK has been resumed in the South Yorkshire and adjoining coalfields after the Whitsuntide holidays, although the fine weather caused "play" to be somewhat unduly prolonged. Those engaged upon the steam coal quality were the first to get back to the pits, the others delaying their return until last Monday and Tuesday. Notwithstanding the comparatively slight quantity of coal produced, scarcely any inconvenience has been caused, as the stocks in hand were quite equal to the demand. London agents report very little business. Quotations have remained very much the same, but buyers have had a little advantage during the latter part of the week. Silkstone coal is at 8s. to 8s. 3d., and secondary sorts 7s. 3d. to 7s. 6d. Barnsley house coal in plentiful supply at 7s. to 7s. 3d. per ton.

The keen competition at present existing is having effect more severely on the thin seam coal. Best qualities can only realise 6s. to 6s. 3d. per ton, and even these prices are hard to obtain, many customers preferring to pay a little more for thick seam. There is an active request at present for steam coal. The placing of the Midland Railway's contract at 7s. for South Yorkshire, and 6s. 3d. for Parkgate for a year, indicates that there will be no disturbance in August. The Manchester, Sheffield, and Lincolnshire Railway Company have also been giving out contracts on much the same lines. A large amount of the best steam coal is being forwarded to Hull, mainly from the South Yorkshire districts. Gas coal is in good request for stacking purposes.

At several of the principal works the large stocks on hand show very clearly that the directors view the future with apprehension. The demand for small coal and slack is animated. Coke is also making satisfactory advance. Prices rule as follows:—Best slack, 3s. 6d. to 3s. 9d.; and ordinary pit slack, 2s. 6d. to 3s. Smudge makes 1s. 6d. to 1s. 9d. per ton. Coke is produced in very large quantities, and the smelting furnaces have been fully employed during the holidays. Satisfactory reports are coming in from the new ovens at the Barrow collieries, and a similar remark applies to Silkstone common. Prices range from 8s. to 12s. per ton.

The heavy industries continue in a very satisfactory condition. Armour-plate firms are full of work on Government account. Boiler makers and engineers report a steady trade. Crucible steel, best brands, are easily sold, while the output of both Bessemer and Siemens-Martin has rather increased of late. Values are firm as follow:—Hematites, 55s. to 57s. 6d. per ton, delivered in Sheffield; Bessemer billets, £5 12s. 6d. to £6; bar iron, £5 10s. at makers' works and £6 in warehouse; Lincolnshire pig iron, 39s.; Siemen-Martin steel, £7 10s. per ton, average quality. Reports from the rolling mills are most encouraging.

The values of the various descriptions of wire remain about the same. Common realises £4 15s.; guaranteed carbon, £7 6s.; and Siemens-Martin, special, £9. Old rails are rather scarcer at present, and the price has therefore advanced. Belgium has competed very keenly with English mills this year. Rather less business in cycle sections is being done in the rolling mills, although the manufacturers of material for bicycle work are exceptionally well employed.

The prosperity in the shipyards is having a beneficial effect on the demand for marine castings, heavy crank-shafts, &c. Messrs. Charles Cammell and Co. have just received an order from the Palmer Shipbuilding Company for two crank shafts for the two cruisers ordered by the Admiralty, and now building at Jarrow.

In the building trades some difficulty is reported in getting English girders. One large building for carriage and omnibus proprietors has been delayed on that account. It is understood that Northern girder firms are very busy at present, both on foreign orders and home requirements.

The lighter industries are waking up a little. The dispute in the file trade has been satisfactorily settled, and the men have resumed work at the higher wages. The demand for cutlery has again advanced, more being done in the best classes of pen, pocket, and table cutlery, but there is no diminution in the keenness of competition from Germany. The use of xylonite as a substitute for ivory—and it is wonderfully akin to it in the touch as well as the sight—is rapidly increasing. The silver and electro-plating firms in a large way of business are well employed, but the smaller establishments do not report quite so favourably. The silver, electro-plate, and Britannia metal trades are being added to the long roll of existing trade unions. The chasers, engravers, and etchers were formally organised on Tuesday evening. A determination was expressed to bring every man who is engaged in these branches into the society.

Local manufacturers are watching the motor car movement very closely. With the removal of the present restrictions on street locomotion, a rush of trade is expected, and Sheffield means to be in it, and not let the motor cars pass them as they foolishly allowed the bicycle business to do.

The drought, which ended with the beginning of gentle showers on Wednesday night, has considerably reduced the stocks of water in the Sheffield reservoirs, but not to an extent to cause misgivings. It is understood that in spite of May being so dry a month, the reservoirs contained up to Wednesday sufficient water to give five months' supply to the city. The falling of the rain will not merely swell the stores, but cut off the great quantity required for garden watering and kindred purposes, in which gross waste takes place.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

AN upward movement has been in progress in local trade this week, business has been fully resumed after the holidays, and consumers are evidently going earnestly into business, as they are recovering confidence, and having done little buying since Easter, the time is approaching when they must make arrangements for securing further supplies, and they do not think that by waiting they will be able to purchase on easier terms than those now ruling. Almost everything favours the improvement, prospects are encouraging, the stock markets are becoming stronger and more animated, railway traffic receipts increase, and political matters no longer exert a detrimental influence on trade generally. Consumers are rather anxious to buy iron for forward delivery, but sellers are not prepared to commit themselves in the face of a rising market. Exports are well kept up; indeed, Monday's pig iron shipment from the Cleveland district was the largest on record, reaching 10,750 tons, whereas in June a slackening of oversea deliveries is usual.

Prices of Cleveland pig iron this week have been advanced 3d. per ton, and a good deal of business is said to have been done at the higher figures. No. 3 Cleveland pig iron could on Monday have been bought at 37s. 3d. per ton for prompt delivery, but 37s. 6d. has been the general price since, and nothing less than that will be accepted, either by makers or merchants, and the cheap iron that was offering last week has been withdrawn. Cleveland warrants are improving in value, they were at 37s. 3d. cash when the week opened, but rose to 37s. 7d. on Tuesday, and on Wednesday closed at that. Last month Connal's stock of Cleveland pig iron was increased 4694 tons, the quantity held by them at May 31st being 198,450 tons. Of hematite pig iron Messrs. Connal held 159,524 tons, the increase for the month being 5290 tons. No. 1 Cleveland pig iron is at 38s. 9d.; No. 4 foundry is advanced to 37s.; No. 4 forge to 36s. 6d.; and white is at 36s.

The upward movement is least conspicuous in the hematite pig iron trade, for the opinion is that the output is in excess of the requirements, and the increase in Connal's stores favours that idea. Of course no reliable figures can be given as to the stocks of hematite pig in makers' hands as no returns are officially collected. It is thought, however, that the market would be strengthened if two or three furnaces making hematite were blown out, instead of more being put in. Russia, which for the last few years has been a large buyer of Cleveland hematite pig iron—taking last year between 60,000 and 70,000 tons—this year is importing very little, as more is being made at home, additional furnaces having been erected in South-East Russia. As the Russians levy such a heavy duty on imported pig iron, Cleveland makers find it difficult now to compete with native producers. The quotation for M. Nos. of Cleveland hematite pig is 46s. per ton for early delivery, but 45s. 9d. is generally accepted.

The May statistics of the Cleveland Ironmasters' Association are regarded as rather unsatisfactory, because in spite of good shipments, and practically a decrease in the production of Cleveland pig iron, the stocks show an increase of 3308 tons, while the estimate was that the consumption would be at least equal to the production. The total quantity of Cleveland pig iron held at the close of the month was 353,305 tons. The increase was not in makers' hands, however, for their unsold stocks were reduced 505 tons, and the stock in their stores 2146 tons. The accumulation was in the public stores, the North-Eastern reporting 1265 tons, and Connal's 4694 tons. The increase of 10,624 tons can be accounted for by the extra day in May over April, but actually the rate of production in Cleveland iron was lessened, seeing that the rate of increase should have been 4300 tons, if the output had been kept up at the April rate, whereas it is only 2218 tons. The production of hematite, &c., pig is again in excess of that of Cleveland iron. Of the 96 furnaces in operation, 49 were producing Cleveland iron at the close of the month, and 47 hematite, &c., there being a decrease of 2 making Cleveland iron and an increase of 3 producing hematite, &c. The Carlton Iron Company blew in a furnace during the month. What caused the estimates to be wide of the mark was that more hematite pig iron was exported than had been counted upon. The following summary of the statistics of make and stocks is interesting:—

Make of Pig Iron.

	1896.		Increase
	May	April	
	Tons	Tons	Tons
Cleveland pig iron, Middlesbrough..	115,725	114,012	1,713
Do., outside Middlesbrough	20,249	19,744	505
Do., whole district	135,974	133,756	2,218
Other kinds of pig (including hematite, spiegel, and basic pig iron), whole district	140,746	132,340	8,406
Total of all kinds, whole district	276,720	266,096	10,624

Stocks of Cleveland Pig Iron.

	1896.		Increase	Decrease
	May 31	April 30		
	Tons	Tons	Tons	Tons
Makers' stocks Middlesbrough ..	86,401	87,320	—	919
Do., outside Middlesbrough	11,235	10,821	414	—
Do., whole district	97,636	98,141	—	505
Makers' stores, whole district ..	29,684	31,830	—	2,146
Public stores:—				
N.E. Railway Company's	27,535	26,270	1265	—
Connal's	198,450	193,756	4694	—
Total	353,305	349,997	3308	—

Altogether 96 furnaces were at work, against 89 a year ago.

The pig iron shipments from the Cleveland district during May, though not the largest on record were excellent, more especially when they came after such heavy exports as those in March and April. For three consecutive months the export of pig iron from Cleveland has exceeded 100,000 tons per month, a circumstance quite unprecedented in the history of the trade. Previous to last year it was a rare occurrence to see 100,000 tons reached; indeed, it was reached only four or five times since the trade was established. Last month's shipment of pig iron was 104,191 tons—1279 tons less than in April, but 2086 tons more than in May, 1895, and 12,157 tons more than in May, 1894. The exports for the five months elapsed of this year have amounted to 451,575 tons, exceeding by 42,000 tons the previous best returns—that of 1889, when 409,592 tons were shipped. This year's figures have been 63,442 tons better than those of last year, and the deliveries, both foreign and coastwise, were the best on record. To Italy the quantity sent has never been exceeded, and it is some years since Germany, Holland, Belgium, and Canada had more than is reported for this year. The tonnage sent to Scotland has only once before been exceeded.

The finished iron and steel trades are exhibiting better features, except the steel sleeper department. The demand for steel sleepers appears to be falling off very materially, just when extensive plant at several works has been put down to manufacture the material. Engineers seem to be abandoning the use of such sleepers, especially in India, on account of their extra liability to corrosion, and the companies are returning to the use of the old cast iron pot. The ironfounders benefit by this; they had in many cases come to look upon this trade as a decaying one, but it has become active lately, while at the same time the steel sleeper trade has fallen off. Heavy steel rails are at £4 10s. net per ton at works, but it is difficult to secure this price, and transactions in other districts at a considerably lower price have been reported. Common iron bars are quoted at £4 17s. 6d.; best bars at £5 7s. 6d.; steel ship plates at £5; steel ship angles at £4 17s. 6d.; iron ship plates at £4 17s. 6d.; and iron ship angles at £4 15s., all less 2½ per cent. f.o.t.

Sir Christopher Furness, and the gentlemen interested with him in the purchase of the property of the Teesside Iron and Engine Works Company, Middlesbrough, intend very shortly to issue the prospectuses of the new companies which are being formed to carry on the works. The liquidator of the old company, Mr. Wm. B. Peat, has informed the preference shareholders that he will send them copies, so that they may individually elect whether they will in respect of their present holding take 10s. per share in preference shares in the new companies, or accept 7s. 6d. in cash.

The shareholders of the Darlington Steel and Iron Company, at their annual meeting, were averse to finding £55,000 to bring the works up to date and re-start them. They appear to have no hope of their being carried on successfully as a rail manufactory, and decided that it is advisable to wind up the company under voluntary liquidation. A meeting of shareholders is to be called to pass a resolution to this effect.

The Tees Conservancy Commissioners have had a communication from the Admiralty asking for particulars as to the dimensions, depth, &c., of the Commissioners' Graving Dock. The Commissioners have decided to memorialise the Admiralty, asking whether they would be prepared to subsidise by a money grant the Commission, in the event of that body determining to construct a large dry dock on the Tees, for the purpose of meeting all modern shipping requirements, including vessels of war. There is no graving dock on the North-East Coast large enough to accommodate a man-of-war.

The Tees Conservancy Commission are moving in regard to the tipping of blast furnace slag in Tees Bay, viz., to systematise the tipping so that it may come in useful as a foundation in case a harbour of refuge should be constructed there. Thousands of tons are tipped weekly into the bay, and other ironmasters, who are short of land, are proposing to send their slag to sea. The chairman of the Commission has had an interview with Mr. Goschen on the subject, and told him that if the Commissioners received from the Admiralty any encouragement to believe that when the proper quantity of slag had been tipped below the water the concrete works would be undertaken by the State, they would have the slag tipped in the direction indicated in Sir A. Rendel's plans, and furnish the necessary lightships. Mr. Goschen is to look into the matter.

The coal trade is brisker so far as regards the steam coal branch, and the price of best steam coal is fully 8s. 3d. per ton f.o.b. The Earl of Durham's fourteen collieries are to pass into the hands of Sir James Joicey and Co. on July 1st, and the officials have received notice to that effect.

The steel lighters which have been built by Sir Raylton Dixon and Co., Middlesbrough, for the Rotterdam Coal Shipping Syndicate, have made their first trips this week, each carrying 1000 tons of coal from the Wear to Rotterdam, and being towed by Dutch tugs. They will perform weekly voyages.

Mr. Charles Fenwick, M.P., has been nominated for the presidency of the Northumberland Miners' Association, vacant by the death of Mr. John Dixon.

The Gas Committee of the Stockton Corporation have recommended the adoption of a carburetted water gas plant and buildings at a cost of £5000.

The death is announced of Mr. Donald Fraser, for many years goods manager for the Northern District of the North-Eastern Railway. He retired in 1892 after being fifty years in the company's service.

Messrs. Wm. Doxford and Sons, at Pallion-on-the-Wear, have just launched the twenty-fifth and largest steamer of the turret deck type yet built. She is for Messrs. A. R. Hansen and Co., Copenhagen, and her gross register is 3400 tons, net about 2190, and deadweight 5600 tons on 21ft. 8in. draught. Messrs. Doxford and Sons will supply the engines also, and they have adopted two of Babcock and Wilcox's patent water-tube boilers. It is believed that this is the first cargo steamer built for a foreign flag in which this type of boiler has been introduced.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has been a rather better feeling in the pig iron market, although the amount of business done was not very large. Two weeks ago there was an impression that the market was about to go back owing to threatened labour troubles, and increasing stocks. The bears took advantage of this feeling to some extent, and prices fell away considerably, consumers having for the time evidently been well supplied with iron. A more hopeful view is now taken of business. Scotch warrants opened for the week at 46s. 7d., advancing to 46s. 9½d. The price was easier at 46s. 8d. afterwards, but evidences of a marked improvement in the finished iron trade sent up the price subsequently to 47s. 1d. cash. The demand for Scotch warrants was mainly for cash, and the price for one month was relatively lower than usual. Business was limited in Cleveland warrants, which was done at 37s. 5½d. to 37s. 6½d. cash. In Cumberland hematite there was a moderate business, mainly for one month, at 47s. 6d to 47s. 9d. The cash price was about 47s. 5d., and one lot was done for delivery in nine days at 47s. 6d.

The production of Scotch pig iron is maintained at the rate of last week. One furnace has been taken off ordinary iron, but an additional one has been placed on hematite. There are now 39 furnaces making ordinary, 39 hematite, and 3 basic iron, total 81, compared with 77 at this time last year.

Stocks of pig iron are on the increase, although there is as yet no reason to anticipate that the additions will in the meantime be inconveniently large. The increase in the past week to the stock in Glasgow warrant stores was 2340 tons, bringing up the total to 358,348 tons, compared with 282,361 at the end of May last year, thus showing an increase compared with that time of 76,000 tons. There is no certain means of ascertaining the condition of the stocks in makers' yards, as these are only reported at the end of the year, but the movement in the public stores is generally accepted as a fair indication as to what is taking place with regard to makers' stocks.

The prices of makers' pig iron have been steady, and are as follows:—Govan, Monkland, and Carnbroe, f.o.b. at Glasgow, Nos. 1, 47s. 6d.; Nos. 3, 46s.; Clyde, No. 1, 50s.; No. 3, 47s.; Summerlee, Calder, and Gartsherrie, Nos. 1, 50s. 6d.; Nos. 3, 48s.; Coltness, No. 1, 53s.; No. 3, 48s. 6d.; Glengarnock at Ardrossan, No. 1, 50s.; No. 3, 45s. 6d.; Eglinton, No. 1, 47s.; No. 3, 45s.; Dalmellington at Ayr, No. 1, 46s. 6d.; No. 3, 45s.; Shotts at Leith, No. 1, 52s.; No. 3, 48s. 6d.; Carron at Grangemouth, No. 1, 52s. 6d.; No. 3, 48s. 6d.

The shipments of pig iron from Scottish ports in the past week amounted to 5837 tons, compared with 7724 tons in the corresponding week of last year. There was shipped to Germany 440 tons, Holland 472, United States 10, Australia 75, India 316, Italy 170, Belgium 30, China and Japan 100, other countries 290, coastwise 3934, against 4704 in the same week of last year. For the first five months of the year the total shipments have been 126,153, compared with 133,644 in the same period of 1895. The foreign shipments during the five months have been 44,848 tons against 47,699 last year and the coastwise shipments 81,305, compared with 85,945 in the same time last year, there is thus a decrease both in the exports and in the coastwise shipments of Scotch pig iron. While the movement of ordinary Scotch pig iron has thus been rather falling off, there is reason to believe that the consumption of it at home has been well maintained, and there is no doubt that the quantity of hematite iron used by Scotch makers has materially increased. The imports of English iron at Grangemouth since the beginning of the year have been 187,912 tons, showing an increase of 33,873 tons over the quantity received the first five months of 1895.

The malleable iron trade is fairly busy, and the makers have at length seen their way to advance prices, establishing an increase of 5s. per ton. The steel works are very busy, chiefly with shipbuilding material. It is intimated that the Clydebridge Steel Company has received an order from the Government, and tenders for additional quantities of steel for the Admiralty are expected to be given out.

During May, 33 vessels with an aggregate tonnage of 22,470 were launched from the Clyde shipyards, with 27 vessels of 48,705 tons in May, 1895. The output of the five months now past comprises 101 vessels and 156,974 tons, against 92 vessels and 139,883 tons in the same period of last year. The month's output, as will have been noticed, is comparatively moderate, but that for the five months is larger than has been recorded for any corresponding period in the history of the trade.

A fair amount of new shipping has been placed in the past month, and a number of contracts are reported in the past few days. Messrs. Russell and Co., Port Glasgow, have received an order to build a steel twin-screw steamer for passenger and cargo service on the river Amazon. The Union Steamship Company of New Zealand has placed an order with Messrs. William Denny and Brothers, Dumbarton, for a fast steamer with extensive accommodation. The Fairfield Shipbuilding Company has contracted to build for the Isle of Man Steam Packet Company a paddle steamer which is intended to excel the best of the splendid vessels now running between Liverpool and the Isle of Man. This vessel will have accommodation for 2000 passengers. She will be 350ft. long and 42ft. wide, with engines of 10,000-horse power. Messrs. A. Stephen and Sons, of Glasgow, will build a screw steamer of 2800 tons gross for French owners.

The coal trade has not improved since last report, the total shipments from Scotch ports have been 152,779, against 167,647 in the preceding and 134,953 in the corresponding week last year. The five months' shipments, however, show an increase of 196,978 tons. While the current shipments are but moderate, it is gratifying to note that orders have been coming in rather more freely in Fifeshire, and business is fairly active in the West. Coal exports from the Clyde to the Mediterranean have fallen away, owing to a scarcity of ready tonnage; otherwise, there is no new feature in the trade. Main coal is quoted f.o.b. at Glasgow 5s. 9d.; splint, 6s. 3d. to 6s. 6d.; ell, 6s. 3d. to 6s. 9d.; steam, 7s. 6d. per ton.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THERE was a considerable falling off in coal shipments last week on account of the holidays, and in Cardiff especially coalowners, shippers, and the collective body interested on 'Change and elsewhere in the coal trade had to reflect on the important contrast between the week's totals and those of the preceding week. In round numbers the difference was 85,000 tons. One comment by a coalowner was pungent, "We pay heavily for the pleasure of our holidays." This is also very applicable to the monthly holiday of the colliers.

Newport totals were, of course, also affected, but Swansea recorded a despatch of 50,000 tons, or exactly 20,000 tons above the weekly average of coal and fuel. Amongst the Swansea items I note one—8260 tons anthracite for San Francisco.

This week the report from the Cardiff Exchange is on the whole favourable, though the old activity in business has not been quite regained. The inquiry for best and good seconds at last prices was fairly sustained, but drys are not selling well, and Monmouthshire coals are slack. Mid-week there was a little more buoyancy, and closing prices were as follows:—Best steam coal, Cardiff, 10s. 3d. to 10s. 6d.; best seconds, 9s. 9d. to 10s.; seconds, 9s. 3d. to 9s. 6d.; drys, 8s. 7½d. to 9s.; best Monmouthshire, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s.; best small, 4s. 9d.; seconds, 4s. to 4s. 6d.; drys from 3s. 6d.

The long prevalence of hot weather has not helped matters in the house coal trade, and only a moderate business is being done. Last prices, Cardiff, are:—Best house, 9s. 6d. to 10s.; No. 3 Rhondda, 9s. 6d.; brush, 7s. 6d. to 8s.; small, 6s. to 6s. 3d.; No. 2 Rhondda, 7s. 3d. to 7s. 9d.; through, 6s. to 6s. 3d.; small, 4s. to 4s. 3d. Swansea prices are:—Best anthracite, 11s. to 11s. 6d.; second quality, 9s. to 10s.; ordinary large, 8s. to 8s. 9d.; small rubble culm, 4s. to 4s. 6d.; steam, 9s. to 10s.; seconds, 8s. 3d. to 9s.; bunkers, 7s. 9d. to 9s., house coals, No. 3 Rhondda, 9s. 6d. to 10s.; No. 2 Rhondda, 8s. 6d. to 8s. 9d.; through, 6s. 6d. to 6s. 9d.; small, 5s. to 5s. 3d.; patent fuel, 9s. 9d. to 10s. 3d.; Cardiff quotations, 9s. 9d. to 10s. 3d.; coke, Cardiff, prices maintained; furnace, 13s. to 14s. 9d.; foundry, 15s. 6d. to 16s. 9d.; special, 19s. 6d. to 19s. 9d.; good demand.

The iron and steel reports of Swansea is encouraging. Pig iron has showed a slight advance upon the week, and the market continues firm, so that there is almost a certainty of better prices. One of the imports of the week took the form of 1550 tons of pig iron from Bilbao, while the consignments of ore have been unusually large. Dowlais received seven cargoes this week, Crawshay Bros. three, La Société Commerciale and Ebbw Vale one each. Reports from leading ironmasters are to the effect that rail orders in hand are sufficient to keep mills going for some time, and that an appreciable improvement is showing itself in bars.

One of the leading steel consignments of the week has been 800 steel billets from Newport for Riga.

The mid-week quotations, Swansea Exchange, were as follows:—Glasgow pig, 46s. 10½d., cash buyers; Middlesbrough, No. 3, 37s. 5½d.; hematites, 45s.; Welsh bars, £5 10s. to £5 12s. 6d.; iron plates, £6 to £6 17s. 6d.; steel plates, £6 to £6 17s. 6d.; Bessemer steel, bars, £3 17s. 6d.; Siemens, £3 18s. Steel rails, heavy sections, £4 10s. to £4 12s. 6d.; light, £5 10s. to £5 15s. Tin-plates, makers' quotations: Bessemer cokes, 9s. 3d. to 9s. 4½d.; Siemens' coke finish, 9s. 6d. to 10s.; ternes, 28 by 20, 16s. 6d., 17s. 6d., to 21s. 6d.; best charcoal, 12s. 9d. to 13s.; wasters, 6d. to 1s.; odd sizes, usual extras. Block tin, £59 17s. 6d. to £60 10s. Lead, English, £11 5s.; Spanish, £11 2s. 6d.

One of the excitements of the past week in the Cardiff district has been in the pitwood trade. Owing to the scarcity of tonnage, prices advanced from 15s. to 17s. per ton, and as contractors were unable to supply their mines, and had to look about in all quarters, those who held stocks did well. At the end of last week and the beginning of this cargoes began to put in an appearance—some heavy ones for Newport Pitwood Company—and the tendency now seems to be for prices to regain their normal condition. Present prices, 16s. 3d. Manganese ore is coming into Pyle from Coquimbo. North Walian tracts only feebly worked so far.

In tin plates there has been a little more doing, and last week's shipments being heavier than usual helped to lessen stocks. Makers are looking at the situation thoughtfully, for, as remarked on 'Change, Swansea, this week, only a hand-to-mouth business is being done, and prices are such that there is little or no profit to be made. Yet, in various quarters, movements show that mills which have been laid by are going to start, and the result must soon be critical again.

Distress prevails in the Cwmfelin district on account of stoppage, and a fund is to be opened.

At Ely Tin-plate Mills, Llantrissant, men have agreed to accept a reduction of 25 per cent., and two mills will be started.

Swansea works are fairly well employed, but there is a scarcity of orders for forward delivery.

In the Briton Ferry district last week eighteen mills were at work, and business in that quarter is tolerably brisk, both in tinplate and steel bar. Cyfarthfa is also turning out more tin bar of late.

Cardiff prices for ore, which is in good demand, is as follows:—Best Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d.; Garucha, 10s. 9d. to 11s.

A visitor from Wales to Bilbao reports favourably of the condition of things there. In the North there is still ample supply, but the question is will quality depreciate in further working? As regards the South, yield is practically inexhaustible.

The drought of to-day over the mining districts began this week to awaken apprehension in more than one quarter, and local authorities have been closely investigating at the chief towns, and calculating possibilities. At Aberdare, the Rhondda Valley, Swansea, Merthyr, and Cardiff, water is the prominent theme, and I shall fully expect that the outcome will be strenuous efforts in the future to get different reservoir requirements where the investigation has found them lacking. Cardiff is well placed, but there has been a scare on account of insufficient ventilation in some of the storages. Newport is fairly well off. Aberdare is on a very short supply. Ogmore Valley is well supplied. Given ample engineering outlay in the hill districts, and the last report should be made to apply to all.

As anticipated, the Bute Dock new issue was applied for more than three times over. A large request was made by Cardiff alone, so that many are disappointed. Probably more ventures are in the near future.

I see that the new issue of Davis and Sons, Ferndale, is the subject of a good deal of speculation. The addition of Tylerstown collieries probably causes this, as a much longer duration of output is certain; but authorities state that in all probability the new issue will be taken up by the present shareholders of the company.

Taff Vale ordinary shares have advanced to 95¾. Port Talbot a fraction less than last quotation.

I much regret to announce the death of Inspector Cunningham, of the Brecon Railway, an able railway official, for more than thirty years connected with this well-managed line.

I see that the Brecon and Cambrian Railway authorities are arranging the royal programme, necessary by the visit of the Prince of Wales to Aberystwith and Cardiff. The locomotives are to be, from what I hear, marvels of decorative art, as well as of excellence.

The Cambrian Railways, and Brecon and Merthyr, are to make a record season, if prospects hold good. It is opening well.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

OWING to the holidays few large purchases have been made during the past week, and business on the iron market has consequently been a shade quieter.

A healthy tone characterises the Silesian iron trade, and there is good reason to expect a further increase in the employment of the different branches, the general movement being decidedly in an upward direction.

In Austria-Hungary the blast furnace works, as well as the rolling mills, have continued in fair activity. Heavy contracts are comparatively scarce, but small orders, especially for home consumption, are plentiful. Nearly all the branches of the building and engineering line are very busy, and in the railway department good employment is secured till September. It appears that since the beginning of last year the locomotive factories have been uncommonly active. In 1895 no less than 180 locomotives were built, against 100 in the year before; among these thirteen were small truck locomotives.

In France the iron and steel producing establishments have been, on the whole, in satisfactory occupation. The works of Alais have secured an order for 31,000 steel rails for the Paris-Lyons Railway at 140f. p.t., while the steel works in Longwy have booked a contract for 2000 steel rails at the same price for the East Railway. Both makers and manufacturers are entertaining fair hopes with regard to future employment, as June promises to be a very busy month.

There is not much of interest to be related this week in connection with the iron trade in Belgium, holiday influences having naturally been felt in nearly all departments. Satisfactory reports are, on the whole, given with regard to the business that is done on home account, both demand and prices being good, but foreign orders, though willingly accepted at quotations that are often considerably lower than those officially quoted, continue to be very scarce. Especially plates remain extremely dull. Belgium import and export during the first quarter of the present year has been as under:

	Import.		Export.	
	1896. Tons.	1895. Tons.	1896. Tons.	1895. Tons.
Iron ore	468,467	441,252	80,447	54,862
Raw cast steel	3,048	—	46	—
Ingots	2,822	—	—	—
Billets and plates	1,363	—	—	—
Steel wire	1,612	1,048	502	154
Steel girders	98	115	10,105	8,472
Steel rails	196	37	19,239	11,365
Sheets	22	—	2,303	—
Bars	2,702	2,106	6,894	5,400
Nails	—	2	2,303	1,012
Steel manufactured goods	226	492	4,885	5,564
Raw cast iron	94,092	—	3,999	—
Manufactured cast iron	832	186	5,087	8,473
Scrap iron	13,857	3,668	6,502	2,063
Iron rails	797	—	13	—
Iron wire	1,454	1,064	627	99
Iron girders	146	17	13,494	5,988
Iron plates	1,786	687	15,523	13,368
Manufactured iron	2,410	2,234	47,449	32,956
Iron nails	227	188	1,068	1,438
Hardware	1,259	1,003	7,182	6,3 7
Tin sheets	933	—	118	—
Rolling material	61	360	6,268	6,588
Machines	5,521	4,132	7,971	5,151

On the Rhenish-Westphalian iron market general demand has been good, and prices are very firm all round. The pig iron trade is briskly employed in almost all departments, and most satisfactory reports are received with regard to the number of contracts that have been booked, many works having already disposed of their output till the end of the present year. The malleable iron industry maintains a very firm appearance; it is generally felt that as the year advances business increases also. This is particularly the case with bars, which have been improving slowly but steadily ever since the upward movement in trade began. There is likewise a considerable weight of business doing in girders, as well as in plates and sheets. The wire trade is also progressing favourably, and rivets have been fetching decidedly better prices of late. The engineering industries have been fully engaged, and new work continues to come in freely.

Total output of pig iron in Germany, including Luxemburg, was, for April of present year, 538,396 t.; of which 148,241 t. were forge pig and spiegeleisen, 44,259 t. Bessemer, 264,805 t. basic, and 81,091 t. foundry pig. Production in April, 1895, amounted to 470,420 t.; in March, 1896, it was 551,157 t. From January 1st to April 30th, 1896, no less than 2,058,751 t. were produced, against 1,875,843 t. during the corresponding period the year before.

According to statements published by one of the leading Belgian iron and steel companies, the average pay of their men amounts to M. 776 per head per annum, while the Rhenish-Westphalian machine and hardware industries report the yearly wages of their men to be M. 921 per head. The average pay of a French miner has been officially stated to amount to 1181f. per annum, daily wages being about 4·14f. per head.

Very satisfactory reports have recently been received with regard to the iron business in Sweden; shipments for March and April have been uncommonly large, owing to a specially brisk trade in manufactured iron. As the majority of the works have sold their summer output, contracts for autumn deliveries can only be accepted at advanced prices. During the first three months of the present year there were exported from Sweden 5895 t. pig iron, against 3791 t. in the year before; 568 t. castings, against 174 t.; 2601 t. raw bars, against 1262 t.; 27,239 t. finished bars, against 19,600 t.; 188 t. scrap iron, against 185 t.; 390 t. iron wire rods, against 356 t.; 609 t. iron plates, against 534 t.; 52 t. wire, against 49 t.; 561 t. nails, against 521 t.; totals amounting to 38,067 t., against 26,382 t. for the corresponding period the year before. Exports in iron ore were 73,322 t., or 53,000 t. more than during the same period last year.

A FLEET of steel canal boats of the Cleveland Steel Canal-boat Company arrived in New York on May 13th. It consisted of one steam barge with five consorts, all loaded to a draught of 5ft., which is the maximum now practicable in the Erie Canal. The fleet left Cleveland on May 3rd at 1 a.m., arrived at Buffalo May 4th at 8 a.m., left Buffalo May 4th at 6 p.m., arrived at New York May 13th at 8 a.m.; lost 10 hours at Buffalo on account of ice in the harbour, 4 hours at Brockport cleaning fires, 4 hours at Troy waiting for teams through single locks; total, 18 hours lost time. Actual running time from Cleveland to New York, 9 days 13 hours; Cleveland to Buffalo, 31 hours; Buffalo to Troy, 5 days 20 hours; Buffalo to New York, 7 days 12 hours. The cargo included 653,000 lb. of nails for export to Japan; 375,000ft. of lumber for New York; 10 tons paraffin wax for Germany, and a miscellaneous cargo for New York. *Engineering News* says the west-bound cargo will consist chiefly of sugar for Detroit, Toledo, Cleveland, and the south-west.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

19th May, 1896.

10,788. Electric Arc Lamps, E. J. Bagnall, London.
10,789. Cases for Carrying Bottles, &c., A. Walby, London.
10,790. Golf Club Blade, W. Atkinson, London.
10,791. Covering for Pneumatic Tires, C. W. Hazeltine, London.
10,792. Pneumatic Tires, A. E. Alexander.—(*F. W. Morgan and R. Wright, United States.*)
10,793. Means for Joining Metal Plates, J. L. Kennedy, London.
10,794. Kettles, A. B. Spencer, London.
10,795. A Game, W. A. Shaw, London.
10,796. Inflatable Air Tubes, A. H. Walker.—(*F. W. Morgan and J. E. Parker, United States.*)
10,797. Heating Steel Bands, &c., A. E. Woodhouse, London.
10,798. Locks for Cycles, F. J. Hoyt, London.
10,799. Driving Gear for Velocipedes, J. White, London.
10,800. Lifeboat, J. H. Raffety, West Worthing, Sussex.
10,801. Transmitting Rotary Motion, J. M. Rauhoff, London.
10,802. Printing Machines, H. H. Lake.—(*C. B. Cottrell and Sons Company, United States.*)
10,803. Heating by Electricity, E. Davies, Manchester.
10,804. Electric Railways, H. H. Lake.—(*E. H. Johnson and R. Lundell, United States.*)
10,805. Filters, T. Linke, London.
10,806. Machines for Repairing Valves, F. E. Dexter, London.
10,807. Shields for Inkstands, H. H. Lake.—(*R. G. Hopkins, United States.*)
10,808. Collapsible Gangway, J. C. Margetson, London.
10,809. Tires for Cycles, &c., J. C. Margetson, London.
10,810. Tires and Rims for Wheels of Cycles, F. Swanborough, London.
10,811. Production of Electrodes, A. J. Marquand and E. Hancock, London.
10,812. Producing Motive Power, &c., A. Millard, London.
10,813. Cycles, C. Dell and J. T. Clifton, London.
10,814. Tobacco Pouches, Purses, &c., E. W. Dickins, London.
10,815. Making Building Blocks, L. R. F. Griffin, London.
10,816. Electric Measuring Instruments, J. Devonshire.—(*E. Thomson, United States.*)
10,817. Electric Brakes, J. Devonshire.—(*W. B. Potter, United States.*)
10,818. Electric Tramways, J. Devonshire.—(*W. B. Potter, United States.*)
10,819. Fixing of Artificial Fringes, S. Lichtenfeld and W. Kluge, London.
10,820. Dressing of the Hair, S. Lichtenfeld and W. Kluge, London.
10,821. Cycles, R. German, London.
10,822 Removing Impurities from Gas, H. Kirkham, London.
10,823. Cycle Pedals, E. Crofton, London.
10,824. Sounding Apparatus, J. Mohs and the Berliner Kunstdruck und Verlagsanstalt vormals A. and C. Kaufmann, London.
10,825. Securing Covers of Inspecting Chambers, H. H. Marten, London.
10,826. Hydraulic Mechanism for Opening Doors, W. F. D. V. Ollefen, London.
10,827. Manufacture of Di-ortho-nitro-toluene, J. Y. Johnson.—(*The Chemische Fabrik Griesheim, Germany.*)
10,828. Rotary Engines, H. H. Lake.—(*E. P. Howe, United States.*)
10,829. Internal Combustion Engines, J. Roots, London.
10,830. Incandescence Gas Lighting, O. Knöfler, London.
10,831. Respirators, A. R. Moody, London.
10,832. Wrenches, E. H. Smith and W. O. V. Schaick, London.
10,833. Frictional Driving Gear, J. Monteith, London.
10,834. Securing Window Panes in the Sashes, R. Schaellibaum, London.
10,835. Designs for Puzzle Boxes, C. L. Jones, London.
10,836. Car Brakes, W. J. Cartwright, London.
10,837. Production of Glycerine, J. Glatz and O. Lugo, London.
10,838. Pipe Wrenches, W. H. Wheatley.—(*The Klose Wrench Company, United States.*)
10,839. Oil Lamps, D. and A. Clerk, London.
10,840. Wallet Attachments for Cycles, F. Weintraud, London.
10,841. Manufacture of Paving Material, H. Schneider, London.
10,842. Heavy Ammonia Soda, J. Y. Johnson, London.
10,843. Means for Recording Votes, C. T. Marzetti, London.
10,844. Application of Steam to Cycles, R. O. Allsopp, London.
10,845. Plaster Support, W. P. Thompson.—(*F. L. Union and M. A. Hannon, United States.*)
10,846. Electric Arc Lamps, W. P. Thompson.—(*C. L. Coffin, United States.*)
10,847. Filters, W. P. Thompson.—(*E. J. Durant and A. Scharff, United States.*)
10,848. Instruments for Automatic Operation, W. P. Thompson.—(*E. H. White, United States.*)
10,849. Binding Machines, E. Kellett and E. J. Forknall, London.
10,850. Frames for Cycles, J. and W. C. Cubbon, Manchester.
10,851. Brushes, E. and M. Sweeney, Liverpool.
10,852. Saddle Supports for Cycles, J. Slee, Liverpool.
10,853. Inflating Pneumatic Tires, R. G. Owen, London.
10,854. Apparatus for Working Metals, T. L. Stewart, Liverpool.
10,855. Cycles, B. Green, London.
10,856. Tires for Cycle Wheels, E. G. Gearing, London.
10,857. Handle Bars for Bicycles, &c., A. Anscombe, London.
10,858. Folding or Collapsible Chairs, G. W. B. Crees, London.
10,859. Preserve Tins, A. W. Manconochie, London.
10,860. Stays for Boilers, R. T. Preston and J. Holden, London.
10,861. Driving Mechanism for Road Carriages, C. P. Elieson, London.
10,862. Incandescent Gas Lighting, S. Falk, London.
10,863. Fire-alarms, J. Caroc, N. Smith, and E. Schiemann, London.
10,864. Protecting Metallic Surfaces, B. Politzer, London.
10,865 Alarms for Cycles, C. Bauer, London.
10,866. Pneumatic Tires and Cases therefor, C. Bauer, London.
10,867. Cycles, C. Bauer, London.
10,868. Artificial Silk, O. A. Berend and the "Lehner" Artificial Silk Company, Limited, London.
10,869. Eyeletting Boot Uppers, W. E. Downs and H. J. Scott, London.
10,870. Construction of Incubators, J. A. Hooper, London.
10,871. Gentlemen's Coats, J. W. Oliver, Sheffield.

21st May, 1896.

10,872. Trimming Glass, T. R. Watson, Aberdeen.
10,873. Paper Fasteners, S. Learoyd, Huddersfield.
10,874 Motor Cycles, E. Wootton and W. H. Eaves, Warwickshire.
10,875. Oscillating Seat for Bicycles, W. J. Goodman, Staffordshire.
10,876. Cold Chamber, &c., S. D. and W. M. Egan, Liverpool.
10,877. Double-necked Knotting Bottle, E. Exley, Heckmondwike.
10,878. Implement for Crushing Clods, C. Downing, Barnsley.
10,879. Safety Cotton Hook, P. J. Murphy, Bootle.
10,880. Sleeve-link Fastening, W. E. Thompson.—(*J. H. Woods, South Africa.*)
10,881. Brakes, E. V. Tilley, Liverpool.
10,882. Garden Tool, J. Lytle, Liverpool.
10,883. Appliance for Ladies' Skirts, R. J. Edwards and R. Hall, Liverpool.
10,884. Tires for Wheels of Cycles, W. Merritt, London.
10,885. Rims, W. Merritt, London.
10,886. Rims, W. Merritt, London.
10,887. Application to Dating Stamps, J. W. Sutton, London.
10,888. Valves for Cycle Tires, A. H. Damkoehler, Berlin.
10,889. Envelopes, I. A. Keene and C. Rompler, London.
10,890. Manufacture of White Lead, T. H. Cobley, London.
10,891. Apparatus for Controlling Organs, P. R. Owen, Liverpool.
10,892. Actuating Valves, &c., J. B. S. Booth, Manchester.
10,893. Flax Machines, W. H. Taylor.—(*A. Coulter, Russia.*)
10,894. Speed Gear for Cycles, C. Hahlo.—(*F. Pribil, Austria.*)
10,895. Supporting Bicycles, C. Hahlo.—(*F. Pribil, Austria.*)
10,896. Latches, J. Prestwich and The Protector Lamp and Lighting Co., Manchester.
10,897. Barrel Tilter, D. Woolly, Manchester.
10,898. Oil Lamp Reservoirs, W. E. C. Pinchbeck, London.
10,899. Scarf Pins, Safety Pins, &c., J. Boyd, Dublin.
10,900. Bicycles, A. B. Lewis, London.
10,901. Velocipedes, J. R. Rickard, London.
10,902. Toilet Powder Boxes, M. S. Rowland, London.
10,903. Hasps, R. W. Barker.—(*Buckley and Thomson, South Africa.*)
10,904. Raising Vessels, R. W. Barker.—(*Midford Pneumatic Salvage Co., United States.*)
10,905. Pillar Box, P. E. Fisher and J. Godding, London.
10,906. Traction, W. Kingsland, London.
10,907. Ambulance Wagons, &c., K. Goldschmidt, Manchester.
10,908. Differential Crank for Cycles, A. Williams, Nottingham.
10,909. Chimney Tops, R. Aspden and J. Haworth, Lancashire.
10,910. Hair Curlers, J. E. Hulbert, Birmingham.
10,911. Adjustable Safety Lock, T. Campbell, Sunderland.
10,912. Safety Pins, R. H. Bishop and W. Down, London.
10,913. Producing Designs on Fabrics, A. A. Kuenemann, Manchester.
10,914. Tires for Road Vehicles, P. H. Mules, Manchester.
10,915. Dress Holders, W. Pearce, Birmingham.
10,916. Sewing Machines, M. H. Pearson and Pearson and Bennion, Limited, Leicester.
10,917. Machines for Straps, M. H. Pearson and Pearson and Bennion, Limited, Leicester.
10,918. Machines for Marking Leather, M. H. Pearson and Pearson and Bennion, Limited, Leicester.
10,919. Supporting the Frames of Cycles, W. P .O'Neil, Dublin.
10,920. Tires for Cycles, A. A. Vérel, Glasgow.
10,921. Sterilisation of Liquids, &c., F. T. Bond, Gloucester.
10,922. A Door Silencer, H. A. and C. H. Stuart, Reading.
10,923. Tires for Wheels of Cycles, T. More-Madden, Dublin.
10,924. Hook and Band Attachments, S. Dracup and R. Fox, Halifax.
10,925. Anti-corrosive Compositions, T. B. Rawlins, Glasgow.
10,926. Manufacture of Steel Chairs, A. E. Muirhead, Glasgow.
10,927. Tinman's Double Folders, F. and J. Crabbe, Swansea.
10,928. Unbreakable Feeding Bottle, J. M. Rees, London.
10,929. Clips, J. E. Hulbert.—(*C. B. Bennett, United States.*)
10,930. Hammock Cycle Saddle, F. R. Bolton, Birmingham.
10,931. Holder for Music for Violins, H. Wood, London.
10,932. Brake, J. B. Hamilton, London.
10,933. Toy, W. J. Blunden, London.
10,934. Steam Sterilisation Apparatus, S. Delépine London.
10,935. Clothes Peg, C. Brown, London.
10,936. Bleaching Vegetable Fibres, A. F. B. Gomoss, London.
10,937. Hollow Cylindrical Valves, C. E. Murdock, Camborne.
10,938. Sail Arrangements for Yachts, A. Pengelly, Teignmouth.
10,939. Ladders for Fire-escapes, W. Beckett, Sheffield.
10,940. Hinges for Controlling Doors, H. Hyde, Sheffield.
10,941. Separating Metallic Substances, S. Edwards, Sheffield.
10,942. Apparatus for Purifying Air, S. Edwards, Sheffield.
10,943. Spring Safety Hook, H. M. Hollingworth, Cowes.
10,944. Tires, G. W. Tarver, E. H. Jones and J. Dring, London.
10,945. Tires for Cycles and other Vehicles, J. H. Goodall, London.
10,946. Stoves, F. W. Blasberg, London.
10,947. Cycle and other Wheels, G. H. White, London.
10,948. Electric Contact Gear, F. Brown and C. H. Offord, Walsall.
10,949. Electrical Motive Power, R. O. Allsop, London.
10,950. Brass, &c., Letter Plate, G. H. Chambers, Workington.
10,951. Tires for Wheels of Bicycles, A. A. Vérel, Glasgow.
10,952. Steam Winches for Derricks, A. B. Brown, Glasgow.
10,953. Cellular Cylinders, C. E. Mumford and J. W. Jaggard, Bury St. Edmunds
10,954. Driving Power for Bicycles, &c., R. Evans, Gosforth.
10,955. Soap Composition for Flannel, C. Drummond, London.
10,956. Box for Carrying Tobacco, &c., F. W. Ford, London.
10,957. Tobacco Pipe and Cigar Holder, E. B. Tait, Glasgow.
10,958. Toy, J. H. Ruddick, Newcastle-on-Tyne.
10,959. Inflated Tires for Wheels, J. Adair, Waterford.
10,960. Silencer for Explosion Engines, A. G. New, Woking.
10,961. Pneumatic Tires for Cycles, J. W. Smallman, Nuneaton.
10,962. Check Tills, F. R. M. Phelps, London.
10,963. Smoke Consumer, C. Kindler and J. Slavan, Edinburgh.
10,964. Course Finder for Chart Use, J. W. Gillie, North Shields.
10,965. Finishing Incandescent Gas Mantles, A. E. Brunne, London.
10,966. Knives for Mowing Machines, E. Pratt, London.
10,967. Locks, L. A. Mérot, London.
10,968. Means for Consuming Smoke, W. M. Brown, London.
10,969. Tires for Cycles and other Vehicles, R. Wight, London.
10,970. Tunnelling Shields, C. P. Markham, Sheffield.
10,971. Suspenders for Ladies' Dresses, A. E. Drew, London.
10,972. Check or Buffer Straps, &c., A. Dewhurst, London.
10,973. Raising and Lowering Blinds, H. Hawkswell, London.
10,974. Clog Irons, R. Harker and J. Veale, London.
10,975. Flushing Water Closets, &c., R. Swales, London.
10,976. Trawling Apparatus, J. H. Maclure, London.
10,977. Steering Vessels, F. W. Ouston and M. Anderson, London.
10,978. High-pressure Kitchen Boilers, J. Paton, Holyhead.
10,979. Cycle Tires, J. M. Urquhart and W. H. House, London.
10,980. Washing Printing Blankets, J. Welsh, Manchester.
10,981. Carriage for Transport of Beds, G. Allzeit, London.
10,982. Horses' Strain Reliever, J. Smith, London.
10,983. Softening and Purifying Water, J. G. Chamberlain, Manchester.
10,984. Engines, J. W. T. Cadett, London.
10,985. Rest and Brake for Vehicles, C. G. Roberton, Barrow-in-Furness.
10,986. Ball Bearings, F. Waters, Birmingham.
10,987. Pneumatic Tire Inflators, J. H. Phillips, Birmingham.
10,988. Electro-magnetic Gear, D. Cook, Surrey.
10,989. Belt Pulleys. J. Willoughby, Plymouth.
10,990. Marking-out Tennis Courts, O. J. Allen, Bristol.
10,991. Picture Height Adjuster, J. G. Walthew, Manchester.
10,992. Preventing Refilling of Bottles, J. Creasy and H. Everest, London.
10,993. Electric Lamps, E. Bailey and J. M. Symington, Glasgow.
10,994. Reproducing Photographs, S. Rappa and J. Berry, Bristol.
10,995. Pneumatic Tire for Cycles, E. R. F. Mason, Leeds.
10,996. Vehicle Tires, W. G. Cook, Glasgow.
10,997. Water-supplying Apparatus, J. N. E. Hardy, Huddersfield.
10,998. Processes for Curing Butter, C. E. Metcalfe, London.
10,999. Cycles, G. Gibbon, London.
11,000. Kettles, Saucepans, and Coffee Pots, F. Moore, London.
11,001. Photographic Camera Obscura, &c., J. Airs, London.
11,002. Pipe Covers, W. E. Patterson, Birmingham.
11,003. Tires and Wheels, G. T. Teasdale-Buckell, London.
11,004. Combing Machine Stop Motion, W. B. Lee, Bradford.
11,005. Cycle and other Wheels, G. R. Williams, Bath.
11,006. Illuminated Railway Tunnels, A. Pickard, London.
11,007. Miners' and other Safety Lamps, A. Webb, Birmingham.
11,008. Hinged Foot Rest and Shield, W. S. Howell, Birmingham.
11,009. Pneumatic Brakes for Cycles, J. J. Eckert, Strood.
11,010. Raising Clotted or Scalded Cream, W. W. Paul, Sherborne.
11,011. Statical Machines, H. and F. Nehmer, London.
11,012. Doors, J. Phillips, London.
11,013. Supporting Stage Scenery, R. Courtneidge, London.
11,014. Stoppering Bottles, S. J. Stent, London.
11,015. Photographic Cameras, H. W. G. Plunkett, London.
11,016. Cleaning and Polishing Syphons, S. Munckton, London.
11,017. Toy Cannons and Pistols, R. S. Bedford, London.
11,018. Knife-cleaning Apparatus, E. M. Llewellyn, London.
11,019. Rulers, M. S. Haymes, London.
11,020. Windows, H. W. G. Plunkett, London.
11,021. Driving Poles for Carriages, E. Wooster, London.
11,022. Motor Carriages and Cycles, J. Clements, London.
11,023. Tubular Cushion for Velocipedes, W. Moulder, London.
11,024. Covers for Fruit Baskets, A. J. F. Gibbons, London.
11,025. Tires for Bicycles and Carriages, E. S. Copeman, London.
11,026. Clocks, J. Davidson and J. Rombach, London.
11,027. Mechanical Gearing for Cycles, &c., H. W. Horne, Edinburgh.
11,028. Velocipedes, D. Burns, Carlisle.
11,029. Kitchen Ranges, H. Steven and J. D. Duckett, Glasgow.
11,030. Wheels for Vehicles, W. Tinto and J. Fearon, Glasgow.
11,031. Swivel Looms, J. Melven and J. Dittrich, Glasgow.
11,032. Garment Supporters, R. W. Parramore, London.
11,033. Safety Window-cleaning Platform, C. M. MacQuibban, Glasgow.
11,034. Combined Padlock and Seal, A. Stephenson and W. Butterfield, Barnsley.
11,035. Electric-insulation Tubing, &c., F. G. Treharne, Llanisheu, near Cardiff.
11,036. Sacks, W. E. Leece and W. B. Christopher, Birkenhead.
11,037. Cycle Gear Band, J. Chadwick and T. L. Plunkett, Dublin.
11,038. Non-collapsible Tire Support, G. Savill, London.
11,039. Bedsteads, &c., J. A. Crane, Staffordshire.
11,040. Simplex Linaural Stethoscope, S. Coxeter London.
11,041. Pneumatic Hubs on Cycles, W. Oppenheimer, London.
11,042. Tires for Cycles, W. Oppenheimer, London.
11,043. Earthenware Scale Plates, &c., G. Herbert, London.
11,044. Production of Spectacular Effects, G. C. Downing.—(*G. Abazoff, France.*)
11,045. Self-acting Hydraulic Air Compressor, &c., Société Anonyme du Gaz Aéro-pétrolique, London.
11,046. Rockets for Signalling, R. H. Courtenay, London.
11,047. Reaping Machine, M. Alexandrescu, London.
11,048. Casting Armour Plates, &c., H. V. Holden London.
11,049. Traction Arrangement, D. M. B H Cochrane, London.
11,050. Tires for Bicycles, J. S. Curtius, London.
11,051. Valves, T. F. Edwards, London.
11,052. Crank Driving Mechanism, R. Grisson, London.
11,053. Protecting Covers for Pneumatic Tires, F. Casassa, London.
11,054. Boot and Shoe Heeling Machines, A. Andres, London.
11,055. Air Brake for Railway Trains, J. H. Loch, London.
11,056. Lubricating Bearings, E. J. Clubbe, A. W. Southey, and The Electric Motive Power Company, London.
11,057. Rotary Oil Engines, E. J. Clubbe, A. W. Southey, and The Electric Motive Power Company, London.
11,058. Motor Cars, &c., E. J. Clubbe, A. W. Southey, and The Electric Motive Power Company, London.
11,059. Wheels for Motor Cars, &c., G. Eastwood, London.
11,060. Manufacture of Products from Tea, J. Davidson, London.
11,061. Derivatives from Piperidine, &c., J. Turner and Co., Ltd., P. Schidrowitz, and O. Rosenheim, London.
11,062. Valve for Pumps, Tangyes Limited and E. Johnson, London.
11,063. Coal Tongs, &c., R. H. Berkeley, London.
11,064. Self-adjustable Cover for Closing Receptacle, J. Gordon, London.
11,065. Vaginal Syringes, H. A. Smythe-Martin, London.
11,066. Auto-motor Road Carriages, W. J. Brewer, London.
11,067. Corsets, H. Bendy, London.
11,068. Lock Mechanism for Guns, H. W. Holland and W. Mansfield, jun., London.
11,069. Drying Chambers, W. P. Thompson.—(*A Castellani, Germany.*)
11,070. Raising Hoods of Vehicles, W. P. Thompson.—(*E. Nardi, Italy.*)
11,071. Pneumatic Tires, J. C. Montgomerie, London.
11,072. Saddles for Velocipedes, J. C. Montgomerie, London.
11,073. Moistening Device, U. Buchenhorner, Liverpool.
11,074. Pneumatic Tires, P. H. Baily, London.
11,075. Production of Tartaric Acid, H. Rasch, London.
11,076. Treatment of Ores, A. M. Clark.—(*E. A. Ashcroft, Australia.*)
11,077. Friction Clutch, A. Peugeot, London.
11,078. Oil Engines, A. Peugeot, London.
11,079. Eye Covers for use of Marksmen, J. B. Lee, London.
11,080. Filter, J. A. Orme, London.
11,081. Producing Patterns on Fabrics, S. H. Sharp, London.
11,082. Stoves, J. E. Russell, London.
11,083. Removing Superfluous Brazing Material, H. E. Newton.—(*E. A. Hine, United States.*)
11,084. Tire for Cycles, R. Elsdon and J. F. Starkey, London.
11,085. Pen Nibs, T. W. Bowman, London.
11,086. Propelling Vessels by Steam Turbines, C. A. Parsons, London.
11,087. Adjusting the Hinged Parts of Plates, A. E. Paskell, London.
11,088. Igniters for Motors of Automotive Vehicles, P. F. Gans, London.
11,089. Stoppering Bottles, G. Elsley and R. Hill, London.
11,090. Crank, G. H. H. Shapter and T. A. Mulcahy, London.
11,091. Operating Chairs for Dentists, &c., C. F. Rutterford and F. Beauchamp, London.
11,092. Lock Nuts, A. Williams, London.
11,093. Apparatus for Aerial Suspension, &c., W. D. Bridger, London.
11,094. Combination with Floating Bodies, A. E. Narlian, London.
11,095. Relief of Atmospheric Pressure, G. J. Epstein, London.
11,096. Varying the Speed of Cycles, S. Frank, London.
11,097. Cooling Milk, R. A. Lister and G. E. Snoxell, London.
11,098. Cyclists' Companions, M. T. Sharp, London.
11,099. Tune-strips for Organs, A. A. M. Gavioli, London.
11,100. Incandescent Gas Burners, G. F. Redfern.—(*J. B. P. W. de Malberg, France.*)
11,101. Bicycles, B. A. Spaull and F. E. Spaull, London.
11,102. Vegetable Dishes, T. J. Shaw and A. Shaw, London.
11,103. Improved Solid Disinfectant, W. S. Duff, London.
11,104. Cabinet for Vapour Baths, J. and R. J. Foot, London.
11,105. Driving Gear for Cycles, A. T. Collier, London.
11,106. Incandescent Gas Lamps, A. H. Catherwood, London.
11,107. Pneumatic Tires, A. B. Shaw, London.
11,108. Securing Boats' Tillers, T. H. Stringer, London.

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11,109. Application of Artificial Fuel, C. Weygang, Hampshire.
11,110. Steam Traps, J. C. R. Okes and A. Stubbs, London.
11,111. Hot-water Kitchen Boilers, C. Boddy, Manchester.
11,112. Clarifying Fats, A. Beveridge and J. Pursell, Leith.
11,113. Joining Hollow Materials, J. Smithies, Cheshire.
11,114. Cycle Wheels, T. Duncan, Oldham.
11,115. Reducing Vibration in Vehicles, W. Pirrie, London.
11,116. Supporting, &c. Street Lamps, T. Redman, Bradford.
11,117. Cycle and the like Brakes, T. Redman, Bradford.
11,118. Tires for Wheels of Cycles, S. Bunting, Birmingham
11,119. Presses for Bricks, Tiles, &c., J. Jones, Loughborough.
11,120. Sunshade, O. J. and W. T. Pritchard, Shrewsbury.
11,121. Manufacture of Wheel Tires, T. Sloper, Devizes.
11,122. Bicycles, C. F. Owen, Manchester.
11,123. Pneumatic Tires, F. T. S. Hamilton, Liverpool.
11,124. Stoppering of Bottles, H. O. and J. O. Roberts, Gloucester.
11,125. Gelatine Pill Coating Machine, J. Cocks, Plymouth.
11,126. Cover Rests, T. C. Grant, Watford.
11,127. Producing Steel Tubing, J. Evans, Birmingham.
11,128. Spokes for Bicycle Wheels, J. Perceval, Birmingham.
11,129. Pneumatic Cushion Tire, W. M. Winby, Birmingham.
11,130. Tires or Fellies of Cycles, J. R. Taylor, Derby.
11,131. Railway Signalling, G. C. Purvis, Edinburgh.
11,132. Safety Appliances for "Wells," A. Walker, Halifax.
11,133. Decomposition of Liquids, G. and G. W. Bell, Liverpool.
11,134. Show Cases, E. H. Scott and F. Scott, Bradford.
11,135. Machines for Making Cigars, D. W. Bullard, Manchester.
11,136. Extracting Grease, E. C. Mills and J. G. Chamberlain, Manchester.
11,137. Colour Printing, A. R. Byles, G. Allan, and J. Saville, Bradford.
11,138. Making Plastic Objects from Fibrine, L. Grote, London.
11,139. Improved Coking Stokers, J. Proctor, Manchester.
11,140. Machines for Cleaning Fruit, C. Duckworth, Manchester.
11,141. Rope Ways, J. and E. Wright, Ltd., and W. E. Hipkins, London.

11,142. Reducing Vibration in Vehicles, M. Bliss, London.
11,143. Tires of Wheels, T. H. Ramsden, Leeds.
11,144. Golf Club Grips, J. D. Dunn, Bournemouth.
11,145. Toilet Requisite for Cyclists, &c., J. Cook, London.
11,146. Polishing Floors, R. Leighton and J. C. Ferguson, London.
11,147. Clasps for Mooring Purposes, R. H. Francis, London.
11,148. Chain Wheels, J. Hollis, London.
11,149. Rims for Pneumatic Tires, W. Y. Lambert, London.
11,150. Ball Bearings, E. Rother, London.
11,151. Brake for Vehicles, E. Rother, London.
11,152. Driving Gear for Velocipedes, J. Tourtel, London.
11,153. Device for Fastening Corsets, &c., G. Frank, London.
11,154. Pneumatic Tires, G. G. Picking and W. Hopkins, London.
11,155. Cycle Cranks, H. L. Todd and F. W. McClellan, London.
11,156. Hydraulic Motor or Break, W. F. Bower, London.
11,157. Gearing for Velocipedes, M. Boudard and H. A. Shelton, London.
11,158. Locks for Cycles, E. H. Jones and G. Young, London.
11,159. Improved Inkpot for School Desks, L. Bohm, London.
11,160. Obtaining Pure Alumina, &c., S. J. Payne, London.
11,161. Moulds for Confectioners, J. G. Ingram, London.
11,162. Electric Alarm Apparatus, F. W. Golby.—(*H. Winter, ——.*)
11,163. Cycle Spring Tires, S. H. Hurst and H. G. Hayes, London.
11,164. Clarifying Beer, &c., A. A. Hollander, London.
11,165. Sun-dial, R. C. Thompson and C. A. Bury, London.
11,166. Perfume, J. C. Mewburn.—(*The Chemische Fabrik von Heyden Gesellschaft mit Beschraenkter Haftung, Germany.*)
11,167. Preparing Surgical Dressings, B. R. Seifert, London.
11,168. Automatically Discharging Liquids, The Iron Ring Inventors Syndicate and H. H. Johnson, London.
11,169. Automatically Discharging Liquids, The Iron Ring Inventors' Syndicate and H. H. Johnson, London.
11,170. Automatically Discharging Fluids, The Iron Ring Inventors' Syndicate and H. H. Johnson, London.
11,171. Lever Chains, W. S. Simpson, London.
11,172. Slate Pencil Sharpeners, F. A. Miller, London.
11,173. Fireplaces, F. Hughes, London.
11,174. Printing Labels, W. Holmes, G. Penny, J. Hodgson, jun., and the Ulverston Shutter and Lift Company, Ld., London.
11,175. Pulleys, Taylor and Challen, Ld., and S. W. and W. B. Challen, London.
11,176. Boilers for Heating Water, J. Chambers, London.
11,177. Refrigerating Machines, A. McVicar and W. K. White, London.
11,178. Bicycles, H. J. Edwards, London.
11,179. Closing Mouths of Jars, W. Willis and W. H. Smith, London.
11,180. Billiard Table Cushion, H. W. Silver and W. F. Teignmouth-Shore, Sidcup.
11,181. Cycle Pedal Cranks and Handle-bars, E. Robb, London.
11,182. Preparing or Treating Wood, W. P. Thompson, Liverpool.
11,183. Feeding Scutching Machines, S. H. Brooks and W. Frost, Manchester.
11,184. Bottle Stoppers, C. E. Eaton, Liverpool.
11,185. Paging and Numbering Machines, J. S. Barclay, Manchester.
11,186. Cycle Locks, C. F. S. Wright, Liverpool.
11,187. Boxes, R. Ripley, Liverpool.
11,188. Printing Waterproof Fabrics, S. Wiener, Manchester.
11,189. Attachment for Bicycles, F. R. Martin, Liverpool.
11,190. Pneumatic Tires, A. F. Beach and E. Chappell, London.
11,191. Inflator, G. Ramsay, London.
11,192. Scarf Pins, Hat Pins, &c., F. Fosheim, London.
11,193. Bicycles, W. C. Burbank, London.
11,194. Bicycles, J. B. Ingalls, London.
11,195. Bottles, E. A. Sanders, London.
11,196. Shade Supports, E. O. Steele, London.
11,197. Materials for Debasing Alcohol, J. E. Lang, London.
11,198. Petroleum Gas Lamps, O. Imray.—(*M. Sievert, Sweden.*)
11,199. Safety Appliances for Rack Railways, R. Abt, London.
11,200. Tires, D. C. Defries, London.
11,201. Cartridge Cases, H. Imray.—(*La Compagnie Anonyme des Forges de Chatillon et Commentry, France.*)
11,202. Coin-freed Fluid Meters, J. F. Simmance, London.
11,203. Waste or Slop Water-closets, A. Hocking, London.
11,204. Adjustable Spanners, L. A. Parrock and B. Waldron, Birmingham.
11,205. Motor Driven Vehicles, E. J. Pennington, London.
11,206. Binding and Exhibiting Maps, S. Curwen, London.
11,207. Cornice Pole Rings, R. and H. F. Phillips, London.
11,208. Shaft Bearings, L. Worthington and J Soar, London.
11,209. Vaporisers for Petroleum Engines, O. Bomborn, London.
11,210. Polishing Compositions, H. L. Haas, London.
11,211. Fastening Cords and Ropes, H. C. Corbidge, London.
11,212. Dry Cells for Galvanic Batteries, T. Clark, London.
11,213. Rolling Furnace Flues, W. F. Suddaby and the Leeds Forge Company, Ld., London.
11,214. Tires, H. S. Maxim, London.
11,215. Driving Note Discs in Accordions, R. Wünsch, London.
11,216. Electro-chemical Apparatus, C. Dawson.—(*F. Manza, Austria.*)
11,217. Wheels, E. Robson, H. Willford, and T. D. Stagg, London.
11,218. Rendering Tires Non-collapsible, W. L. Mansfield, Cork.
11,219. Sinking Pits, W. Morgans and R. A. Thomas, London.
11,220. Lamp Chimneys, W. B. Fitch, London.
11,221. Cycles having Pneumatic Tires, W. B. Fitch, London.
11,222. Marking Bank Drafts, &c., W. C. Sellar, London.
11,223. Marking Bank Drafts, &c., W. C. Sellar, London.
11,224. Acetylene Lamps, W. C. Sellar, London.
11,225. Lid for Baskets for Fruit, F. le Poidevin, London.
11,226. Operating Variable Speed Gear, A. Peugeot, London.
11,227. Stop Valves for Gas and Steam, C. Wehner, London.
11,228. Velocipedes, W. Welford, London.
11,229. Actuating Stamping Machines, W. E. Downs and H. J. Scott, London.
11,230. Electrical Regulating Apparatus, H. Pieper fils, London.
11,231. Tool Bag or Wallet for Cycles, E. Labenz, London.
11,232. Current Conducting Apparatus, C. F. P. Stendebach and O. H. Linker, London.

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11,233. Working Signals, Hurst, Nelson, and Co., Ld., and G. T. Wheatley, Glasgow.
11,234. Apparatus for Carrying Glass, J. J. Spear, Portsmouth.
11,235. Driving Mechanism for Vehicles, E. B. Fenby, Birmingham.
11,236. System of Sewer Ventilation, S. S. Allin, London.
11,237. Portable Poultry Houses, H. J. F. Rose, Dunstable.
11,238. Mud Scraper for Brushes, R. T. Hewlett, London.
11,239. Governing Engines, J. Maxton and A. L. Jones, Belfast.
11,240. Controlling the Legs of Step Ladders, E. Hart, Bristol.
11,241. Rust Preventer, W. Preston and F. D. Docker, Birmingham.
11,242. Cement, J. Walker, Derby.
11,243. Purifying Sewage, E. W. T. Jones and J. Garfield, Wolverhampton.
11,244. Weight Indicators for Carts, J. H. Butler, Wolverhampton.
11,245. Galvanising Metal Sheets, Davies Brothers and Co., E. A. Davies, and S. T. Thomas, Wolverhampton.
11,246. Tumbler Glasses, A. Walker, Halifax.
11,247. Traction Engines and Motor Cars, O. Thom, Manchester.
11,248. Pipe Flanges, F. A. Jones and J. Constabie, Birmingham.
11,249. Electric Car Driving Apparatus, W. Griffin, Halifax.
11,250. Pipe Vices, F. Bosshardt.—(*Blau and Co., Austria.*)
11,251. Cycle Tire, R. N. Redmayne, Newcastle-on-Tyne.
11,252. Tires, R. R. Gubbins, London.
11,253. Mud Guards for Cycles and Vehicles, T. Ellis, Nottingham.
11,254. Sounding Board, C. F. and K. Stahlecker, London.
11,255. Cycle, &c., Tires, T. Chappell and H. Smith, Sheffield.
11,256. Brakes for Bicycles and Tricycles, W. Tapp, Bristol.
11,257. Driving Fibres into the Pins of Circular Combs, H. R. Wickins, F. L. Speight, and J. H. Exley, Bradford.
11,258. Stacking Hay, C. Grieves and J. H. Davies, Bristol.
11,259. Ball-bearing Nest for Axles, R. F. Hall, Birmingham.
11,260. Machinery for Manufacturing Seamless Steel Tubes, R. F. Hall, F. Warwick, and T. Smith, Birmingham.
11,261. Distributor for Agricultural Purposes, T. C. Sargeant, Northampton.
11,262. Artificial Light Photography, C. E. Elliott, London.
11,263. Applying and Removing Tires, A. A. Vérel, Glasgow.
11,264. Ball Pneumatic Tire for Cycles, A. Pardon, London.
11,265. Fasteners for Ladies' Waist Belts, W. Pearce, Birmingham.
11,266. Tires for Cycles and Vehicles, A. A. Vérel, Glasgow.
11,267. Producing Acetylene Gas, T. Thorp and T. G. Marsh, Manchester.
11,268. Producing Acetylene Gas, T. Thorp and T. G. Marsh, Birmingham.
11,269. Charging Gas Generators, T. Thorp and T. G. Marsh, Manchester.
11,270. Cycle Handle, J. F. Phillips and A. E. Pennington, Leigh.
11,271. Pneumatic Tires, W. Turner, London.
11,272. Unicycles, C. T. Craig, London.
11,273. Pneumatic Tires, A. Norreys, London.
11,274. Knitting Machines, W. Buckler, D. Routledge and Co., and O. Kerr, London.
11,275. Smokeless Gunpowder, T. Hawkins, J. W. Carr, and A. Wellby, London.
11,276. Pedal Cranks for Velocipedes, M. Ryan, London.
11,277. Forced Draught Apparatus, J. K. Broadbent, Manchester.
11,278. Lawn Tennis, &c., Nets, T. P. Howard, Manchester.
11,279. Heating Boilers and Furnaces, S. Pointon, Manchester.
11,280. Register, &c., Fire-grates, S. Pointon, Manchester.
11,281. Looms, R. L. Hattersley and S. Jackson, Bradford.
11,282. Cotton Carding Machinery, T. R. Marsden, Manchester.
11,283. Cotton Carding Machinery, T. R. Marsden, Manchester.
11,284. Instantaneous Steam Generators, J. H. Knight, Farnham.
11,285. Cycle Gear Cleaner, J. Wilcock and A. Bradley, Manchester.
11,286. Excavating Machinery, E. B. Butler and J. Pearson, London.
11,287. Puncture Proof Shield, I. Hayes, Runcorn, Cheshire.
11,288. Method of Advertising in Railway Lavatories, F. J. Caygill and J. Stephenson, Newcastle-on-Tyne.
11,289. Inflating Tires, W. and J. R. Brocklebank, Manchester.
11,290. Making Tires for Cycles, &c., J. C. B. Taylor, Bath.
11,291. Boat Propelling Apparatus, A. G. Ramage, Leith.
11,292. Valves, J. H. Carruthers and H. Brier, Glasgow.
11,293. Feed-water Heaters, Babcock and Wilcox, Ld., and W. Reavell, Glasgow.
11,294. Adjustable Wrench, T. Armstrong and J. Frankling, London.
11,295. Joint for Pipes and Tubes, G. M. Bowen, Birmingham.
11,296. Artificial Limbs, S. D. Leeper, Liverpool.
11,297. Block for Manipulaling Butter, E. Jones, Birmingham.
11,298. Wheels for Cycles and Carriages, J. Hamblet, London.
11,299. Rims and Tires of Cycles, &c., J. Barclay, London.
11,300. Brush for Fastening Revoluble Brushes to their Spindles, L. Bradshaw and C. Whitfield, London.
1 ,301. Coiled Tubular Boilers, E. N. Beszant and The Swiftsure Safety Kitchen Boiler Company, Liverpool.
11,302. Drains and Sewers and Pipes, A. Whittaker, London.
11,303. Linoleum and Floor Covering, W. Oppenheimer, London.
11,304. Wheels, J. Favets, London.
11,305. Tires, S. Pattisson, London.
11,306. Photograph Developing Solution, J. Hauff, London.
11,307. Gas Engines, J. Doy, London.
11,308. Finishing Type, T. W. Smith and R. Chitson, London.
11,309. Colouring Matters, Read, Holliday, and Sons, Ld., and H. Dean, London.
11,310. Brakes, W. C. and J. H. Punchard, and W. and I. Darby, London.
11,311. Pads for Polishing Purposes, &c., D. Scott, London.
11,312. Night Light Cases, G. C. and M. B. Fowler, London.
11,313. Vaporising Burners, A. J. Boult.—(*G. Bartel, Germany.*)
11,314. Steering Gear for Bicycles, J. Monteith, London.
11,315. Bogies for Railway Vehicles, I. A. Timmis, London.
11,316. Window and Skylight Blind, A. J. B. Squire, London.
11,317. Tins for Preserved Milk, &c., J. W. Palmer, London.
11,318. Locks, R. Friberg, London.
11,319. Studs, Links, &c., G. Caryl and T. H. Hooper, London.
11,320. Electric Railway Signals, W. M. Klees, London.
11,321. Cooling Water, D. Halpin, J. B. Alliott, and L. Sterne, London.
11,322. Mattresses, &c., O. Imray.—(*C. S. Hurd, France.*)
11,323. Apparatus for Serrating Materials, E. C. Blackett, London.
11,324. Velocipede and other Saddles, J. F. Rees, London.
11,325. Machine for Pointing Pencils, K. Pintz, London.
11,326. Manufacture of Cyanides, E. A. and J. F. C. Williams, London.
11,327. Heating Retort, E. A. and J. F. C. Williams, London.
11,328. White Lead, D. Urquhart and J. M. Small.—(*L. H. Despeissis, France.*)
11,329. Surgical Needles, W. D Calvert and W. C. Weight, London.
11,330. Tires, A. A. Furst, London.
11,331. Improved Pneumatic Tires, H. A. Couchman, London.
11,332. Inflatable Tire for Cycles, M. A. Wier, London.
11,333. Chains, M. A. Weir, London.
11,334. Inflatable Horse Collars, W. J. Coupland, London.
11,335. Appliances for Driving Cycles, J. J. Rathbone, London.
11,336. Ball Bearings, W. R. Smith, London.
11,337. Musical Instruments, W. Heilbrunn and S. Blüth, London.
11,338. Electrodes for Electrolytic Purposes, E. A. G. Street, London.
11,339. Gas Lamps, T. Gordon and W. R. Swift, London.
11,340. Clutches, I. Björnstad and E. Anderson and Goolden, Ltd., London.
11,341. Vehicles, C. A. Faure, London.
11,342. Vehicles, C. A. Faure, London.
11,343. Fasteners for Belts, H. T. How and W. Pearce, Birmingham.
11,344. Elastic Tires for Wheels, W. H. Trimble, London.
11,345. Apparatus for Mixing Liquids, A. Gates, London.
11,346. Stacking Apparatus, O. E. Adolph, London.
11,347. Hydrocarbon Motors, E. Wiseman and J. Holroyd, London.
11,348. Spring Hooks, H. W. Ley and A. G. Bagot, London.
11,349. Cyclometers, R. M. Marples.—(*Seth Thomas Clock Company, United States.*)
11,350. Incandescent Mantles for Gas Lamps, J. H. H. Duncan and D. W. Sugg, London.

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11,351. Rotary Engines, W. Hayward, London.
11,352. Non-collapsible Tires for Cycles, W. Pennington, Belfast.
11,353. Supplying Cotton to Scutchers, W. J. Orr and S. Walmsley, Manchester.
11,354. Automatic Game and Pheasant Stop, R. T. H. Somerset, Monmouthshire.
11,355. Pneumatic Tires of Cycles, F. Richmond, Burnley.
11,356. Brake Mechanism for Velocipedes, A. Munro, Glasgow.
11,357. Manufacture of Drive Chain, J. C. Rollason, Birmingham.
11,358 Flexible Tires, M. J. Adams, Leeds.
11,359. Garden Tent, W. S. Coppin, London.
11,360. Construction of Pneumatic Tires, I. Lenehan, Dublin.
11,361. Mowing and Reaping Machines, T. Eddleston, Blackburn.
11,362. Cycles, W. A. Comber, Ilfracombe.
11,363. Appliances for Lubricating Axles, T. Cook, Sheffield.
11,364. Purification of Syrups, J. D. Scott and A. Smith, Glasgow.
11,365. Combined Envelope and Blank Letter, E. W. Margetts, Stourbridge.
11,366. Direct Acting Steam Pumps, &c., J. Weir, Glasgow.
11,367. Springs for Wheeled Vehicles, G. Johnston, Glasgow.
11,368. Chairs, J. Davies, London.
11,369. Boring Holes, J. and W. Jones, Halifax.
11,370. Production of Colouring Matters, Read, Holliday, and Sons, and J. and J. Turner, London.
11,371. Scouring Wool, W. R. Jones.—(*T. A. Jones and D. Gibb, Australia.*)
11,372. Water-closets, J. Shanks.—(*T. van Heemstede Obelt, Holland.*)
11,373. Bracket for Lamps, W. J. Ward, Newcastle-on-Tyne.
11,374. Tires for Cycles, J. N. Peake, Longport, Staffordshire.
11,375. Rims of Wheels of Cycles, J. A. Williamson, Glasgow.
11,376. Driving Mechanism for Cycles, A. M. Arter, London.
11,377. Shape of Pneumatic Tires, J. A. Hennessy, Limerick.
11,378. Wheel Rim for Cycles, W. D. Mastaglio, Newcastle-on-Tyne.
11,379. Head Lock for Cycles, A. T. Blood, Huntingdonshire.
11,380. Securing the Cords of Window Sashes, J. Gibson, Glasgow.
11,381. Machine for Basting Meat, A. C. Hall and J. Malcolm, Glasgow.
11,382. Keyless Money Box, R. Hird and J. Underwood, Barrow-in-Furness.
11,383. Construction of Cycles, P. Bendall, Cheltenham.
11,384. Chimney Pots, G. W. Taylor, Rawtenstall, Lancs.
11,385. Cocks for Regulating Gas Lights, J. E. Rogers, Birmingham.
11,386. Sectional Water-tube Boilers, H. McIntyre, Glasgow.
11,387. Railway Signal Apparatus, A. G. Horne, Glasgow.
11,388. Covers for Books and Albums, A. Martyn, London.
11,389. Process of Beating, &c., Syrup, J. Werner, London.
11,390. Marking Sheep, H. W. Potter and S. Frankel, London.
11,391. Cut-outs for Electrical Uses, J. C. Reynolds, Wolverhampton.
11,392. Fastening for Down-spouts, E. T., L., and E. Fletcher, Wigan.
11,393. Road Locomotives, &c., J. G. Inshaw, Birmingham.
11,394. Lasting Clog Uppers, E. Lee, London.
11,395. Pneumatic Tires, P. A. Horrocks, London.
11,396. Ore Crushing Machinery, G. Bowman, London.
11,397. Finishing Inlaid Linoleums, W. G. Thomson, London.
11,398. Lifting Jacks, W. C. Crawford, London.
11,399. Tramcar Fenders, P. Jones, London.
11,400. Two-wheeled Vehicle Brake, M. J. Oliver, Cornwall.
11,401. Valve for Pneumatic Tires, T. J. Harris, Birmingham.
11,402. Sprocket Wheel, H. L. Todd and F. W. McClellan, London.
11,403. India-rubber Mats, &c., W. C. Cunningham, Preston.
11,404. Gear Cases, W. H. Corker and S. J. and E Fellows, Ld., Birmingham.
11,405. Handle Bars for Bicycles, G. A. Phillips Birmingham.
11,406. Securing Tires to Rims of Wheels, J. Adair, Waterford.
11,407. Toy, J. Savreux, Brussels.
11,408. Lubricating Stuffing-boxes, J. B. Davis, London.
11,409. Rotary Boot Trimming Machine, A. S. Vose, London.
11,410. Trimming and Randing Boots, A. S. Vose, London.
11,411. Construction of Gas Pendants, G. F. Ostins, London.
11,412. Scarves, I. Boyd, Lanark.
11,413. Telephones, J. C. Chalmers, Glasgow.
11,414. Signalling Apparatus, J. F. Barker, Glasgow.
11,415. Apparatus for Cleaning Ships, P. Reilly, London.
11,416. Lubricators, J. J. Kennedy, London.
11,417. Connecting Rails, R. C. Brown and F. E. Huntress, London.
11,418. Stop Valve for Gases, &c., O. Brunler, Berlin.
11,419. Lighting Lamps, H. D. Fitzpatrick.—(*The Empire Self-Lighting Oil Lamp Company, United States.*)
11,420. Motive Power Engines, J. Lewthwaite, London.
11,421. Dynamos and Electromotors, J. D. F. Andrews, London.
11,422. Propelling Boats, &c., J. and J. B. Swallow, London.
11,423. Elastic Tires for Velocipedes, W. Carter, London.
11,424. Aerial Machines, R. Wesch, London.
11,425. Adjustable Partitions for Drawers, L. Conant, London.
11,426. Saddles for Bicycles and Tricycles, P. Turner, London.
11,427. Twisting and Winding Yarns, Count C. de Rossetti, London.
11,428. Cooking Eggs, F. E. V. Baines, London.
11,429. Electric Brakes, The British Thomson-Houston Company, Ltd.—(*W. B. Potter, United States.*)
11,430 Pumps for Pneumatic Tires, &c., W. Cross, London.
11,431. Tires for Velocipedes, &c., H. W. Tyler, London.
11,432 Steering Handle for Velocipedes, C. Farmer, London.
11,433 Regenerative Gas Furnaces, F. Siemens, London.
11,434. Automatically Closing Door, A. B. von der Ropp, London.
11,435. Springs for Saddles, &c., F. J. Esmond, London.
11,436 Cycles, T. Watson, London
11,437. Gasogenes, J. C. Mewburn.—(*H. Carrière and A. Vazou, France*.)
11,438. Prismatic Piston Valve, J. J. Campbell, London.
11,439. Portable Apparatus for Writing, J. Pool, London.
11,440. Antiseptic Cleansing Device, M. Frisch, London.
11,441. Electric Arc Lamps, T. E. Adams, London.
11,442. Steam Engines, A. Hoe, London.
11,443. Cocks, Faucets, and other Valves, W. Heston, London.
11,444. Combined Weight and Cost Indicating Apparatus for Spring Balance Scales, &c., The Combined Weight and Cost Indicating Scale Company, Limited, H. J. Wood, and W. Thomson, London.
11,445. Toy Pumps, J. T. Lawrence, London.
11,446. Boxes for Transporting Butter, &c., G. Pontin and Pontin's Patent Butter Box Company, London.
11,447. Lambs' Wool or Slipper Sole, S. Borchardt, London.
11,448. Barrel Machine, W. T. Vale and A. Buntin, London.
11,449. Producing Lithographs, W. G. Rochester and S. E. la Ronde, London.

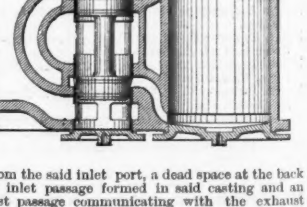
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

555,508. Steam Locomotive, *W. P. Henszey, Philadelphia, Pa.—Filed November 15th*, 1895.

Claim.—The combination in a locomotive cylinder, of the casting having a cylindrical valve chest, a central inlet port for live steam, exhaust ports at each end of the valve chest and ports leading to the cylinder mid-way between the inlet port and exhaust ports, a central inlet passage formed in said casting and extending from the said inlet port, a dead space at the back of the inlet passage formed in said casting and an exhaust passage communicating with the exhaust ports and situated back of the dead space so that the steam inlet passage is separated from the exhaust passage, substantially as described.

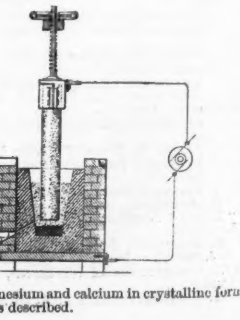
555.508



555,796. Compound of Magnesium, Calcium, and Carbide, *C. Whitehead, Washington, D.C.—Filed December 30th*, 1895.

Claim.—(1) The double carbide of magnesium and calcium, substantially as described. (2) The double carbide of magnesium and calcium in crystalline form substantially as described.

555.796



THE NATIONAL ELECTRICAL EXHIBITION AT NEW YORK.

The Electrical Exhibition held at New York during the month of May, 1896, under the auspices of the National Electric Light Association, was large and successful. More than this, it included some of the latest important applications of electricity, and was fairly representative of the various scientific and commercial applications of electricity, with one important exception. This exception was the electric railway, the exhibits in this department being confined to a couple of truck frames for electric cars, one or two electric rail bonds, and some line fittings. This deficiency of the Exhibition was particularly surprising and regrettable, in view of the great extent of electric railways and the great amount of money and inventive skill expended in their equipment and improvement. There was a very complete historical exhibit, and the popular interest was catered for by the exhibits of Roentgen ray phenomena, vacuum tube lighting, &c., and by conveying the "roar of Niagara" by telephone. To persons who have heard the steady pulsating roar of the great cataract this was very interesting. The receiver was placed at the foot of the American fall, being shielded from the flying spray.

The display of lamps was very large, ranging from the tiny bulbs used in dentistry and surgical work for illuminating the interior of the mouth, throat, or other organs, to the various sizes and styles of incandescent lamps for ordinary lighting and decorative purposes, and the large arc lamps for street lighting. Many of these latter had opal or clouded globes entirely enclosing the carbon and apparatus, preventing the unpleasant and dazzling effect of the arc, and burning very steadily. The Brush Electric Company showed three of its old machines as matter of interest. The first was the first Brush arc dynamo which was sold in 1877, and used steadily for twelve years. The second was a 16-light 2000-candle power arc dynamo, which was run by the Fulton Worsted Mills from September 1st, 1879, to April 10th, 1892; and the third was a 40-light dynamo operated by the Berkeley Mill Company from December 1st, 1881, to May 19th, 1893. These two latter machines were bought from the users by the Brush Company to be exhibited at the Chicago Exhibition of 1893, and they were exhibited at New York just as they left the factory. This company's working exhibit included arc dynamos of 80, 100, and 125-light dynamos, and double arc lamps. The 80-light dynamo was connected direct to a 60-kilowatt 220-volt motor, the machine running with its load of eighty lights—of 2000-candle power—with a difference of potential not exceeding 1500 volts between any part of the machine or circuits, the machine maintaining its automatic regulation. In other words, it is a division of an internal and an external circuit of an arc dynamo into three circuits, with a difference of potential not exceeding one-third of the total load on the dynamo. These three circuits were run direct from the terminals of the dynamo, and on any one of these circuits the voltage will not exceed 1500 volts, or on which there will not be more than twenty-seven lights. The circuits may be run from the switchboard, and can be thrown together in any combination if desired. The greatest potential around the dynamo or circuit will be that of the greatest circuit. The dynamo will run its full capacity with any distribution of load on the different circuits. Three-fourths of the load may be run on any one circuit, and one-fourth divided up between the other two, or all the load may be run on any one circuit. The advantages claimed are the flexibility of handling the circuits, the reduction of high voltages on circuits run from large dynamos, and the use of large units with corresponding increase in efficiency, saving in floor space, belting, &c.

The Edison Electric Illuminating Company showed the Van Vleek edgewise regulating system, with dynamo switches, regulators, ampère meters, volt meters, and controlling apparatus feeder. Current for this exhibit was supplied to the feeder switchboard from the company's street mains and from a storage battery, illustrating the use of such batteries in Edison stations. From the switchboard the current passed through a feeder tube—as used in the streets—to a feeder box, thence to a distributing box and a street main to a service box such as placed on a consumer's premises. Next to the feeder box was a new controllable box by which a tie-feeder can be divided from the station into distributing feeders. From the service box the current was carried through on Edison chemical meter—as usually placed on the consumer's premises—and a Thomson-Watt meter, and was then distributed as it would be in a house, showing its practical application for heating rooms, lighting, cooking, running sewing machines and dental machinery, &c. This company has now six stations in New York—one of which has generators of 800 kilowatts—supplying 6000 customers, with about 300,000 incandescent lamps, 3700 arc lamps, and 15,000-horse power for power and miscellaneous purposes. The company also showed two of its double-light ornamental poles, with Edison-Bowker lamps, as used in Fifth Avenue.

The General Electric Company exhibited, among other things, the Thomson constant potential arc lamps for direct current incandescent, power and railway, and alternating current incandescent circuits. The direct current lamps for incandescent circuits are run two in series on nominal 110-volt circuits. The standard current is 9 ampères with 44 volts at the arc. The extra voltage is taken up by a resistance which is placed in series with the arcs. Lamps are made for 4, 5, or 7 ampères, or any current up to 20 ampères. The railway lamp is intended for use on direct current power and railway circuits, and the number of lamps to be placed in series depends on the minimum potential of the line for any considerable time at the point where branch is taken off. With the carbons furnished, each lamp with its proportional part of resistance takes 50 volts; therefore, ten lamps can be run from a circuit whose minimum potential is 500 volts, and four lamps from a 220-volt circuit. An adjustable rheostat is placed in each series of lamps. Each railway lamp is provided with an automatic cut-out to prevent breaking the 500-volt current, should the carbons be burned short or the arc extinguished from any cause. The cut-out, in operating, substitutes for the arc a resistance which is carried on the chimney, and which assists in preventing an excess of current. Not more than two lamps out of ten, however, should be out at the same time, for in this case the current will unduly increase and the waste energy become excessive. A prominent feature claimed for this lamp is its ability to operate satisfactorily during considerable changes of potential on the line.

The alternating current lamp is placed directly on the transformer or compensator circuit, and under normal conditions no extra resistance is included in the circuit. The feeding mechanism is regulated wholly by the main current, and there are no potential coils. All of these lamps are made either plain or ornamental in various styles and sizes.

The applications of power were numerous and varied. including pumps, fans, heavy machine tools, passenger elevators—or lifts—printing presses, &c. The Niles Tool Works showed drilling and planing machines, and special machine tools for street railway repair and construction shops, all operated by electric motors mounted on frames. The Crocker-Wheeler Electric Company, which employs electric motors for driving all its tools and machinery—as described in The Engineer—included an electric hoisting engine in its exhibit. Pumps driven by electric motors were shown by the General Electric Company—using a Knowles pump—and by the Worthington and Goulds Pump Manufacturing Companies. The Goulds Pump Manufacturing Company has at Canandargna two triplex pumps of 1,000,000 gallons daily capacity, each driven by an induction motor of 100-horse power, using the three-phase system over a transmission of 3½ miles. It has also supplied an electric pumping plant for the waterworks of De Kalb and Memphis, the latter having a daily capacity of 500,000 gallons. Smaller pumps are used in mines, office buildings, &c.

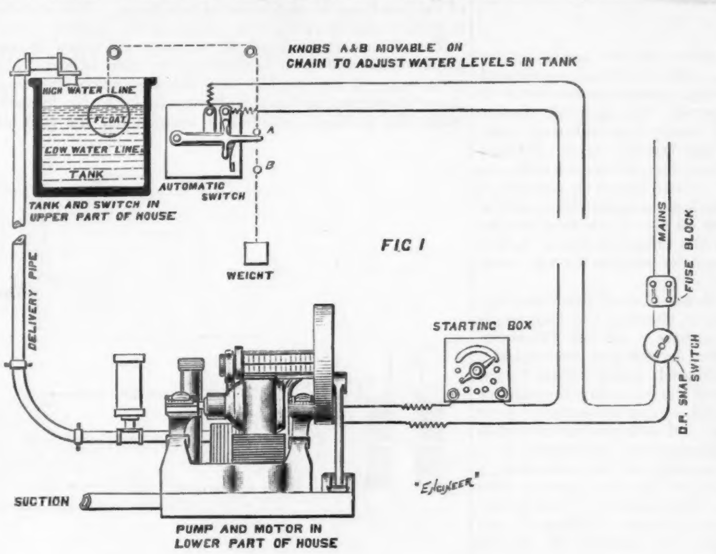


FIG I

The Worthington electric pump is specially intended to supply the reservoir tanks of high office buildings or residences, where the pressure carried on the city main is not sufficient to elevate water above the lower stories. It is made in two sizes of 250 and 500 gallons capacity per hour respectively, has a limited number of working parts, and requires little or no attention when once installed. A special feature is the absence of gears, the motor being connected to the pump entirely by belt, thus avoiding the noise usually caused by gearing. The plunger is differential, displacing equal quantities of water on both the up and the down stroke; and as the normal speed of the pump shaft is 200 revolutions per minute, the result is an even and regular flow of water through the discharge pipe. Another advantage of the differential plunger is that it equalises the work, throwing a constant load on the motor. The actual amount of power consumed varies between ½-horse power and 1-horse power, depending upon the head pumped against. The diagram—Fig. 1—shows the method of wiring the motor, and an automatic controlling device for stopping and starting the pump. This arrangement insures a supply of water always ready for immediate use. The operation, briefly described, is as follows. A regular hand rheostat is placed in the main circuit, one wire being first led through a snap switch located in some convenient place near the tank. Suppose the pump to be running delivering water into the tank, the float rises until the knob A comes in contact with the lever of the switch, when the suspended weight snaps it open, breaking the circuit and stopping the pump; when the float descends, owing to water being drawn from the tank, the knob B comes in contact with the lever, closing the switch and again starting the pump. By adjusting A and B, any desired water level may be maintained. Worthington pumps suitable for all services are built to be driven by electric motors; and special designs have been made to cover the requirements of hydraulic elevator service, mine service, waterworks supply, irrigation purposes, fire protection, or, in short, any service where electric motive power can be used to advantage.

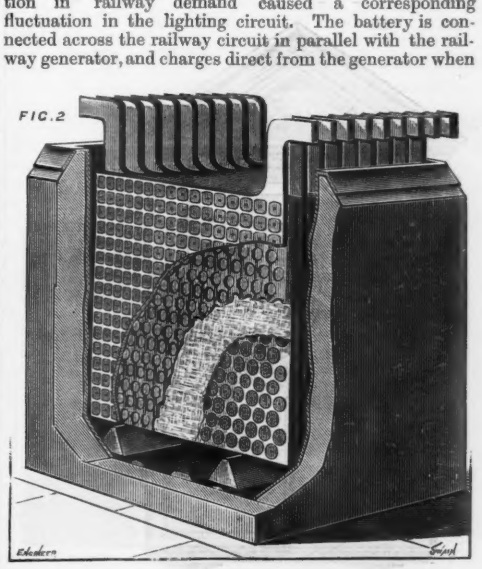
The development and introduction of storage batteries has been greatly hindered by litigation over the various patents, but within the past few years the Electric Storage Battery Company has acquired the patents and patent rights formerly owned and controlled by some twelve companies, and now has the sole right to supply in the United States storage batteries of all the important types, which enables it to supply the type of battery best suited to individual cases. This company is the sole manufacturer of the chloride accumulator, which has been largely introduced for large installations in power plants, and has also been applied for motor carriages and yachts. The company exhibited a handsome launch fitted with batteries supplying current for a little motor under the floor, which drives the screw. It also exhibited a four-wheel carriage on the Morris and Salom system, which has been described by The Engineer in connection with the Chicago competitive runs last year.

In regard to the application of storage batteries at central power stations, it may be noted that the Twelfth-street station of the Edison Electric Illuminating Company has a battery of 150 cells of 4000 ampère hours capacity, installed 75 on each side of the three-wire system, giving a total capacity of 8000 ampère hours at 130 to 150 volts. It is capable of being discharged at a very rapid rate, viz., 4000 ampères. The battery is installed just about the centre of the network of mains, and is also in direct communication with the principal generating stations. This enables it to be used for a variety of purposes, namely: (1) To assist during the hours of heavy load after being changed from any station which is working on a light load; (2) to act as a regulator all the time—in fact, never being cut off the system; (3) to supply the entire output during hours of light load from one or more stations, thus enabling them to be shut down and operated with two shifts of labour instead of three.

In the Edison station at Lawrence a storage battery of 140 cells of 800 ampère hours capacity is installed on the three-wire system, giving a total capacity of 1600 ampère hours. This battery is chiefly used to carry the peak of the load for two hours daily, and has saved the installation of more generating machinery to meet an increased output, and at the same time has not increased the coal consumption perceptibly. It is also used continuously as a regulator, and to carry the entire load during the greater part of Sunday. At the Germantown Electric Light Station the entire day load is carried by a storage battery, which is charged during the hours of light load after midnight. Before the battery was used the generating plant was run for twenty-four hours continuously, the day load being carried at a loss. After the battery was installed this loss was entirely wiped out and a profit obtained.

Some time ago the Electric Light and Railway Company, at Merrill, installed a plant of 240-type eleven "F" chloride accumulators — capacity 500 ampère hours at 50 ampère rate—in order to increase the lighting capacity and also to regulate the voltage on the railway circuit, as the light and railway dynamos are connected to the same system of shafting and water-wheels, so that every fluctuation in railway demand caused a corresponding fluctuation in the lighting circuit. The battery is connected across the railway circuit in parallel with the railway generator, and charges direct from the generator when current is not required for running the cars, and discharges on the railway circuit when the demand is greater than the generator can supply. So instantaneous is this action, that the power required to operate the generator is practically constant, and thus the light voltage, which, before the battery was installed, varied constantly—sometimes as much as nine volts on each side the three-wire system—is now perfectly steady. This battery has sometimes been called upon to operate the railway for a day at a time, without assistance from the generator. It has capacity for supplying 400 incandescent lamps of 16-candle power for ten hours, or 600 lamps for a shorter

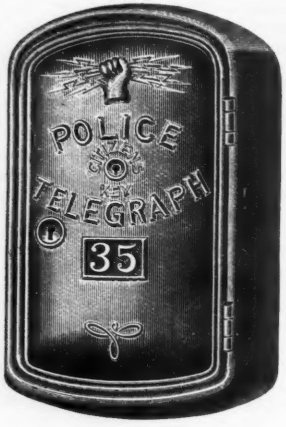
FIG.2



period, and can be utilised for part of the lighting load, thus relieving one of the water-wheels at the power house of lighting duty, so that it can be disconnected from the lighting shaft and solely used for the railway generator. One of the large type "G" batteries, as used in station work, is shown in Fig. 2. It has forty-one plates, 15½in. square, and the cell is 28in. high, the weight with 260 lb. of acid, lead lined tank &c., being 1220 lb. The tank is 21½in. long and 37¾in. wide.

The Electric Storage Battery Company has recently equipped storage battery cars, which are now being operated with success in New York. Instead of placing the batteries under the seats, they are carried on the truck frame, supported on a tray placed between the two axles. With this arrangement the car bodies may be made lighter than was formerly possible. The electrical equipment consists of sixty cells of battery, grouped in two series of thirty cells each, which operate two general electric motors wound for a speed of twenty-four miles an hour. The cells are of the nine-plate traction type. When a car returns for fresh batteries, the discharged cells are removed by means of an electric elevator, carrying a small four-wheeled truck, which rises under the centre of the car. When the cells are on the truck this can be lowered and wheeled off to the charging-room. A new set of batteries is then placed in position by the same machinery.

FIG. 3



A highly interesting exhibit was that of the Gamewell Fire Alarm Telegraph Company, showing the company's system of police and fire alarms. In the fire-alarm system the alarm is given from an iron box attached to a lamp-post, each box being numbered. At the central station a loud gong rings the number of the box, while the number is at the same time displayed by an annunciator over the case containing the gong. Of still greater interest is the company's police telegraph system. An iron box is attached to a building, lamp-post, &c., or placed in a patrol box—resembling a locked sentry box—at convenient points of the city. The exterior of the police box used on lamp-posts, &c., is shown in Figs. 3 and 4, which show the outside and interior of a box used in the patrol box, the door of this police box having no keyhole for the citizen's key, as the door of the patrol box is locked. The interior fittings are alike in both cases. When a policeman goes out on his beat he has orders to report periodically at a certain box, say No. 35. At the required times he reaches the box, unlocks it, pulls the spring lever, shuts the box, and goes off again. His action registers the number of the box and the time of the call on a tape at the central office, and causes the gong to strike three and then five strokes. If the officer at the central station wishes to communicate with the policeman, he can by pressing a button cause a bell to ring in the police box, and when the policeman passes a box or opens it to send in his call, and hears this bell, he takes up the telephone and notifies the office that he is ready to receive a message. Should the policeman have a drunken or dead person to dispose of, he sends in his call, with a special signal calling the officer to the telephone, and notifies him to send a patrol wagon or ambulance. In case of a fight, riot, &c., and help being needed, he turns on an emergency call, which keeps an alarm gong ringing in the central office, a special signal or telephone message being used to indicate what is needed. The central office man has nothing to do but to signal on to the stable for ambulance, reserves, &c., and in a few minutes or seconds the horses of the police wagon will be galloping through the streets to the location of the box from which the signal was given. This system is used in nearly all the large cities, and is of great value.

FIG 4

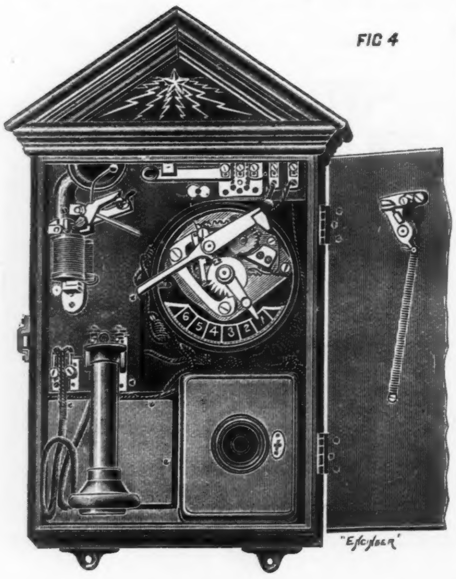
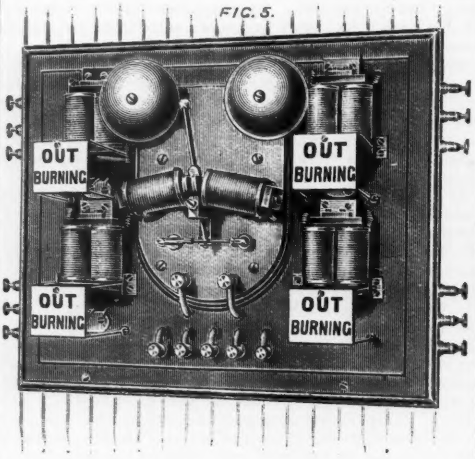
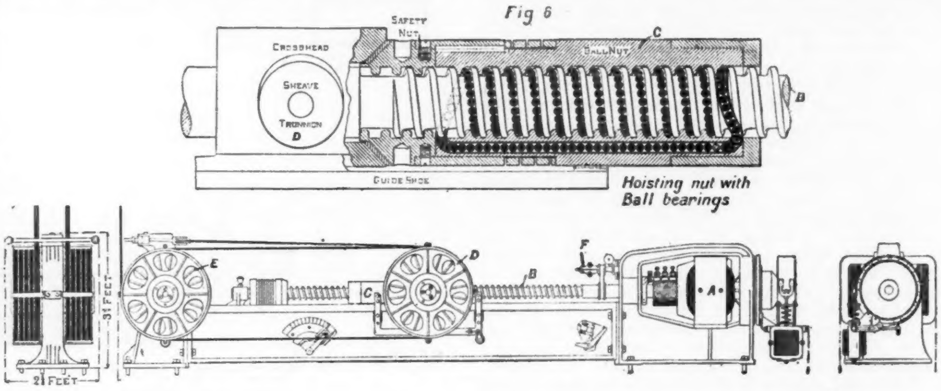


FIG. 5.



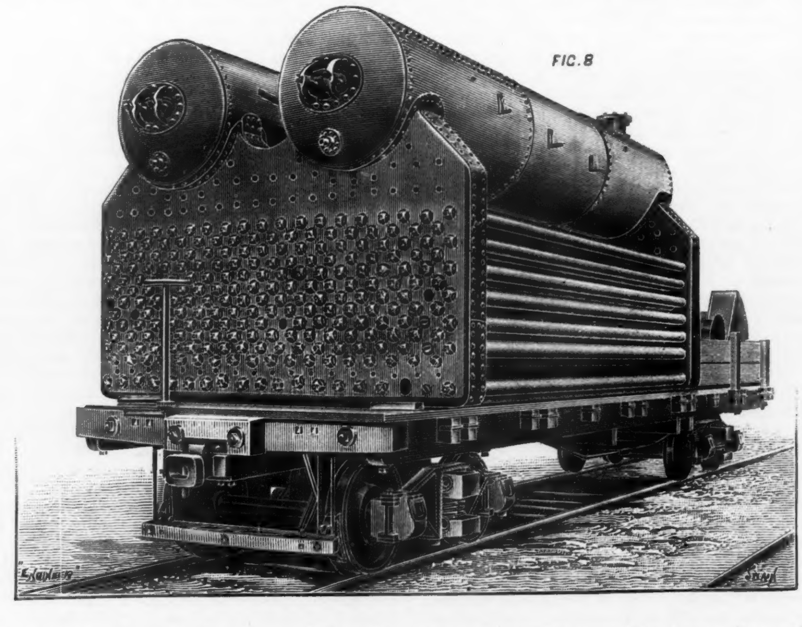
The Russell-See electrical indicator for ships' lights gives visible and audible warnings in case of any light going out. It may also be so fitted that when one lamp goes out another in the same lamp case is at once lighted, while the warning continues to sound until the first or main lamp is relighted. This is shown in Fig. 5, and is applicable to railway signals, &c.

Fig 6



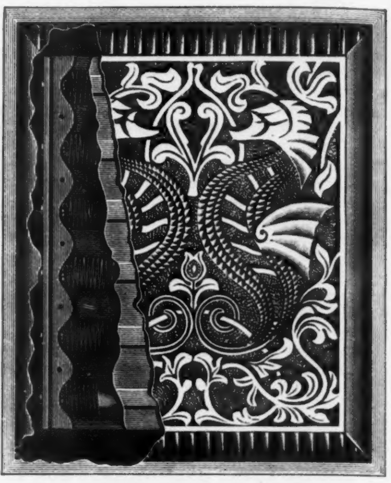
The Sprague electric elevator—Fig. 6—has a motor A, driving the screw B, upon which runs a nut C, carrying the travelling sheave D. The peculiar feature of this is in the use of a ball bearing thread in the nut, the balls returning through the horizontal chamber or passage. The sheave E is journalled in fixed standards on the bed-plate, and F is a speed governor. These are in use in a number of office buildings of five to twenty-one stories in height.

FIC. 8



The Gold Car Heating Company exhibited Gold's electric heater, Fig. 7. The resistance coils are usually 1¼in. diameter, three coils high, the coils being held in position by grooves in the asbestos boards, so that a broken wire could not get out of position and cause a short circuit or burning out of wires or fuses. Three gradations of temperature are obtainable by the use of a special switch. Various forms of ventilating fans are shown. A large exhaust fan is driven by a Lundell motor, from ¼-horse power for an 18in. fan at 1000 revolutions, to 15-horse power for a 6ft. fan at 350 revolutions, the voltage being 115 in all cases, and the ampères from 1·5 to 50. Vertical desk fans and horizontal ceiling fans were shown in great numbers, all operated by individual motors. The desk fan has an alternating current motor, for alternations of 7200 to 16,000, and a voltage of 52 to 104. To the female visitors the exhibit of the American Electric Heating Corporation was a great attraction, as the baking of pastry, the making of coffee, the boiling of water and the ironing of clothes was being carried on by electrically heated ovens, kettles, and laundry irons. Boiling, frying, &c., can be done in the same way, and glue pots, pitch kettles, stoves, portable heaters, &c., can all be heated by electricity.

FIG 7



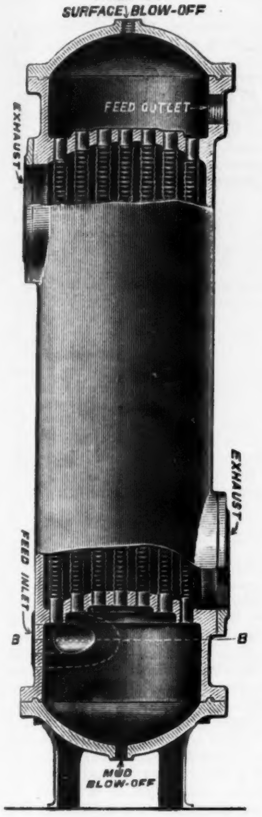
For underground conduits, iron, clay, and wooden pipes and connections were shown. The Interior Conduit and Insulation Company showed its iron and brass armoured conduits, using pipes from 1in. to 3½in. outside diameter, in 10ft. lengths, with screwed sleeve couplings. The Williamsport Wooden Pipe Company showed the Chesnut patent creosoted wooden conduit.

A 40ft. model of the Erie Canal showed the Lamb electric touring system, which has been experimentally installed on a length of four miles.

The power plant consisted of twelve horizontal engines, ten of which were directly connected to the dynamos, while two drove their dynamos by belting. All were horizontal engines, and their smoothness and noiselessness of running were very notable. The "Ideal" engine had its bed mounted on three blocks on the floor to show the freedom from vibration, and another engine had its bed merely resting on the floor, and not secured by any holding-down bolts. Only one of the engines was a compound, but all of them were high-speed engines. Steam was furnished by two Abendroth and Root water-tube boilers of 250-horse power each, carrying 125 lb. steam pressure. The anthracite coal delivered from the street was conveyed by a Hunt noiseless conveyor to a hopper, with spouts leading to the hoppers of the Wilkinson mechanical stokers, which fed it to the inclined grates. The ashes and cinders were carried away by a Hunt ash conveyor. The feed-water was supplied by a Worthington steeple pump, driven by a Crocker-Wheeler electric motor; two Root water-level regulators started the motor automatically when the water fell below the normal level, and stopped the motor as soon as the normal level had again been reached. The Locke automatic damper regulator was used. The first engine—a Phœnix compound—took steam at 125 lb. pressure, but a Foster reducing valve on the steam pipe beyond this engine reduced the pressure to 90 lb. for all the other engines. Two Edison recording gauges were fitted to show the steadiness of pressure maintained on the high-pressure and low-pressure sides of the reducing valve. A Foster automatic stop valve was also placed in the main steam pipe near the boiler, to close instantly in case of a break in the steam pipe or its connections. The exhaust from all the engines passed to a Goubert feed-water heater. The steam pipes were clothed with the Gilmour asbestos covering and the Keasbey magnesia sectional covering.

The arrangement of the engines and dynamos was as follows:—First, a Dick and Clunel — Phœnix — compound non-condensing engine of 125-horse power, with automatic cut-off, directly connected to a Walker generator of 75 kilowatts. Secondly, a Ball and Wood engine of 150-horse power, directly connected to a Siemens and Halske direct current compound wound dynamo of 100 kilowatts and 125 voltage, the speed being 250 revolutions per minute. Thirdly, a "straight-line" engine of 125-horse power, direct connected to a general electric dynamo of 75 kilowatts. Fourthly, a 75-horse power engine driven by compressed air, and directly connected to a Crocker-Wheeler dynamo of 50 kilowatts. Fifthly, an "Ideal" engine, directly connected to an Eddy multipolar generator of 40 kilowatts. Sixthly, a Watertown engine with cylinder 10in. by 12in., directly connected to an Eddy dynamo. Seventhly, a Payne engine of 50-horse power, directly connected to a Card dynamo. Eighthly, a McEwen engine with cylinder 10in. by 10in., directly connected to a Thompson-Ryan dynamo of 40 kilowatts. Ninthly, a single-cylinder Weston engine of 90-horse power, belted to a Warren alternating dynamo of the induction type, 60 kilowatts, having a stationary armature and a field coil. Tenthly, a "safety" engine with cylinder 13in. by 12in., automatic cut-off, 100-horse power, belted to a Crocker-Wheeler dynamo. Eleventhly, a Woodbury engine 9in. by 12in., directly connected to a Fort Wayne direct current generator of 25 kilowatts. Twelfthly, a Shapland vertical engine 6in. by 6in., directly connected to an Eddy generator of 10 kilowatts.

FIG. 9.



In addition to the power plant, as above described, there were several exhibits in connection with power plants for electric stations. All the boilers shown were of the water-tube type, and in addition to the Root boilers in service there were exhibits of the Babcock and Wilcox, the Root, the Westinghouse, the Stirling, the Heine, and the Climax boilers. The two first-named use larger tubes than the others, the tubes being slightly inclined from the horizontal, as are those of the Heine boiler. The Stirling boiler has its rows of tubes nearly vertical, while the Climax boiler has a central vertical shell with interlaced loops of pipe projecting from it, the whole being encased in an outer sectional shell. With this outer shell removed the boiler resembles a pile of coils of wire rope, but in spite of this apparent complication of tubes the boilers are extensively used. Being vertical they occupy a small floor space in proportion to their area. A 500-horse power Heine boiler, mounted on a car for shipment, is shown in Fig. 8. Several forms of mechanical stokers were shown, and numerous steam appliances and fittings, including the Wainwright water-tube feed-water heater shown in Fig. 9. A device which is important enough to call for some attention, and which has been applied in several cases, is the Green's fuel economiser, which may almost be called an auxiliary boiler, always ready for service when emergencies arise, as, for instance, when a cloudy or dark afternoon causes a sudden increase of the demand on the lighting capacity of the electric light plant. It consists essentially of a series of vertical water tubes placed in the main flue between the boilers and the chimney, and absorbing a large amount of the waste heat. It is protected from radiation when the boilers are banked down during a period of small demand for electricity, and furnishes an immediate and ample supply of hot feed-water as soon as the boiler is put in active steaming work. At the power house of the Toronto Electric Railway Company in Canada there are six Scotch or marine boilers, 10ft. diameter and 14ft. long, each having grates 6ft. by 3ft. The Green's economiser consists of 960 tubes in two groups, with a heating surface of about 9600 square feet. A two days' test with and without the economiser showed that in the former case there was a saving of 18·3 per cent. in the quantity of fuel used. As an average the water enters the economiser at 111 deg. Fah., and leaves it at 231 deg., while under ordinary methods the temperature of the feed-water is only about 95 deg. Fig. 10 shows the apparatus as placed in one of the power houses of the Brooklyn City Electric Railway.

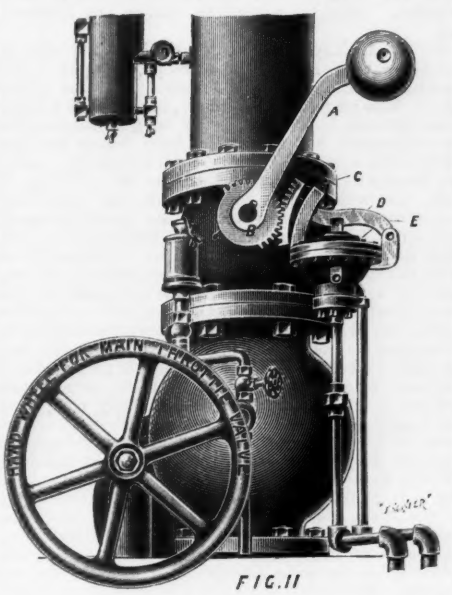


FIG. 11

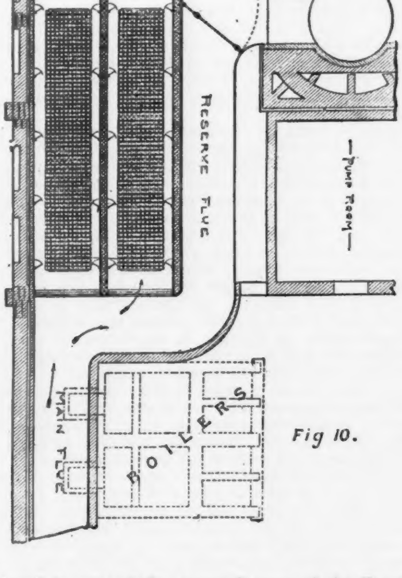


Fig 10.

The Bonta safety engine stop, used in the power house of the North Hudson County Electric Railway, has a system of piping, with sections of glass pipe so placed as to be broken by the governor balls if they rise above the proper level, or to be broken by a broken belt, &c. The pipes are charged with air to a pressure of 40 lb., the pump being automatically started as soon as leakage allows the pressure to fall. The throttle valve on the main steam pipe is a butterfly valve, with a weighted lever A—Fig. 11—and a circular rack B, gearing with the segmental rack C on the lever D. This latter lever is supported on the stem of a piston moved by a rubber diaphragm in the casing E, which is connected with the air pipes. As soon as air is allowed to escape from the pipes, purposely or by the fracture of one of the glass sections, the valve drops and the weighted lever closes the steam valve. Two pipes enter the casing below the diaphragm, one is $\frac{1}{32}$in. diameter, and supplies the air pressure, the other is $\frac{3}{4}$in. diameter, and serves as the exhaust, so that the exhaust being so much larger than the inlet, the air pressure cannot hold up the valve when the exhaust is open.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE summer meeting this year, at Hamburg and Berlin, of the Institution of Naval Architects, promises to be a most memorable event in the annals of the society. When it was made known to the members that a cordial invitation had been issued to them by a select number of prominent officers and others in the Royal Prussian Ministry of State, in the Imperial Ministry of the Interior, of the Marine, of Public Works and of Education, and by representatives of the Chamber of Commerce and the other great industrial institutions of Hamburg, as well as by the city of Berlin, and the various societies of German shipbuilders and civil engineers, no sooner had Mr. Holmes, the indefatigable secretary to the Institute of Naval Architects, completed his capital programme, than applications to attend the meeting poured in so rapidly that it was found essential to limit the number of those to be present to about 450, including lady friends.

The actual muster of members, associates, and their lady friends, who assembled at St. Pancras Station, as a rendezvous, at a quarter to nine upon the evening of June 6th, was about 380; and after the countless Saratoga trunks, containing pretty summer frocks to captivate the hearts of the susceptible Teutons of Berlin and Hamburg, had been stowed away, together with portmanteaus and other gear appertaining to the masculine order, the entire party steamed away to Tilbury in two special trains, to embark upon the magnificent Hamburg American liner, Fürst Bismarck. This fine ocean greyhound, had been most generously and courteously placed at the disposal of the Institution of Naval Architects by the Hamburg American Company, to convey its members direct to Hamburg from the Thames, entirely free of all charge, most sumptuous entertainment being provided for them moreover on the voyage. In all, including the smallest details, the comfort of "the four hundred" was most thoughtfully arranged between the German Company and Mr. Holmes, even labels for luggage "wanted" and "not wanted" on board being forwarded to the intending travellers, who found their light *impedimenta* ready stowed in their cabins almost as soon as they arrived at the vessel.

The voyage across commenced at about four o'clock on Sunday morning, the 7th inst., and the sea, the sky, and the temperature seemed to conspire together to render the passage most delightful. The fine ship sped on her way across the North Sea so easily that even the most indifferent sailors amongst the fair sex seemed to forget that they were crossing the waters, and a delicious breeze carried us right into the mouth of the Elbe at a *very* early hour on Monday morning. So early indeed, that we do not think anyone was awake when we passed Cuxhaven.

Most of our old and well-known friends of previous summer meetings were amongst the party, and a strong contingent of the German members of the Institution, as well as Herr C. Ferd. Lacisz, Chairman of the Hamburg Chamber of Commerce, one of the Reception Committee, also the Naval Attachés of Germany and Austria. Passing up the Elbe to Brunshausen, where we bid farewell to the Fürst Bismarck and her courteous company, to embark in the fast tender Blankenese for conveyance to the city of Hamburg itself, it appeared very clearly, by the emerald look of the pasture fields on the river banks, that the rainless condition which our country has had to deplore during the month of May has not been the fate of our neighbours across the sea. At this point in our voyage, the heartiness of the reception that we were about to experience began to unfold itself. The tender came alongside with an excellent military band, and amidst the strains of the National Anthem, Rule Britannia, and other essentially English tunes, we quickly ran up the river amidst displays of bunting, cheers from the various ships as we passed along, and lastly, a salute of light guns from a signal station at Blankenese-on-the-Elbe, an exquisite spot, where the rounded hills, clothed with trees to the water's edge, stand out upon the right bank of the river, with beautiful villas and more pretentious-looking mansions appearing in the midst of the mass of foliage.

The landing arrangements were excellent, and it was quite a mystery how at least twelve or fourteen hundred packages could be distributed, popped away into conveyances, and rattled off to the various hotels with their owners in something less than twenty minutes. Lord Wolseley with half-a-dozen quartermasters-general could not have done it!

So soon as a light luncheon had been disposed of, our hospitable entertainers carried us off, through the broad and handsome streets of the ancient "Hanse Town," with its network of deep and wide canals penetrating everywhere into the blocks of warehouses and business residences, past elegant churches, two of them with spires rivalling that of Salisbury Cathedral or the dome of St. Paul's in height, which were peeping out from behind the great colonnades here and there — to the Baaken Hafen, which is a huge sheet of water leading out of the Elbe, surrounded with wharves, at which steamers were lying, and having rows of piles driven into the centre line of the Hafen throughout, thus forming an additional wharf, at which countless lines of sailing vessels of large size were moored. Hydraulic cranes were placed at short intervals right around this extensive basin, so that, by means of a continuous gantry upon which they were mounted, they could be made available at any spot where the steamer to be loaded or unloaded happened to be moored.

In order to inspect these basins and the banks of the Elbe itself, which was similarly provided with wharfage appliances, three steamers, handsomely dressed with bunting, and having on board members of the indefatigable Reception Committee, were waiting at the Grassbrook landing-stage, in readiness for our embarkation.

As we steamed up the Baaken Hafen, and then, after being turned round in the narrow waters in the deftest manner by an attendant tug-boat, we emerged upon the bosom of the Elbe, it was impossible to resist a sense of the deepest admiration for the vigour and industry of the Hamburgers, who could thus convert the entire river basin at this spot into one gigantic dock. Here, in the Elbe itself, were double sets of rows of the wharfage piles driven into its bed, and secured to them were steel-built clipper sailing vessels of the very largest size, lines of them one after another, extending for quite a mile. At all those places work was being vigorously carried on, and, although the appearance of the vast mass of shipping gave the idea of a fête day, as every vessel was dressed in bunting in rainbow fashion from stem to stern, this did not prevent the immense activity of the workers all along the lines of wharfage being very observable. In point of fact, one of the members of the Institution present remarked, and with considerable justice, that this was more an object lesson for the working men and artificers in our factories and shipbuilding yards than for naval architects.

Too soon we were swept past the busy scene upon the great waterways, and were landed at the works of Messrs. Blohm and Voss, a short description of which will be found on another page.

The heads of the firm, and many of their obliging employés, were waiting to receive us, and the gallant "four hundred," together with some seventy other members and friends who had not been able to obtain passages in the Fürst Bismarck, but who had meanwhile arrived in Hamburg—a fact omitted to be mentioned—were soon scattered throughout the workshops and building slips of this establishment.

Of the two great steamers upon the slips, the "liner" mentioned in the description presented most points of interest. The system of building differs in many respects from that noticeable in our yards. The various parts of the bracket-framed structure are not only put together, but their several features completed, shaft tunnels and other etceteras, before the framing proceeds. There was a very great difference between the two ships that we saw in course of construction, the frames and scantlings of the larger one being enormously stout and strong, whilst the smaller vessel appeared almost dangerously light in comparison.

The shops and machinery are of the latest and most approved description. The machine and lathe shop is exceptionally fine and lofty, and contains a boring mill for cylinders of very unusual dimensions. In point of fact, it is clear that this firm is prepared to undertake the construction of propelling machinery for the largest steamers either afloat on contemplated.

The boiler-making sheds of Messrs. Blohm and Voss are remarkably spacious, and contain the latest appliances for punching out manholes in one piece and riveting, all by hydraulic power. The shells of the largest sized boilers, weighing from 50 to 100 tons, were suspended from the piston-rod of an hydraulic cylinder attached to tke roof of the building, and power being introduced by a flexible pipe beneath or above the piston, the shell was lowered or raised, as required, with the greatest ease by a single artificer, so as to bring the rivets opposite the hydraulic ram of the riveting machine.

Later on upon Monday evening the members of the Institution were all embarked upon special launches for an extended tour on the Alster Lakes. The scene was most lively and interesting ten thousand electric lights sparkling amongst the trees which surround these beautiful sheets of water, and being reflected across their surfaces, whilst the towering spires of St. Nicholas, St. James, and many other churches, were graceful amongst the masses of buildings and splendid residences, whose gardens descended to the water's edge. In the evening the members and ladies were received by the Senate of the City of Hamburg in the new Rathhaus, a wondrous building replete with taste, though entirely modern. It is in the German renaissance style, and profusely decorated with painting, wood carving, and sculpture. A band dressed in the old mediæval burgher style discoursed excellent music during the evening, a sumptuous supper being also provided.

On Tuesday morning the whole of the 450 members and their lady friends were carried off in countless carriages, a large number of them being private vehicles kindly placed at the disposal of the reception committee, and taken to Luding's Concert House, a fine and well-decorated building, for the reading and discussion of papers.

In the first place, an address of welcome of the warmest and most cordial character was delivered in German by Bürgermeister Dr. Mönckeberg, President of the Senate of Hamburg. It was most ably rendered into English by Mr. George Holmes, and was to the following effect:—Dr. Mönckeberg, on behalf of the town of Hamburg, begged leave to express the satisfaction that all felt at the visit of the Naval Architects' Institute to their city. There always was and always had been the liveliest sympathy between the people of England and those of Hamburg. A community of interests has drawn them together. From mediæval times they had been connected by commercial ties. When circumstances attached to the revolution occasioned by the discovery of America had diverted the shipping interests of England into other interests than those of trade, cargoes were transferred by English merchants to be conveyed in Hamburg ships. Singularly enough, after a lapse of some three hundred years, this day is the anniversary of the first English cargo arriving at Hamburg. Since then British commerce has revived, and Hamburg, after a period of dulness, has been again reawakened to a peaceful competition with its neighbour, to which nothing lends a better aid than naval architecture. They wished the visitors every gratification during their visit, and made heartily welcome.

The Earl of Hopetoun replied in a few pithy and graceful words, acknowledging with warmth the cordiality of the Bürgermeister and people of Hamburg. He expressed his admiration of the vast improvements which had recently been made in the resources of the port of Hamburg, and believed that peaceful rivalry and competition in commerce were the elements of success as regards the countries on both sides of the water. Germans and Britons came from the same stock. The world was large enough for the commerce of both countries. There was no need to tread on one another's toes.

Mr. F. A. Meyer, engineer-in-chief of the city of Hamburg, then read a valuable paper upon "The Maritime Position and the Principal Features of the Port." This we publish elsewhere, but, as it is a paper of the greatest importance, being an able summary of the commercial history of Hamburg during the last thirty years, during which period the tonnage in vessels has increased from one million to six millions of tons, we will briefly touch upon it. Hamburg was always a thriving place as the great Hanseatic Free City, but its importance was threatened in 1881 when it resolved to enter into the Customs Union of the German Empire. At a cost of six millions sterling, however, a large part of which was subscribed by the merchants themselves, a district on both sides of the Elbe marked out on a map with a thick hatched line, supplied to all the guests—was retained in lieu of the old free city, and the splendid docks and basins—marked in grey colour in the map—commenced, together with new store-houses and quays. Now the scheme is practically completed, and a new Hanse town has virtually arisen. In all a space of 2500 acres was separated off, and 10·5 miles of quays for sea-going vessels with railroad tracks and sheds added to the resources of the port. These all remained free. It is the intention of the City of Hamburg to eventually remove the bar between Hamburg and Brunshausen, which prevents large vessels coming further up than the latter place, and to deepen the existing harbour basins so as to accommodate ships with the deepest draught. This is truly a colossal scheme, both as regards what has been carried out and what yet remains to be done.

The discussion on this paper, and the subsequent papers read on Tuesday, will be dealt with next week.

THE ROYAL SOCIETY.

THE ladies' conversazione of the Royal Society took place on Wednesday, 10th June, and in the spacious rooms of Burlington House were shown a large number of interesting exhibits. The Lords of the Committee of Council on Education have arranged for the public exhibition in the western galleries of the Science Museum at South Kensington of a number of the objects, and this exhibition will remain open to the public for about a fortnight. Space will, of course, not permit of a description of all the exhibits, which illustrated very numerous branches of science. We shall, therefore, merely allude to a few of the scientific apparatus which appeared to us of special interest to engineers.

The Cambridge Scientific Instrument Company showed a bifilar pendulum in action. This instrument was designed by Mr. Horace Darwin for observing and recording slow tilts and pulsations of the crust of the earth, by whatever cause they may be produced, and is a modification of that used by the Messrs. Darwin in 1881 at the suggestion of Lord Kelvin. It is possible with this pendulum to observe a tilt of less than $\frac{1}{300}$ of a second, an angle less than that subtended by a line an inch long placed at a distance of a thousand miles, as was shown by the experiments made at Birmingham by Dr. Charles Davison.

A small dynamo for measuring the permeability and hysteresis of iron was shown by Professor M. L. Ayrton, F.R.S., and Mr. T. Mather. This is a piece of apparatus intended for workshop experiments. The specimen to be tested may be in the form of a bar of a bundle of thin plates, and forms the yoke of the field magnet; it is cramped in position, and, through a coil surrounding it, is passed the magnetising current, the winding of the coil being so arranged that the current in ampères is numerically equal either to the magneto-motive force per centimetre of the bar or to one-tenth of that value. When the armature is run at a speed of 1150 revolutions per minute the induction per square centimetre in the bar is approximately equal to 10,000 times the E.M.F. in volts produced. The magnetising current and induction are, therefore, measured by a steady deflection, and not, as is usual, by the instantaneous swing of a ballistic galvanometer. When we examined the apparatus the E.M.F. being used was two volts, and an adjustable carbon resistance was employed. The current was five ampères, but currents up to twenty ampères can be used if desired.

Mr. J. Frith showed the different effects on superimposing a small alternating current on a direct current arc, according as cored carbons or solid carbons are employed. When a small alternating current is superimposed on a direct current arc formed with cored carbons, the oscillations of potential difference and current are in the same direction for all frequencies higher than one and a-half periods per second. On the contrary, if the carbons be solid, the oscillations of potential difference and current are in the opposite direction for all frequencies tried up to 256 periods per second. We were informed that the alternating current was one-fiftieth of the direct current. The lag of phase between the E.M.F and current curves is 180 deg. with solid carbons, while the two curves are in phase with cored carbons.

The Röntgen rays formed the subject of several exhibits. Professor S. P. Thompson, F.R.S., showed the production of electric dust shadows by this means. When the rays are allowed to fall upon an electrified sheet of aluminium placed above a plate of ebonite, they carry electric charges to the plate and electrify it. If objects of metal are laid on the ebonite sheet they intercept the Röntgen rays, and the part of the ebonite surface immediately shaded by them does not become electrified. On removing the ebonite plate and dusting upon it Lichtenberg's powders—mixed sulphur and red lead—the electric shadows become visible. A number of interesting experiments were shown with the apparatus.

Messrs. Siemens Bros. and Co. showed electric discharges in vacuum, a facsimile of Dr. Wm. Watson's vacuum tube of 1751, which was the first apparatus ever constructed for experiments on the electric discharge in a vacuum. The discharge of a Leyden jar passed through 10in., and that from a frictional machine through 3ft., the whole length of the tube. A facsimile of Lord Cavendish's double barometer of 1751; also a facsimile of Dr. Wm. Morgan's shortened barometer of 1785. Dr. Morgan, by long continued boiling of the mercury in a barometer tube, produced a vacuum of such excellence that no discharge would pass, and equal therefore to that in a Hittorf or Crookes' tube of the present day. It is probable that it would have sufficed for the production of Röntgen rays. This apparatus has been designed by Dr. Eugen Obach.

Mr. J. J. H. Teall showed a series of photographs of the electric discharge at various stages during the exhaustion of a Crookes bulb of the Jackson type. Mr. Herbert Jackson gave a demonstration of the use of phosphorescent materials in making *x* rays visible. The tube used to produce the rays is a slight modification—described in the "Proceedings" of the Chemical Society—of a tube originally introduced by Mr. Crookes to illustrate the heating effects of the cathode rays. These are brought to a focus at the centre of curvature of the concave cathode, whence they proceed in nearly a straight line to a platinum plate, from the surface of which they are apparently scattered in all directions. The rays penetrating the glass fall upon phosphorescent bodies and are rendered visible, thus showing the different extents of response of these bodies to such rays.

Mr. F. E. Ives showed a stereoscopic photo-chromoscope. This is an instrument which, with almost equal simplicity, records and reproduces colours more perfectly than the phonograph records and reproduces sounds. The photo-chromoscope camera makes at a single exposure on a commercial photographic sensitive plate three pairs of images, which, by differences in their light and shade, constitute a record of everything tnat excites vision in the two eyes. The stereoscopic photo-chromoscope translates this record to the eyes, so that the object photographed appears to be seen through it.

Professor Roberts-Austen, C.B., F.R.S., showed modifications of an experiment of Monsieur Charles Margot. A wire of aluminium is raised by a current of 30 ampères to a temperature far above the melting point of the metal, but a film of oxide on its surface prevents the wire from breaking. The molten wire through which a current is passing may then be attracted by a magnet.

Sir David L. Salomons, Bart., exhibited a new form of stereoscope; while Mr. T. Andrews, F.R.S., showed a series of accurate micrographs, taken at a high magnifying power, illustrative of the microscopically visible and tangible micro-flaws, almost invariably present in considerable number in steel railway axles, rails, tires, propeller shafts, &c. The presence of these germs of metallic disease in steel—mostly due to sulphur and other impurities—greatly influences the deterioration by fatigue of the metal, and they are a potent factor in inducing the sudden fracture of engineering constructions in steel.

THE BARRY DOCKS.

IN our impression of the 7th of February last we published a map and plan of the Barry Docks and railway connection, and of the site of the East Dock and Lock now under construction, together with some plans and sections of the great lock and photographic view showing the great lock and gates. These extension works are amongst the most remarkable dock works ever constructed, not only because of their size, but because of the unprecedented growth in the trade that has made them necessary. The original Barry Docks, and the first extensions, have been from the first most profitable undertakings, a fact which in itself is very remarkable with regard to works of the kind. Some idea of this may be gathered from the account of the docks which has appeared in the "Proceedings" of the Institution of Civil Engineers. On page 585 we give a few more engravings showing the approach viaduct to the coal tipping towers, which are also shown, and whose positions were shown on the plan, page 136 *ante*, of a steel bridge on the line of the same approach, sections of the pitched slopes and timber wharves of the junction cut between the docks, and of those on the north-western side of the new dock. Type sections of the walls of the same dock on the south-eastern side.

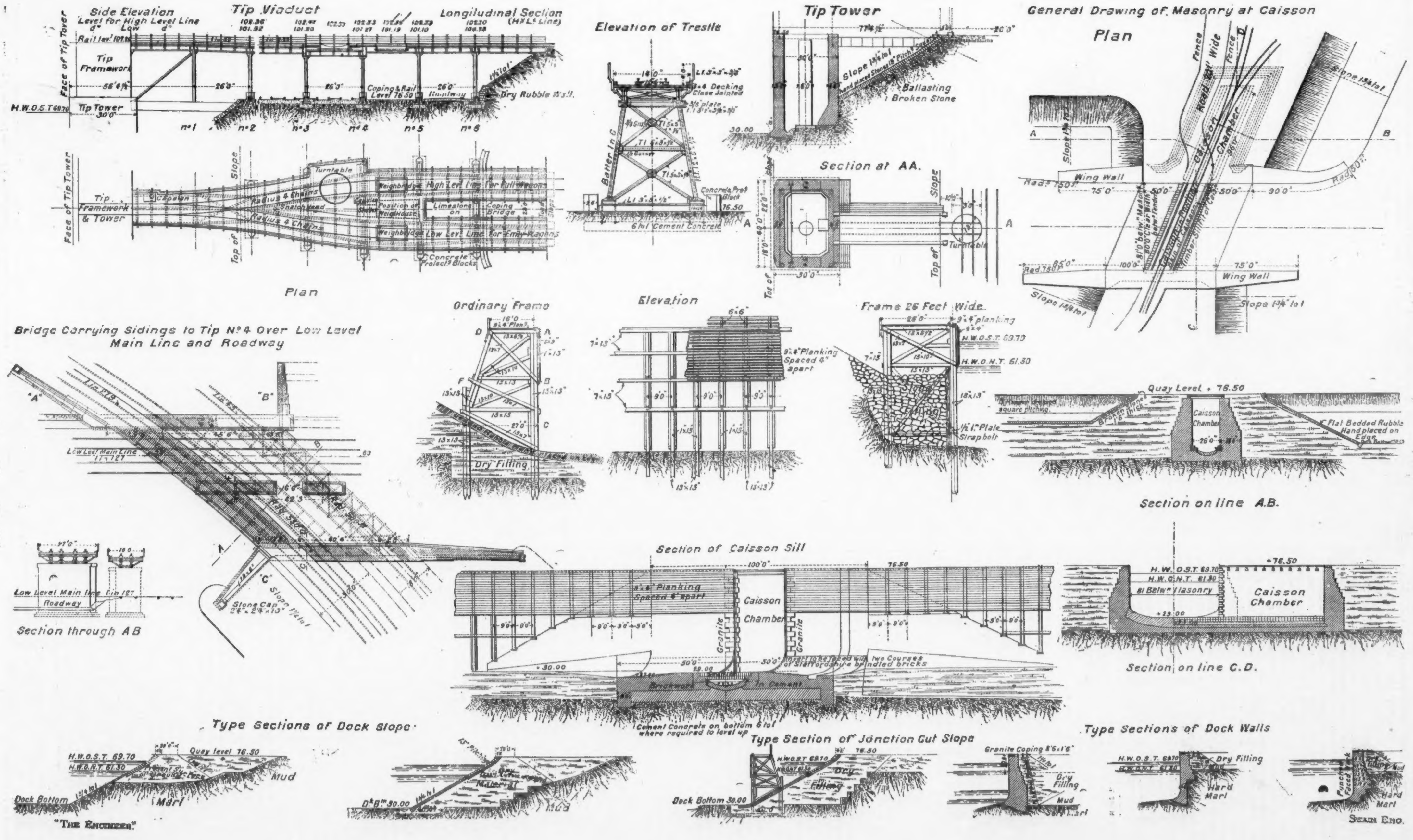
Between the new East Dock and the existing dock, which are connected by the junction cut shown on the plan already referred to and by the plan and three sections on page 585, there is a very large double-faced caisson for maintaining the level inthe new East Dock. This caisson is of the rolling type, and retires into a chamber as indicated. The clear width of opening covered by it is 81ft., which, with the great depth over the sill of 42ft. at the centre, affords accommodation for the largest ships afloat. The caissons and lock gate work generally present numerous features of interest, the gates being opened by direct-acting piston-rods in long cylinders, working on vertical trunnions. The gates and caissons have been made by Messrs. Robert Stephenson and Co., Newcastle-on-Tyne, and the hydraulic machinery by Sir W. G. Armstrong, Mitchell, and Co., of the same place. The contractors for the new dock are Messrs. Price and Wills, who commenced work in August, 1894. Mr. John Wolfe Barry, C.B., Pres. Inst. C.E., is the engineer of the new work, as he has been of the whole of the vast operations which have converted Barry Island in eleven years from an almost unknown land to one of the largest exporting ports in Great Britain, and he is to be congratulated on the success of his designs and on the excellence of the work carried out by the contractors under his superintendence. The works are of such an extensive character that we are at present unable to deal with them further at present.

COMMENTING on the recent explosion on board the French battleship Amiral Duperré, the *Temps* says that it now seems to be established that the explosion was caused by the spontaneous decomposition of the powder in a gun-cartridge under the influence of the heated atmosphere. Our contemporary repeats the statements that the powder magazines are in the Amiral Duperré contiguous to the engine-room, and are entered by a passage through which pass a number of steam pipes. It has often been noticed, adds the *Temps*, that the temperature was more than 104 deg. Fah. in this passage, and at this heat powder undergoes a partial decomposition, giving off inflammable gases. Moreover, it is declared that the recent explosion was the second which has occurred in the Amiral Duperré owing to the same cause. The first accident occurred some years ago and wounded several men. In order to avoid a similar occurrence a refrigerator was bought, but the *Temps* and *Army and Navy Gazette* say that, owing to the irrational manner in which it was fixed, it was of no service.

THE BARRY DOCKS—NEW EAST DOCKS

MR. JOHN WOLFE BARRY, C.B., PRES. INST. C.E., WESTMINSTER, ENGINEER

(*For description see page 584*)


Side Elevation
Tip Viaduct
Longitudinal Section (H^y L^l Line)
Level for High Level Line
Low
Face of Tip Tower
Rail lev^l
Tip Framework
Tip Tower 30'0"
H.W.O.S.T. 69.70
Coping & Rail Level 76.50
Roadway
Dry Rubble Wall
n°1
n°2
n°3
n°4
n°5
n°6
Plan
Tip Framework & Tower
Turntable
Radius 4 Chains
Weighbridge
High Lev^l Line for Full Wagons
Position of Weighhouse
Limestone Coping on Bridge
Low Lev^l Line for Empty Wagons
Concrete Protect^g Blocks
Slope
Top of Slope
Elevation of Trestle
9"×4" Decking Close Jointed
Batter 1 in 6
6 to 1 Cement Concrete
Concrete Pref^d Block
16.50
Tip Tower
Slope 1¾ to 1
Hand placed Stones 9" Pitching
Ballasting Broken Stone
30.00
Section at AA.
Turntable
General Drawing of Masonry at Caisson
Plan
Fence
Road 40' Wide
Caisson Chamber
Wing Wall
Slope 1¾ to 1
75'0"
50'0"
30'0"
100'0"
A
B
C
D
Bridge Carrying Sidings to Tip N°4 Over Low Level Main Line and Roadway
"A"
"B"
"C"
Low Level Main Line
Stone Cap
Slope 1½ to 1
Section through AB
Roadway
Ordinary Frame
Dry Filling
Elevation
9"×4" Planking Spaced 4" apart
Frame 26 Feet Wide
9"×4" planking
H.W.O.S.T. 69.70
H.W.O.N.T. 61.30
1½"×1" Plate Strap bolt
Quay Level + 76.50
Caisson Chamber
Flat Bedded Rubble Hand placed on Edge
Section on line A.B.
Section of Caisson Sill
100'0"
9"×4" Planking Spaced 4" apart
Caisson Chamber
Granite
Invert to be faced with two Courses of Staffordshire brindled bricks
Brickwork in Cement
Cement Concrete on bottom 6 to 1 where required to level up
+30.00
+76.50
H.W.O.S.T. 69.70
H.W.O.N.T. 61.30
61 Belw^r Masonry
Caisson Chamber
+29.00
Section on line C.D.
Type Sections of Dock Slope
H.W.O.S.T. 69.70
H.W.O.N.T. 61.30
Quay level 76.50
Mud
Marl
Dock Bottom
D^k B^m 30.00
Type Section of Jonction Cut Slope
Dock Bottom 30.00
Dry Filling
Type Sections of Dock Walls
Granite Coping 8'6"×1'6"
Dry Filling
Mud
Marl
Hard Marl
Punched Face
"THE ENGINEER."
SWAIN ENG.

DEVELOPMENT IN DESIGN AND CONSTRUCTION OF GERMAN MEN-OF-WAR.[*]

By HERR A. DIETRICH, Wirklicher Geheimer Admiralitätsrath, Constructor in Chief of the Imperial German Navy.

THIRTY years ago only one shipyard in Germany was able to construct men-of-war adequate to the demands of the time, the Royal Prussian Dockyard at Danzig. At that time this yard was building the wooden screw frigate Elizabeth, and a short time later two ships for the newly-formed North German Confederation, the Undine, a sailing brig for training purposes, and the armoured screw covette Hanse of 3600 tons displacement; the last one was the first ironclad vessel ever built in Germany. The dockyard at Danzig was fitted out to build only wooden hulls, so the iron unarmoured superstructures of this ship were built up by the Vulcan private dockyard at Stettin, the armour plates were ordered from England. In the year 1869 the first iron armour-clad ever built in Germany, the turret ship Grosser Kurfürst, was commenced in Wilhelmshaven, where the new dockyard was not even nearly finished. The shipyard Vulcan in Stettin started shortly afterwards on the Preussen, a sister vessel of the Grosser Kurfürst. Work on these vessels could only be carried on very slowly during the time of the Franco-German war, so that the first iron armour-clad built in Germany, the Preussen, could not be launched before November, 1873. Her sister ship, the Friedrich der Grosse, was launched in 1874 from the new Imperial Dockyard at Kiel. Owing to the unfinished state of the dockyard at Wilhelmshaven, and the very unfavourable conditions, the Grosser Kurfürst was not ready for launch before September, 1875, six years after work was commenced.

After the Franco-German war the chief of the German Admiralty, General von Stosch, laid out a plan to build up the navy—Flottergründungsplan—according to which work was commenced, but is not quite finished at present, as not all types of ships have the intended number of vessels. To get armour-clads as quickly as possible, it was necessary to place orders abroad, since German shipyards were not efficient enough at that time. The two armoured frigates, Kaiser and Deutschland, were built at Samuda's dockyard from the designs of Sir Edward Reed, and were launched in the year 1874. These two ships form still part of the German battle fleet, after having been reconstructed, as well as it was possible, to suit modern requirements. Since that time no German man-of-war of any considerable size has been built abroad, the German shipyards were in the meantime well fitted to execute all orders. Then those vessels were commenced which suited best the formation of the German coast. According to the building plan, four coast defence armour-clads—Ausfall-Corvettan—of the Sachsen type were ordered, which, on a draught not exceeding 6 m.—19·68ft.—had to carry the heaviest armour of 16in. thickness—Sandwich system—and an armament of six guns of 26 cm. (10in.) calibre. These ships are nearly the first armour-clads ever constructed on the citadel type. The keel of the Sachsen was laid as early as 1874, and she was launched in 1877; the first citadel ships, the Inflexible and the Duilio, were launched in 1876. The last of the three sister ships of the Sachsen type, the Baden, was not launched till 1880.

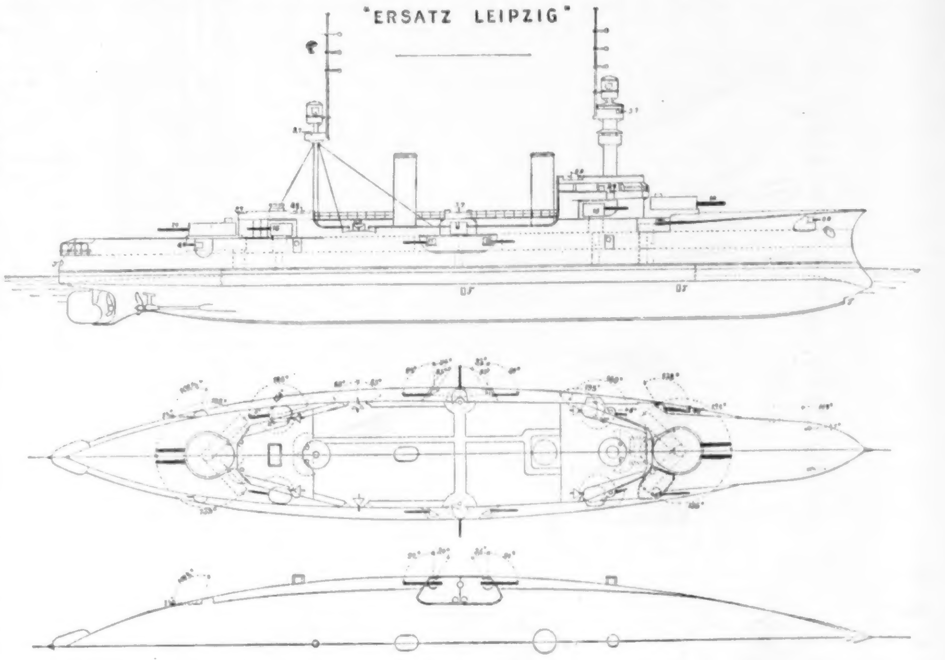
Coast defence had to be considered before everything else, and, therefore, contemporaneously with the above-mentioned vessels, work was commenced, not on monitors as at first planned, but on ironclad gunboats of the Wespe type. These boats, of 1000 tons displacement, were plated 8in. (200 mm.) armour, carried one gun of 12in. (30·5 cm.) calibre, and drew only 3 m. (9·84ft.) Eleven of these boats were built. For a long time no armour-clad was built in Germany except the Oldenburg, which was started in March, 1883, and finished in November, 1886. She was intended to be the fifth vessel of the Sachsen type; but, owing to want of money, she had to be made smaller and of quite another type. With the armour-clad Siegfried a quite new type was started in 1887, also intended for coast defence only, and especially for the mouth of the river Elbe, on account of the construction of the Kaiser Wilhelm Canal. Eight vessels of this type were built, but the two last, the Aegir and Odin, are somewhat different from the sister ships, being constructed after the citadel type ships. The main condition for these vessels also is the low draught, only 5·5 m. (18ft.) They carry, on a displacement of 3500 tons, heavy ordnance, three 24 cm. guns, arranged especially for defending river estuaries, and are armoured with 240 mm. ($9\frac{7}{16}$in.) plates, and have a speed of 15 knots. Thus, since 1873, three different types of armour-clads, of 7400 tons, 3500 tons, and 1000 tons, were built for coast defence, each type designed and executed for this limited purpose.

The construction of seagoing armour-clad battleships, which have to advance farther out, in order to defend the coasts more effectually, was not commenced before 1889, after a lapse of sixteen years. Then, however, four vessels of the same design were started simultaneously; these are the Brandenburg, Weissenburg, Wörth, and Kurfürst Friedrich Wilhelm, of more than 10,000 tons displacement, a speed of 17 knots, 400 mm. (15·75in.) thickness of armour in the belt which surrounds the water-line, and, in addition to a reduced light armament, six guns of 28 cm. (11in.) calibre in three revolving turrets. Two still bigger ships, the Ersatz-Preussen and Ersatz-Friedrich der Grosse—to replace the before-mentioned ships—whose principal dimensions were materially affected and restricted by the small size of the existing German dry docks, are being built now at the Imperial Dockyard at Wilhelmshaven. The development of the unarmoured ships was strongly influenced by closely adhering to and imitating the types of screw frigates and corvettes existing in the year 1871 in the German Navy, the type of the full-rigged single screw frigates and corvettes with broadside guns without any armour protection. The vessels had full sailing capacity, and great stress was laid on the training of the crew in the rigging, but the fighting capacity of the vessels was neglected. Such vessels were constructed even as late as 1887—Charlotte, Arcona, Alexandrine.

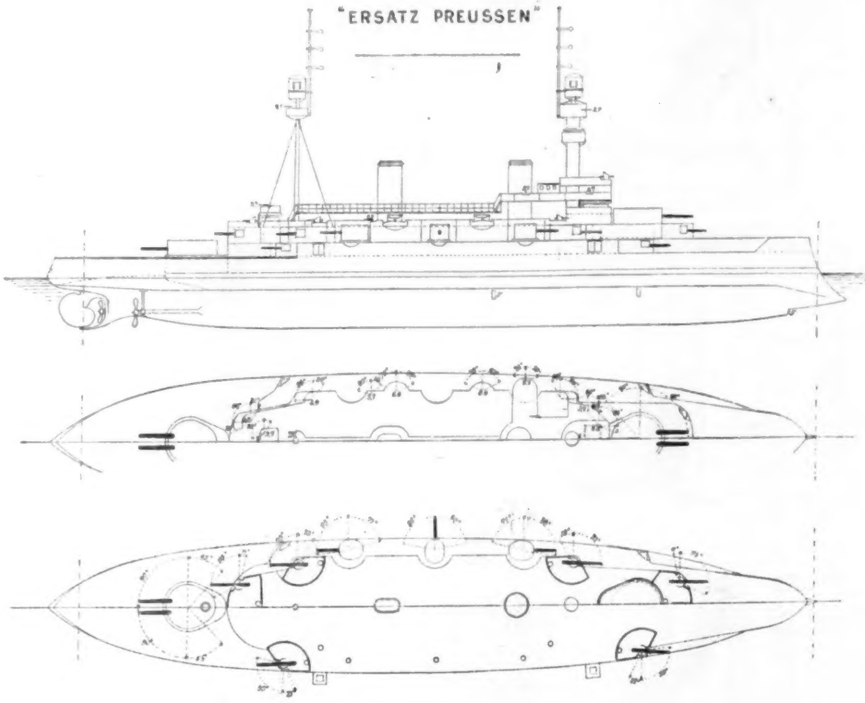
Cruisers to suit modern requirements were not commenced before 1885. Three of those vessels of the second-class have been built up to now, the Irene, Princess Wilhelm, and the Kaiserin Augusta; the last of which is the first triple-screw ship which crossed the Atlantic. Up to 1895 only one moderately armed and protected cruiser of the third-class—Gefion—was built, together with a number of smaller cruisers of the fourth-class—Bussard type. By this time the want of cruisers was felt so severely that three second-class cruisers of more than 5600 tons—Ersatz-Freya, K and L—and one first-class armoured cruiser of 10,650 tons—Ersatz-Leipzig—were commenced. To these vessels were added this year two more cruisers of the second-class—M and N.

A special feature in the German Navy has always been the "avisos," speedy vessels of small fighting capacity, designed only to serve as scouts for the fleet. But soon these vessels were required to fight, especially after the introduction of the torpedo; in consequence, the vital parts had to be protected. Out of the last German vessel of any size built abroad, by the Thames Ironworks, 1875-76, viz., the Zieten, the modern German "avisos" were developed. These were first of all the Blitz and Pfeil, with under-water torpedo armament and of 16 knots speed, forerunners of the later-built English boats, Surprise and Alacrity. The Greif, of 19 knots speed, succeeded in 1885, and was followed by the Wacht and Jagd, of 19½ knots speed, and fitted with a protective deck. After these come two small "avisos" of the same speed, the Meteor and Comet, of 1000 tons, and then the "aviso" Hohenzollern, a splendid vessel fitted out as an Imperial yacht, with 21·5 knots speed, of about 4000 tons displacement. The last of the "avisos" is the Hela, of 2000 tons displacement, now beginning her trials. I will pass over the torpedo division boats and torpedo-boats, even though the development of these craft in Germany is very interesting.

This short review, perhaps, shows some of the difficulties which had to be dealt with to build up the Navy. But now the strong influence of his Majesty the Emperor, supported by the great efficiency of the German shipyards and steel works, and all those other trades which help to finish a modern man-of-war, opened up the way for the new development. In the years after 1870, as the material was needed for the naval vessels to be built in Germany, ironworks had first to prepare to fulfil the orders for material of the same quality as was required by the English rules, which were adhered to. Plates and angles were soon produced, just of the same good quality as in England; but it was difficult to forge heavy pieces, like stems, sternposts, and rudder frames for bigger ships, and for several years these had to be ordered from England. To-day in this respect, too, German works are equal to any



"ERSATZ LEIPZIG"



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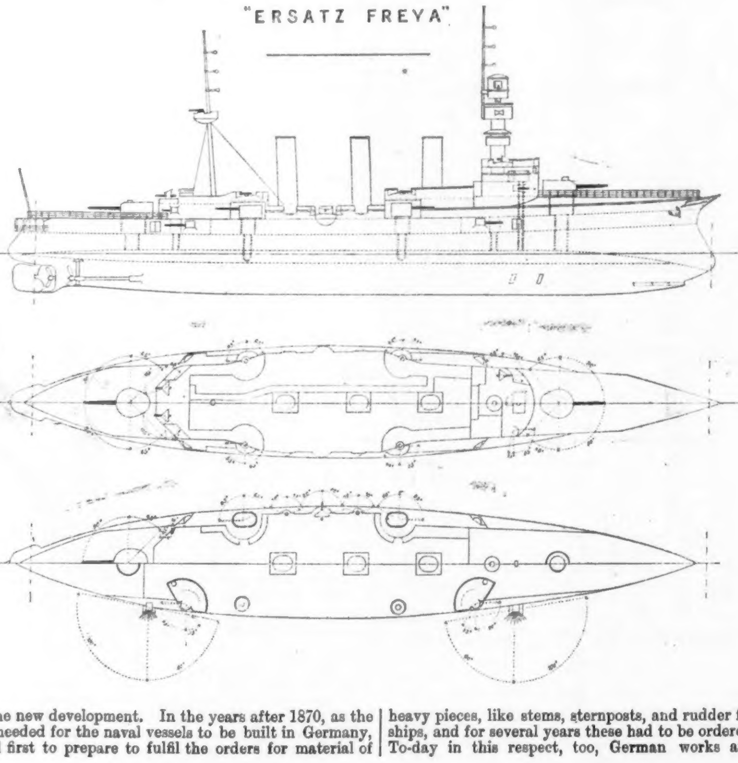

"ERSATZ FREYA"

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[*] Read at the summer meeting of the thirty-seventh session of the Institution of Naval Architects, June 9th.

demand; the stem and sternpost, with rudder frame of one of the armour-clads of the Brandenburg type made by Krupp was much admired at the Exhibition in Chicago. The production of armour plates for our armour-clad ships and vessels shows a rather slow development. The armour plates were first ordered in England from Charles Cammell and Co. and John Brown and Co., both in Sheffield. In 1876 the Dillinger Works on the Saar made preparations to produce iron armour, and furnished first the 203 mm. (8in.) plates for a number of armoured gunboats of the Wespe class, afterwards plates of 254 mm. and 305 mm. (10in. and 12in.) thick for two ships of the Sachsen type—the Baden and Würtemberg; and in 1879-80 plates 305 mm. (12in.) thick for the reconstruction of the König Wilhelm.

In 1880 the Dillinger works obtained the English "Wilson" patent for producing steel-faced armour plates—compound armour—and furnished those plates, first for the Oldenburg, and thereafter for all armour-plated German ships, until in 1890 steel-faced plates were superseded by nickel armour-plates, which are also produced by the Dillinger works. Since 1891 the works of Krupp, in Essen, also have made great preparations to manufacture armour plates. These two factories now work together, and not only can turn out all the armour-plates needed in Germany, but execute foreign orders also. The latest face-hardened armour-plates of these two works are perhaps the best plates produced anywhere. Germany has become perfectly independent in this respect also.

England has been Germany's teacher in the construction of hulls, engines, and boilers. Those ships which were bought from and built in England for the German Navy had to serve as standards from which to imitate the details. Our inspectors kept their eyes and ears open, and the many publications, as, for instance, Sir Edward Reed's and Sir William White's precious works, the "Transactions" of the Institution of Naval Architects, the instructive articles in the periodicals, THE ENGINEER and *Engineering*, offered an abundance of information to those who intended to learn, like the Germans of that time. The engines of the screw frigate Elizabeth had to be ordered, in 1867, from England—Maudslay—because they could not be designed and built in Germany. The first larger screw engines for navy ships were constructed in 1871, and in the following years at the works of Egells, in Berlin, for the corvettes Ariadne and Luise, and at the Vulcan works in Stettin, 1874, for the armour-clad Hansa. These engines were of English model in general design, and entirely so in all details. But since that time German industry has made such progress in the building of large marine engines that it now comes up to the highest standard, and has grown to be wholly independent. Already, nearly twenty years ago, German manufacturers went their own way in working out the plans and the details of engines and boilers, taking advantage of all the new inventions in England and France. To-day, the construction of navy vessels in Germany is worked out from original ideas, in order to fulfil the military requirements for each type. The new German men-of-war now in course of construction will, in many respects, be worthy of interest, since all modern improvements in science and technical knowledge has been taken advantage of to produce a most perfect tool for any war purpose.

I shall describe now, in a few words, some arrangements in which German men-of-war, in my opinion, differ from the English-built warships. I mention here, first of all, the divisions into water-tight compartments. The armour-clads, armoured cruisers, and protected cruisers are divided into as many water-tight compartments as it was deemed possible without interfering with the working of the vessel. Perhaps this is carried out already too far, and the service on board may be obstructed. The paper of Lord Charles Beresford read before the meeting of the Institution in March of this year mentions those considerations which prompted the constructor here to carry every athwartship-bulkhead above the waterline, without any door in it. Any door may be left open, therefore one has to accept the probability that it will be left open; and, consequently, it is better to have no door at all. Communication from one engine-room to the other, from one stokehold to the other, must be established only over the protective deck, above water, or may be carried on below by telegraphs and speaking tubes. Only in the athwartship bulkheads which are beneath the protective under-water deck of citadel ships, or in the foremost and aftermost parts of protected cruisers, doors are permitted. This circumstance speaks strongly against the construction of such vessels. The above-mentioned principle is strictly adhered to in all new German Navy vessels. It is difficult to ventilate a ship divided in this way. Air from above must directly lead into, and out of, each compartment between two athwartship bulkheads, which has direct access from above. Only for the forward and aft compartments underneath the protective under-water decks air ducts are carried through the athwartship bulkheads, and water-tight shutters have to be provided for, which are perhaps insufficient, but have to be made use of in vessels of the citadel type.

Modern vessels suffer a great deal from the heat which radiates from the steam piping belonging to the large number of auxiliary engines installed in all parts of the ship, and which supplies the ship with continuous steam heating. All attempts of engineers to cover these pipes with non-conducting materials, and to insulate them so as to prevent this radiating heat, have entirely failed, and every room through which a steam pipe is carried is heated very disagreeably. The best method of counteracting these effects of steam engines and steam pipes was found to be by omitting them, and by employing electricity, the conducting wire taking the place of the steam pipe. Only by driving the many fans made necessary for the water-tight compartments by electricity is the division into so many compartments rendered at all possible. All new German warships in course of construction have electricity as motive power, not only for those ventilating fans, but also for the turning gear of the 15 mc. gun-turrets, for ammunition hoists, for boat-hoisting, and coaling winches, and such like gear. For the turning gear and ammunition lifts of the heavy guns, hydraulic power has been retained, and steam is still used for the steering gear where it was especially difficult to install the electric motor, as well as for the anchor windlasses, which are only comparatively seldom used. Only one vessel in the German Navy, the nearly finished Aegir, is experimentally fitted throughout with electric appliances even for steering gear and windlasses. The results of these experimental installations will decide if, in the future, electricity can be used more extensively for motive power on board ships, and if the heat sources can be further dispensed with.

His Majesty's cruiser Kaiserin Augusta, of 6300 tons displacement, over 13,000 indicated horse-power, and with a speed at load draught of over 21½ knots, is the first German vessel with three screw propellers; she is also the first triple-screw steamer which ever crossed the Atlantic. [In 1893, in order to be present at the celebration of the four hundred years' jubilee of the discovery of America.] It is hardly necessary to discuss at any length the considerations which caused the adoption of a system accepted already some time before in Italy for the Tripoli, and decided on in France for the Dupuy de Lôme. By dividing the excessive motive power of the modern warships into three parts, the smaller engines could be more easily constructed, and, as they do not stand so high, it is less difficult to place the vertical engines underneath the protective deck. In a combat additional security of working is provided, as compared with the twin-screw ships, and, lastly, saving of fuel should result in using only one of the smaller engines when cruising at reduced speed. Although the engine-room staff has to be augmented, greater engine space is required, and the three engines themselves are to a small extent heavier, these disadvantages were not considered important enough to outweigh the advantages of the triple screw for all battleships, and for the first and second-class cruisers in the German Navy. Triple screws are provided for the new battleships Ersatz-Preussen and Ersatz-Friedrich der Grosse, the armoured cruiser Ersatz-Leipzig, and the second-class cruisers Ersatz-Freya, K, L, M, and N.

In all the new ships the armament and its protection, in accordance with the latest experience, requires so much of the weight which makes up the displacement, that somewhere else weight had to be saved, which would be available for armour and guns. Nowhere could weight be reduced, since more was asked for everywhere. Though, to facilitate work, more auxiliary machinery is installed, the number of the crew is not diminished; these engines require even more attendants. The weight of hull is, through rational construction and reduction of the scantlings, lessened as much as the strains will permit, in some cases even in excess of a sufficient margin of safety. Considerable reduction in the weight of the ships' hulls was effected by the restricted use of wood. The splinters of wood scattered by penetrating shells were always dreaded, the experiences drawn from the battle at Yalu have clearly shown how dangerous such combustible material as wood is for the construction of a ship and its fittings.

In the outfit and the construction of the new German ships wood is used only for a few minor parts. Wooden deck planks are no longer laid, steel deck plating is covered with linoleum, sometimes over a layer of cork. In the crews' quarters the sides of the ships are not ceiled; in the officers' rooms the ceiling is made of steel plates, 1½ mm. thick, and lined with cork. For cabin bulkheads the steel is covered with thin woollen cloth, and with cork lining underneath where it is desirable to exclude sound or lower the temperature. Where heat is radiated from engine or funnel casings cork lining is resorted to. All wood is removed from the ammunition rooms, save the racks for shells and powder charges, which are still made of wood. For all ladders and steps steel is used. The handrails on the conning bridges are no longer of wood, but of some other material which will not burn or splinter, and which is more agreeable to the touch of the hand than steel or brass. Chart-houses and captains' rooms on bridges are entirely made of steel, and fitted out with non-combustible materials. Since all such changes will be a little exaggerated, it seemed to be advisable to abandon wood for the interior fittings, and especially for the furniture, and to resort to fireproof material, which will not splinter. Many things were tried: furniture was made of steel and aluminium, lined with cork and covered with linoleum or canvas, but it was not equal to wood furniture. Only the bedsteads are constructed of iron, steel, or brass, which materials are also much in use ashore. The insignificant quantity of wood in the few pieces of furniture when ignited is not the dangerous source of smoke, but much more is the outfit of the state-rooms, the mattresses, blankets, clothing, books, &c. Therefore, for the present, wood cannot be abandoned entirely. Top and signal masts, flag poles, &c., will be made of steel, but there one cannot save weight.

Details as to German Warships in Course of Construction, 1896.

Class of ship.	1st Class battleship.	1st Class cruiser.	2nd Class cruiser.	2nd Cl. cruiser.	2nd Cl. cruiser
Name.	Ersatz-Preussen.	Ersatz-Leipzig.	Ersatz-Freya.	K.	L.
By whom designed	A. Dietrich, Constructor-in-Chief	As before	As before	As before	As before
When and where laid down	Imp. Dockyard, Wilhelmshaven. March, 1895	Imp. Dockyard, Kiel, Autumn, 1895	Imp. Dockyard, Danzig, October, 1895	Vulcan Works, Stettin	Weser Works, Bremen
Date of completion (presumed)	1898	1898—99	1897	1897	1897
Material of hull	Steel	Steel, wood sheathed, Muntz metal bottom	Steel	As before	As before
Length between perpendiculars	115·0 m.	120·0 m.	105·0 m.		
Breadth extreme	20·4 m.	20·4 m.	17·4 m.		
Mean load draught	7·85 m.	7·9 m.	6·25 m.		
Displacement in tons of 1000 kg.	11,130	10,650	5650		
Armament:—					
(1) Ordnance	Four 24 cm. in two armoured revolving turrets	Four 24 cm. in two armoured revolving turrets	Two 21 cm. in two armoured revolving turrets		
	Twelve 15 cm. Q.F. in armoured single casemates	Six 15 cm. Q.F. in armoured single casemates	Four 15 cm. Q.F. in armoured single casemates		
	Six 15 cm. Q.F. in armoured revolving turrets	Six 15 cm. Q.F. in armoured revolving turrets	Four 15 cm. Q.F. in armoured revolving turrets		
	Twelve 8·8 cm. Q.F. with shields	Ten 8·8 cm. Q.F. with shields	Ten 8·8 cm. Q.F. with shields		
	Twelve 3·7 cm. Q.F. machine guns	Ten 3·7 cm. Q.F. machine guns	Ten 3·7 cm. Q.F. machine guns		
	Eight 8 mm. Q.F. machine guns	Eight 8 mm. Q.F. machine guns	Four 8 mm. Q.F. machine guns		
(2) Torpedoes	One 45 cm. † stem tube Four 45 cm. ↓ broadside tubes One 45 cm. † stern tube	One 45 cm. ↓ stem tube Four 45 cm. ↓ broadside tubes One 45 cm. † stern tube	One 45 cm. ↓ stem tube Two 45 cm. ↓ broadside tubes		
Armour:—					
Belt	On ⅔ length from forward thickness 300, 250, 200, and 150 mm. hardened steel	All round the water-line, thickness 200 and 100 mm. hardened steel	—	As before	As before
Turrets	24 cm. 250 mm. thick 15 cm. 150 mm. thick	24 cm. 200 mm. thick 15 cm. 100 mm. thick	21 cm. 100 mm. thick 15 cm. 100 mm. thick		
Casemates	15 cm. 150 mm. thick	15 cm. 100 mm. thick	15 cm. 100 mm. thick		
Conning towers	280 and 150 mm.	200 and 100 mm.	200 and 100 mm.		
Armoured decks	On top of belt, 65 mm.; underwater armoured deck aft, 75 mm.; splinter decks, 20 mm.	On the citadel on top of belt, 50 mm.; before and abaft, 30 mm.; underwater armoured deck before and abaft, 50 mm.; splinter decks, 20 mm.	Horizontal above-water part of protective deck, 40 mm.; inclined sides, 100 mm.		
Makers of machinery	Imp. Dockyard, Wilhelmshaven	Imp. Dockyard, Kiel	Germania Works, Tegel, Berlin	Vulcan Works, Stettin	Weser Works, Bremen
Number of screws	3	3	3	3	3
Indicated horse-power	13,000	13,500	9000	9000	9000
Engines	Vertical 3-cyl. triple-expansion	Vertical 4-cyl. triple-expansion	Vertical 3-cyl. triple-expansion	Vertical 4-cyl. triple-expansion	Vertical 4-cyl. triple-expan.
Boilers	For ⅔-power cyl. Scotch boilers For ⅓-power water-tube boilers	For ⅔-power cyl. Scotch boilers For ⅓-power water-tube boilers	Niclausse boilers	Belleville boilers	Dürr boilers
Speed at load draught	18 knots	18·5—19 knots	18·5 knots	18·5 knots	18·5 knots
Coal capacity at load draught	650 tons (of 1000 kg.)	1000 tons (of 1000 kg.)	500 tons (of 1000 kg.)	500 tons (of 1000 kg.)	500 tons (of 1000 kg.)
Masts	Two military masts with fighting tops, foremast with inside ladderways	As before	As before	As before	As before
Number of crew	655	565	439	439	439

The fighting capacity of the ships is without doubt increased through these innovations, since the ship is less apt to burn, the effects of splinters are restricted, and considerable weight is saved, which is available for ordnance and armour. But still greater reductions were needed, and though the power of the engines had to be raised their weight had to be kept as low as possible. In the engine department the condenser plant is now exceedingly complicated; also, the boilers are at present very heavy in consequence of the high pressure used; boiler feed-water, which was formerly not needed, has to be carried; and the weight of machinery has increased above that of the old engines with low pressure when the boilers were fed with sea water. Granted the modern engines consume less coal, might it not be better to save weight with a less complicated engine and carry more coal? I only refer here to engines of war vessels where quite other conditions prevail than in the mercantile marine, where the vessels always go at full power, while the man-of-war very seldom utilises the full power of her engines and boilers. This is a chapter by itself worth the investigation of a specialist, who could thoroughly clear up this question, but it is outside the scope of this paper.

The engine weights could not be reduced, so one had to look for reduction to the boilers, which represent such a considerable weight. Here a reduction could be had by adopting the water-tube boiler. This problem of the water-tube boilers is one of the most important and difficult ones in modern marine engineering, and is very actively discussed in the English, French, and German navies. Subsequently to the French and English navies, the German has also taken decided steps, accepting water-tube boilers for many vessels. Not less than four different kinds of water-tube boilers are adopted for the new German ships now in course of construction, viz.:—Aegir, armour-clad fourth-class, 4800 indicated horse-power, Thornycroft boilers; Ersatz-Freya, cruiser, second-class, 9000 indicated horse-power, Niclausse boilers; K, cruiser, second-class, 9000 indicated horse-power, Belleville boilers; L, cruiser, second-class, 9000 indicated horse-power, Dürr boilers. The two armour-clads of the first-class, as well as the armoured cruiser, Ersatz-Leipzig, will be fitted with two cylindrical boilers and one-third water-tube boilers of the system, which will be found best from the results of the trial trips soon to be commenced. The English Navy seems to prefer Belleville boilers for bigger ships, the French Navy provides for these ships, together with the Belleville boiler, those of D'Allest and of Niclausse; the Dürr boilers are very similar to those last mentioned. The trial trips of this and the next two years will show more clearly the value of the different types of the boilers. All the so-called theoretical discussions and contentions are useless; only practical experience can decide this question, but years may lapse before it is settled. In the future the use of water-tube boilers cannot be avoided in navies. By fitting them for one-third of the engine power—13,000 indicated horse-power—in first-class ironclads about 140 tons of weight are saved; and the reduction of weight for second-class cruisers of 9000 indicated horse-power where water-tube boilers are entirely used amounts to about 280 tons. The combined working of water-tube and cylindrical boilers was the subject of a paper at the meetings of the Institution last year, but no decided opinion was arrived at. In the Dutch Navy, too, the combined system is adopted for the three new large cruisers, but in a different form to ours, as the Dutch intend to generate two-thirds of the engine power with water-tube boilers, and one-third with cylindrical boilers. The leading idea in the German arrangement is that, as a rule, the vessel steams at reduced speed, and uses only one set of cylindrical boilers, keeping the other free for easy cleaning. The water-tube boilers are provided in order to get up, in the shortest time, steam for the highest engine power; at all other times fires are drawn from those boilers.

The greater coal consumption seems to be a drawback to the use of water-tube boilers; only actual trials of ships in service will decide the merits of each type of boiler. In the meantime we are in the dark. It is at any rate hazardous to proceed with the use of water-tube boilers, so long as we have only the experience acquired in the French Navy, and nowhere else; but the increased fighting power demanded, which cannot be provided otherwise, forces us to such action. What an engineer of note wrote a short time ago in the *Daily News* is certainly correct, viz., "In the next war the side which has the best boilers will win."

Some more characteristic features of German ships of war could be brought forward; for instance, the fact that the protective underwater deck is never cut through for ventilation or coaling purposes; then the peculiar construction of the cork-filled coffer-dams; the singular shape of the stern and rudder; the very high bow and low stern; but it would take too much time to thoroughly deal with them. The annexed table and three sheets of sketches contain the particulars of the German men-of-war of the latest type. I trust, though this paper is necessarily very incomplete on account of the very short time available for its preparation, the Institution will perceive from it how hard we had to work here in Germany to call into existence a navy in the short space of a quarter of a century; how we had to study and to test, in order to achieve the result that the vessels planned by German designers, and constructed out of German material in German dockyards, shall be fully equal to the vessels of the old English and French navies. I hope that this may be the case.

THE Belgian Conseil Supérieure de l'Industrie et Commerce, which was organised in accordance with a Royal Decree in 1890, has been reconstituted by another Royal Decree of 15th January last; and the elections to this arbitration board have just taken place. The members for the Province of Liège, returned without opposition, include for engine construction, M. Charles Beer, engineer, and M. Timmermans, general manager of the Atelier de la Meuse; for the iron industry, M. Greiner, general manager of the Cockerill Works, and M. A. Race, Administrateur Délégué of the Pugrée Company; for metalliferous mines, M. Taskin, director of the Angleur Company, M. C. Timmerhaus, engineer to the Vielle-Montagne Company; for collieries, M. Léon d'Andrimont, President of the Hasard Colliery, M. Joseph Dubois, general manager of the Marrihaye Colliery, and one of the inventors of the Dubois-François rock drill and *bosseyeuse*, and M. C. Petit, general manager of the Bois d'Avroy Colliery. The great questions now to be dealt with by this body are the labour contract, and compensation for injuries sustained during work.

THE VULCAN WORKS, STETTIN

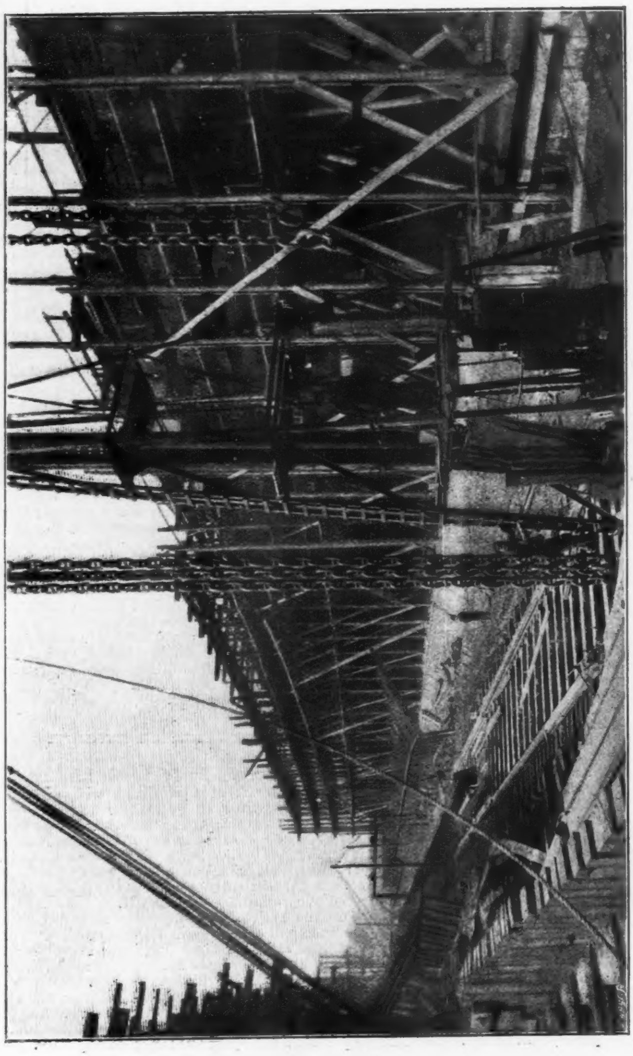


Fig. 1—LAYING THE KEEL OF A MAIL STEAMER

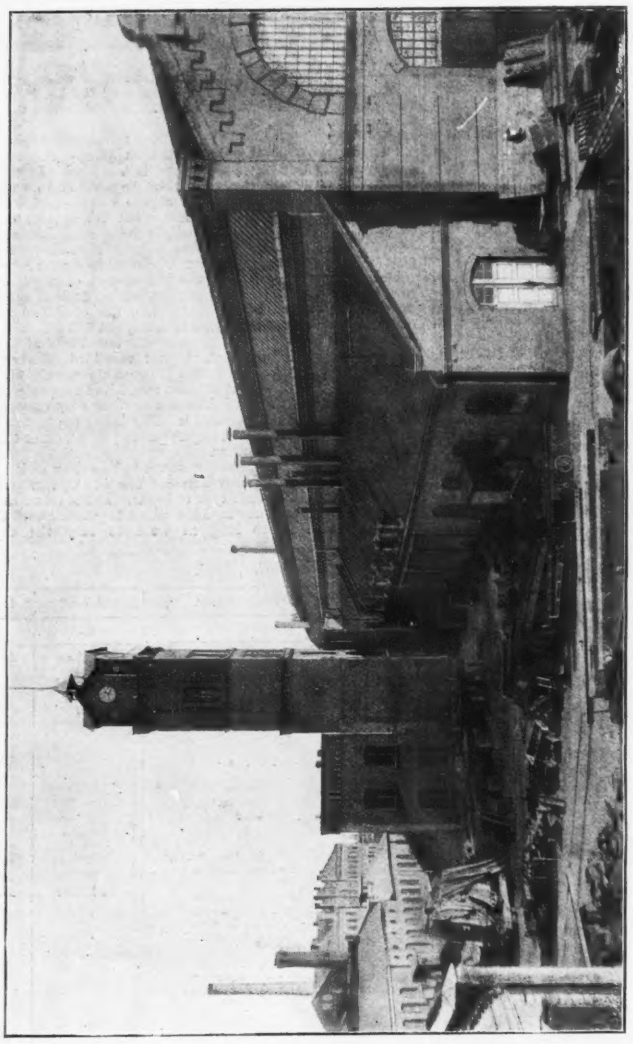


Fig. 2—FOUNDRY AND CLOCK TOWER

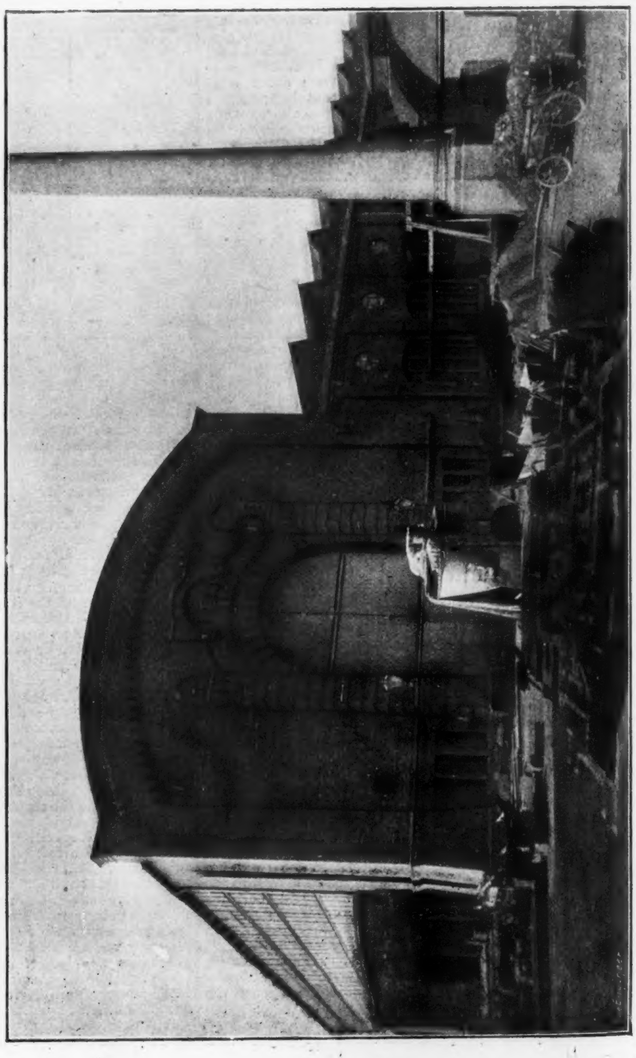


Fig. 3—FRONT VIEW OF ERECTING SHOP

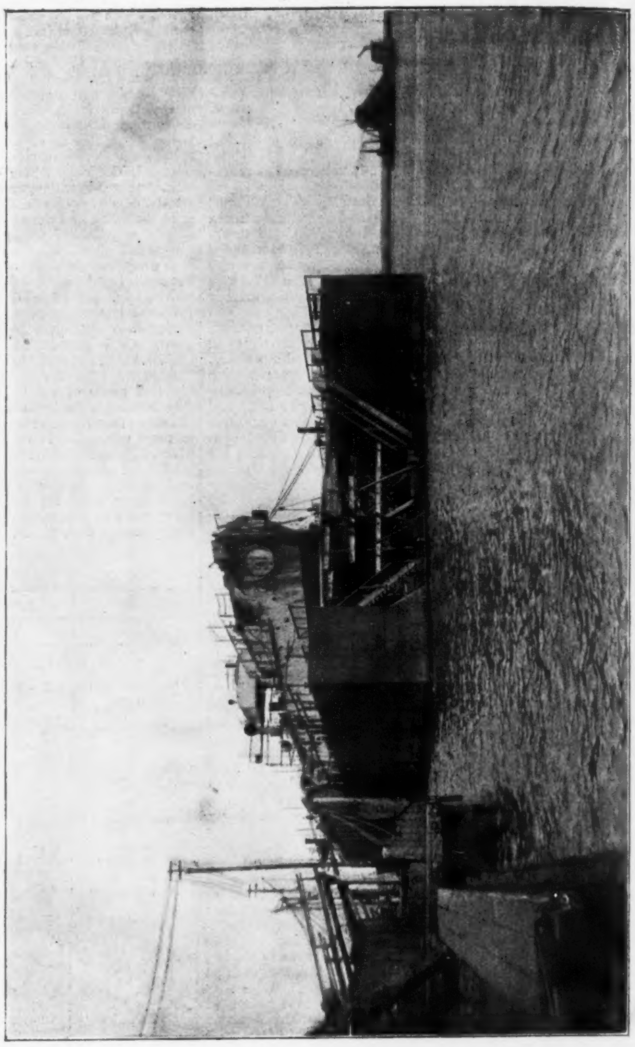


Fig. 4—BRAZILIAN IRONCLAD 24 DE MAYO, IN FLOATING DOCK

THE VULCAN WORKS, STETTIN

Fig. 5

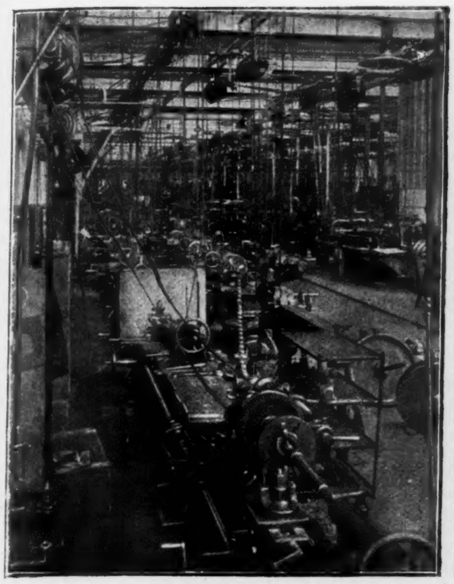


Fig. 6

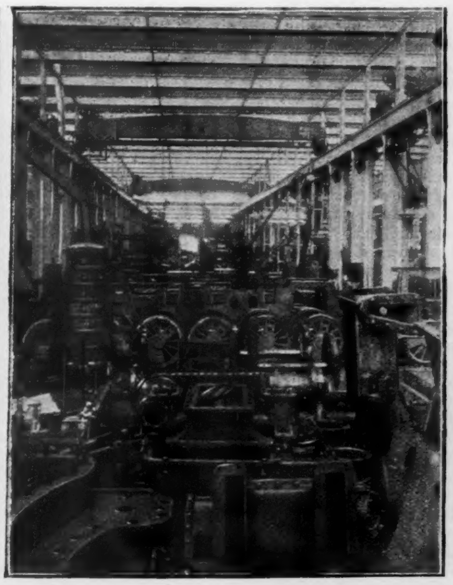
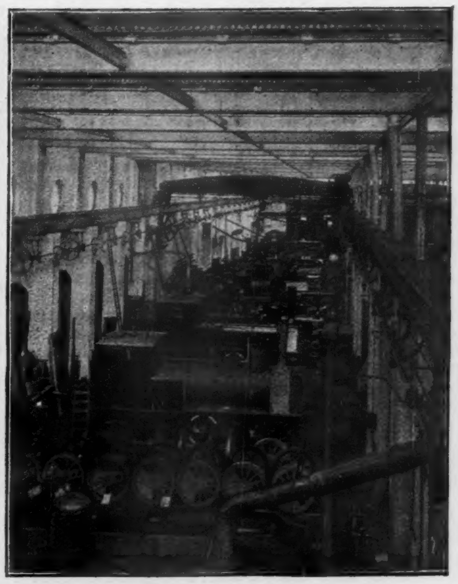


Fig. 7



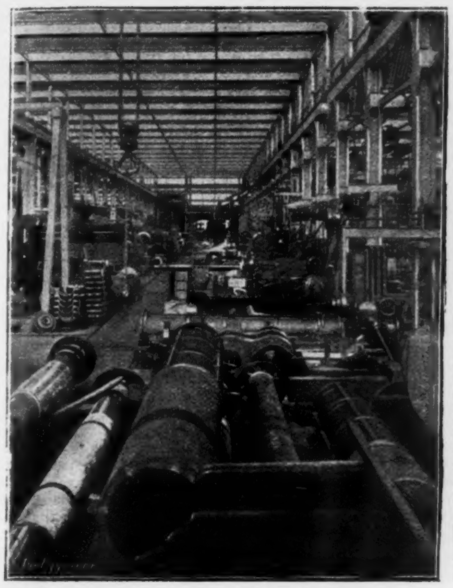


Fig 8

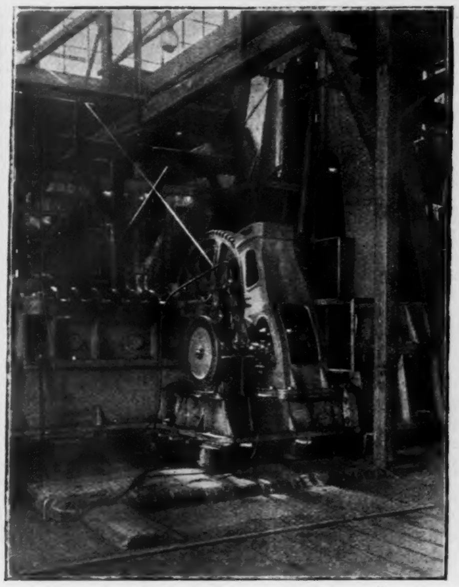


Fig. 9

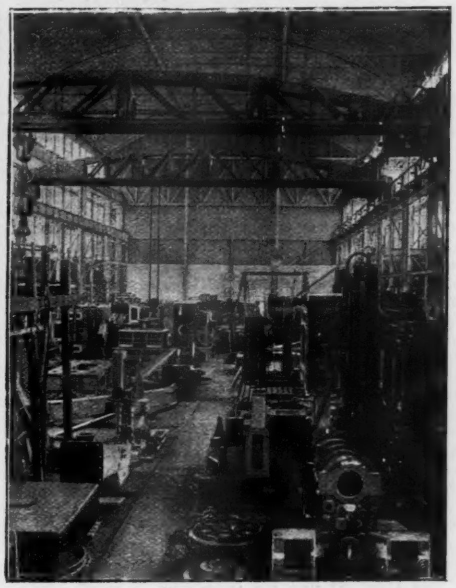


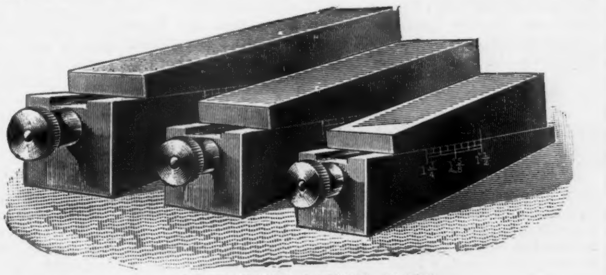
Fig. 10

THE VULCAN WORKS, STETTIN.

In our last impression, on page 564, we gave a bird's-eye view of these celebrated works and a general description. We now give above and on page 588 a series of reduced photographic pictures, which will serve to convey an idea of the magnitude and importance of the place. Fig. 1 possesses special interest, as it shows the ways prepared for laying the keel of what will be the largest ship in the world—a great liner of 20,000 tons displacement and 28,000 indicated horse-power. Figs. 2, 3, and 4 explain themselves. In the engravings above, Fig. 5 is a view taken in one of the large turning shops, Fig. 6 is an erecting shop in which locomotives are in progress of construction, Fig. 7 is another view in the same shop, Fig. 8 is a view in the heavy erecting shop for marine work, Fig. 9 shows a marine engine in course of erection, and Fig. 10 is a view taken in the main erecting shop, of which Fig. 3 is an external view.

THE SUNDALE PACKING BLOCK.

The accompanying illustrations will explain themselves to engineers, and the want of a packing block capable of being quickly and accurately adjusted in thickness, and so arranged as not to shake loose in working, has long been felt, and the packing block illustrated herewith has been introduced by Messrs. Selig, Sonnenthal, and Co. to fill such want, and so supersede the large and miscellaneous assortment of old nuts, old washers, broken flanges, bits of tin, &c. &c., which are to be found in nearly all engineers' shops, piled up by the side of every machine, for use as packing blocks in setting jobs. The Sundale blocks are quickly adjusted, and are provided with a fine adjustment by screw, which is continuous throughout the whole range. The adjusting screw also admits of the use of a steeper angle of wedge than is possible in the case of ordinary plain double wedges without a screw. This gives a wider range, and there is no danger of shaking back. The packing block can be accurately adjusted to any definite thickness—within its capacity—by means of a scale on the side.



THE SUNDALE PACKING BLOCK

THE LIGHTING CORPORATION, LIMITED.

Like many others, we watched with some touch of sentimental misgiving the demolition of the chapel at Bloomsbury, and wondered what sort of corporation had ventured to appropriate this site for purposes of commerce; therefore, in answer to an invitation, we attended various functions arranged and provided by the Lighting Corporation, Limited. The functions consisted of a banquet in the basement of the Woolpack Restaurant, Gracechurch-street, E.C., a subsequent dramatic entertainment at the Duke of York's Theatre, and a final reception and supper in some windowless rooms at the Corporation's offices in Bloomsbury. From the speeches after the banquet we gathered that these agreeable functions had been arranged so as to enable the visitors to judge as to the efficiency of the illumination and ventilation, effected by the improved Wenham light, which the Lighting Corporation is now exploiting, and had installed in various places, along Piccadilly for instance, as well as in the room in which we were, in the theatre in which we would be, and in the suite of rooms to be visited still later. The basement of the Woolpack is a large low-pitched room, and was remarkably stuffy when we arrived; but later on, when the lights were turned up, the atmosphere cleared and the ventilation improved, although about 200 people were present, many of them smoking, and the lamps, like the old Wenham lamps when new, gave a bright and pleasant light. At the theatre, too, the ventilation was good, whilst at the crowded reception afterwards we were much struck by the excellence of the light, for the rooms were artistically decorated with ornament in various materials, stone, metal, wood, fabrics, and paper, and in diverse colours, besides oil paintings, water colours, and sculpture—all could be seen to good effect by the single light in the centre of each room; and further, in spite of the crowded assembly in these windowless rooms, no oppressive sensation and yet no draught could be noticed.

We, therefore, the following day visited the works privately in order to see for ourselves the appliances adopted to produce the gratifying effects that had been so generally admired the evening before; and we are now able to give a description of these appliances. They consist of arrangements—(1) For governing, conveying, pre-heating, and consuming the gas; (2) for admitting, pre-heating, and directing the course of the air supply; and (3) for disposing of the products of combustion and hot air, which, of course, constitutes the ventilative factor. All these things have been done before, and all have been done in a somewhat similar manner, and many failures have been recorded; but with the various improvements introduced in the present instance, success is anticipated by the enterprising Corporation.

The governor is a bell governor with a mercury lute, the pressure being regulated by a lever with sliding weight resting on the top of the bell, and is very steady under great variations of consumption; a main pipe with a spiral bye-pass takes the gas to the ring burner, to which part of the air is supplied at the centre through radiating channels meeting in a central chamber, and at the other end opening into the air; the balance of the air supply enters through perforation in the periphery of a ring, between which and a lower ring the flange of a suspended hemispherical glass is loosely clamped, silicated cotton packing being used to avoid the contact of the glass and metallic surfaces; the glass globe directs the air on to the flame. The hot products of combustion and heated waste gases escape through an annular space round the ring burner, pass between and heat the radiating air supply channels previously mentioned, are then directed by a conical sheet metal screen to a cylindrical sheet metal chimney which surrounds the gas supply pipes, and these, of course, become heated. The waste gases are then delivered into a gas-box, from which they pass into a flue, suitably placed in floors and walls, and protected by non-conducting silicated cotton; into the same flue the hot air in the vicinity of the lamp is drawn through orifices in the outer casing. The flue terminates in the external air with a cowl having an upright cone in the mouth to prevent any back draught. A pilot flame is used for lighting the lamp.

THE INCORPORATED GAS INSTITUTE.

THE thirty-third annual general meeting of this Institute opened on Tuesday, the 9th inst., at the rooms of the Society of Arts, London, under the presidency of Mr. W. R. Chester, M. Inst. C.E. The report of the Council shows a net increase in the membership of 44 during the year. The loss sustained by the death of Mr. Denny Lane, of Cork, a former president, meets with special notice. The accounts show a net profit of £86 11s. 1d., making up a balance of £935 14s. 6d., to be carried to next year's profit-and-loss account. The president's medal and a prize of £10 have been awarded to Mr. D. Irving, of Bristol, for a paper on "Unaccounted-for Gas," read at last year's meeting; a second prize of £6 to Mr. Lewis T. Wright, of Westminster, for one on "Matters of Interest in Connection with the Washing of Crude Coal Gas"; and a third prize of £4 to Mr. C. S. Ellery, of Bath, for a paper entitled "Some Improvements in Methods of Manufacturing Sulphate of Ammonia."

The President, in his inaugural address, alluded to the flourishing condition of the Institute, which he said had recovered from the effects of the secessions which culminated eight years ago in the formation of a rival body. He then reviewed the growth of the gas industry in the country during the past year. According to the Board of Trade returns, about 1¾ millions sterling represents the increase in the capital invested in gas undertakings, and the make of gas shows an increase of over 3 per cent. He then referred to the erstwhile hated rival, but now "colleague" of gas, viz., electricity, and proceeding from general remarks to the particular case of the gas and electricity supplies of Nottingham, he concluded that a given amount of light cost for electricity 2·72 times as much as for gas. It was pleasing to hear the engineer of the Corporation Gasworks bearing testimony to the fact that since the electricity works at Nottingham opened two years ago, there had not been a single failure, nor a single instance of the full voltage not having been maintained. We notice that the President credited the ordinary flat-flame burner with an efficiency of 3½ candles per cubic foot of Nottingham gas. The Metropolitan consumer, who seldom invests in the "London Argand" burner, and hence regards so high a duty for gas as fabulous, will envy his Nottingham brethren their richer supply. Mr. Chester proceeded to disclaim, on behalf of the gas industry, a desire for abnormally cheap coal, and considered that fluctuations in price were more injurious to it than a somewhat high but stable cost of its raw material. He blamed the oft-reviled middleman for the prevailing low price of sulphate of ammonia, and recommended the Sulphate Manufacturer's Association to the attention of members. But so long as Beckton has unused retort house stages on which to store several months' production of sulphate, the middleman can scarcely be considered to hold producers "in the hollow of his hand." Tar and its products advanced in price, notwithstanding the alleged attempt on the part of distillers to keep it low. The President suggested the establishment of a sliding scale, based on the profits of the distiller, to fix the price of tar, and disapproved of the erection of competing tar distilleries in gas works. He considered there were no signs of the coke market rallying, but recommended members to endeavour to improve the quality of their product, and to sort and cut it according to the needs of customers; and instanced the wide market which Nottingham coke thus obtains, in support of his advice. The gaseous firing of retorts had, in his opinion, effected a saving of at least 2¼d. per 1000 cubic feet of gas made, and the principle had the advantage of being readily applied to inclined retort settings. He considered this system "especially well adapted to moderate-sized works, where full employment cannot be found for carbonising machinery." The introduction of the latter he regarded as a blessing to both employer and employed; but he spoke with some hesitation of the advantages of an auxiliary carburetted water-gas plant. We must confess to a sense of disappointment that he did not make more than a passing allusion to improvements in the methods of purification, and to the recovery of cyanogen compounds from gas, more especially as there were no papers before this year's meeting dealing with these matters. The process for the extraction of cyanogen, which has been used in London for more than a year, is no secret; but many others have been recently tried on an extensive scale, and the criticism of so good a chemist as Mr. Chester would have been very welcome. On the subject of gasholder construction he was less reticent, and spoke of rope-guided holders from actual experience of their working. He discussed at some length the transfer of gas undertakings from private to public control, and the more rapid fall in the interest charges in the case of local authority supply than in the case of company supply. He concluded his address with an appeal to members to come to the aid of the Benevolent Fund of the Institute, which has of late years inadequately met the growing demands upon it.

The President's address, though singularly free from contentious matter, was highly suggestive, and showed an excellent appreciation of the present position of the gas industry. We have already said that we wish he would have seen his way to have amplified it in more than one direction, especially as some of the papers which followed it were of comparatively little merit, and might with the discussions they induced have been curtailed with much advantage. The paper by Mr. E. Lloyd Pease, of Stockton, on "New Details in Gasholder Construction," was, however, of considerable interest. The "new details" referred solely to rope-guided holders, four typical cases of gasholder construction or enlargement on this plan were taken as the basis of the paper. Of these, the most notable was that of the three-lift holder recently constructed at Middlesbrough. This has a diameter of 184ft., and consists of three lifts 30ft. deep, in a steel tank on the surface of the ground. This is the largest columnless gasholder in existence, and as it was said to have worked in a perfectly satisfactory manner, Mr. Pease may be considered to have vindicated the efficiency of rope guiding for large as well as small holders. He pointed out that the weight of the Middlesbrough holder, 350 tons, was employed in the construction of one column half as high as it is wide, carried and formed into a rigid whole by the confined gas, while the weight of the standards which would be employed if ropes were not used would be 200 tons distributed in eighteen posts tied together by light girders and diagonal bracing, supporting its own weight, and, in comparison, decidedly loose jointed. He thought the suggestion that this light iron tracery was there to give assistance to the holder by preventing distortion was almost absurd.

"Gas Engines as Economical Motors" was the title of a paper by Mr. J. Holliday, of Scarborough, which was also read on Tuesday. The information given was taken from various sources, and in some cases was of rather dubious worth. The author anticipated the supplanting of steam by gas power in all small and moderate-sized electric lighting stations. He decided against the introduction of differential rates of supply for gas according to the purpose for which it was consumed, and believed that the use of motors would quickly spread on a general cheapening of gas supply. He suggested that gas works should supply motors on hire to suitably accredited consumers.

The proceedings on Wednesday, the 10th inst., opened with a lecture by Prof. Frank Clowes, D.Sc., of Nottingham, on "Explosive Mixtures of Combustible Gases with Air." The lecture was admirably illustrated by diagrams and experiments, and though most of the information has been given on other occasions, it formed a very welcome item in the Institute's programme. The following were among the more interesting points of the lecture:—The limiting percentages of coal-gas forming explosive mixtures with air are 5 and 28; of water-gas, 9 and 55. Many mixtures of gas and air which would not fire from above could be fired from below. The risk of a mixture being fired explosively increases with different gases in the following order:—Methane, ethylene, coal-gas, water-gas, carbon monoxide, hydrogen. Carbonic oxide, whether derived from the incomplete combustion of gas, or from escapes of water-gas, or similar mixtures, is a highly dangerous addition to the air; 0·2 per cent. produces an ill effect, and 2·0 per cent. is fatal to human beings if breathed for a short time. Dr. J. S. Haldane some years ago systematised the tests for carbonic oxide depending on the colour change it produces in blood. The detection of inflammable gas in air and its approximate estimation are best carried out by the flame-cap test, which has been brought to perfection by Dr. Clowes. He introduces a small hydrogen flame of definite height into the mixture to be tested, and observes the height of the halo or flame-cap which is produced. As a matter of common prudence, the flame is, of course, within a safety-lamp, and is fed from a small steel cylinder of the compressed gas. The hydrogen flame is superior to other flames on account of its greater heat, which produces a more vigorous combustion of the combustible gas in the air, or, in other words, a larger flame-cap. Since the heat of the flame determines the size of the flame-cap, it is evident that variations in its size will prevent accurate estimations. For the general use of Professor Clowes' hydrogen flame inflammable gas detector, tables have been prepared giving the percentages of coal gas in the air corresponding to different heights of the flame-cap. The instrument has now a fairly extended use in collieries and in gas-works, and is made in a conveniently portable form by Messrs. W. J. Fraser and Co., of London. A specimen of the Redwood-Clowes inflammable vapour detector was also exhibited to the meeting.

After the passing of a vote of thanks to Professor Clowes, a paper by Mr. E. H. Stevenson, M. Inst. C.E., on "The Principles Governing the Transfer of Gas Undertakings," was read and discussed. Briefly, the author gave in outline a method of capitalising the maintainable profit, and from the sum so found he proposed to make deductions on account of any part of the works or plant which was not in a proper state of efficiency. The discussion drifted into side issues, and scarcely touched the actual subject of the paper.

On Wednesday afternoon a paper by Mr. Norton H. Humphrys, A.M.I.C.E., of Salisbury, on "Letting Gas Apparatus on Hire," was discussed, in conjunction with one by Mr. A. Dougall, of Tunbridge Wells, on "The Popularisation of Gas," The latter dealt solely with the coin-meter system, which was accepted by the meeting without one dissentient voice as a valuable aid to the spread of the use of gas, and remunerative to gas companies. The improvements in coin meters have won over many gas managers who were formerly opposed to their introduction. The discussion on these papers frequently showed a lamentable want of appreciation of the relative importance of details, and much valuable time was wasted on trivialities.

The proceedings on Thursday, the 11th inst., the last day of the meeting, will be reported next week. The members of the Institute, of whom some 250 have attended the meetings, were asked to join a steamboat trip down the Thames on Friday, the 12th inst.

THE SHIPYARD AND FLOATING DOCKS OF MESSRS. BLOHM AND VOSS, HAMBURG-STEINWARDER.

THIS shipyard is to be visited by the Institution of Naval Architects on June 8th, and is situated on the Elbe, and at the entrance of the Schanzengraben, and has an area of over twenty-five acres. Founded originally on a modest basis, it is now, after having been in course of time considerably extended, in a position to build the largest vessels both for the Government and the merchant navy. The ground necessary has been recovered by dredging 654,000 cubic yards of sand from out the Elbe, so that the depth of water in front of the shipyard now permits the largest vessels to lie directly alongside the quay. The quays have a frontage of 1804ft. on the Elbe and of 787ft. on the Schanzengraben.

Directly opposite the shipyard are situated the two floating docks constructed of iron and consisting of six sections, each dock capable of lifting ships of a length of more than 300ft. A third much larger dock, capable of lifting vessels up to 17,500 tons displacement is now in course of construction. The large new buildings are entirely constructed of iron and brick. At the entrance of the shipyard are the main offices, consisting of the private rooms of the principals, where all the plans for the construction of the ships are originated, the offices for the shipbuilding and marine engineering departments, the general offices and a large model room, in which all the models of vessels built by the firm are exhibited.

At the east of the dockyard is the shipbuilding establishment, of an area of 5500 square metres, containing the furnaces, bending blocks, rolling, bevelling, punching, shearing and planing machines, as well as hydraulic riveting machines. In front of these works are the seven berths for the construction of ships up to 558ft. and more long. Next to these berths are the sheds of the angle-smiths, locksmiths, coppersmiths, and tinners. Opposite to the entrance of the yard are the engine works, fitted with the latest and most modern machinery for the construction of engines up to the largest sizes. Here we find large planing and cylinder boring machines, lathes, cranes, &c.; moreover three engines of 150-horse power each for driving the different lines of shaftings, as well as the dynamos for the six electric travelling cranes, capable of lifting from ten to thirty tons each.

The boiler works are also fitted with a full complement of special machinery and hydraulic tools for bending and flanging plates for boilers up to the largest sizes and highest pressures. Here are also a number of swing cranes, as well as three travelling cranes of a capacity of thirty tons each, driven partly hydraulically, partly by electricity. The smithy is of large size, and contains sixty hearths, &c., as well as different steam hammers of various sizes. The joinery works are a large building three stories high, entirely built of iron and brick and fitted with special machinery, such as moulding, planing, dovetailing, boring and milling machines, band and circular saws. Next to the joinery works is the sawmill, with large rack and band saws and planing machines, and adjoining this the carpenter's shop.

On the quays are the necessary cranes for lifting the material and placing on board the engines and boilers. There is a large shear-leg crane of a capacity of 100 tons, and a height of 92ft.; two stationary cranes of 20 tons each, one derrick crane of 10 tons, and three travelling cranes. A second very large derrick crane of 150 tons capacity at a radius of 66ft., 45 tons at 105ft. radius, and a height of 147ft. above ground, is in course of construction. Three tank locomotives and more than a hundred trucks are employed in transporting material, and a complete telephone system connects all departments. The number of workmen employed averages more than three thousand.

HORSELESS CARRIAGE NOTES.

THE following account by the Hon. Evelyn Ellis of a recent tour in his Daimler motor carriage will prove generally interesting:—"In February last I took my Daimler motor carriage to Marseilles with the object of touring through the Alpes Maritimes and the country generally lying between Marseilles and the Italian frontier. I found no road, however steep, which had a hard foundation, that could not be ascended, but, of course, at reduced speeds. The actual horse-power of my carriage is 3½; the weight of the carriage and motor complete 16 cwt. With three passengers, but without luggage, the vehicle attained an average speed of about eleven miles per hour on fairly level roads, with fine weather. I returned to Marseilles, and left that city for Havre during the third week in May, the route taken being *viâ* Lyons, Dijon, Paris, and Rouen, the distance, as nearly as possible, being 660 miles. The whole of the way to Dijon—300 miles—a very heavy northerly gale, 'the mistral,' accompanied with rain, hail and dust, blew right in our teeth, and throughout the journey to Havre, with the exception of two days, rain and strong northerly winds prevailed. The routine of each day was as follows:—Starting at 8 a.m., our first stoppage would be at 12.30 for lunch; the journey being resumed at 2 p.m., and a halt for the night made about 6 p.m., the distance generally travelled being from seventy to eighty miles each day. The speed during the whole of the journey averaged nine miles per hour, and the amount of petrol used as fuel was under twenty-nine gallons, with one gallon of lubricating oil and grease, the total representing, at English prices, a cost of 28s. 6d. The running time of the whole journey was nine days. During my stay on the Riviera I wore out a new set of solid rubber tires, owing to many of the roads being in such a bad state of repair, and for the trip from Marseilles to Havre I had to replace them with old wheels which were used in England last year. I also wore out two band brakes, owing to the many long and steep descents. Besides the foregoing, which was simply fair wear and tear, my only expense during the whole period from my first arrival on the Riviera until I reached Havre was 2f., this being incurred for a broken hook. I have frequently been told that a great objection to these carriages is the necessity of having a skilled engineer in charge, but this idea is utterly wrong. During the above journey I was accompanied by a man who had been fifteen years a coachman, but whose employer had given up his horses. This man being known to one of the firm who built my carriage, spent six weeks at their works learning the general details of the machinery, and how to drive the vehicle, and though he has never had any other mechanical training he has been everything I could require. Now, if this is possible in France, surely the average English coachman has enough intelligence to do the same, and would find no difficulty in adapting himself to the new order of things when this method of locomotion becomes more common."

MUCH doubt exists in the minds of many who are making oil and spirit motors as to the restrictions under which the light oils may legally be used. The subject is one which can be stated as far as the Acts are concerned, and on some points not defined by the Acts we can only be guided by a few decisions. To put the matter on a more definite footing, however, the Government is now, by Mr. Mundella's Committee, taking evidence, and inquiring generally as to the results of the various uses of petroleum, and as to the necessary regulations, more particularly on points such as the storage, use, public and private, sale, and carriage of light oils. Freedom to use these oils appears at present to be neutralised by limits as to storage.

RAILWAY MATTERS.

The total length of electric tramways in operation in Europe at the beginning of the present year was 902 kiloms. = 560 miles, stocked with 1747 cars, against 700 kiloms. = 435 miles and 1236 cars at the beginning of 1895. Of the above length Great Britain only possesses 109 kiloms. = 67 miles, while Germany has 406 kiloms. = 252 miles, and France 132 kiloms. = 82 miles. The trolley system is adopted on nine lines, as compared with three with underground conductor and eight with accumulators.

Comparative figures of the coal consumed per car mile run on French tramways, employing different methods of propulsion, are contained in an article on electric lines by E. Cadiat in the *Portefeuille Economique des Machines*. As regards storage-battery traction, on the lines from St. Denis to the Madeleine, and from the Opera to Neuilly, the car mileage aggregated, in 1893, 502,060, or 1376 car miles per day. The steam engines at St. Denis furnished for this service a total of 6500 H.P. hours, or 4·72 H.P. hours per car mile.

The Government of Chili, it is reported, will propose to limit the expenses of the State railways to the amount of their earnings, and will submit a Bill which will not permit the companies in future to fall back upon the National Exchequer for larger assistance. According to this Bill the directors of the railway department will yearly fix the estimates for the coming twelve months, and the total expenditure will have to be paid out of the income and not be provided for, as has been the case in the past, in the Budget, in which railways will no longer figure.

A new fast train service between New York and Buffalo, over the Lehigh Valley Railroad, was started May 17th. The trains will make the run of 448·6 miles in ten hours, leaving each end of the line at noon. On the first trip the northbound train made the run in nine hours forty-six minutes, or nine hours eight minutes running time. Each train, *Engineering News* says, consists of a combination baggage, dining, and smoking car, 77ft. long, with library, writing desks, &c., two Pullman day cars, and an observation parlour car, with a woman's sitting room and seating capacity for twenty-eighty persons.

A general classification of the accidents in April in America shows:—

	Collisions.	Derailments.	Other accid's.	Total.	Per cent.
Defects of road	0	14	0	14	15
Defects of equipment	4	13	0	17	18
Negligence in operating	12	7	0	19	20
Unforeseen obstructions	0	11	1	12	13
Unexplained	5	27	0	32	34
Total	21	72	1	94	100

When the Light Railways Bill was under consideration of the House on Thursday, the 4th inst., amendments were agreed to, (1) that the advance made for the construction of any light railway should not exceed one-half the cost of construction; (2) that the period during which the rateable value of the land used by the railway should not be increased shall be ten years instead of fifteen; (3) that the holding of a local inquiry shall be required in all cases; (4) a clause requiring the Board of Trade to report to Parliament when circumstances wherein variations in the provisions of the Lands Clauses Acts are necessary; and (5) Clause 13 was amended to allow in certain cases 10 per cent. for compulsory sale of land. It may be hoped that "cost of construction" will be properly defined.

On Tuesday a trial was made with one of the new engines which are being built for the fast service of the East Coast passenger traffic, the run being from Newcastle to Tweedmouth and back with six of the improved carriages attached. The engine "1869" has 20in. cylinders, with 27in. stroke, and 7ft. 7¼in. coupled driving wheels. The length of the coupling rods is 9ft. 6in., or 6in. longer than the coupling rods of any existing express engine. The driving wheels have 6in. greater diameter for coupled wheels than any other engine running. The engine works at a boiler pressure of of 175 lb. per square inch, but can be worked up to 200 lb. The tender will carry five tons of coal, but only 3000 gallons of water, against 4500 gallons with the engines now in use for this traffic. The North-Eastern is to introduce the pick-up arrangement similar to that in use on the London and North-Western, and the pick-up troughs which will be between Lucker and Beal will be ready by July. Fifteen engines of this type are to be constructed. The running of both engine and carriages was considered satisfactory.

Writing on electric tramways for London, a correspondent in Kingston, N.Y., U.S.A., writes to the *Times* saying:—"I notice that negotiations are in progress to acquire the street car lines from the County Council, and to adopt the system of electric traction. I wish to strike a note of warning which I firmly believe every Englishman who has visited America will re-echo. In every city or town of importance in the States they have these electric street car lines, and, although they are not so bad in small towns, in the big cities they are a positive danger and menace to life and property. In Brooklyn alone there have been 148 lives lost up to the present time through accidents with these cars. Over here the almighty dollar rules the roost, and life and safety are a secondary matter; but, thank God, in England the protection of life and property is the first duty of every loyal subject. Therefore I hope every effort will be made to keep these death-dealing vehicles out of the metropolis. Regarding the statement that the underground conduit system was running successfully in New York, I would say that this is false. The only underground system is that of the cable cars, all electric cars being run on the overhead trolley system, which necessitates the running of a bare, overhead, live wire through the streets at a height of about 18ft. above the ground, and carrying a current of immense power, to come into contact with which means instant death. I hope the time will never come when money will be able to buy up an Englishman's rights to protect his life and property."

That is how the matter strikes an English visitor. The following is what a writer in *Cassier's Magazine* says:—"New York's underground trolley electric street railroad has thoroughly demonstrated its practicability by running satisfactorily throughout a winter season which has been particularly troublesome to street car traffic by reason of a number of heavy snowstorms. For several years the much spoken-of Budapest road and the Blackpool line in England stood alone as successful practical examples of this type of construction, while failures of competing designs seemed to be the order of the day, chiefly because it was the inventor who was at work, making paper designs and taking out patents, and not the engineer. To the latter the problem of building a street railroad which would take its power from an electric conductor in an underground conduit ought long ago have been one of comparatively easy solution, had he but taken it in hand, and the strange part of it might seem to be that he did not sooner devote himself to it. One explanation may be found in the lack of inducement which probably existed to the construction of such a road. Overhead trolley lines were cheaper to build and consequently more alluring to capital, and in some places, where these were prohibited by local legislation, the cable system had already been installed, and was giving fair service. With the more and more certain promise, however, of greater economy of operation which electric car propulsion held in view, and with the ultimate design of extending the electric system to its cable sections, the Metropolitan Traction Company of New York decided last year to take up the subject in a practical way, and the result has been, as stated, thoroughly successful. A little simplicity and common sense are of vastly more importance in a work of this kind than any amount of complex refinement, and this is very well demonstrated in the plant in question."

NOTES AND MEMORANDA.

Insurance companies have decided that electric lighting, when the wiring is well done—and they have formulated special rules on the subject—is the safest of all illuminants. Statistics show the following comparative risks:—Fires in one year from paraffin and kerosene, 259; from gas, 110; matches used for gas, 35; candles, 88; arc electric lights, seven; and incandescent electric lights, only one.

The total area of land surface of the earth is calculated to be 28·3 per cent., and that of sea as 71·7 of the earth's surface, certain assumptions being made for the unknown polar regions. The ratio of land to water surface is thus 1 : 2·54, by Professor Hermann Wagner. Other interesting levels are that of the mean height of the land 700 metres—2300ft.—above actual sea level; and of the condensation spheroid, *i.e.*, the physical globe if the water were condensed to the density of the rocks of the crust, 1300 metres—or 4260ft.—below present sea level.

A paper on "The Application of the Formula of Clapyron to the Melting Point of Benzine," has been printed in the *Comptes Rendus* by M. R. Demerliac. It records an experimental study of the lowering of the melting point of benzene by pressure. The pressure gauge used had been calibrated against a mercury column directly, and the alterations in temperature were measured to ·001 deg. by the changes in resistance of an iron wire forming an arm of a Wheatstone's bridge. The alteration in melting point for an additional pressure of one atmosphere calculated from Clapyron's formula is 0·02936 deg.; the experimental figure is ·0294, the difference being less than the errors of observation.

At a recent meeting of the Berlin Meteorological Society, Dr. Schwalbe spoke on the investigation of some important theories of atmospheric electricity, and added an account of experiments he had made on the dissipation of electricity by vapour. A metal plate insulated, charged to ten volts, and connected with a Thomson's quadrant electrometer, discharged itself in exactly the same time when dry as when wetted with water or other easily vaporised fluid. Sprinkling with finely pulverised quartz greatly hastened the discharge; coarsely powdered glass to a less extent. The time of discharge was the same for a rough as for a polished plate. He considered that these experiments had settled the fact that vapour does not discharge an electrified body, but that fine powders do.

Circumstances connected with the drying of timber, that happened and were also noticed by accident, have been communicated to *Cosmos*. Some oak posts were placed for convenience against the wall of a shed, with the root end upwards; and when they were removed, a viscous substance was noticed on the ground where they had stood, while it was also remarked that the timber was drier than might have been expected from the time that had elapsed since it was cut. As the rapid drying of the posts could only be attributed to the inverted position, which had permitted the sap to run off, the same method was henceforth adopted for all timber, while rods were placed under the lower ends, for permitting the sap to run off more freely, and the same favourable results were observed.

Messrs. Morehead and De Chalmot state categorically in the *Journal* of the American Chemical Society that the Willson Aluminium Company can make calcium carbide at less than £5 per ton, including wear and tear and interest on capital. Mr. Hunt (*loc. cit.*) "believes, from his own experience in the matter, that it can be manufactured by suitably devised apparatus at a rate of £8 10s. per ton." In Dr. Ahren's recent book "Die Metallcarbide, &c.," the selling price at Neuhausen is quoted at £20 per ton, the material being about 79 per cent. pure. Morehead and De Chalmot record a large number of experiments made on the large scale, the average purity of their product being 80 per cent. Using unslaked lime, and a current of 1800 ampères at 80 volts, they obtained from their carbide on an average 4·97 cubic feet of acetylene per lb., or 48·33 cubic feet per horse-power day—twenty-four hours. With air slaked lime the yield fell to 39·52 cubic feet.

In giving an abstract of a report on "The Caking Power of Coals," by L. Campredon, the *Journal* of the Society of Chemical Industry says: "To determine the caking power of a coal, the sample is ground sufficiently fine to pass through a sieve of 400 holes per square centimetre. It is then diluted with varying proportions of fine dry sand and the mixture ignited in a covered crucible, the character of the resulting coke being noted. The weight of the coal being taken as unity, the largest amount of sand that the sample will bear and yet give a coherent coke represents the caking power of the coal. In the case of some Welsh coals, the coke takes the form of a powder without the addition of any diluent; therefore the number found on examining different samples may vary from 0 to 17. It should be noted that mere exposure to the atmosphere affects this property of coal; at elevated temperatures the loss of caking power is still more rapid. There does not, however, seem to be any connection between the quantity of volatile matter in the sample and its caking power."

On the glass of a Crookes tube, which has been used for some time, being heated in the blow pipe, it assumes a dead or dull appearance which, observed M. Gouy to the Paris Academy of Science, at first leads to the supposition that it has become devitrified. The alteration is, however, limited to the internal surface of the tube, being so much more marked as the glass has received a more intense cathodic radiation, and being absent in the portions not so exposed. The microscope shows that this dull surface is chiefly constituted by a vast number of gaseous bubbles in the substance of the glass, but near its surface. On the heating being continued these bubbles unite and increase in volume, so that at length they become visible through the magnifying glass, and sometimes even to the naked eye. Glass, therefore, which has been exposed to intense cathodic rays gives out numerous gas bubbles when softened by heat, a phenomenon which occurs in no other case; and it would seem that the cathodic rays cause the gases of the tube to penetrate into the substance of the glass, afterwards remaining occluded until set free by the softening of the glass. The experiments which gave rise to these observations were made with four glass tubes slightly differing one from another, but only one of them showed a considerable number of bubbles in the portions most exposed to the cathodic rays.

At a recent meeting of the Société Francaise de Physique, M. Broca showed the new Bandsept burners for perfect combustion, applicable to heating as well as lighting by gas, which they render more economical. When, observed M. Broca, gas, previously mixed with air, is consumed in Bunsen burners, the mixture of the gas and air is very imperfect, and if the air has been admitted in exact proportion for combustion, the latter will be complete at some points, leaving an excess of oxygen, and incomplete at others, the combustible gas being in excess, whence arises the want of homogeneity of the Bunsen flame, which shows a cold and blue internal zone. These conditions are evidently very defective for a proper utilisation of the gas, which does not give out all the heat of which it is capable. In the Bandsept burner, on the contrary, the veins or minute currents of air and gas are forced to mingle intimately by means of a series of imbricated and truncated conical caps; and, to cause the molecules of the two gases to assume a whirling motion, they are made to pass through two metal gauzes, the wires of one opposite the holes of the other, placed at the combustion orifice. The effect of this arrangement is, not to increase the maximum temperature of a burner, but to render the flame much hotter for producing incandescence in the caps, which may be made much thicker, higher, and stronger than usual, while attaining the same degree of incandescence.

MISCELLANEA.

The East London Harbour Board, South Africa, have ordered a powerful twin-screw sand pump hopper dredger of 1000 tons capacity from Messrs. William Simons and Co., Renfrew. This vessel will be fitted with special arrangements for dredging the bar at East London.

Her Majesty's Secretary of State for Foreign Affairs has received from her Majesty's Consulate at Palermo a despatch reporting that tenders have been invited by the municipality of Messina for a concession to be given for the supply of drinking water for the city and suburbs of Messina. Particulars may be seen on application to the Commercial Department of the Foreign-office, between the hours of 11 and 6.

Rotherham has suffered from scarcity of water, requiring the supply to be turned off from 9.30 p.m. to 5.30 a.m. The Sheffield Corporation have been approached with a view to obtain a temporary service, and arrangements are now being made between the Waterworks Committee of Rotherham and the Sheffield Waterworks Department for that purpose. The Sheffield and Rotherham Corporations have their two systems so near to each other that the connection can be made in a week at the merely nominal cost of some £300. The members of the Rotherham Corporation have expressed themselves very warmly upon "the generous and neighbourly way in which Sheffield has met them."

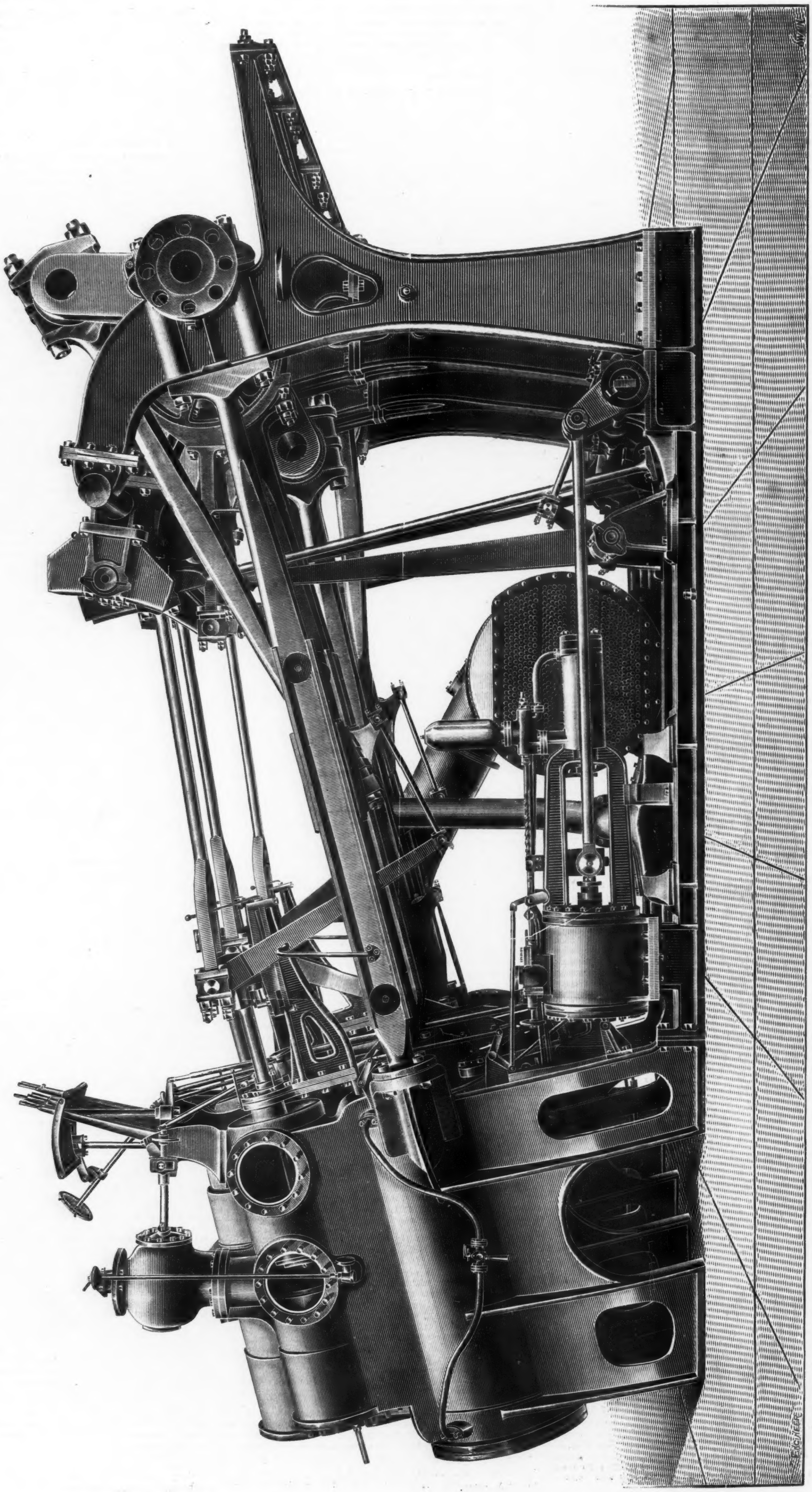
The Sheffield Art Crafts Guild opened its second exhibition on Monday in Cutlers' Hall. Nearly every art craft existing in Sheffield is represented, the collection of works including examples of the fine productions of craftsmen of the past as well as of modern days. One of the most interesting features is the display of old Sheffield plate. The exhibits of decorative and applied art embrace designs and models, tapestry, embroidery, stone and wood carving, cabinet work and upholstering, ceramics, gold and silversmiths' work, metal work, chasing, repoussé, saw-piercing, wrought iron work, &c. The master of the Guild, Mr. T. Swaffield-Brown, delivered an able address on "Art as Applied to Local Manufacture."

Nearly two years ago the Admiralty sanctioned experiments in long distance signalling at sea with a diamond-shaped apparatus, the joint invention of Capt. Prince Louis, of Battenberg and Capt. Percy Scott; but when it was found after several trials on the gunboat Insolent that the mechanism could only be worked with considerable manual strain, permission was given to experiment with a collapsible drum, the invention of Rear-Admiral C. G. Fane, who was at the time admiral-superintendent of Portsmouth Dockyard. The *Naval and Military Record* says that in consequence of the success of the apparatus, which could easily be worked in a high wind, it was fitted to several ships and tested against Rear-Admiral A. K. Wilson's masthead semaphore in last year's manœuvre. The reports have since been under the consideration of the Admiralty, who on Saturday intimated to the Portsmouth Dockyard authorities that in future the semaphore is to be fitted to all seagoing ships.

A statement from the Board of Trade showing the production and consumption of coal and the number of persons employed in coal production in the principal countries of the world in each year from 1883 to 1894, so far as the particulars can be stated, has been issued as a parliamentary paper. In 1894 the United Kingdom produced 188,277,000 tons, Germany 76,741,000, France 26,964,000, Belgium 20,534,000, Austria 9,573,000, Japan (1893) 3,371,000, and the United States 152,448,000 tons. Of the British Possessions, Canada produces between three and four million tons, and in addition imports about half her total consumption, principally from the United States. New South Wales produces about three and a-half million tons, but, unlike Canada, her output has been of late years practically stationary. New Zealand yields over 500,000 tons per annum, but shows little or no increase. Natal's output rose from 26,000 tons in 1889 to 141,000 in 1894. Similarly in British India the production has steadily risen from 1,316,000 tons in 1883 to 2,821,000 tons in 1894. The countries which import coal in excess of the amount they export are Russia, Sweden, France, Spain, Italy, and Austria-Hungary; and of British Possessions, Canada, Victoria, Queensland, Tasmania, New Zealand, the Cape, and British India, together with all the minor Colonies, with the sole exception of Labuan—Borneo.

Dr. Stevenson Macadam, Professor of Chemistry in Edinburgh, gave evidence on Friday last before Mr. Mundella's Committee on Petroleum, and expressed a strong opinion that no oil used for illuminating purposes could be considered safe which had a lower flash-point than 100 deg. Fah. close test. He would not, indeed, prohibit the sale of oil with a lower flash-point, but would insist upon its being labelled, so that the public who used it should know that they were dealing with an oil which was attended with danger. He mentioned that by abstracting 10 per cent. of the spirit from the American oil it could be brought up to the flash-point which he recommended without any difficulty, and that the cost of this process would not amount to more than ¼d. per gallon. On the question of the danger from lamps, the witness differed from previous witnesses like Lord Kelvin, in that he preferred a strong glass to a metal reservoir, because experiments which he had conducted showed that the metal reservoir raised the temperature of the oil considerably more. He had never known any accidents take place from the vapour thrown off by Scotch oil. The chairman pointed out that in France and Germany oil was sold at 70 deg. flash-point, and there were comparatively few accidents. Dr. Stevenson Macadam said he would still insist upon the 100 deg., and that if there were fewer accidents in those countries it was probably due to the higher intelligence of the people. Mr. Alex. Cross, a Scotch member of the committee, remarked that he was sorry to hear such a statement from a countryman of his own. The chairman said he might be sorry, but he was afraid the statement was only too true. The committee adjourned.

The Water Committee of the London County Council, in a report which has just been issued, state that under the standing orders of the Council, unless their recommendation is brought up by the 9th inst., the Council well not be able to initiate any legislation with regard to the water supply in the coming session. The Council cannot let this water question alone, or cease wasting the ratepayers' money on futile schemes of no use to anyone except those concerned in the spending or receipt of this money. It is not, however, true that the committee has proposed to go either to Loch Shin, Loch Katrine, Loch Erne, or Loch Derg, but "without desiring to prejudice the position of the water board proposed in the Government Bill, the committee nevertheless could not disregard the possibility that the Government Bill might not become law." They therefore recommend the Council to go forward in the matter of a supplementary supply from the Welsh water areas. Certain engineering and other details in connection with the scheme might require reconsideration. The committee have engaged the services of two eminent engineers, whose opinions will in due course be reported. The committee formally recommend the Council to pass a resolution authorising application to be made to Parliament in the ensuing session for power to bring additional supplies of water to London from the watersheds of the Usk and Llangorse, upon the lines of the report of the Water Committee as approved by the Council. The committee add that on the subject of the future supply of water to the metropolis they could not disregard the question of the purchase of the existing water undertakings, but for the present they consider it sufficient to recommend that a Bill or Bills should be prepared for introduction in the session of 1897 for the purchase of the undertakings of the eight metropolitan water companies.



TRIPLE-EXPANSION PADDLE ENGINES OF THE SOUTHEND BELLE

MESSRS. DENNY AND SONS, DUMBARTON, ENGINEERS

(For description see page 596)

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S. D. (Dorking.)—*You will find in our portfolio of working drawings a complete set of Cornish engine work. For the rest we should advise you to consult the back volumes of* THE ENGINEER, *which you can do on application to our publisher.*

D. C. M.—*The facts are precisely as stated in our article. The flange rail succeeded the cast iron rail. You write as though the flange rail had been given up for no reason whatever. The American rail is carried on hard wood sleepers. Do you suppose it would pay our companies to import hard wood and revert to the flange rail? If so, why not produce your figures, and let the question be dealt with on the proper pecuniary basis.*

A YOUNG ENGINEER.—*The effective brake radius is measured from the centre of the fly-wheel to the centre of suspension of the weight, not to the rim of the fly-wheel. The virtual diameter of the brake wheel was more than 3ft. judging from your sketch. We should say that the foot-pounds per revolution were 330. This would give for 250 revolutions per minute 2·5 H.P. It is not at all unusual for small gas engines, which have been at work for some time, to give a brake horse-power only half of the indicated. But it is not every one who can indicate a gas engine accurately. You say nothing of the number of explosions per minute.*

IRON MOULDING.

(*To the Editor of The Engineer.*)

SIR,—Would you or some of your learned readers kindly inform me when "Iron Moulding" was introduced into Great Britain, by whom, and where; also when, and in what part of the world was the art first discovered, and much oblige. IRONFOUNDER.

June 8th.

STRAW BOTTLE CASES.

(*To the Editor of The Engineer.*)

SIR,—I shall be obliged to any reader who will give me the address of makers of machinery for producing cases of straw for bottles. J. H.

June 9th.

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, June 17th, at 7.30 p.m.: Papers to be read, "Arctic Hail and Thunderstorms," by Mr. Henry Harries, F. R. Met. Soc. "Climatology of Valencia Island, Co. Kerry," by Mr. J. E. Cullum, F. R. Met. Soc. The following Paper will probably also be read, "The Winter Climate of Egypt, based on results from self-recording instruments, 1893-96," by Mr. H. E. Leigh Canney, M.D.

THE ENGINEER.

JUNE 12, 1896.

THE DEFENCE OF THE EMPIRE.

WE give elsewhere an abbreviated report of a paper read by Admiral Colomb "On the Function of the Army and Navy in the Defence of the Empire," which deserves attention, not only on account of the subject itself being of the first importance, but also because the author is specially capable of grasping the question, and because the audience contained many high authorities on the matter brought under consideration.

The main object of the paper was to urge that dependence should be placed on mobile sea and land forces rather than on fortified positions—in fact, that we should depend on throwing a large force on to any point attacked rather than in rendering each point independently strong; that a Power that expended its strength in fortifying all points divided its strength, and that an equally strong Power that mustered all its forces to attack would successively overcome all the positions of the former. As a general principle to be kept in view, many of us will agree with the Admiral. Most of us will concur with him in urging the need of grasping the question of National Defence as a whole, and wish, with Sir Lintorn Simmons and other speakers, that a strong Commission were appointed to deal with this question. When we come to practical steps the difficulties arise. Admiral Colomb clearly objects to fortifying London. There he joins issue with a considerable body of scientific officers, especially Royal Engineers, by whose advice some actual steps have been carried out, perhaps unknown to the public generally, and a first commencement has been made of a system of the very unobtrusive defensive works which are now found most effectual. The Admiral certainly did well to withdraw, as we understand it, his classification of the schools of defence as "instinctive" and "reasoned." Our leading Royal Engineer officers are hardly likely to be won by being told that reason is now to be opposed to their instinct. Reason is the attribute of a man, and instinct of a beast. We are quite sure that the Admiral did not intend to call our military advisers beasts, and we are most anxious that it should be understood that he disclaimed any such deduction, however obvious. Nevertheless, we think that the Admiral's condemnation is too vague and sweeping. He practically puts the great wall of China and the Paris fortifications into the same category. On this principle it might be urged that a position possessing the advantage of interior lines, so that it can concentrate on any point more quickly than its enemy, is in the same position as an army surrounded and hemmed in. Proportion and circumstances make all the difference, and we would remind Admiral Colomb that it was the first Napoleon, whose grasp of warfare was peculiarly startling and bold, and who wielded his forces with singular unity of purpose, who fortified Paris. The Admiral will doubtless reply that this line of action was Napoleon's notorious mistake, and that when he at length fell back before the allies he exhibited it in another shape in weakening his army by leaving forces clinging to fortresses which were bound to yield in succession when his main army had been rendered too weak to recover lost ground. The opposite action, however, is illustrated in a measure when Napoleon returned from Elba and found most of his old forces available again for such a blow as Admiral Colomb would probably commend when he aimed by mobile forces in the Waterloo campaign to strike in detail armies which, when all gathered throughout the Continent, would become irresistibly strong. The fact is that in both cases Napoleon was overmatched in whatever line he followed, and it is difficult to argue positively on the question. The defence of Paris certainly gave the Germans more trouble and anxiety than was generally known in England at the time, so it now appears, but how far this was due to actual guns and earthworks may be questioned. Admiral Colomb would doubtless attribute it to the difficulties he pictures connected with the attempt of a general to attack unfortified London. Leaving this, we may turn to the next practical application of the principles we think the Admiral suggests, namely, the substitution of active for reserve forces. If this means that a given sum of money be taken from volunteers and given to establish regular forces, we entirely disagree with him; but we cannot think that this is meant, as it would cripple the very object the lecturer had in view. At least 1000 volunteers would be sacrificed to obtain 100 regulars, and a very limited application of such a process would soon bring down our forces to such numbers that we should be unable to allow any of our regulars to leave the kingdom, which is the last thing desired by the Admiral. The same difficulties in detail beset us in dealing with foreign stations. We understand that guns and a sufficient force are advocated to prevent surprises, but not for prolonged defence, because eventual safety is to be secured by the arrival of a mobile force. So far we agree with the Admiral, but for safety against surprise, we need some kind of works round the guns, and some force of men, otherwise, in most cases, the enemy would land and take us in reverse. So again with our own defended ports, Admiral Colomb himself says that no consideration of leaving "places behind him" "insufficiently fortified and garrisoned "would deter an Admiral from striking at any equal or inferior force within reach." He could hardly more completely establish the necessity for pretty strongly fortified and garrisoned ports, for the only case in which they could be dispensed with is that when it was absolutely certain that the "equal or inferior" enemy was the only possible one, or else very inferior indeed. Could a defenceless general regard with equanimity the sudden surprise of even a moderate force that had by any means eluded the British fleet; or even suppose the fleet to have returned after fighting an "equal" one, would it be in a state to defeat any enemy subsequently arriving?

If the enemy's force takes the form of men-of-war escorting transports of troops, the Admiral thinks that tugs and almost any craft might act as rams. Can he mean that all these dart out animated with one mind, and, reckless of danger, dash in numbers at the enemy? We think it would be madness to reckon on such action—unheard of so far as we know. The English ships doubtless did something that loosely might seem like this, when the Armada swept up the Channel; but our ships possessed such speed, and were so handled, that they fought with comparative immunity. They were manned by the pick of our seamen. The tugs and craft left behind by our forces ramming with the prospect of almost certain destruction, are in a totally different case. Moreover, the commander of an attacking expedition would surely have quick-fire guns disposed to defend his ships in such a way that, for a time at all events, any tug or unarmoured vessel approaching would be doomed to certain and instant destruction. The English sailors under Essex, Drake, and Raleigh gathered increased audacity from the immunity with which they made their attacks. We fear that our captains and crews of tugs would witness sweeping destruction falling on all who first ventured near the enemy's transports. We question if this condition of affairs seriously entered Admiral Colomb's calculations as actually arising. We think that the general superiority of our naval forces is too present to his mind; but can such general superiority, which may be very limited in certain combinations, ensure the non-existence of some local temporary superiority? Generals cannot be blamed for questioning it. Engineer officers may also urge that forts cost very little compared to ships, and are permanent, while ships wear out. Thus a selfish view suggests that it is best for our fathers to have spent money on forts and for us to spend it on ships, and this, in a measure, is realised in the present condition of things.

On the whole, we agree with Admiral Colomb in broad principles, and we agree with him and other speakers that the question of national defence should be seriously taken up; but, for the practical application of principles, it is necessary that a very able and strong Commission should be appointed to sift the matter as it can only be sifted in a time of peace. If the paper helps in bringing about such action we shall be greatly indebted to Admiral Colomb.

QUACKERY IN ENGINEERING EDUCATION.

IN the United States, as in this country, are to be found engineers who lift up their voices and protest against the Technical College, its ways and its methods, its works and its claims to greatness. An amusing article, by Professor Edward Kidwell, appears in the last issue of the *Engineering Magazine*. He has taken for his text, "Quackery in Engineering Education." He hits hard and spares not; uses rather strong language, and produces an effective picture. He has singled out as the deplorable example no less important a person than Professor Thurston; and we are not surprised to find that the Editor of the *Engineering Magazine*, in a foot-note, "invites perfectly frank and free discussion of the subject here broached, alike from those engaged in educational work, from college graduates, and from practical men." Possibly Professor Thurston will take up the cudgels in defence of his views. Mr. Kidwell's case is, however, so strong that it will not be easily broken down. By the word "quackery" he tells us that he means "any promise or pretence to do that which cannot be done, either because the thing itself is impossible or because he who made the promise knew that the means to execute it were wanting." He goes on to show that the trustees of a technical school are not as a rule qualified to select teachers; and he holds, to put matters in plain phrases, that the technical schools too often obtain pupils by making statements which are not true. In proof he quotes an utterance of Professor Thurston to the effect that a pupil may be made a good smith by a few days' work, and that "in wood working and machine shop practice he may soon learn to handle tools like an old hand." We find it difficult to believe that Professor Thurston could have made such statements seriously; but it is beyond question that he has done so. "If the terms mean the same to Mr. Thurston that they do to engineers and mechanics, then they furnish an example of exaggeration and bad logic. They are not true and never can be," says Mr. Kidwell. This is hitting Professor Thurston pretty hard, but he certainly deserves it. Mr.

Kidwell pushes the indictment home. He writes succinctly, and uses no more words than are necessary. His arguments are, therefore, all the more cogent and convincing.

We have so often written on the same subject, and to much the same effect, that it might almost seem that nothing more remains to be said. Fortunately, however, there is some evidence, growing, too, daily in strength, that the tide is turning, and that common sense is beginning to assert its power and have its way. Such an article as that from which we have quoted is a case in point. Mr. Kidwell is himself a teacher of engineering in a college, and knows very well what a college training can and cannot do. He speaks with authority. In this country more than one professor of engineering has insisted on the adoption of rational methods of instruction; and has refused to sanction the issue of exaggerated claims. Nor is this all. There is manifest elsewhere than in engineering schools a tendency to regard even the higher education as a means to an end, not as the end itself. It begins to be understood that life is too short to make it safe to spend years in the acquisition of useless knowledge. A noteworthy example of this is afforded by the consideration which is being given by the College of Physicians to a proposal that the character of its examinations should be modified in a way to concentrate the maximum effort of the student on the acquisition of that species of information likely to be of most use to himself and his patients in after life, instead of wasting time in learning for the purpose of passing his examinations that which he forgets immediately afterwards, simply because he is never called upon to make the smallest use of it. Mr. Kidwell does not appear to think that anything is properly taught in technical colleges. We certainly shall not go so far, at least as regards this country. The defect inseparable from college training is one for which the professors can scarcely be held responsible. It is that no importance whatever is attached to the commercial aspect of any form of engineering science taught. In actual life, however, the mechanical and the civil engineer alike have to study economy in designing and carrying out their work. Of this truth the professor, so far at least as our experience goes, takes no account. Of two designs, for example, the professor will regard one as better than the other on grounds which have nothing in the world to do with the cost of production. Of course the engineering firm that followed this practice in daily life would find itself in the Bankruptcy Court in a few months. As we have said, we do not hold professors responsible for this, because it is quite out of the question that they should impart more than the rudiments of the science of engineering economics to their pupils; but we do hold them responsible if they assert that the young men to whom they give diplomas are fully trained mechanical engineers. The scientific and theoretical man continually finds that the question of cost in any structure is quite as important as the question of strength; and that he who can produce a given result with the smallest outlay is, as a rule, the most competent engineer. Nor does this apply merely to the machine made. It holds good of the working of the machine. Let us take as an illustration a rotary cutter shaping machine. The first point to be considered by the draughtsman in designing such a tool is that it may be made to bring in the largest possible profit to the firm constructing it. Incidentally, we may add that this it certainly will not do unless at the same time it gives satisfaction to the purchaser—the person, that is to say, using it. Now, it is easy to see that a skilful designer, working with a view to profit, will so arrange matters that the first cost of his patterns shall be small, and that the moulding work to be done in the foundry shall involve the least amount of labour. So far so good. But the designer must not only do well up to this point, he must bear in mind that while saving work to the pattern-maker and the founder, he may be inordinately augmenting the quantity of machining to be done subsequently. He must not "rob Peter to pay Paul." Assuming that he has got over all these difficulties, it may nevertheless easily happen that the net result of his labours is a machine which cannot turn out work as cheaply as it ought. Thus, it may be too slow in its movements; and the arrangements for securing and adjusting work on the tables may be bad in the sense that they are tedious in their action, or involve much setting and resetting before the work is properly adjusted. As a matter of fact, the slow and costly tool, embodying in itself every commercial fault, may be able to turn out consummately good work. It may be strong, durable, and consume little power. Now, in the eyes of the professor, it would for these reasons be perfect, because one set of conditions would for him be eliminated. The price of the tool would affect him in no way. The cost of the work turned out by it would not even interest him; and herein lies one great difference between learning to design machines in the college or the technical school, and learning to design under the eyes of the competent head of a real drawing office. Therein the pupil finds that a sheet of paper and a pencil are the cheapest appliances with which it is possible to obtain information about proposed machines; and that ten hours of a draughtsman's time are well spent if they result in the saving of even a sovereign in the construction of each machine made from his drawing. We have said that we do not hold the professor of engineering responsible. Possibly in this some will think that we go too far. Certain it is that there are professors who maintain that it is practicable, even in a technical school, to teach engineering under conditions which, up to a certain point at least, shall be as practical as can be desired. But do we not also find that such men are constantly thwarted and opposed, checked and limited by trustees and governors, who really cannot and do not possess the information essential to the formation of a sound judgment as to the merits or demerits of the teaching staff? We have one noteworthy case in mind at this moment, and we know that in others the professors have had to give way with reluctance and against their own better judgment.

The pity of it all is that, of course if properly used, the technical college is capable of doing admirable work. Indeed, within its walls can be taught much of great value that can be acquired nowhere else save with infinite pains and trouble. But to this end the professor of engineering and the demonstrator must never forget that all that they can teach amounts to little more than an introduction to the finished art of engineering; that the time of tuition is short, and that none of it must be wasted in imparting useless information. On this last point Mr. Kidwell is at once energetic and amusing in no ordinary degree. He quotes the information, for example, supplied in one college to the student concerning hemlock spruce fir, which is mainly botanical, and largely inaccurate, and goes on to say, "The *habitat*, metric measurement of the cones, and configuration of the leaves may be very important to somebody, but what an engineer wants to know is that hemlock is a rather hard, extremely brash, and treacherous wood, liable to crack open in rings, and is usually so wind shaken that the interior is a mass of splinters; hence the wood is used in only the most inferior class of structures, and in some localities is not considered worth cutting for the market even for firewood." There are two essentials to success in teaching engineering. The first is that the professor should know how to teach, and the second is that he should know what to teach. We believe, and we hope that the day is not distant when the true functions and position of the engineering college and technical school will be understood. Then, and not till then, will they do the excellent, if limited, service of which they are capable.

THE LONDON DOCK COMPANIES AND SHIPOWNERS.

A short time back the daily papers were full of letters discussing certain new rules that the associated London dock companies proposed as to the overside discharge of vessels. These proposed rules, which would practically have the effect of stopping unloading into barges of goods destined for the outside wharves and warehouses, were received with vigorous remonstrances by all concerned in the import trade of London. Apparently the dock companies realised that it would be impracticable to put their proposed rules into force. At all events, the subject seems to have been removed from public discussion, and it has been generally understood that the new code had been withdrawn. But a fresh departure has now been taken by the Dock Association Board which proves that its intention was simply *reculer pour mieux sauter*. This body has given notice to the shipowners customarily using the several docks in the Thames to terminate an existing agreement with them—entered into, we believe, shortly after the now historic strike of the dockyard labourers—whereby the privilege was accorded to the shipowners of employing their own labour force for the loading and discharge of cargoes, as well as that allowing the larger lines to have fixed berths for their fleets. The agreement to this effect was terminable by the dock companies on their giving six months' notice. This has now been given, and we understand that the privileges named will come to an end about the end of August or beginning of September next.

The step thus taken is said to have aroused a very bitter feeling among the shipowners. They feel, it is rumoured, that the action proposed by the dock companies has been due to an adverse feeling arising out of the belief that the measure at first proposed had been defeated for want of full support by the owners of shipping. It is also rumoured that the latter had promised that support, but that this had been withdrawn when the storm of remonstrance to which we have referred found expression. With this aspect of the question, however, it is not our province to deal. But what we have concern with is the consideration as to how far measures under contemplation may be likely injuriously to affect the trade of London as a maritime port. As in all cases there must be, there are two parties chiefly concerned in this present quarrel. On the part of one of these, the dock companies, it is urged that their shareholders must live, and that by some means or other a dividend must be earned for them. On behalf of the other party, the shipowners, it is contended that while not denying the legal right to give them the notice tendered, the effect of it must be to dislocate all their arrangements, and to force upon them the raising of freights at a time when competition by the foreigner weighs heavily against the successful sailing of vessels under the British flag. Both parties to this dispute are possessed of certain powers for attack or for retaliation. The London dock companies form a monopoly, unfortunately a somewhat impecunious monopoly. These, therefore, are possessed of the whip-hand in the present dispute. But competition with them, it must be remembered, is not confined to the Thames. Southampton and other large shipping centres would go far in liberal concessions to re-attract services that formerly patronised their docks, but have of late years abandoned them for London. It would, therefore, not be surprising to hear that negotiations with these might result in the re-transfer of much profitable business from the central to the outer ports. Should this occur, the dock companies will have killed the goose that laid their golden eggs, while serious injury will have been done to the prospects of the Thames as a resort for shipping. It will be as well to quote some figures illustrative of the extent to which the shipowners of London may be affected by the withdrawal of their existing privileges. It is the custom of the dock companies to charge shippers about 1s. 6d. per ton for expenses on discharge of cargo. The tariff published by the dock companies as that they will enforce when this business comes again into their hands, varies for different classes of goods between 3s. 6d. and 4s. 6d. per ton. Taking one article in illustration, tea, we find the tariff for this to be 4s. Now the tea shippers of Calcutta have, we have been informed, a running contract for tea freights extending for five years. During the remainder of that period yet to run, it therefore follows that the shipowners will have to lose on that particular item of freight no less than 2s. 6d. per ton, a loss for which they will have no power to obtain reimbursement. Surprise can scarcely be felt that in anticipation of such a direct loss, the ship companies may decide on very serious steps to avoid its incurrence.

But although we have space only to quote this single instance, it is palpable that there must exist many other interests that will become largely affected by the new rules and their accompanying new tariff. Indeed, we must presume that to meet the extra charges on cargo after arrival in the Thames, the 2s. 6d. we have named must be met by a corresponding rise in freights to London generally. What this would mean to British producers throughout all the dependencies of our Empire will easily be realised. If it has been the intention, as has been surmised, that the shipowners should be "put in a hole," the dock companies have certainly succeeded in doing so. Whether it may be worth their while to face the risks of retaliation that we have pointed out must be a matter for them to consider and decide. We have been told that the executive of the associated dock companies are fully alive to the dangers that the latter are incurring. But they have before their eyes a threat, which is said to take the following form: "If our present management does not secure a dividend, we must get one that will." This threat opens up a further consideration in our theme. We have referred to the dock companies of London as being an "impecunious monopoly." Were it not so, no such ill-considered threat as that above recorded would have been made on its behalf. Now we fear there is little sympathy felt with the dock companies in their present position. Almost from the first their history has been a record of extravagance, the result of which has been that they are for the most part incapable of earning good dividends. We believe it is now over forty years since the Shadwell Basin was constructed. This one work will suffice as an instance of the line of action that has brought the dock companies to their present position. The site of that basin was, when acquired, densely populated. We fear to state what it cost for purchase and compensation. Men of that day stood aghast at the outlay the selection of such a site involved. Several of these, and notably the late Mr. Bidder, saw the mistake that was being made, and quietly purchased for what was relatively a mere trifle the waste land now the site of the Victoria Docks. As little outlay was made as might be sufficient to provide the proposed accommodation for shipping, timber being almost solely used in furnishing this. But it sufficed for the object in view, and, while the Victoria Docks were largely resorted to, the costly accommodation provided higher up the river was without customers, the monopoly of the older companies was endangered, and the result was—as Mr. Bidder and his astute fellow adventurers had foreseen—that the Victoria Docks were bought up at about three times the amount of their first cost. In this and similar ways millions have been spent in providing the present dock accommodation in the Thames. We are telling, we know, but what is an old and oft-repeated story; but it has been too much the case that it has been lost sight of. It is legitimate that the dock management should endeavour to earn a dividend—even a good dividend—but it must not be forgotten that the attempt to earn the latter may inflict irreparable injury on the port of London.

WANTED, THE REASON WHY.

As information is acquired concerning natural phenomena, it becomes more and more evident that many of our most treasured theories and explanations will have to be thrown on the scrap-heap of scientific hypotheses. The researches of Lord Rayleigh, in argon and helium have already demonstrated that there is much in the received molecular theory of gases that will have to be rejected as untrue. The Röntgen rays have done the same for light, and now Professor Dewar has shown that as yet nothing like a satisfactory theory of electricity and magnetism has been framed. The Friday evening discourse last week at the Royal Institution was delivered by Professor Fleming, and was mainly a statement of the very remarkable results obtained in the course of a series of experiments carried out by himself and Professor Dewar on electrical conduction at low temperatures. It is not too much to say that these results go far to upset all our preconceived notions, and tempt us to ask if the phrase "conservation of energy" conveys any adequate idea whatever of any natural processes. Thus, for example, Professors Dewar and Fleming seem to have established that a pure metal at absolute zero would have no electrical resistance, so that the smallest filament could carry the most enormous conceivable current without being heated. Some time since we stated that it was quite conceivable that a magnetic screen might be produced, and that if it was produced we should be within measurable distance of perpetual motion; in other words, of a machine which could work itself. Professor Fleming stated on Friday night that a pure metal at the absolute zero would form an absolutely opaque screen to electro-magnetic radiation. But the whole lecture bristled with statements going to show that there is no apparent connection between causes and effects, and that the expenditure or not of energy in the performing of processes is brought about in ways of which we know nothing. For instance, it is impossible to send a current of electricity along a pure metal at normal temperatures without loss of energy. We have only to bring down the temperature to zero, and the loss of energy ceases. What is the connection between heatin the wire cone and the expenditure of energy? As the years roll on science seems to drift closer and closer to the rocks of agnosticism; and the man who studies and experiments most will in the end be he who knows least.

PETROLEUM IN THE UNITED STATES.

An increase in natural oil production means so much that is good for makers of drilling and boring machinery, of piping, of oil-pumping machinery, of oil reservoirs, of tank steamers, oil-refining machinery, and of other constructive work, that it will be deemed excellent news which reaches England this week from the United States. We refer to several new developments in the oil fields of Kentucky.

Operations have, indeed, been so extended as to induce a general belief in America that the southern section of that State will develope an oil field that will rival the northern territory in its richest production. Interest in Kentucky oil land, especially in the valley of the Big Sandy and the eastern counties, is increasing, and very liberal terms are being offered for leases at many points. It is now believed that two-thirds of the State of Tennessee, with its 46,000 square miles, is a magnificent oil-producing section. The belt is simply the southern end of the famous Pennsylvania, West Virginia, Ohio, and Kentucky oil fields. Quito recently the Standard Oil Company secured control of 95,000 acres of land near Sunbright, in addition to the large quantity of land which it already leases. This Company now owns upwards of 700,000 acres of land in its own right, and has secured leases on more than 1,000,000 acres besides, and has just decided to spend a million dollars—about £200,000—in a new pipe line from Burnside, Kentucky, to Allgood, Tennessee. It is also erecting three iron storage tanks, capable of holding 120,000 barrels of oil each, at East Port, Pickett county. Statistics just issued show that the average daily production in April of the whole of the famous Appalachian oil region, compared with the previous month, had increased from 87,188 barrels to 97,308 barrels. The output of that region in April reached 2,883,569 barrels, or an improvement on the previous month of 204,248 barrels. Stocks in the whole of the Appalachian field have increased to 6,697,480 barrels, or an increase of 691,748 barrels over the month previous. Though American engineers will get the most, English firms will certainly share with them a portion of the orders which these developments entail.

"DEAR OLD SMOKY SHEFFIELD."

DOES Sheffield really enjoy its smoke? The question is suggested by the lack of enthusiasm over the Pure Air Fund, started by the *Sheffield Daily Telegraph*, and headed by the proprietors of that paper. The fund was preceded by pressing appeals for smoke abatement, and a series of carefully-written papers by an engineering expert, showing that smoke could be greatly lessened, and was indeed being almost abolished, in many of the Sheffield establishments. It was not necessary to demonstrate, for it was matter of common knowledge, that the Sheffield Corporation literally let the nuisance alone. An occasional prosecution only served to remind the public that there were laws against excessive smoke-making, but when the local authorities did secure a conviction, the penalties imposed were so small as to be practically powerless to help the fight for pure air. That being so, the Pure Air Fund was started. At this moment, after weeks of work, many columns of urgent writing and of explanatory special contributions and drawings exhibiting the ease with which smoke can be dealt with, the total amount of the fund is only slightly over £200, of which £100 is given by the newspaper which originated the enterprise, and Messrs. Walker and Hall, a silver firm who have been active in efforts to put down smoke. The result is a distinct disappointment. It is the custom sometimes for Sheffield people, even in public, when they are in a mood of local patriotism, to speak lovingly of "dear old smoky Sheffield." Can they really mean it? They certainly show no zeal to get rid of the gloom and its accompanying grime. Is it possible they like it, as the Scottish dame did the dirt, because, as she put it "the dartier the cosier"? Sir Frederick Mappin, Bart., M.P., member for the Hallamshire Division, holds that the duty is not one for private enterprise but for the public authority. That may be one reason why the Sheffield people are so supine. No doubt Sir Frederick is right in laying the blame upon the shoulders of the local authority; but as the local authority is so careless of the general interest in this respect, it seems essential that some effort should be made to compel action. And, surely of the two evils, the greater evil is to leave it alone! It *will* be left alone, unless private effort goads the lumbering civil executive to action, and if the present movement is discouraged by cold counsel, Sheffield will remain, as it has ever been, in the words of Horace Walpole, "the foulest town in the fairest country I have ever seen."

LITERATURE.

A Treatise on Civil Engineering. By W. M. PATTON, author of "A Practical Treatise on Foundations;" formerly Professor of Engineering at the Virginia Military Institute; Engineer-in Charge of the Mobile, Ohio, Susquehanna, and Schuylkill River Bridges; late Chief Engineer of the Mobile and Birmingham, and the Louisville, St. Louis and Texas Railways; Consulting Engineer, Chicago, Illinois. First Edition. First Thousand. New York: John Wiley and Sons, 53, East Tenth street. 1895.

IN commencing his voluminous and comprehensive work, the author enunciates principles which we have always persistently and consistently recognised and advocated in our columns. Even in these days of cramming, the truth and importance of these principles are becoming more widely known and appreciated. If it were only engineers of the old school, "rule-of-thumb men," of which there are not very many left now, who condemned the vicious system of placing theory before, and at a height immeasurably above practice, there might be something to be said on the other side. But it is not so. As a matter of fact, engineers whose educational, scientific, and professional attainments are of the highest order, unhesitatingly set their face against the manufacturing of their younger brethren by sheer theory and book teaching. Like our author, we fully recognise not only the expediency but the absolute necessity of an "extended training in pure and applied mathematics," but also hold with him that the "important principles of engineering as a practical science should not be lost sight of." We have nothing to urge against the numerous so-called engineering schools and colleges. The education they afford is very good in its way when viewed from a purely theoretical point of view, but they undoubtedly do foster the idea—the serious error, which is very widely believed in by outsiders—that two or three years' attendance upon the classes of their professors, and the passing of an examination, turn pupils out not only as good, but far better engineers than if they had served their apprenticeship to a first-class firm, or their pupilage with a well-known civil engineer in practice. If there is one profession more than another whose proper motto is "*Facta non verba*," it is that of engineering.

The contents of the volume before us may be divided into three general heads, viz., theoretical, practical, and descriptive. "Articles," or as our publishers would put it, "Chapters" I. to IX. are devoted to the preliminary branches of the profession, and include surveying, ranging lines and curves, both on land and water, reconnaissances and locations. At page 45 there is a little confusion. The equation

$$r = w\frac{A\,C}{B\,C} \quad . \quad . \quad . \quad . \quad . \quad . \quad (31)$$

should read,

$$r = w\frac{B\,C}{A\,C};$$

and in the following line, for B C = 1 mile = 5280ft., read A C = 1 mile = 5280ft. This formula (31) is repeated in page 72, and quoted as stated in our correction. With respect to the system of American levelling Mr. Patton remarks, "Just here, however, is the only objection to this method of levelling. There is no method of correcting the error in readings, and incorrect elevations are often obtained. Consequently some engineers prefer the method of keeping notes known as the column of differences." We very much prefer the system of "some engineers." Building and constructive materials of every description are treated of in the following ten articles. It is universally admitted that there is a proper time of the year for felling timber, but unless there was an absolutely close season it would be futile to expect any attention to be paid to that particular detail. Both here, and on a far greater scale in America, where sudden demands for large-sized timbers are constantly occurring, when the material is required, it has to be procured. It matters nothing whether the tree be fit for felling or not; the sap may be literally oozing out, but it is cut down, sawn to the proper scantlings, and built up while as green as grass. It is a clear case of "*force majeure*," which, however regrettable, is equally unavoidable. It is well remarked under "Cast Iron" that "it is better far to specify what properties the material should possess than to describe modes and methods of producing those results; for however instructive and interesting may be the methods of producing the many and varied castings of all kinds, it is more important to be able to determine their good and bad features." The mere breaking test of iron, irrespective of other circumstances, is known to be alone no criterion of either its quality or strength. In Article XXI. we pass on to structures, equilibrium of forces, bending moments, and the resistance and strength generally of beams and girders. The definition, or rather the distinction, between "stress" and "strain" is scarcely so clear as it might be. It is not apparent whether the stress produces the strain or the strain developes the stress. It is important that these two should not be confounded, although it is but a little while since they were employed as nearly synonymous terms in numerous text-books and scientific works. It is stated that "for every kind of strain produced there is developed a corresponding stress," which might incline one to the conclusion that the strain is the cause of the stress. The generally received order of procedure is as follows:—Loads or weights on a structure of any description produce stresses in the various members, which are attended by slight deformations or alterations of form, which usually result in a lengthening or shortening of the members. These elongations and compressions constitute the strain which is developed by the stress itself. Our readers may expect to find that many details, the working out of practical and theoretical questions and problems, are treated in a somewhat different manner to what they are accustomed to find in English text-books, and in connection with this remark, it may not be superfluous to some of them to point out that in determining the coefficients of elasticity, the formulæ,

$$E = \frac{5000}{1/3206} = 16{,}030{,}000 \text{ lb.}$$

would with us be written

$$E = \frac{5000}{\frac{1}{3206}} = 16{,}030{,}000 \text{ lb.}$$

At the same time it should be stated that the former method of indicating a fraction is common among continental engineers. Indeed, we use it ourselves, when we employ small fractions of the monetary and other units. In Article XXXII. "Moments of Inertia" are dealt with, and as they are sometimes a stumbling-block to beginners and young engineers who do not exactly see the necessity for them, as admitted in the article, they are treated with great care and in an exceedingly lucid and explanatory manner. The "Deflection of Beams" introduces us to our old friend $E\,1\,\frac{d^2y}{dx^2}$ and to the equations connected therewith, from which all the problems relating to deflection can be satisfactorily solved.

The practical part of the "Treatise" may be said to commence with the article on "Construction," in which the application of the principles previously enunciated is carried out in the design and construction of the foundations of engineering works, all on a scale of considerable magnitude. Among American engineers the open-crib process for getting in foundations has always been a favourite one. It was used in the building of the pivot pier of the swing span of 520ft. in length of the Interstate Bridge. This span is stated to be the largest of its kind at present in existence, and to exceed by 15ft. that of another similar structure in the States. For the purpose of illustrating other practical and also important details attached to possibly the most arduous and anxious part of the duties of an engineer, the Memphis, Poughkeepsie, Washington, East River, St. Louis, Susquehanna, and Ohio Bridges have been quoted. It is but fair to state that the author has not restricted himself solely to examples of works in his own country, but has also described the methods employed in the Forth and the Tower Bridges, and in the Amsterdam and North Sea Canals. Retaining and reservoir walls, dams, and weirs, arches of masonry and concrete, are fully treated of, both theoretically and practically, and constitute a large, interesting, and very readable part of the volume. "Tunnels" have an article to themselves, and as in the case of the foundations for bridges, numerous examples are quoted from nearly every country in the world. Under the title of "Framed Structures," the loads upon trestles and supports, their shearing and bending moments, the stresses upon iron piers, and in roof and bridge trusses, are investigated both graphically and analytically. Examples are given of some of the almost innumerable different forms of trusses affected by American engineers, of which the favourites appear to be the Howe and the Pratt types. As the former, with the exception of the vertical tension rods, is built entirely of wood, it is not adapted for long spans, and, in fact, has been greatly superseded by its rival, the Petit truss. A modified form of this truss was proposed for the Channel Bridge. The concluding portion of this "Article," relating to the "Amount and Distribution of Live Loads," should be read with attention, as it states this much-vexed question with practical fairness and frankness.

The "Designing of Simple Trusses" supplies all the data for bridges, whether highway or railway, although they cannot all be classed under the category of "simple." It is a thousand pities that the form of the bridge which, except in America, where the suspension principle still continues to hold its own, promises to prove the most economical for great spans, should be so excessively unsightly. No treatise on engineering would nevertheless be complete without some reference to and description of it. Cantilever bridges are *par excellence* those best adapted for erection by "building out," as it is termed. We must differ from our author in a remark he makes in his article on designs of bridges. Referring to riveted truss bridges, he observes: "They are often considered stiffer and safer than pin-connected trusses. The secondary stresses developed cause these trusses to be less satisfactory than pin-connected trusses." We will not dispute for the moment the theory respecting the secondary stresses, although we do not concede it unconditionally. But we are aware of more than one example, the Crumlin viaduct to wit, both at home and abroad, in which pin-connected trusses have, through the medium of gusset pieces and cover plates, been converted into riveted trusses. We cannot call to mind a single instance in which the rivets in a riveted truss have been cut out, and their places supplied by either pins or bolts. The last 300 pages of this exhaustive volume are devoted to the different branches of hydraulic engineering, including a description of the Chignecto Ship Railway, which is, it is said, in actual progress, and also of the proposed similar undertaking at the Isthmus of Tehuantepec.

Mr. Patton's "Treatise" is valuable. It displays much research, a thorough acquaintance with both theory and practice, a careful selection of excellent examples and illustrations, and a candid and impartial regard for the opinions of other competent engineers and scientists, although they may, and do, in some instances, differ from those of the author.

In his preface, Mr. Patton acknowledges his indebtedness to his daughter, who, "during her leisure hours out of school, prepared nearly all the drawings in this volume," which amount to nearly 500 in number. We trust—*place aux dames*—we may be permitted to also acknowledge our indebtedness to the young lady. The type is very clear and good; the cuts and drawings, although necessarily on a reduced scale, come up well, and the publishers have ably fulfilled their *rôle* in introducing to the public a work which unquestionably brings the multifarious branches of civil engineering thoroughly up to date.

SHORT NOTICE.

Aluminium. The Aluminium Supply Co., 38, Victoria-buildings, Manchester. 1896.—This little book is sent out as a description of the aluminium products of the Pittsburgh Reduction Company's Works, where aluminium in castings, ingots, plates, sheets, tube, and structural shapes are made under the C. M. Hall Patents. The book contains all the information concerning the physical and mechanical properties of aluminium which would be wanted by anyone proposing to use the metal for any but exceptional purposes. It is so well done as a handbook in this respect and is so much more than a catalogue, that we notice it in this place; indeed, there is very little in it at all of the catalogue nature, not in fact so much as in many so-called text-books. It is entered at Stationers' Hall by Mr. A. G. Brown, the manager of the Manchester Supply Company, and author of the books on the indicator which we have favourably mentioned. Beside giving the properties of aluminium, it gives the properties of numerous alloys of this metal, and gives the comparative figures for the more commonly used metals, such as steel, iron, copper, and so on. For the sake of brevity in speaking and in writing the writer calls the metal alium throughout the book. In dealing with corrosion the author has mentioned most of the corrosive agents, but readers will have expected to find more, and unless they read through the part relating to solubility, will be disappointed. Most of that given under the head of solubility relates to corrodibility. On working aluminium in many ways the book is very instructive, and much more use is already made of it than is generally supposed. To complete the book tables of weights of the metal and other metals and alloys in rolled, cast, or drawn forms, are given, and to enable the designer of structures in aluminium to be independent of the older handbooks, tables of areas, circumferences, temperatures, and other frequently required figures are given.

BOOKS RECEIVED.

Applied Magnetism. An Introduction to the Design of Electromagnetic Apparatus. By J. A. Kingdon, B.A. London: H. Alabaster, Gatehouse and Co. Price 7s. 6d.

The London and South-Western Railway. Half a century of Railway Progress. By G. A. Sekon. London: published at 79 to 83, Temple-chambers, Temple Avenue, E.C. 1896. Price 2d.

An Analysis of the Accounts of the Principal Gas Undertakings in England, Scotland, and Ireland for the year 1895—being the twenty-seventh year of publication. Compiled and arranged by John W. Field. London: Eden Fisher and Co., or of the compiler, Horseferry-road, Westminster. Price 15s.

International Railway Congress. Fifth session. London. 1895. Question 1, Strengthening of Permanent Way in view of increased speed of trains. Appendixes of the first report—for non-English speaking countries—by Mr. Asp. Appendix to the list of questions. Technical information. Form A, the breaking of Steel Rails, by Mr. Bricka. Form B, the current cost of Metallic compared with Wooden Sleepers, by Mr. Kowalski. Form C, the Life of Wooden Sleepers of different kinds, not pickled, or pickled according to various processes, by Mr. V. Herzenestein. Form E, Locomotive Fire-boxes, by Mr. Hodeige. Form F, Locomotive Boilers, by Mr. Belleroche. Form G, Lubrication of Rolling Stock, by Mr. Hubert. Brussels: P. Weissenbruch, publisher.

NARROW GAUGE SELF-PROPELLED TRAM CAR

THE DAIMLER MOTOR COMPANY, LONDON, ENGINEERS

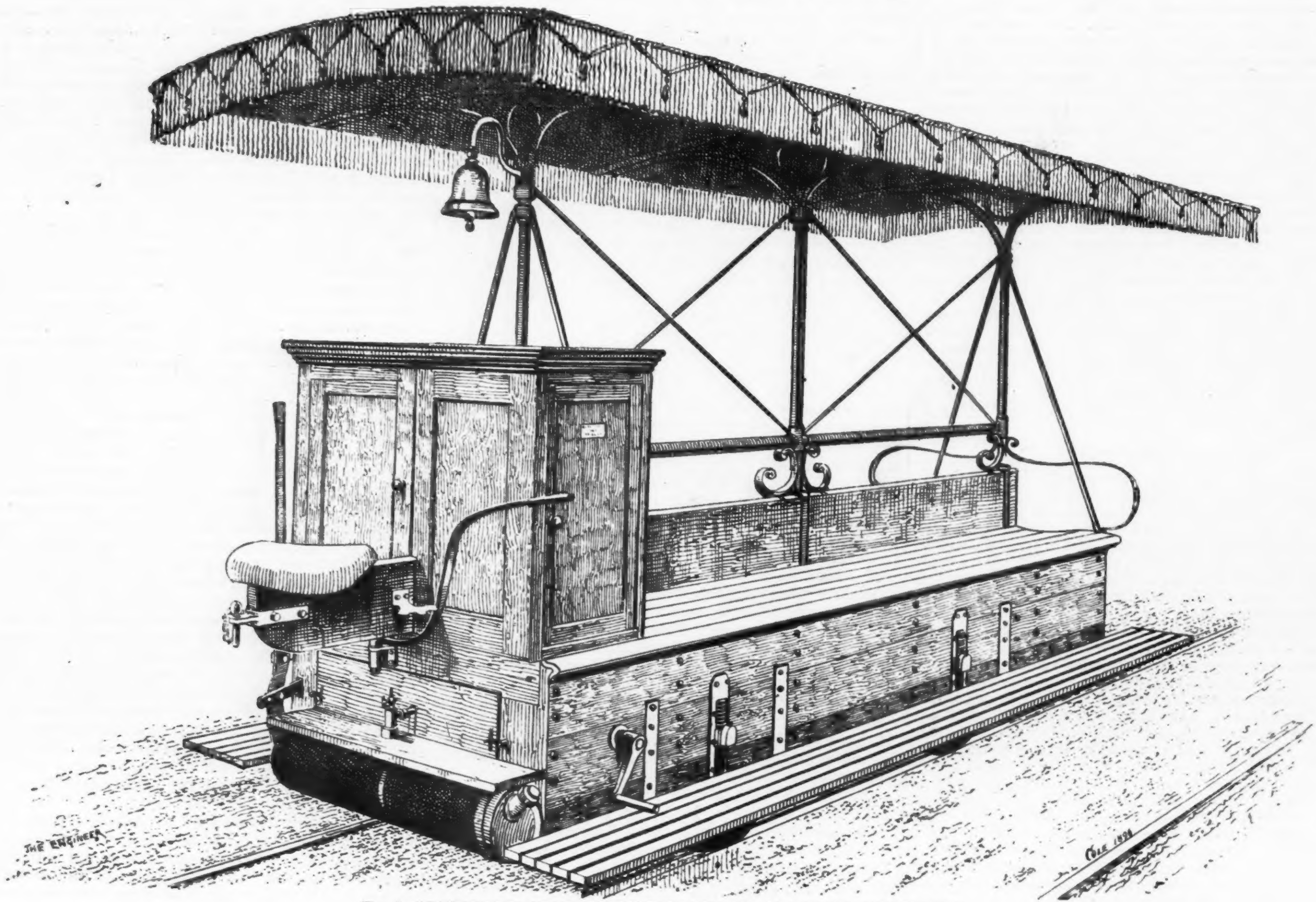

Fig. 1—PERSPECTIVE VIEW OF SELF-PROPELLED CAR FROM MOTOR END

HORSELESS CARRIAGES.

AMONG the vehicles exhibited in the Imperial Institute Exhibition is a narrow-gauge tramcar for carrying about a dozen passengers on longitudinal seats, as shown in the accompanying engravings. It has a light canopy over it, and is propelled by a Daimler motor placed in the case shown at one end. At the same end is the seat for a driver, within whose reach are placed the two levers necessary for controlling the movements of the car, the arrangement of the motor, the gearing, and the brake and gear levers. The motor we have already described* as to its oil or benzoline, and air-supply arrangements. It has two cylinders, and is connected to the driving axle by strong gearing thrown in or out of gear by a flat bar connected to the brake-lever M. On this bar is a projection having an inclined surface. This passes through a slotted head projecting from the end of the hollow continuation of the crank shaft at K, the head being connected to the friction clutch by a rod through the hole in the shaft up to the clutch at L. Thus when the lever M is pulled to put the brake on the driving wheels, the driving power is simultaneously cut out by the separation of the friction clutch surfaces, the which are pressed together by a spiral spring which is seen between the outer bearing and the small pinion E. When the latter is in gear, as shown with the wheel G on the intermediate shaft, the slowest speed is made, and by pulling the lever N out, the pinion F is put into gear with the wheel H, a higher speed being obtained. From the third wheel on this shaft the wheel I is driven. At D D are the two cylindrical exhaust boxes. The exhaust from both cylinders passes into the box nearest the engine, and from this it passes by a pipe to the bottom of the second box, from the top of which it passes into the air by a pipe which turns over from the top and leads it to near the ground. The oil vessel is not shown in our sketch, but provision is made for about a day's working. The arrangement of the car and its motor is very neat, and it gives a good idea of what may be done for vehicles for light narrow-gauge tramways or tramroads.

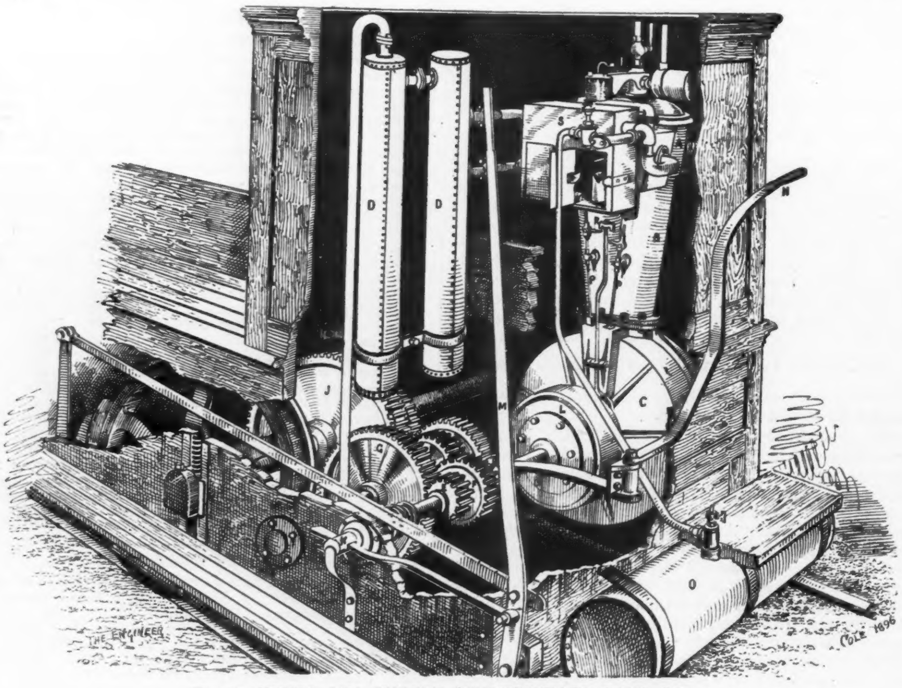

Fig. 2—MOTOR AND GEARING—SELF-PROPELLED TRAM CAR

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* THE ENGINEER, December 20th, 1895.

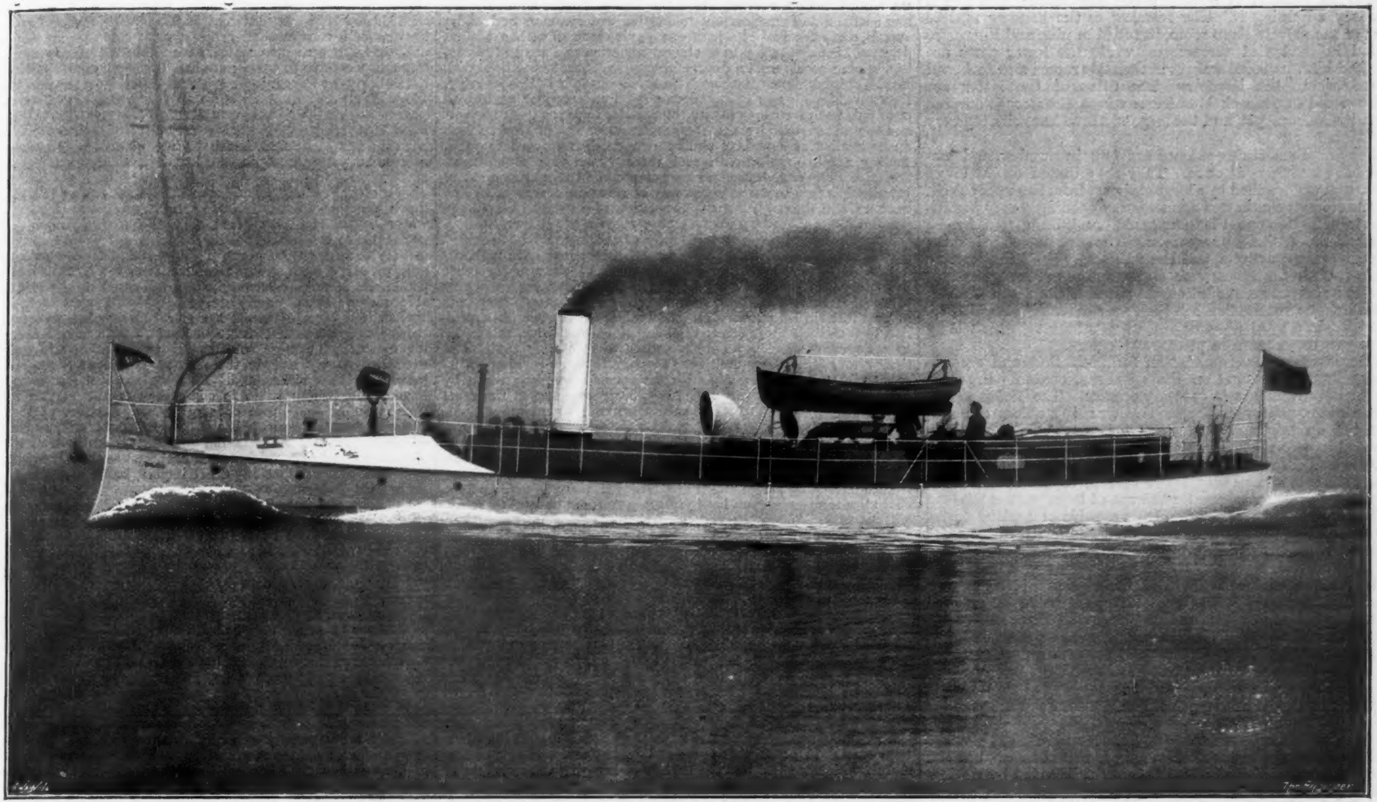
RHEA FIBRE.

THE great strength, length, and lustre of the fibre of the rhea plant so eminently adapt it for use in the textile manufactures, that its production in quantity in an economical manner and of suitable quality constitutes one of the most important problems of the day. The history of the many endeavours to effect this object extends back some forty years and more, and many thousands of pounds have been expended in the endeavour to compass the end in view. The solution of the question has been sought mainly in two directions—the mechanical and the chemical. At first, and for a long time, attention was chiefly directed to mechanical means, and the Indian Government has thrice within the last five-and-twenty years offered a handsome reward for a machine which should produce the fibre in a condition suitable for the required purpose. The French Government also took up the matter in 1888, and offered prizes for any process or machine by which the fibre could be produced in commercial quantities and of proper quality. The fibre occurs in the stem of the rheea plant, being embedded in a resinous substance, which in its turn is enclosed within the bark, and the greatest difficulty in the way of success is the satisfactory treatment of the gumming matter. Hence chemical science stepped in to aid in the solution of the problem, M. Frémy, the celebrated French chemist, being among the first, if not the first, to devise a method of chemical treatment, which was brought before the public in 1883. Since then several methods have been proposed, but none appear to have been applied commercially, at any rate not in this country. A recent invention in this direction is that of Mr. Henry Ferguson, who, after several years of experiments and research, perfected a system which has been put in practice on a commercial scale at the Phœnix Spinning Mills, Brighouse, Yorkshire. The process is both simple and effective, and at the same time economical. The stripped bark containing the fibre, and known as "brown barked rheea" is packed in large openwork wire cages, which hold the bark in separate layers, thus preventing them becoming matted or entangled. When charged, the cages are immersed in a solution of caustic soda for about three hours, the solution being maintained at the boiling point by steam heat. By this means the extraneous matters, consisting of bark and the gum in which the fibres are embedded, become softened, and the cages containing the fibre are then transferred to a tank of warm water, in which they are kept at a given temperature for several hours, the result being that the fibre is automatically de-barked in a stationary position, the use of scutching machinery being obviated. On removal from the warm bath the fibre is well washed in cold water, and is then found to be thoroughly prepared for the use of the spinner, so far as relates to the complete removal of extraneous matters. In order, however, to adapt it for use on existing machines, and to impart suppleness to it, the fibre is immersed for a short time in a cold composition of vegetable oils, alkalies, and water. On removal from this oleaginous bath, the fibre is air dried, which completes the process of preparation for spinning. The prepared fibre is taken to the spinning mill, where it is made into sliver, which is spun into yarn. It easily spins to all counts, and according to an expert in rheea treatment of thirty years' standing—Mr. Taylor Burrows—Mr. Ferguson can be said to have definitely solved the problem of producing rheea fibre in a cheap and effective manner, the fibre resulting from his treatment being fine and uninjured. Mr. Burrows expresses the opinion that "there is now every certainty of this beautiful fibre becoming one of the most important of textile industries."

THE Wolverhampton Corporation is applying for various powers for the purpose of establishing new waterworks, in addition to those at present existing. Borings have been made, and the estimated cost of sinking the wells, putting down the plant, &c., is £35,000.

THE STEAM YACHT SCUD

MR. J. S. WHITE, COWES, BUILDER AND ENGINEER



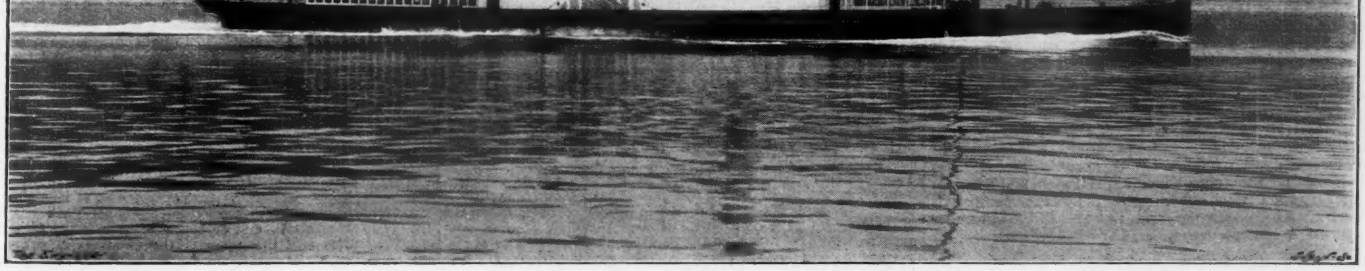
STEAM YACHT SCUD.

THE Scud is a steel screw "turnabout" yacht of the following dimensions:—Length over all, 90ft.; breadth, extreme, 10ft. 9in.; depth of hold, 5ft. 6in. She has been designed and built to the order of Mr. A. H. E. Wood, late owner of the Rona, by Mr. Jno. Samuel White, East Cowes, I.W. The vessel is fitted up throughout in a most luxurious manner, having a moderate sized saloon aft, entered from a spacious cockpit, with owner's room, pantry, and w.c. adjacent. These apartments are enclosed by a mushroom teak deck-house having low-pitched skylights on top. The saloon is upholstered in the style of a first-class railway carriage, with silk curtains and edgings; and the panels are of selected pieces of pollard oak. The forward part of the vessel has been devoted to the crew's quarters, and is fitted up with pine lockers and folding cots. An electric light installation has been supplied throughout the vessel, with a projector forward. The steam steering engine, by the builder, is placed in the after peak, and actuates a quadrant on the forward rudder—this vessel having two being built on Mr. White's patent "turnabout" system. Our illustration gives a very good idea of the general appearance of the yacht. On her official trial trip at Stokes Bay she attained a mean speed of $20\frac{1}{3}$ knots, running smoothly and with a total absence of vibration.

The engines are of the compound surface-condensing type having one high-pressure cylinder, 11in. diameter, and two low-pressure cylinders, $17\frac{1}{2}$in. diameter, by 11in. stroke, working on three cranks set at 120 deg. The high-pressure cylinder is placed in the centre, and is fitted with a piston valve; the two low-pressure cylinders are fitted with flat valves. The air pump is worked by levers off the forward engine, and the feed pumps at a reduced speed through worm gearing at the forward end of the shaft. The shafting is hollow, and all the reciprocating parts are as light as possible and balanced. The main bearing and crank-pin brasses are of a special mixture of aluminium, the hotwell is fitted with a feed-filter, and there are also a feed-heater, duplex donkey pump, centrifugal circulating pump, Parsons' turbine dynamo, fan engine, and reserve feed tank in the engine room. The boiler is of the Blechynden type with incurved tubes, and so constructed to admit of every tube being examined and withdrawn individually without disturbing any other tubes. The working pressure is 200 lb. per square inch. The propeller is of Stones' bronze, 4ft. 10in. diameter, by 5ft. 3in. pitch, the slip at full speed being 9·7 per cent. The energy developed was about 550-horse power, the revolutions being 430 per minute. The machinery was specially designed to reduce vibration to a minimum, and proved singularly successful, the vibration at full speed being practically nil.

THAMES PADDLE STEAMER SOUTHEND BELLE

MESSRS. DENNY AND SONS, DUMBARTON, BUILDERS AND ENGINEERS



THE THAMES PADDLE STEAMER SOUTHEND BELLE.

UNTIL within quite recent years the steamers employed in passenger service on the Thames were, both as regards their speed and accommodation, very much behind the capabilities of modern naval science, and they presented a poor appearance in contrast with those which had long been running on the Clyde. That a city with a population of between four and five millions of people, and situated upon a river possessing the attractions of the Thames, should be served with so antiquated and uncomfortable a class of steamboats was a puzzle to visitors from the North and elsewhere, more especially in view of the well-known proclivities of the Londoners for tripping and holiday making. This state of things could not always continue, and so, thanks to the enterprise of such companies as the Belle Steamers Company, an end has been put to it. There is now to be found on the Thames a rapidly increasing fleet of pleasure steamers second to none found elsewhere in the United Kingdom, or, indeed, in the world. One of the most recent additions to the Thames passenger fleet is the Southend Belle, recently built and engined by Messrs. Denny, of Dumbarton. Our illustrations show the engines of this vessel, as well as her appearance when running her steam trials on the Clyde.

The Southend Belle is a saloon steamer with a long promenade deck, her principal dimensions being 249ft. by 30ft. by $10\frac{1}{2}$ft., and she has accommodation for about 2000 passengers. The first-class passengers' saloon is at the after part of the upper deck, and it is fitted up in the most artistic and luxurious manner. The sofas are arranged in horseshoe shaped bays, and both sides of the apartment are fully occupied with large plate-glass windows, divided by decorated pilasters, and hung with blue and gold silk tapestry curtains. The sofas are upholstered in blue frieze velvet, and the floor is covered with Brussels carpet, overlaid down the centre passage with a broad runner of thick velvet pile. Additional light is admitted by handsome skylights, which add greatly to the appearance of the apartment. Just on the fore side of the first-class saloon are the ladies' boudoir and two private cabins, while forward of these are the vestibule and stairway to the lower or dining saloons. The ladies' boudoir is a very pretty apartment, and has a lavatory adjoining it. The framing of the boudoir is, like that of the private state room, panelled in pine and lincrusta, tinted in shades of terra-cotta, while the lower parts are finished with polished walnut in the state rooms and darkened mahogany in the boudoir. The sofas of the latter are upholstered in peacock blue frieze velvet, the floor is covered with Brussels carpet, and the large windows have silk tapestry curtains.

The first-class dining saloons are two in number, and can seat 120 passengers at once. They are situated on the lower deck, and are reached by a large stairway from the upper deck. In the framework around the stairway opening a very beautiful stained glass panel is introduced, containing four heads, symbolical of the four seasons. The decoration of these saloons is most artistic, and the upholstery is all that can be desired, both for appearance and comfort. Throughout all the first-class accommodation the metal fittings are electroplated. The ventilation has been very carefully attended to, resulting in a total absence of that "stuffiness" which is by no means uncommon in pleasure steamers.

The lavatory accommodation for both first and second-class, situated as usual on the sponsons, contains the most recent improvements in sanitary science. The ticket office, parcel room, pantry, larder, and other ship's offices are also situated on the sponsons. The fore part of the vessel is devoted to second-class passengers, and the berthing of the officers and crew. Immediately on the fore side of the boiler-room there is a large airy lower saloon, especially intended as a private dining saloon for the use of large parties wishing to have it reserved for them. It is capable of seating forty-six persons, and is in direct communication with the forward pantry, which contains every convenience for prompt and efficient service.

Without going into a detailed description of the accommodation provided for second-class passengers, it may be sufficient to state that it is second class only in name.

On the promenade deck, situated in a large deck-house, is an extensive bar in the American style, also a special cabin similar to those on the deck below, stalls for the sale of newspapers, confectionery, &c., and the captain's cabin. This promenade deck is of exceptional area, and provides space for nearly 400 persons.

Our illustration shows that the Southend Belle has a smart and powerful appearance. Not only is this the case, but she is as trustworthy as she looks, being subdivided by no less than eight water-tight bulkheads, and constructed to satisfy the Board of Trade requirements both in regard to strength and life-saving appliances. She is fitted with both bow and stern rudders for the greater facility of steering in a crowded waterway; has an excellent installation of electric lighting, and is steered by the steam gear of Messrs. Bow and McLachlan.

A by no means unimportant point in connection with passenger comfort is the means adopted in the Southend Belle for arresting the small cinders, sparks, &c., which proceed from the funnels of steamers, especially when forced draught is employed. A continual shower of hot cinders and dust is a source of great annoyance to all, especially lady passengers, and to cope with it Messrs. Denny and Brace's patent spark catchers have been fitted, an apparatus which in this and other cases is always a complete specific against the nuisance.

The Southend Belle is fitted with direct-acting triple-expansion diagonal paddle engines, illustrated on page 592, having cylinders 28in., 41½in., and 60in., with a length of stroke of 5ft. The valve gear is upon the fixed quadrant principle, as designed by Mr. W. Brock, the valves being on the top of the cylinders, thereby reducing the athwartship space occupied, and bringing the gearing within convenient reach of the engineer. Piston valves are fitted to the high-pressure and intermediate cylinders, and a flat slide valve with balance rings to the low-pressure. The entablatures of the engines are of cast steel, and stayed at top with a cast steel tube carrying the valve motion quadrants, which are also of cast steel. The centrifugal circulating pumps are by Messrs. Drysdale, of Glasgow. The air pump is worked off the main engine, as also are the sanitary and bilge pumps. The air pump discharges the water into a tank from which it is pumped to the boilers by a pair of Weir's direct-acting pumping engines, each of which is sufficient to feed the boilers when the vessel is developing full power. One of Edmiston's feed filters is fitted on the main feed-pipe range, and is found to act very efficiently in preventing the passage of grease or oil from the engines to the boilers. It may also be noted that in the main lubrication of the engines oil is not used, there being fitted a complete installation of the Axiom automatic lubricating gear, which is also found to be both efficient and economical, besides keeping the engine-room clean and free from the unpleasant smell of heated oil.

Steam is supplied to the engines from two boilers of the Navy type, having in all six furnaces, and working at a pressure of 160 lb. per square inch. They are worked upon the closed stokehold principle, and air is supplied to them by a large fan driven by a Chandler silent enclosed engine, which, along with the steering gear, stands upon the deck over the boilers. The joints to the pipes exposed to high pressure are made by means of Pope's patent flanges, and the main steam pipes are hooped with steel bands on Mr. Peter Denny's system, to strengthen them against the risk of bursting.

Upon her trial runs on the Clyde the Southend Belle attained a mean speed of 21¼ miles per hour. She is intended for the further development of the company's passenger service to Southend, Clacton, Felixstowe, Harwich, and Ipswich. Her construction was superintended by the company's engineer, Mr. Dugald Brown, and she was fitted out under the supervision of her commander, Captain Holland.

SHIPBUILDING IN GERMANY.*

By C. FERD. LAEISZ, Associate

ASSUMING that a brief survey of the development of the shipbuilding industry in the country you are about to visit may, although totally devoid of scientific value, be not altogether unwelcome in the present stage of your proceedings, I venture to lay before you the following remarks. In the old times of wooden sailing vessels shipbuilding in this country had attained to a considerable degree of excellence, and many a fine clipper ship has been launched from German yards, both in the Baltic and at North Sea ports. Since, however, wood was superseded by iron, and an ever-increasing portion of the world's carrying trade fell to the share of steamers, the natural resources Great Britian possesses in her enormous mineral wealth close to the sea, allied to her great capital power and wonderful enterprise, have assured her an ascendancy in this as in many other industries, with which other countries have found it extremely difficult to keep pace. It is thus we lagged behind very considerably, and not until Great Britain had accumulated an enormous tonnage of iron steamers and sailing vessels, were the first efforts of our yards crowned with a certain degree of success. They have always laboured, and are still labouring, under considerable disadvantages in the competition with British shipbuilders. Although labour is cheaper in this country, that advantage is more than outweighed by the higher cost of all material, and of coal, owing to the greater distance from the pits and the mines, and by the comparative scarcity of work, which does not allow of squads of skilled men going from yard to yard, finding ample employment, and thereby working much more actively. The restrictions our laws impose on the employment of juvenile labour also stand in the way of creating a race of skilled workers, and the contributions to accidents-insurance and old-age pension funds obligatory upon employers are a heavy burden.

Since, however, the growing trade of the country has enabled our shipowners to materially increase their tonnage, and particularly since the Imperial Admiralty has given constant employment to a number of yards, thereby largely fostering the inventive genius of naval architects and marine engineers, and educating thousands of men into skilled workers, our shipbuilders have been in a position to turn their attention to the highest class of work, and aspire to a degree of efficiency enabling them to rank with the best of their profession. The quantity of tonnage they are turning out is, of course, small as compared with the enormous figures shown by British statistics; in point of quality, however, some of the craft "made in Germany" may be well worthy of your notice.

I cannot here dwell on the various stages of Admiralty work, which I have to leave to someone more competent to speak upon, but confine myself to specimens of our merchant navy. In its development we have, naturally, mostly followed in the wake of British enterprise; here and there, however, you will find we have shot ahead, although you have not often suffered us long to retain a front seat. When the ocean greyhounds came into fashion in the North American trade, the North German Lloyd were among the first to put a number of high-speed vessels on that line, and they have for a considerable time had more steamers of that class running than all the other lines put together. The first half-dozen were built at Fairfield, the later editions at the Vulcan Yard, of Stettin, where a steamer is just now building for the same owners, which is to vie with the famous Cunard flyers. Her dimensions are 625ft. between perpendiculars, 66ft. beam, and 43ft. moulded depth; while her twin engines are to develope 28,000-horse power. The same company have another boat of similar properties building at Dantzic by Mr. Schichau, the well-known torpedo-boat builder, who has also supplied a couple of mail steamers for their Eastern service.

The Hamburg American line were among the first to introduce twin screws in ocean steamers; and one of them, the Fürst Bismarck, which has just had the honour of bringing the members of this Institution over from England, has, I trust, merited your approval as a fair specimen of German shipbuilding and engineering skill. She and another of her type were built by the Vulcan Yard above mentioned, while two sister ships were supplied, one by Messrs. Laird Brothers, and the other by the Fairfield Yard. The same owners have also taken to twin screws in their large cargo boats, some of which were built by the Vulcan Yard and by Messrs. Blohm and Voss, of Hamburg, and they have at present a huge steamer of that description building by Messrs. Harland and Wolff, which is destined for some time, and until you go one better, to rank as the biggest carrier; her deadweight capacity being over 12,000 tons. Her dimensions are 560ft. by 62ft. by 41ft. You will have occasion to inspect the yard I have just referred to—of Messrs. Blohm and Voss in this city—and I think you will find it admirably situated and well laid out and fitted with all the machinery required to produce excellent work. At the same yard you will find in course of construction a floating dry dock capable of lifting 17,000 tons, of which we are sorely in need, considering the great displacement of many of our new ships. At another yard close by, the Reiherstieg, you will find an off-shore dock, in which vessels are hauled in sideways, as there is not sufficient space to put them in end on. At each of these two yards there is a passenger steamer building for the East African Mail service; the first of them is to sail on July 10th, on an excursion round the Dark Continent, and I hope some of you will be disposed to take passage in her.

Turning again to cargo boats, I may mention that the first steamers carrying oil in bulk were built for German owners by Messrs. Sir W. G. Armstrong, Mitchell, and Co., who have supplied quite a fleet to the German American Petroleum Company and other owners. Latterly, however, some boats of this class were also built in German yards. The chance is that, in going over our yards, you will see one or two tankers repairing, as the strain upon their numerous bulkheads has proved the delight of the shipbuilder who has not built them. I must say, however, that in this respect, as in every other, each succeeding production shows that the difficulties attending this description of vessel are being better contended with. Our attention has also been turned to the turret-decked ship, and there is now at Flensburg a so-called elliptical steamer building, which is expected to be an improvement upon the Sunderland type. The ordinary plain cargo steamer, the ocean tramp, is a species that has prospered but very indifferently in this country, where I think she cannot be worked as economically as in England. Over and over again owners who began with tramp steamers have ended by finding them employment in some regular line, or they have been swallowed by the lines. It is probably due to this fact that our steamers show a coefficient of fineness seldom over 0·76, and I know of scarcely a German steamer with as full lines, as there are many under the British flag, approaching, or even exceeding, 0·8.

All improvements in the engine department have, of course, been closely followed in this country, and we have endeavoured to profit at not too great a cost by the never-resting inventive genius of the marine engineer. The Kosmos Line, of Hamburg, for instance, were among the first who adopted quadruple expansion engines of Messrs. Wigham, Richardson, and Co.'s pattern; and since hydraulic riveting permits of subjecting boilers to very high pressure with absolute safety, several of our engine works have turned out quadruple engines that have given the utmost satisfaction. You are, of course, familiar with the plan devised by our colleague, Mr. Schlick, of balancing engines, so as to materially diminish vibration. The paper he read upon the subject before this Institution two years ago has met with much approval, and his name, allied to that of some eminent English engineers, has gained the Yarrow, Schlick, and Tweedy System marked success in your country, as well as in France and Germany. Forced draught, on the other hand, is not much believed in in this country, and some of its devotees have been cured of their partiality at their own expense. Perhaps ill-luck in the beginning has deprived us of the courage to go in for the right system, and give it a thoroughly fair trial.

Sailing shipowners in this country have long clung to wood, and their reluctance to go in for iron was not overcome until builders proved capable of turning out iron vessels that were as fast sailers as our old wooden clippers, and yet required very little ballast. In the last twenty years, however, a number of very fine iron and steel sailing ships have been built in German yards, and some of them have become famous for their record passages. I may name the Preussen steel ship, built by Blohm and Voss, Iquique to Hamburg, 71 days; Luna, iron barque, built by the Germania Yard, Rangoon to Falmouth, 92 days; Placilla, steel four-masted barque, built by Tecklenborg, Channel to Valparaiso, 58 days; Selene, steel ship, built by the Rostock Yard, Channel to Melbourne, 71 days; Hebe, steel four-masted barque, built by Blohm and Voss, Channel to Adelaide, 69 days. The last-named vessel covered 13,485 nautical miles at an average speed of 8·14 miles per hour, and the Selene averaged 9¼ knots over a course of 6425 miles. Mr. John C. Tecklenborg, of Geestemünde, built last year a steel five-masted barque, the Potosi, which is at present the largest sailing vessel afloat. Her dimensions are 360ft. between perpendiculars, 49½ft. beam, 31ft. moulded depth, and 4026 register tons; she carries 6200 tons deadweight, displaces 8470 tons on 25ft. draught, and spreads canvas of 50,020 square feet sail area. She has proved a very fast sailer, and a most comfortable ship at sea, and she tacks with the greatest ease. The very heavy strain these large vessels have to undergo when heavily laden has shown the advisability of strengthening them beyond the requirements of Lloyd's rules; bulkheads close to every full-rigged mast have proved an excellent transverse strengthening, and a bridge-house amidships for about one-sixth of the vessel's length not only largely adds to her structural strength, but gives her a considerable reserve buoyancy, and prevents her decks being swamped fore and aft.

Few of our sailing vessels are fitted with water ballast, not so much, perhaps, from technical as from economical reasons; where water ballast has been fitted deep tanks have proved decidedly preferable to the double bottom, which is apt to raise the centre of gravity to a dangerous point, if the vessel is loaded with a homogeneous cargo, such as coal, rice, &c. Very few German owners had confidence in composite vessels, and the number of them built in this country is consequently exceedingly small; fortunately so, I may say, as that type of vessel has soon become obsolete. Steel was readily adopted when it first appeared on the scene as a shipbuilding material, the more so as it was produced in this country in excellent quality, and, in the first few years, at a comparatively lower price than in England. Latterly, however, our steel makers have found it impossible to compete with the British material, which can be laid down cheaper at any German port than the home-made article which has to pay railway carriage over a long distance. It must be borne in mind that no duties are imposed on any shipbuilding material, nor on coal, just as there is no difference in the harbour dues, or any other impost, between a German and a foreign ship.

I should like here to correct an error I have frequently met with in English papers, that is the belief that our merchant navy is largely subsidised by the Government. Such a contention can hardly be sustained, if you consider that, with the exception of two mail subsidies—one of £200,000 yearly for the Eastern and Australian service, another of £44,000 for an East African line—there are no subventions, premia, surtaxes, or privileges, of any shape or form, in favour of ships built or owned in this country over those of other nationalities. Legislation, which is doing so much in certain countries to hamper enterprise, has not quite spared us, but it has, so far, been satisfied to let shipowners look after themselves, provided they do everything that can be desired to render navigation as safe as possible, and indemnify sailors who have come to grief through accidents at sea, and their widows and children. A Mutual Accident Insurance Association, to contribute to which is compulsory on every German shipowner, has to assess the pensions fixed by law, and to levy the yearly contributions; and, as it has thus become the joint interest of shipowners to prevent accidents, the Association is empowered to enforce whatever it deems imperative for the safety of life and limb on board ship. Its regulations embody, therefore, a great many things provided for by the English Life-saving Appliances and other Acts, and its surveyors, guided by the advice of the Germanic Lloyd, are fulfilling the duties incumbent upon the Board of Trade officials in your country. We have not yet seen the wisdom of imitating the English Load Line Act, but we have our Bulkhead Committee pondering on the solution of the problem of rendering our ships unsinkable, and thus satisfying the clamour of the landsman, who is loath to acknowledge the truth of the old adage, *Navigare necesse est, vivere non est necesse.*

MUNICIPAL ELECTRICAL ASSOCIATION.

THE first annual convention of this recently formed body was opened at 10.15 a.m., Wednesday, 10th June, by Mr. Arthur Wright, the borough electrical engineer of Brighton, in the Lecture Theatre of the United Service Institution, Whitehall. Without any preliminaries he immediately proceeded to deliver his address, which we publish below.

The attendance was very good, and besides the municipal electrical engineers themselves, there was a good sprinkling of other persons interested in the work of the convention. The Board of Trade was represented by Sir Courtenay Boyle, and later on by Major Cardew, while a number of the chairmen of Municipal Electric Lighting Committees were also present.

PRESIDENT'S ADDRESS

You have done me the great honour of asking me to preside a this our first annual convention, and I feel I cannot take up a portion of your time to better purpose than by proving the pressing want of some such Association as we are now inaugurating, to further and protect the interests of the municipal electricity undertakings, which in the very near future will probably exceed eighty in number, and represent a capital outlay amounting to £4,000,000 sterling. I, therefore, propose to show how exceedingly numerous are the questions that are being constantly met with in our special branch of electrical engineering, and why, in my opinion, none of the existing societies can really supply our want.

I think you will share my regret that the very nature of our problems, and the particular standport from which we municipal men have to look at them, prevents us from deriving the great benefit of having among our regular members the numerous experienced managers and engineers of companies supplying electricity.

Although the objects of this Association are generally and very tersely stated in the constitution, I may be allowed to amplify the wording there by stating that, in promoting the special interests of municipal electricity undertakings by bringing together, for the purpose of comparing experiences, the men responsible for their management, we hope to succeed in getting the representatives of the ratepayers to participate in our discussions, and to obtain their valuable co-operation and municipal experience in trying to solve our difficulties, so that our recorded conclusions may receive the greater consideration from the head governing bodies. For the purpose of classification, I will divide some of the problems that have already confronted the management of municipal electrical undertakings into three distinct groups—those relating to policy, to commercial, and to technical questions. Although it could be truly said that some of the questions of policy come within the sphere of one, if not more, of the older societies, and that many of our commercial and technical problems could be advantageously discussed from a general point of view before some of them, yet it must surely be to the advantage of the community to have the particular interests of our industry safeguarded and properly represented by an Association comprising among its members the representatives of the ratepayers and the technical officers in charge.

The group of "Questions of policy" must obviously include those relating to what should be the proper period allowed for the repayment of loans. That some decision ought soon to be arrived at is evident when we remember that in London the vestries can get permission from the County Council to repay their capital in periods exceeding forty years, whereas, in many of the provincial towns, twenty-five years is the period fixed by the Local Government Board. There is obviously no reason why posterity outside the metropolis should be so much more generously dealt with, at the expense of the present generation, or why folks in the provinces, who have to pay all the expenses and suffer from the inevitable troubles incidental to the starting of a new industry, should also have to behave so much more handsomely to people who it must be remembered will have an advantage over us in being born twenty-five years later in the world's progress.

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* Read at the summer meeting of the thirty-seventh session of the Institution of Naval Architects, June 9th.

Take, again, the question of assessment of electricity works and mains. The interpretation of the law on this point is so uncertain among experts that it is actually possible, in the case of two municipal electrical undertakings in the South of England, for the relative assessments to be nearly as ten is to one, although the capital invested is about equal. At first sight, to anyone not directly interested in the success of municipal electricity works, this variation of assessment would probably not be considered very serious, as apparently it is only a question of taking money out of one municipal pocket and putting it into the other; but to the men responsible for the success of this one special department, the question of assessment affects the vital results of the electricity undertaking paying or the reverse, and increases or diminishes the near possibility of a reduction in the tariff for supply, which they realise is necessary to ensure the general use of electricity among all classes of ratepayers.

The decision arrived at, as to what policy should be pursued in relation to the profits obtained, has a similar effect on the rapid growth of municipal electricity undertakings. The practice of insisting on maintaining high tariffs, so as to be able to hand over large profits to the general body of rateyayers, on the ground that they should be handsomely repaid for their risk in mortgaging their rates, is very naturally resented by those ratepayers who make use of their own municipal supply. They contend that by this policy they are being severely taxed, in the shape of having to pay heavy electricity bills, for the benefit of a number of people who we now know ran practically no risk at all, and as non-users do not help their own municipal enterprise. Again, when we remember how prone some municipalities are to pride themselves on the large profits made in their undertakings, and when we remember the policies advocated by some of our friends, who would lead us to imagine that the object is simply to supply electricity to those who can afford to pay the necessarily high initial price, it is evident that good must come from our discussing this point, and bringing home to the governing bodies the truth that the criterion of success of a municipal electricity undertaking, trading in what cannot be called a necessity, is not so much the profits made out of the undertaking as the more or less general use the ratepayers make of the supply offered.

Those who advocate putting aside a large proportion of the annual profits to building up a reserve fund for use in case of unlooked-for contingencies are often charged with want of consideration for the general ratepayers who backed the necessary cheque in starting the undertaking; these critics, however, forget that in this matter it is the duty of a Corporation not only to start, but to continue to supply a cheap and satisfactory service, and to insure against any possible mishaps that may arise in the future. Again, the question of creating a mutual electricity works insurance fund seems a fitting subject for discussion, considering how all our works are now being tarred with the same brush by the fire offices, and classed by them among the same hazardous risks as factories, &c. Again, the practice of the various municipalities differs considerably in deciding whether one or separate committees should manage the gas and the electricity departments. The former practice frequently prevails, and what seems to many of us the inevitably slow progress that results from such a policy is not at present fully realised. In some towns human nature seems to be so over-rated that their Corporations have made one manager responsible for these two competitive departments.

Another point in connection with the general policy that is to be followed in carrying out municipal electricity undertakings is one on which electricity works managers are not by any means all agreed among themselves—namely, whether a Corporation should make all ratepayers pay a uniform profit on the cost of production of the electricity they individually consume, or charge a uniform price to everybody. I scarcely need add that the two systems cannot both be adopted. The former has the advantage of justice on its side, while the latter has that of greater simplicity; unfortunately, however, it involves the commercially unsound principle of charging the same price for commodities which may individually require capital outlays differing as much as tenfold or more.

Again, owing doubtless to the youth of our industry, no definite rule has yet been established among municipalities as to how they should charge for electricity consumed in their street lighting and public buildings; whether, for instance, this should be done on the sound principle of having only one universal tariff, or should special tariffs be arranged for their own municipal consumption. The latter course, in view of the charges that are constantly being made of some Corporations making their electricity profits out of their own pockets, seems difficult to justify. The wisdom, or the contrary, of municipalities taking joint action in threatened patent litigation, or in view of new Parliamentary regulations or restrictions, wants discussion and settlement. The questions whether municipalities should carry out the wiring of private premises in competition with local tradesmen; whether they should have powers to hire out motors, arc lamps, and fittings; the advisability of establishing municipal telephone systems, electric fire alarms, and electric fire engines; the possible benefits of combining the water and electricity works; the use of the plant in periods of light load for the production of such by-products as disinfecting fluids, acetylene and carborundum, &c., are all interesting problems of policy, which I trust will be ventilated and argued at our conventions.

Another municipal variation of practice is shown by some believing that it is to the interest of the ratepayers to employ a sufficiently strong resident engineer to carry out both the design and the running of their undertaking, on the ground that no one but a resident can properly grasp and retain the local bearings of the problems involved in a distribution scheme of the nature of electricity supply, while others consider that a consulting engineer, owing to his having the opportunity of gaining much more varied experiences from all sorts and conditions of towns, should serve them in better stead. On the answer to the above delicate question of course depends what should be considered the proper remuneration of the resident engineers who have the virtual control, whether their councils fully realise it or not, of property amounting in many cases to hundreds of thousands of pounds.

The touring experiences of many of our best electrical engineers is advantageous to the men themselves in gaining fresh experiences, but it increases the unfortunate loss to the Corporations when the engineers are snapped up for better appointments elsewhere. The existence of this constant system of changing proves beyond all doubt that many Corporations have not yet realised the value of the immense experience these men take away with them, and how impossible it is to replace their experience by even better men until some considerable time has elapsed. Some Corporations fully see the advisability of getting their engineers to visit other electricity works for the purpose of keeping up to date. The great extent to which the ratepayers benefit by this policy is not, I am sorry to say, apparent to all the governing bodies. Although many of our senior brother municipal officers will be prone to think that some of the above questions do not come at all within our province for discussion, I feel that if we obtain the valuable assistance of the chairmen of our committees in discussing and solving them, there will be little difficulty in getting the correct principles accepted and adopted by our councillors.

All the above, and a host besides, are questions of policy that press for solution, and I think many will agree with me in thinking that if we leave them to the other societies to fight out, we may as well adopt the equally slow course of leaving each Corporation to worry for themselves when they are individually confronted with them. The founders of this Association saw that co-operation in arriving at conclusions upon these problems would save a great deal of time, and would avoid the repetition of a vast amount of work by the different Councils. They also saw the importance of putting in black and white the results of careful consideration by competent men of the different policies advocated, so as to afford help to those among their *confrères* who may be in need of it.

With the second class of problems connected with our work, viz., those requiring consideration from a commercial point of view, it seems to many of us quite impossible to get this class of question satisfactorily and adequately discussed before societies, however influential and well organised, which comprise among their members men representing absolutely conflicting interests; and it appears equally futile to discuss these questions before institutions including among the members the managers of electricity supply companies, whose object in developing their business, viz, to get the biggest return on the capital expended, is so entirely different to ours in trying to supply the greatest number of ratepayers at the smallest possible cost. Moreover, it can hardly be fair or interesting to the majority of the members of existing engineering institutions for us to take up their time discussing problems which can only properly be thrashed out before a special body representative of our particular subject of municipal electricity supply.

Under the heading of "Commercial problems" must come the important question of the proper organisation of the electrical staff; that is to say, how to so organise a staff, and separate the undertaking into separate departments, as to be able to define the duties and responsibilities of each member of it, and to insure against any discontinuity in the business in case of illness or resignation of the chief officers. Whether the principle of giving the staff a bonus depending on the results of the year's working is likely to be to the benefit of the ratepayers or not is a question on which much can be said on either side; and it ought not now to be difficult to decide what should be considered the proper scale of remuneration to the different members of the staff in accordance with their term of service, so as to avoid as much as possible the inconvenience and loss of experience to a Corporation of having their officers merely use the undertaking as a sort of training school.

I think a very useful purpose would be fulfilled by our Association if we could all agree on some proper method of keeping electricity accounts, or perhaps I ought to say, of properly filling in the Board of Trade regulation form of accounts. Everyone will now admit the great value electric lighting statistics, financial as well as technical, would be, providing they were made on an absolutely uniform basis, and I trust some of our members will early suggest some form which we can all approve and adhere to. The question as to the right method of determining the cost of electricity supply has yet to be thrashed out, as it seems to some of us that the usual method of taking the average cost of all the units delivered is as useless for the purpose of calculating the cost of supplying any one class of consumer as if a land agent were to calculate the cost of a particular plot of ground in a town by dividing the total land value of the town by its total area. On this matter of costs depends the very important question of the actual cost of electrically lighting streets; also whether there is any justification, commercial or otherwise, for the plan adopted in many towns of charging a lower rate for electricity consumed in motors than in lamps.

Another most interesting and still unsettled point is what should be the basis on which to calculate the cost of energy wasted in feeders, transformers, &c., for the purpose of determining the relative cost of different systems of distribution. I have not yet succeeded in meeting two men agreed as to how this should be done. Again, it has not yet been generally recognised, as some think it ought to be, that it pays a Corporation to cater in our industry for the same class of people that prove so remunerative to the railway companies, viz., those who choose to travel third class; and that it would probably be very much more advisable for Corporations to run mains into their districts, than only into the districts occupied by the houses of the rich and often absent residents, or the early-closing shopkeepers. To put it shortly, many of us have still to realise and prove to our governing bodies that it may be far better to get electricity used in a poor man's kitchen and one dwelling room than it does to get it into many of the drawing-rooms of the wealthy.

Again, you will all agree, I feel sure, that it is very important, in order to inspire confidence among the ratepayers, to show as early as possible after the starting of a municipal electricity undertaking that it can be made self-supporting, and therefore independent of the rates. With this object in view, it is an interesting problem in electricity supply to find whether capital is better employed in the early days of an undertaking in extending its sphere of operations into all parts of a borough, or in spending money on coal-saving refinements. To point out a danger confronting many of us, I may add that sound business men often express a belief that electricity undertakings would progress much faster if their managers took as much interest in understanding the commercial problems as they do in the over-absorbing engineering details and the fascinating scientific points connected with the industry.

The subject of wiring regulations and fire risks is one that has already received a great deal of attention, and I submit that it is still an unsettled question whether we are not weakening our position by enacting pages and pages of regulations which we have no very practical means of enforcing, and cannot afford to keep a sufficient number of inspectors to see carried out. Although I believe a certain amount of regulation writing is necessary in the early days of any industry, yet, in view of the utter absence of observed regulations concerning the use of paraffin lamps and compo gas pipes, one may be forgiven for thinking that it is better to realise at once the futility of electricity supply authorities formulating regulations—that the proper people to do this and see them carried out are the fire offices, and that the more thoroughly this is recognised the more likely these offices will be to fall into line and organise their staffs so as to ensure strict and general inspections. This seems to me to be the only way to improve the character of the interior wiring work, which at present varies much in quality.

With regard to the last group of questions, those of technical interest, which to most of us are infinitely more attractive than those of commercial expediency, it is hardly necessary for me to do more than enumerate many of the most pressing problems. Foremost among these, in my opinion, must surely stand the question of what should be considered the best system of distribution of electricity to any particular town or district. That the present state of things cannot be finality is obvious, when we bear in mind how numerous are the different methods at present advocated and in use for towns of comparatively the same class. Owing to the absence of some such Association as ours, this vital question has not yet been thrashed out by men who are unconnected financially with particular systems; but I hope we shall not be so very much longer now in settling upon some method of selecting the plant and means of distribution which should be put down by a municipality, so as to insure an absolute continuity of cheap electricity supply, and at the same time bear the severe practical test of enabling the manager and the rest of the officers who have to work during the day to go home comfortably to their five o'clock tea without expecting every moment to be rung up on account of some mishap or other.

In connection with this battle of the systems must be decided the proper voltage of supply to be adopted by works to be erected in the future; also whether it is advisable, and if so in what stage of their progress, for works in actual operation to raise their voltage of supply, and the best method of effecting a change. I only wish I could see a chance of our discussing within the next year or so such specially interesting technical problems as the advisability of earthing the neutral conductor of a low-tension system of supply, the most suitable class of mains to adopt, the proper size of feeders and generating units, the advisability of adopting for commercial, if not technical reasons, one uniform periodicity for alternating current plant, the wisdom of interconnecting all the low-tension network of a town, &c. Although the question of the best design for an electricity works depends so much on local circumstances, yet the main considerations affecting this ought now to be determined.

The question of locating faults on a system of distribution is another point on which we must all derive benefit by comparing our different methods and difficulties. Up to the present, busy men in practice have been apt to keep their various methods too much to themselves, forgetting that probably the combination of other methods with their own would be of great value. As it has now been recognised that the present system of wood casing for interior wiring cannot be considered finality either from an electrical or æsthetic point of view, a paper on this subject up to date would be most interesting and useful to all of us. Again, the best means for lighting streets, wide and narrow, can now, with the experience of many of our members, be advantageously discussed.

Our constitution has been framed on a very liberal basis, and I trust we shall escape the internal troubles which some of the older societies have had. On Friday we proceed to elect from among our members a president, two vice-presidents, three members of committee, a treasurer, and a secretary. In conclusion, I feel sure that if we can only persuade ourselves to be mutually communicative and ready to exchange our views and experiences, the result will be so beneficial to the community at large, that they will be as thankful to the members who first took up the idea of forming this Association as we ourselves ought to be to Mr. Magden, our first very energetic honorary secretary, who by his ability in organisation has done so much towards making this Association promise to be a permanent and useful success.

Sir Courtenay Boyle made a very interesting speech. He said he was very agreeably surprised at the tone of the papers and discussions. He thought they would be very valuable, both to the State Department which he represented, and also to municipal bodies. They were all working for the consumer, an individual whom he had heard mentioned by various speakers with great respect. They had, of course, to look to the consumer to approve their actions. He pointed out that the science they were dealing with was still young. It had been stated that the Board of Trade regulations were still defective. He was sorry to hear that said, and he felt that his Department must rely upon the opinions expressed at such a convention in order to improve the regulations. He had two matters to put to the meeting: (1) Can no one find a suitable name for a Board of Trade unit? He had hoped that the word "Kelvin" would be adopted, but Lord Kelvin had felt unable to accept the proposal, as he was personally interested in an electricity meter. (2) The Board of Trade must rely upon the gentlemen present and others in like position to guide them as to the selection and approval of good electricity meters. His friend, Major Cardew, could, of course, make the most careful and accurate laboratory tests, but they needed also to know how the meters acted in ordinary everyday work, and whether the readings remained constant. The Board of Trade had found considerable difficulty in these matters, and he thought that the engineers and municipal bodies would be the proper persons to assist his Department with valuable advice.

Our space will not permit of reproduction of the papers, but we shall deal with them in our issue of next week. Many of the points raised are of great interest to electrical engineers.

PETROLEUM MINES IN ROUMANIA.—The Berca-Paclete petroleum mines, in the Buzio district of Roumania, are reported by a correspondent of the *Echo des Mines* to possess a well, which alone yields, from a depth of 210 m.—114½ fathoms—on an average 20 tons daily of a petroleum which, in its raw state, burns with a flame like that of refined paraffin

TRADE AND BUSINESS ANNOUNCEMENTS.—Messrs. James Cleminson and Son, of Dashwood House, New Broad-street, announce that they have resumed their original telegraphic address, namely, Cleminson, London.—Messrs. Chamberlain and Hookham have appointed Mr. J. G. Statter, electrical and mechanical engineer, late of Victoria-street, to be the head of their dynamo factory.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Engineer: James H. D. Barry, to the Hawke, to date June 5th. Assistant engineers: Clifford Howle, to the Vulcan, temporary, to date June 5th; Albert J. Kenning, to the Repulse, temporary, to date June 6th; Cyril E. J. Hammond and Ernest E. Pethick, to the Vivid, supernumerary, for disposal, to date June 6th.

CITY AND GUILDS OF LONDON INSTITUTE.—Those of our readers who have been fortunate enough to receive an invitation to the conversazione to be held at the Central Technical College, Exhibition-road, S.W., this—Friday—evening, will find a large amount of food for reflection and study. Practically the whole of this vast and well-arranged college will be thrown open to the visitors. The department of civil and mechanical engineering, under the direction of Professor W. C. Unwin, F.R.S., M. Inst. C.E.—who is also the dean of the college—including the engineering workshops and laboratory, the boiler-house, the calorimetric laboratory, the material testing laboratory. The cement testing laboratory will be open for inspection, and engineers will find in this section alone quite sufficient interesting material for one evening. In addition, the departments of mechanics and mathematics, presided over by Professor O. Henrici, F.R.S.; physics and electrical engineering, under the direction of Professor W. E. Ayrton, F.R.S.; chemistry, the head of which is Professor H. E. Armstrong, Ph.D., F.R.S., will put on view all their most interesting appliances and processes, while there will also be the inevitable demonstration of the use of the *x* rays in photographing and observing otherwise invisible objects.

THE FLUTOMETER.—Under this title Messrs. Simonsen, Nielsen, and Wedum, 28, Masshouse-lane, Birmingham, are introducing into this country an instrument of which, we understand, 8000 have been sold on the Continent. Its object is to indicate the amount of draught in the furnace and flues of a steam boiler. It consists essentially of a counter-weighted vane movable about a spindle within a cylindrical casing, and combined with a pointer moving over a dial, by which the deflection of the vane under the influence of an air current induced through the casing by the draught in the chimney or flue is indicated, the degree of deflection being a measure of the strength of the current, and consequently of the draught. The casing has an inlet and an outlet at opposite sides of a partition, and the outlet is adapted for connection with the chimney or flue of which it is desired to measure the draught. The instrument is generally fixed in front of the boiler on a tube, leading into the draught hole, it does not matter where, as long as it is below the dampers. If the tube is hammered through the wall any mortar or dust must be blown out before the instrument is fixed. The necessary degree of draught to keep up a good fire without wasting coal depends, of course, upon the size of the boiler, but when that is once ascertained the flutometer will always indicate whether there is too much draught or not. An excessive air admission is, of course, very wasteful of fuel.

LETTERS TO THE EDITOR.

We do not hold ourselves responsible for the opinions o: our correspondents.)

PERMANENT WAY.

SIR,—I would not presume to refer to your leader in last week's ENGINEER if I were not perfectly satisfied, from a long acquaintance with your estimable journal, of your fairness and impartiality in all matters that come under your notice. But while I consider you are perfectly right in the importance you attach to the proper use of ballast, I think you might insist somewhat on the value of other items involved in the construction of permanent way. I say this because, with all the well-known advantages belonging to "ballast as is ballast"—and good ballast is often the saving clause where much else is bad or imperfect—there is no item in any department of railway administration that will so surely hold its own as the various kinds of ballast now used, from humus to broken stone, together with the manner of its manipulation, and a very plausible excuse may be advanced for this.

In venturing to address you again, Mr. Editor, upon this subject, I promise you I will be guided by Montaigne, and only "write about what I know," and not with my "little pittance undertake to write a whole body of physics;" therefore, you may believe me when I say, that of all the difficulties that present themselves to the railway constructor—taking precedence even of what kind of foundations are to be obtained for his structures—the item of ballast stands out with the greatest prominence, and often gives rise to a good deal of anxiety. The biggest lump of a cutting, which is sometimes the key to the length of time required for the execution of the whole work, is just a matter of calculation; how many "roads" may be got to attack it, and how many wagons and "sets" of them can be got out of it per day, and the thing is done to the hour. Bricks may be made on the spot, and stone and wood and other material are nearly universal; but ballast, if not never, is certainly hardly ever to be found just where it is wanted, and just what it should be when found.

If often fortunately happens that rock cuttings occur where all the bottom ballast required for the line may be saved, even if attended with some inconvenience in the matter of long lead in its distribution; and some small stone, kept back from tips, with more broken stone in the absence of anything else, will be made use of as top ballast. But stone-breaking is to be avoided, as it costs money; and I have seen, at home and abroad, where, rather than go to this expense, much has been risked with other material that has been used in ballasting.

When the railway is constructed and handed over to the company, the "crux" is only transferred, and, if possible, with increased difficulties attending it. If it should happen that the line pass through strata such that as, with some attendant twinges of conscience, the contents may be accepted as ballast, then the line is provided for all future repairing needs, with pits conveniently situate on the sides of it at various places. Now, is it likely that the stuff which sometimes presents itself in such situations will be very closely scrutinised? No! And why? Because another material got from a distance, or off the line perhaps, as good as it really ought to be, would cost more in the getting it.

You have said that "Railways are slow to lead ballast from a distance." That is true, and it is also true that they will never get it from a distance; although not to do so should be demonstrated to be, as you say, "penny-wise-and-pound-foolish." And it will remain so until pressure is put on, and it may come to that eventually.

You say also, "What would a railway company be reimbursed if it doubled the number of sleepers in every mile of the track?" May I ask any of your readers, or anyone who knows only a little more than his multiplication table, whether, if there had been more sleepers on the track at Little Bytham, even with no more ballast about them than common, every additional sleeper would not have gone a little way toward rendering that road safer than it proved to be, even though the number should not have been doubled?

The recompense to be obtained also may really be a negative one, but it nevertheless assumes a very positive aspect when the cost is dotted down in the account books of the line, after the accident takes place. And is reputation for safety and freedom from disaster to be considered as no recompense at all?

My early training, more than half a century ago, was all in the direction of railway work, until opportunity interposed, and I became a telegraph engineer instead of a railway engineer. After some work in England, I went to the United States of America to serve a big telegraph contractor, but in a short time found myself engaged in railway instead. While still occupied in telegraphy, however, and impressed with the miserable state of the permanent way on the many miles of railway I had gone over on foot, I caught the American fever of racing with the locomotive, and for that matter steamboats too; and as one hundred miles per hour were freely talked about, I became "enthused," and voted boldly for one hundred miles; and, moreover, I advertised in the *New York Tribune* newspaper—1851—that I could suggest the construction of a road which should be safe at that or higher speeds.

In a country in which a man could obtain a patent for the simple re-arrangement of the rails of the well-known Virginia snake fence, I thought I might even obtain one for my road; but this illusion was dispelled. Therefore, as per advertisement, I published the fact that I was willing to give such information to whomsoever it might concern. There was no lack of interest shown by Americans, including some well-known railroad men, who actually had the uncommon modesty to think that it was possible to learn something from somebody else. But when I asked for three times as much iron, and nearly three times as much wood as they were then using, together with some other trifling adjuncts, they did not laugh at me, but said that all the iron used on their railroads came from Great Britain, perhaps a thousand to fifteen hundred pounds worth per mile, and that it was always paid for with paper "stock" pretty freely issued; consequently, extra expense was to be avoided, even if the British capitalist would—which was not likely—take a greater responsibility upon himself; therefore my road was not to be thought of.

I must say it, to the very great credit of the American, that my idea was not ridiculed; and while some said that perhaps I was right, none said I was positively wrong in any detail; others said I was quite right, and more than one, who knew what they were talking about gratified me by saying that what I proposed would some day come to be the general practice, "but it would be of slow growth, and then only as it was seen to be necessary from time to time." I might have seen how the thing would have to be evolved, and not be made a new creation at once; and it has come to this at last, as they said it would; but my enthusiasm in the matter was excusable, for I was very young then.

Now for another little matter, Mr. Editor, which is suggested by your own leader and the remarks of several correspondents in the last two weeks' ENGINEERS. I was so taken with the "bogie" on the other side of the Atlantic, that on my return to England in 1853 I saw some eminent engineers on the subject of its introduction here. One of these gentlemen happened to be an old personal friend, and one other to whom I was introduced in order to relate my transatlantic experiences, heard me out with evident impatience. My friend knew me well enough to take the liberty of concluding his opinion on the affair by telling me that I "knew nothing about a locomotive," and I was about as successful with the other, who was a much more eminent man. He said, "If my head never aches until the advantages of the bogie truck are recognised in England, I shall consider myself to be the most lucky of men."

I only relate this circumstance as affording a little side light on that conservative disposition—not to give it a more decided term—which can be evinced by really good men. Not being myself quite satisfied with their verdicts, I thought I would take my case to a higher court, and so wrote a letter to the *Mining Journal*, and it appeared in the issue of April 9th, 1853. If you will be good enough, Mr. Editor, to allow me, I will just select two short paragraphs from it to be reproduced here.

"My business has taken me on railroads in the United States for two years or more, and I believe that no English carriage would keep the rails for a distance of ten miles, at the rate of twenty miles per hour, on half the roads I have travelled in America at thirty and forty miles in safety, and I have been from Maine to Missouri. If I have shown that inequalities in the permanent way, or small curves of great length, do not necessarily cause accidents, it is that you may know the reason for it. The Americans mount their carriages, &c., on trucks of four wheels, each having a bearing of 2ft. 7in. only. Sufficient explanation.

"McConnell's new engines may 'run from London to Birmingham in two hours or less,' until they run off and kill. I will only say that if these engines were fitted on trucks, drawing carriages mounted also on trucks, the public need not fear one hundred miles an hour, even with our present permanent way."

In view of what we all know is done with the bogie now, and which, I regret to say, the two gentlemen of whom I have spoken above cannot realise, as they are, unfortunately—or fortunately, perhaps—beyond the reach of all "headaches," I can only refer with some satisfaction to the estimate I had of it so early in the day, in order that I may "point the moral" that it is unwise to overlook any item that may possibly be of use in the domain of railway administration, for whatever reason or from whichever side it may come.

J. W. WILKINS.

June 8th.

THE LIGHT RAILWAYS BILL.

SIR,—I agree with your remarks in your issue of June 5th, that the Government should define in this Bill what is meant by the term "light railway;" but I think you have fixed the axle weight too low when you stipulate for five tons. Several light railways will be built on the standard gauge, and this limit will prevent, say, a truck of coal from passing over such a line. I venture to suggest that the following definition will meet all requirements, viz., that the words light railway shall mean:—

(*a*) A railway constructed on a gauge of 4ft. 8½in., at a cost not exceeding £3500 per mile, including equipment, with a rail not exceeding 50 lb. per lineal yard, and worked at a speed not exceeding twenty-five miles per hour; or (*b*) a railway on a gauge of, say, 2ft. 6in., constructed and equipped at a cost not exceeding £3500 per mile, with a rail not exceeding 41½ lb. per lineal yard, and worked at a speed not exceeding twenty-five miles per hour. In the case of (*b*) the gauge should be fixed by Parliament so as to prevent a multiplication of gauges in different parts of the country.

J. C. MACKAY.

28, Victoria-street, Westminster, S.W., June 8th.

SIR,—Referring to the article in THE ENGINEER of the 5th inst. on the above subject, I find a light railway is defined in 31 and 32 Vic., Cap. 19 (Acts for Regulation of Railways, 1868) section 28, as follows:—

"A light railway shall be constructed and worked subject to such conditions and regulations as the Board of Trade may from time to time impose or make; provided that (1), the regulations respecting the weight of locomotive engines, carriages, and vehicles, to be used on such railway, shall not authorise a greater weight than eight tons to be brought upon the rails by any one pair of wheels; (2), the regulations respecting the speed of trains shall not authorise a rate of speed exceeding at any time twenty-five miles an hour."

I suppose this definition will stand if the new Light Railway Bill becomes law.

J. M. BURKE, M. Inst. C.E.

Dublin, June 8th.

NAVIGATION OF THE THAMES.

SIR,—May I be allowed to reply briefly to the letter from Mr. Henry Law, which appears in THE ENGINEER of May 29th? He states that the top of the Thames Tunnel is more than 36ft. below low-water springs. This, however, does not alter the fact that the tunnel is an obstruction, with, I believe, only about 12ft. at low-water, as stated in my previous letter.

While the tunnel remains it seems to me it will be an obstruction to the largest vessels. Does Mr. Law think the depth of the ground over the tunnel can safely be much reduced, or sufficiently so for the largest vessels?

A. SCOTT.

Newcastle-on-Tyne, June 4th.

PUFFING BILLY.

SIR,—I see two letters on Puffing Billy in your issue of May 29th ult., but I think few people are aware that an equally famous locomotive, no less than Puffing Billy's own twin-brother Wylam Dilly, is now preserved in the Royal Museum of Science and Art in Edinburgh. The everlasting separation of these old companions, in the interests of knowledge, in our two metropolitan cities might move some of your poetic readers to verse commemorative, seeing their names lend themselves to rhyming.

NORMAN D. MACDONALD.

15, Abercromby-place, Edinburgh,
June 3rd.

NORTH-EASTERN RAILWAY CARRIAGES.

THE trial run has taken place of the first of a number of entirely new trains which the North-Eastern Railway has built for the more important traffic on its line, and which present a number of great improvements and evince the desire of the company to be well "up-to-date" in matters affecting the comfort and safety of its patrons. The run was over the line between York and Scarborough, and proved in every sense successful, this route being chosen because of the number of sharp curves and the varying gradients, which enabled the officers—among whom were Mr. G. S. Gibb, the general manager; Mr. J. Welburn, the superintendent of the line; and Mr. Raven, the assistant locomotive superintendent—to satisfy themselves that the coaches could pass round the curves at a high speed with the utmost ease and absence of jolting.

Each train consists of five coaches, namely, two combined brake and third-class coaches, one third-class coach, one first and third-class lavatory coach, and one luggage composite coach. Each coach is 52ft. long and 8ft. 6in. wide—or 6in. wider than a standard coach—and is carried on a pair of four-wheeled bogies. These bogie trucks have been very carefully designed, and are constructed of flanged steel, with laminated bearing springs, and Timm's spiral bolster springs, which, while they allow the coach to take the curves with ease, at the same time eliminate the disagreeable vibration and noise which are inseparable from the old six-wheeled rigid coach, with its wheels fastened to the frame. The underframe has been built on an entirely new plan, the object in view being greater strength, combined with lightness; and for this purpose it is constructed of steel channel-iron soles, with cross rails of angle iron riveted to corner plates on the channel irons. The coaches are equipped with powerful laminated buffing springs, and the continuous draw-gear has india-rubber springs.

The body is made of mahogany, finished externally with the rich standard lake paint with yellow lines, and the N. E. R. coats-of-arms. The external appearance is very handsome, owing to the clerestory roof which runs the whole length of each coach, and gives a feeling of height and massiveness, rising as it does to a height of 13ft. 5in. from the rail level. The train is lighted throughout by Pintsch's patent gas, two lamps in each compartment, thus giving ample light. Every wheel of the train is fitted with double blocks of the quick-action Westinghouse brake, an improved brake, practically instantaneous in action, and which at the elaborate brake trials carried out on the North-Eastern Railway last year proved itself capable of stopping a train running at sixty miles an hour in 100 yards less distance than the brakes hitherto used in this country. It will be readily seen that such an advantage is of immense value for preventing collisions, and the public will be glad to know that the North-Eastern is the first company in Great Britain to adopt it as its standard brake.

Internally, the woodwork of the first-class compartments consists of brown oak facings with sycamore panels cross-banded with figured Kauri pine, the door panels being solid brown oak. The seats are trimmed with blue cloth and finished with red and black lace, the walls being decorated with four groups of photographs and bevelled edged mirrors. The third-class compartments are trimmed in red and black rep with lace to match, the walls above and at the sides being faced with millboard painted in cream and brown, which does much to deaden the sound. The groups of photographs of North-Eastern Railway scenery, framed in wainscot oak, are placed under the racks. The whole of the floors in the trains are covered with patent Kork matting, which is both noiseless and very warm for the feet, and each compartment is amply supplied with patent torpedo air extractors. The interior of the coaches is both light and airy, owing to the high clerestory ceiling with its separate windows, entirely doing away with the feeling of depression so common in a small railway compartment; and the large ventilators in the clerestory should be of much use in keeping the atmosphere fresh.

In the brake and third composite there are three third-class compartments and a large guard's van; the third-class coach has eight compartments; the luggage composite has three first and four third-class compartments and a luggage van; the lavatory composite has four first-class and three third-class compartments connected by corridors with the lavatories. These corridors are panelled in oak and sycamore above, and with old gold Lincrusta-Walton below. The lavatories are complete with tip-up basins, mirrors, towel racks, &c.

From the above brief description it will be seen that the coaches have been designed with the utmost care, and present several marked features of advance on the standard of coach hitherto used for ordinary trains, and indeed they reflect great credit on Mr. David Bain, the carriage superintendent, under whose supervision the work has been executed at the North-Eastern carriage works at York from designs prepared by the locomotive superintendent of the company. The train will be brought into service between Leeds and Scarborough, commencing 1st July.—*Newcastle Daily Chronicle.*

THE INSTITUTION OF CIVIL ENGINEERS.

THE annual general meeting was held on Tuesday, June 2nd, Sir Benjamin Baker, K.C.M.G., the president, in the chair. The report of the Council for the session 1895-96 dealt first with the changes that had been effected during the session in the charter and the bye-laws. The question of the constitution and the mode of election of the Council had received careful attention from successive Councils since 1888. The outgoing Council had been of opinion that the existing circumstances rendered changes in the constitution and the mode of election of the Council desirable in the interests of the Institution. That view having been cordially concurred in by the members generally, the Council had recommended that a supplemental charter should be applied for. At a special general meeting held on the 6th February last, a petition to her Majesty was duly adopted, and a new supplemental charter was granted on the 20th March. At a special general meeting held on the 15th April, the bye-laws were altered to bring them into conformity with the powers thus obtained. Under the new charter the members of the institution are at liberty to fix the number of the Council by bye-laws from time to time—thus admitting of the full and proper representation of all engineering interests both at home and in the Colonies and India—whilst in voting for the election of the Council personal attendance is no longer necessary.

The tabular statement of transfers, elections, deaths, and resignations during the year showed an effective increase of 109 on the previous total of 5,921, while the number of students was 877 as against 816 at the corresponding period of last year. The gross numbers on the books on the 31st March in 1895 and 1896 were 6737 and 6907 respectively.

During the year the following amounts had been received:—Income, £21,778 17s. 3d., of which £17,847 14s. 6d. represented subscriptions, £1705 19s. 5d. miscellaneous items, and £2225 3s. 4d. dividends; capital, £24,359 2s., of which £20,690 18s. 6d. was derived from the sale of stocks to meet expenditure on the new building; and trust funds account, £474 15s. 8d., making a total of £46,612 14s. 11d. The expenditure amounted to £53,334 0s. 11d., allocated as follows:—Income, £17,074 7s. 9d., including £9061 13s. 1d. for publications; capital, £35,935 12s. 2d., of which £34,205 12s. had been absorbed directly by the new building, while the remainder represented incidental expenditure incurred in connection therewith; and trust funds account, £324 1s.

The first meeting of the session had been held in the new building on the prescribed day, when the President delivered an address to a very large audience, 598 names being recorded in the attendance book. There had been twenty-three ordinary meetings, at which nineteen communications had been read and discussed, covering a range as wide as that comprised in Tredgold's well-known definition of the art of the civil engineer.

In recognition of the merits of some of the papers awards out of the funds appropriated to that purpose had been made to Messrs. George F. Deacon, H. Riall Sankey, J. A. Ewing, J. O. Arnold, G. H. Hill, Jeremiah Head, E. L. Corthell, R. C. Parsons, H. Heenan, W. Gilbert, T. Wrightson, and H. F. Parshall. The papers printed without being discussed treated as usual a variety of subjects, and, in recognition of the labours of some of the authors, premiums had been awarded to Messrs. Brian Donkin and Alan Brebner for papers published in vol. cxxii. It was stated that the awards in the case of selected papers published during the session 1895-96 would be announced at the opening meeting of the next session.

The fourth annual lecture of the "James Forrest" series—"Physical Experiment in Relation to Engineering"—was delivered by Dr. Alex. B. W. Kennedy, F.R.S., M. Inst. C.E., on the 7th May. This discourse would be printed in the concluding volume of the "Proceedings" of the session.

The attendance at the supplemental students' meetings had shown some improvement, the average having been 48. Several papers of merit had been read and discussed, and Miller prizes had been awarded to Messrs. W. O. Leitch, jun., A. S. Butterworth, E. S. MacDonald, and S. Thow. Awards of Miller prizes had also been made to Messrs. J. Scott and J. Andrew for papers read before the Glasgow Association of Students, and to Mr. M. De Ville for a paper read before the Manchester Association.

The report having been adopted, cordial votes of thanks were passed to the president, the vice-presidents, and other members of council for the services they had rendered during the past session; and to the auditors and the scrutineers for the time and trouble they had devoted to their respective duties. Messrs. A. C. Hurtzig and J. G. Griffiths were appointed auditors for the ensuing session.

The ballot for council resulted in the election of John Wolfe Barry, C.B., F.R.S., as president; William Henry Preece, C.B., F.R.S., Sir Douglas Fox, James Mansergh, and William Anderson, C.B., D.C.L., F.R.S., as vice-presidents; Alexander Richardson Binnie, Henry Deane, William Robert Galbraith, George Graham, James Henry Greathead, John Clarke Hawkshaw, M.A., Charles Hawksley, John Hopkinson, jun., M.A., D.Sc., Wh.Sc., F.R.S., Alexander Blackie, William Kennedy, LL.D., F.R.S., John Kennedy, George Fosbery Lyster, Sir Guilford Lindsay Molesworth, K.C.I.E., Captain Sir Andrew Noble, K.C.B., F.R.S., late R.A., William Shelford, Bindon Blood Stoney, LL.D., F.R.S., Francis William Webb, Sir William Henry White, K.C.B., LL.D., F.R.S., and Sir Edward Leader Williams, as other members of council.

The next session will commence on the first Tuesday in November.

THE FUNCTIONS OF THE ARMY AND NAVY ON THE DEFENCE OF THE EMPIRE.

UNDER this title Admiral Colomb has read a paper at the United Service Institution, Earl Cowper being in the chair, to an audience containing many high authorities on the subject. The lecturer said the conclusion that he wished to establish was that we have laid too much stress on the defence of isolated positions, and not enough on the idea of mobile forces, naval and military, connecting the positions and throwing their whole strength on any point seriously threatened. The Navy, he said, had escaped the drag upon its mobility which formerly beset it but the Army has not escaped it, and all through the Empire the drag of an immobile and isolated system of defence keeps the Army down, and makes insignificant a force that ought to be looked upon as a pattern in the same way that the Navy is so regarded by other nations. For example, in an Army return last March 13th, the charge for the effective Army in the United Kingdom is set down at £5,081,100, while that for garrisoned positions at home and troops in reserve is £3,677,500. Thus nearly four-ninths of the whole is for troops not intended to operate beyond the United Kingdom. Taking this as indicating a proportion between mobile and immobile forces, the lecturer held that the Empire was not safe with so small a force as is thus indicated as being ready to embark at short notice. He held that history teaches that we have long had the greatest Navy ever known, but an Army always insignificant at the point of contact, and consequently generally acting as an ally. This has been due, not to the fact that the money voted for the Army was small, for it has generally been greater than that devoted to the Navy, but that the money has been wrongly applied. The independent action, then, which the Army and Navy have taken in the past, has not hurt the Navy, but has seriously injured the Army.

The Admiral next divided the advocates of defence into two schools, which he termed the "instinctive" and "reasoned." The former seeks to defend everything on independent grounds. This school built the great wall of China and sea coast batteries which barbarians unkindly took in reverse; it walled in Paris and shut up an army in Metz. It sunk immense sums in fortifying Portsmouth and Plymouth, and it pines to build a wall round London. The "reasoned" school looks on defence as a whole, considering that a force divided up in isolated positions, however strong, must yield bit by bit in succession to an equal force concentrated on each in succession, and pleads that history bears this out. Hence, this school seeks to prevent attack, or to meet it by mobile forces readily concentrated and thrown on to the threatened point. Thus the instinctive force does not take time into account, while, with the reasoned defence, time is everything, and beyond very small forces sufficient to prevent surprises, it depends wholly on the operation of mobile forces. The instinctive school in reality only secures delay. The reasoned school defies any attack not strong enough to deal with the mobile force.

If it is urged that isolated places can be made impregnable to attack, the reply is that it is sufficient to invest and starve them. The instinctive school acts on possibilities, the reasoned school deals with war as a speculative business, in which a prospective gain should be kept in view, greatly exceeding the prospective risk. It puts itself as far as possible in the enemy's mind, reflecting that his object is conquest and occupation, plunder, or lastly, destruction. The first requires assured, permanent communication, and fails when the place is afterwards surrounded and cut off; and the two last require communication for a certain time, which the reasoned school operations should forbid.

To apply these principles in the case of the Empire: the British Empire consists of many positions divided asunder by great or little bands of sea. An enemy's business is to isolate them by its navy, if possible, while land frontiers may be invaded by an enemy's army if not prevented. No one denies to such a case the application in some measure of the action of mobile forces, naval or military. No one, for example, would free the mobile army from the duty of going to the frontier of India or Canada. As to the sea frontiers, the contention arises whether to attempt local defence by forts or coast defence ships, or to depend on a great mobile naval force. Thus we now depend on ships in squadrons or groups, near the United Kingdom, in the Mediterranean, Chinese, Indian. African, Australian, and American waters. Experience tells us what are the first steps taken by our Navy on threat of war. This is, we "shadow" the warships of the enemy everywhere by equal or superior forces in all neutral ports. Watching an enemy's own ports is an actual act of war. At a station where no force of the threatening enemy exists, the ships are assembled at some central and convenient rendezvous. An enemy to obtain success must be prepared to beat any group of ships within reach, or he must only attempt surprises on a very small scale. If he falls back into his own ports blockade follows, which, if complete, constitutes a complete defence to the Empire. The Army may keep an enemy's ships at bay till a defending force arrives; the probable time of its arrival may be such as to prevent the enemy attempting attack at all. The strength of a garrison, then, should be proportioned to its distance from the place of concentration of the naval force. If the enemy breaks blockade he must be followed.

The lecturer then pointed out the fallacy of the phrases, "The Navy is our first line of defence," and "Liberation of fleets for attack the true defence." The former, he said, appears to be based on the false conception that the British Islands are guarded by a sort of chain of ships. The latter is false because the Admiral of a fleet would always endeavour to strike any equal or inferior fleet within reach. It would be hopeless for him to excuse himself by declaring that he believed places behind him were insufficiently fortified and garrisoned. An Admiral should meet any flotilla about to sail, if possible as soon as it puts to sea, and any known weakness of his country's land defences should especially prompt such action, and only distinct inferiority in strength could justify any other course.

Again, modern changes in war material rather emphasise the above, such as great increase in speed, improved supply of intelligence, and the substitution of steam power for wind; so again, do increased power of gun fire, increased cost of warships, the rise of the torpedo and submarine mine. From these result greater certainty for a defending force in striking, while an attacking force is limited to a certain radius of action from its centre of supply. The transports of an attacking force are specially open to destruction by torpedo vessels and rams. Blockade and the watch of an enemy's ports ought to be facilitated by the above, but unless this be more effective than formerly, commerce still remains open to attack chiefly in the vicinity of commercial ports. Here the action of localised defended ships may come in, which, supported by batteries, might keep a foe at bay until reinforcing cruisers arrive; but it is not now possible for a cruiser to see an enemy capturing ships which the direction of wind makes it impossible for her to assist. In the face of a superior navy, night attacks on shipping by torpedo boats and the like will not develope greatly, but may be expected early in a war, and here the joint defence by Army and Navy should be close and intimate.

To come to actual features, the United Kingdom is of all parts of the Empire least liable to attack as the heart of empire and great rendezvous of naval forces. The prevention of landing, not the disposal of an enemy after landing, is the great matter. Lord Overstone has warned us that the landing itself, not what would follow, would bring about a financial collapse, yet sums of money sufficient to supply quite a fine mobile army have gone chiefly on preparations for fighting an enemy after he has landed. The invasion of such a country as Great Britain necessitates immense preparations, and renders secrecy and surprise impossible. This was pointed out over 100 years ago, when a French fleet had once been actually seen from Plymouth, and when our own fleet had been sent out for a two months' voyage each year. The study of the subject of invasions would convince anyone of the impossibility of conducting it on a large scale suddenly.

The lecturer then considered the position of a general landed in England with 100,000 men, and marching on London, on reaching the area covered by streets, with 500,000 troops in the island gathering to attack him, backed by the whole civilian population available for street fighting, and he dwelt on the impossibility of his reaching or overawing the mass of those gathered round the locality. As a fact, the lecturer questioned any serious invasion of England being attempted, except one based on meeting with allies among the English themselves, and did not believe that even 20,000 men could be landed on the shores of the British Isles without being opposed at sea.

It is sometimes urged that possible distributions of our naval forces might give an enemy time to land unopposed. Two occasions are quoted, one in 1878, when the Mediterranean fleet passed the Dardanelles, and one in 1882, when it attacked Alexandria, but in the latter case the fleet could proceed to Spithead as immediately as if it had not been in action. It should also be pointed out that in 1878 there was a home fleet in commission of seventeen battleships, five cruisers, twenty-three gunboats, eight smaller vessels, and two torpedo boats, besides fifty sail, including ten battleships completing in the Reserve. In 1882 there were at home in commission seventeen battleships, one cruiser, twenty-one gunboats, eight small vessels, and nine torpedo boats. Complete in the Reserve were ten battleships, seven cruisers, eleven gunboats, and eighteen torpedo boats. Besides, there were forty-two sail, of which five were battleships completing in the Reserve.

The development of the torpedo vessel puts the possibility of invasion further off, and the crowd of tugs and smaller vessels ought to make short work of transports crowded with troops by ramming them; indeed, the dangers now besetting a transport are such that the lecturer did not know how an admiral could guard against it. Isolated attacks of ports or harbours have become more difficult, since steam and telegraph have given power of rapid action to a defending force.

That which is true of the United Kingdom on a great scale applies on a smaller scale all over the Empire; that is, let the mobile defending force be greater than the enemy, and the local defending functions of the Army are greatly diminished. A defending mobile military force, however, should be collected on the same principle as in the United Kingdom. Let it be apparent that a port would take longer to subdue than would suffice for the arrival of the mobile defending force, and attack would not be attempted. The highest functions of the Army, it may be noted, must ever be in inland operations. An enemy to benefit by plunder must be left free to carry it home. To undertake destruction is serious for an inferior Power, because reprisals will be measured out to it on a multiplied scale.

The lecturer pleaded, in conclusion, that he had established a *primâ facie* case for a large and mobile army to be obtained by suppressing exaggerated ideas of localised and immobile defences. He trusted that it might be clearly understood, however, that he was not dealing with that death struggle which may occur in distant parts of the Empire if ever the power of mutual help is destroyed by the suppression of the Navy. This conjuncture the lecturer declined to consider until some other authority has done so, or so soon as he saw preparations for it going on.

In discussion Field-Marshal Sir Lintorn Simmons said that undoubtedly the dangerous weakness of the defences of England that had been pointed out by the great Duke of Wellington had been remedied in important respects, our fleet being much stronger than in his day and our force of volunteers having been established; but he considered that the lecturer had treated intelligence as more certain than it would be in war, when cables might be cut. He was not satisfied that we could safely detach squadrons of ships as suggested without defences behind them. He recommended the investigation of the whole question by a Commission. Capt. James, late R.E., supported Sir Lintorn Simmons in pressing the need of a Commission, but, while he believed that our mobile force was too small, he questioned if it could be increased by sweeping away our auxiliary forces. Mr. L. Swinburne urged that an admiral would be more free to strike with a defended base. General Sir H. Smythe, R.A., urged that the great importance of the British Isles as the heart of the Empire and main rendezvous of our forces was of such paramount importance that the strength of its defences ought to be secured in a measure out of proportion to the other parts of the Empire. Admiral Close commended Mr. Balfour's proposal of a Minister of Public Defence. He noticed the difficulty of getting naval and military authorities to accept advice from each other when an actual point arose, although in public in general terms they expressed the desire to do so. Admiral Fitzgerald expressed his conviction that there was nothing in Admiral Colomb's paper that anyone seriously differed from. He failed, however, to understand a remark that counter attacks were imaginary either by land or sea, and said that the lecturer might have read in the history of his own country a striking account of simultaneous attacks being made by two chieftains with their forces on each other's strongholds, when they took different roads, missed each other, both going and returning, and each met with such complete success that they ended by having simply exchanged all their women and cattle.

THE MARITIME POSITION AND THE PRINCIPAL FEATURES OF THE PORT OF HAMBURG.*

By HERR FRANZ ANDREAS MEYER, Engineer-in-Chief of the Free and Hanseatic City of Hamburg.

IN the fifth century of our chronology a number of my Lower Saxon countrymen left, on three sturdy crafts, these lowlands to assist the Britons against the Picts and Scots. I cannot blame those Anglo-Saxons for not returning to their rude lacustrine habitations and dark forests of the flat North German coast; no doubt they found it more preferable to remain in the sunny isle of Albion surrounded by the blue ocean. These emigrants, though, have not been lost to their native tribe; on the contrary, they raised a race akin to us, who have always sympathised with them.

The mighty spreading of the Anglo-Saxon race, enabling Great Britain to become a pioneer in the civilisation of the whole inhabited world, was shared by the Lower Saxons of the German coast, as they had of old proposed similar tasks, at the period of the Middle Ages, especially those of the Hanse towns, of which the city of Hamburg claims its honourable name up to this day. Later on, at the time of the Reformation, when the political distress of our large and beautiful country took larger dimensions, Hamburg had to keep up its commerce under rather difficult circumstances, and it was at this period that the English achievement in successfully increasing civilisation was of great advantage to our town, as it could in many ways rely thereon. In Hamburg, where we are now reaping the good of a united Germany, we cannot therefore forget these advantages offered to us by our English neighbours, who are connected to us by the most intimate relations of commerce, customs, and religion, and thus we are delighted that a highly respected party of that nation have felt the necessity of paying us a visit, in order to find out what has become of the settlements of our mutual ancestors in the course of many centuries.

There can scarcely be anyone so aged among our most esteemed guests from Great Britain as to have personally any remembrance of the time of Hengist and Horsa, nor is any contemporary to be found here. The chronicles of that period having also preserved no record thereof, we can only suppose that at that time, on the spot where Hamburg now lies, no town-like settlement existed. The North Sea, without doubt, sent its waves far up the estuary of the Elbe, even up to the Saxon forest, where our great Altreichskanzler, Prince Bismarck, has now taken up his abode. In this wide bay the seafaring and fishing Lower Saxons could not offer any sheltered anchorage to their ships, but were compelled to moor them in the creeks which here discharge their waters into the Elbe from the Holstein Highlands. Their dwellings were to be found on the wooded and lovely banks of the Bille, coming from the Saxon Forest, and on the Alster, winding its way through Holstein, till Charlemagne, at the beginning of the ninth century, built a stronghold, very near the place of this assemblage, containing a cathedral—more or less an ecclesiastical Hamburg—the Holy Ansgarius being the first bishop. From the windows of the Patriotic Building may be seen the monument of this venerable man erected on the bridge called Trostbrücke, which crosses the oldest outlet of the Alster into the Elbe. On the other side of this oldest bridge the valiant Counts of Schaumburg, figuring in the Crusades as well as in exploits against the Danes, had their stronghold, the New Burgh, which the benignant Adolphus III. of Schaumburg sacrificed in the twelfth century to the Hamburg citizens for the erection of warehouses and the laying out of the first harbour. You will now see on the Neue Burg the offices of your associate Herr Laeisz, and in the place of a former chapel dedicated by fishermen to St. Nicholas, the beautiful Gothic structure of St. Nicholas Church, built by the eminent English architect, Sir George Gilbert Scott, after the great fire of 1842, the spire of which, having a height of 482ft.—36ft. less than the total length of the Hamburg-American liner Fürst Bismarck—is surpassed by only a few spires in the world.

By embanking the marshes situated further south, the town, including the harbour, was by degrees drawn out of the region of the Alster nearer to the Elbe. At the same time the river Elbe was brought nearer to the town by means of most ingenious cuttings. Everbody visiting Hamburg before the time of the grand structural changes called forth from 1883-1888, in consequence of incorporation with the German Customs Union, will surely remember the fine roads of the harbour stretching before the embankments of the river to the height of the Stintfang, and from its summit, which is crowned by the buildings of the Imperial German Observatory for nautical and meteorological purposes, they will not have forgotten the exquisite view over the harbour and the river.

The effects of the severe sufferings caused by the occupation of the city by the armies of Napolen in 1813-14, and the compulsory contributions levied on the inhabitants, may be traced far into our century, and it was only by the introduction of railways and steamships; by the removal of the fortifications restored by the French when in possession of the town; by the rebuilding of one-fifth of the city, reduced to ashes in the great fire of 1842, that those features were gained which give to our city its present appearance of a great maritime metropolis. The principal latest reorganisation has been made by transforming the harbours and making new commercial arrangements called forth by the Customs Union of the new German Empire, and these have only been finally completed within the last years. What we are aiming at now is a thorough rectification of the Lower Elbe to further improve navigation, and thus to allow big vessels of the latest type to pass the bar between Hamburg and Brunshausen. By effecting this the favourable situation of the largest continental seaport, even now accessible to vessels drawing 24ft. and upwards, will be completely utilised for universal trade. You will be able to form an opinion on this fact by my showing you the present arrangement of the port in connection with the means of conveyance. I shall, however, omit every historical retrospect.

At the mouth of the Elbe in the North Sea, the river has a depth sufficient for any draught. Coming from the Dutch Islands along the German coast, and keeping to soundings of 12 to 14 fathoms depth, you will be led safely into the mouth of the Elbe. Even above Glückstadt, *i.e.*, about forty nautical miles farther up from the proper mouth, the channel maintains throughout a trough-shaped character, running in two mighty concave-shaped lines. The lower one is directed towards the banks of the Hadeln and Cuxhaven; in its grandness it will scarcely be surpassed by any river in Europe. In this part of the river the North Sea-Baltic Canal—Kaiser Wilhelm Kanal—navigable for vessels up to 29ft. draught, enters from the right bank, and nearly opposite, at Cuxhaven, belonging to Hamburg, there has been laid out a grand tidal basin with a depth of 26ft. at ordinary low water and a tide of 9ft., allowing the largest steamships to enter and leave irrespective of conditions of tide. In the course of next year everything will be completed, and the greyhounds of our Hamburg-America line will then start from this point. Vessels with the deepest draught get up the Elbe now without lighterage as far as Brunshausen, sixteen miles below Hamburg. Up to Hamburg, vessels with a draught of 24ft. may always come up at normal tides, but the new harbour basins here have been constructed in such a manner that they may be deepened, the removal of the bar between Hamburg and Brunshausen being only a question of time.

As at Hamburg the ordinary tide rises only 6ft., all our harbours could be laid out as tidal basins. The estuary changing at our port—sixty-eight miles from the mouth of the Elbe—into the real bed of the river, it may be said that Hamburg is situated just on the right point of the river, as here the navigation of ocean vessels and river craft meet, and, therefore, allow transhipments from the ocean to the interior with great facility. By means of an upper course of 650 nautical miles in length, navigable far into Bohemia, in connection with numerous affluents and ship canals, the river Elbe has opened to the Hamburg trade a large interior of country, not only in the German Empire, but also in the Austrian Monarchy.

The importance of this position of the port of Hamburg, and the development of transhipment between ocean and river trade will be better apparent by the following figures. The tonnage of ocean vessels trading to and from Hamburg has increased in the last thirty years from 1,200,000 registered tons to 6,200,000 registered tons, and in the last twelve years doubled its amount. The quantity of goods passing from Hamburg to the interior by means of river craft has increased in the last thirty years from 330,000 tons to 2,400,000 tons; in the last twelve years even twice as much. On the other hand, the import of goods floating down to Hamburg is now yearly 2,000,000 tons.

That the shipping trade of Hamburg is equal to that of the largest seaports of the North Sea and the Channel will be understood by comparing the total number of seagoing vessels that arrived in 1894 at the following ports:—

	Hamburg.	Bremen.	Antwerp.	Rotterdam.	Havre.
Vessels	9,165	4,178	4,721	5,109	6,602
Registered tons	6,228,821	2,172,075	5,002,704	4,143,403	2,860,308

Of the above-mentioned vessels arriving in Hamburg, 6500, or nearly 70 per cent., are steamers with nine-tenths of the total tonnage. In some English ports these figures are surpassed, but then it must be borne in mind that in England coasting is done on a much larger scale. Excluding coasting traffic, the shipping trade of London is 50 per cent. higher than that of Hamburg; from this point of view the figures are, for vessels arriving from foreign ports in 1894, viz.:—

	Hamburg.	London.	Liverpool.
Vessels	6,354 ..	10,384 ..	3,873
Registered tons	5,699,547 ..	8,301,868 ..	5,492,327

The technical contrivances for the accommodation of vessels and for the handling of goods in Hamburg have assumed their present day appearance only after completely extending the system of railways in Germany about the year 1860. Up to that time, steamers were compelled to land or to receive cargo by anchoring in the river and discharging into barges, which brought their goods by means of numerous canals, to the different warehouses scattered in various parts of the town. I may add here that the arrival of the first steamer in Hamburg took place in 1816; it was the Lady of the Lake from your island.

In 1865, the first basin for sea-going vessels was dug out of trenches belonging to the former fortifications, and secured by a timber embankment. The quay was provided with open goods sheds, rails were laid connected with the terminus of the Berlin line, and the arrangement was completed by a number of portable steam cranes of the well-known Brown Brothers' type. Within ten years the flats of the Grasbrook were covered by basins of a similar kind, amounting in total to a length of twenty-six miles of quay walls, the old picturesque roads of the harbour with its forest of masts remaining still in use. When the city of Hamburg, in 1881, resolved to enter into the Customs Union of the German Empire, its old conditions of a "free city" underwent a change. An area of about 2500 acres of the port with its storehouses for transit goods was separated from the former business and residential city, and rebuilt into a uniform free port district. [The extension of this area is shown on the plan handed to you yesterday.] In carrying out this plan, the modern harbour construction was practically completed in connection with the inland railways, ending at the upper boundary of navigation for sea-going vessels, which is the bridge of the Hanover line of rails crossing the Elbe. At the same time the marshes on the left bank, which were previously laid up and extended to the boundary with Hanover, were included, giving in all 10·5 miles of quays for sea-going vessels with railroad tracks and sheds, the latter covering an area of 1,900,000 square feet. All harbours are open tidal basins, as much as possible parallel to the course of the river, and act at the same time as reservoirs for regulating the channel, while they narrow towards their entrances in order to avoid silting up at these points. The extensive quays are constructed of masonry, and provided with railroads, streets, long rows of sheds, and of late, with a great number of portable steam cranes, elevated upon large wrought iron frames, which span the rails, and allow the trains and cars to pass underneath. The largest crane of the port lifts 150 tons. For the future development of the harbours the western part of the left bank, which still belongs for a good way down the river to Hamburg, is reserved.

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* Read at the summer meeting of the Thirty-seventh Session of the Institution of Naval Architects, June 9th, 1896.

The large Hamburg dockyards on the left bank, of which those of Messrs. Blohm and Voss and the Reiherstieg-Schiffswerft are especially prominent, are included in the area of the free port, thus keeping the vessels, whilst building and repairing, free of duty. The number of ships built and building in the yard since 1878 up to the present time is 121, including some 24 sailing vessels, all of which have a very good record for fast sailing. At present one steamer for the Hamburg-South American Steam Navigation Company of about 6500 tons deadweight is building, also two steamers for the German Steamship Outfitters Company of Hamburg of 7000 tons each, moreover two twin-screw steamers for the North German Lloyd, Bremen, one passenger and freight steamer of a length of 525ft. and 10,000 tons deadweight, and one of 4000 tons. Besides, the shipyard has just delivered for the Hamburg-Heligoland passenger service a light draught saloon paddle steamer with a speed of 16 knots. Finally, there is approaching completion a twin-screw passenger steamer of a length of 400ft. and 6000 tons deadweight, built to the order of the German East-African line, Hamburg. Also several large basins for the accommodation of river craft have been arranged in the precincts of the free port, in order to facilitate transhipments between sea-going vessels and river craft. Constant care is taken for the river service of our port, by reforming the courses of traffic, providing for new harbour basins within the Customs boundary-line, and by erecting landing stages. An extensive network of canals is connected with the tributaries Alster and Bille. These canals are situated in the embanked lower parts of the city, and are connected with the Elbe locks. By means of these canals, the transport of goods by water is made possible to many residential and business parts of the city, and to industrial works situated at a greater distance from the river, in the Customs Union.

During the period of the construction of the works necessary for the accession to the Customs Union, not less than 4·6 miles of quay walls for river service have been carried out mostly in embanking the Zollkanal, which separates the free port from the part of the city included in the Customs Union, and in embanking those canals bounding the warehouses of the free port. [Compare the red hatched part of the small plan.] Warehouses became necessary in consequence of the incorporation of the town into the Customs limits, in order to allow the merchants the storing of goods for their outward trade in connection with offices in the immediate vicinity of the centre of Hamburg trade, the ancient merchants' houses having been included within the Customs boundary. The space required for the said purpose was created by purchasing a certain portion of the town inhabited by 20,000 persons, upon which, after pulling down all houses, a building site was created measuring ten acres net. The warehouses of the free harbour territory are partly erected by a company—Lagerhaus Gesellschaft—partly by Government. They contain five to six stories and a cellar, each for warehousing goods, and are administered by the company above mentioned. They offer room for storing goods covering about 3,230,000 square feet surface, of an average bearing capacity of 1·5 tons per square yard of ground surface. For a further increase of the number of warehouses, which at present seems requisite, an area of about 5·4 acres has been reserved, called Wandrahm-Insel.

The central hydraulic power station of this town of warehouses possesses the energy of 500-horse power, and delivers the water at 711 lb. pressure per square inch, whereby it became possible, at the same time, to construct hydraulic-power hydrants for fire-extinguishing purposes in the streets and at all parts of the warehouses. In connection with this plant there is an electrical station of 970-horse power, and accumulator service for lighting purposes and motor service for the driving of machines used for the manufacture of goods. The canals between the said warehouses can only be used for barges. No direct connection has been established between the warehouses and the quays for sea-going vessels, for the reason that a sea-going vessel seldom brings goods for only one warehouse, and that she has to be quickly discharged and dispatched at one single berth, whereby the separation of goods has to be effected through an intermediate system of transport. Dwelling houses and retail trade are prohibited within the free-harbour territory. All roads situated inside the Customs boundary, both by water and land, are brought round the said territory, thus allowing passengers and goods to pass Hamburg without being submitted to any examination by the Customs authorities. Only passengers and goods arriving by sea are subject to Customs control as soon as they pass the free-harbour limits. Coffee and dining halls have been erected for comfort of workmen and officials employed in the free-harbour territory, the said halls being under Government control, and they sell goods whereon duty has been paid. The greatest part of the mercantile business is transacted inside the ancient part of the city, close to the free-harbour territory, the centre of which is formed by the Hamburg Exchange. In the immediate neighbourhood of the latter we have placed our fine new Town Hall, built in German Renaissance style.

The ancient city of Hamburg was formerly surrounded by very high fortifications, through which only five gates allowed exit and entrance. The population by degrees increased to such an extent that in some quarters of the city there dwelt above 400 persons to the acre, and even the reconstruction of the part of the town destroyed in 1842, after the great fire, did not alter this state of affairs. Only the wealthier classes used to live at their country seats on the lovely banks of the Lower Elbe, the Alster, and Bille rivers, sometimes at a good distance from the gates. In 1862 the population amounted to about 200,000 inhabitants. After the abolition of the old gate toll at that time, and after the decision to transform the high city walls by degrees into public parks, to be crossed by radial streets, there began an unexpected development of the organism of the city. It was almost like an explosion. Beyond all the gates the buildings extended like a stream, surrounding the Alster lake. Thus the old centre of the town was opened up by many straight cuts. By a removal of the wealthier classes towards the outside, and an increased erection of warehouses, Hamburg more and more adopted the character of the city of London, viz., a gathering of shops and offices, whereas the parts surrounding the outer Alster may well be compared with the West End of London. The parishes situated at a greater distance from the Alster, towards the neighbouring towns of Wandsbeck and Altona, show the character of medium-sized townships.

The population of the "city" decreases annually by about 1 per cent.; but on the whole the population of Hamburg increases, on the average, by more than 3 per cent. per annum, amounting at present to 630,000. It has almost been impossible for the municipal work to keep pace with this increase. A network of sewers has been spread all over the town, having a total length of about 230 English miles, whereby all drainage, including sewage, is passed into the strongest current of the Elbe below Hamburg. The water supply is regulated by means of a pipe-service to all parts of the town, about 325 English miles in length. The water is taken from the river a good distance above Hamburg, near the Billwärder Island, and the quality of it has been much improved by means of large settling and filter works erected within the years 1890 to 1893. Two large central stations, of together about 10,000-horse power, supply the town with electrical power for lighting and motor purposes by means of cables measuring about 150 English miles. They form a competition to the gas works, which supply the whole town and suburbs with gas. We are trying to make the gas available for heating purposes in order thereby to solve the difficult question how to get rid of the soot. A well-organised street-cleaning brigade, established ten years ago, looks after the cleanliness of public streets and squares, which measure, at present, in all 59,200,000 square feet. The said brigade musters 350 hands. For making house refuse harmless, we have recently erected at the Bullerdeich a "refuse destructor," containing thirty-six cells, after the approved English system of Horsefall, Leeds.

The ancient city walls, after the unhealthy and narrow streets situated behind them were pulled down, have been transformed into splendid parks, the last part of which is just now under construction, near the quarter of St. Pauli. The old pasture grounds, situated outside the gates, have been made available for football and tennis playing. However, the rapid extension of the town caused in many outer parishes a certain irregularity in the erection of buildings, rendering it necessary to establish an extensive plan for the laying out of new houses and streets within the town and suburbs. A new Act is now prepared in the interest of public welfare, limiting the speculation in new houses and the right of single individuals to erect buildings as they choose. The said plan for the construction of new buildings is intended to cover an area of 15,000 acres, and is based upon the supposition that the density of population, which, within the inner city, including the suburbs of St. Pauli and St. Georg, is on an average 200 persons per acre, shall not exceed 100 in the outer districts. It may be hoped that in this way may be furthered the old inveterate love of the Lower Saxons of residing in single buildings—in English fashion—which has been so badly checked within the last decades by the mania of house speculators for utilising the building site to the utmost degree for large tenements. It further appears most desirable, by leaving a sufficiently large space in front of and behind the houses vacant, to further as much as possible the cultivation of gardens and lawns which flourish so well in our moist coast districts. There also exists an absolute necessity to take greater care than hitherto in regard to the proper laying out of roads, including footpaths, considering the always increasing distances of the outskirts from the centre of the town and from each other.

We possess, it is true, an extensive network of tramways, measuring about sixty English miles in length, that portion worked by electricity being about fifty-two English miles in length, on which about 275 motor cars are driven simultaneously. However, although this method of transport is being steadily improved by the never-ceasing inventions in the field of electro-engineering, still it cannot master the traffic, even when supported by the steamboats on the Alster and the ferry-boats on the Elbe. It will be necessary to adopt different means, as in other large towns, to satisfy the want of quicker conveyance; also the banks of the river Elbe must be better connected by solidly constructed thoroughfares, either above or below sea navigation. From this prospective view of intended engineering works you will recognise, gentlemen, that labour never ceases. It is an old rule that life and rest exclude each other. This leads to the consequence that you never can build your house quite ready, it may then be the "old-age house," wherein you intend to end your latter days. I firmly believe, gentlemen, that Hamburg has no intention whatever to sit down as yet for her "old-age rest." As long as there is any space left at our disposal for harbour purposes, and as long as the river Elbe can be kept navigable from the mountains down to the ocean, so long there will never cease to exist at this place a brisk, industrious life, filled with trade and commerce. In what manner the city of Hamburg may—perhaps within a short time—have further developed by new schemes for trade and intercourse, or may be altered in consequence of new experience gathered on the field of national economy, I am unable to say, just as little as I can say how you will like the present features of our town.

And now, you gentlemen and dear colleagues who are not satisfied with a quiet and contemplative sphere of life, but who prefer a steady and unceasing progress in new building and construction, you may perhaps, I venture to hope, not even find it inconvenient if you fail to meet at this place the comfort of a ready-built house, but find rather a workshop full of restlessness and labour. In this sense, gentlemen, I beg you on your present visit, so heartily welcomed by us, to return to the city of Hamburg the sympathy which we old Hanseatic citizens and Lower Saxons cheerfully offer to our Anglo-Saxon cousins.

LAUNCHES AND TRIAL TRIPS.

Messrs. Fleming and Ferguson, shipbuilders and engineers, Paisley, have launched from their yard a powerful steel screw tug steamer, built to the order of the British Admiralty, being the last of four such vessels ordered by the Admiralty with this firm.

The steam yacht Kathleen, 316 tons, belonging to Earl Fitzwilliam, which has recently been fitted with new triple expansion machinery by Day, Summers, and Co., Southampton, went out for her trial trip on the 2nd instant, when the mean speed obtained on four runs at the measured mile in Stokes Bay was, we are informed, 11¾ knots. The diameters of the cylinders are 14in. 21½in., and 37in. by 24in. stroke, and the boiler is 11ft. diameter, by 9ft. 4in. long, the working pressure being 150 lb. The machinery is fitted into the same space as that occupied by the old machinery. The trial trip was in every way satisfactory, there being an entire absence of vibration which was much complained of with the old engines, the speed also being much greater.

The s.s. Jupiter left the port of Hartlepool for her trial trip a few days ago. The Jupiter has been built by Messrs. Wm. Gray and Co., for Messrs. Schmidt and Hansen, Flensburg, and is a steamer intended for the timber and general cargo trades, is built to Lloyd's highest class, and is of the following dimensions:—Length over all, 270ft.; breadth, 39ft.; depth, 18ft. 2in. She has been supplied with triple expansion engines from the Central Marine Engine Works of Wm. Gray and Co., the diameters of the cylinders being 19in., 30½in., and 51in., with a piston stroke of 36in., and steam is supplied by one large steel boiler working at a pressure of 160 lb. per square inch. The vessel had on board a cargo of pig iron and coal, and the trial which the ship and her machinery underwent was considered eminently satisfactory. The owners were represented by Mr. Harald Casper and Captain Hohlmann, the shipbuilders by Captain Murrell, the engine builders by Mr. G. H. Baines and Mr. Lindsay, and there were also present Mr. J. T. Sinclair, of West Hartlepool, and Mr. Lucas, of Darlington. On the completion of the trial the vessel at once proceeded on her voyage to Flensburg, under the command of Captain Hohlmann.

The steamer Lord Kelvin, which was recently launched by Messrs. Bartram and Co., of Sunderland, went on her trial trip on the 5th inst. The vessel is owned by Messrs. John Heron and Co., of Liverpool, and has been superintended during construction by Messrs. Flannery and Tritton, of Liverpool and London. She is of the following dimensions:—Length, 350ft.; breadth, 45ft.; depth, moulded, 26ft. 9in., with a carrying capacity of about 5200 tons on a very light draught of water. She is fitted with evaporator, freshwater condenser, feed-heater, and other modern steam fittings, all of which were tested under working conditions with satisfactory results. The main engines, which have been supplied by Messrs. John Dickenson and Sons, of Sunderland, have cylinders 24in., 39½in., and 65in., by 42in. stroke, and steam is supplied by two large single-ended boilers. The vessel was tried for several hours on the Tyne at full speed with most satisfactory results, the machinery working without the slightest hitch at seventy-eight revolutions, and steam being maintained with the greatest ease. Owing to the special arrangements devised with regard to the funnel and ventilation, the draught was unusually good, and the stokehold and engine-room very cool. The vessel was tried for several runs over the measured mile, and although her light draught, with propeller only partly immersed, made the conditions very unfavourable, she obtained a speed of upwards of 11½ knots. Her turning powers were also thoroughly tested, and proved her very handy. The owners and a large company of ladies and gentlemen were present.

On Saturday morning last, the fine steel screw steamer Simonside went on her trial trip. She has been built by Messrs. Wm. Gray and Co., to the order of Messrs. J. and E. Kish, of Sunderland. She takes Lloyd's highest class, and is of the following dimensions:—Length overall, 336ft.; breadth, 47ft.; depth, 24ft. 10in.; has a half poop, bridge over machinery space, topgallant forecastle, tasteful saloon and state rooms, together with captain and officers' rooms. The hull is built with web frames and double bottom under each hold for water ballast; there are six steam winches, steam steering gear amidships and screw gear aft, patent direct steam windlass, iron longitudinal grain division, and stockless anchors. The engines are of the triple expansion type, and have been supplied by the Central Marine Engine Works of Wm. Gray and Co. The cylinders are 24in., 38in., and 64in. diameter, with a piston stroke of 42in. There are three large main boilers of steel, working at a pressure of 160 lb. per square inch. This arrangement enables donkey boilers to be dispensed with, as any one of the main boilers can be kept under steam for working the winches, windlass, &c. A Mudd's evaporator and tail shaft preserver sleeve are supplied, and the vessel is otherwise fully equipped with all the appliances carried by a first-class cargo boat. The owners, Messrs. J. and E. Kish, were on board, as also their superintendent, Mr. M. Metcalfe—under whose superintendence the vessel and her machinery have been constructed; Captain Murrell represented the shipbuilders, and Mr. Jas. Lindsay the engine builders; there were also present Mr. C. L. Cummings, Mr. J. Wilson, Mr. H. Simpson, Capt. W. L. Sinclair—who is in command of the vessel—and Mrs. Sinclair, the Misses Forster, and Mr. John Tulley. The trial was a thoroughly satisfactory one, the engines running with great smoothness, the bearings keeping perfectly cool, and the boilers and glands quite steam-tight. Owing to the dense fog no speed trial was made. The vessel arrived at Sunderland at 8.30 p.m., where part of her company went on shore, the rest proceeding with the vessel to Barry Dock, where she loads for Port Said.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

There was a fair attendance on 'Change at Birmingham to-day—Thursday—and a satisfactory amount of business was done. The leading marked bar iron manufacturers report further inquiry, and recent quotations in that line are firmly maintained. A steady trade is moving in common bars at £5 5s. to £5 15s., and in merchant bars at £6 to £6 5s. There is a more pronounced demand for black sheets from the galvanisers, and prices are dearer by from 2s. 6d. to 5s. per ton more than last month's, £6 15s. being asked for doubles, and £7 15s. for trebles. Orders are offered to extend well into the next quarter, but manufacturers are reluctant to sell. Two new sheet mills have been erected and started at the Corrugated Iron Company's Stour Valley Works, Wolverhampton, which will increase the output by 100 tons weekly. The hoop and thin strip manufacturers report a fair amount of orders, and they are realising £6 7s. 6d. A steady volume of business is on the books for angles at £5 15s. Stamping sheets are £9 10s., and nailrod is £6 10s. Galvanised sheets are £10 5s. to £10 7s. 6d. for 24-gauge in Liverpool. In pig iron a moderate trade is being done, and prices are firm at £4 10s. for cold blast; 55s. for Staffordshire all-mine; 40s. to 42s. 6d. for part-mine; and 35s. for cinder. Northampton forge is 40s.; North Staffordshire and Derbyshire, 40s. to 41s.; and Lincolnshire, 43s. to 44s. The steel makers are actively engaged in executing last month's accumulated orders, and good lines are coming forward. Bessemer billets and blooms of Staffordshire make are £4 5s. to £4 7s. 6d.; Siemens billets are £4 10s. to £4 12s. 6d.; bars, £6; girders and angles, £5 12s. 6d.; and boiler-plates, £6 5s. The Association of Axlemakers has resolved, having regard to increased values of iron and activity of trade, to reduce discounts 2½ per cent. The Board of Trade returns for May show gratifying increases in the exports of iron and steel. Galvanised sheets in particular continue to occupy an excellent position in the market. Makers are full of orders, and prices are stiffening. The demand from the Colonies and foreign countries keeps up, and for the month of May the total reached the gratifying figure of 21,364 tons, as against 17,298 in May last year, and 14,222 in May, 1894. For May the percentage of increase on last year is 36·2, and for the five months it is 47 per cent., and other articles also show satisfactory increases.

The cycle and cycle-tube makers report continued activity of production, and the season's prospects are considered at least as good as they were a month or two ago, when the boom was at its height.

An interesting trial of the Kane-Pennington motor, an American invention, which the Humber Company, Coventry, have lately been using in the construction of self-propelled bicycles and tricycles, took place at Coventry this week. The trial took place on the Kenilworth-road, under the direction of Mr. Pennington, a Humber safety being fitted with the motor. In the matter of speed and facility of control the machine appeared to give perfectly satisfactory results.

It is of interest to the Birmingham marine engine building trades that H.M.S. Swordfish, the first of two of the new torpedo boat destroyers, built at Sir W. G. Armstrong, Mitchell, and Co.'s Elswick shipyard, and engined by G. E. Bellis and Co., of Birmingham, left the Tyne a day or two ago for Chatham, making the passage round the Nore in fourteen hours from Shields. This is, it is particularly noteworthy, the quickest passage on record, but, of course, well within the speed at which these vessels can travel. The sister vessel, Spitfire, together with the Swordfish, have, in fact, had satisfactory three hours' full-power runs off Tynemouth at a speed of 27½ knots, the machinery developing 4300 indicated horse-power. Both vessels are fitted with two sets of four-cylinder triple-expansion propelling machinery, with eight water-tube boilers, specified to develope under fan-forced draught 4000-horse power, and owing to the high speed at which the vessels have to be driven, the design has had to be very specially considered, to keep the weight within the maximum 110 tons. The shafting and working rods are hollow throughout, and the machinery at full power is run at the very high speed of 400 revolutions, or at a piston speed of 1200ft. per minute. The whole of the machinery and boilers, as well as the air compressors for torpedo work, the electric light plant, and other auxiliary machinery were built by Messrs. Belliss and Co., at their Birmingham works, and were fitted by their staff of Birmingham men on board the ships at Elswick shipyard. The machinery on the trials and passage round has been under the charge of the firm's marine superintending engineer, Mr. Thomas Scott, R.N. Messrs. Belliss have already completed four other ships of this class, built at Elswick and the Royal Dockyards. But I may mention that they are now so busy with electric light orders for central station and other installations that they have been obliged not only to extend their premises, but for the present at least to give up marine engine work almost entirely.

NOTES FROM LANCASHIRE

(*From our own Correspondents.*)

Manchester.—The ample supplies of both raw and manufactured material on the market, notwithstanding the general briskness throughout all consuming branches of industry, are making it evident that the existing means of production are fully sufficient to keep pace with any present prospective requirements. To this, no doubt, is due the check which has of late been given to the upward move in prices, whilst merchants and dealers are encouraged to underquote makers in the competition for orders, in the expectation that they will be able to squeeze down prices when they have to cover. The position, however continues very steady, with makers and manufacturers for the most part by no means over-anxious about new business just at present, orders in hand being, as a rule, still sufficient to keep them going, and there is a prevalent tone of confidence in the gradual improvement of trade.

The improvement in the iron market noticed last week has scarcely been fully maintained, and there was an absence of anything like general activity on the Manchester Exchange on Tuesday. For pig iron inquiries were only moderate, and although makers generally were firm at their late quotations, underselling still goes on amongst merchants, who frequently cut in very low to secure orders. For local brands of pig iron quotations are unchanged, and Lincolnshire and Derbyshire foundry qualities are also without quotable alteration; Derbyshire, however, continues weak, if anything. In forge Lincolnshire the partial advance of 6d. per ton, as I anticipated last week, has become general, 41s. net cash being now the all-round quotation delivered here. Middlesbrough and Scotch iron maintain late rates, but with makers in some cases putting into stock, the position is not altogether strong. Good foundry Middlesbrough averages 45s. 10d. to 46s. 4d. net delivered by rail Manchester, and 44s. Docks, with Eglinton about 46s. delivered Lancashire ports, and 48s. Dock Quays, Manchester, and Glengarnock obtainable about 9d. above these figures, although makers quote 49s. 9d. delivered ex stock Manchester, 48s. 6d. delivered Preston, and 47s. 6d. other Lancashire ports.

Although there is still low selling in the manufactured iron trade, chiefly in some of the commoner qualities of bars, which could be bought at £5 6s. 3d. to £5 7s. 6d., the position seems to be improving, and local branded irons are generally firm at £5 10s., with Staffordshire bars £5 10s. to £5 15s. Sheets are fetching rather better prices, £7 to £7 5s. being now the minimum, with hoops firm at £6 2s. 6d. for random to £6 7s. 6d. for special cut lengths, delivered Manchester district, with 2s. 6d. less for shipment.

In the steel trade only a moderate business is reported generally, but good foundry hematites are firm at 57s. 6d. to 58s., less 2½ delivered here. For manufactured material, however, prices are barely maintained at late rates, local-made steel bars being rather easier, if anything, the average selling prices being now about £5 17s. 6d. to £6, whilst ordinary local billets are obtainable at under £4 7s. 6d. net cash, with boiler-plates averaging £6 5s. per ton, delivered in the Manchester district.

In the metal market an active demand for all descriptions of manufactured goods continues the general report, the advance in prices which I reported last week not only being fully maintained, but the tendency is still in an upward direction.

Activity continues to prevail in all the iron-using industries, founders in many cases not having been so busy as they are now for several years past, whilst reports as to the condition of the engineering industry continue most satisfactory, and the employment returns of the trades unions show a continued tendency in the direction of a further decrease in the number of out-of-work members on the books.

At the closing sessional meeting of the Manchester Geological Society, held on Tuesday, Messrs. Holroyd and Barnes read a very interesting paper on the "Mountain Limestone Caverns at Tray Cliff Hill, Castleton, Derbyshire," in which they gave the results of their investigations with regard to the mineral deposits of the caverns, and of experiments they had made with a view of ascertaining the true origin of the varied colours found in the well-known Blue John spar, which is found in these mines. With regard to the origin of these minerals, the writers added that nothing in their researches, or in those of others had been put forward, that did not agree with the theory that both the metalliferous and mineral deposits were due to the action of waters derived from hot mineral springs, under suitable conditions of temperature and pressure. Of course there might have been other modes of formation, but the district contained all the conditions most favourable to deposition of the substances according to the above theory, viz., hot springs, the much-faulted ground, the nature of the country rock, and pressure of interbedded igneous rock, which had afforded additional metallic substances, and brought about in various ways most important changes. As to the conclusions which previous investigators had come to, that the varied colours of the Blue John spar were due to the presence of minute quantities of hydrocarbons, taken up from solutions, from which the mineral had been crystallised, the writers said that the chemists who had analysed fluor spar seemed to have confined their attention to the coloured varieties. If they had analysed the colourless variety, they would have found the same chemical constituents which were said to produce the colours. They, the writers, had made a number of experiments to find what substances were present in the spar, and determine the reason for its being coloured. They found that the dark fluor yielded ·12 per cent. of organic matter, and that the colourless fluor gave a similar amount, and these experiments thus showed that the organic matter present could not be the cause of the colour, as it was found both in the coloured and colourless fluor. The writers then asked themselves whether it was possible to produce, from pure material, fluor spar, and by synthesis, produce it coloured. If so, they would have proved beyond reasonable doubt that the colouring depended neither upon the iron and manganese present, nor upon the organic matter. They therefore endeavoured to synthesise the substance by taking pure calcium and hydrofluoric acid in excess and water, and after removing by evaporation the excess of acid, enclosing some of this white amorphous powder in a steel cylinder, and subjecting it to intense heat for many hours. On opening the cylinders, they found in practically every case crystalline fluor spar of various colours—green, yellow, rose, purple, and colourless. Eminent engineering authorities had given it as their opinion that the pressure inside the steel tubes was from six to eight thousand pounds per square inch. Given a sufficiently high temperature and pressure, they—the authors—believed that all substances, however refractory, might be made soluble in water, and on removal of the pressure, or on cooling, would crystallise out. From these experiments they deduced the fact that coloured fluor spar, whether naturally or artificially made, did not owe its colour to any special mineral ingredient or hydrocarbon, though these might be present, but rather to some peculiar molecular or physical state of the particles forming the crystals, or the crystalline mass, it was an optical phenomenon dependent upon crystallisation, and the physical state of the substance. This was borne out by the fact that pulverisation, which bruised the crystals, caused much of the colour to disappear, and that complete change of the physical state could be brought about by heating, as the particles decrepitated and lost their power of acting upon light. It was also found that if a coloured crystal was tapped gently on a solid angle of a cubical crystal, so as to induce a fracture parallel to the octohedron planes, the colour changed, and eventually disappeared. In a short discussion which followed, the point chiefly raised was with reference to the theory put forward as to the causes which produced the colour in the Blue John, some doubt being expressed as to whether the conclusions arrived at by Messrs. Holroyd and Barnes could be accepted as more than partially explaining the origin of these colours.

Business still drags on very slowly in the coal trade, the demand for all descriptions except engine fuel being extremely dull, and the absence of business coming forward is compelling colliery owners to limit their output, pits not now running on an average above four days per week. House coals meet with but a slow demand, and although prices are nominally unchanged, an easing tendency is noticeable. Steam and forge qualities continue very difficult to move, and for special sales extremely low figures are quoted, whilst the gas coal contracts continue to be competed for at under last year's rates. Engine classes of fuel, which are becoming less plentiful, are in good demand, with a hardening tendency, an advance of 3d. per ton being discussed, but as yet only actually quoted in very special cases. At the pit-mouth, best Wigan Arley averages 9s. 6d. to 10s.; Pemberton four-feet and seconds Arley, 8s. to 8s. 6d.; common house coal, 6s. 6d. to 7s.; steam and forge coals, 5s. 6d. to 6s.; common gas coal, 6s. 3d.; best sorts, 7s.; common slack, 3s. to 3s. 6d.; and best qualities, 4s. 6d. to 5s. per ton.

The shipping trade continues inactive, with prices low and unremunerative, and delivered Mersey ports 7s. is the full average figure for ordinary descriptions of steam coal.

Barrow.—There is an improvement to note in the demand for hematite pig iron, and makers are busier than they have been for some time past. They have only thirty-nine furnaces in blast, as compared with twenty-nine in the corresponding week of last year, but the output is a very large one, as the make per furnace now approximates 800 tons per week. Prices were up to 47s. 8d. on Tuesday, but on Wednesday they were down at 47s. 5½d. net cash sellers, 47s. 5d. net cash buyers. This depression was caused by speculative movements, and not by any shrinkage in the demand. Makers are quoting 49s. to 50s. per ton net f.o.b. for parcels of mixed Bessemer numbers. Stocks show a slight increase.

Iron ore is at its old price of 10s. per ton net at mines for ordinary sorts, and best descriptions are at 12s. 6d. to 14s. 6d., and there is a fair business doing in the latter. Spanish qualities are still largely used for mixing purposes at the West Coast furnaces, and the imports into Barrow and West Cumberland are steadily maintained. 60 per cent. descriptions are at the old rate of 12s. 6d. to 12s. 9d. per ton at West Coast ports.

Steel makers are well off for orders for plates and rails, and report a very good inquiry for forward delivery. Prices are very steady. There is a brisk trade doing in billets and hoops, but next to nothing doing in tin bars. This, however, is the only inactive department of the local steel trade.

Shipbuilders report no new orders, but tenders have been asked of the Barrow Company for the construction of a line-of-battle ship and one or more first-class cruisers. The preliminary steam trials of H.M.S. Powerful, first-class cruiser, have taken place at Barrow this week, with results giving the highest possible satisfaction. The port and the starboard engines were separately tested and both together at about quarter speed, and the Belleville boilers, of which there are forty-eight, were proved to be quick generators of steam. The Powerful is now ready for delivery to the Admiralty.

Coal is quiet, but coke is firm.

Shipments of pig iron from West Coast ports during the week have been 2735 tons and 3034 tons of steel, as compared with 5965 tons of pig iron and 4567 tons of steel in the corresponding week of last year, being a decrease of 3230 tons of pig iron and 1533 tons of steel. The aggregate shipments to date this year total up to 133,897 tons of pig iron and 200,608 tons of steel, as compared with 115,518 tons of pig iron and 157,194 tons of steel in the corresponding period of last year, an increase of 18,379 tons of pig iron and 43,414 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

IN the South Yorkshire coalfield four to five days a week are being made, with no perceptible change in the course of trade, except in regard to steam qualities, which are in brisker request. The coal requirements of London are at present abnormally small, judging by the tonnage sent from this locality, but it is believed that the sea-borne fuel is making the most of the market. Silkstone coal is now at 8s. to 8s. 3d. per ton for the best, while inferior sorts can be had from 7s. to 7s. 3d. In house coal, best Barnsley fetches from 7s. to 7s. 3d., thin seam coal being abundant at 6s. to 6s. 3d. per ton. Best South Yorkshire brands for shipment are in good demand, a number of the more important collieries sending freely to Hull. Last week the shipments of Yorkshire coal exceeded the business done in the corresponding periods of the last two years. Shipments are also well maintained at Grimsby, but Goole is taking a reduced tonnage. That port is chiefly supplied by the West Yorkshire pits. Railway companies are drawing supplies largely under their contracts, the Midland this season having placed a heavier weight than usual with the pits along their own line. In the open market prices of steam coal are from 7s. to 7s. 3d. for the best qualities, and 6s. to 6s. 6d. for secondary sorts. Manufacturing fuel continues to be in better demand, a large quantity going forward for coke-making purposes. Best screened slack makes from 3s. to 3s. 6d.; ordinary pit slack, 2s. 3d. to 2s. 6d.; smudge, 1s. 3d. to 1s. 6d. per ton, according to quantity ordered. In coke the output steadily increases, the pig iron trade being brisk in North Lincolnshire, while a fair tonnage is also taken by Derbyshire and Northamptonshire. Prices are from 8s. 6d. to 11s. for good smelting coke, best washed occasionally getting as high as 12s.

Apart from military material and several specialities, less animation is reported in the general run of the heavy industries, more particularly in railway and shipbuilding work. Manufacturers, however, have satisfactory orders on their books, and the lull will enable them to overtake any arrears caused by the holidays. Orders for armour for the additions to the naval programme are not yet forthcoming; foreign Powers are also much longer than was anticipated in placing their new work. Quotations:—Bessemer billets, £5 12s. 6d. to £6 per ton (special carbons); hematites, from 55s. to 57s. 6d., delivered in Sheffield; bar iron, £5 10s. at makers' works, £6 in warehouse; Lincolnshire forge iron, 39s.; Siemens-Martin acid steel, £7 10s. for average qualities.

Several Sheffield manufacturers who have just returned from the United States report business there to be more depressed than English people are aware of. Although he did not find that the Sheffield makes of high-graded steel, best cutting tools, &c., were being superseded by American or foreign production, yet there was no demand. In sheep shears for the River Plate the shipments are larger than usual; steel cutlery and edge tools are in fair request for Australia, and more is doing with the Brazils, the Argentine Republic, and Portugal.

Makers of agricultural machinery, whose business is largely in foreign countries are anticipating a better season in 1896-7 than the year which ended on the 31st of March last. The reports presented to public companies show that last season's harvest in many of the markets outside this kingdom was almost a complete failure, and greatly reduced the turn-over. Still, in spite of that drawback and the general complaints of extreme competition, the dividends have been well maintained, and in some instances a little more has been paid. It is remarkable that, with the increasing adoption of machinery, the demand for scythes, sickles, and the accessories of handwork in harvest getting, is greater than ever.

Mr. A. Bertram, for many years chief engineer at the Wigan Coal and Iron Company's Collieries, Wigan, has been appointed to a similar position at Messrs. Newton, Chambers, and Co.'s, Thorncliffe Collieries, near Sheffield. Before leaving Wigan, Mr. Bertram was entertained by the officials and workpeople at the Royal Hotel, Wigan, and presented with a cheque for £55, while Mrs. Bertram received a diamond ring.

The new Town Hall of Sheffield, which was to have been opened by the Queen last May, and is still waiting her Majesty's convenience, is now entirely completed, and partly occupied. The original estimate, as set before the Sheffield Corporation, was £80,000, but there have been so many additions and alterations, that the cost, including interest on sinking fund, is expected to exceed £250,000. The building, in its architectural features, has been already referred to in THE ENGINEER; now that it is finished the effect is both imposing and elegant. The Sheffield Electric Light and Power Company are working the installation. The public mains are tapped in Surrey-street, from which the electric current enters the transformers in a room in the basement, and is sent into the lamps at a reduced pressure of 100 volts. On each floor there are two points for the distribution and control of the current necessary for each side of the building. At the different points of distribution the lamps are divided into a large number of sub-circuits, in order that the current density in any of the circuits may not exceed 500 ampères per square inch of copper, and that all the lamps of similar candle-power may be of uniform brilliancy. Altogether about 1500 lamps, each of 16-candle power, will be fixed in the building.

The death is announced of Mr. Harry Wright Atkin, senior partner in the firm of Messrs. Atkin Brothers, silversmiths and electro-plate manufacturers, Truro Works, Matilda-street, Sheffield. Mr. Atkin, who resided at Norton Lees, Highgate, London, has for some time suffered from a weak heart, from which he died suddenly at the London office of the firm on the 2nd inst. The firm was established by the father of the deceased in 1824, and was conducted for nearly thirty years under the style of Henry Atkin and Co. In 1853 Mr. H. W. Atkin, with his two brothers, Mr. E. P. Atkin and Mr. F. S. Atkin, succeeded to the business, the name of the firm being then changed to Atkin Brothers. In the same year the works were transferred from Howard-street to Matilda-street. Mr. H. W. Atkin took charge of the London branch. Three of his sons are connected with the business, which is one of the best in the Sheffield silver and plating industry.

As this letter is closed, the Board of Trade returns for May come in. The two heads which chiefly concern Sheffield are "hardware and cutlery" and "steel unwrought." In the first the foreign business in May reached a value of £172,493, against £145,319 for May of 1895; the value for the five completed months of the year being £853,220, against £718,676 for the corresponding period of 1895. In steel, unwrought, the foreign trade reached a value in May of £233,503, against £147,366 for the corresponding month of 1895. In hardware and cutlery all markets show an increase, except Holland, Belgium, Foreign West Indies, and Argentine Republic. In steel, the only decreasing market is the United States, which took a value of £25,751, against £26,202 in May of last year.

Professor J. O. Arnold, of the Sheffield Technical School, has been awarded by the council of the Institute of Civil Engineers a Telford Medal and premium for his researches on "The Influence of Carbon on Iron."

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE iron market, though quieter than last week, has this week been fairly brisk, and on the whole must be described as in a satisfactory state. Some of the makers have sold considerable quantities of No. 3 for shipment, and have realised more than the generally quoted prices, as it is more likely that the prices will increase than decline. After the lull in business which was reported during May, consumers are beginning to buy more freely, and are showing a disposition to purchase for forward delivery, as they are not likely to gain anything by waiting. But producers do not care to sell forward, as prospects are in their favour. A very good feature of the market now is the excellent shipments of pig iron that are recorded from the Cleveland district. Usually June is a quiet month, and exports fall off; it was this year thought that they would be more likely to do so, seeing that the shipments during the past three months were the largest on record, and it was almost too much to hope that the briskness in deliveries would be maintained. However, the experience is that the exports are increasing; in fact, they much exceed those of each of the last three months, and if maintained will probably be the best on record. What is further noticeable, is that the deliveries are much more than maintained to the Continent, and it is to the Continent that they generally fall off in the summer months. There is, however, this year a tendency to buy more briskly, and this week one of the leading continental buyers of Cleveland pig iron —Mr. S. Elkan, of Hamburg—has been in this district. The exports of pig iron from the Cleveland district this month, up to Wednesday night, reached 49,993 tons, as compared with 35,164 tons in May, and 36,197 tons in June, 1895, to 10th.

The price of No. 3 Cleveland ordinary pig iron has been maintained both by makers and merchants at 37s. 6d. per ton for prompt f.o.b. deliveries, and nothing below that has been reported. Some producers have realised 38s. Merchants have sold for July-August delivery at 37s. 9d., but makers are not disposed to let their iron go at that. Cleveland warrants have kept about 37s. 5d. cash. No. 1 Cleveland pig, which is in fair request for the Continent, is firm at 38s. 9d., but No. 4 foundry and grey forge being more plentiful than for several months are easier in price; in fact, no difficulty is experienced in getting No. 4 foundry at 36s. 9d., and grey forge at 36s. 3d. Cleveland hematite pig iron is also easier in price, as the supply is in excess of the requirements. M. Nos. can be got at 45s. 9d. for prompt delivery, and a little less would not be refused by a good number of the producers. Cleveland hematite warrants are practically a drug on the market, and the nominal price is considerably below that obtained for makers' iron. Consumers do not care to buy Cleveland hematite warrants, for they do not know what brand will be supplied to them, and they may get one which will hardly suit their requirements. Accordingly they prefer to give a higher price, and secure the brand they need. The stock of Cleveland pig iron in Connal's public warrant stores is not increasing much this month, but that could hardly be expected with such heavy shipments. On Wednesday night the quantity held was 198,904 tons, or 454 tons increase this month.

The tendency in ore prices is to rise; in fact, Rubio ore has been put up 1½d. per ton this week, and is now quoted 12s. 9d. per ton, delivered at wharves on the Tees. The reasons for the advance are two-fold—in the first place, the rates of freight have been increased, as steamers are finding more employment in other and better paying directions; and, in the next place, there is a likelihood that the Spanish Government will put an export duty on iron ore, in order to help to provide funds to meet their expenses in Cuba. An export duty on ore has frequently been talked about and advocated in the Spanish journals, but now the time seems to be within measurable distance when a tax will be levied. Such a tax would increase the cost of hematite pig in this district, and would give the makers of basic pig iron and basic steel a better chance of competing than they have hitherto had. The Cleveland ironstone industry would likewise benefit by a curtailment of the imports of foreign iron ore.

The inquiry for finished iron and steel is rather quiet, but works in nearly all cases are well employed. Very large exports of rails, chairs, bridge work, and locomotives are being made from the Tees to India, Japan, and Australia. Some of the bridgework is from the Midlands. Some very large boilers, which have been constructed at Liège, have this week been put on board at Middlesbrough for Rio. We hear so much of British goods being forwarded to Hamburg and Antwerp in transit to the East that it is well to record a case of goods sent to this country in transit. The present quotation for heavy steel rails is £4 10s. net at works. Makers of steel railway sleepers complain of the falling off in demand, owing to many engineers going back to the old cast iron bowl chairs. Steel sleepers are quoted at £5 15s. per ton; cast iron bowl chairs, £3 5s.; and cast iron ordinary railway chairs, £2 17s. 6d., net at works. Steel ship-plates are at £5, less 2½ per cent. at works, and a fair demand is reported as shipbuilding is active. Some of the bar manufacturers have not been so well off for orders for many years, but they cannot advance prices, as others are not so fully occupied, and keep their quotations at the old figures. About £4 17s. 6d. per ton, less 2½ per cent. f.o.t., is now the rate for common iron bars. The steel mills are very well occupied, and particularly is the demand good for galvanised sheets, which are largely needed for export.

Pipe and chairfounders are more fully employed than for several years past, but have not been able to put up their prices much, because there is still plenty of room for improvement as regards the amount of work in hand. Engineers, particularly the locomotive and marine engineers, are doing well on the whole, and shipbuilders have a good deal more work on hand than at this time last year. Wire manufacturers have seldom been more fully occupied than at present, and the same may be said of wire rope manufacturers. Messrs. R. S. Newall and Sons, Washington, Durham, have started new rope-making plant at their works, and they claim that it is the largest cable-making plant in the world. They have in hand a cable for the Glasgow Subway Company, which will weigh 60 tons, and will be 33,600ft. in length and 4¾in. in circumference. It will be without a splice in any part of it. Cables up to 80 tons in weight can be made in one length by the new machinery.

The price of Durham coke has eased a little, as the supply is now larger than it has been for several months, and has at last more than overtaken the consumption, though the surplus is only small. Most consumers have already arranged their contracts for next quarters' requirements, and in some cases for the next half-year. There is now more coke being offered than has been known for nearly a year, and 13s. 6d. per ton delivered on Teesside will be accepted for average sorts. For steam coal the demand has considerably improved, shipments are brisk, and collieries producing this description of fuel are actively employed, this being the best time of the year for them. The price of best steam coal has been increased by some sellers to 8s. 6d. per ton f.o.b., but others will still accept 8s. 3d., and small steam coals are at 3s. 9d.

The Northumberland colliers are to vote by ballot whether their conciliation board is to be continued or to be abolished. It will be remembered that the Durham miners a short time ago voted for the abolition of their board. The shipments of coal from North-eastern ports last month amounted to 1,429,124 tons, or 71,451 tons less than in the corresponding month last year. A curious cause for a strike is reported at the Black Prince Colliery, Tow Law, the men refusing to work because a considerable number of the miners at that colliery are in arrears with their payments to the Union. The employers are thus made to suffer seriously through no fault of their own, but just because the men practically cannot agree among themselves.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Glasgow pig iron market has shown a good deal of activity this week. The settlement of the wages question in the marine engineering trade, which had been the occasion of much uneasiness, has produced a very good effect, as has also the Board of Trade returns, which indicate that an increasing export business is being done in iron and steel manufactures. A large business has been done in Scotch warrants from 47s. to 46s. 10d. cash. Hematite warrants have been in greater request than for a considerable time past, and Cumberland iron has sold between 47s. 5½d. and 47s. 8½d. cash. Only a small inquiry has existed for Cleveland warrants, which have been done about 37s. 6d. cash.

The output of Scotch and hematite pig iron has been maintained at the highest point, there being 81 furnaces in blast compared with 76 at this time last year. There are 39 furnaces producing ordinary, 39 hematite, and three basic iron.

Stocks of pig iron are increasing in the public stores, which would seem to indicate that makers are turning out a surplus that cannot be fully absorbed at the moment. The addition to stock in Glasgow warrant stores in the past week has been upwards of 2000 tons, bringing up the total to 360,000 in round figures, against 282 at this time last year.

The shipping demand for Scotch pig iron continues on a moderate scale. The quantity cleared in the past week was 5210 tons, compared with 3692 in the same week of 1895. Of the total, there was despatched to Germany, 515 tons; United States, 350; India, 335; Canada, 70; South America, 20; Australia, 260; France, 184; Italy, 116; Russia, 200; Holland, 50; Belgium, 40; China and Japan, 170; other countries, 115; the coastwise shipments being 2785, against 1769 tons in the corresponding week. The total shipments, coastwise and abroad, from the beginning of the year to date, amount to 131,363 tons, compared with 137,336 in the same period of last year.

The prices of Scotch makers' pig iron are as follows:—Govan, Monkland, and Carnbroe, Nos. 1, 47s. 6d.; Nos. 3, 46s.; Clyde, No. 1, 49s. 6d.; No. 3, 46s. 6d.; Gartsherrie, Calder, and Summerlee, Nos. 1, 50s.; Nos. 3, 47s. 9d.; Coltness, No. 1, 52s. 6d.; No. 3, 48s.; Glengarnock at Ardrossan, No. 1, 50s.; No. 3, 45s. 6d.; Eglinton, No. 1, 47s.; No. 3, 45s.; Dalmellington at Ayr, No. 1, 46s. 6d.; No. 3, 44s. 6d.; Shotts at Leith, No. 1, 52s.; No. 3, 48s. 6d.; Carron at Grangemouth, No. 1, 52s. 6d.; No. 3, 48s. 6d.

Makers' of finished iron report that business is keeping up very well; indeed, this branch appears to be in a better position than for a considerable time past. A feeling had been growing for years that malleable iron was doomed to be superseded by steel, but this apprehension seems now to be falsified, for there is a substantial revival in the demand for malleable iron, and that, too, at the very time that steel is likewise very active.

The position of the coal trade is rather disappointing, the past week's shipments from Scottish ports have amounted to 143,387 tons, compared with 152,779 in the preceding week, and 148,289 in the corresponding week of last year. The reduction in the shipment is in part due to a scarcity of handy steamers; shippers to the Mediterranean, for example, are reported to have had, within the last few days, orders in hand which they could have executed if suitable tonnage had been available. For main, splint, and steam coals the demand is quiet. Furnace coal and dross, and the better qualities of household coals are in active request. The municipalities and gas companies are now purchasing considerable quantities of cannel and splint coals. Prices f.o.b. at Glasgow are, for main coal, 5s. 9d.; splint, 6s. 3d. to 6s. 6d.; ell, 6s. 3d. to 6s. 9d.; steam, 7s. 6d. per ton.

The question of the wages of the operative engineers in the marine engineering trade of the Clyde and Belfast has now fortunately been arranged. The employers offered an advance of ¼d. per hour, advance to hold good for six months, taking effect from the middle of the present month, and the workmen have accepted these terms by a vote showing a considerable majority.

Several good shipbuilding contracts have been received by Clyde builders, in addition to those noted last week.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

A FAIR amount of business was done last week at the iron and steel works, and I am glad to see that, not only has there been a substantial increase in steel bar orders, but tolerably good ones for steel rails are in hand. The report on 'Change, Swansea, this week, was to the effect that there was an increased demand for finished iron and steel, but more particularly for the latter; that the demand for rails in that district continued brisk, and that rail makers will be fully employed for months to come; and that for steel bars there was a pressure for immediate delivery.

At the close of last week an important cargo of steel rails, 1400 tons, went to Singapore and Hong Kong from Cardiff. This week one cargo of 370 tons rails went to London from Newport, and a small one of 118 tons for Highbridge from the same port.

The leading ironmasters have been getting in large stocks of ore this week from Elba, Castro, Garucha, and Bilbao. Blaenavon was specially noticeable for one cargo of 3900 tons, and another of 1850 tons, Ebbw Vale one of 1600, and three important cargoes for Dowlais. Another large shipment of pig iron from Bilbao came into Newport this week, while Scotland, Barrow, and Whitehaven have been busy importing pig iron to Swansea. In all 570 tons came by sea to Swansea last week, also another cargo of sulphide ore, 2562 tons, consigned from Port Pirie.

There is a gratifying improvement in tin-plate, but makers, whose mills are now working briskly, are afraid that it is of but a temporary character, as such a large number of mills are idle, and there will be a great likelihood that the news of improvement will prompt tin-plate manufacturers to start and bring about by over-production a repetition of the old state of things. Still it will be well not to get unreasonably apprehensive. The "turn" may be at hand, and if increased demand should set in, well and good. I see that last week the shipments of tin-plates amounted to 90,928 boxes, while make was only 68,454 boxes. Stocks at Swansea are now down to 164,056 boxes.

Statistics to hand are encouraging, as showing a greater variety of customers for Welsh plates, the falling off to the States being partially made up by increased shipment elsewhere. Some countries have exceeded their former requirements by 83 per cent. Taking the totals for May, 1895 and 1896, I find that the shipment to Germany last month was 1432 tons against 491 for May, 1895; France, 995 tons against 784 tons; Portugal, 669 against 284; Italy, 894 against 538; Austria, 211 against 90; Straits Settlements, 1111 against nil. Canada showed a decline—142 tons against 765 tons.

An improved trade in spelter is announced, an indication that the make of galvanised sheets is on the increase.

Prospects at Pyle are improving, and increased briskness is likely. Large quantities of ferro-manganese used to be sent from this quarter.

Iron and steel quotations, Exchange, Swansea, mid-week, were as follows:—Glasgow pig, 46s. 10½d. cash; Middlesbrough, No. 3, 37s. 6½d., hematite, 47s. 5d.; Welsh bars, £5 10s. to £5 12s. 6d.; iron plates, £6 to £6 17s. 6d. Steel, £6 to £6 17s. 6d.; steel rails, heavy sections, £4 10s. to £4 12s. 6d.; light, £5 10s. to £5 15s. Bessemer steel, tin-plate bars, £3 17s. 6d.; Siemens, best, £3 18s. Tin-plates, Bessemer steel cokes, 9s. 3d. to 9s. 4½d.; Siemens coke finish, 9s. 6d. to 10s.; ternes, per double box, 28 by 20c., 16s. 6d., 17s. 6d., to 21s.; best charcoal, 12s. 9d. to 13s.; wasters, 6d. to 1s. per box less, all delivered Prince of Wales' Dock, Swansea, cash less 3 and 1 per cent.

The coal shipments last week again showed the result of holidays, the total from the Cardiff ports being about 285,000 only, and until the 300,000 tons are again exceeded the inference must be that the old state of make has not been regained.

I note, however, this week that the demand for best is improving, and the long list of large tonnages on several days is a promise of better things.

Mid-week good seconds were inquired for freely, but drys and Monmouthshire coals were not selling well. Small steam is getting a trifle more brisk. House coal continues sluggish, and some of the minor coalowners look forward somewhat gloomily to the summer months ahead.

Swansea coal shipments last week were satisfactory, slightly exceeding late averages. Newport total foreign was 37,515 tons; coastwise, 19,453 tons. From Briton Ferry some large cargoes of coal and coke have been despatched. I see that at Porthcawl the coal trade has been fairly brisk. Engineers have been surveying the dock of the Great Western Railway Company at this place, with a view to carry out extensive repairs of gates and piers. The estimates are now under consideration. This carried out, and the Esplanade put into good order, would materially benefit one of the best seaside resorts of the Glamorgan coast.

At Cardiff there is an unabated demand for coke, and shipments continue large. Patent fuel is also in moderate demand at Cardiff and Swansea.

Cardiff quotations mid-week, on 'Change, were as follows:—Best steam, 10s. 3d. to 10s. 6d.; special seconds, 9s. 9d. to 10s.; ordinary seconds, 9s. 3d. to 9s. 6d.; drys, 8s. 7½d. to 9s.; best Monmouthshire, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s.; best small, 4s. 9d. to 5s.; seconds, 4s. to 4s. 6d.; drys, 3s. 6d.; best house, 9s. 6d. to 10s.; No. 3 Rhondda, 9s. 6d. to 9s. 7½d.; brush, 7s. 6d. to 7s. 9d.; small, 6s. 3d. to 6s. 6d.; No. 2 Rhondda, 7s, to 7s. 3d.; through, 6s. to 6s. 3d.; small, 4s. to 4s. 3d.

Swansea quotations:—Anthracite, best, 11s. to 11s. 3d.; seconds, 9s. to 10s.; steam, 9s. to 10s.; seconds, 8s. 3d. to 9s.; No. 3 Rhondda, 9s. to 10s.; No. 2, 8s. 6d. to 9s. 6d. Cardiff quotations: —Coke, furnace, 12s. 9d. to 13s. 9d.; foundry, 15s. 6d. to 16s. 9d.; special, 19s. 6d. to 19s. 9d. Pitwood, 16s.; quieter, more cargoes coming in. Swansea patent fuel, 9s. 9d. to 10s. 3d.

A quantity of colliery plant, machinery, &c., is to be dispersed this week at Penrhiwfer, one of the collieries of the Glamorgan Coal Company in the Rhondda, and next week a compact tin-plate works at Aberavon, known as the Japanese Works.

Amongst the leading subjects of discussion in the district is the rumoured amalgamation between the Taff Vale Railway and the Rhondda and Swansea Bay Railway. Sir John Jones Jenkins, approached on the matter by the representative of a Swansea contemporary, expressed his opinion that it would be a good thing, particularly for the Taff Vale, if the amalgamation came off.

Wales is again excited by the recommendation of the Water Committee of the London Council to go forward in the matter of a supplementary supply from the Welsh watersheds. The end of the drought of sixty days has brought about a lessened friction between town surveyors and urban Boards as to the condition of local water supplies; and if the engineering work now going on in various localities be brought to a head by next spring, I do not think that the protest of Welsh members in the House against the London scheme will be so severe as anticipated. If Wales were to be afflicted with a great drought during the water campaign in the House, the Rebecca, Tithes, and Chartist days would have the addition of another formidable agitation.

The new coal charter continues to form a topic of discussion on 'Change, Cardiff. At a special meeting of the Cardiff Shipowners' Association on Monday, the secretary was instructed to write to the local dock companies, stating that by the terms of the new coal charter, which comes into operation on the 1st July next, the wharfage on cargo hitherto paid by the shipowner will be paid by the charter.

The viaduct on the Great Western Railway at Cardiff was opened for traffic this week, and forms an excellent improvement, obviating a great deal of waiting and delay outside the station.

The "6ft." seam of coal has been struck at Morfa, Port Talbot, causing much rejoicing.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THERE is not much of special interest to be reported this week, the raw and finished iron departments being, without exception, in a healthy, active condition.

It is gratifying to note the lively business on the Silesian iron market, which has been steadily improving from week to week, and is now in a state of general briskness, such as has not been known for a long time. As the employment of the manufactured iron and steel works is sure to increase as the year advances, a very strong demand continues to come forward in the pig iron trade, and for orders for the first quarter of 1897, which here and there have been booked, purchasers willingly pay higher prices.

Prospects for further satisfactory occupation in the manufactured iron industry are very good. Besides being actively engaged in the production of girders and bars, the mills also report an uncommonly brisk demand to be coming forward for plates and sheets; the tendency of prices naturally continues to be in an upward direction.

The favourable condition of the Russian iron market is having a good influence on the Silesian export trade, the orders received from Russia being, as a rule, heavy. Projected enterprises in railway plant and mining developments will help to secure a good employment to the engineering industries.

The iron market in Austria-Hungary continues to exhibit a tendency to improve. Stocks are very low, consumption being almost equal to production. Official quotations are the same as previously reported.

French iron business shows considerable animation, and a very firm tone with regard to prices prevails. In Paris merchant iron is exceedingly scarce, which may partly be due to the exceptionally mild winter and to the consequently early revival in the building trade. In the Maas and Moselle district a very considerable decrease in stocks has taken place, and prices are very much inclined to rise; since the beginning of the year an advance of 4f. p.t. has taken place.

Belgian iron business has been just a trifle more quiet during the week that is now past, only few and rather small contracts having been placed. However, there is still a healthy activity noticeable in the different departments, which will probably continue until a fresh amount of work is secured. Prices are firm. The Belgian coal trade is very steady, and slight advances in quotations have even been ventured. At a recent tendering for 400,000 t. locomotive coal for the Belgian State Railways the collieries have well maintained the lately enhanced prices.

Orders for both raw and manufactured iron continue to come in satisfactorily on the Rhenish-Westphalian iron market, and nearly all the works are consequently in brisk employment. Iron ore has met with a decided improvement; the Siegerland mines are hardly able to produce the quantities required, spathose iron ore having, perhaps, never before been so briskly inquired for as it is now. Prices are, for spathose iron ore, M. 9 to 9·60 p.t.; roasted ditto, M. 12 to 13 p.t.; calcined iron ore, M. 12 to 14 p.t. at mines. In Nassau the trade in iron ore is less lively, but may still be regarded as fairly satisfactory, the 50 p.c. red iron ore being sold at M. 9·60 to 9·80 p.t. Lorraine minette is quoted M. 2·40 to 2·60 p.t.; the 40 p.c. sort fetching M. 3·20 p.t. net at mines.

The pig iron market is very active, and stocks are small. Last week's quotations were:—Spiegeleisen, 10 to 12 p.c. grade, M. 50; forge pig, No. 1, M. 53 to 55; No. 3, M. 42; hematite, M. 65; foundry pig, No. 1, M. 65; No. 3, M. 57; basic, M. 56; iron for making steel, M. 54 to 56 per ton at works. Luxemburg forge pig is quoted 56f. p.t. free Luxemburg. The physiognomy of the malleable iron business continues bright. Makers have well filled their order books, and are rather indifferent about selling largely at present. Prices remain exceedingly firm, but leave very little profit generally. However, so long as the raw materials do not further advance, manufacturers are fairly well satisfied with the present state of things, feeling sure that a rise in quotations will take place ere many weeks have passed. Bars remain in strong request, both on home and on foreign account. The same may be told of girders. The hoop mills are well employed, and have raised the basis price. Rivets are in good call, comparatively speaking, and prices show a stiffening tendency.

The following are the present list quotations, per ton at works: Good merchant bars, M. 120 to 122; angles, M. 130; girders, M. 94 to 97; hoops, M. 125; billets in basic and Bessemer, M. 85 to 86; heavy plates, for boiler-making purposes, M. 160 to 165; tank plates, M. 135 to 140; steel plates, first quality, M. 145; second quality, M. 130; tank plates, in steel, M. 120 to 125; sheets, M. 137 to 150, in some instances, M. 155; iron wire rods, common quality, M. 130; drawn wire, in iron or steel, M. 118 to 138; wire nails, M. 127 to 130; rivets, good qualities, M. 185 to 190; complete sets of wheels and axles, M. 280 to 290; axles, M. 220; steel tires, M. 200; steel rails, M. 118; steel sleepers, M. 110; fish-plates, M. 120 to 130; light section rails, M. 100.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

THE demand for steam coal keeps fairly good, with prices unchanged. House coal shipments are quiet; prices same as last week. Tin-plates continue in demand, with prices very firm. The iron and steel works are all well employed. Fairly good attendance.

Coal: Best steam, 8s. 3d. to 8s. 6d.; seconds, 7s. 9d. to 8s.; house coal, best, 9s. 9d. to 10s.; dock screenings, 5s. to 5s. 3d.; colliery small, 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 46s. 9½d.; hematite warrants, 47s. 5d. f.o.b. Cumberland; Middlesbrough, No. 3, 37s. 5d. prompt; Middlesbrough hematite, 44s. 10d. Iron ore: Rubio, 12s.; Tafna, 11s. 3d. Steel: Rails, heavy sections, £4 12s. 6d.; light ditto, £5 f.o.b.; Bessemer steel tin-plate bars, £4. Siemens' tin-plate bars, best, £4 2s. 6d.; all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel, coke, 9s. 3d.; Siemens, coke finish, 9s. 6d.; ternes, per double box, 28 by 20 C, 19s. to 20s. 6d. Pitwood: 16s. to 16s. 3d. London Exchange Telegram: Copper, £47 13s. 9d.; Straits tin, £60. Freights firm.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, June 4th.

MANUFACTURERS are more deeply concerned with business politics this month than with quotations, feeling the latter will take care of themselves, if political measures are right. It is virtually settled that the money power in the United States has been propitiated by private assurances, which satisfies it that it will own the next president, hence the almost death-like silence in the gold journals. The masses of the people have no suspicion that they are to be sold out, but it is all fixed, and Britain's millions can start on their crusading investment in "Americans" as soon as they feel like starting. The iron trade is very dull, for two or three reasons: first, people are waiting to see what way the St. Louis cat will jump. It will be into the gold bag with a sympathetic purr, for silver buyers of steel will not place their big contracts much before July. It would be no more than guesswork to say now what volume of business will probably be placed in July, or what such action will have on prices. It is known that quite a number of large iron and steel consumers have already been assured of supplies at fixed prices, and it is presumable that these people will not be in as great haste as others on the first appearance of the better conditions which almost all are anticipating for the latter half of the year. The actual consumption of iron and steel is heavy, probably on a basis of 170,000 tons per year. When the urgent work projected for this year is entered upon, these figures will be exceeded. There is some movement among railroad managers for rolling stock, which may develope into a considerable demand by August. Earnings improve slowly. Prices are low, but this fact augurs well. Buyers frequently go like sheep when something occurs to start the first one, and that is the next thing in order.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

26th May, 1896.

11,450. Blacking Brushes, J. C. Wickers, London.
11,451. Producing Musical Sounds, W. P. Thompson.—(*G. Breed and C. A. Bragg, United States.*)
11,452. Shafts of Vehicles, W. P. Thompson.—(*Schmidt Langkutt and Co., Germany.*)
11,453. Locks for Safes, W. Ward and Milner's Safe Co., Liverpool.
11,454. Wheel for Road Vehicles, W. Hewitt and A. G. Sidwell, Birmingham.
11,455. Cycles, J. Slee, Liverpool.
11,456. Shirts or Other Garments, M. L. Schloman, Liverpool,
11,457. Dress Shields, B. F. Sutton, London.
11,458. Manufacture of Pharmaceutical Compounds, H. E. Newton.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
11,459. Tents for Military Purposes, A. F. Budden, London.
11,460. Casks, W. Porter, London.
11,461. Supplying Ammunition to Heavy Guns, J. Vavasseur, London.
11,462. Transparent Show Cases, J. T. Robin, London.
11,463. Steps for Cycles, J. M. Keen, London.
11,464. Treatment of Ores, &c., S. O. Cowper-Coles, London.
11,465. Separating Metals, &c., S. O. Cowper-Coles, London.
11,466. Portable Warming Devices, A. Harpley, London.
11,467. Disengaging Hooks, J. P. Hitchcock, London.
11,468. Type-writing Machines, A. J. Boult.—(*C. Spiro, United States.*)
11,469. Tune-changing Apparatus, E. P. Riessner, London.
11,470. Manufacture of Hair Curlers, E. S. Browett, London.
11,471. Arc Lamps, W. L. Wise.—(*A. B. Fernald and J. H. Hubbell, United States.*)
11,472. Bottles and other Vessels, F. Caluzio, London.
11,473. Electric Railways, J. C. Love and J. E. Hodges, London.
11,474. Advertising Tickets, J. Kahn, London.
11,475. Burners for Petroleum Vapours, V. L. Longuemare, London.
11,476. Machine for Feeding Cardboard, A. A. Cohen, London.
11,477. Engines, R. L. Weighton and D. B. Morison, London.
11,478. A New Tire for Cycles, &c., L. Redmond, Dublin.

27th May, 1896.

11,479. Tooth Brushes, H. Besson and G. H. Kent, London.
11,480. Hub for Cycles, &c., F. W. Ruther, Bordeaux.
11,481. Driving of Machinery, Boats, &c., T. Tomlinson, Bray.
11,482. Driving Gear for Cycles, R. L. Tapscott, Liveroool.
11,483. Tires for Cycles and other Vehicles, R. L. Tapscott, Liverpool.
11,484. Fire Indicator, G. McAll and G. Crees, Ross.
11,485. Cycle Saddle, J. Mitchell and D. Tansley, Staffordshire.
11,486. Steam Generators, R. E. C. Shann, London.
11,487. Polishing Wheels, B. R. Rowland, Manchester.
11,488. Tank Furnaces, R. Orrock, London.
11,489. Wash Stalls or Lavatories, H. W. Williams, Liverpool.
11,490. Producing Rotary Motion, J. H. Meikle, jun., Glasgow.
11,491. Internal Combustion Engines, H. C. L. Holden, Woolwich.
11,492. Sharpening Saws, R. Taylor, jun., and L. Dunkerley, jun., Manchester.
11,493. Spinning and Doubling Frames, R. Taylor, jun., Manchester.
11,494. Dress Bodices, A. Nicholson and J. Hall, Staffordshire.
11,495. Railway Carriages, &c., J. O'Brien, Manchester.
11,496. Occulting Lights for Lighthouses, J. R. Wigham, Dublin.
11,497. Pneumatic Wheel Tires, E. L. Levetus, Birmingham.
11,498. Piston Packing, S. M. W. Croskery.—(*T. Roberts, United States.*)
11,499. Devices for Sextants, S. M. W. Croskery, Liverpool.
11,500. Jets for Fire Extinguishing, / G. Browning, Manchester.
11,501. Tap, W. S. Mackay, Birmingham.
11,502. Pneumatic Tires, J. J. Richardson and R. Pearce-Brown, London.
11,503. Toothed Wheelgearing, F. H. Boyce and E. A. Claremont, Manchester.
11,504. Pneumatic Tires, D. Collins and W. H. Wallis, Southampton.
11,505. Cork Tires for Cycles, G. Parrock, Birmingham.
11,506. Road Vehicles Driven by Oil Motors, J. Magee, Glasgow.
11,507. Rims and Tires of Wheels, G. W. Parker, Glasgow.
11,508. Pneumatic Cycles, W. Coulter, Manchester.
11,509. Pneumatic Tires, L. Callender, London.
11,510. Tires for Cycles, J. S. Hughes, Rockcliff, Portmadoc.
11,511. Driving Gear for Cycles, F. S. D. Scott, London.
11,512. Steam and Water Separator, F. D. Potter, London.
11,513. Machinery for Winding Yarn, J. Boyd, Lanark.
11,514. Forming Eaves Troughs, C. F. Throm, London.
11,515. Driving Chains for Cycles, &c., J. Moore, London.
11,516. Wheels for Road Vehicles, A. G. Jennings, London.
11,517. Electric Light, H. A. Bessemer, Southampton.
11,518. Cycles, J. Wilson, Birmingham.
11,519. Induction Coils, R. J. Crowley and A. B. Hutchings,——
11,520. Electrical Signal, W. M. Klees, London.
11,521. Tandem Safety Cycles, J. P. C. Rigby, London.
11,522. System of Glazing, H. Hayward, London.
11,523. A New Stand for Plates, J. L. Fletcher, London.
11,524 Manufacture of Safes, H. W. Chubb, London.
11,525. Tires, R. Elsdon and J. F. Starkey, London.
11,526. Tires for the Wheels of Cycles, W. Heatley, London.
11,527. Treating Wooden Surfaces, H. Beyer.—(*F. Recke, Germany.*)
11,528. Pneumatic Cycle Tires, S. De la G. Williams, London.
11,529. Sounding Musical Instruments, E. Edwards.—(*The Lochmann scher Musikwerke Company, Germany.*)
11,530. Carburetted Water Gas, The Economical Gas Apparatus Construction Company, Ltd., and L. L. Merrifield, London.
11,531. Improved Billiard Markers, H. R. Nathan, London.
11,332. Cuff Links, J. C. Scarborow, London.
11,533. Crayon Holders, H. H. Leigh.—(*G. Rosenfeld and Co., United States.*)
11,534. Monocycles, R. J. Meek and F. E. Palliser, London.
11,535. Machines for Grinding Cutlery, A. F. Bannister, London.
11,536. Fasteners for Mail Bags, &c., L. Lawson, London.
11,537. Automatic Recording Compass, A. H. Edwards, London.
11,538. Treatment of Seaweed, A. Krefting, London.
11,539. Elastic Wheel Tires, E. E. Duller, London.
11,540. Steering Gear for Velocipedes, J. Monteith, London.
11,541. Trees for Boots, H. W. Mobbs and A. Lewis, London.
11,542. Pneumatic Tires for Cycles, L. T. Darnault, London.
11,543 Axles, J. R. Quain and F. W. Dunlap, London.
11,544. Binocular Hand Glasses, E. Bloch, London.
11,545. Means of Advertising, F. J. Watts and F. Poston, Ilford.
11,546. Construction of Gas Engines, J. G. Horsey, London.
11,547. Umbrella Frames, W. P. Thompson.—(*L. E. Bisson, France.*)
11,548. Spark Arrestors, W. P. Thompson.—(*F. E. H. W. Krichauff, Australia.*)
11,549. Devices for Gas Engines, A. A. Hamerschlag, London.
11,550. Applliance for Ladies' Skirt, R. J. Edward and R. Hall, Liverpool.
11,551. Cycle Handles, J. G. Dobson.—(*H. H. Johnson, United States.*)
11,552. Means for Switching Current, C. Adam, Liverpool.
11,553. Production of Filaments, &c., J. W. Swan, London.
11,554. Velocipedes, S. Frank, London.
11,555. Manufacture of Sulphide, D. A. Peniakoff, London.
11,556. Saddles Suitable for Cycles, F. M. Gilmore, London.
11,557. Producing Gaseous Mixtures, S. Pitt.—(*The Société Anonyme de l'Institut Raoul, Pictet, Switzerland.*)
11,558. Machines and Motor Cycles, A. Williams, London.
11,559. Water-softening Apparatus, H. L. Doulton and A. W. Manger, London.
11,560. Hydraulic Forging Presses, C. Davy, London.
11,561. Rifle Bullets, A. Reinhard.—(*A. Krupp, Austria.*)
11,562. Nut-locking Devices, W. Wright, London.
11,563. Toys, W. Tyree, London.
11,564. Distributing Pulverulent Material, C. Oesterheld, London.
11,565. Excluding Dust from Bearings, C. A. Drake, London.
11,566. Globes, W. H. Gritton, W. Edwards and H. B. Sheridan, London.
11,567. Saddles, O. von Briesen, London.
11,568. Tobacco Pipes, H. J. Bird, London.
11,569. Resilient Soles for Boots, J. R. Gumley, London.
11,570. Boxes for Storage of Papers, W. Willig, London.
11,571. Means for Advertising, R. D. G. Hall, London.
11,572. Boxes, W. H. Scott and W. M. Turner, London.
11,573. Automotive Vehicles, R. Haddan.—(*F. de Couinck, France.*)
11,574. Skein Holders and Winders, H. Brocklebank, London.
11,575. Toys, W. L. Urquhart, London.
11,576. Reflecting Light from Candles, L. Silberstein, London.
11,577. Constructing Marine Vessels, E. L. Kitchingham, London.
11,578. Double-faced Automatic Machines, L. Silberstein, London.
11,579. Fastener for Envelopes, J. W. Wilkins, London.
11,580. Manufacturing Nuts, J. H. Sternbergh, London.
11,581. Gas Lighting, G. Moreau and A. Poulhiès, London.
11,582. Apparatus for Pearl Fishing, E. Veron, London.

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11,583. Stop-cock for Hose Branches, W. Hanlon, Cork.
11,584. Machines for Filling Bottles, A. P. Blaxter, sen., London.
11,585, Cycle Seats or Saddles, T. W. Woodgate, London.
11,586. Metal Liquid Polish for Brass, C. D. Scott, Birkenhead.
11,587. Locomotive or Motor Vehicles, E. K. Dutton, Harrogate.
11,588. Air Pumps for Pneumatic Cycles, H. D. Simpson, Derby.
11,589. Chair Backs, &c., P. J. Job and P. B. H. Seabrook, London.
11,590. Attaching Golf Club Shaft to Head, G. Young and J. Anderson, Glasgow.
11,591. Oil Lamp Burners, A. H. Griffiths and T. B. Smith, Birmingham.
11,592. Pulleys for Hauling and Winding, T. Bodycombe, Bristol.
11,593. Gulleys, A. T. Swain, Manchester.
11,594. Window Tickets, J. Parkinson, Keighley.
11,595. Covers for Cycle Tires, D. Nelson and A. Tayler, Glasgow.
11,596. Leather Cleaning Apparatus, J. W. Blakey, Leeds.
11,597. Adjustable Spanners, J. R. Cooper, Birmingham.
11,598. Elastic Tires for Vehicle Wheels, J. P. Roe, London.
11,599. Mixing Liquids and Solutions, G. T. Gillespy, Manchester.
11,600. Cycle Frames, J. McElroy and R. McMillan, Belfast.
11,601. Harness, A. Black, Edinburgh.
11,602. Gas Meters, Bruxelles, sen., Brussels.
11,603. Piano Keyboard Guide, F. Gunther, Brussels.
11,604. Transforming Negatives, &c., M. Magnus, Brussels.
11,605. Purses, Bags, Pocket Books, E. G. Johnson, London.
11,606. Lamp and Heating Device, J. D. Humphrey, London.
11,607. Boots, A. M. Boilinger, London.
11,608. Sheet Metal Rolling Mill, J. Matthews and A. G. Sherman, London.
11,609. Frames for Grindstones, S. C. Schofield, London.
11,610. Velocipedes, A. J. Murphy. London.
11,611. Cuff Holders, N. L. Reynolds, London.
11,612. Moulding and Fret Cutter, J. Delli, London.
11,613. Opening Out Vegetable Fibres, A. R. Waddell, Airdrie.
11,614. Automatic Tipping Apparatus, R. M. Howatt, London.
11,615. Safety Clip for Lift Ropes, G. Q. Roberts, London.
11,616. Pneumatic Springs for Vehicles, F. J. Esmond, London.
11,617. Electric Alarm for Railway Trains, H. Binko, London.
11,618. Hook and Eye, D. Joy, Kent.
11,619. Fluid for Cleaning, &c., Paint, J. Cornwall, London.
11,620. Small-arms, T. Perkes, London.
11,621. Effecting the Separation of Gases, H. Maxim, London.
11,622. Duplex Gripper Pneumatic Tire, G. E. Brinkworth, London.
11,623. Writing and Drawing Pencil, K. Gengnagel, St. Leonards-on-Sea.
11,624. Appliance to be Attached to Bicycles, T. P. Chittenden, London.
11,625. Tires of Cycles, J. James, sen., and J. James, jun., London.
11,626. Pneumatic Wheel Tires, W. E. Rowlands, London.
11,627. Secondary Batteries, E. J. Clubbe, A. W. Southey, and The Electric Motive Power Company, London.
11,628. Buttons, N. Hipwell, London.
11,629. Toy, W. P. Thompson.—(*E. Reuther, Germany.*)
11,630. Biscuit Boxes, G. A. Foster, London.
11,631. Lasting Machines, H. von Kalinowski, London.
11,632. Water Gas, J. E. Goldschmid and C. Dellwik, London.
11,633. Filtering Apparatus, S. K. Welch, London.
11,634. Elastic Tires, C. Fox, London.
11,635. Brake Mechanism for Bicycles, &c., P. E. Doolittle, London.
11,636. Oil Lamps, J. F. C. Jürgens and A. B. Kistritz, London.
11,637. Apparatus for Preserving Milk, A. J. Vause, London.
11,638. Bicycle Supports, P. A. Newton.—(*J. J. Slevin, United States.*)
11,639. Exhibiting Phases of Movement, J. N. Maskelyne, jun., London.
11,640. Optical Instruments, J. Richard, London.
11,641. Files for Letters, F. W. Marriott, London.
11,642. Game Scorers, T. F. Barber, London.
11,643. Parcel-carrying Apparatus, J. Smith.—(*N. Guthridge, Australia.*)
11,644. Brake Pipe Couplings, J. E. Bousfield.—(*M. L. Weaver and B. B. Babcock, United States.*)
11,645. Mattresses, F. W. Golby.—(*O. Steiner, Germany.*)
11,646. Mechanical Musical Instruments, F. W. Golby.—(*U. Schwerin and Co., Germany.*)
11,647. Electric Couplings. E. Theodora, London.
11.648. Braking Road Vehicles, D. Cremmen, London.
11,649. Frames for Cycles, B. Verity and T. Stoward, London.
11,650. Wheels for Railway Wagons, &c., F. Ludewig, London.
11,651. Cutting Glass, A. J. Boult.—(*B. Gruhl, Germany.*)
11,652. Letters or Characters, W. R. Lake.—(*G. J. B. Rodwell, United States.*)
11,653. Material for Packing Articles, J. N. Beach, London.
11,654. Pneumatic Tires, O. Jones, London.
11,655. Engine Indicators, F. Grover and G. A. Mower, London.
11,656. Engines and Motors, F. Lamplough and F. T. Goodman, London.
11,657. Pneumatic Tube Valves, J. P. Hitchcock and J. Dring, London.
11,658. Keels of Sailing Vessels, C. A. Jensen.—(*C. Stangeby, Norway.*)
11,659. Pneumatic Tires for Cycles, V. de H. Dowler, London.
11,660. Variable Speed Gear for Cycles, D. Joy, London.
11,661. Fixing Music and Reading Desks, J. H. Rosoman, London.
11,662. Corkscrews, R. A. Brown, London.
11,663. Harness Hangers, C. E. Barber.—(*The Gleason and Bailey Manufacturing Co., United States.*)
11,664. Ore Separating Apparatus, W. T. Newman, London.
11,665. Tea and Coffee Cups, &c., H. C. Parsons, London.
11,666. Pneumatic Tire Covers, A. H. Culley, London.
11,667. The Union Stopper, G. A. Leighton and C. Ball, London.

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11,668. Small Arms, R. P. Puelma, London.
11,669. Saddle Pins for Cycles, J. Womack, Doncaster.
11,670. Vessels for Containing Liquids, R. J. Parkes, Liverpool.
11,671. Supporting the Frames of Cycles, R. J. Parkes, Liverpool.
11,672. Wheel Tires, W. Hughes, Birmingham.
11,673. Marking Emery Cloth, W. M. Fuller and F. G. Williams, Birmingham.
11,674. Carpets, The Heckmondwike Manufacturing Co. and W. Holt, Halifax.
11,675. Wheels for Cycles, Auto Cars, &c., E. Wright, London.
11,676. Wheels for Cycles, J. W. Laing, Glasgow.
11,677. Raising and Lowering Cages, M. J. Oliver, St. Tudy, Cornwall.
11,678. Springs for Use in Cycles, &c., D. Doyle, Youghal.
11,679. Boot Tree or Last, W. Bourne, Ashton-on-Mersey.
11,680. Shaping Metal Tubes, W. T. Smith, Keighley.
11,681. Hubs for the Wheels of Cycles, R. F. Hall, Birmingham.
11,682. Manufacture of Silica Bricks, J. Dixon and A. Reynolds, Sheffield.
11,683. Safety Flush Bolt for Doors, A. Wache, Berlin.
11,684. Paper Feeding on Double Action Machines, A. Hellman, Berlin.
11,685. Velocipedes, J. E. Evered and D. G. Pappa, London.
11,686. Cycle, &c., Route Indicator, H. C. Hope, London.
11,687. Pneumatic Tires, H. J. Heinze, London.
11,688. Pneumatic Tires, H. J. Heinze, London.
11,689. Door Lock Furniture, H. D. Hodgkinson and R. A. Hall, London.
11,690. Opening Sealed Cans, R. A. Sloan and J. E. L. Barnes, Liverpool.
11,691. Pneumatic Tires for Cycles, E. C. Ogden, London.
11,692. Uniform Pressure in Gases, &c., F. Doller, London.
11,693. Burning Vapourised Petroleum, H W. Hatfield, London.
11,694. Drawing Down Machines, A. C. Wright, London.
11,695. Hardening Chrome Leather, K. Möller, London.
11,696. Coin-freed Gas Meters, R. T. and J. G. Glover, London.
11,697. Typewriters, J. Melling, Kent.
11,698. Soldering Appliances, G. B. Harkes and C. E. Bacon, London.
11,699. Pneumatic Tires, A. F. Aldridge and T. Hewett, London.
11,700. Toy, R. Wallwork, London.
11,701. Polishing Steel, G. Hales, C. Tutill, and C. Greensides, London.
11,702. Medicine for Curing Lumbago, C. Canham, London.
11,703. Stern Tubes of Steam Ships, D. C. F. Wulff, Sheffield.
11,704. Constructing Steam Generators, M. Le Blant, London.
11,705. Elastic Tires for Vehicle Wheels, J. P. Roe, London.
11,706. Purifying Acetylene Gas, E. F. J. C. Bauweraerts, London.
11,707. Burner for Acetylene Gas, E. F. J. C. Bauweraerts, London.
11,708. Generation of Acetylene Gas, E. F. J. C. Bauweraerts, London.
11,709. Pneumatic Duplex Teats, A. E. Booth, London.
11,710. Joining Metallic Tubes, W. L. Poole, A. tone, A. St. V. Turquand, London.
11,711. Threshing Machines, F. Korb, London.
11,712. Frames of Velocipedes, J. Mason, London.
11,713. Generator for Road Carriages, P. Davies, London.
11,714. Receptacles for Holding Papers, G. Blakey London.
11,715. Bicycles, S. A. Watkins and W. A. D. Keys, London.
11,716. Fertiliser and Insecticide, F. E. Rutland, London.
11,717. Covering Steel Plates with Copper Sheeting, W. T. Lougher, Swansea.
11,718. Basic Lining for Pig Iron, O. Imray.—(*Oberschlesische Eisenbahn-Bedarfs Actien Gesellschaft, Germany.*)
11,719. Attaching Pneumatic Tires to Wheels, C. Merington, London.
11,720. Lock Stitch Sewing Machines, A. E. Duncan, London.
11,721. Corsets, H. Bendy, London.
11,722. Cycles, S. A. Watkins and W. A. D. Keys, London.
11,723. Pneumatic Tires for Cycles, H. N. Grove, London.
11,724. Electrical Hot Plates, A. E. Woodhouse, London.
11,725. Gear Wheels, R. O. Cowan, London.
11,726. Pneumatic Tires, W. Corah, jun., London.
11,727. Cycles, W. A. Aikin, London.
11,728. Cycles, W. F. Hills, London.
11,729. Nutlocks, W. P. Thompson.—(*J. Schirra, United States.*)
11,730. Producing Galvanic Depositions, W. P. Thompson.—(*The Elekta Galvanoplastische Anstalt, H. Teith, and A. Floeck, Germany.*)
11,731. Separating the Husk of Locust Bean Kernels, P. C. D. Castle, Liverpool.
11,732. Plate for Storage Batteries, F. Grünwald, Liverpool.
11,733. Steam Generators, A. J. Boult.—(*J. B Loquet, and J. B. Ketelair, Belgium.*)
11,734. Steering of Horseless Vehicles, M. L. Blant, London.
11,735. Pigeon Traps, E. Harrison, London.
11,736. Otter Boards of Trawling Gear, J. Epton, London.
17,737. Storage of Acetylene Gas, E. Clausolles, London.
11,738. Plastic Substances, H. H. Lake.—(*M. Friedheim, Germany.*)
11,739. Softening and Purifying Water, O. Guttmann, London.
11,740. Pointing Wires, W. H. Spottiswoode and E. J. Passingham, London.
11,741. Tires for Wheels of Vehicles, D. Davy, London.
11,742. Gauge Glasses, J., E. T., T. W., and F. S. Tomey, London.
11,743. Closing Device, C. A. Floyd and A. E. Morrall London.
11,744. Elastic Tire for Cycles, R. McAllan and J. Henderson, London.
11,745. Elastic Tire for Cycles, R. McAllan and J. Henderson, London.
11,746. High Explosives, S. A. Rosenthal.—(*S. J. V. Romocki, Germany.*)
11,747. Cartridges, E. Rubin, London.
11,748. Tank Wagons, S. Fox and The Leeds Forge Co., Ld., London.
11,749. Air Guns, W. F. Markham, London.

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11,750. Side and End Tipping Wagons, C. W. Lyon, Dewsbury.
11,751. Spring Tube Scraper, C. Vincent, Belfast.
11,752. Fastener, &c., J. Pipan and L. Bangerter, London.
11,753. Pockets for Garments, R. Colegate and E. B. Woods, Folkestone.
11,754. Hoes, W. Savery, Bristol.
11,755. Cycle Chain Adjustments, J. Whitehead, Birmingham.
11,756. Ink-wells, S. Sauvage, London.
11,757. Utensil for Washing Dishes, &c., A. M. Unger, London.
11,758. Street-sweeping Machines, T. J. Robertson, London.
11,759. Rubbers for Carding Engine Condensers, A. Hardwick, Halifax.
11,760. Trusses, The Accrington Surgical Appliances Company, Ld., and W. J. Bell, Halifax.
11,761. Golf Balls, W. Park, jun., Glasgow.
11,762. Fastener for Window Sashes, T. White, J. Buchanan, and W. Wilson, Glasgow.
11,763. Cycle Gearing, W. Downie, Glasgow.
11,764. Tires for Vehicle Wheels, D. Halley, London.
11.765. Self-cleaning Sanitary Gulley, H. W. Swain, Bristol.
11,766. Roller Brake, W. Gardner, Harborne, near Birmingham.
11,767. Cranks for Bicycles, W. Hall, J. T. Blackett, and W. Hutton, Guisborough.
11,768. Doors for Gas Cooking Stoves, R. Clayton, Wolverhampton.
11,769. Spiral Roundabout, A. Marsden, Stockton-on-Tees.
11,770. Ladies' Tie-up for the Hair, E. A. Stamps, Birmingham.
11,771. Photographic Cameras, W. J. Lancaster, Birmingham.
11,772. Additions to Small-arms, A. Tunstall, Birmingham.
11,773. Fork-end Lugs for Cycle Frames, J. Johnson, Birmingham.
11,774. Looms, R. L. Hattersley and S. Jackson, Keighley.
11,775. Manufacture of Weldless Steel Tubes, J. Davies, Wednesbury.
11,776. Gas Engines, C. W. Siddle and R. Field, Huddersfield.
11,777. Velocipedes, F. J. P. Cheesbrough and E. R. Royston, Liverpool.
11,778. Lamps for Velocipedes, W. T. C. Gray, jun., and H. T. Livesley, Liverpool.
11,779. Electric Arc Lamps, J. G. Lorrain.—(*J. McLaughlin, United States.*)
11,780. Checking Delivery of Measured Quantities of Liquids, E. A. Pallister, Leeds.
11,781. Flat Stripping Motions for Carding Engines, J. Edge, Manchester.
11,782. Construction of Passenger Cars, T. W. Main, Dumbartonshire.
11,783. Electric Railways, H. H. Lake.—(*G. Ferraris and R. Arno, Italy.*)
11,784. Automatic Weighing Machines, T. S. Sheard, Liverpool.
11,785. Pump, C. Schey, Brussels.
11,786. Wool-beater, E. Beaumont, Brussels.
11,787. Automatic Flushing of Water-closets, C. Losange, Brussels.
11,788. Self-closing Tap, G. Laguens, Brussels.
11,789. Hygienic Feeding and Drinking Apparatus for Carrier Pigeons, E. Goemans, Brussels.
11,790. Refining Sugar, G. Ranson, Brussels.
11,791. Suet Cutter, W. Stabb and F. Little, London.
11,792. Bottle, W. Stabb and F. Little, London.
11,793. Cycle Mudguards, W. Stabb and F. Little, London.
11,794. Obtaining High Pressures, C. W. Siddle, R. Field, and W. G. Robinson, Huddersfield.
11,795. Vernier and Wind Gauge Combined, J. Wight, Ayr.
11,796. Cycle Lighting, G. R. Jaggs and A. Bodwell, London.
11,797. Abrading Machines, P. M. Justice.—(*A. R. Pritchard, United States.*)
11,798. Bicycle Driving Chains, S. Z. de Ferranti, London.
11,799. Tires for Bicycles, &c., S. Z. de Ferranti, London.
11,800. Electric Meters, J. Atherton, G. Knight, and G. Ellis, London.
11,801. Socket for Electric Lamps, J. Katzenstein, London.

11,802. Impregnating Wool with Oil, G. R. Smith, London.
11,803. Encaustic Tiles, J. E. Heath and J. Adams, London.
11,804. Child's Seats, W. F. Locke, J. H. Sargent, and P. Gallaher, London.
11,805. Tires, H. W. Tyler (Knight) and J. F. Dowding, London.
11,806. Pipe Couplings, M. F. Lancrenon and G. W. A. FitzGeorge, London.
11,807. Pneumatic Tires for Cycles, &c., R. Crittall, London.
11,808. Metallic Rims for Wheels, A. L. Kendrick, Birmingham.
11,809. Gas Mechanism, W. P. Thompson.—(*A. Dempster, Australia.*)
11,810. Bicycles, Tricycles, W. A. and A. A. Legg, Liverpool.
11,811. Retaining Aerated Liquids, S. Barnett, London.
11,812. Rings, H. H. Perkes, London.
11,813. Cables, W. A. Price, London.
11,814. Boats, F. W. Zimer, London.
11,815. Stoppers for Bottles, &c., R. D. Todd, London.
11,816. Lock, E. Draullette and A. E. Catois, London.
11,817. Regulating Warp Tension, G. W. Burrows, London.
11,818. Sieves, N. Greening and Sons and F. R. Crowder, London.
11,819. Battens for Weaving Looms, J. Poyser, London.
11,820. Manufacture of Tires, &c., T. Sloper, London.
11,821. Hand Tools for Miners, &c., E. Bingham, London.
11,822. Skirt or Garment, B. Polich and O. Beyer, London.
11,823. Cart, H. Scheller, London.
11,824. Carriage, C. Miethe, London.
11,825. Mail-carts, R. R. Thom, Kilmarnock.
11,826. Protective Covers, B. Lobee and M. Callahan, London.
11,827. Counter for Looms, A. J. B. E. Darras, London.
11,828. Apparatus for Drying Fabrics, T. Bradford, London.
11,829. Swansea Plate, W. T. Lougher, Swansea.
11,830. Door Knocker, A. King, London.
11,831. Motor Carriages for Roads, M. L. Blant, London.
11,832. Using Volatile Substances, J. Bengue, London.
11,833. Toughening Manganese Steel, R. A. Hadfield, London.
11,834. Wheels, E. Latham, London.
11,835. Tires for Cycles and Vehicles, S. H. Sharp, London.
11,836. Taking Photographs, J. Terme and A. de Maroussem, London.
11,837. Motor Carriages for Roads, M. L. Blant, London.
11,838. Railway Permanent Way, G. B. V. Scharberg, London.
11,839. Extracting Gold from Ore, A. S. F. Robinson, London.
11,840. Shafts for Carriages, &c., F. D. Bernier, London.
11,841. Velocipedes, D. Pascual-Hernandez, London.

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11,842. Explosives, G. G. André and C. H. Curtis, London.
11,843. Puncture-proof Pneumatic Tire, E. Oades, Wokingham.
11,844. Hat Retainer, C. H. Raddatz, Birmingham.
11,845. Castor, W. U. Coates, Fairfield.
11,846. Condensing Water from Steam, W. Weir, Glasgow.
11,847. Making Tiles and Quarries, J. E Brindley, Hanley.
11,848. Nickel Muffles, J. H. Gartrell, Penzance.
11,849. Steering Gear, T. H. Poole and T. W. Wright, Clonakilty.
11,850. Tire, J. Harding, Wolverhampton.
11,851. Paper Threader, L. Fletcher and A. H. Tuer, Wigan.
11,852. Rotary Hutch Tipplers, T. Thomson, Glasgow.
11,853. Envelope, J. B. Wilson, Glasgow.
11,854. Pole or Rod Holders, &c., G. Riley, Leicester.
11,855. Lighting and Heating Apparatus, P. Fraser, Glasgow.
11,856. Potters' Kilns, H. Cartlidge, Longport.
11,857. Fixing Screw Propellers, J. K. Oldfield, London.
11,858. Electrically-driven Pumps, J. C. Merryweather, London.
11,859. An Automatical Fruit Tree, G. Fritsche, London.
11,860. Corks, S. Greenwood, Liverpool.
11,861. Battledore and Cup, J. McCarthy, R. W. Stewart, and J. R. Johns, Liverpool.
11,862. Balance Attachment to Bicycle, C. T. Menke, Birmingham.
11,863. Self-propelling Road Vehicles, C. F. Wood, Enfield Lock.
11,864. Securing Tires to Rims of Wheels, J. Adair, Waterford.
11,865. Shoe Lasts, G. König, Glasgow.
11,866. Pessaries, W. Viebahn, jun., Barmen, Germany.
11,867. Buckles for Articles of Dress, T. E. Williams, London.
11,868. Device for Locking Velocipedes, A. Lonks, Birmingham.
11,869. Tires or Wheels for Cycles, E. J. Smith, Birmingham.
11,870. Bicycle Pedal, C. Curdle, London.
11,871. Chain Driving Wheels, T. S. James, London.
11,872. Address Seal, J. T. Grant and T. Williams, London.
11,873. Disinfecting Gas from Sewers, D. F. Andrews, London.
11,874. Bacon and Meat Knife and Saw, J. W. Broyd, Haslemere.
11,875. Obtaining Resilience in Wheels, E. P. Allam, London.
11,876. Envelopes, A. Busch, London.
11,877. Printing Tickets and Cheques, E. Verkhowsky, London.
11,878. Manufacture of Albuminous Compounds, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
11,879. Heating Railway Carriages, M. W. Household, London.
11,880. Shaft Couplings, W. J. Pitt, London.
11,881. Rotary Engine, W. J. Pitt, London.
11,882. Wheels for Chain Gearing, T. Hewett, London.
11,883. Bicycle Wheels and Tires, C. E. Kelway, London.
11,884. Locking Nuts, F. W. Golby.—(*A. Vosmaer, Holland.*)
11,885. Cash Registers, J. Sharpe and J. A. Banfield, Ottawa, Canada.
11,886. Roulette Game, A. N. James, London.
11,887. Cycles, E. B. Ricketts and R. M. Cunningham, London.
11,888. Cycle Brakes, E. B. Ricketts and R. M. Cunningham, London.
11,889. Cycle Wheels, E. B. Ricketts and R. M. Cunningham, London.
11,890. Withdrawing Nibs from Pens, F. Smith, London.
11,891. Grip Clutch for Telegraph Wires, W. Phillips, London.
11,892. Lace Fasteners for Boots, &c., A. Smith, London.
11,893. Cycles, R. M. Benham, London.
11,894. Opening Doors by Electricity, S. Cambie, London.
11,895. Cleaning the Bottoms of Ships, D. H. Sisson, London.
11,896. Filling, &c., Metal Capsules, E. Stern, London.
11,897. Boot Lasts, H. H. Lake.—(*O. A. Miller, United States.*)
11,898. Pneumatic Tires for Cycles, &c., J. Tyte, London.
11,899. Saddles or Seats for Cycles, J. Tyte, London.
11,900. Ship Manœuvring Apparatus, E. Smethurst, London.
11,901. Tires, R. Buchanan, Liverpool.
11,902. Churns, J. E. Nyquist, London.
11,903. Frictional Electric Machine, H. Sobersky, Liverpool.
11,904. Cycle Driving Mechanism, E. E. Fournier-d'Albe, London.
11,905. Rotary Planing Machinery, &c., E. Hanff, London.
11,906. Moulding Butter, J. Flynn and W. Muirhead, London.
11,907. Heating Apparatus, G. G. M. Hardingham, London.
11,908. Spring Buffers, T. H. Ward, London.
11,909. Photographic Apparatus, A. E. Dehnert and K. H. G. Hedwig, London.
11,910. Glass Bottles, T. Broadbent and W. Brown, London.
11,911. Connecting-rods, J. S. Raworth, London.
11,912. Auto-cars or Self-propelling Vehicles, C. Casman, London.
11,913. Steering Cycles and Carriages, H. T. Davis, London.
11,914. Motor Propelled Vehicles, F. Lutzmann, London.
11,915. Marking Cords and Holders, G. K. Spitzenberg, London.
11,916. Gauge Glass Protector, G. J. J. Manvell, London.
11,917. Anti-vibration Device for Cycle Handles, G. Chappell, London.
11,918. Anti-vibration Device for Cycle Handles, G. Chappell, London.
11,919. Brakes for Cycles and Vehicles, G. Turton, London.
11,920. Water Gauges, C. Neuhaus, London.
11,921. Automatic Weighing Machines, P. A. Depaepe, London.
11,922. Railway and Insurance Tickets, G. H. B. Dalman, London.
11,923. Driving Chains, W. L. Wise.—(*E. F. Morse, United States.*)

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11,924. Navigable Vessels, A. J. Boult.—(*P. Hamelle, France.*)
11,925. Raising Gigs for Weaving Fabrics, J. Bailey, London.
11,926. Inflating Tires and Saddles, J. B. Torres, London.
11,927. Reducing Metallic Compounds, J. B. Torres, London.
11,928. Driving Mechanism for Cycles, C. E. Challis, London.
11,929. Cycle Chain and Wheel Gear, C. H. Angell and R. H. Abrey, London.
11,930. Cycle Frames, A. A. Thornton, London.
11,931. Castors for Furniture, H. H. Hemmings, Sittingbourne.
11,932. Steam and Vapour Engines, E. J. Duff, Liverpool.
11,933. Steam Generators, J. R. Green, London.
11,934. Opera Glasses, A. Wrench, London.
11,935. Apparatus for Teaching Drawing, C. H. Bray, London.
11,936. Cycles, W. E. Sutton, Dublin.
11,937. Driving Gear for Cycles, W. J. Baird, Belfast.
11,938. Production of Gases, T. Hawkins, A. Wellby, and J. W. Carr, London.
11,939. Cog Gear, G. Davis, London.
11,940. Intercommunication, &c., A. Barrett, Cambridge.
11,941. Cycle Frames, A. Pickard, Harrogate.
11,942. Cushions for Cycles, &c., H. W. Hill, Nottingham.
11,943. Attachment for Spiral Springs, J. Brown, Manchester.
11,944. Door Checks, L. C. Gorisse, Manchester.
11,945. Testing Eggs, J., A. and G. Lyons, Manchester.
11,946. Manufacture of Pedestals, H., J. and A. Coulthurst, Manchester.
11,947. Tires for Wheels of Cycles, S. Bunting, Birmingham.
11,948. Pans for Culinary Purposes, H. Collins, Birmingham.
11,949. Method of Advertisements, W. Quack, Berlin.
11,950. Shafts, H. Loesner, Berlin.
11,951. Treating Carbonaceous Substances, J. Meikle, Glasgow.
11,952. Pins, P. M. Justice.—(*The Consolidated Safety Pin Co., United States.*)
11,953. Looms, O. Akerlund, Manchester.
11,954. Governing Speed of Engines, J. W. Melling, Manchester.
11,955. Illuminating Gas, W. Young and G. R. Hislop, Glasgow.
11,956. Hydraulic Valves, K. Bryan, Glasgow.
11,957. Controlling Distribution of Power, R. C. Sayer, Bristol.
11,958. Target Practice Apparatuses, J. L. McCullough, Wolverhampton.
11,959. Convertible Ladies' Coat, C. and G. Posse, London.
11,960. Shears, B. Wesselmann, Manchester.
11,961. Handling Paper Stock, T. C. Cadwgan and the O. S. Kelly Company, Manchester.
11,962. Compressed Gutta-percha Tire, J. A. Romer, London.
11,963. Transmitting Indications of Instruments, H. G. Watel, Buckhurst Hill.
11,964. Pneumatic Suspension Wheel, W. Eason and F. Jones, Coventry.
11,965. Driving Gear for Cycles, S. D. Gibson, Birmingham.
11,966. Detachable Adjusting Lugs, J. E. Meredith, Birmingham.
11,967. Paint, T. Turnbull, Fife.
11,968. Colliery and Similar Corves, G. Milnes, Barnsley.
11,969. Pneumatic Tires, E. H. Simpson and C. B. Ketley, Birmingham.
11,970. Frame for Miners' Lamps, M. B. Baird and T. Thomson, Glasgow.
11,971. Guard for Ships' Tables, R. C. McCunn, Glasgow.
11,972. Gas Engines, J. Wolstenholme and J. F. Bennett, Sheffield.
11,973. Movable Platform for Lamp-posts, A. Dalolry, Ealing.
11,974. Gas Burners, C. W. Davis and H. C. Turner, London.
11,975. Seats or Saddles for Velocipedes, J. Harris, London.
11,976. Machines for Mixing Syrup, J. Werner, London.
11,977. Machines for Cooling Syrups, J. Werner, London.
11,978. Tying Packages, C. A. Burr, H. Ewell, G. M. Flumerfelt, and A. G. Griggs, London.
11,979. Wood-working Machinery, H. McD. Jessop and L. Barnett, London.
11,980. Road Carriages, A. H. Adcock and W. Corteen, Birmingham.
11,981. Electrical Indicating Apparatus, J. G. Lorrain.—(*M. Pfatischer, E. S. Hosmer, and H. Binney, United States.*)
11,982. Speed Indicators, J. G. Lorrain. — (*M. Pfatischer, E. S. Hosmer, and H. Binney, United States.*)
11,983. Draught and Dust Excluder, R. de M. Lawson, London.
11,984. Chain Gear, G. G. Bauve, fils, and P. V. C. Hirschfeld, London.
11,985. Electric Arc Lamps, C. E. H. Edman, London.
11,986. Card Game, G. Tout, London.
11,987. Tubular Steam Generators, J. J. Cain, London.
11,988. Bicycles, H. Hardy, London.
11,989. Pipe Plug, F. Williams, London.
11,990. Frictional Gear, J. P. Maginnis and R. Harrison, London.
11,991. Pneumatic Cushion Tire for Cycles, T. J. Phipps, Watford.
11,992. Mechanical Movement, J. Polke, London.
11,993. Cycle Tires, W. J. T. Goatley and A. Hunter, London.
11,994. Motor Driven Cycles, E. J. Pennington, London.
11,995. Aerial Navigation, E. J. Pennington, London.
11,996. Boilers, C. D. Holmes, London.
11,997. Spring Latch Runner, F., W., E., and H. Claughton, London.
11,998. Mud Guard, C. G. Buik and G. S. Ullathorne, London.
11,999. Marine Telegraphy, R. J. Crowley, London.
12,000. Velocipedes, J. W. Cottee, London.
12,001. Support or Rest for Velocipedes, C. Lester, London.
12,002. Driving Gear, C. D. Abel.—(*The Gasmotoren Fabric Deutz, Germany.*)
12,003. Starting Gas Engines, C. D. Abel.—(*The Gas motoren Fabrik Deutz, Germany.*)
12,004. Flower Holder and Dress Fastener, R. C. M. Sterling, London.
12,005. Magic Lanterns, R. Ehrlich, London.
12,006. Brakes for Road Locomotives, F. J. Burrell, London.
12,007. Bottle Stoppers, H. H. Lake.—(*G. W. Steffens, United States.*)
12,008. Drying Granular Substances, T. T. Oliver, London.
12,009. Preventing Rattling in Couplings, J. W. Willard, London.
12,010. Scales, E. N. Gilfillan, London.
12,011. Brakes for Railway Trains, A. M. Willets, London.
12,012. Hat Ventilators, D. B. Metchim, London.
12,013. Wire Ropes, G. G. M. Hardingham.—(*Felten and Guilleaume, Germany.*)
12,014. Mud Guards, W. P. Thompson.—(*H. Engelbreit, Germany.*)
12,015. Saddle Support, W. P. Thompson.—(*Haag and Saalmüller, Germany.*)
12,016. Preventing Stoppage of Drains, J. Edmundson, Liverpool.
12,017. Tires, R. Buchanan, Liverpool.
12,018. Tires, A. M. Reveley and M. L. Barbeau, London.
12,019. Rotary Cutters, M. T. Denne, London.
12,020. Tins for Preserving Meat, W. E. Jope, London.
12,021. Hat Fastener, W. A. Collett, London.
12,022. Shoes, J. Wenzel, London.
12,023. Saddle Pins for Cycles, S. A. Parkes, London.
12,024. Buttonhooks, S. Wigglesworth, London.
12,025. Support for Sleeves of Garments, H. Loeb, London.
12,026. Bicycle Support, H. S. King, London.
12,027. Fibre Extracting Machine, V. B. F. Bayley. —(*F. J. Moden, India.*)
12,028. Caps for Electric Incandescent Lamps, R. J. Bott, London.
12,029. Clothes Drying Apparatus, L. H. Wood-Seys, London.
12,030. Tires for Bicycles, &c., H. H. Sturges, jun., London.
12,031. Ladies' Garment Hook, E. L. and A. Vaughan, London.
12,032. Axle Bearings for Cycles, &c., P. C. Lawless, London.
12,033. Cycle Pedals, P. C. Lawless, London.
12,034. Brake for Pneumatic Tires, W. Panter, Beckenham.
12,035. Cycle Stand, J. Henderson and R. McAllan, London.
12,036. Dies for Forming Nail Strips, S. M. Cutter, London.
12,037. Cheque Blanks, G. H. Rogers, London.
12,038. Railway-car Coupling, G. Schubert, London.
12,039. Transmitting Electric Signals, G. Marconi, London.
12,040. Caps for Air Valves, D. Doherty.—(*G. B. Doherty, India.*)
12,041. Machinery for Motor Cars, W. R. Smith, London.
12,042. Steam Generator, G. Viggars, Newcastle-under-Lyme.
12,043. Pencil Holders, J. Lee, London.
12,044. Meter for Reckoning Distance Traversed, P. Sylva, London.
12,045. Machines for Separating Light, H. Secks, London.
12,046. Generating Acetylene Gas, M. C. A. Fourchotte, London
12,047. Generating Gas, M. C. A. Fourchotte, London.
12,048. Photographic Shutters, G. J. F. M. Mattioli, London.
12,049. Boats, A. J. Hook, Surrey.
12,050. Removable Clips, E. Levison and C. I. Steiner, London.
12,051. Bells, E. Levison and C. I. Steiner.—(*H. Dissner, Germany.*)
12,052. Action of Bells, E. Levison and C. I. Steiner. —*H. Wissner, Germany.*)
12,053. Recovery of Zinc, &c., H. R. Angel, London.
12,054. Steam Turbines, A. J. Boult.—(*J. Comas, ——.*)
12,055. Apparatus for Producing Acetylene, G. Kern, London.
12,056. Metallic Threads, M. L. Ross.—(*E. Oberlé, France.*)
12,057. Watering Plants, A. J. Boult.—*G. B. Martinetti, Italy.*)
12,058. Looms, B. Hilbert, London.
12,059. Steam Generators, S. Lacavalerie, London.
12,060. Rotary Engines and Injectors, S. Lacavalerie, London.
12,061. Bottles, L. C. Werner, London.
12,062. Pipes, A. F. Volk, London.
12,063. Bottle Attachments, M. and L. W. Tebbetts, London.
12,064. Guards for Lamps, &c., S. N. Goodman, London.
12,065. Bottles, J. H. Green, London.
12,066. Rod Fastening, C. Schwinke, London.

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12,067. Till, G. H. Himus, Cambridge.
12,068. Ventilation, W. Birch, Sheffield.
12,069. Machines for Cutting Wood, R. J. Lines, Northampton.
12,070. Transmission Dynamometers, W. E. Dalby, Cambridge University.
12,071. Billiard Cue Tip, J. R. Sutton, London.
12,072. Ladder Platform for Roofs, R. Beckett, Wilton.
12,073. Soaps, J. M. C. Grierson, London.
12,074. Rotary Motors, C. Burgess, King's Heath, Worcester.
12,075. Pneumatic Tires, J. Taylor, St. Helens.
12,076. Explosion Engines, W. Rowbotham, Birmingham.
12,077. Gearing for Vehicles, W. Rowbotham, Birmingham.
12,078. Horse Collars, D. Bowen and W. G. Cummings, Swansea.
12,079. Making Tubes for Cycle Frames, C. Binks, London.
12,080. Pattens, W. Brown, Swansea.
12,081. Invertible Label Damper, T. F. Lynch, London.
12,082. Fixing Handles to Cycles, J. B. Belcher, Birmingham.
12,083. Pneumatic Tires, B. Fox, Manchester.
12,084. Bicycles, W. Carson, Glasgow.
12,085. Brush and Broom Fastener, G. Shelvoke, Birmingham.
12,086. Combing Machine, J. Stake and A Stead, Halifax.
12,087. Brakes for Railway Wagons, L. W. Williams, Glasgow.
12,088. Cotton Spinning Machinery, J. Lord and T. Wilson, Tyldesley.
12,089. Fastenings for Broom Handles, J. H. Filbee, Birmingham.
12,090. Stoppers, A. J. Logan, London.
12,091. Walker's Mudguard Brake, J. Walker, Birmingham.
12,092. Cycle, &c., Hubs, H. Hiscott and J. Andrews, Birmingham.
12,093. Button Fasteners, &c., A. C. Twigg, Birmingham.
12,094. Substitute for Human Milk, T. Drewery.—(*M. V. Hagen, Holland.*)
12,095. Cog Wheels for Chain Driving, E. C. Bellamy, Birmingham
12,096. Bicycles, T. W. Sheffield, Liverpool.
12,097. Wheels of Cycles and Vehicles, W. Booth, London.
12,098 Cycle, &c., Tires, J. T. and S. E. E. Stephen, Leicester.
12,099. Water-closet Pans or Basins, J. C. Martin, London.
12,100. Gear Chains of Cycles, E. L. Tournet, Birmingham.
12,101. Reversing Valves of Engines, T. R. Robertson and W. E. Moss, Liverpool.
12,102. Hat Fastener, T. W. and M. Marsters, Nottingham.

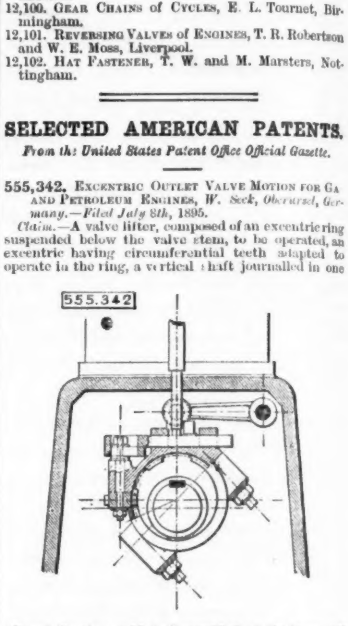
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

555,342. Excentric Outlet Valve Motion for Gas and Petroleum Engines, *W. Seck, Oberursel, Germany.—Filed July 8th*, 1895.

Claim.—A valve lifter, composed of an excentric ring suspended below the valve stem, to be operated, an excentric having circumferential teeth adapted to operate in the ring, a vertical shaft journalled in one edge of the ring, said shaft provided at its lower end with a worm wheel adapted to be operated by the excentric, and at its upper end with a cam and a slide, adapted to be operated by the cam, said slide provided with an upwardly projecting pin, whereby the valve stem is operated, substantially as set forth.

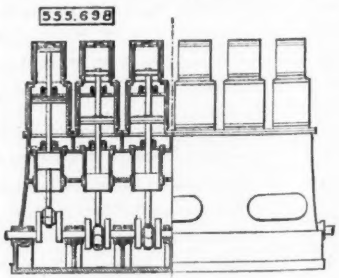
555.342



555,698. Balanced Steam Engine, *J. J. Heilmann, Paris, France.—Filed December 1st*, 1894.

Claim. (1) A balanced engine having a number of cylinders standing side by side with their axes in the plane of the shaft, said cylinders being a multiple of three or four or the equivalent thereof, and divided into two equal portions, the cranks in said two portions being symmetrical relatively to a vertical plane marking the line between the portions, and each symmetrical pair of cranks standing at the same angle and moving in the same direction, substantially as described. (2) An inverted vertical engine having six cylinders or series of six cylinders standing side by side of which the cranks are symmetrical relatively to a vertical plane cutting across the centre of the engine, the three cranks of each half of the engine being 120 deg. apart, and the pistons, piston-rods and other reciprocating parts having respectively exactly the same weight for each cylinder, substantially as and for the purpose hereinbefore described and illustrated by the accompanying drawings.

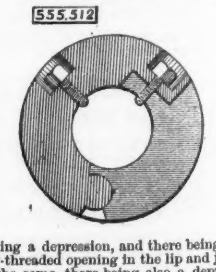
555.698



555,512. Split Slip Collar, *J. B. Johnson, Gouverneur, N.Y.—Filed October 12th*, 1893.

Claim.—A split slip collar comprising two parts secured together by a rocking groove and tenon joint, their opposite ends provided with a lip and jaw respectively, and shoulders against which the ends abut, the lip having a depression, and there being a coincident screw-threaded opening in the lip and jaw, a bolt engaging the same, there being also a depression in the collar and a screw-threaded opening, and a set-screw to pass through said opening and engage the shaft, as and for the purpose specified.

555.512



THE CRYSTAL PALACE EXHIBITION.

It is not too much to say that in the Crystal Palace is now to be seen the most remarkable and completely historical collection of carriages of all kinds for use on common roads that has ever been got together. It is true that the horseless carriage is more conspicuous by its absence than its presence, but that fact is in itself one fraught with instruction, and by no means devoid of importance. Of vehicles propelled by animal power, there are, however, enough to satisfy all but the most exacting. The exhibition of pictures and illustrations of locomotion is more than nearly complete, it is exhaustive; and we commend particularly to the attention of our readers the probably unique series of photographic reproductions of sculptures, paintings, tapestries, and old prints lent by M. Maurice Bixio, illustrating every conceivable form of vehicle from the days of Ancient Greece and Egypt to the nineteenth century. Many of the mediæval pictures are extremely quaint and curious. There are other collections got together by Sir David Salomons and Mr. Sennett, extending from the old French diligence to the modern French locomotive, in which will be found some historical engines, of which we fancy even Mr. Stretton has never heard. The entire display reflects infinite credit on Mr. Gillman and the Crystal Palace authorities.

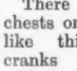
The principal interest, however, for engineers centres just now in the self-propelled carriages and vehicles of various kinds; and those who are now scheming and inventing, and devising and patenting, will miss an object lesson of maximum importance if they do not visit the Crystal Palace and see what is to be seen there. Of petroleum spirit motors there are seven or eight in or about the Palace; but, unfortunately, only two of these seem to be generally available for running in the grounds. These are two Arnold "Victorias," very similar in construction, and worked by Benz motors, driving at two speeds, with belts. There are two or three Delmar "Victorias," but these are run in a very erratic fashion by the representative of the firm, who sometimes takes them out and sometimes leaves them in the Palace for a week at a time. Sir David Salomons' carriage is also there, but Sir David allows no one to run it but himself, at which we are not surprised, because its works are a dreadful nightmare of parts. It would appear, however, that the display is at least as satisfactory as that at the Imperial Institute. There, there are a few more carriages, and no satisfactory place in which to show what they can do; whereas at the Palace there is ample room, and stiff hills and long ones to display all the characteristics, bad and good, of the horseless carriage. The display is small. The fact reminds us of well-known lines in the *Critic*, "The British fleet we cannot see because it is not yet in sight." The motor car we cannot have because it does not yet exist.

We think the time has come when we should speak out, and warn the public asked to take shares in companies being formed to supply horseless carriages of all kinds, that no vehicle is yet on the market which is free from radical faults of construction. That money should be subscribed to develope the horseless carriage, to try experiments, and work out something that will be satisfactory, is quite legitimate. But that is a very different thing from suggesting that it is possible at this moment to supply such demands as the British public will be likely to make now or in the immediate future. We can only speak of things as we find them. Leaving out for the moment the objections which may be urged, on the score of danger, to the use of petroleum spirit, let us consider what the carriages at the Crystal Palace demonstrate. In the first place, then, they are one and all unhandy. They have brakes, but these brakes will not hold them going down a steep hill; and in one case the attempt to stop resulted in tearing the india-rubber tire and smashing the brake gear. The vehicles cannot be stopped, started, run a few yards and stopped again in the way that would be necessary for street working. When running they have practically two speeds, say four miles an hour and ten miles, and they will not run with any certainty at any other speeds. They are in this respect subject to the well-known conditions of all explosive engines, the speed of which must be fairly constant. At times the engines cannot be induced to start, as much as twenty minutes being now and then expended in getting them to run, for no readily detectable cause. This is when they are in the hands of skilful men well accustomed to all their peculiarities. How the inexperienced man would get on with them we do not care to contemplate. The workmanship of the motors is about as good as that of a lawn mower. The coppersmiths' work, of which there is a good deal, is simply astoundingly bad. Soft solder seems to enjoy more favour than brazing. The one or two exceptions only make the defects of the other vehicles more prominent.

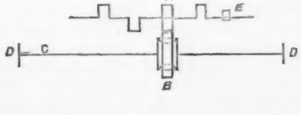
It may, and no doubt will be said that all these defects are remediable. This is true in part; it is true of workmanship and proportions, but it is not true of other things. Variable speeds can only be got by the aid of gearing more or less complex, because the motor must be run within very narrow limits at the same speed, whatever the exigencies of traffic may demand. All the carriages at the Crystal Palace are underpowered. They cannot start with the high speed gear on a level. How they will climb even moderate hills in bad weather, with muddy roads, we are not prepared to say; but already we hear that at the Imperial Institute the short ramp on the track has not been surmounted without the assistance of friendly hands to push. Given a nice level, or moderately level road, and plenty of room, they run with perfect ease, and give no trouble whatever. But none the less are they very unhandy, and unsuitable for working in crowded thoroughfares. Whether this unfortunate peculiarity can ever be overcome while an explosive engine is used, is more than we feel justified in saying. Reversing can be effected, but at a cost of complexity of gearing which few will care to encounter. All these facts should encourage English engineers to take the subject up. They have a clear course as far as competition is concerned; for we feel persuaded that no French or American machine yet produced and put in the market will either satisfy the British demand, or prove able to hold its own in competition with that which our own engineers can turn out. As we have said, we write of the horseless carriage as we find it; not as it may be; not as it appears on paper. We have not the least doubt but that all the Crystal Palace carriages, for example, could be remodelled with great advantage. Sir David Salomons has had his almost rebuilt. But this is not the point. That on which we insist is that the horseless carriages which have reached this country, or have been made here, up to the present, are little more than highly instructive toys, constituting an excellent groundwork for future operations, but a thousand miles from finality.

Nor is it to be supposed that the steam carriages shown at the Palace are much better. Our readers will find two of them not very far from the Galloway engine driving the electric lighting plant. These are very much alike, save in the form of the carriage body, with which we need not concern ourselves. We may confine our attention to one, the steam carriage built in 1892 to take part in the *Petit Journal* competition. A general description of this carriage appeared in our seventy-eighth volume. We may consider and criticise it in some detail with advantage; but we earnestly advise any of our readers interested in road locomotion to go and examine it for themselves. If they will apply at Mr. Sennett's office in the building they will be given every facility. Beginning with the carriage as a vehicle, it will be seen that the front wheels are much too small. The "fifth wheel," or fore carriage, and central pin are inadequate to prevent that "tucking in" of the fore carriage under the main body of the vehicle to which there is always a tendency. When a horse or horses *draw* a vehicle, the traces being attached to the fore carriage, the tendency is to pull the wheels out in front, and the "fifth wheel" may be a small affair having little to do. But in the self-propelled carriage, as in the traction engine, the leading wheels are *pushed* instead of being pulled; and it is easy to see that if they dropped into a small transverse rut in the road they might be doubled up under the carriage. We have seen this very doubling up occur to two ploughing engines in succession in trying to cross a stubble field. The evil is much aggravated by the small diameter of the wheels.

Turning now to the hind wheels, we find that strong and well designed as they are they have been shaken to pieces by the faulty method of driving adopted. On the hub of each wheel is fixed a pitch chain wheel. This wheel is not more than an inch or an inch and a-quarter thick; its boss constitutes a brake drum. The diameter of the whole is so small that a very heavy stress is brought on the spokes in the hub. The chain wheel ought to have been very much larger and secured to the spokes near the felloes. The chain pins are so small and short that they are much worn. The stress on the chain and the wheels is the greatest possible, instead of the least trouble. The brake consists of a strap of flat wire rope round each hub drum; it is, no doubt, very powerful, and so it must be, because the Serpollet engine and boiler are so worked that, as is well known, there is no throttle valve, and the engine is stopped by shutting off the feed, and will always make a few revolutions with the water remaining in the boiler. The brake will, however, bring the carriage up almost dead; but, as we have said, at the expense of greatly stressing and straining the wheels. The boiler is of the type with cross tubes set in a square casing, the tubes being in cross section like the annexed sketch. The fire-door is very inaccessible, and the grate is so high that it is a puzzle to us how a fire more than a couple of inches thick could be carried; but to burn coke to advantage a heavy fire is needed. The grate is very small, and we believe that, as a matter of fact, steam was kept up with much difficulty, especially going up hill.



There are three horizontal cylinders with the valve chests on top. The arrangement of the crank-shaft is like this. Two cranks close together, then an interval, in which is mounted a steel spur pinion A, which gears into a spur wheel B, about three times as large, on the second-motion shaft. This wheel contains the jack-in-the-box bevel wheels shown by dotted lines in the diagram. At E is an excentric, working the feed pump. Our sketch diagram is a plan. The whole is right under the foot-plate, just where it can best get dust from the road and coal and cinders from the foot-plate. The second-motion shaft is very light; the proportions, indeed, throughout will not commend themselves to English engineers, and it is evident that certain strengthening parts have had to be added. The workmanship is inferior throughout.



Here, again, it may be said that all this can be modified and improved. That is quite true. It is for this reason that we commend the Serpollet carriage to the attention of those designing steam carriages. Compared with the Randolph carriage close by, the French coach seems very feeble; yet, it must be remembered, that it has been run quite successfully for a time in France, and we hope to see it running again in the grounds of the Palace. The owners, indeed, have stipulated that it is only to run during the last fortnight of the Exhibition. Why, we are unable to say.

We wish we could say something about the Ward electrical omnibus; but it is only the carriage part that is to be seen, and as the underframe and driving gear has not yet arrived we are compelled to silence. The old Ward omnibus stands close by; a glance is almost enough to show that however excellent as an experiment it could never attain complete success. Indeed, Mr. Ward admits as much by providing what is claimed to be very much better, one of the special advantages being that in some way not yet explained the batteries are prevented from being run down too fast. It is a very tempting thing to turn on a tremendous current to get out of a hole or ascend a short steep incline like a high pitched bridge. But there is always the imminent risk of dissipating the insulation of the armature in a flame, or of irreparably injuring the accumulators. We believe that the underframe carrying the motors is being made in Leeds, and is daily expected at the Palace.

THE INSTITUTION OF NAVAL ARCHITECTS IN GERMANY.

The Earl of Hopetoun, in returning thanks to Bürgermeister Doctor Mönckeberg for his courteous address, gracefully acknowledged in a bright little speech the exceeding cordiality of the welcome which we had received. He was charmed to observe that his advice to the members—to accept the invitation generally—had been acted on so implicitly. He only hoped it was not too implicitly for their hosts. But he wished to explain that the Institution of Naval Architects was a cosmopolitan society. It was certainly not British in an exclusive sense. It represented the naval architectural skill of all great naval powers, for members from all these countries were included in its ranks. Hence there was all the more cogent reason for the warmest sense of international brotherhood when its members met together. It was the scribblers to papers who did all the mischief, and stirred up disturbances amongst nations between whom the strongest natural ties existed. He remarked that two important papers were being read that day, which reminded him in the most distinct manner that German enterprise has gone ahead. Of that they had a remarkable, and at the same time agreeable object lesson, in the splendid ship which brought them over. They had seen, too, on Monday, the immeasurably valuable improvements in the Port of Hamburg. Perhaps the contemplation of their importance might occasion anxiety as well as admiration. But rivalry and competition are the true elements of success. He meant peaceful rivalry. It must never be forgotten, moreover, that Germans and Britons came from the same old stock. The world was large enough for both, and there was no need for them to tread upon one another's toes.

In the discussion which followed the paper by Mr. F. A. Meyer, upon the "Maritime Position, &c., of the Port of Hamburg," published in our last impression, Mr. Brown said a few words in regard to the question of the portable steam cranes, the introduction of which, by his firm, into the wharfage appliances of the port, had been so appropriately noticed by Mr. Meyer in his paper. We should have mentioned that the lecturer had prepared a most elaborate and valuable series of plans, of large size, which were on view at the Concert Haus, and which we regret not to be able to reproduce.

Sir E. J. Reed expressed his sense of pleasure and admiration at the paper which had been read. It was an important and concise contribution to the history of that great port, the increase of whose resources had hardly been understood. He thought that if any place of similar character in our country had an analogous history—though not in so considerable a sense—it was Cardiff! He was particularly struck by the energy and enterprise observable everywhere whilst running through the harbour basins on Monday afternoon. The majestic Elbe, with its great arms stretching out in all directions, embraced the commercial enterprise of the world. Cardiff was, of course, only a centre for coal exportation. Hamburg supplied the wants of the Continent of Europe in the widest sense. The reception of the Society of Naval Architects in Hamburg had been a panorama of magnificence.

Lord Hopetoun remarked, in regard to this capital and instructive paper, that, as a direct descendant of the Picts and Scots, he was exceedingly glad that Hengist and Horsa came over from Germany. Perhaps one reason for their remaining in England and not returning to their own country, was that they had uncomfortable ships. They had not a Fürst Bismarck to return in.

Mr. Meyer replied that he only hoped, as the members of the Institution were so pleased with their reception, that they would imitate Hengist and Horsa by remaining in the country to which they had come.

A paper was then read by Mr. C. Ferd. Laeisz, Chairman of the Hamburg Chamber of Commerce, upon "Shipbuilding in Germany." He pointed out that when wooden sailing vessels were superseded by steamers of iron, the vast natural resources of Great Britain, allied to her immense capital and wonderful enterprise, prevented other states from keeping pace with her. Germany still laboured under considerable difficulties. The great cost of materials, and the restrictions imposed by the law in the employment of juvenile labour stood in the way of employers. Hence the quantity of tonnage turned out was small compared with England. Some of the craft, however, "made in Germany" might be worthy of the Society's notice. Two boats were building now for the North German Lloyds, one at the Vulcan Yard, Stettin, the other by Mr. Schichau, at Dantzic. Their dimensions were 625ft. between perpendiculars, 66ft. beam, 43ft. moulded depth, displacement, 20,000 tons, indicated horse-power, 28,000. Mr. Laeisz noticed that the new German steamers showed a coefficient of fineness seldom over 0·76, whilst many under the British flag approached, or even exceeded 0·8. Forced draught was not extensively believed in in Germany. It had been found necessary to strengthen some of the large new sailing ships beyond the requirements of Lloyd's rules. Germany had not seen the wisdom of imitating the English Load Line Act, but her Bulkhead Committee was "pondering over the solution of the problem of rendering her ships unsinkable."

In the discussion which ensued, we cannot but think that an undue spirit of self-depreciation was observable amongst some of the speakers on the British side. Perhaps it was out of a sincere desire to render a tribute of homage and admiration to the remarkable energy and ability of their hosts, as exhibited in the perfecting of the city of Hamburg as a great commercial port. Nevertheless, we are of opinion that the respect of others is not likely to be gained by running ourselves down wholesale.

Mr. Martell noticed that much of the machinery which we employ is of an ancient character, whilst Hamburg shipbuilders appeared to have everything brand new. His position as a guest in that hospitable country, and after so splendid a reception had been accorded to him and to his colleagues, forbade criticism, even if there was any to offer. He had seen the day before, upon the wharves, and in the shipyard workshops, magnificent appliances, and was tempted to wonder where they could have come from, until he was reminded of the works of Messrs. Krupp and Co., at Essen, and their unrivalled workmanship. In regard to what was said in the paper upon the accidents which had occurred to oil tank steamers, it must be remembered that, at first, shipbuilders did not realise fully the conditions under which oil was carried in bulk, nor the strains which were brought to bear upon the bulkheads. He observed that although Germany built her ships under trying restrictions as regarded material and labour, they could be run more economically, because there was better discipline amongst the crews and other employés. The fact of there being no Load Line Act rendered Germany independent, but she was following a bold course in this as in other respects, an illustration of this being found in the circumstance that she was just turning out a great cargo vessel to carry 14,000 tons of dead weight. He must, however, find one fault with the paper, and protest against the modification of Lloyd's rules, and the strengthening of its formulæ as to scantlings, &c. He would say, in conclusion, that Germany had begun her enterprise in shipbuilding where we left off.

Sir W. H. White did not acquiesce in the view of the Load Line Act which was taken by the writer of the paper, and gave unqualified testimony to the efficiency and importance of Lloyd's rules. Mr. Martell was quite right in indicating the position which Germany now occupied, as beginning where we left off. It was, indeed, better to come after and improve upon the work of other nations, in shipbuilding or anything else. Messrs. Blohm and Voss had been born at the right time, and they had opportunely taken advantage of what they had learned in England. It is a proud position to occupy, that of an instructor, and to have pupils growing up around one; yet sometimes one almost feels inclined to wish that he had been born later. As regards the restrictions and difficulties of manufacture in Germany, he could not help thinking that Germans bought their material most economically, whilst they employed the cheapest labour. They had a great advantage in this last respect, which was a most important consideration when we illustrate it by saying that 70 per cent. of the cost of work in a torpedo gunboat is labour. He would not himself personally invest money in a shipbuilding yard which did not employ the cheapest labour and materials. He considered that we had a vast deal to learn from Germany in everything.

Mr. Archibald Denny paid a graceful little compliment to the value of the work of instruction which he had received under the teaching of Sir W. H. White, whilst he remarked that Hamburg had gone ahead of Great Britain as her pupil. He would never advise Germany to introduce the load-line law. As regards the question of bluff coefficients, it was imperative to build mercantile vessels of this character, as shipowners demanded them. They were under the impression that they had already gone too far in reducing the solid rectangle.

The Earl of Hopetoun, in proposing a vote of thanks to Mr. C. Ferd. Laeisz for his excellent paper, said that he had by it added one more item to the load of gratitude which we owed to our kind and hospitable hosts.

A paper upon the subject of "Recent Improvements in Docks and Docking Appliances," which we publish elsewhere, was then partly read by Mr. Lynel Clark, but, owing to the pressure of time engagements for the day, it had to be considerably curtailed. This, though necessary, was a pity, as the paper was of considerable value and importance, and it is to be regretted that it could not have been introduced during the second day's readings, in the presence of the Emperor, in lieu of the somewhat uninteresting dissertation by Professor Elgar upon the "Classification and Relative Power of Warships"—a question which is purely academic. The paper had, too, a peculiar application and interest attaching to the visit of the Institution of Naval Architects to Hamburg, as the docks and dock appliances to which it alludes could be seen in full swing at the shipbuilding yards of Messrs. Blohm and Voss, and the Reiherstieg Schiffswerfte. The initial cost of graving docks for the repair of vessels, and the immense labour and expense of pumping them out for use, which is, as Mr. L. Clark points out, in inverse ratio to the sizes of the vessels to be docked, should prohibit their employment for this service. Yet, as we know, this system is commonly employed in our country, more especially in Government dockyards. The rapidity with which the floating docks, whose use is advocated in this paper, can lift a vessel and place it in readiness for examination, is very remarkable. It is said that the present Hamburg large dock lifts a vessel of a dead weight of 5000 tons clean out of the water in a space of thirty-two minutes, and that, with the new North Shields dock, this rapidity has been still further increased, as it will lift a vessel of a displacement of 6000 tons, and a draught of some 20ft., in a space of thirty minutes.

The proceedings at Ludwig's Concert House were terminated with the proposal, by Sir W. H. White, of a cordial vote of thanks to the Bürgermeister, Senate, and people of the port of Hamburg, and to the Reception Committee who represented them. He remarked that this Committee represented all who were great and influential in Hamburg, whether socially or officially. When he had stepped upon the Fürst Bismarck he was welcomed by Herr C. Ferd. Laeisz, as upon German soil. This welcome had been emphasised more and more warmly as events wore on. We had felt the cordiality of our welcome most sincerely. In the harbour, as he landed, as he moved along the streets, he realised that it was a royal one in every sense.

Herr Laeisz replied that Hamburg was delighted to see the Institution of Naval Architects. The meeting was one which would tend to cement most closely the ties and intimacies between us, both nationally and socially.

The carriages, which had been so kindly provided by the city of Hamburg, then rapidly swept the visitors along the fine wide streets and boulevards of the town to an elevated spot near the new bridge, which spans the site of the old fortifications. Here at the Fährhaus, looking out upon the broad and glittering bosom of the Elbe, amidst shady trees and terraces, luncheon was served to the entire body of members and their lady *compagnons-de-voyage*. After the discussion of this—which we are bound to confess was a far more animated one than that of the papers—the whole party was driven out of the town around the beautiful waters of the Alster Lakes, across which they had steamed the night before. A countless variety of fine villas and mansions dotted the green slopes which led down to the water's edge, and these were embowered in trees and their lawns bright with flowers.

After an hour and a-half's breathing space, devoted by the ladies of the party to the unpacking of their pretty frocks, they were carried off in the same carriages to the St. Pauli landing stage and embarked on board the Prinzessin Heinrich, newly built by Messrs. Blohm and Voss for the Heligoland service, for conveyance down the Elbe to Blankenese, a picturesque village upon the hilly right bank of the river, where they were entertained at dinner by the citizens of Hamburg and their wives. After a most excellent repast, a few hearty speeches of welcome and reply were made, during which Sir E. J. Reed pointed out how the superior education of Germany had contributed to her success in shipbuilding, the party descended the hill side to their steamer and started for the town. It was now dark, and as the paddles began to revolve slowly, the party gradually found themselves at the head of a large procession of small steamers and launches lighted up most gaily. It was 12 p.m. before the procession ended, and the visitors had been driven back, delighted with the reception accorded to them, to their several hotels. Thus ended the visit of the naval architects to Hamburg.

On Wednesday morning early the visitors gathered at the railway station, where the thoughful kindness of the reception committee had arranged that they should have a special train in readiness for their conveyance to Berlin, only one halt to be made on the journey at Wittenberge for lunch. Capital arrangements were made by the committee, aided by the indefatigable secretary of the society, Mr. George Holmes, for the transport of the baggage, which by this time, swollen by the addition of that belonging to the passengers who had arrived independently at Hamburg, had assumed most formidable dimensions.

At a little after 2 p.m. the train steamed into the Lehrter Station in the last-mentioned town, after crossing the fertile plains of North Germany for some 140 miles, during which not a single cutting or embankment had been negotiated, so flat is the surface—a sandy expanse, but green and excellently cultivated, with pasture or grain fields peeping out between small fir woods and groups of silver birches. The villages and farms were few and far between. It is clear that the crowding of the inhabitants into the town of Berlin, whose population has enormously increased since the war of 1870-71, has thinned the country districts. This Germany will live to repent, as has been the experience of our own country.

It was very hot in Berlin, and the sun-glare very powerful in the streets, but the watering arrangements are so good that, although the city is built upon a sandy plain, there is very little dust being blown about. The banks of the Spree are a model of neatness. In the commercial quarters of the town every available square inch of the water's edge is taken up by goods. Barges are seen loading and unloading sand, not by clumsy baskets, but by rows of neat revolving bands, with buckets upon them. Bricks are piled neatly in stacks, so that the contents of these latter could be ascertained in a moment. There are advertisements on the wharfs, but they are clear, and do not obstruct one another. The street advertisements are all on tall columns, specially constructed.

In the evening the members of the Institution and ladies were entertained at the New Royal Opera House, Berlin, by the Imperial German Government. Supper was served in the saloons adjoining the theatre, and was a very substantial affair altogether.

On Thursday, June 11th, the members of the Institution, as well as the ladies, were all in attendance in the Great Hall of the Technical High School. The Emperor had notified his intention of being present at the reading of the papers. At a little after ten o'clock the large proportion of the party, who had remained outside waiting for the coming of the Kaiser, filed into the room, amidst lines of smart-looking students in handsome uniforms, with swords and small scarlet caps. Then a side door was opened and the Emperor entered, and was received with hearty cheers.

The following inaugural speech was then delivered by his Excellency, Admiral Hollmann, after the Emperor had taken his seat, and his presence had been duly acknowledged by the speaker:—"My lord, ladies, and gentlemen, on behalf of my Imperial German colleagues I bid you heartily welcome to the German Empire. Our thanks are ever due to the Institution of Naval Architects for the improvements in shipbuilding which they have inaugurated. The admiration of the world has always been called forth by shipbuilding perfection. Architecture in building may call for admiration, but a building is inert. 'A ship, however, is a thing of life!' By the art of shipbuilding, great battleships, great Atlantic liners, great cruisers, beautiful yachts are evolved. Who has created all these? The Institution of Naval Architects. The interest taken in your visit to this country is evidenced by the presence in our midst of our beloved gracious sovereign. (Loud and prolonged cheers.) May your pleasure here be great, and may all your efforts be crowned with success."

The Earl of Hopetoun briefly responded, assuring his Majesty the Emperor—himself a member of the Institution—of the deep sense of gratitude which the Institution experienced at the honour which he had conferred upon it by his presence in their midst. He, the Emperor, had himself a practical knowledge of the ships of all nations. In regard to the paper which was about to be read, it would be well in the discussion to avoid comparisons between Imperial German and British navies. Each nation had definite requirements as to conditions of service of the vessels employed, and must have its own peculiar models to meet those requirements. But whichever navy was under consideration, whether that of Germany or that of England, it must, if efficient, be of world-wide usefulness. A powerful navy is a sure factor of peace.

Herr A. Dietrich, constructor-in-chief of the Imperial German Navy, then read a paper upon "Development in Design and Construction of German Men-of-war." This paper we published in our last issue. Herr Dietrich particularly noted the assistance he had received from The Engineer in respect to matters touching upon warship construction.

Sir William White remarked that this was a most valuable paper, and an important contribution to the history of the development of the German Navy. As Lord Hopetoun had said, the several requirements of each individual navy must be considered in the designs of men-of-war. Germany and England present different features in their requirements. There are also so many divergent views of naval officers to be consulted, even before those of the naval architect. There is the question of the weight of heavy guns forward and aft. Then the matter of boilers, whether they shall be cylindrical or water-tube, must be a point to be settled by the requirements of local circumstances. He had seen the greater part of the German warships afloat, and fully recognised their admirable points. We were certainly not too proud to come to Germany to learn, and the presence of the beloved sovereign of Germany showed the keenness of his interest in the matter.

Mr. Thornycroft thought that the two great points of interest in the paper were the application of electrical appliances to the German ships and the matter of boilers. He thought that electrical apparatus was especially valuable, as it was so simple and easy to repair. He did not, however, agree with the paper as to the use of tubulous boilers for short and broken periods of use. He preferred to keep his boilers going.

Lord Hopetoun seemed to think that the only material which should be inflammable on board ship should be the men.

A vote of thanks was given to Herr Dietrich for the paper, and Professor F. Elgar was called upon to read that upon "The Classification and Relative Power of Warships." It was a difficult subject to treat, and, although dealt with in a satisfactory manner by Mr. Elgar, interest in it fell rather flat. One or two interesting points in it may be noticed. Dr. Elgar states that "the cost of a ship increased at a rapid rate with growth in size—roughly, in proportion to the displacement in different types." Also that "as ships go on growing in size the weight of hull will absorb an ever-increasing proportion of the displacement, and that the remainder that is left available for the different elements of fighting power will become relatively less." He also said that "it certainly should be required of a warship that she would be reasonably safe after a single blow from the ram or torpedo." These three points are deserving of the utmost attention, and redeemed the otherwise dull nature of the paper in question.

The discussion of this paper was of little importance, with the exception of some remarks by Sir E. J. Reed and Sir W. H. White. The former said that the warship which is able to speak first, loudest, and most truly in the time of battle will be the most effective. The latter observed that the protective-decked ships of the Japanese at Yalu did not appear to suffer much during the action.

The Thursday meeting then terminated. We shall give in our next the result of a visit to the works of Messrs. Siemens and Halske, which took place in the afternoon of the same day.

HORSELESS CARRIAGE NOTES.

The Locomotive on Highways Bill was read a third time in the House of Lords on Tuesday, June 16th, and passed. Assuming that the House of Commons exhibit the same knowledge of the spirit of the times and the recognition of the requirements of the various industries and trades, we shall not long rest under the stigma of being the only nation that allows itself to be taxed by heavy penalties and restrictions on road transport.

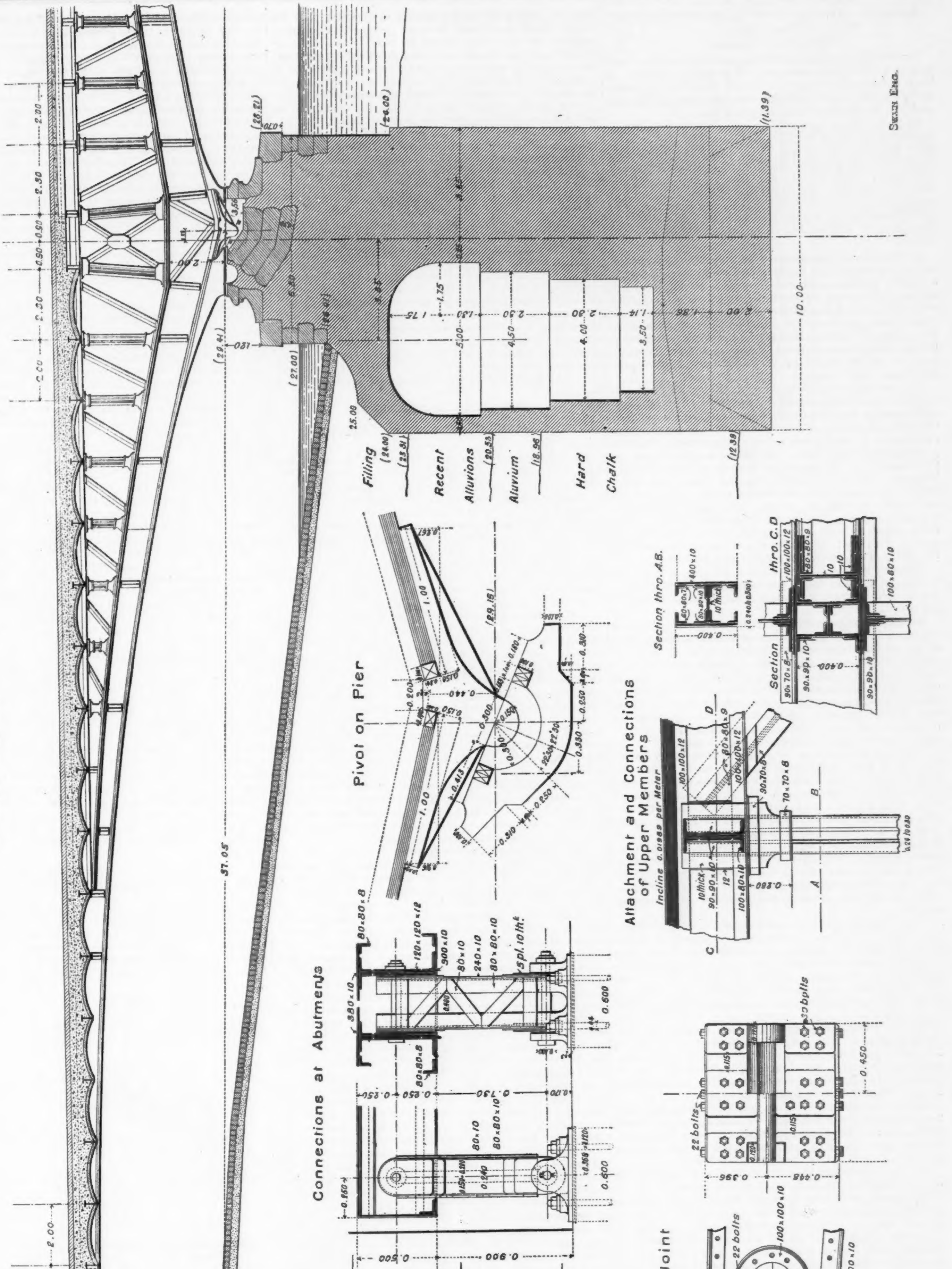
The opinions of M. François Deloncle, député of the Lower Alps, concerning horseless carriages and their uses, are published by the *Petit Journal* of the 6th inst., at considerable length. He is of opinion that already sufficient has been achieved to show the possibility in the near future of the establishment of regular lines of vehicles connecting places not already connected by rail, and he is confident that the automobile will render unnecessary any extension of the light railway system.

With a view to the establishment all over France of the modern equivalent of the stage coaches of former days, but with the advantage of everywhere better roads, a great Société Nationale des Express Automobiles is proposed, and strongly supported.

THE MIRABEAU BRIDGE OVER THE SEINE

M. RESAL, PARIS, ENGINEER

(*For description see page 615*)


37.05
Filling
Recent Alluvions
Alluvium
Hard Chalk
Alluvium
Sand
Clay
Sand
Chalk
Connections at Abutments
Pivot on Pier
Attachment and Connections of Upper Members
Incline 0.0188 per Meter
Section thro. A.B.
Section thro. C.D
Central Joint
22 bolts
30 bolts
10.00
SWAIN ENG.
"THE ENGINEER"

ENGINE POWER AND SELF-PROPELLED TRAFFIC.

By Sir DAVID SALOMONS.

THE technical and general Press have published a great deal of information concerning self-propelled vehicles. A large number of carriages have been described in detail, and the merits of such vehicles have been trumpeted, right and left, in advertisements duly paid for.

So far as I have been able to gather, nothing has been published in regard to the question which I may term the "kernel within the nut." By this I mean, what is really the horse-power required to do a given work on a high road? This matter has been solved long ago in respect to railways—for all inclines, and for all weights of trains; and there is no doubt that the problem has been solved many a time for the high road, but I do not believe that anything definite has so far been published on the subject.

It will naturally be imagined that to mount an incline on the highway would require more power than to mount a similar incline on the railway. This is not the case, although the power required to travel on a level road when compared with a given incline—the surface of such roads being equal—would be practically equivalent to the increased power necessary had it been a tramway, but the initial force required on the level in the case of a tram or railway would be very different to that of propulsion on a high road.

It is not my intention to compare the railway with the road, but to confine myself to the latter. Many years ago I made a number of experiments in regard to traction on good high roads. When the modern horseless carriage appeared I at once pointed out to the makers that the power placed within them was far too small, with one or two exceptions, for practical work in a hilly country. The main advantage of self-propelled traffic over horse traffic lies in the fact of greater speed, which within reasonable bounds is certain and regular, and consequently in being able to run hour after hour at a constant speed without fatiguing the animal drawing the vehicle, with the further advantage of easing the mind of the driver of any feeling of perpetrating a cruelty.

A vehicle which will travel at a given speed, say of twelve to fourteen miles per hour, no matter whether the country be flat or hilly, is a great factor in annihilating space.

Before my steam carriage with the Serpollet boiler was constructed, I was anxious that a series of calculations and experiments should be made in order to be fairly sure, in advance, that the result I sought was likely to be realised. The results are closely in accord with the experiments I made at an earlier date, and it may be of interest to those engaged in the manufacture of these carriages to have some information on the subject. In giving the figures, I take round numbers, which are quite close enough for all practical requirements.

I assume the carriage to weigh 2½ tons when laden, then on a good level road a speed of 7½ miles per hour can be obtained for 2⅓-horse power, and on a bad level road for 4⅓-horse power. To travel up an incline of 1 in 20 on a good road at the same speed would require 10-horse power, and on an incline of 1 in 10 on a similar road about 19-horse power would be necessary. It will be noticed from these figures that each succeeding horse-power necessary is practically double the preceding one. It will also be observed that the increased power required between a level rough road and an incline of 10 per cent., which is not uncommon in many districts, is practically as 1 to 5.

From these figures it is obvious that in order to travel at so slow a speed as 7½ miles per hour, whether on the level or a hill of 10 per cent. rise, in the case of a carriage weighing 2½ tons, when provisioned and laden, the vehicle must carry an engine capable of giving up to, say, 20-horse power. If a speed of 12½ miles per hour on a good road is sought, nearly 4-horse power is necessary; on a bad road, 7⅓-horse power; on a 1 in 20 incline, 16¾-horse power; on a 10 per cent. incline, roughly, 80-horse power. For a speed throughout at the rate of 15½ miles per hour on a good level road about 5-horse power is necessary; on a bad road, 9-horse power; on an incline of 1 in 20, 20-horse power; and for an incline of 10 per cent. rise, nearly 40-horse power.

If the weight of the vehicle when laden was, say, one ton, the horse-power necessary for similar speeds would be two-fifths of the figures given above. This I mention, because one ton is approximately the weight of most petroleum motor-driven carriages when laden.

If it now be desired to travel on the level and up hill at an unvarying speed of, say, twelve miles per hour, which speed would hold good for downhill also, since a greater speed would probably not be tolerated, it would appear, when it is taken into consideration that except in a few districts the roads are rarely what may be termed good in the strict sense of the word, such a carriage should carry an engine capable of giving from 2-horse power up to 12-horse power. Since the majority of the carriages in question are fitted with engines incapable of giving more than 4-horse power, the desired uniform speed of twelve miles per hour will, therefore, be reduced to one-third, viz., four miles per hour where a 10 per cent. incline is reached. This is what they realise in practice, and may be taken as a very good proof that the figures I quote are very approximately correct.

The general analysis given above is instructive, for the reason that it teaches two important facts which are essential when a given average speed is required: (1) That no vehicle is of much service for heavy work unless an engine capable of giving out not less than 30-horse power is fitted; (2) that for light traffic the engine should give not less than 12-horse power for the maximum.

That both these conditions can be fulfilled with steam has been proved, but in the case of petroleum-driven motors I do not think that the result has yet been satisfactorily obtained. To increase the power of the latter form of engine threefold, means in practice that its weight would be at least twice as great, and that more water would have to be carried for cooling the cylinder or cylinders, water in all probability being lighter than any form of cooling apparatus to do the equivalent duty. It is, therefore, clear that if the petroleum motor is to be heavier, the first conditions stand altered, and in consequence of the carriage being heavier, the speed will be reduced, or a still larger engine must be carried.

I therefore conclude, in the present state of our knowledge, that if the light petroleum-driven carriage is required to run at an average speed of twelve miles per hour on good and bad roads, where inclines exist up to a 10 per cent. rise, the carriage laden will probably weigh not less than 1½ tons and require a maximum of not less than 18 to 20-horse power.

So many statements have been made as to the capabilities of special types of carriages, that I consider this a proper time for the public to have every means of gauging how far such assertions are true, and the above information, although it does not pretend to be mathematically accurate, is true to within a very small percentage, and sufficient for all practical purposes.

In conclusion, it is only fair to say that by comparing the statements of the many makers of these vehicles, that although it frequently occurs that their statements are misleading, yet in a great number of instances they are approximately correct, but it will always be observed how slow petroleum-driven carriages are stated to be for the hills.

THE INCORPORATED GAS INSTITUTE.

ON the resumption of proceedings on Thursday, the 12th inst., Mr. W. J. Dibdin read a paper on "A Standard Photometer," and this was immediately followed by a paper by Mr. W. Sugg on "Photometers and Standards of Light." The object of Mr. Dibdin's paper was to suggest a form of photometer suitable for general adoption as a standard instrument for testing the illuminative value of coal gas. Mr. Dibdin's views are well known to gas engineers, and the present paper did not contain any fresh development, nor the record of any new work undertaken in their support. Briefly, he advocated the general adoption of a simple open-bar photometer, as first suggested by King, with the addition of a reversible holder for the Bunsen disc and mirrors, mounted in an easily movable box, and with velvet screens 12in. from each light to prevent reflection from other surfaces, and a screen to cut off direct rays from the observer. The photometer should stand near the middle of a well-ventilated but not draughty room, kept at a temperature of about 65 deg. Fah., and with walls coated with a dead wash. Mr. Sugg's paper was replete with historical matter very interesting to those anxious to learn how the modern forms of photometer and methods of gas testing have been evolved. He is of opinion that both the modified Evan's photometer as used in London, and the Letheby, which is also sanctioned by the Metropolitan Gas Referees, give equally trustworthy results, and he considers that if the pentane Argand standard were adopted in place of candles, the testing of the illuminating power of coal gas would be satisfactorily settled.

These two papers provoked much discussion, but, unfortunately, little criticism. Mr. Dibdin had asserted that Mr. Lewis T. Wright had misused the 10-candle pentane standard in some experiments, the results of which were unfavourable to it. In response to this challenge Mr. Wright explained his use of the standard, and amplified the account of his experiments. The confidence of the meeting in it was much shaken when Mr. Dibdin, in his reply, refused to remain its sponsor, and retreated from the discussion, on the plea that the recommendation of the standard by the last Board of Trade Committee placed it beyond the pale of common criticism. Mr. Dibdin should have refrained from remarks adverse to Mr. Wright's published work if he was not prepared to meet that gentleman's reply, and we hope to see him take an early opportunity to reassure engineers who are using his 10-candle standard that their confidence has not been misplaced.

A suggestion, said to be due to one of the London gas examiners, that the position of the disc at each observation on the photometer should be recorded by the impress of a spring-pointer on a paper scale placed on the photometer bar, instead of being read by the observer, met with general approval, and as it was proposed to have the record of the whole series of ten observations on one paper-scale invisible to the observer, the method seems calculated to remove any suspicion of his later readings being biassed by the knowledge of his earlier ones. But if the necessity for such a method of recording observations is admitted, it becomes a question whether the movements of the disc throughout the period of observation should not be traced by a pencil on a roll of paper. Such a record would be invaluable to counsel in arguing disputed cases of deficient illuminating power, and would afford the chief gas examiner a ready means of checking the work of his assistants. The question of errors introduced through defective vision of an observer appeared to be a momentous one to many speakers. There seemed to be some little doubt in the minds of many as to the issues here involved, and we therefore make no apology for a few words of explanation. There is the question of the purely personal equation, *i.e.*, as to whether two observers of tolerably normal eyesight, *cæteris paribus*, make similar readings. It has been pretty generally conceded that they do. There is, however, the further question as to whether the receptivity of the eyes of any one observer is the same. It is known that very many people credited with good sight can see better with one eye than with the other. The result of this unequal power of vision would be a tendency to make readings always to one side of the correct position of the disc. To obviate such a tendency, Mr. F. Beale and other speakers suggested that only one eye should be used in making observations, but there are obvious objections to the general adoption of such a plan. We were much surprised that those present at the meeting seemed unaware of the simple means of compensating for unequal receptivity of the eyes which the method of taking readings alternately from different sides of the photometer bar affords. As it is now conceded that it is desirable on other grounds that a photometer should be placed in the middle of a room, the necessary structural alterations of the instrument to permit readings to be made from either side of it would be but small.

The proceedings on Thursday afternoon opened with a paper by Mr. Frederick G. Dexter, of Winchester, on "A Season's Experience with Incandescent Public Lighting." He recommended the use of the bulb pattern light, with metal reflector, in place of the ordinary burners with glass or mica chimneys; in other respects he found the common bye-pass burner the best. The anti-vibration spring burners had proved no more satisfactory than the ordinary ones. At Winchester vibration had been deadened as much as possible by packing the lamp column with sawdust.

The author gave some interesting results of the effect on the illuminating power of incandescent lamps, of variations in draught, and air supply. To obtain the maximum efficiency the flame should fill, but no more than fill, the space enclosed by the mantle. The author's experience with 500 street lamps at Winchester showed an average consumption, inclusive of the bye-pass jet, of 3⅞ cubic feet of gas per light per hour, and an average of three mantles per light per annum for renewals. The glass bulbs were broken on half the number of lamps in use in the course of the year. In the course of the discussion on Mr. Dexter's paper, an invention by Mr. W. R. Clay, of Bolton, for minimising the effects of vibration on incandescent mantles was described. From the top of the pillar, ⅛in. brass pipe is carried out horizontally to a distance of about 1¼in., then bent at right angles, and carried upwards to the height of the chimney top. It is there bent into a coil of three turns, and carried down again alongside the chimney to the base of the burner, of which it forms the supply pipe and sole support. In effect the small diameter brass supply pipe thus forms a coil spring, from which the burner is suspended. This device, which is provisionally protected in all countries, was said to entirely overcome the disastrous effects of vibration from traffic on the mantles of street lamps.

At the close of the discussion on Mr. Dexter's paper, the President announced the election of the following gentlemen as officers for the ensuing year:—As President, Mr. C. S. Ellery, of Bath; as Vice-presidents, Messrs. J. Stelfox and S. Stewart; as Members of Council, Messrs. G. Winstanley, Isaac Carr, S. S. Mellor, and W. Cotton; and as Honorary Secretary, Mr. Andrew Dougall, of Tunbridge Wells. The President then presented, on behalf of the members of the Institute, a choice silver bowl to Mr. J. Hepworth, M. Inst. C.E., in appreciation of his several years' services as Honorary Secretary of the Institute. An illuminated address was presented to Mr. F. G. Burfield, the late Secretary of the Institute, and after the transaction of some formal business the meeting closed with a hearty vote of thanks to Mr. W. R. Chester for his services as President and Chairman. In 1897 the annual general meeting will be held at Bath.

THE NEW "DESTROYERS" NOW BUILDING.

THE following list comprises the whole of the new type of "fast destroyers"—forty-eight in number—now building to the order of the British Government by the different firms mentioned. Messrs. Yarrow and Company will be fully engaged for months to come on foreign orders.

Messrs. Laird Brothers, Birkenhead.

	Knots.
Express	33
Wolf	30
Seal	30
Panther	30
Locust	30
Griffon	30
Ernest	30
Thrasher	30
Virago	30
Sparrow Hawk	30
Quail	30

Messrs. J. I. Thornycroft and Co., Chiswick.

Albatross	32
Cynthia	30
Cygnet	30
Coquette	30
Ariel	30
Angler	30
Mallard	30
Foam	30
Fame	30
Desperate	30

Messrs. Palmer and Co., Jarrow-on-Tyne.

Fawn	30
Flying Fish	30
Chamois	30
Crane	30
Bat	30
Whiting	30
Star	30
Flirt	30

Messrs. J. and G. Thomson, Clydebank.

	Knots.
Arab	30
Kestrel	30
Vulture	30
Recruit	30
Electra	30
Brazen	30

Messrs. Doxford and Sons, Sunderland.

Sylvia	30
Violet	30

The Naval Armaments Co., Barrow-in-Furness.

Avon	30
Bittern	30
Otter	30
Leopard	30

The Fairfield Shipbuilding Co., Govan.

Osprey	30
Fairy	30
Gypsy	30

Messrs. Hawthorn, Leslie, and Co., Newcastle-on-Tyne.

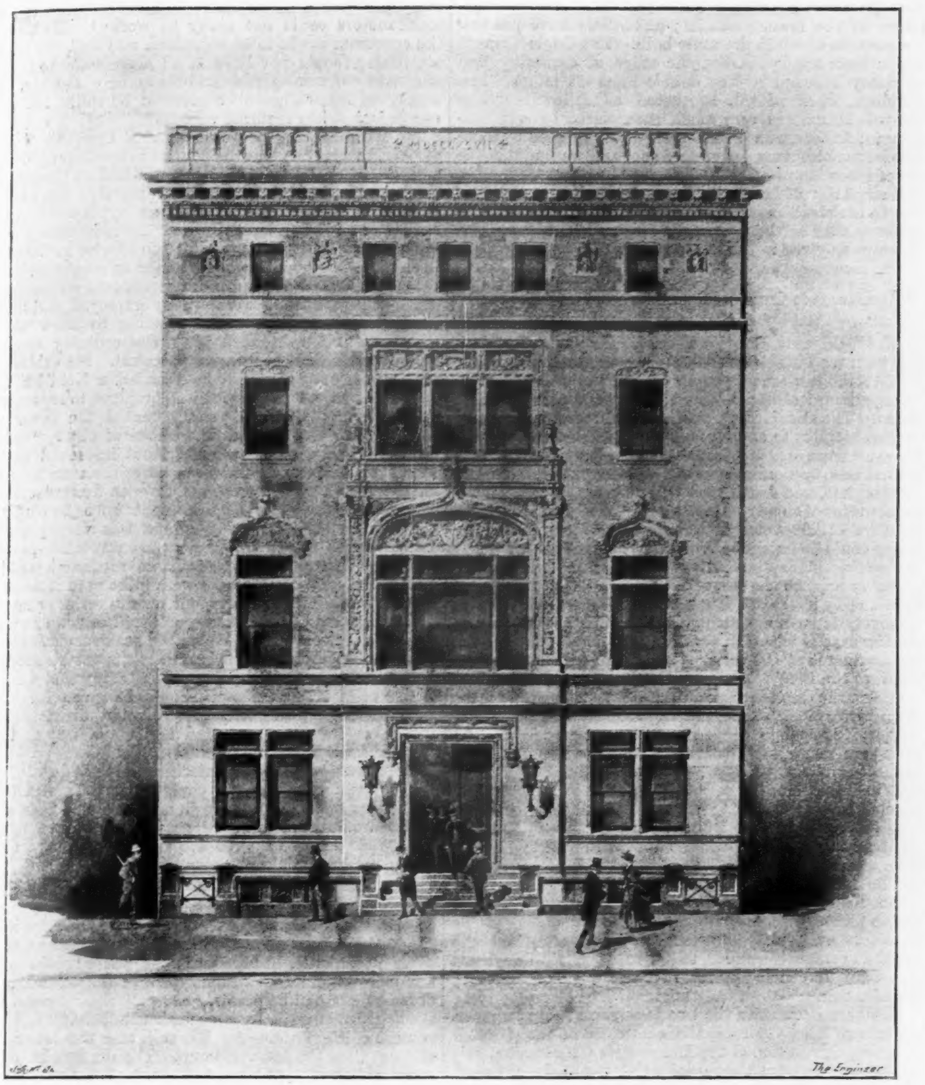
Mermaid	30
Cheerful	30

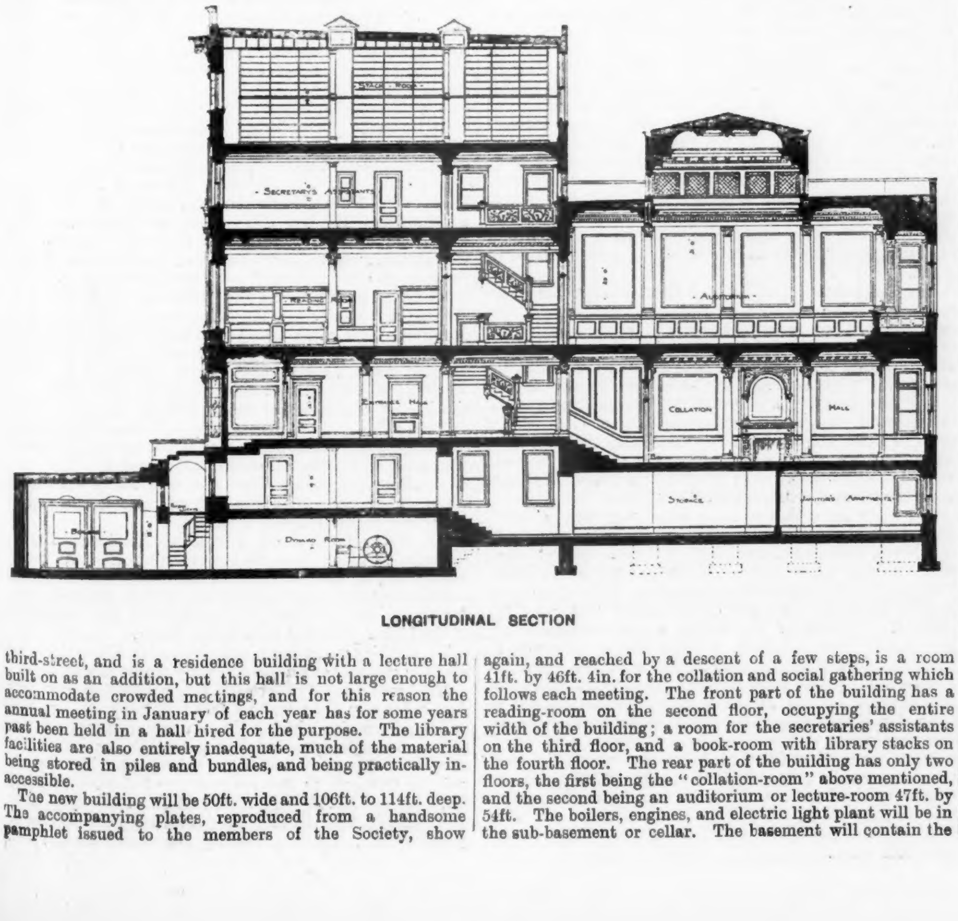
Earle's Shipbuilding Co., Hull.

Bullfinch	30
Dove	30

KING'S COLLEGE ENGINEERING SOCIETY.—At the last meeting Mr. Standen read a paper on "The Great Western Railway." The author commenced by a brief summary of its history, which was followed by a description of the first stage of the railway, Paddington to Bristol, all the important structures, such as the Wharncliffe Viaduct, the Maidenhead Bridge, and the Box Tunnel being referred to. He then gave a brief description of the works at Swindon, showing three types of engines on the screen. In the second division Mr. Standen dealt with the South Devon Railway, showing how Brunel constructed his line along the seashore, and explaining the atmospheric system as there used. This was followed by a description of the great bridge at Saltash, and an illustration of trestle work viaducts was shown. The author then dealt with the South Wales portion of the line, alluding to the "battle of the gauges," and the proposals for crossing the Severn. The Lydbrook and Crumlin Viaducts were described at this point, followed by the Chepstow Bridge over the Wye.

THE NEW HOME OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS





LONGITUDINAL SECTION

NEW HOUSE FOR THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

THE American Society of Civil Engineers, whose headquarters are in New York, has recently purchased a site and approved plans for a handsome new building on West Fifty-seventh-street, as it has long outgrown the capacity of its present building. The present building is on East Twenty-third-street, and is a residence building with a lecture hall built on as an addition, but this hall is not large enough to accommodate crowded meetings, and for this reason the annual meeting in January of each year has for some years past been held in a hall hired for the purpose. The library facilities are also entirely inadequate, much of the material being stored in piles and bundles, and being practically inaccessible.

The new building will be 50ft. wide and 106ft. to 114ft. deep. The accompanying plates, reproduced from a handsome pamphlet issued to the members of the Society, show the street elevation, and a longitudinal section. The main floor is raised a few steps above the street level. On the right of the vestibule and hall are the secretaries' rooms, while on the left are a reception-room and a coat-room. Beyond these is the main stairway hall, lighted from a narrow court on each side, while a toilet-room opens from one corner and the coat-room from another. Beyond this again, and reached by a descent of a few steps, is a room 41ft. by 46ft. 4in. for the collation and social gathering which follows each meeting. The front part of the building has a reading-room on the second floor, occupying the entire width of the building; a room for the secretaries' assistants on the third floor, and a book-room with library stacks on the fourth floor. The rear part of the building has only two floors, the first being the "collation-room" above mentioned, and the second being an auditorium or lecture-room 47ft. by 54ft. The boilers, engines, and electric light plant will be in the sub-basement or cellar. The basement will contain the janitor's rooms, and also ample accommodation for storing books, records, stereotype plates, &c.

The architect is Mr. G. L. W. Eidlitz, whose plans were accepted from among twelve sets of competitive plans. The site cost £16,000, and the estimated cost of the new house is £18,000 for the building and £2000 for furnishing.

THE CONVENTION OF THE MUNICIPAL ELECTRICAL ASSOCIATION.

AFTER the delivery of the presidential address, which we published last week, the business of reading the papers and discussing them was proceeded with. We were glad to find that each author only read a very brief summary of his paper, it being taken for granted that all members had had time to read the advance proofs.

The first paper was by Mr. A. S. Barnard, the borough electrical engineer of Hull, and the subject was

"ELECTRICITY SUPPLY AT 220 VOLTS."

We have not space to reproduce the paper verbatim, but shall summarise the chief points. The author pointed out that nearly all systems include networks of distributing mains, maintained at about the same pressure as required by the lamps on the consumer's premises; he, therefore, dealt chiefly with the advantages and disadvantages of the use of 220 volts on the distributing mains, without dealing with the vexed question of supply. It should, in the first place, be remembered that it is not to the much-discussed new regulations of the Board of Trade that we owe the beginning of a new era, in which 200 to 220 volts will be the accepted standard of pressure for incandescent lamps, as 100 to 110 volts is at present. The regulations did not produce the lamp, but it naturally followed that as engineers were considering the advisability of adopting the higher potential, that they should have been anxious to secure liberal clauses in these regulations, which should allow the use of 220 volts on the three-wire system, involving 440 volts between the outer cables. In the end they were mainly successful, but there are qualifications and conditions which will, in some cases, prove almost insuperable difficulties in the way of changing over an existing system.

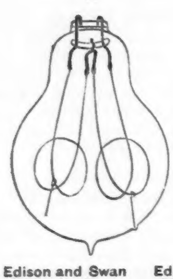
Whatever doubts exist as to the benefits to the consumer of the higher voltage, there can be no question of the immense gain to the supply works by its adoption. In the first place, should the Westinghouse Company succeed in its application for a renewal of the three-wire patent, some stations having three wire networks at 110 volts may find it worth while to discard their middle wire and adopt a two-wire 220-volt system rather than continue to pay royalties on their mains. Briefly the advantages of the change will be as follows:—(1) Existing mains can supply twice as many customers, at the same time reducing the percentage of loss in the cables by one half. (2) Variations and fluctuations due to the switching on or off of motors or large groups of lamps, or carelessness in switching dynamos in or out at the station, are all reduced by at least one-half. (3) New customers can be supplied at a much greater distance from the station. After a station has been in operation two or three years the mains are usually overcrowded, and as electric light becomes more and more regarded as a necessity and not a luxury, this matter will entail very heavy expenditure. It was thought that the same end would be attained by the use of 110-volt lamps, which should take half the current which they now do for a given light. At present the most efficient 110-volt lamps take 2½ watts per candle-power, and the best 220-volt lamps in the market about 3½ watts, that is to say, the 220-volt lamps will consume about 40 per cent. more current than the high efficiency 110-volt lamps. Most people, however, prefer the 3 to 3½ watt lamps, which last longer and do not cause the annoyance of burning out so rapidly. No complaints of the 220-volt lamps have been received in Hull, where a number is in use. The author thinks 2½ watts per candle-power lamps will soon be produced for 220 volts.

Passing to the second point, the reduced variation of pressure, the author gives numerical examples, showing that if a person has a motor now worked at 100 volts, it will, of course, take only half the current if supplied at 200 volts. At starting it may cause a "jump" in the neighbouring lights of perhaps 4 per cent. of the pressure, but on the higher potential this will only cause a flicker due to 1 per cent. drop. Then there is the "coefficient of personal error," which makes itself felt if an attendant switches a machine in parallel with others, at say, 3 per cent. to 5 per cent. above the normal pressure. This error would be reduced to one half on the higher potential of, say, 200 or 220 volts.

With regard to the third point mentioned, the advantages to be derived are very obvious. A station distributing at 110 volts on a three-wire system can supply an area of about one square mile, or, say, an area of half a mile radius. Beyond this distance the cost of the heavy feeders and distributing mains is almost prohibitory, and the point is soon reached where it pays better to adopt a high tension system with transformers. To what distance it is possible to supply economically at 220 volts can hardly be said to be settled yet. Mr. Addenbrooke, in his recent paper before the Institute of Electrical Engineers, claimed that a 220-volt three-wire system could cover an area of 25 square miles from one station. As regards improvement in regulation, if the present condition of things in most towns, having a supply over an area of about one square mile from one station, be the best obtainable at 110 volts, it would seem that too much loss has been allowed in the distributing mains, and the error should not be repeated when the area is being extended. The author would not care to recommend the attempt to supply much more than four square miles from one station or sub-station, and this could be done in the case of many existing stations by doubling the pressure, using mains, which cost little over half as much as the mains laid in the business parts of the town, and yet reducing the loss and variation of pressure at the lamps to half the percentage obtaining at present. The new area would not, of course, be nearly equal to the present area in the number of lamps connected per yard of mains laid, and whatever basis be taken for calculating the sizes of mains in the business part, it should be quite safe to take two-thirds or even half of that figure as the basis for mains laid in streets of villas, private houses, &c.

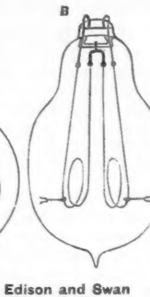
At Bradford, as stated by Mr. Gibbings, the new station is designed to supply an area of about nine square miles on the three-wire system with 230-volt lamps. Districts at a greater distance, in an area of about seventeen square miles, will be supplied from the same station by means of motor transformers. This arrangement is practically the same as that recommended by the author for Hull.

A



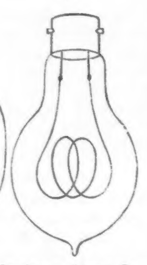
Edison and Swan
200 volt, 16 c.p.,
first type

B

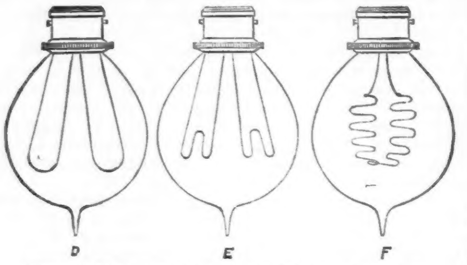


Edison and Swan
220 volt, 16 c.p.,
new type

C

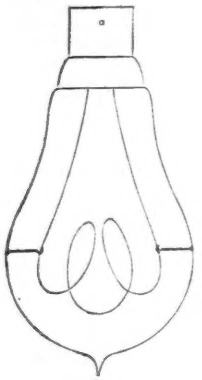


Sunbeam Lamp Co.
16 c.p., 220 volt



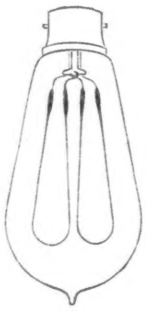
Stearn's high voltage Lamps—Zurich Incandescent Co.
8 or 16 c.p., 220 volt.

For new stations, of course, capital outlay on mains can be largely saved. The author considers that installations designed for 100 or 110 volts pressure when changed over to 220 volts, run very little, if any, extra risk; the reduction in current quite balances the objection to the pressure being doubled. Certain little American switches, which are largely in use at Hull, get perceptibly warm with a 32-candle power 110-volt lamp, but keep quite cool and sparkless with a 220-volt lamp of the same candle-power. The author considers that with attention to the details of fittings, such as fuses, switches, and ceiling roses, wiring at 220 volts will be just as cheap and rather safer than at 120 volts. One difficulty, however, is with consumers who wish to use single arc lamps or to be able to switch off arc lamps separately, a man will do without a lamp rather than be obliged to have four lamps in series. Perhaps it may be possible to arrange a set of four very small arcs in series in one globe. For street lighting the 440 volts will be a distinct advantage. With respect to incandescent lamps, one firm has brought out an adapter by which two 8-candle power are used in series instead of one 16-candle power at the lower potential; and others have put two filaments in series in the same bulb. The single filament lamps have hardly reached the stage of durability and efficiency attained by the double filament lamps. Mr. Gibbings, of Bradford, is quoted as follows:—"The 230-volt lamps are very much appreciated by our consumers; in fact, we are continually being pressed by those who have not changed over to do so, and we find that the life of these lamps comes out if anything better than the ordinary 115-volt lamps." The author thinks that this is due to the steadier pressure supplied rather than to the better quality of the lamps. We reproduce illustrations of lamps as given in the above paper.



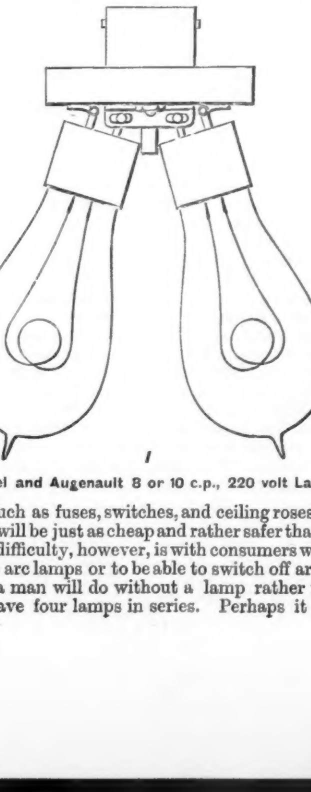
G

Fuller and Company
220 volt, 16 c.p.



H

Cruto high voltage Lamp
Cruto Incandescent Lamp Agency



I

Gabriel and Augenault 8 or 10 c.p., 220 volt Lamp.

The second paper,

"Alternating Current Stations and High Voltage Lamps,"

by H. W. Couzens, Borough Electrical Engineer, Taunton, was then read in short abstract. The author remarks that it is to the low-tension engineer that we owe the high-voltage lamp, although this appears a contradiction in terms. The standard practice for high tension alternate current work is to employ transformer sub-stations, with a low-pressure distribution to consumers; but this hitherto has not been economically practicable in scattered residential districts, and distributed transformers have been the usual means of supply. He points out that with a declared pressure of 200 volts at the consumers' terminals, the mains could be extended four times as far each way, and the saving in capital outlay on the transformers will probably balance the cost of the low-tension network, and the stand-by losses of a number of small transformers with relatively large magnetising currents will be wiped out. A rarer case is where sub-stations are employed and the distribution is at 100 volts. On the two-wire system the pressure can then be easily doubled.

Where the distribution from the sub-stations is on the three-wire system at present, the 200-volt lamp is still of service. Straggling consumers may be picked up, and there are many installations which it would pay to connect at 200 volts although not at 100 volts. Reduction in initial cost is of great importance, and can be effected by this change. At present all the demands for high voltage lamps are from the direct-current stations, and alternate-current engineers appear to have taken very little interest in the matter. The new Stearn M-shaped double filament lamp gives a useful and pretty effect when lighted, and the 8-candle power lamp is also a success, though the importance of this size of lamp is, he considers, over-rated at present, for it is very difficult to get the average consumer to be satisfied with anything less than 16-candle power in these days of increased illumination.

The discussion upon the two papers was taken together. Alderman Higginbottom, the chairman of the Electric Lighting Committee of the Manchester Corporation, said he rose to represent the ratepayer's view of the question. He believed if such a body as the Municipal Electrical Association had been in existence at the time of the Board of Trade Conference in Westminster, that a number of points could have been settled. The President, in his address, had raised a question as to the advisability of having separate committees to deal with particular points, the speaker thought joint committees were best. In Manchester the Electric Lighting Committee does not touch the streets. Is it right to build up a large reserve fund out of the ratepayers' money, and not to reduce the price of the current? Of course, a renewals account is very necessary, but in Manchester after 5 per cent. profit had been made, it was necessary to reduce the price of the current. A contingent fund was permitted up to 10 per cent. of the total capital, and after that, profits must be distributed in some way. Should municipal buildings be charged less than ordinary buildings? He thought not, and they were not so charged in his city. Then as to income-tax. Why should they be obliged to pay when the profit was made by the city for the ratepayers? A municipal electric light station should not be a sort of training school whence their engineers should pass to other towns, and in order to retain their officials good salaries and adequate bonuses should be given.

The Chairman of the Bedford Electric Lighting Committee gave an account of the work in Bedford, and said they had had great difficulties to contend with, but they made a profit last year of £90, all costs included except paying back the instalment of loan and interest—the period within which the loan was repayable was twenty-five years. The committee had had applications for reduced charges for Sunday lighting of chapels and churches, and they were now considering the question, which was one of some difficulty. He thought it would be well if representatives of corporations could have seats upon the Council of the Association.

Mr. Jackson said the lamp efficiency was a most important matter, and should be carefully considered. A 100-volt lamp was more efficient than a 200-volt lamp and a 50-volt lamp more efficient than a 100-volt lamp. The gas industry was now endeavouring to compete more keenly, and the price per candle-power was very important. He believed Mr. Stearn, a lamp manufacturer, had stated that the high voltage lamps were not so economical to the consumer as those of 100 volts. A 4 or 5-candle power lamp was not possible at 200 volts. The question should be taken up by the Association, as the value of the different types of incandescent lamps was very important.

Mr. Carson thought that 220 volts would be very advantageous for outlying districts. If the Westinghouse Company obtained a renewal of the three-wire system patents it would be a bad thing for the supply companies, and payment could be avoided by putting lamps across the outer wires.

Mr. Rider, of Plymouth, was amused to see the low-pressure engineers going in for high-pressure so eagerly; it seemed as though they were following the alternate current system as much as possible. If 220 volts were used the consumer with a single arc lamp must be given up, and small motors could not easily be worked. He thought the consumer ought to be consulted, and that the supply companies should not have it all their own way. The alternate current system was extremely flexible, and supply to houses could be given at 50 volts, 100 volts, and in fact at any required voltage.

Mr. Wordingham, the City Electrical Engineer of Manchester, said his city was the pioneer in the use of 400 volts, and the fact of the use of that potential had led the Board of Trade to raise their standard of low-pressure. They had no difficulty in the supply as yet, although very few of their customers had 200 volt lamps in use. He must utter a warning as to the wiring; it would not do to wire for 200 volts in the jerry way which was now so often employed for 100 volts he had made a number of experiments with ordinary china fittings, such as were usually employed, and he had brought the remains to the meeting to show to the members. He contended that the ordinary crockery would not stand the increased potential. He exhibited a single pole cut-out which had carried a No. 30 S.W.G. tin wire, and he had put on 60 ampères to represent a short circuit; with 200-volts potential the cover was broken. He also showed a number of other "relics," proving clearly, as he thought, that improved fittings would be necessary. In some cases the terminals and all the metal work were fused into an irregular mass. The point which had been brought up as to single arc lamps and 8-candle power lamps was very plausible. The five-wire system in Manchester was a low-pressure system, and gave 100 volts, and two arc lamps could be used in series. If 220 volts were to be used it need not become a question of using four arcs in series or none at all, for it was obvious a great number of consumers would object to use four arcs. He should get over the difficulty by putting in a pair of balancing direct-current transformers across the mains, and he was now advising that a supply of 200 volts or thereabouts should be given for purely incandescent lighting in the residential districts. The apparatus should be arranged in such a way as to be suitable for a given pressure.

Mr. Stearn, a lamp manufacturer, rose and stated that the opposition to the movement in favour of 220-volt lamps was gradually dying away. There had been a few short circuits, but precautions must be taken against risks. He believed the relative risks in the case of the three best-known illuminants were:—

Electricity.	Gas.	Oil.
1	10	40

So that they could very well allow for a slight rise in the risk without even then approaching to the risks of the other illuminants. There was no reason why the use of a higher potential should necessitate the abandonment of lamps of 8-candle power. He entirely disagreed with the suggestion made by one speaker that the 50-volt lamp is more efficient than the 100-volt, and the latter more efficient than the 220-volt lamp. The diminution of the cross section of the filament does not affect the life of the lamp. Filaments of 2 mils. diameter last as long as those of 50-volts, but of course if the cross section is decreased and the filament made abnormally long, it must have some mechanical support. There was no need to abandon either the 8-candle power or even the 5-candle power. Lamps of high efficiency had been strongly advocated by the speaker, but, as a matter of fact, the bulk of those in use consumed from 3·7 to 3·9 watts per candle-power. An 8-candle power lamp at 3·7 watts per candle-power and 200 volts pressure lasts well and is quite satisfactory; for 10-candle power and 16-candle power lamps an efficiency of 3·0 to 3·2 watts per candle-power could be obtained at 200 volts. He thought it was undesirable to attempt too high efficiencies at first, they should begin with lamps which would give perfect satisfaction. For pressures of 200 to 230 volts 16-candle power lamps could be made to take from 3·2 to 3·3 watts only, and these were now obtainable, but engineers should begin with lower efficiencies at first.

Mr. Gibbings, the Borough Electrical Engineer of Bradford, said that the arc lamp question was, of course, a difficulty. He had 379 private arc lamps upon his mains, and he had just ordered a special machine, and was about to use a third wire so as to be able to balance the load on each side, and keep two arc lamps in series between the third wire and the mains carrying the 230 volts. He had carefully tested the efficiency of 220-volt lamps constantly in the last two years, and found that at first they gave 1-candle power for 3·7 to 3·8 watts, and after burning from 2000 to 3000 hours they still gave an efficiency of 3·5 watts per nominal candle-power, although the actual candle-power had fallen to one-half of its original value. He would be able to discuss this portion of the question much better a year hence, as he now had 385 consumers using 230-volt lamps, many of them being of small candle-power. The fact was, many customers asked to be put on to the 230-volt circuit, instead of remaining on the 115-volt circuit.

Mr. Stewart, Borough Electrical Engineer, Derby, remarked that he thought the explanation of the statement made by the last speaker, as to the preference of consumers for 230-volt supply, rather than 115 volts, was due to the fact that the meters registered less accurately at the higher potential than at the lower.

Mr. Gibbings, Bradford, replying to Mr. Stewart, stated that the meters read quite correctly with 230 volts.

Mr. Arnot, the City Electrical Engineer of Glasgow, said that in his city they had no 200-volt lamps in use yet, and the discussion which had now arisen as to the relative efficiencies of lamps of various potentials, reminded him of what a Glasgow doctor told him about Mr. Swan's visit to Glasgow in the early days of electric lighting. Mr. Swan exhibited his lamps, and the same objections were brought forward and difficulties raised as were now brought forward about the high-pressure lamps, and he—Mr. Arnot—had no doubt all these points would soon be surmounted. He believed the 200-volt lamps would be chiefly used in the future, and that the consumption of energy will be materially less than 4 watts per candle. The same discussions had taken place as to the relative economies of high and low-pressures to steam boilers, and he believed that pressures of 300 lb. per square inch were now being used. Sir Courtenay Boyle would doubtless see that the regulations of the Board of Trade precluded the possibility of such results as those shown by Mr. Wordingham in his samples. He should be very glad to see all the crockery which was now scattered about the house cleared off the walls, and put in some safe places. It was no good arguing as to the relative advantages of high pressure or low pressure, alternating or direct current *per se*, each was best for certain districts, and it was for the electrical engineer to decide which system was best suited to his own particular case.

Mr. Barnard then replied, and said he was glad to hear from Mr. Stearn that the opposition to the use of 220-volt lamps was dying away, and that lamps of small candle power could be produced. In Hull he proposed to use motor transformers. In Bradford it had been stated that only 180 eight-candle power lamps were in use. Upon this point we would remark that, from his own personal experience, he felt sure central station engineers are greatly deceived as to the number of low candle-power lamps in use on their circuits. If practice in the provinces at all resembles that in the metropolis, it is quite a common thing for the whole of the lamps in a house to be stipulated as 16-candle power in the specification; this is, of course, done so that there may be no dispute about the size of the wires, every lamp being wired as though for 16-candle power. The application forms are, we know, often filled up from the specification long before the wiring of the house is completed, and we believe it is on these application forms that station engineers rely for their data. The figures obtained from such forms are, however, entirely untrustworthy, as in many houses the bulk of the lamps are 8-candle power; in fact, it is a common thing for a consulting engineer to instruct the contractor to put in 8-candle power lamps throughout, and substitute 16-candle power lamps afterwards in case the consumer complains that he gets insufficient light. With respect to "crockery" being scattered about the house, we suppose Mr. Arnot meant cut-outs, and though this practice may still exist in Glasgow, it is very rarely met with in London. Distribution boards in proper glazed cases are the rule and not the exception.

Mr. Couzens then replied, and said that consumers buy lamps of 3·5 watts per candle-power, and like a lamp with a long life. He had made a number of experiments similar to those carried out by Mr. Wordingham, and had put a farthing into a lamp holder instead of the lamp so as to cause a short circuit; the results, however, were not like those obtained by Mr. Wordingham; in fact, the porcelain suffered no injury. He presumed that this was due to the fact that the alternate current arc did not persist so long as that produced by direct current.

In our next impression we shall conclude our report of the proceedings.

THE NUMBER OF PERSONS EMPLOYED IN COAL PRODUCTION in various countries in 1894 was as follows:—United Kingdom, 665,747; Germany, 299,627; Belgium, 117,103; France, 131,587; Japan (1893), 30,345; the United States (1893), 363,309; British India, 43,197; Canada, 9654; New South Wales, 9131; New Zealand, 1899; and the Cape, 1601.

GAS ENGINES IN ELECTRIC LIGHT STATIONS.—Considerable interest attaches to the statements of accounts of the Belfast electric supplyconcern, recently published. A total of 95,126 units have been generated, with a total consumption of 4,454,667 cubic feet of fuel gas from the town mains, or 46·8 cubic feet per unit generated. The price paid for gas was 2s. 3d. per 1000 cubic feet, or 1·26d. per unit generated. Of the total amount generated, 82,197 units were sold during the hours when the charge is 7d. per unit, and 574 units in the time when 4d. per unit was charged, this is 87 per cent.; and deducting from the remainder the 3822 units used on the works for lighting, starting the engines, &c., the residue represents a loss of only 9 per cent. of the total generated. The energy wasted in the batteries has been 6304 units, and in the mains 2229 units, figures which correspond respectively to 6·7 per cent. and 2·3 per cent. of the total generated. Accordingly, the consumption of fuel gas per unit sold has been 53·7 cubic feet, the cost of which has been 1·45d. The cost of lubricating oil, waste, circulating water and stores, was 0·202d. per unit generated, or 0·232d. per unit sold. It cannot be alleged that either of these figures is excessive. Higher figures are, the *Electrician* says, often reached in steam-driven stations. In fact, the total generating expenses have not exceeded 2·82d. per unit generated, or 3·24d. per unit sold, figures which are not unreasonably large for a station of the size of that at Belfast.

THE LONDON WATER SUPPLY.—In giving evidence before the Hybrid Committee of the House of Commons engaged in the consideration of the London Water Companies' Bills on Wednesday, Sir J. Pease presiding, Mr. R. E. Middleton, M. Inst. C.E., recalled, said that, inclusive of the powers already possessed by the water companies, they would, under the Bill, be able to take 149,000,000 gallons of water per day from the Thames. As the Bill stood, the three companies who were party to it would be able to take 100,000,000 gallons a day from the Thames so long as the flow over Bell Weir was not reduced below 250,000,000 gallons, and what they did not use of the water they so took they could sell to other water companies. They had no intention of doing anything of the kind, but no doubt the joint committee would be the first mortgagees of the water coming over the Bell Weir over 250,000,000 gallons per day. The case of the Conservators of the river Thames, who were opponents of the Bill, was afterwards proceeded with. Mr. C. H. Moore, engineer to the Conservators, declared that the six London water companies had power to take 130,000,000 gallons of water from the Thames per day, but as a matter of fact on single days they had exceeded that amount by 10,000,000 gallons—a serious thing when they bore in mind that the flow of the river had sunk on a certain day in 1877 to 180,000,000 gallons. He thought the companies should not be allowed to increase the amount of their daily intake from the river. Mr. Fitzgerald addressed the committee on behalf of the Thames Conservators, insisting that the companies should not be allowed to sell the surplus water taken from the Thames to other companies, and that whatever fresh water they took they should pay for at the same rate as they paid for their present intake. The case of the London County Council was then submitted. Mr. Dickinson, chairman of the Water Committee, and formerly deputy-chairman of the Council, who was the first witness, gave a history of the London water question, and declared that the scheme of the present Bill, if passed, would prejudice the settlement of that question in the future.

THE MANUFACTURE OF STERILISED BUTTER.

THERE is probably no industry in which this country has been so far outstripped in the race of progress by foreign ingenuity as that of butter-making, and it behoves our dairy farmers to look around them, if they would desire to win back for our own home trade some part of the thirteen or fourteen millions sterling which annually finds its way on to the Continent and to our Colonies for the purchase of butter. Dairymen, even in this country, have for some time past become alive to the necessity of employing what may be termed up-to-date appliances, and we now see those beautiful examples of mechanical ingenuity for separating cream from the milk by centrifugal force almost universally employed. That these appliances are almost solely due to the inventive genius of our continental friends cannot be seriously disputed; and while, on the one hand, this is a matter for regret, on the other it is some satisfaction to know that the net result has been to place this important industry on a far surer and more scientific basis.

Ever since it has become generally recognised that one of the most essential factors in preserving health is the purity of food, scientists have turned their attention largely towards the sterilisation of foods which are generally consumed uncooked. Milk usually undergoes this process before consumption, but butter has baffled ingenuity to devise some method of freeing it from its microbes, which are equally as detrimental to health as those contained in milk. The reason for this is that butter cannot be raised to the required heat, *i.e.*, 160 deg. Fah., for destroying its microbes, without ceasing to be palatable; and it has again fallen to the lot of a Swedish gentleman, Mr. Gustaf Salenius, to sterilise, or, as it is termed on the Continent, "pasteurise" butter by means of a machine which he has invented, and which has for some time been at work with perfectly satisfactory results in Sweden. To this appliance the inventor has given the name of "Radiator," from which it will at once be surmised that centrifugal force again plays an important part in the process. The advantages claimed for pasteurised butter are two-fold: It is conducive to the preservation of health, and its keeping qualities are greatly increased, the latter being a consideration of the greatest importance to the dairy farmer. The chief considerations which Mr. Salenius has had in view in designing his butter-maker are as follows:—First, the production of a very fine, uniform butter, with great keeping qualities; secondly, the importance of obtaining the largest possible yield of butter or cream from the milk; thirdly, the convenience of installation of the machinery in a small space, and facility of management, together with simplicity of the parts and ease of removing and cleaning them; and fourthly reduction in the number of dairy hands required.

Fig. 1 herewith represents a sectional elevation of the "Radiator" butter-maker, and Fig. 2 on page 616 is a photographic reproduction of a complete plant for producing pasteurised butter, which was shown at work at the recent Bath and West of England Agricultural Show. Briefly, the machine consists of a cast iron stand A, a skimming bowl N, churning chamber R, and three tin-plate covers introduced one into the other. The stand comprises a flat base connected with the body, holding the skimming bowl by two uprights, one of which supports the bracket B. The two legs are connected by three crosspieces D, E, K, provided with brass bushes. In the lowest crosspiece D, a footstep bearing is provided for supporting the driving spindle F, with its pulley G. This spindle F is connected with the bowl spindle L by a coupling H, and the bowl spindle passes up through the cast iron body containing the skimming vessel, being supported on ball bearings M, which are kept thoroughly lubricated by the oil tube shown. On the top of the spindle L is a collar which carries the bowl N, and the top of the said spindle is turned up to a cone shape, and fits into a hole drilled in the whole milk distributing basin. Above this cone is placed the inlet cone or pillar S, open at both ends, and through the top of which the whole-milk enters. The upper open end T of this pillar constitutes the cold water distributing cup, the water being conducted to it by a pipe X, surrounding the whole-milk inlet tube V, while wings provided on the pillar support a number of step-shaped cooling plates P. The wall of the cold water distributing cup T is pierced by six holes *l*, to which are fitted an equal number of tubular cooling frames U, placed all round the inside of the churning bowl R. After passing through these the water falls into the cold water receiver *i*, from which it is led away by means of a spout. The churning bowl is fixed on the skimming bowl N by means of a special joint shown. The skim milk is discharged from the chamber N into the receiver *k* by means of six small bent tubes *n*, and from this receiver it is again discharged by the spout *q*. The cream passes up into the churning chamber through an opening *m* in the bottom, and spreads itself in a thin layer on the surfaces of the coolers U, where its temperature is rapidly reduced to that suitable for churning operations.

The churning tube Y is provided with a handle shown, so that the sharp-edged mouthpiece at its lower end may be brought into or thrown out of contact with the layer of cream. When in contact the cream enters with some force into the churning tube, where it is subjected to repeated concussions, which cause agglomeration of the butyrous globules in suspension. It is then passed out of the tube by way of a number of small holes about $\frac{1}{16}$ in. diameter, and being violently projected in fine sprays against the layer of cream produces butter, which rises and passes in a granular form through openings at the upper edge of the chamber into the receiver *g*, where automatically operated scrapers *h* collect the produce and drive it out of the spout *p*. By throwing the mouthpiece of the churning tube out of contact with the layer of cream by means of the handle above mentioned the cream escapes unchurned through the same spout. It will thus be seen that the radiator can be utilised either simply as a cream separator or simultaneously as a separator and churn. *b* is the colour feed apparatus, *c* the thermometer,

Fig. I.

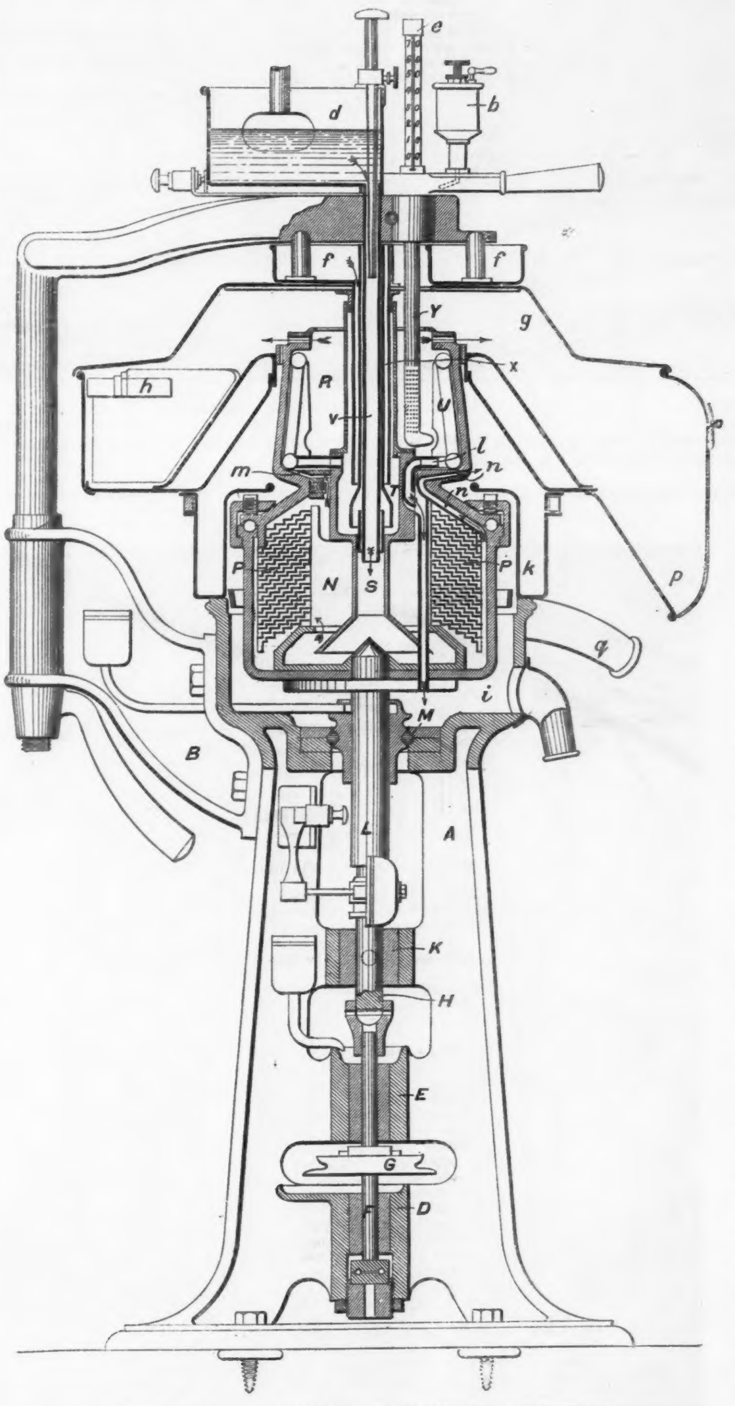
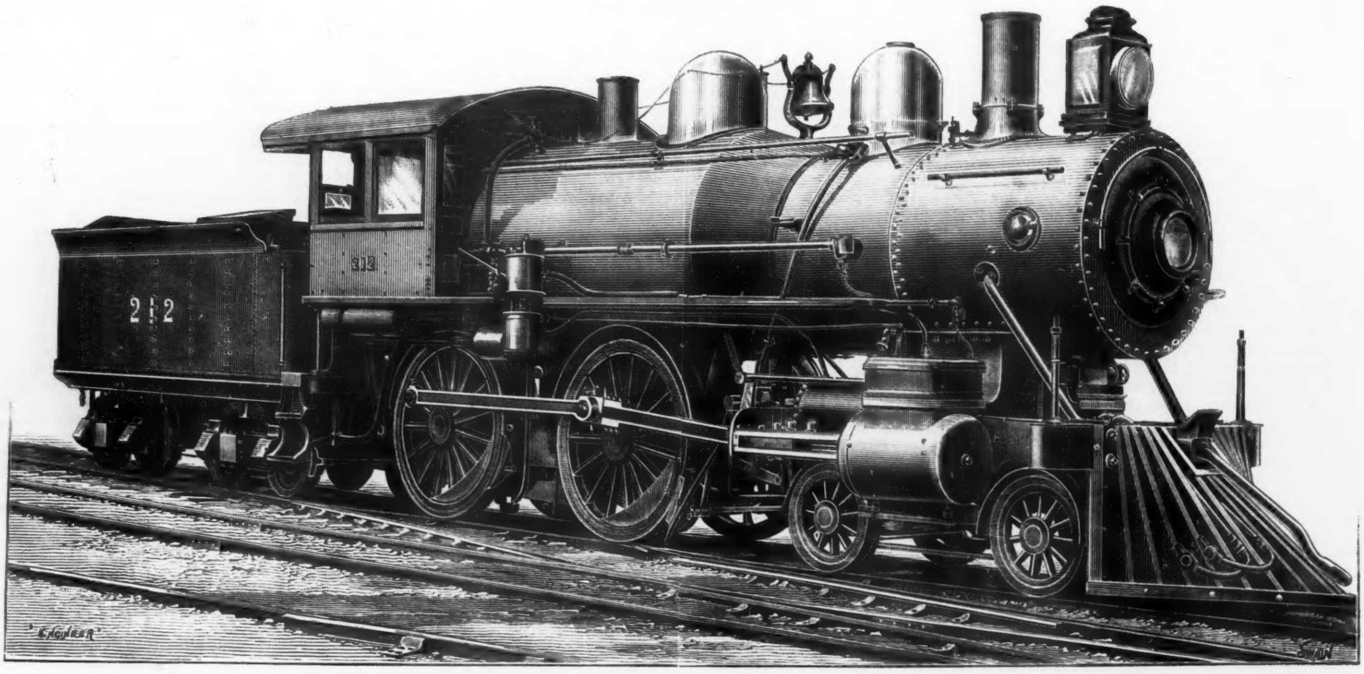


Fig. 1—SECTIONAL ELEVATION OF RADIATOR BUTTER-MAKER

EXPRESS LOCOMOTIVE, BOSTON AND ALBANY RAILROAD, U.S.

(*For description see page* 622)



and *d* the whole milk inlet trough wherein is collected the milk as it comes from the pasteuriser, while *f* is the cold water inlet trough.

Fig 2, as above stated, represents a complete plant for making pasteurised butter, the radiator being shown in the foreground, while on the stand behind it is the pasteurising tank W, in which the whole milk is heated up to the desired temperature, *i.e.*, 160 deg. Fah., before being admitted into the top of the radiator. Behind this tank W is the water tank X^1, from which the cold water jackets are fed by a centrifugal pump. The skim milk from the radiator is discharged into the tun dish shown, and is forced by another centrifugal pump through the pipe X^3 into the cooler X^2. When the milk in the pasteuriser has reached the temperature of 160 deg., and the radiator, after being started, has attained the speed of 6000 revolutions, shown by a speed indicator, the supply cocks for the cooling water and whole milk are opened; one minute after that, the granular butter, impregnated with its buttermilk, issues from the butter spout, and is collected in an open butter tub. It is easy during the working to vary the consistency of the cream by adjusting the whole-milk feed inlet, as well as to maintain unchanged the desired churning temperature, by increasing or reducing the water supply to the tubular frames in the churning bowl. Although in the drawing the radiator has a somewhat complex appearance, it is comparatively simple in construction, and can easily be taken to pieces for cleaning, while the plant required for driving a complete pasteurised butter apparatus capable of treating 200 gallons of milk per hour need only be sufficient to exert about four horse-power. This system of butter making has been extensively used in Sweden for about two years.

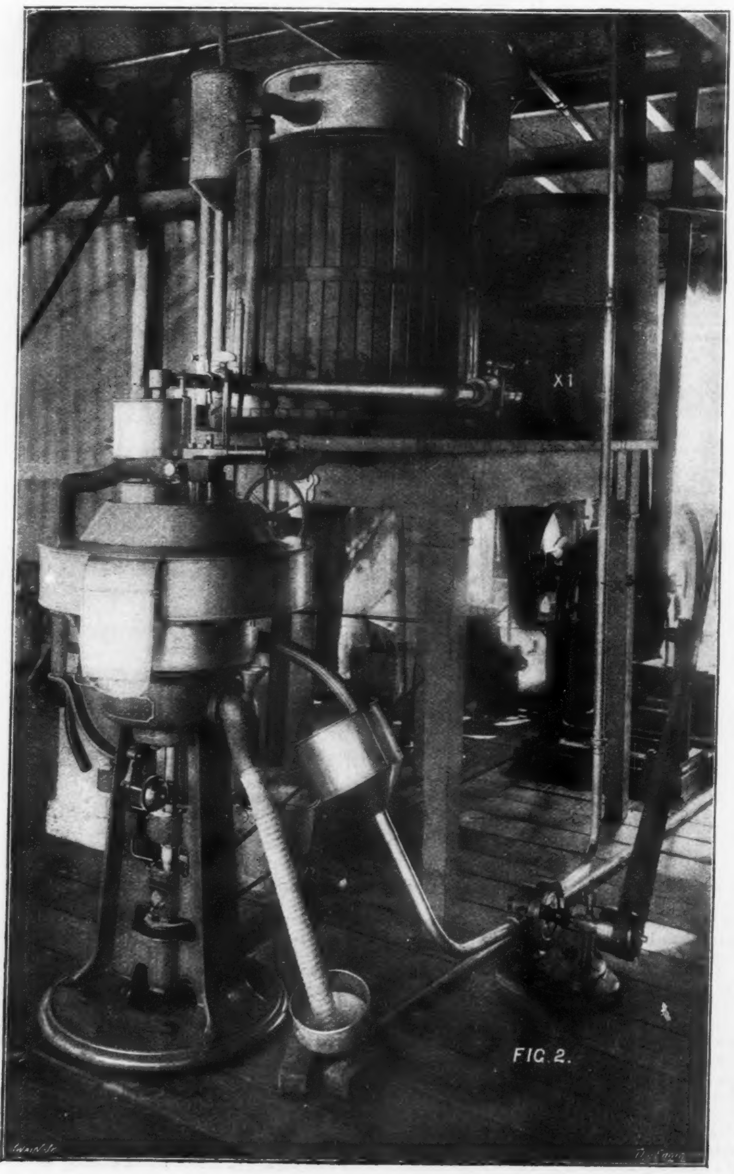


Fig. 2—STERILISED BUTTER-MAKING PLANT

The following is an abstract of a report to the Minister of Agriculture in Paris of trials of the radiator, made by MM. H. Friant and V. Houdet at the Practical Dairy School at Poligny in July last:—

"From a mechanical point of view the radiator is a very ingenious and perfectly constructed machine, which works with irreproachable regularity. In spite of the high speed with which it revolves, and the absence of any foundation, it works silently and without vibration. The mode of mounting it is most simple, and in every way within the reach of our dairy servants. Its starting presents no difficulty, the preparations and precautions are the same as for other centrifugals. From an industrial point of view the radiator indisputably offers important advantages. The space necessary for its installation is only a room 17ft. square, including space for accessory work. The labour is reduced to a minimum. Two persons, in fact, suffice for attending—one to the boiler and engine, the other to the radiator and its necessary appliances, dividing between them the butter working and the cleaning. The radiator can operate either simply as a cream separator, producing pasteurised cream, which can then be soured by addition of lactic ferments, or at all times of the running it can operate simultaneously as skimmer and churn. In the operation of cream separating, the degree of clean-skimming is as high as is practically possible. We do not know any centrifugal which, on this point, is superior to the radiator. The churning is as complete as possible, and does away with the anomalies incident to the souring of cream. In none of our comparative trials has the yield of butter by the radiator been exceeded by that of the procedure ordinarily used.

"The whole-milk is pasteurised, skimmed, and its cream churned while almost completely protected against contact with the air, a very favourable condition, which is not obtained with any other method of manufacture. During the running the pasteurised cream is instantly brought down to a suitable temperature, which is kept constant by regulating the admission of cold water. By this means one avoids the previous heating and cooling of the cream, and also the faults in the butter itself caused by the raising of the temperature, which invariably takes place when using ordinary churns. Not only is the work continuous, but one can control all its stages rapidly during running, within the following limits of temperature—from 85 deg. to 160 deg. for the skimming, and from 54 deg. to 68 deg. for the churning.

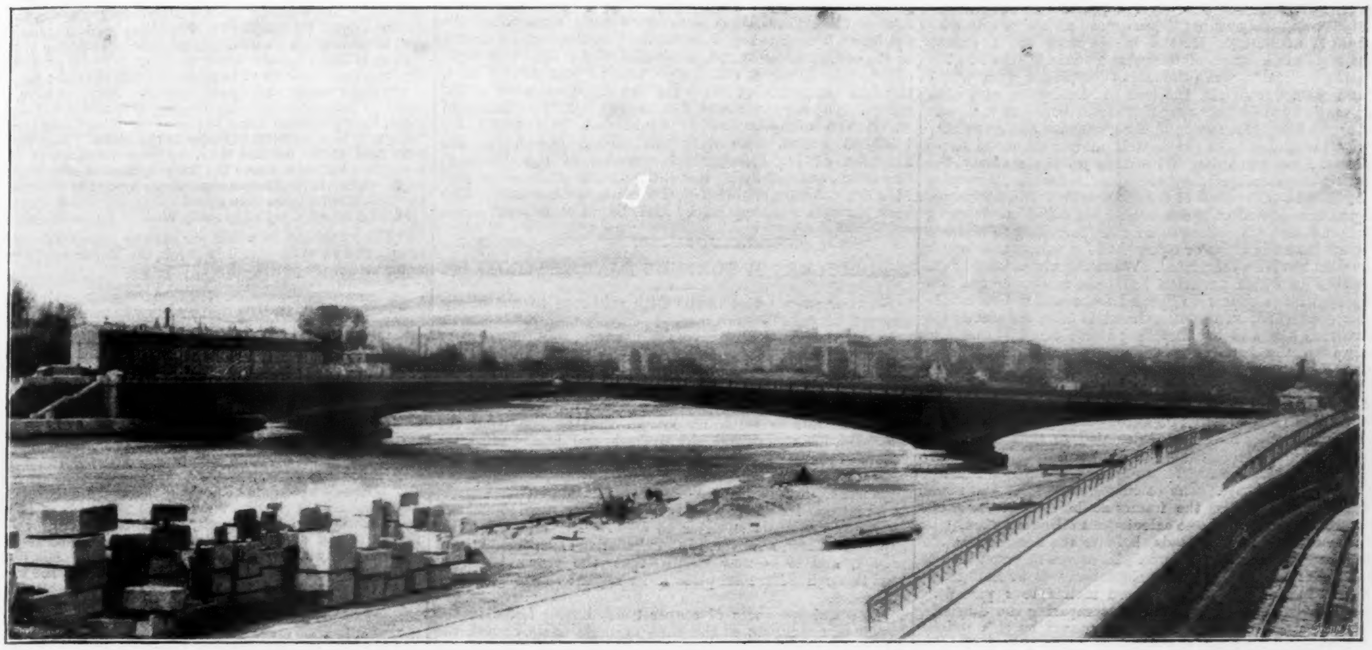
"As regards the quality, the butter leaves nothing to desire, although the cream has not been soured; it is, besides, rendered independent of any special skill on the part of the attendants. The butter is homogeneously plastic, fine, and of good consistency; has a fresh flavour, a delicate aroma, and, owing to the pasteurisation of milk, it has keeping properties which we have in all cases found superior to those of butter made by the usual processes, and a safety in being used as food all the more valuable, as butter, once produced, cannot be sterilised. In conclusion, the radiator gives, economically, excellent work, with a minimum of buildings, of implements, of labour, and of time. It has consequently its place indicated in dairies of some magnitude, notably in those which work for export."

The Société Nordenfelt, 8, Rue Auber, Paris, are the agents for this system as regards England and France.

THE BIRMINGHAM ASSOCIATION OF MECHANICAL ENGINEERS.—At the half-yearly meeting of the above Association, held on Saturday last, the following gentlemen were elected members of the Council:—Messrs. W. Greenup, C. Proctor, F. M. Martin, and W. Holt, vice Messrs. F. S. Green, W. H. Winn, W. Deakin, and Arnold. Mr. W. Arnold was elected auditor vice Mr. C. Hill. The President, Mr. C. Hazel, announced that arrangements had been made to visit Messrs. Siemens in July.

MASON COLLEGE, BIRMINGHAM.—From our advertisement columns it appears that Professor R. H. Smith has resigned his engineering professorship in Mason College. We learn that Professor Smith intends to devote his energies in future entirely to practical work. The restrictions placed upon the development of the engineering school in Birmingham have for some years inclined him to leave it, and the latest arrangement are such as he does not feel he can share the responsibility for. Nevertheless the school has had considerable success. The engineering students of Mason College supply 35 per cent. of the fee-income of the seven scientific departments of the College, and 21 per cent. of that of the fourteen science and art departments forming the whole College, while the engineering expenditure in proportion to income has been much below the average throughout the College. The school has attracted numerous pupils from every quarter of the globe, and a considerable portion of its past students are, we are informed, now in management of important works not only in England, but in many other countries. These students will hear with regret that their *alma mater* is now to pass under other management.

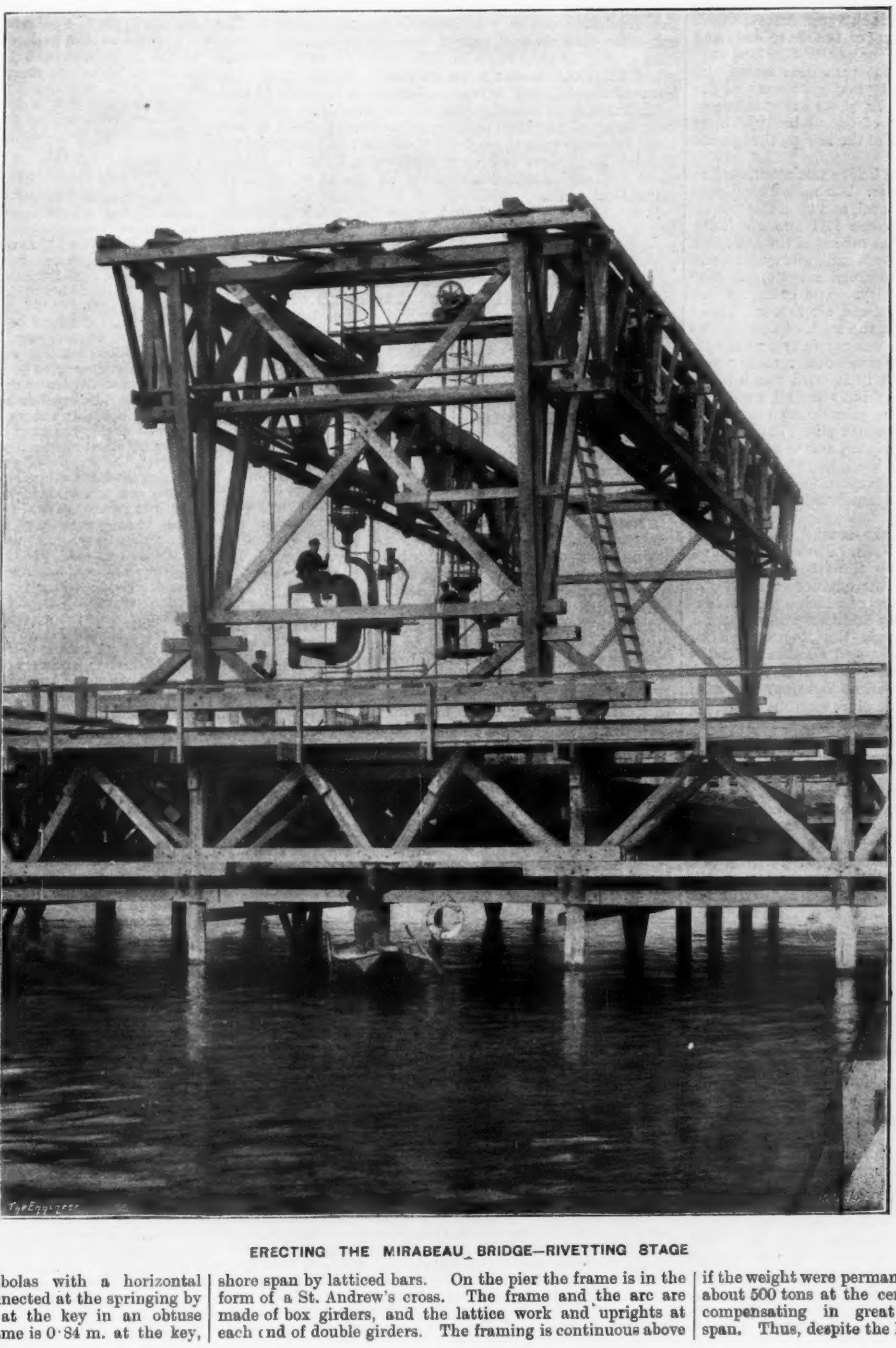
THE MIRABEAU BRIDGE OVER THE SEINE



THE MIRABEAU BRIDGE.

THE particulars we published in a recent issue of the Mirabeau Bridge, which has been constructed across the Seine in Paris to connect the districts of Javel and Auteuil, may be supplemented by details that are not without a certain interest. The main feature of this bridge is the novelty of its design, which has had to meet the special requirements of the traffic in the neighbourhood, both vehicular and water-borne. The conditions laid down were that the approaches to each end of the bridge were to be sufficiently easy to permit of the traffic crossing it without difficulty, at the same time that the structure did not cause any impediment to the passage of vessels. These have been carried out with entire success by the cantilever bridge designed by M. Résal, chief engineer of the Ponts et Chaussées. With a central span of 306ft. and two travées or arms of 106ft. 6in. each, measured between the masonry. The bridge has a width of 65ft. 8in. between the parapets, the roadway itself being 39ft. 5in. wide. The metallic superstructure rests upon two piers, which are founded on a stratum of hard chalk at a depth of 37ft. 4in. on the left and 36ft. on the right of the river. The masonry of the piers is built with Portland cement concrete set off with Cherbourg granite, while the abutment is constructed with hydraulic lime concrete. The superstructure is composed of seven rolled steel frames placed at distances of 3 m. from each other under the roadway and of 3·72 m. under the pavement. The cantilever is made of two equal halves resting upon the pivots and connected at the centre by an articulation, while they are fastened to the abutment by anchoring bolts. Each half river span has a length of 163ft., measured from the pier pivot to the key, and the culasse or shore span measures 122ft. 9in. from the pivot to the extremity. The height from the pier pivot to the centre of the bridge is 20ft. 3in.—see engravings on page 618. The upper part of the cantilever is rectilinear, with an inclination on the horizontal of 0·02 m. per metre. The lower part or the arc has the form of two semi-parabolas with a horizontal axis. These parabolic arcs are connected at the springing by rectilinear elements which meet at the key in an obtuse angle. The height of each half frame is 0·84 m. at the key, 0·50 m. at the end of the shore spans, and 5·35 m. on the piers. The top frames and the arc abut on the same frame at the two ends of the cantilever. At the key they are connected by vertical castings at distances of 2 m., and at the end of the shore span by latticed bars. On the pier the frame is in the form of a St. Andrew's cross. The frame and the arc are made of box girders, and the lattice work and uprights at each end of double girders. The framing is continuous above the pier, and the ends of the arcs are fixed on a steel pivot or balance. This balance is composed of two plates or tables on which the soles of the arcs are bolted, and a central piece with a double heel and collars which support the soles, while the combination rests by means of a half cylinder upon a steel cushion let into a cast iron bed in the granite. The articulation of the key is formed by means of a double series of steel pieces, some being merely plates riveted to the ends of the cantilevers, and the others male and female joints which bolt the cantilever together. The anchoring of the ends of the shore spans is effected by vertical rods, of which the upper parts are fixed in the box girder of the abutment, and the lower part to the trunnions fixed to the cast iron cushion which is fastened to the embankment by four bolts. These bolts pass within the thickness of the abutment and are anchored to an iron framework in the masonry. The pier beds and cushions of the culées are all fixed in cement. The frames are connected together at the level of the arc by latticed girders, by] sections at the right of the vertical uprights, and by girders forming part of the bridge at the upper part. The top of the shore spans is built up on brick vaults set with cement, and that of the river span is constructed of steel plates of 10 mm. in thickness riveted on to the frames. The roadway is paved with wood. The pavements on the shore ends are supported on plates strengthened by double girders let into a thick bed of concrete, and on the river span by plates riveted on to Zorè's sections. The space between the girders which connect the upper part of the frames and the plates supporting the pavement has been left free to permit of the laying down of water and gas pipes. The piers of the bridge are to be adorned by bronze figures, which have been modelled by M. Injalbert, and are now being turned out at the foundries of MM. Thiébaut Frères.

The principle of equilibrium upon which the bridge has been designed is a very simple one. Under the action of a symmetrical weight the two sections of the river span are subjected to a horizontal stress, which if the weight were permanent would be very small, somewhere about 500 tons at the centre, the weight of the shore spans compensating in great part the weight of the river span. Thus, despite the lowness of the central arch, it has



ERECTING THE MIRABEAU BRIDGE—RIVETTING STAGE been possible to give to the piers the moderate transverse dimension of 10 m. Under the influence of loads on the river span the stress increases, and it can attain to as much as four times the stress produced by the permanent weight alone. The temperature also has the effect of causing a fluctuation in the pushing strains, and this brings into play the jointed anchorage. If the bridge were not anchored in this way, an elevation of temperature would result in the key rising vertically, while the end of the shore span would fall and pull away from the axis of the bridge, and each frame would turn slightly round the articulation of the pier. A fall in the temperature would, of course, result in an exactly opposite movement. As the vertical movement of the shore end would have the effect of breaking up the roadway, the anchoring rods compel the bridge to rise without causing any horizontal movement of the shore ends. The anchorage thus produces the effect of a vertical force, sometimes working in one sense and sometimes in another, according to whether the temperature is above or below that for which the length of the rods has been calculated. When the temperature rises above that for which provision has been made, the reaction of the anchorage causes an upward force and the thrust increases; but when, on the other hand, it falls, the traction is a downward one and the thrusting strain diminishes. The pressure on the foundation under the permanent charge alone is 5 kilos. per centimetre at the weakest point. Under the most unfavourable conditions, when the river span is loaded and the temperature is at a maximum of 40 deg. C., the pressure increases to 14·5 kilos. The different parts of the metallic frames have been calculated so that under the most unfavourable conditions of load and temperature the stress on the steel at its weakest part will not exceed 10 kilos. per square millimetre. The calculations were at first made on the supposition that the frames at the ends of the shore spans would be free. These calculations offer no difficulty in the case of symmetrical loads, because the mutual reaction merely causes a horizontal force. To secure an exact idea of the effect of the anchorage, a calculation was at first made of the influence of a weight of ten metric tons placed at the end of the shore span, and, by comparing the displacement of the end of the shore span caused by this weight with that resulting from the different loads that had been calculated for, it was easy to estimate in each case the reaction of the anchorage on the girders and the effect produced by this reaction. It was then only necessary to add this effect to the results obtained upon the hypothesis of the end girders being free. The influence of the temperature was ascertained by the same means, first by supposing the end girders free, and then calculating the reaction of the anchorage. The same scheme of calculation can be employed to ascertain the effects of dissymmetric charges. An estimate is first made of the raising and lowering of the shore ends and of the key of each half girder, upon the assumption that they are isolated, under the action of the presumed forces, and then the calculation is corrected by taking account of the holding together of the frames. In these calculations no account is taken of the rigidity of the plates, which, of course, adds greatly to the strength of the bridge, though the proportion is not easy to ascertain.

The construction of the Mirabeau bridge was sanctioned in 1893, and was begun in the same year. The metallic caissons were put together on the quay at Javel, and then floated out on the river and sunk. Each caisson had two air locks, one for the labourers and one for the raising of the extracted soil. The first of these was upon the Montagnier system, and the others upon the Zchokke and Terrier systems. The caissons were lighted with electricity. The extracted soil was sent to the surface by a compressed air motor. When the caissons reached the solid chalk, the work of sinking was stopped, and the working chamber was carefully filled with concrete. The sinking of the caissons and masonry was carried on so that their level varied little with the level of the water. The upper masonry was built up all round, to serve as cofferdams to permit of the piers being completed. The first caisson was dropped on August 8th. The work of sinking was commenced a fortnight later, and was completed on October 24th. The first granite block was placed six days afterwards. The sinking of the second caisson took place immediately after the first, and the same machinery was used by carrying the compressed air pipes along cables stretched across the river. The sinking of the second caisson lasted from November 10th to December 30th. The compressed air was supplied by engines placed on the right bank of the river, the installation comprising four engines of a total of 60-horse power, four air compressors, of which two were low-pressure machines, upon the Sautter and Lemonnier systems, for the working chambers, one upon the Roy system for working the compressed air motors, and another upon the Burkhardt system was held in reserve. There was also a small motor and dynamo for the electric lighting. In order to avoid condensation and ice in the pipes crossing the Seine, the air for the caisson on the left bank was heated on the right bank pier, and the air for the motors was mixed with steam. The work of erecting the metal superstructure was begun on September 1st, 1894. The programme of the work necessitated the completion of the first half of the bridge before the winter of 1894-95, so that in the event of high water or of ice interfering with operations, the shore spans could be loaded and the metallic frames rendered independent of the centres. The erection was carried on by means of a travelling crane with a reach of 26 m. Starting with the articulation of the pier, the shore spans and a part of the river span were constructed, and then the river span was completed. The soles of the arcs were first bolted on to the balances, and the collars for tightening them were not put into place until the frames were for the most part completed. The riveting was done partly by hand and partly by a hydraulic machine. A compressed air pump and an accumulator were placed on the Javal quay. The erection of the first half of the bridge lasted from September 1st, 1894, to January, 1895. The removal and reconstruction of the centres lasted from February 26th to April 23rd, 1895, and the erection of the second half of the bridge, begun April 13th, was completed on August 24th, 1895. When the two halves had been constructed, the bridge was regulated, which operation consisted in bringing the two extremities of the bridge in line and in placing them at the required level and in measuring the thickness of the wedges on each arc between the articulation and the frames. Once the wedges were prepared, the ends of the bridge were raised with screw jacks. The wedges were then put in position, and the screw jacks removed, the ends of the bridge thus falling in contact at the proper level. Having thus got the bridge into position, the other work of laying the plates, and paving, &c., was rapidly proceeded with, and the bridge was opened to pedestrians on December 5th, 1895. The work of construction thus lasted for about eighteen months, though it was only lately opened to vehicular traffic. It had previously been submitted to very exhaustive trials lasting a week, when heavy loads were drawn over the bridge under every possible condition, and the way in which it stood the test gave entire satisfaction. The bridge will not be formally opened until the bronze ornaments have been placed in position. The quantity of metal used in the superstructure of the bridge was 2744 metric tons, of which 2077 tons were rolled steel, 385 tons rolled iron, and 82 tons forged steel, the rest consisting of metal for the ornamentation of the bridge. The cost in round figures was 2,067,000 francs, of which the metallic superstructure was responsible for 1,235,000 francs. The work was carried out under the direction of M. Rabel, chief engineer of the Ponts et Chaussées, assisted by M. Résal, the author of the plans, and M. Alby, ordinary engineer of the Ponts et Chaussées. The metallic work was supplied by MM. Daydé et Pillé, of Creil.

THE BOILERS OF TORPEDO BOAT DESTROYERS.

SOME erroneous statements with reference to one of the new "destroyers"—the Sturgeon—having been made in the columns of a daily contemporary generally well-informed in naval matters, we think it desirable, in the interests of the Admiralty, the engineers, and the public generally to explain the reasons why this vessel, and some of the earlier vessels of the destroyer type, are being laid up at intervals.

It may not be generally known that at the time the Sturgeon, her sister ships, the Starfish and Skate, and some others of similar type were contracted for, the boilers of the vessels were, in accordance with the Admiralty specifications then issued, fitted with copper tubes. At that date copper, as a material for boiler tube heating surface, was considered by many engineers superior to steel. The fallacy of this supposition has, however, from exhaustive experiments, been proved, and it is now known that the transmission of heat through clean steel plate is as rapid as through plates of copper.

A few isolated cases of copper tubes having failed in the boilers of destroyers, at the time of their trials, caused the Admiralty officials to decide on replacing, as opportunity offered, all the copper tubes of such boilers by tubes of steel. The fact that coal containing sulphur has in active service been occasionally used to the detriment of copper, has been one of the incentives to the discarding of that material for tubes, and it has been now resolved by the Admiralty authorities that only steel tubes shall in future be fitted in all new destroyers' boilers, and that the existing copper tubes in such vessels shall be replaced by steel. As this resolution was only arrived at some time after the first orders for this class of vessels were given out, the change from copper to steel tubes in their boilers had to be postponed until the vessels were delivered. Before they were, however, handed over to the authorities a few rows of their boiler tubes most severely stressed—or those next the fires—were removed, and steel substituted by their makers, so as to enable them to pass through their official trials and continue running until time and opportunity were found to take in hand and complete the alteration at one or other of the Royal Dockyards.

It is satisfactory, therefore, to know that a commencement has already been made to refit the boilers of each of the torpedo boat destroyers originally supplied with copper tubes, with tubes of steel. The boilers of the Hornet have been so fitted, and those of the Sturgeon are now being taken in hand by Portsmouth Dockyard. The boilers of her sister ships built by the same company will in due time be dealt with, as well as those of the Rocket, Shark, and Surly.

That the Sturgeon is the reverse of "a failure," as stated by our badly-informed contemporary, is evidenced by the fact that she has been in commission since her advent until such time as the previously intended alteration in her boiler tubes could be effected. So far as the vessel and her propelling machinery, &c., are concerned, she has proved herself to be a success, the design and working of her engines and boilers being pronounced as most satisfactory by those best able to judge, viz., the officers who have been in charge of her. The Starfish, a sister ship to the Sturgeon, built and engined by the same firm, has just returned from a five months' commission without a defect list, her machinery, boilers, &c., having been reported as most satisfactory. Should, however, opportunity offer she will in all probability have her boilers retubed before being again commissioned. The facility with which repairs to the type of water-tube boiler—the Blechynden—with which the Sturgeon and her sister ships are fitted, can be effected, is probably the reason why these vessels have been first taken in hand for the substitution of steel in place of their copper water-tubes.

The Blechynden type of boiler has been adopted by Mr. J. S. White, of Cowes, who has fitted it to several vedette boats for foreign Governments, and notably in the 20 knot yacht Scud, illustrated last week, belonging to Mr. Wood, which has been running daily at full speed during the present yachting season, and has proved herself, for her displacement, to be the fastest yacht in the world.

LETTERS TO THE EDITOR.

We do not hold ourselves responsible for the opinions of our correspondents.)

HORSELESS CARRIAGES.

SIR,—With reference to your article in THE ENGINEER of June 5th on the horseless carriage competition, we ask your permission to mention one or two points in which you have scarcely done justice to the motor carriage industry. The majority of workers are naturally unwilling to court commercial failure by offering to the public imperfect and ill-considered machines. But the temptation to be first in the field, and the unusual facilities for obtaining public money at the present time, have proved too strong, and certain companies have already been promoted, whilst others are announced, advertising and exhibiting as commercial autocars machines which are totally unsuitable for general use.

The statement that the Crystal Palace and Imperial Institute contain "the very best horseless carriages in the world,"* does a serious injustice to the general body of workers, some of whom have overcome many, if not all, the objections to which you draw attention, but have prudently refrained from advertising a perfect machine before they have one.

It will point these remarks if we indicate very briefly what we ourselves—the Electric Motive Power Company—have done, leaving to others the task of vindicating themselves. As the result of three years' experimental work in electric, and more recently in oil motors, we have obtained results which we briefly tabulate:—(1) An oil motor using "white rose" American lamp oil, and producing less smell than the benzoline and gasoline motors at present being exhibited. (2) Absence of vibration when the carriage is at rest, the oil motor itself being arranged to stop and start again. (3) Absence of vibration while running, the motor mechanism—whether electric or oil—being entirely separated from the body of the carriage. (4) Connection of the mechanism to the driving wheel by means of a flexible coupling allowing play to the mechanism, and avoiding the noise and wear inseparable from a chain gearing. (5) Simplification of steering and regulating gear, so as to prevent the possibility of mistake or confusion in use.

Many of these improvements not being yet fully protected, it is of course impossible for us to publish details of them; but, in view of the great weight which your criticisms carry, we have thought ourselves justified in pointing out that, even within our own knowledge, the exhibitions which you mention do not fairly represent "the very best horseless carriages in the world." Had the contest been held at the original time, we were prepared to enter our carriages; but we welcome the postponement as affording time for improvements in the designs of autocars, a point to which at present too little attention has been given.

E. T. CLUBBE,
A. W. SOUTHEY.

16, Elm-street, Gray's Inn-road, W.C.

[* The statement to which our correspondents take exception means, and we think obviously means, the best carriages that have so far been made public.—ED. E.]

THE ADMIRALTY PROGRAMME.

SIR,—The Admiralty will soon be working out the programme for 1897, if they have not already started, and before it is too late I should like to put in a plea for another Vulcan. This ship has proved herself simply invaluable in the Mediterranean Squadron, where she acts as a sort of floating dockyard, and executes repairs of all sorts for the whole fleet, besides acting in her most important capacity as a torpedo depôt. Putting the Hecla on one side as totally out of date, the Vulcan is the only torpedo depôt ship we possess, and if anything were to happen to her, either in action, or in peace time through accident, her loss when we have nothing else to replace her would be nothing short of a national calamity. At a time like the present, when we are adding such numbers of those delicate and fragile craft, called torpedo destroyers, to our fleet, a second depôt ship to look after them and keep them in order is surely most necessary, and if we had one now to commission for the Channel Squadron, I have no doubt she would soon prove herself a most valuable addition.

I do not know whether we are to have any more first-class cruisers in next year's programme, but if we are, I would draw attention to a very weak spot in our present ships of this class, which seems to have attracted very little notice. The system of mounting 6in. quick-firing guns in casemates is most admirable, but what enemy is going to waste his time pounding away at 6in. Harveyised armour when a single shell placed under the casemate would blow the whole thing up? In our latest designs the casemate merely sits on the main deck, supported by a few web frames which run down to the protective deck, and which themselves have no protection of any sort. In our Terrible and Andromeda classes, if a shell were to burst under the forward or after casemate, it would in all probability disable two guns—the main deck and the upper deck, as they are directly over each other. There is a similar want of protection to the conning tower supports, and in the Terrible to the 9·2in. gun barbettes; even in our modern first-class battleships, though the casemate supports are protected by the belt, the conning tower, which is considered of so much importance that it is built of 14in. armour, is totally without protection underneath.

RETROP.

Helensburgh, June 15th.

LIGHT RAILWAYS.

SIR,—Referring to the letters of Mr. J. C. Mackay and Mr. J. M. Barker in your impression of the 12th inst., on the above subject, will your kindly allow me to give my experience? I think the best definition I have seen of light railways is that given by Sir Douglas Fox—printed in the "Minutes of Proceedings" of the Institution of Civil Engineers, vol. xxvi., page 49, and which I now quote:—"These—light railways—are either branches from existing main lines, or intended for districts requiring the development of their traffic, and should be constructed in a thoroughly substantial and durable manner, equal in their details as to quality to the best main lines, but with every part made only of such strength as to carry loads represented by the rule that no pair of wheels should be allowed to have more than six tons upon it—this would enable these lines to carry the rolling stock of all other railways of a similar gauge, with the exception only of the locomotive."

About twenty-five years ago I made a light railway in Buckinghamshire about eight miles in length—gauge 4ft. 8½in.; the line followed the surface of the land where practicable, the highest embankment and deepest cutting nowhere exceeding 11ft. or 12ft. There are no road bridges, but three public roads are crossed on the level; there are two brook bridges, or large culverts, each 10ft. span, the curves are easy, with one short one of 12 chains radius. The gradients are good, with one short length of 1 in 50. This line has junctions with the Great Western and London and North-Western railways, and consequently can use the rolling stock of these lines, excepting the locomotives. The maximum speed is limited to twenty-five miles an hour, but, as a rule, the speed seldom exceeds twenty miles per hour. The rails, 32 lb. per yard, are flat-bottomed bridge rails—steel topped—and laid on longitudinal sleepers, with cross ties at every 10ft. or 12ft. The entire cost of this line, exclusive of land, was £1400 per mile.

31, St. Julian's Farm-road,
West Norwood, S.E., June 15th.

WILLIAM LAWFORD,
M. Inst. C.E.

RHEA FIBRE.

SIR,—My attention has been drawn to a statement in your impression of the 12th inst., under the above heading, stating that "since 1883 several methods of treatment of 'Rhea' had been proposed, but none appear to have been applied commercially in this country." This is not correct, as this company has been engaged exclusively, for the last two years, in treating "Rhea," and in combing it, and spinning it into yarns of various counts, for which there is a large and ever increasing demand. The process we employ is that of Mr. H. H. Boyle, which we find both simple and effective. We shall be obliged if you can find space for this statement.

FOR MIDLANDS SPINNING CO., LTD.,
ELIAS NEEL, Manager.

Woodland Mills, Long Eaton, Derby, June 16th.

WALSCHAERT'S VALVE GEAR.

SIR,—It is agreeable and gratifying to see M. Walschaert's beautiful valve gear being accepted, applied, and adopted by a British firm after twenty-nine long years, as witness the engines of the Southend Belle and those of the new cross-Channel boats now running between here and Calais. I well remember in 1867 the drawings of Walschaert's gear being published, and my making a copy of them, and even then it struck me how superior it was to the clumsy, heavy, old link motion which still holds its own in this country, an opinion which has yearly become stronger up to the present date.

M. L.

Dover, June 15th.

PERMANENT WAY.

SIR,—In your interesting article on above important subject, you point out clearly why rails are not fastened to sleepers direct in this country, viz., on account of the softness of the wood used, into which the rails cut their way day by day from the constant concussion of passing trains, and the consequent slackening of fastenings.

It may interest railway engineers to know that by a new process the softest woods can be vulcanised and made as hard as oak, increasing both the strength of the wood, as well as the holding power of spikes, and at the same time preserving it against rot, and the attack of insects in land or water.

The process has had a severe trial of some years in America, and so satisfactory have been the results that the Manhattan Railway Company in America now has, not alone sleepers, but all timber used for whatever purpose, vulcanised.

It is being introduced into this country, a factory is being erected on the Thames, and in the course of a few months engineers will be able to avail themselves of a great boon. The process is much cheaper than, and far superior to creosoting, as it can be worked by tools, and it goes through and through the wood.

M. INST. C.E.

WIRE ROPE MANUFACTURE.

SIR,—In your issue dated 12th June you state in a paragraph that wire manufacturers and wire rope makers have seldom been more fully occupied. I assure you, Sir, you are in error, as I doubt whether either of the above-named industries have ever suffered such depression and want of orders as at the present time.

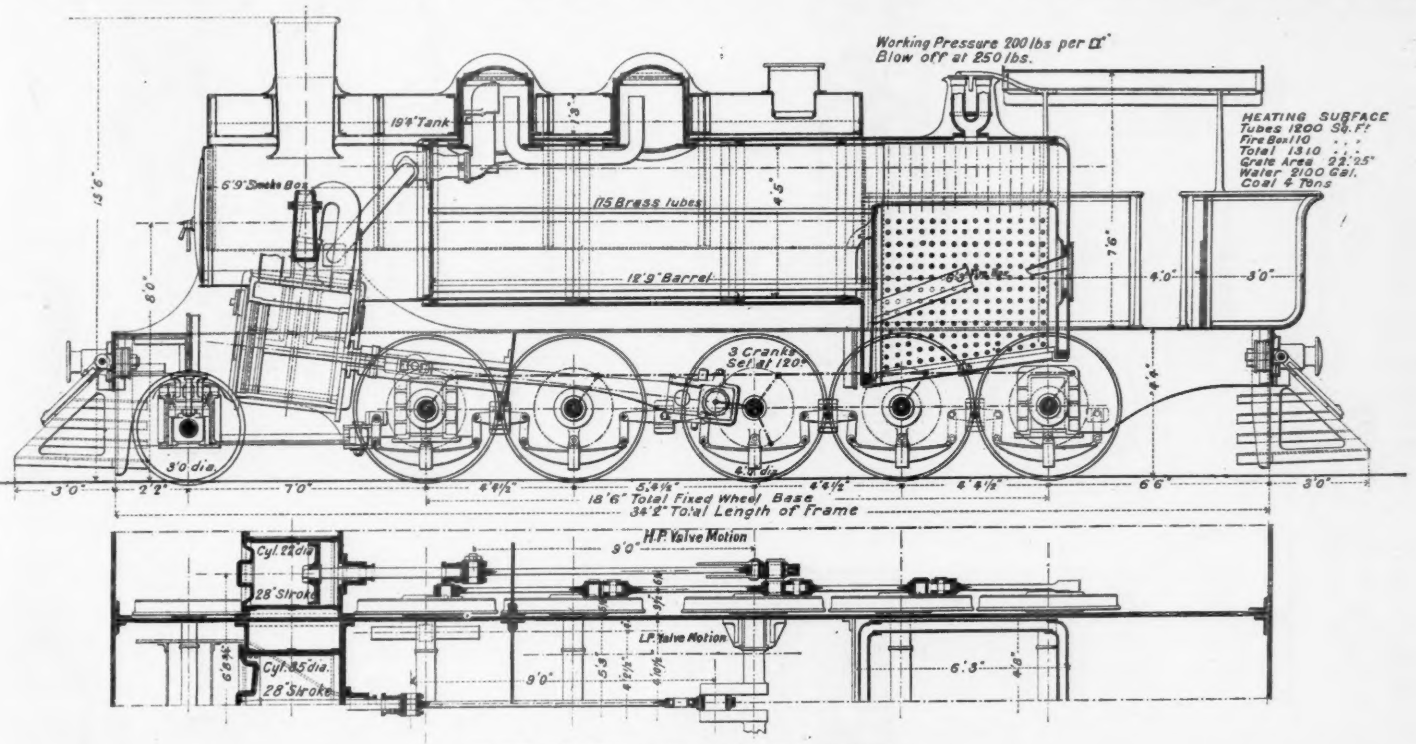
Why, I should have thought that the depressed state of the coal trade, the African trouble, and last, but by no means least, foreign competition—this I do not mean in England, but more particularly so in our continental markets—sufficient to contradict such an assertion. I am only too sorry that trade is not as you state.

June 15th. ROPE MAKER.

TRIPLE-CYLINDER LOCOMOTIVES.

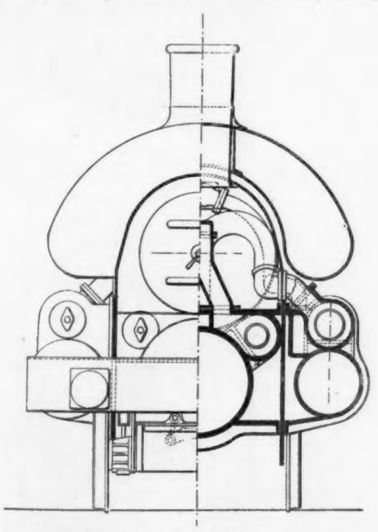
SIR,—Your article on the above which appeared in your issue of 13th March is, in my opinion, a step in the right direction towards making the compound locomotive a successful engine, but only in so far as the number of cylinders mentioned.

There appears to me to be no precedent to justify any one building a compound engine with three cylinders of one diameter as you suggest. Marine engines have been made with one high and two low-pressure cylinders; the latter, however, were not of the same diameter as the former.



RIEKIE'S COMPOUND ENGINE FOR STEEP INCLINES

To my mind the principal object in compounding is, or should be, to use up the steam to the lowest limit of pressure, in fact to get as much work out of it as possible before exhausting. Al condensing engines do this with success, and it appears to me, that to meet with any chance of success when compounding a locomotive engine, we must follow on the same lines; it may not yet be practicable to make a condensing locomotive, so as to work the steam down below atmospheric pressure; it is, however, practicable to work a non-condensing low-pressure cylinder with a steam pressure of 15 lb. to 20 lb., so that the outside low-pressure cylinders of the locomotive engine you suggest would require to be very much larger than 23in. to enable them to be worked with such a low pressure of steam to get economy, and at the same time exert nearly the same power as the high-pressure cylinder. I cannot conceive how three cylinders of one diameter can be successful as a compound; in the first place the exhausts would have to be at high pressure to get good work out of the low-pressure cylinders; moreover, the four exhausts would not be harmonious to the ear. The most difficult problem of all is getting equal work out of each cylinder, and this latter I look upon as a most important factor in a three-cylinder engine. It is true compound locomotives can be made to exhaust at 30 lb. to 40 lb. pressure and so effect a saving over the simple engine exhausting at a higher pressure; this saving, in my opinion, is not good enough. It is necessary to effect a more substantial saving, and I consider that two exhausts as low as 5 lb. to 10 lb. must be reached to make a compound locomotive the success it should be. There is no doubt that this can be accomplished.



CROSS SECTION

Like a few of your correspondents I also have made a careful study of compound locomotives. Many years ago I came to the conclusion that the two-cylinder locomotive was a most unmechanical machine, and I considered it advisable to effect an improvement in the principle of the same.

I took out a patent a few years back for an "Improved Locomotive" to turn the wheel on a constant fulcrum. I may here mention that I also sent an article to your paper in 1892, expecting to be able to start a discussion, and thereby prove to the mechanical world that the power used in turning a locomotive wheel was misapplied. Unfortunately I brought up the question of the fulcrum of the lever of a locomotive wheel—which I maintain is alternately at centre of axle and crank, pin during each revolution—this was sufficient to raise a hornet's nest, so I let the matter drop. I would here like to touch upon that discussion.

"Text-books" and able exponents explain that when the crank is below the axle the pressure on the crank pin tends to push the lever backward, &c. No wonder students are ever raising the question as to how the wheel is caused to rotate when such a fallacy is propounded. In my opinion no amount of thrust can have any such tendency.

Again, if a locomotive wheel is turned similarly to a stationary engine wheel, why is it that both practical and theoretical men are so divided in opinion as to the fulcrum of the lever? Not a few refuse to go into the question of leverage, and argue that the wheel is turned by alternate pressures on the axle-box and cylinder cover.

Now, to my mind it is this alternate pressure or alternate work done in turning the wheel that prevents it from being an efficient machine, and has thus far prevented it from being successfully compounded.

I will now make the bold assertion that a grave error was committed in applying two cranks to a locomotive engine. The minimum number that should have been applied is three, and these should be at angles of 120 deg. to one another, so that the work done in turning the wheel would be constant; in other words, the wheel would be made to rotate by a constant pull or push at a constant point of the wheel. Let any practical man consider the result of turning the wheel of a locomotive with both crank pins alternately above and below the axle; in the former case the pistons are pulling the wheel forward by the crank pins whilst the cylinder holds the axle, and in the latter case the pistons hold the wheel by the crank pins whilst it is pulled forward by the cylinder, and when it is considered that no amount of push on the crank pin can cause the wheel to rotate forward, he may agree with me that the two-cylinder locomotive is the most unmechanical machine of the nineteenth century; certainly, to my mind, a more unmechanical device cannot be conceived. Moreover, the result of having the cranks alternately above and below the axle as explained, necessitates balancing the same not by any accepted rule, but as each locomotive engineer may fancy. Again, when an engine is starting a train, the adhesion is greatest when the crank is below the axle, and it gets gradually less and less—when in this position—as the speed increases.

Engineers have for many years made a study of balancing the wheel to get the engine to run steadily. Their chance of success in this direction, in my opinion, is very remote if they still adhere to two cranks.

Railroad engineers have good ground for complaining about their roads being damaged when such conditions exist.

You mention that a 32in. low-pressure cylinder is the largest that can conveniently be put in an engine in England, and that 1245 square inches of piston area can be had from three 23in. cylinders, as against 1015 with one of Mr. Webb's present engines. Now, it may be; and I have no doubt that it is, impracticable to get larger outside cylinders on to a Webb engine, and so comply with the demands of modern practice. I, however, have patented a compound system, which enables me to get two 20½in. outside cylinders on an engine having a 32in. low-pressure cylinder. Such an engine would have 1464 square inches of piston area, and would consequently be considerably more powerful than the three 23in. cylinder engine. Moreover, I have the designs of a Ghat engine for a 5ft. 6in. gauge railway, which can have two 24in. outside high-pressure and one 38in. inside low-pressure cylinders, and which would have over 2000 square inches of piston area.

Accordingly, in plain words, I advocate a new departure from modern practice, and propose working expansively in two high-pressure cylinders, exhausting from both into the receiver during one stroke of the low pressure piston, delivering the steam at different parts of the stroke to the latter; keeping up a constant pressure, and getting over "receiver drop," instead of cutting off late in one high-pressure cylinder, and exhausting the steam at one gulp, and having a heavy drop. This may be opposed to the acknowledged practice of keeping up the temperature in the walls of the cylinder when cutting off late in the high-pressure cylinder; however, such an engine is at work in India, and gives satisfactory results. These results may be due to the fact that a wider range of expansion is obtained by this system, power for power, than that of any other, and which more than compensates for any loss due to condensation. I may mention that the maximum cut off in the high-pressure cylinders of this system is 50 per cent.

You imply that the compound system can only work to advantage with a load of 200 tons, fast speed, and long runs. I maintain that a compound engine, to be a success, must be able to do every kind of work that a simple engine can now do, and do that, too, more economically by 30 per cent. to 40 per cent. in fuel consumption. It may be said that a third cylinder enhances the wear, by adding more wearing parts to the machine. This, however, is not the case, the three cranks have the work now done by the two distributed between them; moreover, taking the knock off the axle-boxes does away with "pounding"—this improvement is applicable to any two-crank engine, stationary, or otherwise—an engine so constructed will run for months without requiring any repairs whatsoever, a very much different state of affairs when compared against the existing two-cylinder compound engine.

Not a few locomotive men will naturally be chagrined at the fact of a locomotive, with 5ft. 6in. wheels, having attained a higher speed than an engine with wheels of larger diameter. No doubt greater power can be developed with the small wheeled engine. If, however, an engine having wheels 9ft. diameter were built with a piston area such as I recommend, the result would be a higher rate of speed than anything yet attained. I will go a step further, and say that one type of engine, with 7ft. wheels, should be powerful enough for all kinds of work from slow heavy goods to fast mail trains.

The question may be asked, what about a boiler for such an engine? Well, a slightly larger one might be required for the 24in. and 38in. cylinder engine, but for the 20½in. and 32in. cylinders a boiler no larger than the ones now in use on the Great Western Railway would be necessary; indeed, the same volume of steam would be used, but over larger areas. A very important improvement in my proposed system is, that the power of an engine would be so increased that either two 17in. or 18in. outside cylinder, with inside ones to suit, would be able to do more work than is now done by a 20in. cylinder engine, the result would be a substantial saving in fuel consumption and wear and tear to machinery. The enormous wear that now takes place with two-crank engines, when put to heavy work, requires to be seen to be realised. A fair example can be had from engines working on 1 in 25 grades; it is true, on the level this may not be so apparent. All the same, from my practical experience, I should say that the Great Western Railway engines are very heavy in repairs, and I have no hesitation in saying that had three 16in. cylinders been used instead of two 20in., a better engine would have been the result, and it would have paved the way for successfully compounding the locomotive engine.

I should recommend small-wheeled engines to be kept for grade climbing. An engine with 4ft. wheels, having a piston area of 2000 square inches, would be the most powerful engine yet made, and as the exhaust could be reduced to a pressure of 10 lb., or even less, the engine would not only be economical in fuel consumption, but also in wear and tear to machinery and boiler.

I send you the prints of a "Mail and Ghat" engine, and which you may be pleased to publish with this.

JOHN RIEKIE,
Dist. Loco. Sup. N. W. Railway, India.

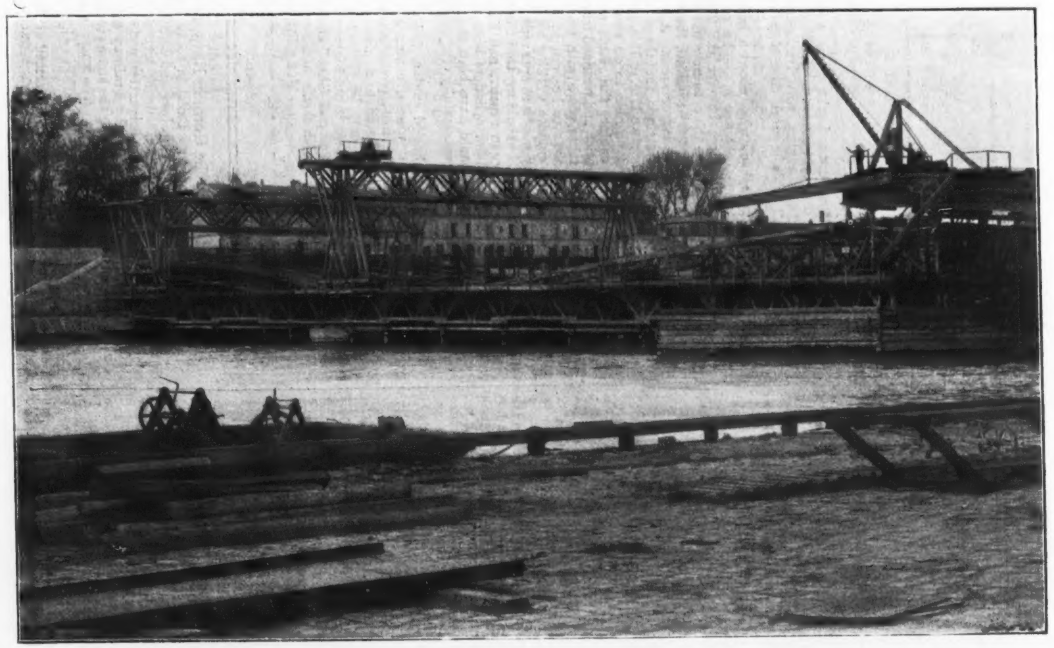
Sukkur, May 5th.

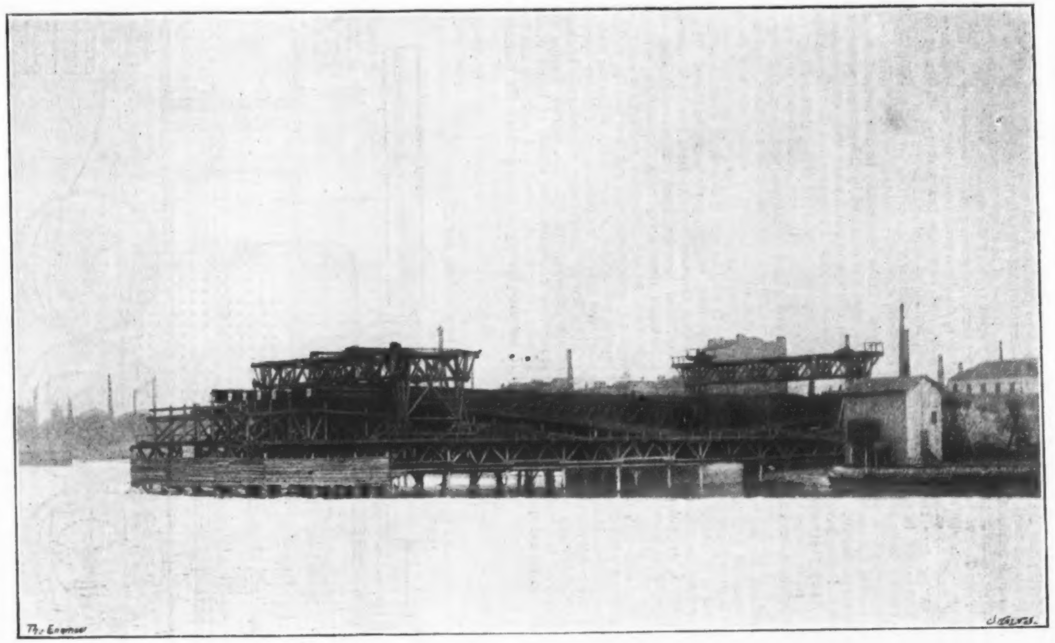
A COALING station for the German Navy at the eastern mouth of the Emperor William's Canal is to be begun shortly. The coal stores, which will be 570ft. long and 65ft. broad, are to be on the south side, close to the harbour for torpedo boats. They are intended both for coals and briquettes, and will have seven loading stages, and be encompassed by a railway with several lines of rails, three of which will run along the stone pier separating the torpedo-boat harbour from Kiel Bay. The water by the pier is so deep that a fleet of warships could coal there. The station is to be finished in two years, and will be able to store about 77,000 tons. A coaling station of similar size is to be formed at Brunsbüttel, at the western mouth of the canal.

ERECTING THE MIRABEAU BRIDGE OVER THE SEINE

M. RESAL, PARIS, ENGINEER

(For description see page 615)

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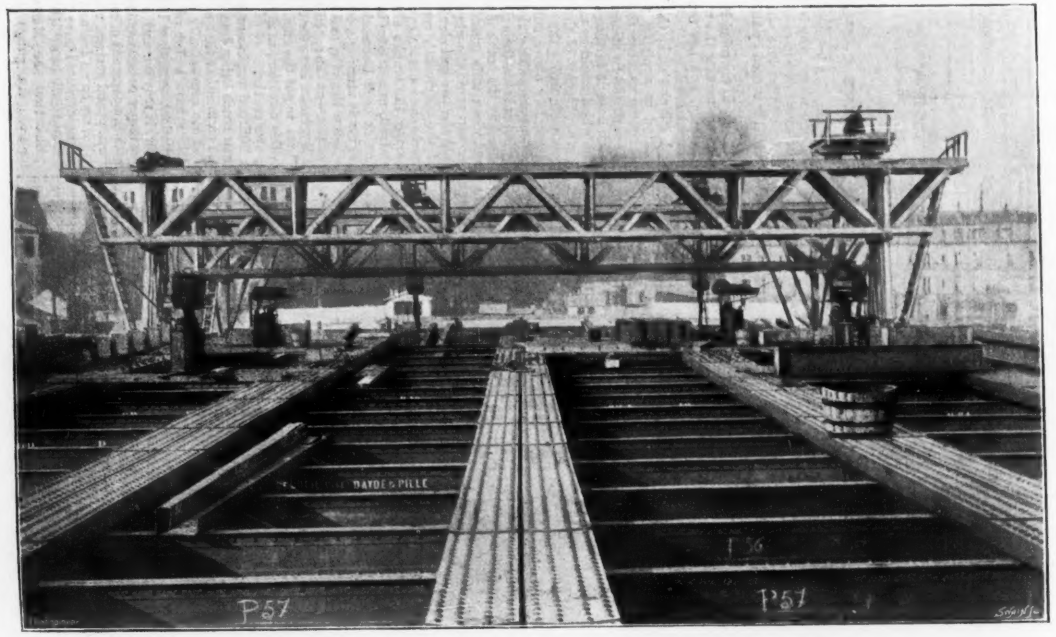
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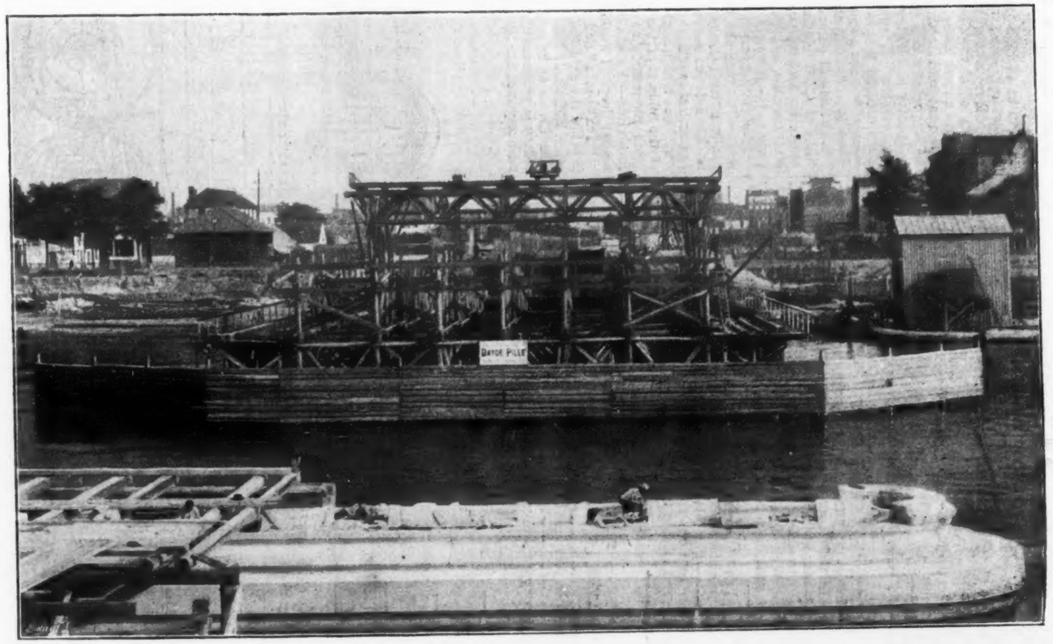
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TO CORRESPONDENTS.

Registered Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and bearing a penny postage stamp, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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SOLID TOP WOOD PEG TURNING AND STAMPING MACHINES.

(*To the Editor of The Engineer.*)

SIR,—Can some of your readers give me the name and address of solid top wood clothes peg turners; and of firms likely to make cheap printing or stamping press to print or stamp parcel handles, as now done by hand?

R. T. C.

Ashton-under-Lyne, June 12th.

EMERY AND CORUNDUM.

(*To the Editor of The Engineer.*)

SIR,—I am wanting information respecting the above as to the different kinds and methods of mixing and manipulating to suit different classes of work. Is there any standard work on the subject, or would any reader kindly give me the information by letter through your office?

June 17th. EMERY.

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

MEETINGS NEXT WEEK.

THE INSTITUTION OF JUNIOR ENGINEERS.—Thursday, June 25th, 6 p.m. to 8 p.m.: Visit the Engineering Works of Messrs. Bryan Donkin and Co., Bermondsey.

THE ENGINEER.

JUNE 19, 1896.

THE NEW COAL CHARTER.

THE new charter party issued by the Chamber of Shipping, which has not been accepted with any particular friendliness by London charterers, appears to be creating a crisis in South Wales. Crises in that part of the kingdom have hitherto been associated with wages disputes and strikes of colliers; but the disturbance with which the Welsh coal and shipping trade is now menaced takes the unexpected form of a strike of one strong body of capitalists against another equally powerful capitalist combination. In its present aspect, indeed, it is a struggle between the shipowners of the country and the colliery proprietors and charterers of South Wales. The origin of the strife must be sought as far back as January, 1895; but so obscure was the issue, and so complicated the questions involved, that for more than twelve months no one heard a whisper of impending trouble, and it was actually not until a fortnight ago that the commotion began which threatens serious and, we might say, disastrous consequences. At the beginning of last year the Documentary Committee of the Chamber of Shipping framed a new form of charter party, which was admittedly directed against the coal shippers of the Bristol Channel ports. The reason given for this action was that for years—in fact from the commencement of the growth of Cardiff into a great coal port—the shipowner had been at the mercy of the charterer; and what with competition at home and from foreign vessels, he was forced to accept terms which lessened his profits and crippled his enterprise. One of the terms complained of in the old charter was that the wharfage toll of 2d. per ton was levied on the ship, whereas the shipowner contends that it ought to be paid by the shipper of the cargo. It is not in dispute that the wharfage has been paid by the vessel ever since Cardiff Docks were opened; but the shipowners say that they accepted the burden because it did not amount to much in the early days of the oversea coal trade, that they have since submitted to it because of their helplessness, and that they are revolting against it now because they are in a stronger position to fight, besides which they are supported by a wealthy phalanx of Protection and Indemnity Associations.

The argument of the charterers, including coalowners representing an output of twenty-five million tons per annum, embraces a variety of technical points, but it is chiefly based on principle. The wharfage dues, they say, are justly levied on the ship, and have nothing to do with the cargo. They point to the fact that hitherto the shipowner has always been content to pay the 2d. per ton, and has reckoned it in his estimates of freight. They insist that it would be impossible for them to transfer the wharfage dues to the price of coal, especially in these days of keen competition, without risking the loss of customers, and diverting trade from the Bristol Channel. It is idle to point out, they urge, that the consumer pays the 2d. per ton in the ultimate result. However that may be, the South Wales colliery proprietor points out that he ships his coal f.o.b., and could not recoup himself in the price as the shipowner can in the freight. But there is another and perhaps a stronger objection raised to the Chamber of Shipping Charter. The document is to come into force on July 1st, except where charterers gave notice by Monday last that they were willing to be bound by it, and in those cases its enforcement would be postponed until January 1st next. Now, a great part of the oversea trade of the Welsh ports is conducted by contracts of a more or less lengthy run. The contract is made at a specific rate f.o.b., and makes no provision for the 2d. per ton the shipowner wishes to saddle upon the shipper. Here it would seem that the resolution of the shipowners would inevitably involve the contracting coalowner in an immediate and continuing loss. The long and the short of it is that the South Wales colliery proprietors have made common cause with the general body of charterers; and at a meeting representing 25,000,000 tons per annum, it was determined to offer the stoutest resistance to the new charter, the coalowners present entering into bonds not to ship, or permit the shipment of, their coal on any vessel sailing under the new rules.

These circumstances point to a complete deadlock, and the colliery proprietors are making every arrangement to face it. As Mr. J. B. Ferrier, late president of the Cardiff Chamber of Commerce, remarks, it would mean a total suspension of trade such as the Bristol Channel ports have not known since the great strike of 1875. It appears incredible that such a condition of things should be allowed to arise out of a petty twopenny toll; but Mr. Ferrier discovers no way of escape except in an abatement of the shipowners' demands. "I do not see," he says, "how negotiations are possible. So far as the coalowners are concerned, they are simply on the defensive. The shipowners have made war with the colliery proprietors; we shall resist them, and they will find that they have tackled a stronger body of men than they anticipated." Yet, despite these ominous words, it is impossible to resist an impression that the outlook for the 1st of July is not altogether so gloomy as the reports from South Wales represent. Of course, there are many vessels chartered in advance under the old conditions, though the stringent rules of the indemnity societies render it doubtful whether those charters will be renewed after the voyages are over. But it must strike an impartial mind, that in assuming an attitude of "no compromise" the Chamber of Shipping has left out of account the vast amount of foreign tonnage which is ready for employment wherever opportunity offers. Something has been said, it is true, of foreign co-operation in opposition to what are known as "dirty" charters. The wharfage due of 2d. per ton, however, does not touch the questions involved as between "clean" and "dirty" charters. To the foreign shipowner it must rather appear a domestic squabble between shipowner and charterer, and one in which he has no interest so long as his stipulated freight is paid. If the colliery proprietors resolve upon an absolute stoppage, and to close their pits in order to bring the British owner to terms, the responsibility will rest upon them. The only excuse for such a step would be dire necessity, and the necessity could not arise while a supply of shipping, of whatever nationality, was seeking orders at the Welsh ports.

Although a number of Cardiff coal exporters provisionally accepted the charter on Monday last, and so gained six months' grace—the wharfage being meanwhile paid by the ship as heretofore—the colliery proprietors regard the position as unaltered. The Monmouthshire and South Wales Coalowners' Association met on Tuesday, and re-affirmed the decision of the joint meeting of the coal trade in the previous week, while anew expressing a unanimous opinion in favour of determined resistance to the shipowners' demands.

THE MANAGERS OF OUR ORDNANCE FACTORIES.

IN days when the skilled mechanic earns higher wages than formerly, it is strange to find the special skill and experience required for the successful direction of mechanical operations on a large scale made little of. This, however, is, we think, unquestionably the case in the Royal Arsenal and the kindred Government manufacturing establishments. We are not now speaking of our dockyards, but of our factories at Woolwich, Enfield, and Waltham Abbey. Strange as this is, it is still more curious that on this state of things being represented by numbers of witnesses to a Committee which was appointed to inquire into the organisation and administration of the manufacturing departments of our army under Lord Morley, and on this Committee strongly recommending that the evil should be remedied, steps were taken to aggravate it in a peculiar manner, so that our managers now stand on such a footing that it might be supposed that some malevolent influence had been exerted to injure the department. That the country has suffered, and must suffer, from so baneful a state of things goes without saying. To put the matter forcibly, let us see what would be as sure and efficacious a way as we could well devise to put managers in a bad position, and then we shall show how nearly this has been approached in actual fact.

To put managers in a false position, and to subject them to special temptation, it would be desirable that they should be without private means, very much underpaid, studiously annoyed, and made little of. This, if combined with great responsibility and influence, with opportunities of obtaining by wrong means what was not given to them for their services, both in the shape of actual money and in advancing the interests of their relations and friends, ought in the long run to produce the result aimed at. It ought to develope a system on which contractors and managers square matters a good deal between them; a system by which on paper the country appears to obtain services cheaply, but for which the country really pays dearly, without being able easily to trace where or how much.

This suggests an ugly picture, and we do not like raising it in connection with a body of men whom we believe at the present time to be doing excellent work, and against whom we have not a shadow of a charge. Indeed, we fear that they are likely to be annoyed at our taking such a line of argument. We may say at once, then, that we are only pointing out what ought to happen, and what must sooner or later occur in individual instances when a system is pursued calculated to foster it. Many years ago all this was urged, and it was urged in the abstract, deprecating any shadow of allusion to any individual. Since that, certain individual managers have been discharged under circumstances bearing out what had been urged. Our object now is simply to get justice done to good men on whom we greatly depend. It is necessary to show that we do depend on them, and this could not be if it were impossible for harm to come, however badly we treat them. We do this especially because it is the only way we know in which to defeat an obvious rejoinder. For suppose we urge that our managers are badly paid and are badly treated, we are at once met by the rejoinder, "Why then do they not go to private firms? It is quite clear that Government service has attraction and advantages which compensate for the great difference in pay, or else they would not remain." Now, this is a most dangerous plea to urge unless we know the exact nature of the attractions and advantages. To assume that they must exist without being able to define them, is to run the greatest risk of their being of a mischievous kind. Let us see whether there are any that we can put our finger on now, which will account for the presence of the valuable men we have at the present time. Formerly managers were what is called "on the establishment," that is to say, they were entered like other members of the permanent staff. They received yearly salaries, and eventually became entitled to pensions. This, with the certainty of the permanence of a Government establishment, might no doubt carry considerable weight. Immunity from the annoyances connected with trade disputes counted for something, so that altogether their pay, and that of managers in private firms, might be expected to stand somewhat in the relation of interest on a Government and private investment. This advantage was strained to the utmost, and, indeed, overshot, before the sitting of Lord Morley's Committee, as is apparent from the evidence given on all hands. Sir Andrew Noble, for example, said that an accountant received £650 in a private firm, and that managers ought to be paid much more highly. Mr. Engelbach, of the War-office, said that the managers were very talented men, and ought to have their present position raised, and that their salaries were not at all commensurate with their responsibilities. Sir H. Alderson said that they were able men and underpaid, and recommended that their pay and position should be improved. Colonel Barlow, Colonel Arbuthnot, and General Close, all spoke strongly in the same sense, and we can find nothing opposed to it, unless it be that General Maitland urged that while their pay should be increased, they should be taken off the establishment. It is not surprising, then, that the Committee should have recommended that in addition to the advantages of security of position, "the State must be prepared to approach nearer than at present to the salaries obtainable in civil life," and get the best men as managers. It will scarcely be credited that since that Committee sat, while no increase of pay has taken place, the managers have been removed from the establishment, their hope of pension has been taken away, and they have been paid by the week, like the mechanics and labourers of the department, and are liable to be discharged at a week's notice.

It is very apparent that the weekly pay of about £8 13s. 1d. on the precarious tenure of a possible week's notice is not enough to induce a good man to undertake the position of manager over an establishment turning out, perhaps, three, four, or five hundred thousand pounds' worth of work in the year. It is more difficult to say why we should still have the good managers we believe that we possess. We account for this mainly because they have a strong hope that the present anomalous state of things must come to an end, and having been long in Government service, they hesitate to throw up all hope of better times. We trust that the event will prove them to be right; if not, we fear that things must get worse in some way. Good managers may leave, and we may get bad ones. Observe: we are advocating paying highly in order to buy efficiency, not honesty. Nevertheless, we do hold that it is both wrong and foolish to put men in an unfair position, to treat them very badly, and to assume that they know how to take care of themselves, though we see no visible legitimate way in which they can do so. Our clerks are all established and pensioned; the managers of our dockyards are established and pensioned. How can it be right and wise that this should be the case, if it is right and wise to refuse our War Department managers the same privileges? However important is the administrative work performed in our offices, the end and aim of a factory is to manufacture war stores, as completely as it is the aim and end of a gun to shoot. In each case everything fails if this one end is not attained. We believe that it would pay the country well in the long run, not only to be reasonably fair, but even liberal. Again, we have long held also that to withhold any benefit which costs the country nothing, is to defraud both the country and the individual concerned. We have never heard of a private firm where managers are paid weekly. The tendency of such a system is to degrade them. Who benefits by this? Is it not obvious that either country or manager is injured, and probably the injury is divided between them. The individual manager feels it first. Eventually the less pleasant position ought to end in less good servants being secured. So with other anomalies; at present the superintendent of a department is the only officer to direct the manager under ordinary circumstances. Should he be absent for a day, it might be supposed that the manager who has worked with him all along, and knows his views, is the natural man to carry them out; but that is not the official view. Will it be believed, that either an officer from a central office in the Arsenal, or the chief clerk of the department, is for this very short interval placed over him?

Our own idea of a manager would be to select the best man we can get, and to put him in a thoroughly good position as to pay and status. With the one exception quoted above, we have never heard of an officer who wished to purchase the power of dismissing a manager at a week's notice by disgusting the entire body of them. We should increase the pay largely, and above all place the managers on the establishment. Experience shows that for one superintendent who prizes the luxury, as it were, of instantly killing and taking possession when he thinks he has a bad man, many would value the hold of a secure future for a good man. We should encourage in managers, as we should in officers, the desire for distinction by putting forward any designs or good suggestions in their own names. The extinction of all this has for many years past been a fixed principle, though for what conceivable reason, except jealousy, or a wish to take credit due to others, it is hard to conceive. Of all rewards, reputation is the one that it best pays to use; for while it costs the country nothing, in the nature of things, it comes only to men who have produced good results. Next, in the selection of men, we have not much fault to find, but we believe this, like everything else, would become easier with higher prizes to offer. Capital men have been taken from Admiralty yards. They might also be taken from private firms. We think also that it ought to be possible for a specially exceptional man to rise from the bench. In the latter case, however, everything should be done to make it clear that the man had entered an entirely new position as completely as a soldier rising from the ranks to be an officer. It might in such a case be easier for such a man to move to a new place and begin in a new sphere altogether. Doubtless the result of this would be to show larger items in salaries, but those who know most of our manufacturing departments are aware of what a small element this is compared with the money that is absorbed in various ways, only traceable by those who "know the ropes" under our present cumbrous arrangements.

◆◆◆

LORD KELVIN.

During the week Lord Kelvin's jubilee has been celebrated in Glasgow. It is not given to many to fill a professor's chair for half a century. Lord Kelvin has received the well-merited congratulations of the whole scientific world and of Royalty itself. The principal events of his life are too well known in the world of science, and have been too recently detailed for the general public to need re-statement here. The work done by Lord Kelvin during a period of more than half a century has been so considerable that it is much to be regretted that the daily newspapers vie with each other in exaggerating its influence and importance. Lord Kelvin is the last man on earth to be pleased by adulation, or charmed by unintelligent glorification. His dignified reply to the speech of the Lord Provost of Glasgow University on Tuesday evening should serve to silence men who have no proper conception of what Lord Kelvin really has achieved. "When I think," he said, "how infinitely little is all that I have done I cannot feel pride; I only see the great kindness of my scientific comrades, and of all my friends, in crediting me for so much. One word characterises the most strenuous of the efforts for the advancement of science that I have made perseveringly during fifty-five years; that word is failure. I know no more of electric and magnetic force, or of the relation between ether, electricity, and ponderable matter, or of chemical affinity, than I knew and tried to teach my students of natural philosophy fifty years ago in my first session as professor." These are pregnant words. It would be well should all who teach bear them in mind. The history of Lord Kelvin's career is well known. He has done nothing great in the sense that Newton or Faraday, Watt, or Stephenson did great things. A fine mathematician, he narrowly missed becoming a poet. His imagination has built up for him fairy realms in the ether, which it may almost be said that he invented. To him the life's history of the sun has formed a vivid picture; and the conception of a world of matter composed of countless myriads of gyroscopes, spinning one within another, originated in a brain which in mediæval days would have found the picture of a million angels dancing on the point of a needle, a thing of delight. No man living has taken keener pleasure in the scientific use of the imagination; while his mathematical dexterity enabled him to bring into order and discipline the atoms whose contemplation gave enchantment to his soul. Leaving theory and turning to actual work, we see that his labours have supplied the world with a splendid collection of electrical and nautical instruments, and little else. It is true that he greatly aided the work of submarine telegraphy; but it is questionable if his mirror galvanometer or syphon recorder can compare in ultimate utility to the world with multiplex telegraphy, concerning the inventor of which not much is heard; and the telephone is not second in importance to any of Lord Kelvin's inventions. He has done excellent service to science, and we heartily unite with Glasgow and Glasgow University in doing him honour. But succeeding generations will be more likely to remember him for what he has done than for what he has taught; and his memory will endure, not because he was great in great things, but because of his mastery of the almost infinitely little. The man who made it possible to send a message through an Atlantic cable, with a battery formed of a lady's thimble and a fragment of copper wire, stands on a different pedestal from the men who taught the world how to cross the Atlantic by taking some of the water out of it and boiling it. Lord Kelvin deserves all that those who best know him will say in his praise. From his "Friends" in the daily press, he may well beg to be saved.

YORKSHIRE MINERS.

Rotherham, once so important that letters to the city which now joins hands were once addressed, "Sheffield, near Rotherham," was on Monday the *venue* of the Yorkshire Miners' Association in their annual demonstration. Forty special trains brought into the ancient borough a multitude of visitors, it being estimated that the aggregate gathering considerably exceeded 60,000, who spent the day in processional display, listening to the music of over sixty brass bands, and the addresses of a score or so of speakers at three different platforms. At each platform two resolutions were passed. These resolutions, as usual, were in effect miniature manifestos from the miners' leaders, covering almost every topic of the mining movement upon which the colliers' executives have set their hearts. Interest chiefly centres in what Mr. Benjamin Pickard, M.P., had to say. As the President of the Miners' Federation of Great Britain and Ireland, and the Secretary of the Yorkshire Miners' Association, Mr. Pickard, more than any other man, is able to forecast the situation in the coalfield. He made two points very clear. The Union had "burnt its boats" over securing a minimum rate of wages. Having succeeded in that effort, they now mean to stick to what they have got. Mr. Pickard scouts all notion that high wages ever killed any trade. Two things he regarded as vital to business—keen competition and the giving of profits away to the middleman. The miners, he contended, were at one in declaring that their wages never caused 1 per cent. alteration in the dividends up or down. He was equally resolute in demanding that so long as the owners gave their profits away, they ought not to call upon the men to make up the deficiencies. "We are not going to stand it," said Mr. Pickard; "we believe the wage we now have is a living wage, if we can work every day in the week, and we will have it continued." Noticing the contention of some owners that a reduction of wages was necessary to enable them to compete effectively with Durham, Northumberland, and Wales, Mr. Pickard replied that the miners did not want to go down to 4s. 2d. a day. Turning to the other point of interest, the Conciliation Board, the speaker said that the coalowners were wanting to meet the miners to try to get a further Board of Conciliation. But the Conciliation Board, so far as the miners' officials understood it at present, was to be "one with a Lord Shand in it." Mr. Pickard, it would thus appear, is not in love with Lord Shand. If the miners' officials can agree with the owners, he is quite content, but he declines to be a party to the other point. As to what was likely to happen at the adjourned meeting between coalowners and the miners' representatives, Mr. Pickard refused to be drawn. Silence sometimes, he said, was golden, and he wanted his hearers to have all the gold. It is quite clear, however, that the policy of "no reduction" is to be maintained during the coming struggle, if there is to be one. The general opinion is that there will not be one, and that the existing situation will be continued, the miners retaining the advantages they enjoy at present, even although their working hours may be reduced, and the amount of money they take home at the week end be considerably less than would be earned under concessions which would enable their employers to obtain a larger share of work, and thus give increased employment. All the speakers at the Rotherham demonstration appear to have got hold of one vital point. They altogether deny that lower wages would help the coalowners. They believe that if coal cost less in labour, the miners would be worse off, and their masters no better. Their doctrine is that the only way to sustain values in the coalfield is to sustain wages, and one of the speakers, who is President of the Yorkshire Association, boldly controverted the idea that a reduction of wages could possibly bring them any more work. He pointed out that new pits were being sunk on every hand, and that there were now 134,000 more men employed in mines than in 1889, and that capital had been enormously increased, and the power of production so abnormally augmented that it was impossible for lower wages to bring about greater employment. The Yorkshire Miners' Association, therefore, which may be regarded as the keystone of the Federation, has decided to stand fast for what their president calls "the great principle of a minimum and fair wage," and Mr. Pickard points out that they are in a position to speak with some authority, having a membership of 50,000, and a nest-egg of about £100,000 with which to back up their demands.

FIRING AT CAPTIVE BALLOONS.

In the "Proceedings" of the Artillery Institution is a translation by Col. J. H. G. Browne of an article, in the *Revue Militare de l'Etranger*, on the attack of captive balloons by artillery. Experiments were made on this in France, Germany, Russia, and Austria in the years 1885-87-91 and 94 respectively. On the 10th July last at the fortress of Steinfield, forty miles from Vienna, some fresh trials were made. The earlier series of experiments had established the fact that the balloon has only one enemy, namely, the cannon, and that small holes produce an inconsiderable effect even in large numbers. The difficulty of laying the gun increases with the altitude of the balloon; sometimes it is found necessary to dig a hole for the trail, which makes the service of the gun slow and difficult. The balloon, therefore, should be as high as is consistent with effectual observation. The Austrians think that an altitude of about 800 metres (2625ft.) has the advantage of spoiling the enemy's fire while allowing observations to be made. About 4000 metres distance (4375 yards) places the balloon outside the effective range of field artillery, without being so far off as to prevent the points which it is desired to examine being distinguishable. Lastly any motion of the balloon, vertical or lateral, renders artillery attack specially difficult. On these premises the trials of July 10th last were commenced. The balloon was placed 5000 metres (5468 yards) from the battery, and at a height of 800 metres (2625ft.) and was twice put in motion during the execution of the fire. The balloon, the Budapest, was 10 metres (32ft. 9·6in.) in horizontal, and 14 metres (45ft. 11in.) vertical diameter, it was raised to a height of 800 metres (295ft.). As soon as it appeared, an eight-gun battery of 8 centimetres (2·6in.) guns began firing at it from 5250 metres (7641 yards) with angles of elevation varying from 25 to 27 degrees, trenches being dug for the gun trails. After eight rounds the range was estimated within about "1000 paces," when the balloon was seen to be moving, and the range had to be found again. This experience was repeated till the eighty shrapnel allotted for the work had been expended, discharging about 10,000 bullets, while the balloon still floated tranquilly. It was eventually found that three small holes had been made, which had no sensible effect. From the above it is thought that a large rent is needed to cause an immediate fall, indeed this had actually been brought about in early trials. A captive balloon at 2625ft. elevation and 5468 yards from an enemy by changing its position occasionally has a great chance of remaining intact. Probably, then, a balloon pack marching 3000 metres (3281 yards) in rear of the artillery of the advanced guard of an army ought to be able to do good service. To this we are tempted to add that in many cases it might be worth while to make an ascent with an empty balloon first to test matters and draw the enemy's fire.

LITERATURE.

Field Artillery. By Lieutenant-Colonel Sisson C. Pratt, late R.A. Revised by Lieutenant-Colonel Eden Baker, R.A. Kegan Paul, Trench, Trübner, and Co., Paternoster House, Charing Cross-road. 1896.

Our reason for noticing the new edition of the book just brought out is that England has recently made important changes in field artillery, and that Colonel Baker, who has in this edition dealt with the question, is a high authority on the subject, and from his position at the Artillery College in Woolwich is at the focus of information. The book is a capital compendium of information on field artillery brought up to date. Our object here is to notice only one branch of the subject, namely, the position in which England stands compared with continental powers in the matter of field guns. This is shown in a series of tables in the chapter on gunnery. We have recently introduced for our Horse Artillery a breech-loading 12-pounder gun weighing only 6 cwt., discharging a shrapnel weighing $12\frac{1}{2}$ lb., containing a $1\frac{1}{2}$ oz. bursting charge and 156 bullets, with a muzzle velocity of 1550ft. per second; and a field battery gun weighing 7 cwt., with a shrapnel of 14 lb., with a velocity of 1550ft., and containing 235 bullets. Germany has a light piece, presumably her Horse Artillery gun, weighing 8·27 cwt., with a shrapnel weighing 17·78 lb., containing 262 bullets, fired with a velocity of 1375 foot-seconds; and a field battery gun weighing 8·66 cwt., for a shrapnel weighing 15·5 lb., containing 300 bullets, with a velocity of 1450 foot-seconds. These are, of course, much heavier pieces. France has a Horse Artillery gun weighing 8·36 cwt., with a shrapnel weighing 13·5 lb., containing 40 segments and 120 bullets; and a field gun weighing 10·43 cwt., with a shrapnel weighing 19·13 lb., containing 77 segments and 160 bullets; while Russia has a Horse Artillery gun weighing 7·19 cwt., with a shrapnel of 15·59 lb., containing 165 bullets, and a velocity of 1352 foot-seconds; and a field gun of 8·64 cwt., firing a shrapnel of 15·59 lb., containing 165 bullets, with a velocity of 1450 foot-seconds.

The practical value and power of field guns depends on the following elements:—Muzzle energy of the projectile, flatness of trajectory, accuracy of shooting, number and weight of bullets and fragments, and spread of them, for field guns now depend wholly on shrapnel fire. Some of these conditions involve difficulties and contradictions. For example, a high velocity gives a flat trajectory, but renders any error in setting a fuse very serious. Still, we may take the above as the elements to be desired. The muzzle energy, and consequent flatness of trajectory, represents the achievement of the gun; while accuracy of fire depends partly on gun and partly on projectile, and the after behaviour of shrapnel depends on the projectile alone. To compare the achievement of the guns as to delivery of energy, we must take their weight into account, and it is usual to follow Krupp's plan of dividing the total energy by the weight of the piece in tons, which gives the energy per ton of gun. This carried out gives us, in foot-tons, per ton of gun, for the Horse Artillery guns, in order of merit: British, 710·6; French, 578·8; German, 563·7, and Russian, 549·4. And for the Field Battery: British, 666·2; French, 566·3; Russian, 526·1, and German, 521·9. In this respect, then, the British guns are very far the best. The question, however, is not completely represented without taking the weight of carriages into account, and this we are not in a position to do, the figures not being yet obtainable. Supposing the British to maintain the position with gun and carriage which they hold with the guns alone, it follows that the recoil is serious, and has to be considered and dealt with. Owing to the use of cordite, however, the recoil of our guns is less than would be expected. It is necessarily, however, considerable. It has been found that the use of drag shoes constitutes the best brake action hitherto tried, and they act with the minimum strain on the wheels. It is to be remembered that the wheels are not made to revolve by the recoil directly, but by the ground holding them and turning them round; consequently a tire brake strains a wheel much less than a nave brake; and of tire brakes, a shoe is one that saves the wheel most completely. To return to the question of efficiency of fire. In number of bullets spread, as well as in accuracy, the British field guns seem to stand first; and if it be understood that the number of rounds stated to be carried in foreign batteries includes, in some cases, some carried in extra wagons in the second line of carriages, it will be seen that in number of rounds per gun we stand first, or nearly first of all. The numbers of rounds per gun are given as follows:—For Horse Artillery: British, 150; German, 126; French, 118; Russian, 75. For Field Batteries: British, 148; German, 109; French, 103; Russian, 63. We have had to lament that in some artillery matters we have allowed other Powers to get somewhat ahead of us; it is satisfactory therefore to be able to speak thus highly of our field artillery at present.

Elements of Descriptive Geometry. By C. W. MACCORD, A.M., Sc.D.; pp. 248 and 280 figs. New York: John Wiley and Sons. London: Chapman and Hall. 1895. 12s. 6d.

THIS is another addition to the already very copious literature of that most popular geometrical study commonly named solid geometry. Several works on mechanical drawing by the same author—notably his "Kinematics"—have previously come under our notice, and the present volume is certainly no exception to the general excellence of these books. The most cursory glance through the pages of the volume before us is sufficient to show how much labour must have been expended in its compilation; and what perhaps makes the work more valuable to engineering students is the fact that the author is, or has been, a practical draughtsman himself, and therefore looks at each problem from an engineers' point of view, with the object of its being utilised in connection with some structure or mechanism The close relationship and mutual dependence existing between the various branches of geometrical or mechanical drawing cannot be too strongly emphasised, although this is so often lost sight of, and we are therefore glad to notice that the author insists on the affinity of descriptive geometry and mechanical drawing, and considers that pupils should have some knowledge of the latter before proceeding to the former. Accordingly, where necessary or possible, the discussion of the problems is divided into parts, in which, under the heading of "Practical Suggestions," the applications of the particular subject in hand are pointed out. The other parts into which the discussion is divided deal more nearly with the geometry of the problem, such as the method to be employed in solving, and the conditions, if any, of symmetry, or of limiting or special forms. If anything, the explanations occasionally become a trifle too solid and profuse, and therefore tend to be somewhat wearying; but in spite of this, they will be of much value to the earnest and more advanced student.

The author fully recognises that with junior students, after they have mastered the projection of the simple solids—with which they are supposed to have already some familiarity—the chief bar to their further progress is the difficulty experienced by the untrained mind in making mental pictures of inclined or oblique planes, &c., when referred to the horizontal and vertical planes. The first chapter, therefore, deals with easy theories of points, lines, and their traces, and gradually advances to problems of more or less difficulty in Chapter II.

Chapter III. forms a somewhat novel departure from the usual beaten track; it discusses generally the generation of such solids as the cone and cylinder, and tangents to these surfaces; which in turn generate the more intricate surfaces of convoluted or screw form. The utility of these considerations will be fully appreciated when studying the succeeding parts of the book, especially Chapter VI. Some of the definitions, however, strike one at first as being unfamiliar; thus, for instance, few English students would know that a "secant plane" is simply a "sectional plane;" or that the word "nappes" takes the place of the usual term "sheets" when applied to different portions of the same surface.

The following chapter is on tangent planes to the surfaces of cones, cylinders, and spheres; these problems, however, do not embrace nearly all those which are usually recognised as presenting difficulties to the student; for although most of these could be solved by the principles considered, reference would need to be made to other works to fully prepare for an examination.

The last three chapters are no doubt the most important from an engineering point of view. Chapter V. gives good illustrations of the intersection of solids and of the development of the resulting sections; but perhaps the most interesting is the next chapter, as it considers much more fully than usual the difficult problems relating to warped surfaces, including the hyperbolic paraboloid, the hyperboloid of revolution, and the helicoid or screw surface. The concluding chapter is, as usual, on isometric drawing; but from the extreme simplicity of this projection there is really no reason why it should not with advantage form the first chapter instead of the last.

The book is very well printed indeed, and the diagrams are simply perfect; the only drawback to the volume is that it contains no exercises whatever, and, as we stated above, the number of selected problems is not nearly sufficient to make up for this deficiency.

SHORT NOTICES.

Engineer Draughtsmen's Work: Hints for Beginners. By a Practical Draughtsman. Illustrations by the Author. London: Whittaker and Co. 1896. Although this is an addition to the many books on this subject, we may say it is one which will be found of practical value to the beginner in the drawing office.

Instructions for Working Plant manufactured by The Brush Electrical Engineering Company Limited. Second edition. London: The Brush Electrical Engineering Company, Limited. Price 2s. 6d.—This little book of instructions is nicely got up, and is illustrated with numerous diagrams. It has value not only to those who have charge of the machinery described, but it has an educational value which is of a practical order. Some of the compilers of a well-known class of cheap text-book will find here instructions for fixing, starting, running, equalising currents, testing, and so on, which will improve several of the works which pretend to go into these matters.

Sewage Purification brought up to date 1896. By E. Bailey-Benton London: E. and F. N. Spon, 1896.—This little book advocates sewage disposal by downward filtration on properly managed farms, and maintains that the cost of coke filters, such as are used by Mr. Dibden, must stand in the way of their adoption. Mr. Bailey-Denton admits that sewage farms are in bad repute, but he attributes this to improper management, and he gives a great deal of more or less detailed useful information about important towns, such as Northampton.

BOOKS RECEIVED.

A Text Book on Gas, Oil, and Air Engines; or Internal Combustion Motors without Boiler. By Bryan Donkin. With 154 illustrations, and selected table of trials. Second edition, revised and largely rewritten. London: Charles Griffin and Co., Ld. 1896.

The London Manual and Municipal Year Book, 1896-7. *Information concerning Public Bodies supplied from Official Sources, or Officially Revised.* Second edition. London: Offices of *London.* Price 1s.

A Practical Treatise on the Otto Cycle Gas Engine. By William Norris, M.I. Mech. E. With 207 illustrations. London: Longmans, Green, and Co. 1896. Price 10s. 6d.

The Facts of Life—Les Faits de la Vie—Idiomatically Described and Systematically Arranged, forming a Complete Dictionary of the Objective Language. Part I., Home Life. The School. Travelling. Plants. By Victor Bétis and Howard Swan. London: George Philip and Son. 1896. Price 3s.

THE FUTURE ROUTE TO ITALY.

WHILE possessing, owing to her extensive coast line and numerous ports, very considerable facilities for traffic and commerce by sea with other nations, Italy is not by any means so advantageously situated with regard to intercommunication with her neighbours by land. Great natural physical barriers and protectors as the Alps are, when viewed from a purely strategical point, they assume a somewhat modified aspect when regarded solely in the light of an obstruction to international intercourse. At present all the traffic in passengers, mails, and merchandise which comes from the Far East, most of which is for the United Kingdom, and are landed at Brindisi, must avail themselves of the French route *viâ* the Mont Cenis Tunnel, which is considerably longer than the one which has for some time been proposed and largely ventilated in public. We allude to the piercing of the Simplon, which it appears is now definitely decided upon, although no actually practical commencement of the great undertaking has yet taken place. It is one of the greatest importance to Italy, as, if carried out, it will unquestionably deprive the present French lines of a not inconsiderable portion of their normal receipts, and divert them in the direction of the new channel. It may be mentioned that the French candidly acknowledge this inevitable result themselves. They may, however, console themselves with the reflection that it will be several years at least before the present project becomes *un fait accompli.* Our neighbours will no doubt make hay while the sun shines. It is doubtful whether Italy is willing, and still more doubtful, considering the heavy demands upon her financial resources, whether she is able to contribute to any great extent towards the expenditure required for an enterprise of this magnitude, notwithstanding its vast future national interest. In the autumn of last year it was stated that the Italian Government would not take any direct part in the construction of the Simplon Tunnel, but would—which is certainly the least it could do—join up its own lines with the Southern Sub-Alpine exit. No contradiction has up to the present been given to this statement. At the same time, when, in the incipient stage of the project, the Swiss Government proposed to place this same end of the tunnel upon Helvetian territory, Italy objected, and insisted upon it being located upon its own soil, and it was under these conditions that their mutual agreement was definitely arrived at.

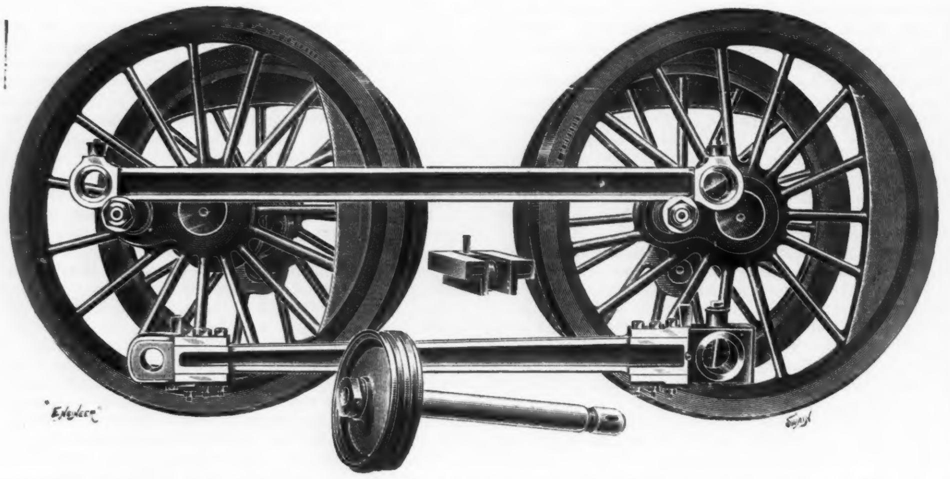
It is not our intention to enter upon any details respecting the character or claims of former plans for achieving the same object, or of the methods for accomplishing it, as they have been in the possession of our readers for some time past; but a brief allusion to some of the superior advantages which the new route can fairly lay claim to with respect to others, both in an engineering and international point of view, may not be without interest.

Between Brigg, in Switzerland, in the Rhone Valley, and Domo D'Ossola, the nearest frontier Italian station, there is really but one mode of communication, which is by the road constructed through the Simplon Pass by the great Napoleon in the beginning of the present century. The tunnel will thus start at a point about a couple of miles from Brigg, and, after passing under Monte-Leone, debouch upon the plains of Lombardy, upon the banks of the river Toce. An international station will be erected on the Swiss side of the Alps, and Isselle has been selected for the site of that on Italian territory. The trace of the tunnel will be rectilinear, always excepting the couple of slight curves at each end, and its total length slightly over twelve miles. It can thus give nearly three miles to the tunnel at St. Gothard, over four to that at Mont Cenis, and is about exactly double the length of that at Arlberg in Austro-Hungary. Although, therefore, longer than its famous predecessors, it compensates for these constructive and financial disadvantages by other merits of its own. It is well known that in mountainous regions the shorter line frequently entails correspondingly heavier gradients, while a longer trace will generally considerably reduce their inclination. Thus, though the shorter line may cost less than the longer in actual construction, the latter will be the cheaper in point of maintenance, both as regards the haulage power and the permanent way, the great items in the estimation of railway engineers and traffic managers. In this respect the Simplon line will be found to score, when compared with the three other examples we have selected. In the first place, it starts from an altitude very much less than that of the other three, which is for the Mont Cenis, 3960ft.; for the Saint Gothard, 3630ft.; and 4290ft. for the Arlberg Tunnel. At its commencement near Brigg, the Simplon Tunnel has an elevation of only 2260ft., reaches its summit level at 2330ft., and drops down to 2190ft. at the Italian terminus. During the first part of the section, the gradient is 1 in 490, and 1 in 140 for the remainder.

The device of running two galleries, and completing for the present only one of them, that is one tunnel, as our readers are aware, will be adopted by the German firm to which the construction of the works has been entrusted, for the purpose of obviating the difficulty, if not the impossibility, of working in the extremely high temperature to which the men will be subjected. At Arlberg the temperature was 64 deg. Fah., at Mont Cenis and Saint Gothard, 86 deg., while it is expected to reach 104 deg. at the Simplon. By frequent cross drifts cut obliquely and connecting the two galleries, it is confidently anticipated that the one will ventilate the other, more especially as the haulage in each will be only in one direction, that is, one track will be the up line and the other the down. By this mode of ventilation, it is calculated that instead of the seventy cubic feet of air supplied per second to the workmen during the piercing of the Saint Gothard tunnel, more than ten times that quantity will be available for the Simplon employés. As one example of the beneficial results which will accrue to Italy from the opening up of the new route, it may be mentioned that the distance between the western districts of Switzerland and Genoa being considerably less than that between the latter town and Marseilles, a portion of the present traffic, which is large, will be lost to that port. Besides, it will be not only the French port which will suffer, but also the French railways in connection with it. So far as we ourselves are concerned, we shall have no cause to murmur. The Simplon route will very considerably shorten the transit from England to Italy, and will bring it within nearer reach of the multitude of English tourists who visit the country and its singularly beautiful surroundings in the summer months.

This example of the value of the new line to Italy is but on a very small scale, and extremely limited in comparison with the ultimate extension and development to which the system might attain. Brindisi, the ancient Brundusium, as already stated, is the most eastern European port open to the traffic of our Oriental dominions, colonies, and dependencies, concerning the annual amount and monetary value of which there is no need of comment. The establishment of Brindisi in 1870 as a principal port of embarkation in the English overland route to the Far East, and subsequently four years afterwards, making it the site of a coaling station for the Peninsular and Oriental Company's fleet of steamers, gave an impetus to the future prosperity of the place, which, to its credit, it has taken advantage of. Since that period, its large and sheltered harbour has been greatly extended and improved, by the construction of two long quays and a breakwater and mole. Mail steamers can now berth alongside the quays with 26ft. of water under their keels, and over a thousand vessels, representing some 650,000 tons of burden, annually avail themselves of the friendly shelter of this important Mediterranean port. A seaport town so advantageously placed, and within sixty hours of London by rail, ought to have a future before it. It is to be hoped that it will—although it may perhaps be going too far, at any rate at present, to hazard the assertion that it will restore the ancient line of communication and commerce between the Far East and the shores of the Western World, and bring back in itself the byegone glories of the once Queen of the Adriatic.

EXPRESS U.S. LOCOMOTIVE—DETAILS



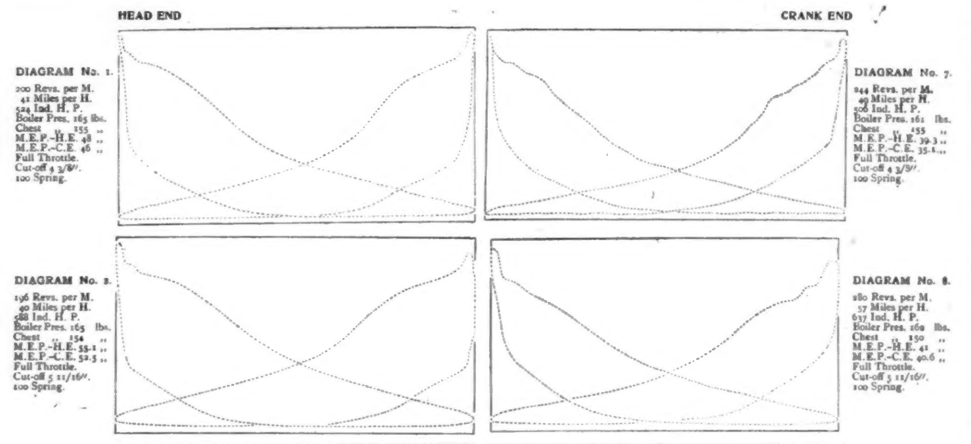
EXPRESS PASSENGER ENGINE, BOSTON AND ALBANY RAILROAD.

We illustrate this week above, and on page 623, a very powerful locomotive built at the Schenectady Locomotive Works, Schenectady, N.Y. Four engines, similar in all respects save one, to which we shall refer in a moment, were built, and put to work last month. The exception is an engine fitted with Fay's valve, which we illustrate fully on the next page. The valve is fitted with Richardson's balancing plate on the back. The general arrangement is no doubt well known to most of our readers. The details are given in our engraving, which has been reduced from the actual working drawing.

The peculiarity of the Fay valve is that, as will be seen from our drawings, passages are made in the cylinder walls, which are opened and closed by the action of the slide valve, the object being to pass steam from one side of the piston to the other, so as to prevent the inordinate compression which takes place when the valve motion is linked up for high speeds.

The result is, of course, that a much "fatter" diagram can be had at higher speeds than is possible without the aid of this simple device. We give a number of diagrams, reduced, which make this very clear. We believe that our engravings are so plain that they do not need any special description to make their meaning evident to any engineer accustomed to slide valve work.

We give a table of the dimensions of the engine, from which it will be seen that it is an enormously powerful locomotive, weighing 53·5 tons, and nearly twice as powerful, indeed, as many English first-class main line engines. The boiler has 2067 square feet of heating surface, and there are 27 square feet of grate. There are no boilers in this country of similar dimensions. The cylinders are 19in. diameter, 24in. stroke, giving a piston displacement of 16 cubic feet per revolution, or $\frac{1}{129}$ of the heating surface, a very large fraction; but to enable the engine to utilise all the steam the enormous boiler can produce the driving wheels are small, being only 5ft. 9in. diameter.



DIAGRAMS SHOWING ACTION OF FAY'S VALVE

The engine is the result of special scheming by the Schenectady Locomotive Works, combined with the suggestions of the master mechanic of the Boston and Albany Road.

Notwithstanding its large size, immense power, and the great speed which it will travel with a very heavy express train, it runs, we understand, very steadily and with little oscillation. The cab is roomy, comfortable, very convenient, and the driver can manipulate this engine with the utmost ease and precision. Its daily duty is to run from Boston to Springfield, and return, 200 miles. For the first 57 miles it has to ascend a grade of 903ft., or say 1 in 334; the remaining 43 miles has a descent of 835ft. It uses two quarts of cylinder oil, three quarts of engine oil, and 3½ tons of coal per day. In stormy weather the amount of coal may be increased. The perfectly satisfactory performance of this engine is largely due, we are told, to the use of the Richardson balanced valve for relieving the pressure of the steam upon the back of the valve, and to the use of the Fay valve for reducing counter-pressure in the exhaust. Speeds of over 70 miles per hour are readily attained with a train of cars weighing 257 American tons without including the passengers. It will easily maintain a pressure of 190 lb. with a heavy train, which is readily understood when we bear the dimensions of the boiler in mind.

As a matter of interest to many of our readers, we give the formula for determining the balancing of the Richardson valve as applied to the Boston and Albany engine No. 273, which we illustrate. The square inches area inside the Richardson balancing strips to be equal to the square inches area of the following named ports and bridges added together:—Exhaust port, one admission port, and both bridges. Thus in engine No. 273 with Fay's valve:—

		Sq. in. area.
Inside of Richardson's balanced strips, 17½in. × 6½in.		105
Exhaust port, 17½in. × 2¾in.	48·125	
Two bridges, 17½in. × 1⅛in. × 2 (bridges)	39·375	
One admission port, 17½in. – 2¾in. : : 14¾in. × 1⅛in.	16·594	104
Difference in square inch area		1

The after end of the boiler is very clear of fittings, being in this respect unlike most English engines. In the upper left-hand corner is the Seabert sight-feed lubricator for oiling the cylinders; a pipe running down the left-hand side carries steam for heating the train; a small gauge on the left-hand side is the steam heating gauge; another on the right-hand side is the air pressure gauge; a small round handle just above the engineers' brake valve operates the sand blast. A small square opening under the front window of the cab is covered with a fine wire screen to keep out cinders and dust. It has an adjustable door, and enables the driver to get fresh air.

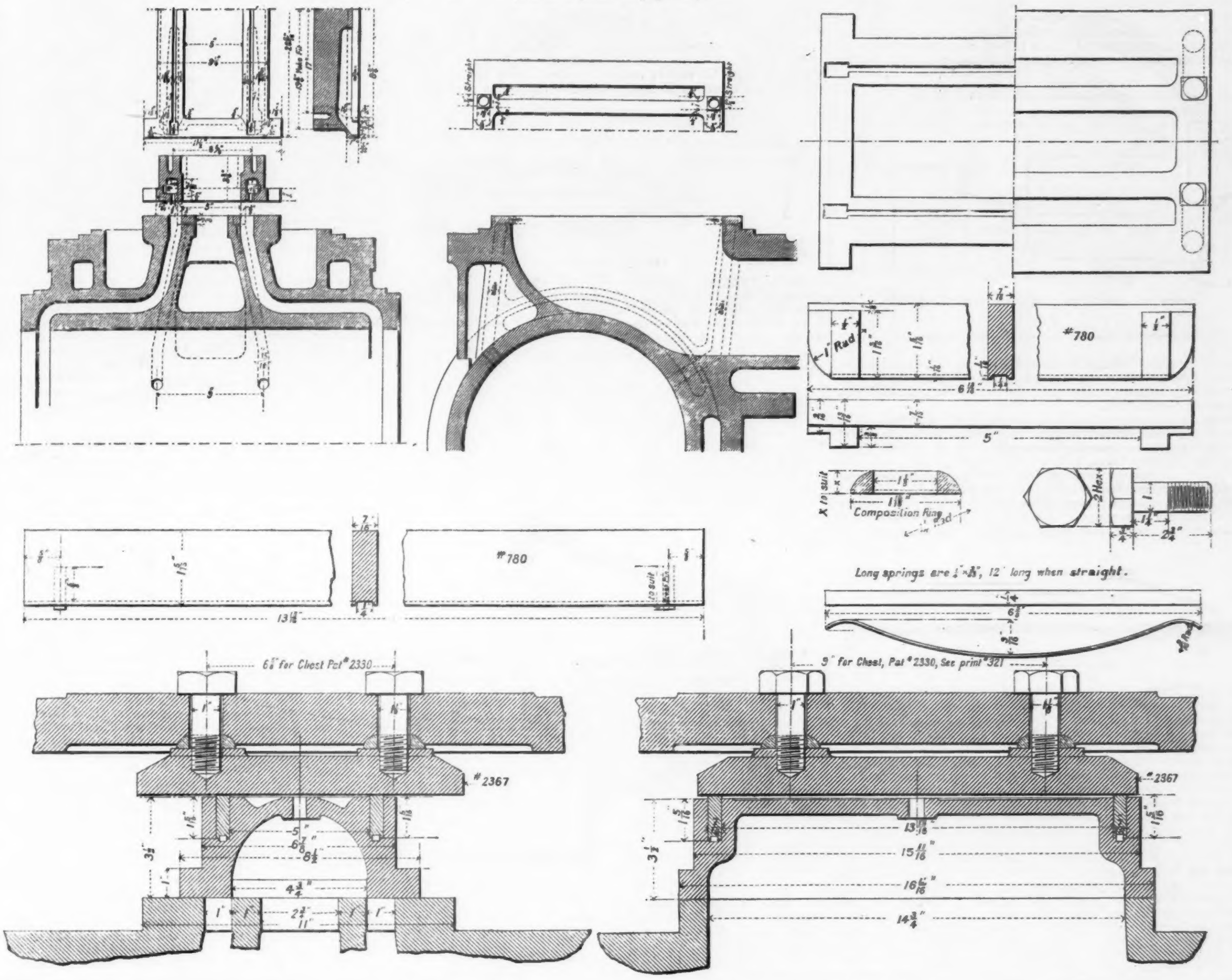
Descriptive Specification of Four Eight-wheel Passenger Locomotive Engines for Boston and Albany Railroad.

General dimensions—	
Gauge	4ft. 8½in.
Fuel	Bituminous coal
Weight in working order	120,000 lb.
Weight on drivers	75,500 lb.
Wheel base, driving	8ft. 6in.
Wheel base, rigid	8ft. 6in.
Wheel base, total	23ft. 5in.
Cylinders—	
Dia. of cylinders	19in.
Stroke of piston	24in.
Horizontal thickness of piston	5¾in. centre, 4¾in. outside
Dia. of piston-rod	3½in.
Kind of piston packing	Cast iron rings
Kind of piston-rod packing	U.S. metallic
Size of steam ports	18in. × 1¼in.
Size of exhaust ports	18in. × 2¾in.
Size of bridges ports	1⅛in.
Valves—	
Kind of slide valves, Fay valves in engine 212, Richardson balanced	
Greatest travel of slide valves	5½in.
Outside lap of slide valves	⅞in.
Inside lap of slide valves	line and line
Lead of valves in full gear	1/16in.
Kind of valve stem packing	U.S. metallic
Wheels, &c.—	
Dia. of driving wheels outside of tire	69in.
Material of driving wheel centres	Cast steel
Tire held by	Shrinkage and retaining rings
Driving-box material	Steeled cast iron
Dia. and length of driving journals	8in. dia. × 11in.
Dia. and length of main crank-pin journals	5½in. dia. × 5½in.
Dia. and length of side-rod crank-pin journals	4⅜in. dia. × 3½in.
Crossheads of cast steel, with hollow wings, brass bearings for four-bar guide, upper 4in. × 18in., lower 3in. × 18in.	
Dia. of engine truck wheels	33in.
Kind of engine truck wheels	Furnished by R.R. Co.
Boiler—	
Style	Extended wagon top
Outside dia. of first ring	62in.
Working pressure	190 lb.
Material of barrel and outside of fire-box	Carbon steel
Thickness of plates in barrel and outside of fire-box, 7/16in., ½in., ⅝in., 9/16in., and 11/16in.	
Horizontal seams, butt joint, multiple riveted, with welt strip inside and outside	
Circumferential seams	Double-riveted
Fire-box, length	96 1/16in.
Fire-box, width	40⅜in.
Fire-box, depth	75¼in. F., 63¼in. B.
Fire-box, material	Shoenberger steel
Fire-box plates, thickness, sides 5/16in., back 5/16in., crown ⅜in., tube sheet ½in.	
Fire-box, water space	front 4in., sides 3½in., back 3in.
Fire-box, crown staying	Radial stays
Fire-box, stay bolts	1in. dia.
Tubes, material	Charcoal iron, 12
Tubes, number of	320
Tubes, dia.	2in.
Tubes, length over tube sheets	11ft. 6in.
Fire-brick arch, supported on	Studs Co.'s style
Heating surface, tubes	1912 sq. ft.
Heating surface, water tubes	—
Heating surface, fire-box	155 sq. ft.
Heating surface, total	2067 sq. ft.
Grate surface	26·96 sq. ft.
Grate, style	Rocking, Tupper pattern
Ash-pan, style	Plain
Exhaust pipes	Single, high
Exhaust nozzles	4½in., 4¾in., and 5in. dia.
Smokestack, inside diameter	14in. at centre, 16in. at top
Smokestack, top above rail	14ft. 1½in.
Boiler supplied by two injectors, Mack, class A, pattern of 1882, size 10	
Tender.	
Weight, empty	38,800 lb.
Wheels, number of	8
Wheels, dia.	36in.
Journals, dia. and length	4½in. dia × 8in.
Wheel base	14ft. 6in.
Tender frame	7in. × 3½in. × 1in. angle iron
Tender trucks, side bearing, wood bolster and arch-bar type, B. and A. standard	
Water capacity	4000 U.S. gals.
Coal capacity	8 tons
Total wheel-base of engine and tender	47ft. 3in.
Total length of engine and tender	57ft. 2½in.

Engine provided with—
- American outside equalised brake on all drivers, operated by air
- Westinghouse automatic air brake on tender and for train
- Westinghouse air signal
- Leach sand-feeding apparatus

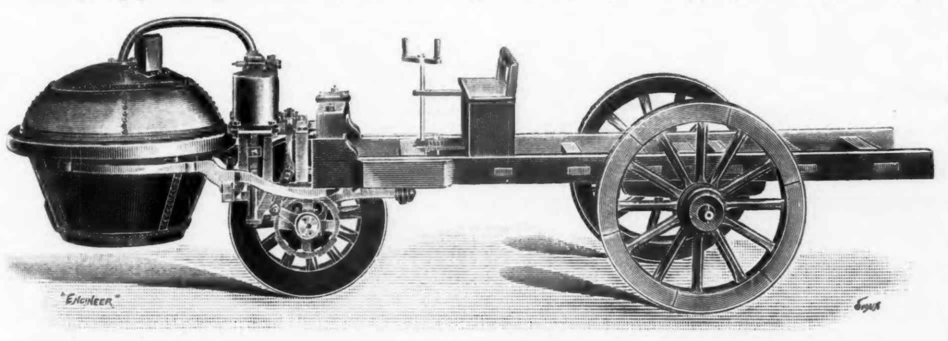
FAY-RICHARDSON VALVE—U.S. LOCOMOTIVES

(*For description see page 622*)


#780
#780
Composition Ring
X 10 suit
2 Hex
Long springs are ¼"×⅜", 12" long when straight.
6¾" for Chest Pat #2330
9" for Chest, Pat #2330, See print #321
#2367
#2367
13⅛"
5"
14¾"

CUGNOT'S STEAM CARRIAGE.

MANY of our readers will be interested in the engraving we now publish of Cugnot's steam-propelled vehicle, with the name and some particulars of which most people are cognisant. An account of the engine and vehicle was given in the "Proceedings" of the Institution of Mechanical Engineers in 1853, page 33, by Mr. E. A. Cowper, and recently we published—page 422—the carefully weighed opinions of its merits and demerits by M. Mallet, who contrasts the work accomplished by Cugnot as compared with that done by Trevithick, the one helped by the State and the other helped by no one. Trevithick was second, but his real success caused M. Mallet to divide the honour between him and Cugnot. Cugnot's old engine, made in 1771, was the first self-moving land carriage ever made, as far as we know. The engraving we publish is from a photograph by Mr. F. A. Field, who writes:—"Being greatly interested in all that concerns locomotive work, I have read with pleasure many numbers of your paper dealing with the historical side of the development of the locomotive, and often wondered why Cugnot's engine should not have had a more conspicuous place therein, but presume that not being a railway machine it might hardly be held to count for much in the history of our railway system. Anyway, an illustration of this venerable auto-car should have found its way to your pages, but I do not believe it has as yet been photographed. Some time ago, being desirous of adding the picture of this engine to my collection, I applied to the Curator of the Conservatoire des Arts et Métiers, Paris, for the necessary permission. No particular objection was raised to the idea of photographing the engine, but apparently it was found impracticable to have it done, as it is stowed away in a rather hole-and-corner fashion in the museum, and much in the dark. I should think, however, if influence could be brought to bear, the obstacles might be overcome, and a very good and interesting photograph obtained. Close by the original, however, is an excellent model, and this was photographed for me, and I send you a copy thereof, trusting it may be of some interest to you. Barring a certain 'newness' of look and excellence of finish, it is an exact copy of the engine itself, and I imagine the photograph I send would make a fairly good illustration for THE ENGINEER." The article by M. Mallet should be read with this engraving as an illustration. Some of his criticisms will then be appreciated.



RECENT IMPROVEMENTS IN DOCKS AND DOCKING APPLIANCES.*

By LYONEL CLARK, Associate.

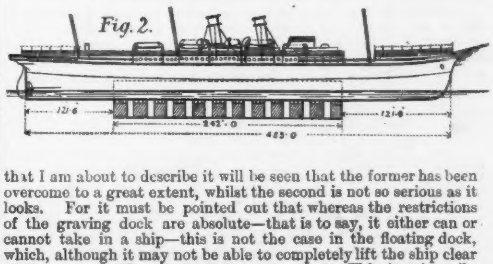
AN historical *résumé*, with which one would naturally commence a paper like the present has fortunately been rendered unnecessary by the previous publication of papers dealing most amply with this portion of my subject.† One point, however, in the history of docks I should like to refer to, and that is, the tendency that is always shown to follow out an existing type, created, perhaps, in the first place by purely fortuitous circumstances, to the complete end. There appears to have been no inclination to take up the subject *ab initio*, to go to the bottom and see how, assuming one's power to be unlimited, one would deal with a ship that required repairing. It is probable that, if perfectly free, we should elect to place such a ship on the level ground close up to our shops; in fact, somewhat in the position in which it was built, but on a level keel. In this position it would be freely exposed to the air, its bottom would dry more quickly, and the paint set harder; we should have the benefit of all possible light, work could be carried on longer without recourse to artificial illumination, and the surveillance of the workmen would be facilitated.

It is quite evident that the ordinary graving dock fulfils none of these desiderata. On the contrary, the ship is at the bottom of a hole, with but little air circulation around it; every piece that requires working has to be lifted out and lowered down again; the size of ship that can be accommodated is strictly limited by the dimensions of the dock, and if it exceed these in either length, breadth, or draught, the dock is as useless as far as regards that ship as if it did not exist. With the advent of the floating pontoon dock, however, many of these disadvantages disappeared. Rennie may be described as the first who introduced this form into practice, and that still lying at Carthagena, and fully described before this society—"Transactions," 1869—may be taken as a type. This dock marked an entirely new departure from the graving dock. The bottom of the ship was no longer got at by shutting it up in a pound and pumping out the water from around it, but the ship was floated over a closed pontoon from which the water was extracted, and which, by means of the displacement thus obtained, raised the ship above the water level.

But with change of design came many other advantages. The ship being supported by the displacement of the pontoon, the water that had to be pumped out from this was proportional to the weight of the ship, and not, as in the case of the graving dock, where the water has to be removed from around the ship, inversely so. Again, the dock was no longer shut in in every direction, but the ends were open, and no gates limited the length of the vessel that could be accommodated. Ships could be taken on and off the dock at all states of the tide, for as the dock rose and fell with the same, the depth of water over the sill remained constant. Even in non-tidal waters the floating dock is more tractable in point of draught, for whereas the depth of water over the sill of a graving dock is rigidly fixed once and for all, the depth of water allowable in a floating dock under normal conditions can always be exceeded in special cases, for no one would hesitate to exceed the normal freeboard and to lower his dock to the very utmost limits if it meant the saving of a sinking ship.

In short, this Rennie dock was already a great advance towards the ideal, its only restrictions being, that the beam of vessel that it could accommodate was limited by the width between the sides, and its weight by the displacement of the pontoon. In the dock that I am about to describe it will be seen that the former has been overcome to a great extent, whilst the second is not so serious as it looks. For it must be pointed out that whereas the restrictions of the graving dock are absolute—that is to say, it either can or cannot take in a ship—this is not the case in the floating dock, which, although it may not be able to completely lift the ship clear of the water, still can raise it to some extent. This fact is strikingly illustrated by the case of the dock we designed for the port of Barrow-in-Furness. This, although of a lifting power of only a little more than 3000 tons, and an overall length of 242ft., was still

Fig. 2.



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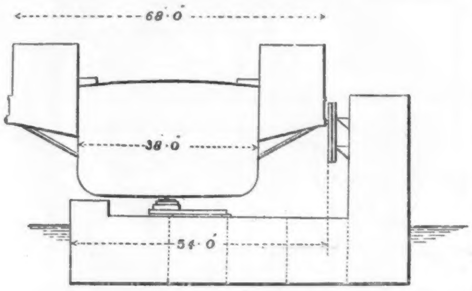
* Read at the summer meeting of the thirty-seventh session of the Institution of Naval Architects, June 9th.

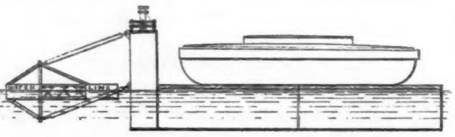
† "Hydraulic Lift Dock," Edwin Clark—"Proceedings" Civil Engineers, vol. xxv., 1866; and "Floating Docks," Sir F. Bramwell—*Engineering*, vol. iii., page 574.

able to lift, and did lift twice, the Empress of China, of a length of 485ft., sufficiently high to allow of her propellers being removed and replaced.

This dock was of a special type, but still an ordinary floating dock could have done the same; but it would, however, have been restricted as to the beam of vessel it could accommodate, and could not have dealt with such a vessel as is here shown, and which was lifted by this same Barrow dock, unless in the first case it had been constructed of an abnormal width and at a correspondingly increased cost. This restriction of beam became a point of capital importance when docking accommodation had to be provided for the circular ironclads of the Russian Navy, of a breadth of 120ft., and which no ordinary dock could then, nor, indeed, can deal with even at the present day.

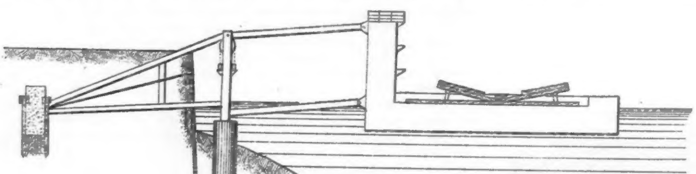


At this time, however, my firm, Messrs. Clark and Standfield, brought out their form of floating dock, known as the depositing dock, and which was described before the present society by my father, Mr. Latimer Clark, F.R.S.—"Transactions," vol. xvii. As this paper is available, I will only say that its chief novelty was the complete suppression of one of the vertical sides, leaving the vessel free to overhang to some extent on the other. The advantage of this power was seen by Admiral Popoff, and we were commissioned to build a dock which should at the same time be capable of lifting the long and narrow vessels of the Volunteer Fleet and the broad circular ironclads known as Popoffkas. This dock was completed at Nicolaieff in 1878, but has since been towed to Sebastopol, in which port it remains in constant use to the present day. This was the first introduction of the one-sided type of dock, and, as in the case of Rennie's dock, other advantages followed from the modification. A most important one was the fact that the removal of one of the sides meant that ships could enter these docks from three directions. They could either come in by the bow or stern, or they could be warped on sideways. In some cases this was more than an advantage, for it meant the possibility of having a dock or not. The dock in this city—Hamburg—belonging to the Reiherstieg Schiffswerfte, although by no means the only example of this, is still a very typical one. The ground at the disposal of this company was such that a graving dock would have cut up their building slips; there was no room for a two-sided floating dock to be moored in the river, and if moored in front of the yard, entry to such a dock would have been impossible. The single-sided dock, however, solved the problem, and the one which you have been able to see was constructed from our plans, and has now been successfully at work for some years.



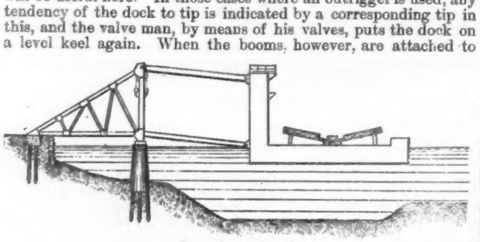
But these one-sided docks also afford important facilities for the easy berthing of vessels. This is well exemplified in the case of the dock belonging to the Smith's Dock Company at North Shields. The graving docks there, as in most other places, are placed at right angles to the river, or nearly so, and therefore an entering ship has to be swung across the strong flowing tide, an operation sometimes of some difficulty. The Smith's dock, however, lies parallel with the run of the tide, and the ship has merely to be sheered sideways on to the dock. No tug is required, but merely hawsers lead to the dock; and, indeed, it would be possible to sheer a ship on to this dock without any extraneous aid whatever. This dock is also interesting as showing the adaptability of the type to any site; both the existing dock and the second one, now all but completed, being placed right inside the river wall, on the site of the old yard, a hole for their reception being cut and dredged out of the river bank.

We have termed this particular modification of our one-sided type of docks the "off-shore dock." It differs from its progenitor, the depositing dock, in the fact that its pontoon is a continuous structure, and not in the form of separate caissons or fingers, and in the fact that stability is obtained by attaching the dock to strong columns sunk in the foreshore instead of to a floating outrigger, although the latter form can be retained, and indeed has been so, in the case of the dock at Stockholm. The details of these columns vary according to the nature of the site, but a few typical examples from actual practice are here appended, showing their adaptability under very different circumstances.

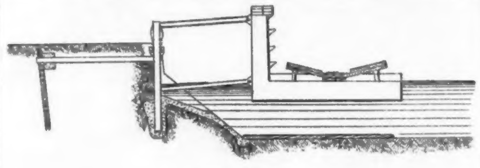


End elevation of Hamburg Dock

A few words as to the practical method of working these docks will be useful here. In those cases where an outrigger is used, any tendency of the dock to tip is indicated by a corresponding tip in this, and the valve man, by means of his valves, puts the dock on a level keel again. When the booms, however, are attached to rigid columns it is evident that there is no means of knowing in what direction the dock wishes to tip until the point of rupture be reached. This is, of course, unallowable, as it is essential in floating docks that the centre of buoyancy be kept under the centre of gravity of the system, by regulating the admission of water into the different compartments; and unless one can see which way the centre of buoyancy is shifting one does not know in which direction to correct it. In the off-shore dock an indication of the tip of the dock is obtained by means of the controlling gear, which is a cam-shaped plate carrying heavy weights, to which the upper boom is pinned, the cam itself being pinned at a different centre to the columns. As the dock tips backwards or forwards, so can the boom swing the cam in and out on the column pin, and thus indicate the direction of heel, which the valve man accordingly corrects by means of his valves. With this exception, the working of these docks is exactly the same as that of any other floating dock, and calls for no special comment.

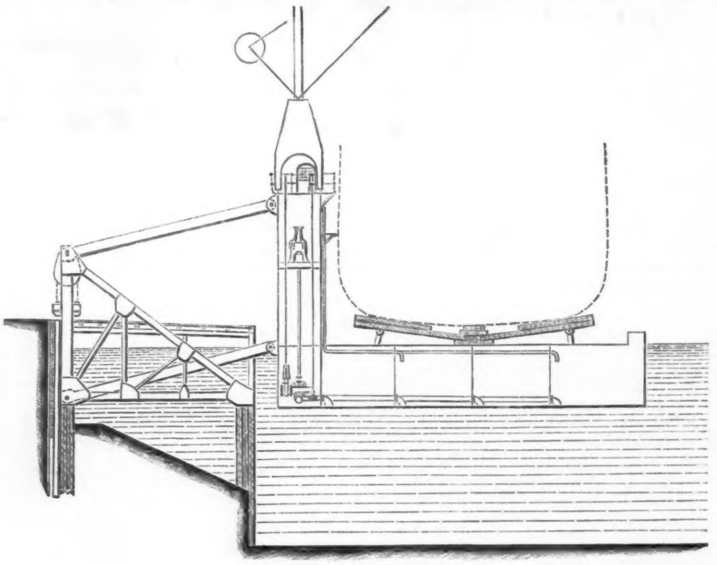


Flensburg Dock



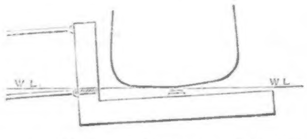
Cardiff Dock

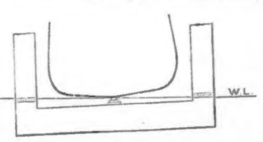
In construction the off-shore dock presents some economical advantages over the depositor and *à fortiori* over the older double-side type. The continuous pontoon is a lighter form of construction than the separate fingers, and the dock has, therefore, less weight in itself to lift at every operation, while the construction of the shore columns compares favourably with that of an outrigger, or of a second side.



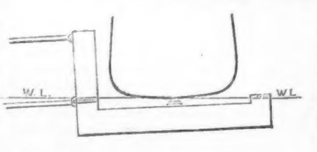
North Shields No. 2 Dock

As a practical advantage, the use of fixed columns permits of a vast increase in the stability of the dock. The question of the transverse stability of this type of dock—for we need not concern ourselves with that in the longitudinal sense—is one of the highest importance, and merits more space than I can spare. Shortly speaking, the tipping moments attain a maximum at a point which we term the critical point. This is when the keel of the vessel is just out of water, whilst the deck of the pontoon remains submerged. It is evident that at this point the whole stability in an off-shore dock must come solely from the shore columns. In a double-side dock we have, under similar conditions, the immersed and emersed wedges of the sides giving us righting moments, but it is easy to understand that the fixed columns afford a much greater resistance than an ordinary side can, and in practice they are constructed to give us about nine or ten times as much stability as an ordinary two-sided dock would have under similar conditions.





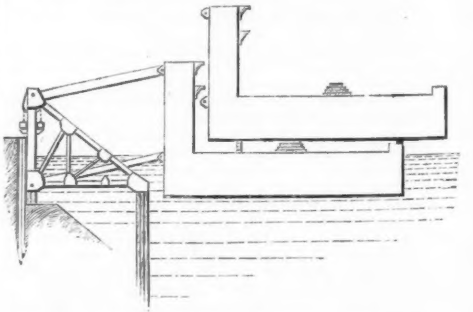
In addition to this, we still further reduce the duration of the critical period, and, indeed, practically suppress it altogether, by means of the "air box." This consists of a light caisson, built along the outside edge of the pontoon, and of a height equal to that of the keel blocks, so that it does not prevent vessels entering the dock sideways. As the dock in working is usually kept slightly heeled backwards, it follows that the top of this box emerges from the water before the inner bilge of the vessel is out, or at least would do so if the dock commenced to tip. The moment the air box emerges, however, it practically converts the dock into a double-sided one. So completely, indeed, is this the case, that I should not hesitate to lift a flat-bottomed craft on one of these docks with the booms entirely removed. This feat, I may add, has been done in the case of the North Shields Dock, where one half was docked on the other before the shore columns or booms were fixed, thus relying entirely on the natural stability of the dock.



But in practical working, of course, we rely on the booms, and look on the air box as merely increasing our factor of safety; and we take advantage of our greatly increased stability to work the dock at a speed which is quite unattainable by any ordinary two-sided dock. For instance, the present Hamburg Dock lifts a vessel of a deadweight of 5000 tons clear out of the water in a space of thirty-two minutes, and that without allowing the dock to get more than an inch or two out of level. In the new or second North Shields Dock this rapidity in lifting has been still further increased, and this powerful machine will lift a vessel of a displacement of 6000 tons, and a draught of some 20ft., in a space of thirty minutes. But the fact that we rely on the shore work for our stability has another advantage, and that is, it permits the reduction of the side to the size required to provide longitudinal stability, and to regulate the descent and ascent of the dock. Since the side is absolutely useless for lifting purposes, and, indeed, on the contrary, has to be carried on the dock and lifted at each operation, it follows that not only is there a saving in first cost by this reduction, but the working cost or power expended in lifting every ship is also less. A further reduction of weight is effected by placing the boilers that drive the dock on shore, steam being conveyed to the engines by articulated pipes. In practice, indeed, the ordinary boilers belonging to the yard are utilised, so that here, again, first cost is saved, and the cost of docking also reduced to the exact amount of coal burnt during the few minutes of lifting a ship.

In the case of the North Shields Dock, still greater economies in weight have been effected, for this powerful machine is driven entirely by the electric current, power being obtained from a central station, which supplies the rest of the yard, and which will eventually drive the first dock also. This very remarkable installation has been carried out under the advice of Mr. Campbell Swinton, and in the Appendix will be found a few notes as to the size and design of what is perhaps one of the largest applications of electricity to the conveyance of power.

I have now to treat of a most important point in connection with these one-sided type of docks generally, and that is the great facilities they afford for a complete self-docking of all their under-water portions. It must on the face of it be evident that a machine built expressly to lift ships can hardly be considered complete unless it can do the same thing to itself. We have always recognised this fact, and all the docks that we have ever designed, of whatever type they may be, possess this power. Indeed, the need of this appears to have been pretty generally admitted, and in most floating docks some approach, more or less successful, towards this facility will generally be found. The one-sided dock is, however, specially adapted for the purpose from its very shape. All that is necessary is to build it in two or more sections, bolted or otherwise connected together, and, when any section is to be docked, the same is unbolted, and floated round over the other section, which then raises it in its lap, so to speak. Such is the procedure adopted in the case of these docks, and the facility with which they can dock themselves is so great that frequent advantage is taken of the same, with the result that their life is thereby prolonged, and one of the most frequent arguments against floating docks is, to say the least, considerably weakened.



But whilst we have been seeking to improve the docks themselves, we have also had to turn our attention to improvements in the gear or fittings of the same. We have found that in many ports where there is great competition there is great demand for rapid lifting facilities, and to meet this we have designed some methods by means of which the berthing of a ship is much facilitated. In the first place, either steam or hydraulic capstans are fitted to the top deck to supplement or replace the ship's own winches. The ordinary method of cutting timber shores to fit each vessel is done away with, and large and powerful shores, actuated by steel worms, pinions, and racks, are contained in tubes let through the side of the dock, and can be rapidly screwed out by means of hand wheels from the top deck. In the case of the new North Shields Dock, hydraulic shores are being provided to deal more rapidly still with the heavy vessels this dock will have to cope with. These shores have other advantages besides those of saving timber. They are marked on their upper side with a scale, so that when the beam of the ship is known, if the shore be screwed out to the corresponding number on these scales, and the ship brought up to them, it is known to be true over the keel blocks. Their strength, too, enables them to be used to push ships forcibly into their correct position, and, in the case of one with a list, they are of great use in replacing it on an even keel.

(*To be continued.*)

ROYAL METEOROLOGICAL SOCIETY.—The last meeting of this Society for the present session was held on Wednesday evening, the 17th inst., at the Institution of Civil Engineers, Westminster, Mr. E. Mawley, F.R.H.S., President, in the chair. Mr. H. Harries read a paper on "Arctic Hail and Thunderstorms," in which he showed that the commonly accepted opinion that hail and thunderstorms are almost, if not quite, unknown in the Arctic regions is incorrect. He had examined 100 logs of vessels which had visited the Arctic regions, and found that out of that number no fewer than seventy-three showed that hail was experienced at some time or other. Thunderstorms were not so frequent as hail; but they have been observed in seven months out of the twelve, the month of greatest frequency being August. Mr. Harries is of opinion that the breeding-place of thunderstorms in these high latitudes is in the neighbourhood of Barent's Sea.

RAILWAY MATTERS.

The jury entrusted with the inquiry into the recent bridge accident at Victoria, B.C., finds that the Consolidated Railway is responsible, and that the Victoria Council contributed to the disaster by its negligence. The verdict is received here with satisfaction. It is likely to be followed by suits for heavy damages against the railway company and the city.

The expedition of Russian Engineers and soldiers, sent from Siberia to China, has, it is stated, nearly finished the survey for the branch of the Siberian line which is to run through Chinese Manchuria, and will materially shorten the distance to the sea. Official Russian reports concerning the progress of the Siberian Railway up to the beginning of this year are very favourable.

It is the opinion of the Federal Council that the Convention between Switzerland and Italy relating to the piercing of the Simplon tunnel should not be formally ratified by Switzerland until the subsidies to be granted by the two Governments shall have been secured. It is said that the Swiss Government will not experience any great difficulty in raising the amount fixed for its subsidy.

The recent report of the Indian railway administration for 1895 shows a great record of progress, as over 800 miles were opened for traffic, while nearly 3800 miles were under construction or sanctioned. The number of passengers carried increased in round numbers by 7,333,000 and the goods traffic by 20,000,000 tons. The net earnings rose 59 lakhs, the total exceeding 14 crores 11 lakhs. The return on capital was 5·78 per cent. Deducting charges for sinking funds and interest on lines under construction, the charge to the State for the whole railway system during the year will be only 76 lakhs, or about half the amount of the preceding year. But for the loss on exchange, a handsome profit would be shown.

The New York, New Haven, and Hartford Railroad Company has recently placed an order with the Schenectady Locomotive Works for twenty heavy passenger locomotives. They are to be of the American type, with 20in. by 24in. cylinders and 73in. driving wheels with steel centres. The engines will weigh about 134,000 lb. The boilers are to be 62in. diameter in the smallest ring, with 312 2in. tubes 12ft. long. The fire-box will be of the "toboggan" type, placed on the top of the frames, and will be 9ft. long and 41in. wide. The boilers are to have an extended wagon top, with radial stays, the dome being on the extension of the wagon top. The maximum travel of valves is to be 6in. The guides are to be of the crocodile form, that is, one bar above and the other below the crosshead. The boilers are made very heavy, with butt longitudinal joints, sextuple riveted. The specifications were prepared by Mr. John Henney, jun., superintendent of motive power of the line. The *American Engineer and Railroad Journal* says the engines will be the most powerful of their class which have thus far been built. The Schenectady Company is also completing five Mogul freight engines for the Maine Central Railroad. These will have 20in. by 26in. cylinders and 63in. wheels.

A meeting of bondholders of the Hudson Tunnel Railway was held on the 11th inst., to consider a resolution for foreclosure and for sale to a new company to be constructed. Mr. H. T. B. Kendall, who was voted to the chair, said the figures were large, but he did not think that without larger figures they could carry the undertaking to a successful issue. There was one feature in the scheme which he was very pleased to refer to—namely, that people in New York now offered to supply half the money that was necessary for completing the tunnel, which would be of immense importance to their city. Mr. H. E. Golding, a member of the committee, stated that the figures now submitted were considerably larger than those previously put before the bondholders. A former estimate put the cost of completing the tunnel at not exceeding £150,000, but that was merely for putting a tube under the river, and not for a completed scheme. The advantage of the present scheme over any other that had been placed before them was that it gave them a commercial undertaking—a tunnel equipped, with the lines through it, and so arranged that it would carry the traffic, immediately it was completed, from New Jersey to New York. Moreover, it was proposed to divert, to some extent, the original route, so as to bring the undertaking in connection with the elevated railway, and thus give an opportunity for through direct traffic from New Jersey to New York. The resolution was carried *nem. con.*

The report of the Electric Traction Company, which was formed for the purpose of constructing the Central London undertaking, the whole of the share capital of which has been subscribed, states that work is being pushed forward as quickly as possible, so that possession of station sites may be obtained to enable the work of construction to be commenced not later than July 1st next. The report adds that the line from Shepherd's Bush to the Bank has been divided into six sections, and on February 19th last a selected number of firms, all of whom were approved by the engineers to the railway company, were invited to tender for the construction of the tunnels and shafts and incidental work in respect of these six sections. A considerable number of tenders having been received, the directors have entered into the following sub-contracts:—Sections 1, 2, and 3, Shepherd's Bush to Marble Arch, Mr. J. Price; sections 4 and 5, Marble Arch to Post-office, Messrs. Walter Scott and Co.: section 6, Post-office to Bank, Mr. G. Talbot. The arrangements with regard to the station at Liverpool-street are progressing satisfactorily. The prices at which these sub-contracts—which cover the principal part of the work of construction have been let, and the cost of acquiring the station sites, are fairly in accord with the estimate formed as to the cost of the undertaking, and confirm the directors' anticipations that the construction and equipment of the Central London Railway will be carried out within the contract price.

In drop-testing machines, such as those used for testing railway axles, it has hitherto been considered that absolute rigidity of the anvil-block support was an essential feature, in order that all the energy of the drop should be exerted upon the axle under test, and none be wasted in compressing or moving the anvil and its foundation. To avoid variable error due to this, Mr. F. D. Casanave, general superintendent of motive power of the Pennsylvania Railroad Company, has reconstructed the drop-test apparatus at the Altoona, Pa., shops by supporting the anvil block on springs. The anvil thus supported offers a constant resistance to the action of the falling weight, when it falls from a uniform height. The anvil is a solid block of cast iron, measuring about 4ft. by 5ft. by 2ft., and weighing 17,500 lb. It is supported by twelve double-coil springs, the outside diameter of the coil being 8in., and the height 9¾in. when open, and 5½in. when closed. When compressed to a height of 7in., the twelve springs will support 80,000 lb. The axle supports are dovetailed into the block, and are placed 3ft. apart between bearing points. The drop weighs 1640 lb., and its maximum height of fall is 43ft. The axle supports are grooved to receive the axle, and the bottom of the groove, in line with the axis of the axle, is curved convex toward the axle to a radius of 5in., so that the axle lies on rounded bearing points. The bottom of the drop weight is also rounded to a radius of 5in., so that it touches the axle only at the middle point. The resistance of the anvil is made up chiefly of the inertia of the mass of iron, weighing 17,500 lb., and the slight movement that takes place is against the resistance of the springs, which is a constant quantity for a given movement. The *Railroad Gazette* says the improved drop offers an opportunity for a comparison of tests made at different times and places, which comparison cannot be satisfactorily made at present on account of the variable condition of the foundations.

NOTES AND MEMORANDA.

The mean temperature of the year 1895 at Greenwich was 49·3 deg., being 0·1 deg. below the average for the fifty years 1841-1890.

In the year ending 1896, May 10th, photographs of the sun were taken at Greenwich with the Dallmeyer photoheliograph, mounted on the terrace roof of the south wing of the Physical Observatory, on 229 days, and of these 459 have been selected for preservation, besides fourteen photographs with double images of the sun for determination of zero of position-angle. For the year 1895 Greenwich photographs have been selected for measurement on 249 days, and photographs from India and Mauritius—filling up the gaps in the series—on 113 days, making a total of 362 days out of 365 on which photographs are available.

It is not a little remarkable that, while the United States are making really considerable advances in the application of machinery to the mining of coal, much less is being done in that direction in this country. A recent official report shows that in the State of Illinois last year the output of coal was 17,735,000 tons, of which 3,531,000 tons were produced by 322 machines. The total number of employés of all descriptions was 38,630, and the total number of boys over fourteen underground was only 811. The *Engineering Review and Metal Worker* says, average value of the lump coal produced in 1895 was only 0·932 dols., or about 46½d. at the mines, and the average price paid for hand-mining was 0·573 dols., or 28½d. per ton.

M. Charles Margot, of Geneva, has recently prepared some interesting aluminium alloys. Thus he finds that 72 parts of platinum and 28 of aluminium give an alloy having a golden yellow colour, whilst other tints can be obtained by varying the proportions of the two constituents. The latter, however, are unstable, breaking up spontaneously. The yellow alloy, on the other hand, is stable, but is brittle. An aluminium alloy containing 75 per cent. to 80 per cent. of cobalt has a colour ranging from straw to brown. It is extremely hard, and will scratch glass, but is very brittle, being easily powdered. Seventy-two per cent. of palladium gives with 28 per cent. of aluminium an alloy having a copper red colour. It is hard and brittle, but stable. With 82 parts of nickel to 18 of aluminium a straw colour alloy is produced, which is as hard as tempered steel, and can resist a hammer blow very well. *Aluminium* says it takes a fine polish, and has a fracture resembling that of bell-metal.

At a recent meeting of the Berlin Physical Society, Dr. du Bois spoke on the magnetising and hysteresis of various kinds of steel and iron, basing his remarks on experiments made in conjunction with Mr. E. T. Jones. The discrimination of different samples of iron by means of their hardness has now lost all its importance; the real criterion is rather hysteresis, coercitive power, residual and maximal magnetisation, which had been determined, together with other magnetic properties, for a large series of samples. Chemical composition is of less importance than the mode of treatment during manufacture from ore to metal. The magnetic constants of the material are of importance to physicists and technologists. The speaker then gave the results of his measurements for three kinds of iron with maximal, and three with minimal hysteresis. As a general rule hardening increases hysteresis and coercitive intensity, whereas residual magnetism is lessened. Krupp's cast-iron is distinguished by its low hysteresis and small coercitive intensity.

In a recent issue of the *Moniteur de la Céramique et de la Verrerie* we find an interesting article by Mr. Leon Appert, the distinguished glass expert, in which he discusses the prominent part which, he thinks, aluminiun is destined to play in the manufacture of glass. "After having made numerous analytical tests of ancient window glass," says Mr. Appert, "I have arrived at the following conclusions, which appear to be of practical, industrial value. The introduction of aluminium into glass prevents or, at least, retards devitrification, which will occur always by the slow and repeated lowering of the temperature. The presence of aluminium makes it possible that a part of the alkaline bases, soda or potash, may be replaced advantageously by an equal quantity of lime. Glass thus modified in its composition is more solid, less changeable, and more elastic. The aluminium can be added to the silica without any inconvenience in a proportion not exceeding 7 per cent. to 8 per cent. The fusibility of glass is slightly increased thereby, while its ductility is not sensibly diminished. The only inconvenience that can arise from the use of aluminium is that it will colour the glass to some extent. This colouring does not result from the aluminium itself, but from the action of the iron oxide, which is always found in it when in an impure condition.

A correspondent of the *Centralblatt fur die Textil-Industrie*, who complains that several belts are dirty from drop oil and dust and desires to know how to clean them, is told by that journal, whose remarks are translated by the *Industrial Record*, to first wash the belts with warm water and soap, using a sharp, stiff brush, and while still moist, to rub them with a solution of sal ammoniac, which saponifies the oil in them. Immediately thereafter the belts must be rinsed well with lukewarm water and then dried with sufficient tension. While they are still moist the belts are to be rubbed well on the inside, and less on the outside with the following unguent: 1 kilo.—2 lb. ¾ oz.—india-rubber heated to 122 deg. Fah. and mixed with 1 kilo. rectified turpentine oil. After the solution is complete, 780 grammes—27 oz.—bright resin are added, and when it is dissolved, 750 grammes—26½ oz.—yellow wax are added. This mixture, by diligent stirring, is mixed with 3 kilos.—6 lb. 10 oz.—fish oil and 1¼ kilos.—2 lb. 12 oz.—tallow previously dissolved in the former. In the further treatment of the belt, rub the inside only and the outside only the first time as stated. This unguent also replaces the tannin extracted from the leather, prevents the dragging of the belt, and imparts elasticity to it.

In a recent paper on "The Relief of the Earth's Crust," by Professor Hermann Wagner, of Gottingen, an abstract of which, by Mr. Hugh Robert Mill is given in *Nature*, some interesting figures are given. By means of the hypsographic curve connecting elevations and percentages of area derived from measurements of height, depth, and area of land and water, the surface of the lithosphere is divided by Wagner into five regions, in place of the three suggested by Dr. John Murray, and hitherto accepted by most physical geographers. The five are as follow:—The culminating area of the earth's crust, occupying 6 per cent. of the surface, and lying altogether above 1000 m., with a mean height of 2200 m., or 7200ft. above the sea. The continental plateau, occupying all the surface from the 1000 m. contour line of elevation to the 200 m. contour line of depth, *i.e.*, to the margin of the shallow sea-border or continental shelf. It comprises 28·3 per cent. of the surface, and has a mean elevation of 250 m., or 800ft. above the sea. The continental slope, from a depth of 200 m. to 2300 m. below sea level, covers 9 per cent. of the earth's surface, and has a mean depth of 1300 m., or 4300ft. The oceanic plateau, between the depths of 2300 m. and 5000 m., occupies no less than 53·7 per cent. of the surface, and has a mean depth of 4100 m., or 13,500ft. Finally, the depressed area, deeper than 5000 m., is assumed to occupy 3 per cent. of the surface, with a mean depth of 6000 m., say 20,000ft. In this classification of regions the coast line is ignored, the abrupt change of slope at 200 m.—or rather the familiar 100 fathom line of our charts—being rightly given the greatest weight in a hypsographic study. The mean level of the surface of the earth's crust is placed by these calculations at a depth of 2300 m., or 7500ft. below actual sea level. The area of the continental block, or region above the mean level of the crust, is found to be 43·3 per cent. of the surface, leaving 56·7 per cent. for the deeper region.

MISCELLANEA.

The Local Government Board have sanctioned a loan of £7500 to Wednesbury for a scheme of sewage disposal designed by the engineer to the Corporation, Mr. Edward Pritchard, M. Inst. C.E., Birmingham.

Mr. Hubert A. Garrett, A.M.I.C.E., Senior Lecturer in Engineering, University College, Bristol, has been appointed head of the Engineering Department at the Northern Polytechnic Institute, Holloway, London, N.

The applications of compressed air have become so immense in the United States that a monthly periodical has been started entitled *Compressed Air*, devoted to the useful applications, amongst which in No. 2 are sheep shearing, underground tramway working, compressed air in work shops, machine shops and foundries, and brakes.

A very interesting table of wheat prices appears in the Minnesota labour statistics lately compiled. In 1867-70 it is shown that the British miller paid 175·6 cents for Minnesota wheat, of which the North-Western farmer received 65·3 cents, the difference, 110·3 cents, being what was absorbed by dealers, middlemen, and transportation companies. This difference declined to 32·7 cents in 1887-90, the price for the farmer being 73·4 cents.

In the United Kingdom, Germany, Belgium, and the United States most, if not the whole, of the coal consumed is of native production. Of Russia's consumption 79 per cent. is her own coal, 17 per cent. is British coal, and 4 per cent. comes from other countries. In Sweden 88 per cent. of the coal consumed is British, in France 12 per cent., in Spain 50 per cent., in Austria-Hungary less than 1 per cent., and in Italy nearly the whole is of British origin.

The use of a channelling machine to open trenches in asphalt pavement is being attempted by Wilson and Jackson, contractors, of Chicago. This firm has secured a channelling machine built by the Sullivan Machinery Company, of Chicago, and will use it in cutting through the asphalt and macadam roadways which are being trenched for the electric wire conduits of the new electric lighting system now being constructed by the West Chicago Park Commissioners.

On the 15th inst. a traction engine, belonging to Mr. Roger Fenton, of Torquay, was going down Fore-street, Teignmouth, when, it is said, the driver lost control of it, and the weight of three trucks of bricks which were attached gave it such an impetus that it went through a confectioner's shop window, demolishing the side wall and the entire window. A little girl named Waite, about six years of age, ran into the doorway, and was killed instantly.

The annual conversazione of the Society of Arts was held last evening in the galleries of the South Kensington Museum. Over two thousand invitations were issued, and a very large concourse attended. The guests were received by the chairman of the Society, Major-General Sir J. Donnelly, and the members of council. Promenade concerts were given by the band of the Royal Artillery in the North Court, and by the Red Band in the Textile Court, and entertainments were given in the Lecture Theatre.

In these days, when so many railroads are built on paper alone, it is refreshing, says the *American Manufacturer*, to note the beginning of a project which is to be put through. Such is the new Butler and Pittsburg Railway, which was organised a few days ago. Mr. Andrew Carnegie, chairman of the Board of Directors, has subscribed 2,500,000 dols. of the 3,000,000 dols. required to build this road. This line, although short, will be a very important one. Its entire length will be but forty miles. It will run from the Edgar Thomson Steel Works, at Braddock, to Butler, where it will connect with the Pittsburg, Shenango, and Lake Erie Railroad. Its route will be along the Alleghany River to Deer Creek, and up the creek straight to Butler. This line will doubtless have an influence on the ore carrying trade, as it will furnish the Pittsburg district another outlet to the lakes. This road will further assist Pittsburg in meeting that fast-growing tendency to move the iron manufacturing industries towards the lake region.

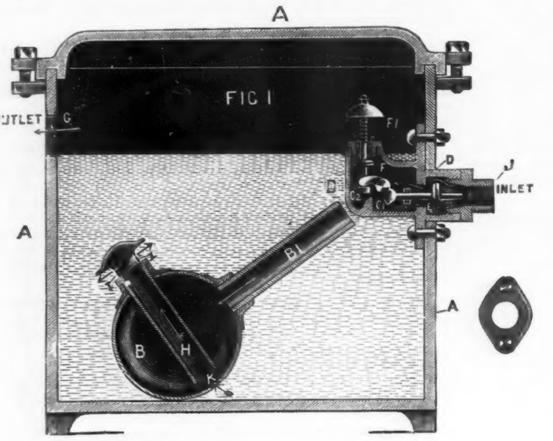
The first cotton spinning factory in Japan was erected in Satsuma by Prince Shimazu Narihisa. In 1850 he established a scientific laboratory in his grounds, and encouraged investigations in Western medical and chemical sciences. He took a great interest in photography, telegraphy, glass making, and gas manufacture. Three years later he established a workshop near his summer villa, in which he made many experiments in machine and engine construction. He also erected at Niriiso, a suburb of Kugoshima, a spinning factory, which still stands, and in which there are 3000 spindles in operation. The machinery was supplied by Platt Brothers, and was fitted up with all the best appliances of the time. The enterprise was started without any thought of profit-making, and everything was done on an elaborate and expensive scale. An Englishman was engaged as superintendent. The yarns soon obtained a high reputation, and were employed in weaving the well-known cotton fabric of Kuagoshima, *Satsuma kasuri*.

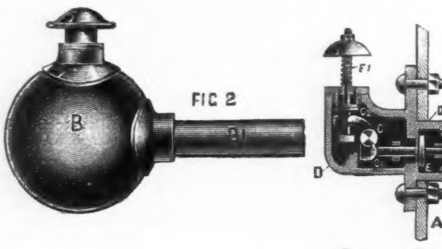
A sudden stop to the machinery at the Star Manufacfacturing Company, Ramsbottom, was recently caused by the breaking of the main driving belt. This belt is 30in. wide, and transmits about 300-horse power, which drives 700 looms and preparing machines; the driving wheel is 27ft. in diameter, and weighs 25 tons, and the velocity or speed of belt is 4100ft. per minute. It was at once concluded in the mill that the engines had broken down, but they were found to be working at the ordinary speed, without any load upon them, or in any way whatever damaged. After two days' stoppage for piecing the belt the machinery was again set in motion. The engines are horizontal compound side by side, made by Messrs. William Sharples and Co., Ramsbottom; they are controlled by their automatic crank-shaft governors, which are connected direct to the expansion valves in the steam chests, and no doubt prevented a very serious accident. It would be interesting to know the condition of the belt and what was the nature of its breakage; a pull of about 80 lb. per inch of width is not heavy.

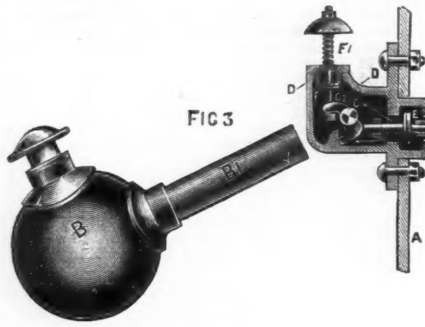
In moving the second reading of the Floods Prevention Bill on Tuesday, Lord Thring said that it was a very simple measure. It was not intended to deal with great calamities, but was intended to provide the local authorities with moderate powers for preventing floods in cases where no such power could be exercised at present. It was a permissive Bill, and proposed that where there were no drainage areas the county council might have power to remove obstructions, repair works, facilitate the passage of water, cleanse watercourses, &c. There was no compulsory power of rating. The county council might, if it thought that it would be for the benefit of the county, pay the expenses out of the county rate, or, if the local authorities were willing to consent and desired to be assisted, the charges might be made partly on the locality and partly on the county. After some remarks by the Marquis of Salisbury, Lord Thring said he should in Committee move to insert a clause saving all the conservancy boards and all elected drainage boards, and it was not intended to interfere with the existing drainage areas. The Marquis of Salisbury said he did not suppose such an idea would cross their minds, but if the County Council were disposed to make a new bid for the river Thames it would be in their power to do so under this Bill. He had no cause to think that any county council would go so far mad, but still the powers were very extensive, and rather in excess of the modest language used by the noble lord. The Bill was then read a second time.

A NEW STEAM TRAP.

THE accompanying illustrations show the construction of a new steam trap now being introduced by Mr. Edward Yates, New Mills, Stockport. It is claimed that this steam trap is essentially distinct in principle from all other traps. When steam is turned into pipes or apparatus that this steam trap is connected to the action is as follows:—The copper ball float B is at the bottom of cistern A, and causes the cam C 1 to hold open the entrance valve E and cam C 2 to hold open the air valve F against the pull of the spring F 1; these cams are on a pivot C in the small valve and cam chamber box D, and are connected to float B by float arm B 1; the air which always comes first is blown away through the air valve F into cistern A, and then away through the outlet G instead of entering the float and causing it to rise prematurely, as is the case with some other traps. The water will next flow through the valve E into the chamber D, and down the elbow pipe B 1 into the float B, up the down pipe H and through the outlet holes I into the cistern A, and away through the outlet G. The steam at last follows the water, and as the area of the steam inlet valve is greater than that of the air valve, the air valve cannot pass the steam admitted by the inlet valve, so it at once forces the water out of the float up the down pipe and leaves it buoyant. It immediately rises, Fig. 2, relieving the position shown in the cams from the valves and allowing the pressure to close the valve E, and the spring F 1 to close valve F without loss of steam, or hammering of the valve faces on the seating. There is a small hole K in the bottom of the float B, which begins to fill from the water in the box A, consequently destroying its buoyancy and causing it to fall and force the cam C 1 against the entrance valve E and push it away from its seating. If live steam be there it will at once rise and allow valve E to close again as before without loss of steam, but if water be present it will receive it all. Cam C1 operates on the entrance valve E first, and will discharge all the water without disturbing the air valve whilst working, and only open the air valve when the apparatus is stopped.







Its action is similar to that of a man standing by a wheel valve and keeping it open so long as condensed water is flowing out, closing it as soon as steam appears, slightly opening it again to see if there is any more condensed water, and if so keeping it open and allowing all condensed water to escape, and closing it as soon as steam commences to appear, and so on alternately.

THE METRIC SYSTEM IN OUR WORKSHOPS: WILL ITS VALUE IN PRACTICE BE AN EQUIVALENT FOR THE COST OF ITS INTRODUCTION?*

By COLEMAN SELLERS.

IN view of the movement which has recently been made to establish the metric system by compulsion in this country, we think the following paper, by a very eminent American mechanical engineer, will be read with much interest. The paper was written twenty-two years ago, but nothing has occurred since to alter the facts or modify Mr. Sellers' line of reasoning:—

IN compliance with the invitation of the General Supervisory Committee, as expressed through your secretary, that, as an associate member of the American Railway Master Mechanics' Association, I should prepare a paper on some subject relating to the objects for which this Association has been organised, I have decided to call your attention to a matter which may before many years be forced upon you, and which you should be prepared to consider with care; I allude to the proposed introduction, by legislative enactment, of the French system of measurement, known as the metric system.

It is not my intention to discuss the subject in all its bearing, for it is a theme requiring more pages of manuscript than I would care to inflict upon you. But I will state in as few words as possible how the proposed change would be likely to affect the workshops of the land. It is now about three-quarters of a century since the metre was first made the legal standard of length in France, and during that time it has been adopted by other countries, either in full or in part, so that the advocates of its universal adoption claim that the proportion of the population of the globe already enlisted in its use numbers 420,000,000. Hence they argue that, for the sake of a uniform metrological system all the world over, England and the United States of America should also adopt it to the exclusion of our present system of inches, feet, &c.

Many of our leading colleges are making the metric system the method of measurement in all their teaching, with a view to sending their graduates into the world as advocates of what to them seems so perfect a system.

There can be no doubt that it is very desirable to have uniformity, not only in regard to measurements of all kinds, but also in money, as such uniformity would certainly facilitate trade and advance our knowledge of the works of other countries. Those who use the metric system in all scientific matters find it wonderfully well adapted to facilitate calculation. In spite of its long names, it is easily understood by persons of moderate education, and can be used even by those who have no idea of the Latin and Greek words from which the names are derived. If the world, as we know it in our arts and trades, was to be made over again, and we were obliged to adhere to ten as the base of our arithmetic, it would doubtless be a good thing in some respects, but very unhandy in more respects, as not admitting of binary division. I have heard it declared by men of high intelligence that its introduction now is retarded only by prejudice, by the unwillingness of people to give up what they are used to, and the necessity of learning certain new rules and methods of thought. Unfortunately, maybe, there is something more than these objections that will retard its introduction. The change involves the expenditure of money—of very large sums of money. When this cost is presented to our minds, we may well consider whether the results to be obtained will warrant the expenditure.

The late Senator Sumner was its earnest advocate, and at one time was determined to push the adoption of the metric system. He said to one of our most distinguished scientists, "I am content to have it legalised in 1870, and to have its use then optional, but in 187— I would make its use compulsory." The gentleman to whom he addressed himself asked if he had well considered what a tax such a measure would impose on the country. "We have now in use," he said, "in all kinds of trades, the pound as our unit of weight, and Messrs. Fairbanks and other scalemakers have for years been making platform scales with beams graduated to pounds. The edict that abolishes the pound will necessitate a change in all these machines for weighing. All their beams must be removed and regraduated to the new unit at an enormous expense." He instanced the change in the weight unit as the one most readily made, as it in the main affects perishable property only.

On February 8th, 1870, a resolution was passed in the United States Senate, that "The President be requested, if not incompatible with the public interests, to invite a correspondence with Great Britain and other foreign Powers with a view to promote the adoption, by the Legislatures of the several Powers, of a common unit and standard of an international gold coinage," &c. In accordance with the spirit of this resolution, a dispatch was prepared by the Department of State.† In this paper, after recounting the requirements of such a unification in coinage as shall not prejudicially affect our interest, it says:—

"It is to be observed that an identity in the measures of value in the different countries will not completely attain the beneficent results which are sought, unless there be also an identity in weights and measures. . . . In commercial transactions an identity in measures of value would be of comparatively little use if unaccompanied by identity in the measures of the quantities to which those values are applied. There would still be a necessity for the intervention of an expert to shift the expressions of the measures of quantity from the terms used in one country to those in use in the other. The resolution of the Senate does not contemplate the extension of this correspondence to these points, nor, in my judgment, would it be desirable to do so.

"It would probably not be difficult to induce the people of different countries to adopt a common standard of weights and measures so far as perishable property is concerned. At first the adoption of unaccustomed systems might cause inconvenience and discontent, but if they should prove to be better than the old ones, and if they should have the further advantage of being common to several countries which possess a common standard of value, and which have extended commercial relations, it is probable that the inconvenience would be patiently submitted to, in view of the greater benefits to be derived from the change.

"But it seems to the Government of the United States that a forced change in the measures of distance, as applied to imperishable property and the permanent investment of capital, may be attended with more serious inconvenience. Thus while it may be practicable to establish a new standard of length-measure for articles of international commerce, such as textile fabrics which are consumed and do not remain, it may be more difficult to make the same change in the standard for permanent values. A few examples will demonstrate the difficulties that would probably attend a change in such measures in this country. . . .

"It is the custom in the United States to lay out all towns and cities in regular quadrangles, and to divide each quadrangle into an even number of lots with an even number of feet. This has been found a convenient mode of dealing in town and city lots and in town and city houses. To make an arbitrary change, which should abolish these measures and substitute different ones in their places, involving the use of fractional numbers, would occasion great inconvenience, and might check the dealings in this species of property, and cause a loss to those who happened to be holders at the time of the change. Again, the whole system of titles in those states which have been created out of the public domain rests upon Government survey, whose results are expressed in the English mile and its subdivisions, rods, feet, and inches. To substitute a different measurement would be a work of serious magnitude.

"Again"—and this is what most seriously affects our interests—"the manufactories of the country are filled with machinery, whose delicately adjusted parts, measured in feet, inches, and component parts of the inch, work together in one grand whole, which is in its turn combined in the same system of measures. To produce this machinery, thousands of shops are filled with costly plants, adjusted upon the same scale, whose delicate operations often require a nicer determination of measurement than can be obtained without mechanical aid. To transmute these measurements so delicate and accurate from the present system into a new one, would appear to be an almost endless labour, if indeed it be a possibility."

To show how clearly these statements express the difficulties that would attend our adoption of the metric system, I will call your attention to certain conditions of the mechanic arts in America, perhaps not fully appreciated by those who think the change is one of education only.

Eli Whitney, whose name has always been associated with the invention of the cotton gin, started in 1798 an establishment for the manufacture of small-arms on the principle known as the interchangeable system, carried out by the use of hardened jigs or forms of the same shape as the parts to be produced, thereby making all parts of guns alike and interchangeable one with another. He introduced the use of milling by means of revolving cutters, those intricate shapes needed in gun work. When he proposed to Thomas Jefferson, then Secretary of State in Washington's Cabinet, to make an arm modelled after the approved French Charville flint lock, in which all parts of all guns should be interchangeable, he was ridiculed by both French and English ordnance officers. The Government aided Mr. Whitney, and in 1800 the Springfield Armoury was established, and Mr. Whitney's inventions and system put in force there. It was not until 1855 that the English War Department was forced to adopt the same system, importing a large amount of machinery from America for that purpose.

This was not the only branch of the mechanic arts that was benefited by this interchangeable system. America, contending with high labour, has been forced to exercise ingenuity, and make labour-saving machines produce cheaper work. This could only be done by carrying the interchangeable system into other processes of manufacture, and American clocks, watches, sewing machines, and all the countless small articles of hardware, are made by machinery, each piece like the others. Recognising the absolute need of this interchangeable quality in everything manufactured, but few trades exist in this country that do not avail themselves of its advantages. Gradually, separate and distinct manufacturing establishments have come to use the same standards and to make their production interchange one part with another. Witness the various devices making up what is known as line shafting, as also all the screws and fittings for steam, gas, and water pipes, and now the so complete recognition of the American system of screw threads for bolts and nuts. The primary object of this Association may almost be said to be to introduce uniformity in all parts of the great railroad system of the United States. There is no country in the world where the value of uniformity in the devices used in common by all mechanics is so fully recognised as in this land of ours. What has been done in this direction, and what is being done now, is founded on the inch as the unit of measurement in the machine shop.

The machine shop, however, is not independent of other trades, and it is necessary to a proper understanding of our subject that we have a clear perception of the nature of this interdependence. Machines made of metal have parts cast and parts forged. Wrought iron is procurable in bars of certain merchantable sizes. When rolling mills are obliged to make round iron, differing in diameter from these merchant sizes, the price per pound is increased as special appliances and extra care is required. So the mechanical engineer conforms his proportions to the procurable sizes of bar iron, and uses the iron, as far as possible, without the expense of re-forging into other sizes. This is noticeably the case in regard to rounds and squares. The tools and appliances in the machine shop have in time been made to conform to these sizes, and are all expressed by the division of the inch into halves, quarters, eighths, and sixteenths. All the gearing in the country, all the patterns of cog-wheels, are spaced in the teeth, by pitches, measured in inches, and the binary division of the inch, ¼in., ½in., 1in., 1½in., &c., pitch; or, in number of teeth to the inch in diameter, called in practice per inch wheels, as 12, 10, 8, or 6 per inch, meaning so many teeth to each inch in diameter; as, for instance, a wheel 3in. in diameter cut to ten per inch, has thirty teeth, *i.e.*, 10 × 3 = 30. The patterns of gear wheels in some instances form no insignificant part of the stock-in-trade of large machine shops, and the immense number of wheels now spaced to pitches in inches must necessitate the continued use of them, whether we call the pitch 1in. or 25·38 mm.

When the metric system was introduced into France, all machine work was done by hand; the planing machines for metals, and all the various appliances known as machine tools, with the exception of the turning lathe, were almost unknown. Sizes expressed in one measurement or another were of less moment than now. I dare say many of my hearers remember the time when the rule-of-thumb was the mechanic's rule; when the "boss" chalked out on the carpenter's bench a thing about "so big," to be made in metal, and then some other thing was made to fit it; at such time it mattered little what standard was used as measure. While French *savants* were labouring to build up this decimal system of interchangeable measures, the better class of American mechanics were solving the problem of making machinery with interchangeable parts. I am perfectly willing to concede that there are workshops in the land in which the change from the inch to the metre could be made at very little cost, simply because these shops are furnished with no special devices for measurement even at this day; such drills and mandrils as they may have are altered in size at the whim and fancy of the workmen. The proprietor of one of this class of shops asked me not many years ago if we had a pattern of a spur wheel of some pitch and diameter, and when I asked him if he had measured the diameter at the pitch line of the wheel, he wanted to know what the pitch line meant. Metres would do for that man quite as well as inches. Such machinists, in stating dimensions, use the terms "full" and "scant" to express fractions which might be quite readily stated with accuracy; sometimes, however, indulging in the extra expression of a "leetle full scant" for very nice measurement.

A well-furnished establishment is provided with gauges, mandrils, reamers, standard drills, and boring tools, as well as all other appliances needed for accurate work made to certain fixed sizes, and in most shops these special tools amount in value to large sums of money. The nomenclature of the sizes of these tools, as expressing the work they are expected to do, is part of their economical use; thus, an inch reamer is expected to make a hole exactly 1in. in diameter, and no great effort of memory is needed to designate its size, but this same inch reamer will make a hole 25·38 mm. in diameter, which is the same size expressed in French measurement.

In the machine shop the unit of measurement is the inch; it is not the foot nor the yard. We express in inches all measurements of objects that may sometimes be made less than 1ft. in size. Thus, pulleys are rated as 5in. or 10in. or 72in. in diameter. Boilers are spoken of as being 36in., 42in., or 48in. diameter. Car wheels are 30in., 32in., or 36in. in diameter. For all calculations in the drawing-office we use the inch and its decimal divisions, corresponding exactly with our dollars and its division into halves, quarters, eighths, and sixteenths. As in money, we say half a dollar or 50 cents with equal facility, so in measurement we have the ½in. or ·50in., each as expressive of size as the other.

(*To be continued.*)

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* A paper read at the Chicago Meeting of the American Railway Master Mechanics' Association, May, 1874.

† See "U.S. Report on Foreign Relations for 1870.'

A NEW LUBRICANT FOR RAILWAY AXLES.

THE Ministry of Prussian State Railways is conducting elaborate tests of a new composition for lubricating the axles of railway wagons. The Minister of Railways takes the liveliest interest in these tests, which are made with the usual exactness of the Prussian officials. The following is a summary of the results obtained from official sources.

On January 27th, 1896, Corridor Car No. 562 was selected by the Directory at Halle, by order of the Minister of Railways, and the new composition applied to its eight axle-boxes. The method of application was to impregnate sixteen cushions, such as are ordinarily used on railway wagons in Germany, with the composition, rendered liquid by heat, and to place two in each box under and over the journals. In addition, some of the composition was put in each box. The total weight of the lubricant applied was 16 kilos. The car was put on the regular train service between Berlin to Frankfurt-on-Main, starting from Anhalt Bahnhof. After running 5000 kiloms. a slight addition of lubricant was made in each axle-box. At the end of 30,000 kiloms. run an official inspection was made at Berlin, and a report submitted to the Minister of Railways.

It was found that the total weight of lubricant which had been applied during the running of 30,000 kiloms. was 31 kilos. The cushions were taken out of the axles-boxes and weighed, and the grease remaining in the boxes was also removed and carefully weighed, the total being 25·700 kilos. The net weight of the cushions without grease was 4·160 kilos., and 1 kilo. of the grease, which had become blackened by the dirty oil formerly used was discarded. The remaining 20·540 kilos. were returned to the axle-boxes and new composition added. The net consumption for the 30,000 kiloms. run was taken at 10·540 kilos. A second and a third test of running 30,000 kiloms. followed in succession, and the consumption was found in each instance to vary but slightly from 10·460 kilos. for each 30,000 kiloms. run. Altogether wagon 562 ran between Berlin and Frankfurt-on-Main, 90,000 kilos., and the total consumption was 31·400 kilos., which is at the rate of ·349 grammes per kilom. run. The same car is now running on the fourth test of 30,000 kiloms., with like satisfactory results. After the first run of 30,000 kiloms, and cleaning out the boxes there has been no discoloration of the composition. A third cushion is put in each box to fill the space at the ends of the axles because it is found unnecessary to have so great a quantity of the composition in the boxes; and by this means it is also found that the boxes can be made dust and dirt-proof.

Making the comparison as to cost for lubricant with the cheapest oil sold in Germany, 20 Pf. per kilo.—the price of oil actually used by the State railways being considerably more —the saving, according to the official figures, in material cost per vehicle comes out at marks 15·84 per each 30,000 kiloms. run, or about 53 Pf. per each 1000 kiloms. But the saving in cost of material is not all, since no labour is required, and no time consumed in examination and in applying lubricant except at the end of each 5000 kiloms., when the boxes are opened, and a slight addition of the composition made. The severest cold known in Germany does not affect the composition, as its freezing point is - 28 deg. Cent. On the other hand, the melting point is so high that the warmest weather ever known there will not cause it to run. There is not the slightest dripping from the boxes, and consequently no waste. In over 100,000 kiloms. run by wagon 562 there has not been the slightest indication of heating of the axles.

Reducing the foregoing metric figures to English weights and measures, the results come out approximately as follows:—One application of the composition suffices for a run of 3100 miles of train service, and in running 18,600 miles eight axles consume less than 23 lb. of the lubricant, which is about 1½ grains per 100 miles run for each axle-box. The saving in material cost, as compared with oil of the cheapest German quality, is 10¼d. per 1000 miles of train service for eight axle-boxes.

USE OF ELECTRICITY ON BOARD SHIPS.*

By HERR F. EICKENRADT, Engineer Inspector.

IN endeavouring to comply with the flattering request of speaking before this assembly, I have chosen for this purpose a subject which at the present time should engage the attention of shipbuilders in general, viz., "Use of Electricity on Board Ships." First of all, I beg leave to request the distinguished company here assembled not to criticise my statements with the eye of the technical electrician, as I do not pretend to pose as a specialist in this subject. I rather shall endeavour to treat the question merely from the point of view of the shipbuilder. Excepting in isolated cases of minor importance, electricity has only been recently brought into more extensive use for working auxiliary machinery on board of ships. Not only has the technical electrician endeavoured in the last few years to interest the shipbuilding industry in the application of electricity, which took such enormous strides in its development, and to draw the equipment of ships into the province of their commercial supplies, but also the shipbuilder—whose work may be described as a rallying point of every new technical invention developed to its utmost extent and completeness, and who is thereby obliged to follow every further step onward with ever-watchful eye—could not afford to neglect the obligation to make a practical test of the value of the electric motor on board ships.

The first question, from the point of view of the shipbuilder, was to ascertain whether electricity, as such, had special advantages to offer over steam power, hitherto generally employed. This question may be answered with a decided "yes" in many cases. The large number of auxiliary engines which are in use on board modern steamers, and still more so on men-of-war, not only as accessories to the complicated main engines, but also for all other possible purposes, necessitated the laying of steam pipes into almost every nook and corner of the ship, both for the purpose of bringing steam power to the spot, and for carrying away the waste steam after use, a fact which does not exactly contribute to the comfort of the crew. This network of pipes produces, notwithstanding the most careful covering with non-conductors, not only troublesome and unnecessary heating of spaces where it is not required, but leads to still greater inconveniences in consequence of the damages to which such steam pipes are unavoidably subjected. The leaking of a single flange may make staying, even in large rooms, perfectly impossible. All these evils are avoided if the transmission of power to the different points for use is effected by a wire, which, when properly adjusted as to dimensions and well insulated, has absolutely no effect upon its surroundings. The second question is, whether the electric motor is superior to the steam motor. As to this, it must be admitted that a steam engine in every part of the ship is disagreeable; it emits heat, and is exposed to many accidents, which may produce detrimental, and, in some cases, even disastrous effects to its vicinity. Such accidents do not arise to the same degree with the electric motor, besides which it has the advantage of being very simple to manipulate, as long as it is at all efficient for use, and, what is especially of importance for the circumstances on board ship, it is much more clean to handle than a steam engine.

I make this reservation with the electrical motor "as long as it is efficient for use." This point appears of importance in regard to its usefulness on board. The electric motor has, however, hitherto remained quite unknown to the engine-room *personnel*. They are not sufficiently familiar with its arrangement, especially with the often very complicated supplementary contrivances, and they do not know what to do when a breakdown occurs. On the other hand, it must be admitted that the technical electrician has already recognised this fact to a certain extent, and has provided for it, partly by simplifying every apparatus which will have to be entrusted to unskilled hands as much as possible, the reliability of the working of which has to be safeguarded under any circumstances, and partly by excluding those parts which do not require special attention from any possibility of being touched by incompetent hands. Supposing that a motor has been constructed, in this respect, with the most complete perfection, the only attention it would require would be that, at certain intervals it is necessary to inspect the bed-plates, and to ascertain the condition of the insulation in the wires. With such simple attention it becomes possible to supervise several motors, which are worked from a common centre, by a very limited number of hands, which undeniably is a great advantage.

I shall now proceed to consider successively the following subjects, viz., installations for lighting, ventilation, and heating, ships' winches, ammunition supplies, appliances for moving guns, and steering apparatus.

Lighting.—When electric lighting was first introduced, there were indeed many opponents, but to-day its abolition is beyond any discussion. Its reliability of working is fully safeguarded with the dynamos in use at the present time, and any danger of fire is as good as excluded, when the installation is properly and scientifically made; therefore the advantages of electric lighting are now so generally acknowledged that even on small cargo steamers, where only a limited number of lamps are required, a small dynamo engine is installed for lighting purposes. Electric lighting installations are indeed reckoned amongst the sanitary fittings of ships, and while mentioning this we are involuntarily driven to the question whether in this respect further improvements might not be obtained by means of electricity. In answer to this question we are led to consider ventilation and heating apparatus.

Ventilation.—Good ventilation on board, both for living rooms and cargo spaces, may now be considered as a generally admitted necessity. But every shipbuilder is aware of the difficulties which the solution of this question presents in regard to natural ventilation, and artificial ventilation has therefore taken its place everywhere on board already. An arrangement of tubes emanating from a central point and leading into every part of the ship would appear to be the most advantageous. However, the carrying out of such a system would be connected with enormous difficulties, considering the circumstances on board ship, and having regard to the conditions which would have to be fulfilled in order to make it efficient; and especially taking into consideration the necessity of preserving the water-tightness of the bulkheads, which would absolutely forbid the passage of air tubes through them. The shipbuilder is therefore obliged to divide the entire system of ventilation into several parts, each independent of the other, and must make allowance for the division of the ship into water-tight compartments. For the working of these separate ventilators, which frequently have to be fitted up in out-of-the-way corners, which are difficult of access, a steam engine has to be again supplied, to which the evils previously enumerated are especially applicable, and which necessitates again a special attendance. For the working of such ventilators, therefore, the electro-motor is excellently adapted, and its driving may be effected from any easily accessible place with the same facility as if it were situated in the immediate vicinity of the ventilator. The kind of motor here in question is of very simple construction, does not require any complicated auxiliary arrangements, and will keep on running without any attendance at all. If there are not many ventilators of large dimensions to drive, the installation of a separate current circuit may be avoided, and the ventilators may be connected with the circuit for the lighting, for which purpose the latter will only experience an immaterial addition to its weight. Should there, however, be several ventilators with fans of 800 to 1200 mm. diameter, and demanding a current of 2000 to 4000 Watts, it is preferable to establish a separate circuit for them.

With regard to the advantages of the electro-motors for this purpose, it is anticipated that they will be generally adopted for the driving of ventilators, and this may occasion, again, an improvement of the systems of ventilation, as they may be extended to spaces which hitherto have been excluded. Also, the ventilators for the stokeholds of boilers under forced draught having a consumption of energy of from 15,000 to 20,000 Watts each, and the engine room ventilators with a consumption of 6000 to 10,000 Watts each, are advantageously driven by electro-motors, because every unnecessary addition of heat to these rooms, which are already very hot in themselves, should be avoided, and because the installation of the ventilators in the heating rooms is often such that the attendance upon a steam motor is thereby made very difficult. In places like the above, where the electro-motors are exposed to the particularly severe effects of coal dust and heat, it is further advantageous, for the maintenance of the good condition of the motor, to construct it inside the suction tube of the ventilator, which can easily be done in centrifugal ventilators, with separate air suction tubes; by such an arrangement the electro-motor will be well protected and kept cool.

Electric heating.—Very little experience is available up to date in respect to electric heating, and, as far as I know, experiments in this direction have only been commenced at a very recent period. Installations for this purpose would offer a great advantage, by enabling us to dispense with the very extensive pipe system required for the steam heating process, with its innumerable flanges, taps, valves, and condensing pipes, all of which details occasion frequent inconvenience, in consequence of leakages and failures in the action of the condensing apparatus. Many perforations through bulkheads are also dangerous inconveniences. All these evils would be avoided in electrical heating, the conducting wires for which could be suitably joined to those for the lighting apparatus with the object of minimising weight and restricting the number of conduits generally, as much as possible. The disadvantage of such an installation consists, however, in the fact that a comparatively large main engine for the generating of current would have to be erected, and that this force would only be fully employed while the limited period for heating lasts. If you take it for granted that a steam heating apparatus with heat-giving copper tubes and a total heating surface of 75 square metres would produce hourly a heat 60,000 calories, an electric heating apparatus of the like power would require a main engine of about 75,000 Watts power, consequently a steam engine of about 100-horse power. The erection of such an engine exclusively for this purpose would, however, only very rarely be suitable for ships. But in case an electric motor is contemplated, say, for boat-hoisting apparatus, &c., which would not be often in use, and then only for a short period, the necessary engine for this purpose might in the interval be used with great advantage for heating. Electric heating all over a ship can, therefore, at present not come into consideration, but it might be advantageous for many spaces where electric lighting has already been resorted to, and where a connection with a steam-heating system presents other difficulties. I should like to mention here that the preceding remarks have been based upon a supposed transmission of 800 calories per hour and per square metre of copper tube in the steam-heating surface. Absolute reliance, however, cannot yet be placed on these figures, and likewise the transmission co-efficients have not yet been exactly ascertained which have to be taken into account for circumstances on board ship. The introduction of electric heating on board, which requires an exact previous calculation of the heating surface and of the dynamo engine, still necessitates, therefore, the investigation of the above-mentioned transmission co-efficients on existing steam-heating installations.

Ships' winches.—The manufacture of electric ships' winches forms already a special department with the electrical engineering firms. They are now so thoroughly understood in all their branches that their general adoption for ships may be confidently anticipated in the near future. The excellent results which many German firms have also shown in this branch have further induced them to go a step forward from the comparatively simple winches for loads up to 2000 kilos. and 3000 kilos. to the heavy boat-lowering winches with a lifting capacity of 10 tons to 16 tons. Such installations, which require a development of force equal to 90 to 100-horse power, can, however, only be advantageously employed when the electro-motor has been adopted for all the auxiliary machinery in a ship. In an installation of this kind it is not requisite that the power of the main engine equals the sum total of the capacity of all the auxiliary engines; the calculations must rather be based upon the total of all the engines which may be in use at the same time. During the period of employment of a boat winch of 50-horse power, which is driven by a central engine, it will always be possible to disconnect a corresponding number of other machines, such as ventilators, pumps, &c.

Ammunition hoists or lifts.—The adoption of electric agency for many motors upon men-of-war appears already of paramount necessity. The working of the great number of ammunition hoists which have become requisite through the ponderous modern armaments, with numerous guns, would necessitate a very large quantity of small but fast-running steam engines, the service of which would unavoidably lead to a considerable increase of engineer hands. The installation of electric motors, driven from a central station and requiring no particular attention and care, seems, therefore, advantageous for this purpose; the more so, as in special cases they are adapted to be fitted in very small dimensions, whereas a steam engine would always occupy a much larger space. If the ammunition supply is not effected by Paternoster appliances, but by lifts, the motors are, however, no longer so simple in their construction as those mentioned before. In the hoisting by lifts, the chairs have to be attached in such a way to the motor that the latter at the ends of travel is automatically stopped and set in motion. Besides, an electric brake must be provided, and by means of special minor appliances the quiet starting of the chair must also be guaranteed. However, there are already numerous installations of this kind in existence, and their efficiency has been proved by practical experience, from the results of which the general adoption of electrical energy for the ammunition hoists may be considered as secured in the near future.

Gun and turret turning.—The manufacture of electrical turning appliances has lately occasioned a lively rivalry; yet, up to date, it cannot be asserted without a doubt, that they will supplant the approved appliances of hydraulic power. Considering the paramount importance of these appliances for men-of-war, the fact that the question has been technically solved in the most complete manner does not only appear to be decisive, but every chance of the gear getting out of order must be practically excluded, and the crew for this service must be so completely familiar with its working that they are able, not only to guarantee its expert handling and the maintenance of its efficiency, but also, in case of need, are able to repair and make good any damage. The current circuit in such installations must of necessity be very complicated, so that a quick detection of any sudden damage requires in any case considerable technical knowledge, especially with regard to the fact that faults in such electrical installations often, unlike those in mechanical appliances, do not show on the outside, but remain hidden in the circuit. In consideration of the necessary shortness of this paper, I must deny myself the pleasure of entering more fully upon particular installations, and I will only state that, with parallel arrangement of the motors in one circuit current, thus avoiding a current of high tension, the connection with the general electro-motor installation and their driving from the general central station can very well take place.

Steering apparatus.—The steering apparatus offers the greatest difficulties for electrical application; but, on the other hand, this makes it one of the most interesting subjects. Before going more closely into the matter of electrical application, I will shortly explain the steam steering gear hitherto in use, in so far as it is necessary for the comprehension of the electrical appliances. The steering gear with its appurtenances may be divided into three separate parts, viz., into the motor proper for working the rudder, into the arrangement of the motor for setting it in motion from the deck, and into the arrangements of the motor for stopping it after the rudder has been moved. In the steam steering apparatus with mechanical appliance for setting it in motion, this is often done by means of a hand wheel, which is fixed on the bridge, and which is turned in correspondence with a scale for bringing the rudder into the desired position. The turning of this hand-wheel turns at the same time a transmission system laid through the whole ship, and moves also, by means of a worm fitted to the end of the transmitting crank, a nut which is in connection with the steam inlet valve, and which thus opens it. By these means the motor proper is put in motion, and causes, by means of the turning of the motor crank, a self-acting return motion of the nut, and places the valve again into its position of rest. As soon, therefore, as the hand-wheel on deck ceases to be turned, the motor will immediately stop itself through its own movement. Every shipbuilder, however, knows the great difficulties caused by the laying of such a long transmission system which has to be worked by hand. Even although the mounting has been successfully completed, it will often happen, after the vessel has been running a short time, that the transmission can no longer be moved, a fact which is due to the contraction and expansion of the bulkheads and decks to which the blocks have been fixed. With the electrical installation, the question is whether the motor, or the moving appliance, or the stopping appliance alone, or the whole apparatus shall be driven electrically. As far as I am aware, the use of electricity for such an entire gear has hitherto not been attempted. In most cases electricity has only been employed for the starting appliance. A combination of the starting appliance with a self acting registration upon the control board on deck by the electric current from the tiller has, however, proved to be so difficult that to judge from what has hitherto been achieved in this direction, we can hardly expect a solution of this problem, at present, which will be satisfactory and always reliable in its action. As it stands to-day, this question allows only the installation of an electrical starting apparatus, which generally is restricted to a common governing apparatus, and which only supplies the current to a comparatively simple electrical apparatus, which in its turn again controls the steam inlet valve. The closing of the valve must then be effected by cutting off the current by means of a separate indicator with a hand showing the position of the rudder, which in its turn again is set in motion by the tiller direct. This apparatus may again be either mechanical or electrical, and several reliable electrical apparatus for this purpose are already in existence.

A very interesting starting appliance, as used on the French cruiser Bouvines, is described in the *Révue Maritime et Coloniale*. Here the distributing valve of the steam steering apparatus is not automatically moved by the apparatus itself, but by a small electrical motor, quite independent of the steering gear, and the latter follows the movement of the valve. The starting of the motor is done from the deck by means of a governing apparatus. Here, however, the current is not led direct into the motor, but first to a relay, which then in its turn governs the motor current. The working of the governor apparatus on deck is effected according to a rudder indicator, which contains several numbered lamps. These different lamps correspond with certain rudder angles, and are lit up by the movement of the tiller. Such lamp signals, which also are employed for engine telegraphs, have, however, the great disadvantage that the different signals which are indicated by the simultaneous burning of different lamps are difficult to distinguish in strong sunlight. It is also very misleading when the different lamps burn with different degrees of brightness, and a failure in consequence of a lamp burning out is also possible.

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* Read at the summer meeting of the thirty-seventh session of the Institution of Naval Architects, June 18th.

If the construction of an electric motor for the steering gear does not at the first glance seem to present any particular difficulties, these are indeed very material. A reversible motor requires a governing apparatus, which must be of very substantial construction, if it is not to be speedily used up, or if undue heating of the same is to be avoided, regard being had to the size of the motor and to the fact that it may have to be worked, perhaps, 1000 times in a day. A continuously running motor, which only moves in one direction, requires again the insertion of electrical couplings for the turning of the tiller to the right and left. The suitability of such couplings for frequent in and out turning has, however, still to be demonstrated. The employment of two constantly moving motors, which work by means of a differential wheel appliance, demand the manufacture of very excellent wheels, if this apparatus is not to work too noisily. This latter machinery is at present in construction in Germany, and the result may be watched with great interest. However, all these contrivances have the disadvantage that they necessitate a very well trained *personnel* for their effective working and keeping in good order. If, therefore, as may with confidence be expected, electrical power is introduced on board ship to a greater degree, the special training of the crew in its use will be unavoidable.

Concluding remarks.—At the close of my remarks I will only touch upon a general question, which is of importance for electrical installations on board. With the increasing employment of electricity on board ship the question arises, whether for such installations continuous or alternating currents should be chosen? In all installations hitherto made, the continuous current has been exclusively used; it has proved completely efficient, and there has been no occasion to discard it, as long as there was only a question of illuminating the interior and of search lights. The latter can only be worked with continuous currents, otherwise their lighting power would suffer a decrease of about 40 per cent. As, on men-of-war, the consumption of energy for the search lights reaches the considerable extent of 20,000 to 70,000 watts, it is evident that, for the kind of current required for lighting the interior, and for several small motors, continuous current only can be utilised. The injurious influences upon the compass may be avoided, with such a current, by careful disposition of the leads, and the scientific construction and fitting-up of the dynamo engines. But when it comes to a general introduction of electromotors for working the auxiliary machinery, and a central station is erected for this purpose, which, like one already in construction in Germany, works with a power of 300,000 watts, the employment of continuous current offers considerable difficulties. In particular, the motors placed on deck for the gun-turning apparatus and ships' winches have to be placed in such dangerous proximity to the compasses, that the disturbing of the latter in the case of parallel current can hardly be prevented. For the working of this machinery, therefore, the use of the alternating current becomes unavoidable, as such a current, and likewise any motor driven by it, has no influence upon the compass. This, however, again, necessitates the erection of two central stations—viz., one for the search lights, and lighting, with parallel current; and a second station, with alternating current, for driving the auxiliary machinery. Unfortunately this arrangement presents the great disadvantage that the motors for one station cannot be employed in support of, and in substitution for, those of the other; and that thereby a great complication would be created for the whole installation, which would demand greater capabilities from the crew. It will be impossible, however, to avoid this if the increased advantages, which the use of the electrical appliances affords on board of ships, are to be secured.

LAUNCHES AND TRIAL TRIPS.

ON Wednesday, the 10th inst., the s.s. Ashby, just completed by Messrs. Ropner and Son, of Stockton-on-Tees, to the order of Messrs. R. Ropner and Co., West Hartlepool, left the River Tees for her official trial trip. On the arrival of the vessel in the Tees Bay her compasses were duly adjusted, after which a very satisfactory run was made, the machinery working very effectively and easily. After the trip the steamer proceeded on her voyage to Bilbao.

Messrs. Wm. Simons and Co., Renfrew, have launched complete a single screw hopper dredger constructed to the order of the Wexford Harbour Commissioners. This vessel is of the following dimensions:—Length, 120ft.; breadth, 28ft.; depth, 10ft. 6in. The Slaney is capable of carrying 250 tons deadweight, and is propelled by one pair of triple surface condensing engines of indicated horse-power sufficient to propel the vessel, when fully loaded, at a speed of 7 knots per hour. The hopper compartments are provided on each side of well, having all the necessary gear for lifting and lowering the hopper doors. A steam crane is provided at after end of hopper for emptying the hopper when filled with ballast.

On the 12th inst. Messrs. Sir Raylton Dixon and Co. launched at their yard, Middlesborough, the steam collier Zuid Holland. This vessel has been constructed for the special duty of carrying coal from this country to the Continent, and will be fitted also with powerful lowering appliances. The dimensions are as follows:—Length, 229ft.; breadth, 34ft.; depth moulded, 17ft. 6½in. She will be supplied with a set of triple expansion engines by the North-Eastern Marine Engine Works Co., of Sunderland, having cylinders 19in., 31½in., 51½in. by 36in. stroke, which will take steam from two single ended boilers 11ft. 9in. diameter, and 10ft. 6in. long, with a working pressure of 170 lb. The vessel will have the highest class at Lloyd's, and is being built from the designs and under the superintendence of Messrs. Flannery and Tritton, of Liverpool and London.

On the 10th inst. the s.s. Borgom was launched from the yard of Messrs. Sir W. G. Armstrong and Co. She is a steel single deck tank steamer for carrying petroleum in bulk, and also case oil, for the economical loading and discharging of which special arrangements of winches &c, have been made. Her dimensions are as follows:—Length, 320ft.; breadth, 42ft.; depth moulded, 22ft. 2in. The engines will be of the triple expansion type by the North-Eastern Marine Engineering Co., of Sunderland, having cylinders 24in., 40in., 64in. by 42in. stroke; they will take their steam from two single ended boilers 15ft. 3in. diameter, and 10ft. 6in. long, with four furnaces in each boiler so arranged that residuum may be used as fuel. The vessel has been constructed from the designs and under the superintendence of Messrs. Flannery, Baggallay and Johnson, of London and Liverpool, for Mr. A. Mantachaff, and is of large carrying capacity. She will be supplied with a powerful pumping system for the quick discharge of liquid cargo. Her electric lighting installation has the latest improvements, and is fitted throughout the vessel.

On the 13th inst. there was launched from the Queen's Island yard of Messrs. Harland and Wolff the P. and O. ship China. The launch was timed for eleven o'clock, and punctually at that hour the magnificent vessel began to move along the launch ways, and a few minutes later entered the river opposite the Belfast shipyard. The launch took place without the slightest hitch. The China is the fifth steamer built on the Queen's Island for this company, and is 500ft. in length by 54ft. beam. She will have two masts, and schooner rigged. Her gross tonnage is about 8550, and she will be propelled by a single set of triple-expansion engines of 7500 indicated horse-power, which are being constructed by the builders of the vessel at their engine works at the Abercorn Basin. The captain's and officers' cabins, the chart-room, and wheel-house are on the boat deck, and the accommodation for first and second-class passengers—of which she will carry a large number—on the hurricane, spar, poop, main, and lower decks. The ship will be fitted as a first-class mail and passenger steamer, and will have a full installation of electric light, also refrigerating chambers for cargo and stores, hydraulic deck machinery, &c.

On the 12th inst. Messrs. Ropner and Son, of Stockton-on-Tees, launched a steel screw steamer of the following dimensions, viz.:—Length between perpendiculars, 270ft.; breadth extreme, 39ft. 6in.; moulded depth, 17ft. 6in.; which they have built for Mr. Christian Klaveness, of Christiania. The vessel is built as a part awning decked steamer with raised quarter deck; her deadweight carrying capacity being 2625 tons on 17ft. 7½in.; the saloon and cabins for captain and officers, also the engineers' accommodation being fitted in deck-houses amidships. She is built on the web frame principle, leaving the holds entirely clear for cargo, and carries her water ballast in a cellular bottom, and in the after peak. All labour-saving appliances are fitted for the economical working of the steamer, and also for the expeditious loading and unloading of cargoes; she has steam steering gear amidships and screw gear aft, four powerful steam winches, a large multitubular donkey boiler, direct steam windlass, stockless anchors, &c. The engines will work up to about 900 effective horse-power, and are by Messrs. Blair and Co., having cylinders 20in., 33in., 54in., by 36in. stroke, steam being supplied by two large steel boilers working at 160 lb. pressure. The name of Kingswood was given to her as she left the ways.

On Friday 12th inst. Messrs. John Scott and Co., of Kinghorn, launched the first of the two new paddle steamers which they are building to the orders of the Wallasay Urban District Council, under the superintendence of Messrs. Flannery and Tritton, consulting engineers of Liverpool and London. These vessels are 160ft. overall by 27ft. beam by 10ft. 6in. depth moulded. They have been built with all the latest improvements, and have been so arranged that the funnel stands amidships, and gives two long unbroken saloons fore and aft, and there is no obstruction by the funnels in the gangways. The vessels are also fitted with two rudders and steam steering gear, the levers for the same are grouped together with the telegraphs in a convenient position at the mate's platform, which is situated forward of the funnel, and gives the steersman an uninterrupted view ahead. The vessels are constructed to carry 1500 passengers on a very light draught of water, and to maintain a higher rate of speed than the present vessels engaged in the same service. The comfort and convenience of the passengers have been especially considered, the saloons being thoroughly heated and ventilated, and tastefully decorated. As the vessel left the ways she was named the John Herron, in honour of the chairman of the Ferry Committee, by Mrs. Finch, the wife of Mr. F. Finch, of the firm of A. Bellbourough and Co., of Lloyd's. The chairman and a large company of ladies and gentlemen were present at the launch. The vessel will shortly proceed upon her official trials, and take her station on the Mersey.

On the 15th inst. the fine screw steamer Ragnar left the port of Hartlepool on her trial trip. The Ragnar has been built by Messrs. Wm. Gray and Co., to the order of Mr. L. H. Carl, of Copenhagen, and to Lloyd's highest class. Her length over all is 285ft.; breadth, 39ft. 6in.; depth, 19ft. The deck erections consist of poop, raised quarter deck, and partial awning deck. A handsome saloon, state-room, and accommodation for captain and officers have been fitted up in the poop, and comfortable quarters for the engineers amidships, and for the crew forward. The hull is built with web frames and cellular double bottom, and with large ballast tank in the after peak. Four steam winches, large patent donkey boiler, steam steering gear placed in the engine-room casing, hand screw steering gear aft, direct steam windlass, schooner rig, boats on beams overhead, grain divisions, and all improved appliances for working the steamer have been provided. The engines are of the triple-expansion type, and have been supplied by the Central Marine Engine Works, of Wm. Gray and Co., the cylinders being 21in., 33in., and 56in. in diameter, with 36in. piston stroke, and steam is supplied by two large steel boilers working at a pressure of 160 lb. per square inch. When opened fully out the engines ran 83 revolutions per minute, for trials on the measured mile they were reduced to 75 revolutions, when the mean speed was found to be 10·3 knots per hour, on a low coal consumption. The trials were highly satisfactory, the engines running without trouble or hitch of any kind, and the boilers remaining quite steam-tight. The trial was witnessed by Mr. C. Nielsen, J.P., Danish Consul, Mr. Hans Neilsen, Mr. Chas. Nielsen, and Mr. Albert Trechmann, of West Hartlepool; Mr. Knutzen and Captain Nordahl, of Sunderland; Captain Murrell representing the builders of the ship, Mr. Mudd on behalf of the engine builders, and Miss Mudd. The vessel and her machinery have been constructed under the personal supervision of Captain Jorgensen, who has also gone to sea in command of the ship. On the conclusion of the trial the vessel discharged her passengers to tug in Hartlepool Bay, and proceeded to Sunderland to take in her first cargo. The Ragnar is the second vessel built and engined for Mr. Carl by Messrs. Wm. Gray and Co., being a sister ship to the Sigurd, recently sent to sea.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

THE demand for steam coal is very good, and the shipments of the past week were above the average. Prices firm. The house coal trade keeps up fairly well for the season, and prices show no alteration. Tin-plates in demand, with prices very firm. The iron and steel works continue well employed at full prices.

Coal: Best steam, 8s. 6d. to 8s. 9d.; seconds, 8s. to 8s. 3d.; house coal, best, 9s. 9d. to 10s.; dock screenings, 5s. 3d.; colliery small, 4s. 6d. to 4s. 9d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 46s. 7d.; hematite warrants, 47s. 5d. f.o.b. Cumberland; Middlesbrough No. 3, 37s. 6d. prompt; Middlesbrough hematite, 44s. 9d. Iron ore: Rubio, 12s.; Tafna, 11s. 6d. Steel: Rails, heavy sections, £4 12s. 6d.; light ditto, £5 to £5 5s. f.o.b.; Bessemer steel tin-plate bars, £4 2s. 6d.; Siemens tin-plate bars, best, £4 5s., all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel, coke, 9s. 3d. to 9s. 4½d.; Siemens, coke finish, 9s. 6d. to 9s. 7½d.; ternes, per double box, 28 by 20c., 19s. to 20s. 6d. Pitwood: 16s. to 16s. 3d. London Exchange telegram: Copper, £49 10s.; Straits tin, £60 15s. Freights steady.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK.

THE commercial situation has grown worse for a week, and prices for many commodities have declined. Railroad earnings are 2½ per cent. ahead of last June. Bank clearings 14½ per cent. below last year, but this is partly due to the absence of speculation. Commercial failures are numerous, and show that the pressure on credit is severe. Currency is flowing from the interior at the rate of one million pounds a week. Large gold exports continue. Interest is growing in the political conventions to be held soon, and until the Republican convention at St. Louis is held there will be no move in business. The immense crops give a strong tone to the markets. Coal mining is not restricted, and prices keep up well. Coke production at Connelsville is one-third less, but price is two dollars. New coke fields will soon be producing. A few blast furnaces have been damped. Stocks will not be permitted to increase much more. Bridge works have lately booked large orders for material, and managers look for a steady influx of orders. Structural material will maintain its advance on small buyers. Skelp iron makers have lately added large orders on their books. Merchant iron is dull, and merchant steel active. The wages question in the rolling mills is now up for its yearly adjustment, and will be amicably disposed of. The tin-plate manufacturers are putting their industry into good shape for future harmony. Building operations are progressing finely in all sections. There is great activity in the gold regions of the Rocky Mountains, and both home and foreign capital is finding welcome and profitable employment.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

ON 'Change to-day—Thursday—in Birmingham the improved tone manifest last week continued. Sheets are very strong, and the prices of doubles is quoted £6 15s., an advance of 2s. 6d. on the week, in consequence of the hot weather having necessitated the mills in some cases being put to stand. Some brokers ask as much as £6 17s. 6d., but this is an outside price, and is obtained in very few instances, consumers reminding sellers that a week ago the open market quotation for doubles was £6 12s. 6d. per ton. Lattens are quoted £7 7s. 6d. to £7 10s., the merchants in certain instances demanding £7 12s. 6d. Sellers here and there quote singles £6 15s., but the price is rather a long one, and there are makers who will not hesitate to accept £6 10s. Some of the largest sheet iron firms in this district having as many as twelve mills running are full up with work, and are not at present anxious about adding to their orders. The galvanisers are also full of work. Galvanised corrugated sheets, f.o.b. Liverpool or equal, are priced at £10 5s. to £10 7s. 6d. for 24-gauge, and quotations are supported, not only by the excellent demand, but by the high price to which spelter has risen. Sheets from Wales for bucket-making are quoted up by merchants 7s. 6d. per ton, and japanners' sheets for trunk making are quoted by middlemen £7 15s. doubles, and £8 10s. lattens. Sellers of bar iron of common and medium qualities are attempting a rise of 2s. 6d., and occasionally 5s. per ton, as the result of the meeting of the Unmarked Bar-makers' Association last week, when such an advance was declared justifiable. The Unmarked Bar Association's price for common bars is now understood to be £5 7s. 6d. to £5 15s. per ton, while merchant bars are £6 to £6 5s., and marked iron is £7 to £7 12s. 6d. nominal.

Excellent reports were brought to 'Change this afternoon of the activity which now characterises some of the wrought iron tube works in the district. Good shipping orders have been booked by certain of the biggest firms. Gas tube strip is quoted to-day £5 7s. 6d. to £5 10s. per ton; hoops are £6 7s. 6d.; and thin strip £6 10s.

The pig iron trade rules strong. The quieting down of a couple of months or so back has given place to a resumed active inquiry, and everyone is busy. Good quality Northamptonshire and Derbyshire forge pigs are quoted an average of 41s. delivered to works in this district, less 2½ per cent., and Lincolnshires—forge—44s. delivered at stations in this district, net cash. Foundry iron of No. 3 Northamptonshire quality is about 43s. 6d. per ton, and Lincolnshire foundry 45s. 6d. Staffordshire pigs are quoted, cold-blast, 90s.; all mine, 55s.; part mine, 40s. to 42s. 6d.; and cinder about 35s.

Steel makers keep busy in all departments; in truth, the managers of some of the largest works this afternoon spoke of themselves as "terribly busy." The activity reported from the other steel centres all over the country is fitly reflected in the condition of local works, both the melting and rolling plants being run at their fullest capacity. The indications are all in the direction of a continuance of the present activity. Bessemer billets and tin bars delivered into this district, from the North of England and South Wales, are quoted £4 2s. 6d. to £4 5s. net, and other descriptions go on up to £4 10s. and £4 12s. 6d. The plants of the Patent Shaft and Axletree Company, Wednesbury; of the Staffordshire Steel and Ingot Iron Company, Wolverhampton; and of the Earl of Dudley's works at Brierley Hill, are all fully engaged, and there is every prospect of all the steel works in the district being fully employed up to the end of the year.

The mechanical engineering trades continue active, both for export and also on local orders connected with factory extensions. The railway rolling stock branch is supported by large Indian and South African orders.

The information is received in this district with much satisfaction that the engineering and kindred trades continue well employed in most branches throughout the kingdom, the percentage of unemployed union members being 2·2 at the end of May compared with 2·3 in April, and 6·6 in May, 1895. Employment at steel works the kingdom over, including this district, continues to show a marked improvement as compared with a year ago. At 113 works included in returns received by the Board of Trade, the number of workpeople employed was 33,768 at the end of May, being 12·5 per cent. more than at the corresponding time last year, and ·3 per cent. more than at the end of April last. At the 89 puddling furnaces and rolling mills, however, from which returns were received, the number employed was less at the end of May than at the end of April, and also less than a year ago, the numbers being, for May, 16,946; for April, 17,695; and for May, 1895, 17,196. These statistics furnish further evidence of the extent to which steel is superseding iron.

The President of the Midland Counties Trades Federation at the annual conference of that body this week at Wolverhampton had some very sensible observations to offer anent the unreasonable outcry which it appears to be the fashion just now to make about foreign competition. He thinks we have very little cause for complaint, and that a comparison of our industrial and commercial position with that of some other nations may well give ground for thankfulness rather than envy. Our total imports from Germany amount to about £26,000,000 per annum, of which only £5,000,000 are manufactured goods, most of the remainder being food. On the other hand, we export to Germany goods to the value of £30,000,000, of which only £1,000,000 consists of food, the remaining £29,000,000 being manufactured goods, and especially machinery, metals, and hardware. While we take only £1,000,000 of iron and steel in manufactures from the United States, we send them £40,000,000 of manufactured goods. Taking all parts of the world together, while we purchase from abroad about £50,000,000 worth of manufactured goods, we export manufactures to the value of nearly £300,000,000, or six times the amount.

The brass workers in the Birmingham district have decided to give notice for an increase of 10 per cent. in wages, but it is hardly likely to be conceded by the employers without a struggle whilst competition continues so keen. The spring makers in the West Bromwich district have given a week's notice for a 12½ per cent. wages increase; and the lock makers of Wolverhampton have handed in notices for a 10 per cent. advance.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—A somewhat stronger tone if anything was noticeable with regard to prices both for pig and finished iron on the Manchester Iron Exchange on Tuesday. It is true there is a good deal of underselling amongst merchants and dealers, which is probably to be explained by the reasons I have referred to in previous notes, but makers are almost without exception firm at their quoted rates, the tendency being rather to harden in some directions. Lancashire makers of pig iron have no difficulty in effecting renewals of contracts with their customers at their full quotations of 46s. 6d., less 2½, for No. 3 foundry, delivered Manchester, and they are also getting better prices for forge qualities now that Lincolnshire makers, having sold freely at recent low rates, are not competing so keenly. In district brands some considerable sales of Lincolnshire forge have been made during the week at the advance of 6d. per ton, and makers in most cases have since put up their prices another 6d. per ton, the general quotation being now 41s. 6d., with foundry firm at 43s. as the minimum. Derbyshire foundry is also decidedly hardening, 46s. to 46s. 6d. net cash, delivered here, being now the average figures. As regards outside brands, makers' quotations are also, if anything, stronger, good foundry Middlesbrough not being obtainable under 45s. 10d. to 46s. 4d. net cash, delivered by rail Manchester, with Scotch iron averaging 46s. 3d. to 46s. 6d. for Eglinton, and 47s. to 47s. 6d. for Glengarnock, net prompt cash, delivered Lancashire ports, and about 2s. 3d. extra delivered Manchester Docks.

The finished iron trade shows a decided improvement, some of the local makers having booked pretty freely during the week, and at better prices. There is, consequently, an absence of the low selling reported recently, Lancashire crown bars not now being quoted under £5 10s., with North Staffordshire qualities £5 10s. to £5 15s. Sheets have been moving up, and are scarcely obtainable under £7 5s., whilst Association list rates for hoops are exceedingly firm at £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths, delivered Manchester district, and 2s. 6d. less for shipment.

No really noticeable move can be reported in the steel trade. Hematites are steady at late rates, averaging 57s. 6d. to 58s., less 2½. Manufactured material, however, remains low in price, considering the general active demand, local-made steel bars being still obtainable at under £6, whilst for boiler plates makers find it impracticable to get more than £6 5s., delivered in this district.

In the metal market, the upward movement in raw material, and the brisk demand for all descriptions of manufactured goods, has led to another advance in list rates of ½d. per lb. on copper tubes, ¼d. on brass tubes, and two separate advances of ¼d. per lb. on brass wire and yellow metal plates since the advance reported a fortnight ago. Brazed brass gas tubes are now quoted 7¾d.; brass wire, 6½d.; copper wire, 7¾d.; and rolled metals 6¼d. per lb. delivered Manchester district, with soft cold rolled copper sheets £68 per ton. This persistent upward move in prices does not appear to have checked business, as with locomotive builders and general engineers all very busy, and coppersmiths and brass founders well employed, a brisk inquiry for all descriptions of manufactured metal goods is reported generally.

Activity is fully maintained throughout the engineering trades, and I hear of further considerable orders being booked by locomotive builders in this district, whilst machine toolmakers have not been so busy for a considerable time past. Stationary engine builders, boilermakers, and the general branches of engineering all continue well engaged.

The monthly returns of the Amalgamated Society of Engineers are of much the same satisfactory character as those of other similar associations referred to last week. In the Manchester district there are now only ¾ per cent. on support, which represents a state of trade better than has been experienced for years past, and it is a long time since there was such a demand for certain classes of workmen as now exists. I may further mention that the Amalgamated Society of Engineers has added 3575 new members to its roll during the present year, and has now a total membership of 82,709. The Steam Engine Makers' Society has also only ¾ per cent. on donation—a slight decrease on the last report.

This exceptional briskness throughout the engineering industries is bringing the wages question to the front, and in addition to the movement on the part of sections of the workmen in one or two outside districts to which I have previously referred, the core makers in the Manchester district have now sent in notices for ao advance. There is not as yet anything in the way of a general move amongst the men for higher wages, and it remains to be seen whether this isolated action amongst comparatively small sections of the workmen is but a preliminary to further agitation should the present demands be conceded; but nothing definite has actually been done, as the notices have not yet expired, and are under the consideration of the Employers' Association.

An improved form of trap is being introduced by Mr. P. Mooney, Clarence-street, Manchester, for intercepting house drains from the sewer where a manhole is used. This trap has been specially designed for manholes when the line of the main house drain differs from the direction of the drain between the manhole and the sewer. Most local authorities insist upon an access arm from the chamber to the outlet side of the trap, and in the ordinary traps made in one piece bends have had to be made where the drain above the manhole is not in an exact straight line with the drain below it, or otherwise a second manhole is necessary. In the arrangement introduced by Mr. Mooney these complications are avoided by providing an adjustable piece, by means of which the inlet and the outlet can be placed in any required direction, and access is afforded to the lower side of the trap, so that the sewer side of the manhole can be thoroughly inspected, when required, in whatever direction the adjustable piece may be turned. The principle of this new trap has, I understand, been approved by many of the leading architects in the district.

The half-yearly meeting of the Manchester Association of Engineers was held on Saturday, Mr. Joseph Nasmith, the President, occupying the chair. The proceedings were chiefly of a formal character. Messrs. J. Matthews, of R. Johnson and Nephew, Bradford; J. A. Bennett, of the Lancashire and Yorkshire Railway Company, Horwich; W. Heap, of W. Rose and Co., Salford, were elected to ordinary membership. Messrs. J. Bolas, F. W. Reed, and F. Slade, members of Committee of Management; and Messrs. G. Kierman and J. Bartlam, auditors to the Association. I may add that by the courtesy of Mr. F. W. Webb, the society is paying a visit to the locomotive works of the London and North-Western Railway Company at Crewe on Thursday next.

Extreme quietude is reported in the coal trade, which is perhaps not more than might be expected, considering that the present period is the slackest season of the year. House fire qualities necessarily are only in the most limited request, and although many of the collieries are not running more than three and a-half to four days per week, a considerable portion of even this restricted output is going into stock. Quoted list rates are nominally unchanged, but for prompt clearance sales representatives of collieries are in most cases prepared to meet buyers with concessions, with the result that prices are weak and irregular. Common round coals are in fair demand for iron-making, steam and general manufacturing purposes, but continue plentiful and extremely low in prices, ordinary steam and forge coals being readily obtainable at 5s. 6d. to 6s. at the pit mouth. With regard to gas coals, many of the principal contracts are now under consideration, tenders having been sent in. Of course nothing definite as regards prices can as yet be reported, but so far as anything is known at present tenders seem generally to have been based on about 3d. under last year's rates, which would represent about 6s. 3d. at the pit for ordinary screened Wigan 4ft. gas coal, and 7s. for the better qualities of Arley gas coal. In engine fuel, the restricted production of slack, owing to the limited demand upon round coals, is necessarily causing some scarcity of supplies, but only in exceptional cases is any advance upon late rates being obtained. Last week there was some talk of advancing list rates 3d. per ton, but no general move in this direction has so far been attempted, and common slack can still be bought at 3s. to 3s. 6d., with better qualities ranging from 4s. and 4s. 6d. up to 5s. for some special sorts.

No improvement can be reported in the shipping trade, and ordinary steam coal does not average above 7s. per ton, delivered either at the ports on the Mersey or the Manchester Ship Canal.

The recent decision of the Railway and Canal Commissioners in favour of the railway companies with regard to the application by the Manchester and Northern Counties Federation of Coal Traders' Association, as to whether the new siding rent charges, which were put in force at the commencement of last year, of 6d. per ton per wagon after four days, exclusive of the day of arrival, were reasonable charges, has been received not only with disappointment, but with considerable surprise, by the merchants and dealers in this and other districts. The general opinion expressed is that the Federation were badly advised in bringing their application first against the Midland Railway Company, which stands in a very different position with regard to the question from the other important coal-carrying companies. The matter has been one of continued agitation and complaint amongst the coal traders for the past twelve months, and acting under the advice of the Federation, they have declined to pay what they consider the increased siding rent charges, with the result that these unpaid and disputed charges now amount to many thousands of pounds. The matter, however, is not to rest where it has been left by the Commissioners, and at a meeting of the Manchester and Northern Counties' Federation of Coal Traders' Associations, held on Thursday at the Manchester Coal Exchange, Mr. George Pearson, of Stalybridge, in the chair, at which there was a very large attendance, it was unanimously resolved that the railway companies be approached with reference to the matter; and that, failing any satisfactory outcome of the negotiations, the matter be proceeded with in such manner as may be decided by counsel. Every member receiving an application for siding rent is to forward it to the Association without delay; and a levy was made, the effect of which will be to raise £1000 for the immediate purposes of the Association.

Barrow.—The week's business in hematite pig iron has been on as large a scale as for some time past, and the business offering gives the assurance of the continuance of the present active market for a considerable time to come. The make of Bessemer iron practically represents the whole of the output, and the consumption by local makers of steel and others is a steady source of trade to smelters, who have large orders on hand, and are likely to be kept busy for the remainder of the year at any rate. Prices are steady at 47s. 5½d. net cash warrant sellers, 47s. 5d, buyers. Makers quote 48s. to 49s. for Mixed Bessemer Nos. net. f.o.b. Stocks have been increased during the week exactly 1000 tons. Thirty-nine furnaces are in blast as compared with twenty-nine in the corresponding week of last year.

Iron ore remains in good demand; the mines are busy, and repeat orders are readily given out. Prices remain unchanged at 10s. per ton for average qualities.

Steel makers report a very satisfactory trade. Orders for rails are held to a very large extent, both on home and foreign account, and the demand remains steady from all sources, while prices are firm. Shipbuilding material of all sorts is in good request, and it is evident the demand is likely to improve. Billets, hoops, and heavy steel castings are in active demand, and the market generally, in merchant qualities of steel, is gaining strength.

Shipbuilders and marine engineers are busy, but the need of new orders is asserting itself more and more every week. Builders hope to secure both Admiralty and commercial orders of some importance shortly, and in the meantime much activity is maintained in the work of completing the contracts in hand.

Coal finds an average market, but there is such a keen competition for orders that prices are kept at a very low point. In coke the trade doing is steady, and prices are well maintained. The supply obtained is chiefly from the Durham district, but a fair business is regularly done with the Burnley district.

Shipping returns from West Coast ports show an export of 6065 tons of pig iron and 13,791 tons of steel during last week, as compared with 7995 tons of pig iron and 6708 tons of steel in the corresponding week of last year, a decrease of 1930 tons of pig iron and an increase of 7083 tons of steel. The total shipments this year so far show 139,962 tons of pig iron and 214,399 tons of steel, as compared with 123,513 tons of pig iron and 163,902 tons of steel in the corresponding period of last year, an increase of 16,449 tons of pig iron and 50,497 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THERE is not much change to report in the working of the collieries in the South Yorkshire district. The stoppages at the collieries already noted still continue, and trouble is expected from several other pits in this part of the coalfield. The present bright warm weather is having an adverse effect on the consumption of house coal. London is taking but an average supply, and values continue low, owing to the keen competition of seaborne fuel. On account of the decrease in the consumption of gas coal only a moderate tonnage is being forwarded to the eastern counties. Merchants are just able to keep up prices, in spite of the fact that unscreened coal and slack can be obtained at the thick seam pits at 5s. per ton. Silkstone, which is only moderately produced, is quoted at 8s. to 8s. 3d. per ton for the best, and 7s. to 7s. 6d. for secondary qualities. Barnsley softs realise 7s. to 7s. 3d., and the best thin seam coal only fetches 6s. per ton at the pits. The condition of the steam coal trade is fairly satisfactory. The output, however, continues largely in excess of the demand, so that an increase in prices is entirely out of the question. A heavy weight of coal is still being sent to Hull. A good tonnage of the best qualities of steam coal is finding its way to Grimsby. The railway companies are taking a large quantity of coal on contract account. The Lancashire and Yorkshire Railway Company has just placed contracts for the supply of locomotive fuel. It is understood that the contract price is under that of the Midland, 7s. per ton. Best Barnsley steam coal commands 7s. to 7s. 6d.; Parkgate, 6s. 3d. to 6s. 6d. Gas coal continues to be freely inquired after. Good slack is at 3s. to 3s. 3d., ordinary pit realises 2s. 3d. to 2s. 6d., and smudge, 1s. 6d. per ton in quantities at the pits. The coke trade continues very satisfactory. The output is large, and a good tonnage is being forwarded to North Lincoln, as well as to Derbyshire and Northamptonshire, at prices ranging from 8s. 6d. to 11s. per ton.

Good reports are still coming in from the heavy industries. Business is very brisk in almost every department. Rather a falling-off is exhibited in the railway material branches. There are some very satisfactory orders yet to work off; and it is expected that before these are completed orders will come in for wheels, tires, axles, and similar goods. An improved demand is reported for both Bessemer and Siemens-Martin steels, as well as for crucible steel of the best brands. The rolling mills, tilts, and forges are well employed. Quotations for raw and finished material run as follows:—Bessemer billets, £5 12s. 6d. to £6; hematites, 55s. to 57s. 6d. per ton, according to brand, delivered in Sheffield; bar iron, firm at £5 10s. at makers' works. For Swedish iron and steel the enormous demand for cycle purposes formerly noted is fully sustained. Great Britain, France, Germany, and the United States are the principal customers. The contract rates range from £12 to £16 per ton f.o.b. For the best brands, which come from the Dannemora district, and are made both on the Bessemer and Siemens process, £16 is easily obtained, the Germans being large buyers of the higher-priced brands. Many thousands of tons have also recently been purchased by Birmingham firms at about £15 per ton; while Sheffield manufacturers have been buying very heavily in all the Swedish iron and steel centres. For the commoner qualities, chiefly rolled for rails and ship-plates, about £7 per ton is realised; in 3in. billets the price is about £7 per ton.

The lighter trades are in a satisfactory condition. The demand for silver, electro-plates, and similar metals has been increasing ever since Easter, although the weight of silver rolled is rather less than for the corresponding period of last year. Several of the larger firms have never been so busy as they are at the present time. Better advices are being received from the leading continental markets, where a more animated business is pretty general in tools and general hardware goods, but orders are not pressing for immediate delivery. The business in table cutlery is in one or two directions abnormally heavy, and there is a good run on the pen and pocket branches. The best part of the trade doing, however, is in case goods. Reports as to the state of the Russian, Australian, and United States markets are very encouraging. It is confidently expected that the full trade with the more important foreign countries will be much more important than for the first six months of the year. Sheffield manufacturers, however, are not very sanguine about American business. A large American manufacturer, who makes goods in Sheffield for his transatlantic stores, does not anticipate that the United States demand for the higher classes of cutlery, which has been steadily maintained since the trades in the secondary grades was taken by Germany, or self-supplied in the States. He does not expect that any immediate results of importance will follow the almost inevitable election of Mr. McKinley. What the country wants, he says, is a quiet time of commercial confidence, and even a higher tariff, if it put an end to the unrest and distressing fluctuations of values, would be better than the present situation, when a man goes to bed at night and may rise next morning to find himself one-half poorer than he was when he laid down the previous evening.

In the file trade customers have been advised that owing to the advance of 10 per cent. in wages, discounts are shortened by 2½ per cent. This has given our rivals of France, Germany, and America another opportunity to push their low-priced wares, and it is feared that the result will be more than a temporary displacement of Sheffield-made rasps and files.

Mr. Amos Joseph Acaster, engineer of the Princess Works, Shoreham-street, died very suddenly on the 16th inst. While engaged at his establishment the previous Thursday, Mr. Acaster was much affected by the heat, and drank cold water freely to quench his thirst. Shortly afterwards he was taken ill, but declined medical aid. On Sunday he was very much better, but early on Tuesday morning had a relapse, which terminated fatally about seven o'clock. Mr. Acaster, whose forefathers were early in the local engineering trades, was the inventor of the Acaster patent rail joint and other contrivances of utility and interest. By skill and industry he had greatly extended his Princess Works, which were in a prosperous condition. He was fifty-six years of age, and leaves a widow and three sons.

The Master Cutler, Mr. H. H. Andrew, of the Toledo Steel Works, entertained a number of friends at Endcliffe Hall last Saturday night, in celebration of the coming of age of his elder daughter, who is the Mistress Cutler of Sheffield. Miss Andrew is the youngest lady who has ever occupied that position, and the reaching of her majority during her father's year of office is also unique. The event was very pleasantly referred to by Mr. Joseph Mellowes and Mr. H. W. Pawson at the supper, and "The Good Health of Miss Andrew" was heartily honoured. Mr. Andrew feelingly responded. Mr. Robert Colver—Messrs. Jonas and Colver, Continental Works—in exceptionally felicitous terms, proposed "The Health of Mr. Andrew and Miss Maud Andrew," which was also warmly honoured, and acknowledged by Mr. Andrew in happy terms. The term of office nominally extends to the first Thursday in September, when the new master is installed; practically it expires in the second week of August, when the Cutlers' Company meet to elect their new head. Mr. Andrew's term will be remembered as one of the most memorable in the Company's annals, alike for the brilliance of his hospitalities, the attention he has given to the work of the ancient corporation, and the uniform courtesy and modest efficiency with which he has discharged all the duties appertaining to the office, which he will leave with the warmest good wishes, not merely of his colleagues in the company, but of the whole community. In Sheffield the Mayor and the Master Cutler are much associated in local work, and the civic chair during his year has been occupied by the Duke of Norfolk. Between the two, collaboration in public and other appointments has been mutually pleasant, as well as satisfactory in its results to the city.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

ON the whole the course of trade in this district is satisfactory, prices generally keep firm, and as prospects are favourable buyers are much more ready to purchase than producers are to sell, particularly where iron for forward delivery is concerned. A considerably better trade is being done than is usual in June, not only in pig iron, but also in finished iron and steel, as well as in the smaller industries, not one of which can be described as really dull. The tendency in prices is upwards, as now that producers are so well supplied with orders competition has become less keen than has been known for several years past, and a better chance of realising higher prices is afforded. The production of pig iron in the North of England is the largest ever recorded in the history of that trade, but at the same time the deliveries have never been so heavy, especially on shipping account, and it is believed that makers will have to draw upon their stocks. The extent of the deliveries at this time of the year, when there is usually a quiet time, is unexpected, and affords excellent evidence of the soundness of the improvement which is taking place in trade. If business is so well maintained in the summer months, it may be inferred that there are very encouraging prospects for the autumn. Shipments of pig iron have not fallen off during this month as was expected; on the contrary, though they have not this week been on as large a scale as during the first ten days of the month, they are very good, and the total for the month so far has been the best on record. Up to Wednesday night the quantity was 67,336 tons, as compared with 54,514 tons last month, 60,263 tons in April, and 64,071 tons in June, 1895, all to 17th. With such an export as that, and with large local deliveries also, better prices ought to be realised, and they would be realised if there were not such an enormous make. Producers have only themselves to blame for the comparatively poor prices they obtain —they increase the output too rapidly, and carry on too keen a competition. If they would regulate the make, and keep it a little below the requirements instead of a little above, as is now mostly the custom, they would benefit not only themselves, but also makers in other districts, whose prices have to be kept down in order to enable them to compete with cheap Cleveland iron. It is satisfactory to see that the quantity of Cleveland pig iron sent into the public stores is very small, but with such deliveries there should be a decrease rather than an increase of stocks in the warrant stores. Connal's on Wednesday night held 199,228 tons of Cleveland iron, an increase for the month of 778 tons only.

The general price of No. 3 Cleveland G.M.B. pig iron has this week been steady at 37s. 6d. per ton for prompt f.o.b. delivery, and nothing less is reported to have been taken by makers, but some of the second hands have sold at a smaller figure. For deliveries to be made over July and August, 37s. 9d. has been accepted, but producers generally hold off for more. Cleveland warrants have this week shown more strength than other descriptions of warrants, and there has been the unusual circumstance of Cleveland warrants rising in value when the others were falling. The market for Cleveland warrants is influenced by the good outlook, and by the smallness of the additions to the stocks in the public stores. Buyers of Cleveland warrants have mostly offered 37s. 6d. cash for them this week, but on Wednesday they would only pay 37s. 4d. The lower qualities of Cleveland pig are more readily obtainable, but the prices are maintained, No. 4 foundry at 36s. 9d., and grey forge at 36s. 3d.

A number of the Cleveland pig iron makers are now using the rich magnetic Gellivara Swedish ore as an addition to the Cleveland store in making ordinary foundry and forge pig iron. They find this ore works profitably in the blast furnace, and improves the quality of the pig iron produced.

Cleveland hematite pig iron is believed to be in larger supply than demand, and the price is hardly so strong as is that for ordinary Cleveland iron, notwithstanding that ore is dearer. The opinion is that producers are adding materially to their stocks, but that can be little more than conjecture, as no statistics of stocks are collected, as some of the makers refuse to give the information, a refusal which hardly can be condemned, as it is not always advisable to admit the public into the position of business. Mixed numbers of East Coast hematite pig iron can be bought at 45s. 6d. per ton for prompt delivery, but the general figure is 45s. 9d., and several of the leading firms hold out for 46s. Rubio ore maintains its increased value, and 12s. 9d. per ton, delivered at Tees wharves, has to be paid for 50 per cent. ore, especially as rates of freight are advancing, Bilbao-Middlesbrough being now 5s. 4½d.; Bilbao-Stockton, 5s. 6d.; Elba-Tyne, 8s.; Garrucha-Tyne, 8s. 1½d.; and Bilbao-Jarrow, 5s. 1½d.

The leaders of the Cleveland blast furnacemen, in spite of all the arguments used by the employers as to the inconvenience and loss caused by a day's stoppage of the furnaces, have determined to hold their demonstration at Middlesbrough on Friday, August 14th. The cost of the stoppage to the masters alone is calculated by them at £5000. Not only does production cease for the day, but there are the after-effects to be considered, as for some time after the stoppage the quality of the iron produced is inferior. It is essential that a furnace, to give good results, should be worked regularly. The blast furnacemen evidently want to be in the fashion—the ironstone miners and colliers have their annual demonstrations—and though the blast furnaces are worked under different conditions, this is not taken into consideration by the men.

Most of the finished iron and steel manufacturers give good accounts of their business; they are nearly all well employed, and in some cases have difficulty in supplying as promptly as is desired the needs of their customers. The heat of this week has come rather inopportunely for manufacturers, as it has necessitated a curtailment of their production, for the puddlers and some of the millmen were unable to pursue their occupation during the greater part of the day. The steel rail makers are well employed, and large shipments of railway material have this week been made to Algoa Bay, Egypt, India, &c., from the Tees, while other large cargoes are being loaded. The nominal price of heavy steel rails is £4 10s. per ton net at works. A good demand has sprung up for girder, sheet, tee, and channel iron, and the tendency in prices is upwards.

Scarcely anything is being done in steel sleepers now, but an unusual shipment from the Tees is reported this week—wooden sleepers; heretofore only metal sleepers have been exported from the river, but they are getting out of favour in some quarters. Steel ship plates are in fair request, but the demand runs more on girder and boiler plates than it did. Steel ship plates are firm at £5; steel boiler plates at £6; steel girder plates at £5 5s.; steel ship angles at £4 17s. 6d.; iron ship plates, £4 17s. 6d.; iron ship angles, £4 15s., all less 2½ per cent. and f.o.b. Sheets are in excellent request, especially galvanised sheets. Cast iron pipes and railway chairs are in improving demand, and almost all the works producing them are well employed. Bridge builders keep their establishments in regular operation, and engineers are as a rule well off, more especially the locomotive and marine engineers.

The death took place a few days ago of Mr. William Bosher, who for the last twenty-two years has been chief cashier of Messrs. Bolckow, Vaughan, and Co. He has spent his whole business life with the firm, having entered their office at the age of fourteen years. He was nearly fifty years old at the time of his death. The death also is reported of Mr. J. Tait, who for the last twenty years has been manager of the Raisby Hill Limestone Quarries, the produce of which is much esteemed in the manufacture of pig iron in Cleveland. Mr. R. E. Robinson, son of Mr. Robert Robinson, chief manager of Messrs. Bolckow, Vaughan, and Co.'s collieries, met with a sad death at the Hazelrigg pit in Northumberland. Deceased was a mining student, aged twenty-three years, and had latterly acted as overman under his father at the Auckland Park Colliery. On the day of his death he visited South Northumberland for the purpose of inspecting the shaft sinking operations at Cramlington and Hazelrigg pits. While inspecting the shaft at the latter pit he descended in the "kibble" to a depth of sixty-four fathoms, and there got upon the "cradle." There the master sinker explained to the deceased the work of putting in the guides for the cages. While looking up to inspect the guides he appears to have stepped back and fallen a depth of sixty fathoms.

The demand for steam coal is active, and work is very brisk at the Northumberland collieries. Part of the activity is due to the approach of the holidays, which are always observed at the pits in the neighbourhood of the Tyne during Newcastle race week. There is also a more than usually brisk demand for coal for the Baltic ports, as merchants are taking advantage of the low rates of freight that are ruling. Best Northumberland steam coals are at 8s. 6d. per ton f.o.b. Gas coals are in slack request, but that is usual at this time of the year, which is always a quiet time. Coke is now in better supply than demand, and some of the manufacturers are putting it into stock. The situation is thus quite different from what it has been for months, and prices are weaker. Average coke delivered at Teeside furnaces can now be bought at 13s. 6d. per ton. Messrs. Cook and Sons, Washington, have completed the construction of an improved coal screening apparatus, which is to be sent out to the Great Eastern Coal Company's mines in South Africa.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has been a quieter feeling in the Glasgow pig iron market this week, and only a moderate business has been done in warrants. The active state of the manufacturing branches helps to keep prices fairly steady. Were it not for this activity it would be a comparatively easy matter at present for operators to depress prices, seeing that stocks of pig iron are on the increase. Business in the open market has been mainly confined to Scotch warrants, which have sold from 46s. 8d. to 46s. 9d. cash, and 46s. 9d. to 46s. 10d. one month. Cleveland warrants have met with very little inquiry. They are quoted 37s. 5d. to 37s. 6d. cash. There has been very little doing in hematite warrants, the price of Cumberland being steady about 47s. 5d. to 47s. 6d. cash.

The number of furnaces producing ordinary pig iron has been reduced by one, and there are now 38 making ordinary, 39 hematite, and three basic iron, the total of 80 comparing with 75 at this time last year. Large quantities of Spanish ore are being imported, and the consumption of it at the ironworks is perhaps greater than at any former time. The rate of freight for this ore from Bilbao to Glasgow is 5s. 6d. per ton. The price quoted for Scotch-made hematite pigs, delivered on railway trucks at the steel works, is 50s. per ton.

The makers of Scotch pig iron have, in a number of instances, reduced their prices 6d. per ton, and the quotations are now as follow:—Govan, Monkland, and Carnbroe, f.o.b. at Glasgow, Nos. 1, 47s. 6d., Nos. 3, 46s.; Clyde, No. 1, 49s. 6d.; No. 3, 46s. 6d.; Gartsherrie, Summerlee, and Calder, Nos. 1, 50s.; Nos. 3, 47s. 9d.; Coltness, No. 1, 52s. 6d.; No. 3, 48s.; Glengarnock, at Ardrossan, No. 1, 49s. 6d.; No. 3, 45s. 6d.; Eglinton, No. 1, 47s.; No. 3, 45s.; Dalmellington, at Ayr, No. 1, 46s. 6d.; No. 3, 44s. 6d.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 48s. 6d.; Shotts, at Leith, No. 1, 52s.; No. 3, 48s. 6d.

The stocks of pig iron in the Glasgow warrant stores continue to increase, and the addition in the past week amounts to about 1660 tons. The total stocks show since the beginning of the year an increase of 16,000 tons over those for the corresponding period of last year.

The foreign demand for Scotch pigs is very backward, and the shipments during the past week are considerably below the average, amounting to only 4011 tons, compared with 6816 in the corresponding week of last year. No pig iron was despatched either to the United States, Canada, or South America, but there was sent to India, 125 tons; Australia, 340; France, 40; Italy, 330; Germany, 1055; Russia, 280; Holland, 115; Belgium, 15; Spain and Portugal, 155; China and Japan, 13; other countries, 270; the coastwise shipments being 1273 tons, against 5638 in the same week of 1895.

The market for finished iron is steady as regards prices, and the quantity of material going into consumption is comparatively large. The steel works continue very busy.

Messrs. Blackwood and Gordon, of Port Glasgow, have contracted to build a screw steamer of 1600 tons gross, with engines of 900-horse power, for Messrs. Alex. A. Laird and Co., of Glasgow, for their cross-Channel traffic between English, Scotch, and Irish ports.

There has been rather more doing in the shipping department of the coal trade, and the total clearances from Scottish ports have been 161,297 tons, compared with 152,779 in the preceding week, and 176,215 in corresponding week last year. The market, however, continues very slack owing to the large supplies. Furnace coal and dross are in brisk request, and there is a good demand for the better qualities of ell coal. The turnover in splint and main is by no means small, but owing to the large output from the collieries prices are depressed. Main coal is quoted f.o.b. at Glasgow, 5s. 9d.; splint, 6s. 3d. to 6s. 6d.; ell, 6s. 3d. to 6s. 9d,; steam, 7s. 6d. per ton. The warm weather has been curtailing to a great extent the demand for household coals.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

I AM gratified in being enabled to report a return to active and hopeful conditions in the coal trade. The total exports from the Cardiff ports last week totalled 355,000 tons. Both Newport and Swansea coal shipments last week indicated improvement, and the buoyancy of the steam coal trade appeared even to tell favourably upon house coal business, which, notwithstanding the hot weather, showed signs of a better character than of late. One good result of the Charter agitation was that prices on Saturday last advanced 3d. per ton.

Mid-week prices, Cardiff, were as follows:—Best steam coal, 10s. 3d. to 10s. 9d.; special seconds, 9s. 9d. to 10s.; seconds, 9s. 3d. to 9s. 6d.; drys, 8s. 9d. to 9s. 3d.; best Monmouthshire, 8s. 6d. to 8s. 9d.; seconds, 8s. to 8s. 3d.; special smalls, 5s. to 5s. 3d.; best quality, 4s. 6d. to 4s. 9d.; seconds, 4s. to 4s. 3d.; drys, 3s. 9d. to 4s. Cardiff, cash thirty days, less 2½. Swansea figures this week are:—Best anthracite, 11s. to 11s. 3d.; seconds quality, 9s. to 10s.; ordinary large, 8s. to 8s. 9d.; rubbly culm, 4s. to 4s. 6d.; steam, 9s. to 10s.; bunkers, 7s. 9d. to 9s.; second-class steam, 8s. 3d. to 9s.

House coal prices at Cardiff are, best, 9s. 9d. to 10s. 3d.; No. 3, Rhondda, 9s. 6d. to 9s. 9d.; brush, 7s. 9d. to 8s.; small, 6s. to 6s. 3d.; No. 2 Rhondda, 7s. to 7s. 3d.

Coke prices are well maintained at last week's figures, namely, 13s. to 19s. 6d., according to quality. Patent fuel, 10s. 3d. to 10s. 6d.; pitwood, 15s. 9d., all Cardiff.

Iron ore prices are firm, and large cargoes continue to come in for the leading ironmasters. Ebbw Vale figures well. Prices, Cardiff, 10s. 9d. to 12s. according to quality.

At a meeting of the Monmouthshire and South Wales Coalowners' Association, held on Tuesday at Cardiff, several important matters were brought forward and discussed. One was the coal charter party, and the movement to oppose the introduction of the new principle of payment of wharfage by the coalowners was commended. It was decided also to support the Bill of the Home Secretary for the amendment of the Mines Regulation Act. With regard to the defences of the Channel, it was contended that the measures adopted for protection were inadequate, considering that the colliery owners of Wales have an output of 35 million tons annually.

The Windsor Dock Bill is now passing its ordeal, and a strong array of counsel is piloting or opposing.

Sir William T. Lewis, this week in thanking a deputation from Hirwain for a valuable testimonial to himself and Lady Lewis, on the occasion of his baronetcy, gave briefly, in reply to the speaker, the history of the sliding scale, which has admittedly done more excellent service to the coal trade, coalowners, and colliers than any other institution or arrangement. The project was first mentioned by Sir William to Sir H. H. Vivian, afterwards Lord Swansea, and the idea having been discussed thoroughly, Sir William applied himself to the matter, matured it, and after great research and much comparison of rates of wages in various districts, brought it to a successful issue. Sir William admitted that he was more proud of the sliding scale than of any other success of his life.

I am reminded of the scale by seeing the results of another of his successful undertakings, the Miners' Provident Fund. The ordinary quarterly meeting was held at Cardiff on Saturday, and the first resolution carried was one of earnest sympathy with its chairman, Sir W. T. Lewis, and regret for his illness, coupled with a strong expression of hope that he would soon be at the helm again. The secretary's report showed that the society is doing excellent work. £13,062 had been paid in during the quarter by workmen, £2970 by employers. The sum of £1025 has been paid for funeral expenses, £2822 to widows, £2520 to children, and £7724 to disabled members. During the quarter there had been 38 fatal accidents, by which 95 members had lost their lives, and there were on the funds at the end of the quarter 866 widows and 1512 children.

The iron and steel trades are fairly good. On 'Change, Swansea, it was reported mid-week that the pig iron market remained practically unaltered, easier if anything in some grades, but a fair demand for home consumption and for foreign supply. Prices indicate no change, except in steel rails, which are offered from £4 7s. up, heavy sections, as low a rate as can be expected; light from £5 10s. Iron and steel plates, Bessemer and Siemens bars, are unchanged. Tin-plates also continue the same: Bessemer from 9s. 3d. to 9s. 4½d., and Siemens coke finish, 9s. 6d. to 10s.; ternes, 16s. 6d. to 21s. 6d.; best charcoal, 13s. to 13s. 3d. Trade is much the same. Fortunately no more mills have been started.

Cyfarthfa continues moderately busy in rails and bars, and Dowlais maintains a good front. Ebbw Vale keeps a more brisk appearance, and if this should continue a more favourable report than the last may be anticipated. It is stated that one of the drawbacks there is a scarcity of men, forty additional workmen being required in the Bessemer department alone. A good sign also comes from Briton Ferry, where it is intended, in connection with the Albion Works, to erect another furnace forthwith. A good average make of pig at the Briton Ferry Works is going on, and of steel bar at the Briton Ferry Steel Works.

The improvement in the tin-plate trade has reacted favourably upon the steel works, and the demand for bars is sometimes sharper than can be met. Last week the shipments of plates amounted to 59,500 boxes; quantity received from works, 46,628, still further reducing stock. Cardiff and Newport next week are to be visited by the North-east Coast Institution of Engineers and Shipbuilders, and, judging from the programme, both places will do their best in the exhibition of the leading features of industries in Monmouthshire and South Wales.

Colliers are getting reckless again. Two in the Rhondda were fined £2 or a month for unramming a shot at one of the Ocean Collieries. It was a wonder both were not blown to pieces.

The patent fuel trade at Swansea is getting into its old groove, no less than 11,000 tons having been shipped last week, and leading makers have orders for three months in hand. Swansea reports a boom on the copper market, and are advancing £2. Block tin is also advancing, and is 30s. better than last week. Present prices: Copper, £50 to £50 2s. 6d; tin, £61 13s. 9d. to £61 15s.

The dispute at Abby Colliery, Rhondda, affecting 300 men, has been settled. The Ebbw Vale directors' report indicates a good deal of effort, and consequently expenditure in the improvement of the steel works and development of the coalfield; but though no dividend is announced, prospects are decidedly better.

The opposition against the Cambrian Railway Bill having been withdrawn, it has been referred to the consideration of the unopposed committee in the House. The further arrangements of the Llandudno Eisteddfod, the Prince of Wales' reception at Aberystwith, and the meeting of the Cambrian Archæological Association upon the occasion of its jubilee, promise well for the Cambrian and Brecon lines.

I see that the Bute Docks and Rhymney Amalgamation Bill has passed its second reading in the House of Commons.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

REPORTS concerning the iron and steel trade remain favourable. There is plenty of work available for makers and manufacturers, and orders are constantly been placed for a variety of material. Prices tend upwards.

In Silesia the iron market continues in a very good position Considerable sales are reported in pig iron, prices being extremely firm. For good forge quality No. 1 M. 60 p.t. is quoted, foundry pig standing on M. 57·25 p.t. at works.

In the malleable iron trade the great activity so frequently reported before has been well maintained all through last week. Foreign demand increases, plates, railway requirements, and the various kinds of small manufactured goods meeting with particularly brisk request.

Very little change has taken place in the iron and steel trades of Austria-Hungary since last week, nor is there any likelihood of much alteration for the present. All round a satisfactory employment is reported. Girders, heavy plates, and structural material in general continue brisk of sale, and there have also been numerous inquiries received upon the week. Galvanised sheets met with an advance of 50 kr. p. 100 kgr. Several other branches, among them the cycle industry, which is specially brisk, are now experiencing a period of improved activity. Some years ago there were only a few large cycle manufactories in Austria, but at date their number has increased to twenty, total production being estimated at 25.000 to 30,000 cycles, worth four to five million florins. The largest of these establishments is that belonging to the Austrian Arms Factory in Styr, which sold about 8000 cycles last year. In 1895 there were exported from Austria 1811 cycles, against 658 in 1894. Import in the same year amounted to 2309, against 3646 in 1894, 1043 coming from England and 1030 from Germany.

The French iron business was comparatively quiet through the greater part of last week, only few orders having been received at the iron works. An alteration in prices cannot be reported to have taken place, bars still fetching 150 to 155f. p.t., while girders are quoted 160f. p.t.

During the week that is now past the different departments of the Belgian iron industry have been exhibiting considerable animation, and there is a healthy tone perceptible in all branches. A specially gratifying fact is that merchants report a better inquiry from abroad, and as foreign demand has been rather weak for some time, an improvement in this direction is naturally hailed with much satisfaction. Bars No. 2 for export are at present offered at 125f. to 127·50f. p.t.; No. 3, 130f. p.t.; iron plates, No. 2, 145f. p.t.; steel plates, 150f. p.t. There has been much life stirring in the steel rail business just lately, and many fair orders have been secured. At a recent tendering for 4000 t. of steel rails for the Portuguese State Railways, the steel works Angleur got the contract, offering lowest at 119f.; the Bochum Steel Works asked 126·50f.; Krupp, 130f.; and Gute Hoffnungshütte, in Oberhausen, 141·25f.

In the Rhenish-Westphalian district business transactions on the iron market continue very satisfactory. In most instances the prices realised may be considered remunerative, and prospects for further advances are decidedly favourable. The business done in the different sorts of pig iron is good, and makers have plenty of orders to engage their attention for some time. Indeed they are, as a rule, booked forward for fully six to seven months ahead. In the malleable iron trade a fair weight of business continues to be reported, and prices for bars are more firm than ever, but leave rather a small profit on the whole. It is, therefore, very likely that a further advance will be agreed upon at the meeting of the Rolling Mill Convention, which is to take place after the 15th inst. The girder trade is in an active position. Plates are also very brisk of sale; particularly those for boilermaking purposes are in very good call. The same holds for sheets. The wire and rivet trade remains without material change, but all through last week a fair demand has been coming in. Pretty many orders have of late been received at the tube mills; stocks show a slight falling off, and the belief is that the tube business will be much livelier this year than last. Quotations for cast iron tubes, which reached the lowest point in March, but have since then been slightly raised, are still exceedingly low, and leave next to no profit.

The total output of the Saar collieries is reported to have been for May of present year 592,925 t., consumption amounting to 595,785 t. During the corresponding month last year 539,690 t. were produced, while 559,500 t. were sold.

According to the annual statistical report of the railways in Germany which has just been published for 1894-95, length of the railway lines was 44,167 kiloms.; length of rails, 79,495 kiloms.; total weight of rails amounting to 5,047,530 t. The number of locomotives is 15,839, while there are 36,354 passenger cars, 319,578 freight cars, and 318,749 load wagons. There were consumed 4,831,181 t. pit coal, and 68,098 t. coke. The number of passengers was 542,745,878, earnings being M. 39,219,812. Tonnage of goods traffic was 22,066,956,833, earnings amounting to M. 963,450,723. Revenue was M. 1,410,262,052; expenditure, M. 860,069,152, surplus amounting to M. 550,192,900. The number of employés and labourers was, on an average, 363,604 per annum, while the wages paid were M. 457,425,597.

Value of German imports is officially stated to have been for 1895, M. 4,246,111,000, against M. 4,285,533,000 in the previous year, which shows a decrease of M. 39,422,000.

Value of export was M.3,424,275,000 against M. 3,051,480,000 in the year before, which is equal to an increase of M. 372,795,000.

During the year 1895 there were produced in Russia—including Siberia and Finland—88¾ million pud pig iron, 28⅓ million pud malleable iron, and 35 million pud steel. Import in iron and steel shows the following figures for 1895:—Pig iron, 8⅓ million pud; raw cast iron and steel, 18⅓ million pud; hardware and tools, 2 1/12 million pud; machines and apparatuses, 6 million pud. This shows that Russia, in spite of an increasing inland production, had to buy 47⅔ million pud from foreign countries in order to cover the continually improving home demand. Indeed, the tendency of the Russian iron market is getting firmer from week to week, and in nearly all departments the prices move in an upward direction.

It has been stated that in 1894 import of foreign ore to France has increased 8000 t.; from Algiers a comparatively small quantity is imported, chief supplies coming from Germany and Luxemburg. Spanish ore is principally consumed in the Department Pas de Calais, Landes et Loire-Inférieure. There came from Algiers, 16,000 t.; from Germany and Luxemburg, 162,000 t.; from Spain, 396,000 t.; Belgium, 46,000 t.; Greece, 8000 t.; other countries, 10,000 t.; together 1,638,000 t., or 8000 t. more than in the previous year. French exports in ore amounted to 248,000 t., or 54,000 t. less than in 1893. To Belgium 110,000 t. were sent; 55,000 t. went to Holland and 48,000 t. to Germany. Exports in ore from Algiers were, for 1894: 308,000 t., having increased 33,000 t. against 1893. Of the above 308,000 t., England received no less than 172,000 t., Low Countries, 103,000 t.; France, 16,000 t.; Belgium, 12,000 t.; Austria and other countries, 5000 t. In France were consumed 3,524,000 t. inland ore and 1,638,000 t. foreign ore, together 5,162,000 t., total consumption of ore having increased 317,000 t. against 1893. Output of pig iron in France increased during the same period 67,000 t

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

3rd June, 1896.

12,103. Cough Mixture for Asthma, H. S. Hoar, North Shields.
12,104. Heating and Evaporating Brine, E. Paul, Liverpool.
12,105. Tires, S. H Adams, York.
12,106. Process for Treating Ores, E. Govett, London.
12,107. Lock with Blocking Signal, O. Strohbach, London.
12,108. Tool for Tires, G. Baker and R. Jewell, London.
12,109. Carburetting Apparatus, P. Hereng, Brussels.
12,110. Fixing Ladies' Dress Guards, L. Lenton, Coventry.
12,111. Pneumatic Wheel Tires, E. L. Levetus, Birmingham.
12,112. Gas Lighter and Regulator, G. Roach, London.
12,113. Whippletrees, A. A Tyler, W. March, and H. Penn, London.
12,114. Tobacco Pipes, A. R. Turner, Middlesex.
12,115. Artificial Silk, W. P. Dreaper and H. K. Tompkins, London.
12,116. Construction of Pavements, C. Mason, London.
12,117. A Calculating Apparatus, J. M. Gray, London.
12,118. Lock for Securing Cycles, J. Howard, London.
12,119. Stockings, W. Buckler and D. Routledge and Co., London.
12,120. Saddles, J. Whitehead and J. A. Crane, Birmingham.
12,121. Bedsteads, J. A. Crane, Birmingham.
12,122. Picker Spindles, W. Watkinson and J. Vose, London.
12,123. Simultaneously Raising Lights, E. J. Parsons, London.
12,124. Gear for Torpedoes, &c., R. B. Molesworth, London.
12,125. Furnaces for Water-tube Boilers, A. Pillatt, London.
12,126. Velocipedes, J. E. Evered and D. G. Pappa, London.
12,127. Automatic Weighing Machines, S. Davey, London.
12,128. Exhibiting Zoetropic Pictures, T. Reich, London.
12,129. Extracting Precious Metals, J. Woolford, London.
12,130. Preventing Cats from Climbing, J. C. Grant, London.
12,131. Traps, W. T. Goold, London.
12,132. Manufacturing Bicycle Spokes, F. Küpper, Aix-la-Chapelle.
12,133. Locomotion, A. E. Borthwick, London.
12,134. Side-gripping Chain-wheel, J. Llewellyn, London.
12,135. Damp-proof Material, &c., E. Nelson, London.
12,136. Tramway Permanent Way, R. A. White, London.
12,137. Horseless Carriage Motors, J. F. Stilwell, London.
12,138. Chainless Safety Bicycles, P. N. Carter, London.
12,139. Suspending Rope Railways, A. Bleichert, London.
12,140. Pneumatic Tires, G. Nivet, London.
12,141. Grates, J. Neil, London.
12,142. Dye-stuffs, S. Pitt.—(*L. Cassella and Co., Germany*)
12,143. Supports for Theodolites, A. M. A. Struben, London.
12,144. Coin-freed Delivery Apparatus, H. M. Robinson, London.
12,145. Manufacture of Frames, &c., L. M. Becker, London.
12,146. Wheels for Carriages, &c., L. M. Becker, London.
12,147. Production of Motive Power, E. B. Badcock, jun., London.
12,148. Dust-removing Revolving Fan, J. Llewellyn, London.
12,149. Electrolytic Apparatus, T. J. Holland, London.
12,150. Preserving Solid Substances, F. O. Jacob, London.
12,151. Sash Fasteners, W. Haddan, London.
12,152. Mud Guards, E. Scheiber and E. Kwaysser, London.
12,153. Weaving, W. P. Thompson.—(*J. B. Deboquoy and J Deperchim, France.*)
12,154. Driving Belts, W. P. Thompsom.—(*L. Landesmann, Austria.*)
12,155. Mud Guards, T. J. Roberts and J. F. Maginnis, Liverpool.
12,156. Straw and Hay Presses, J. Martland, Liverpool.
12,157. Motor Cars, J. Brown, London.
12,158. Tires for Cycles, W. O. Milner.—(*H. Ellis, Canada.*)
12,159. Lucifer Match Boxes, &c., R. Poston, Liverpool.
12,160. Gloves, P. Cole, Liverpool.
12,161. Apparatus for Drying Tea Leaf, N. W. H. Sharpe, London.
12,162. Apparatus for Affixing Stamps, W. Evers, London.
12,163. Coating of Metal Vessels, C. F. Hohenburgh, London.
12,164. Engines, W. J. Hay, London.
12,165. Bearings for Shafts, &c., W. J. Hay, London.
12,166. Dry Lubricant, R. Haddan.—(*J. Muss, Germany.*)
12,167. Gear Wheels and Driving Chains, A. Kotin, London.
12,168. Jacquard Mechanism, L. Kleinburg and J. Szczepanik, London.
12,169. Artificial Stone, A. J. Boult.—(*M. Thys, Belgium.*)
12,170. Engraving Machines, H. H. Lake.—(*A. Sartirana, France.*)
12,171. Driving Band, W. Currie and R. H. Bond, London.
12,172. Polishing Fabrics, B. J. B. Mills.—(*C. Tachon and H. Pervilhac, France.*)
12,173. Metal Tubing, W. J. Goddard and J. R. and A. H. Trigwell, London.
12,174. Construction and Mounting of Cams, E. J. Way, London.

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12,175. Tramcars and Motor Cars, W. Hartnell, Leeds.
12,176. Fixing of Pumps on Cycles, J. Day, Wolverhampton.
12,177. Construction of Seats on Cycles, A. Kirby, Bedford.
12,178. Electric Cycle Lamp, A. H. Tamplin, Leicester.
12,179. Tires for Wheels of Cycles, A. L. Bostock, Kidderminster.
12,180. Contents Measuring Receptacle, C. Raggett, London.
12,181. Handrail, J. R. Ross, Birkenhead.
12,182. Backing Embossed Photographs, H. Piquet, Port Talbot.
12,183. Electric Traction, W. Cope, Birmingham.
12,184. Lavatory, Basins, Baths, &c., F. C. Lynde, Manchester.
12,185. Self-acting Machinery, J. Davies, Pembrokeshire.
12,186. Separating Dust from Cereals, A. M. Robinson, Liverpool.
12,187. Reflector, G. W. Pridmore, T. J. Sturgeon, and E. Yorke, London.
12,188. Preventing Incrustation in Tea-kettles, J. J. Cresswell. Grimsby.
12,189. Scuffling and Hand Hoeing, D. B. Kavanagh, Dublin.
12,190. Hydraulic Machinery, T. Jones, Bristol.
12,191. Pneumatic Tires for Cycles, G. H. Chambers, Workington.
12,192. Handle for Cycles, T. N. Hugo, Dublin.
12,193. Outside Villa Sunblinds, H. Inwards, Luton.
12,194. Gaseous Fluid Compressors, A. J. Adamson, Liverpool.
12,195. Gaseous Fluid Compressors, A. J. Adamson, Liverpool.
12,196. Cycles, J. Darling, Glasgow.
12,197. Pneumatic Tires, J. W. Young, T. Bayliss, and W. S. Tunbridge, Birmingham.
12,198. Roller Grinding Mill, T. and J. R. Torrance, London.
12,199. Covers for Pneumatic Tires, R. Pritt, Lancaster.
12,200. Process for Extracting Gold, A. Trenk, London.
12,201. Cycles, S. E. Howard, Halifax.
12,202. Cutting Pile Fabrics, L. J. Tetlow, Manchester.
12,203. Automatically Tilting Barrels, J. C. Craine, Manchester.
12,204. Colouring Matters, W. H. Claus and A. Rée, Manchester.
12,205. Pockets, L. Wacks, Leicester.
12,206. Boots, S. Thompson and A. A. Megson, Manchester.
12,207. The Mahl Stick Rest, E. B. Rouse, Ramsgate.
12,208. Contracting Crank for Cycles, G. G. Brown, Taunton.
12,209. Rotary Engines, G. P. Grace, London.
12,210. Cleaning Drain Traps, &c., G. Hardie, Glasgow.
12,211. Pneumatic Tires, F. A. Hallsworth and H. J. Bishop, Gloucester.
12,212. Inflators for Pneumatic Tires, J. G. Stidder, London.
12,213. Pneumatic Tires for Cycles, J. G. Stidder, London.
12,214. Bread-making Machinery, W. Watson, London.
12,215. Casings for Pneumatic Tires, E. Herbert, Bristol.
12,216. Cases for Holding Cigarette Papers, C. Leigh and J. A. Bennett, London.
12,217. Iron Hurdles and Fences, S. J. Narracott, Torquay.
12,218. Handle Bars of Cycles, W. E. Partridge, Birmingham.
12,219. Lenses, P. Rudolph, London.
12,220. Manufacture of Gun Cotton, J. W. Swan, London.
12,221. Conveying Bread Doughs, R. K. Balcarras, London.
12,222. Brushes, W. C. Rider, London.
12,223. Mud Guards for Cycles, &c., C. Warren, London.
12,224. Tobacco Pipes, P. Marimian, London.
12,225. Brake for Wheeled Vehicles, A. Ross, London.
12,226. Saddle-bows, C. Egholm, London.
12,227. Secondary Voltaic Batteries, L. Epstein, London.
12,228. Lubricant, F. J. Reinisch and H. Lesser, London.
12,229. Stall Flooring, M. Logan, London.
12,230. Clasp, R. W. Barker.—(*E. N. Gaillard, United States.*)
12,231. Cigar and Cigarette Holders, T. H. Short, London.
12,232. Driving Gear, B. Ljungstrom London.
12,233. Cycles, J. C. Sawer, Brighton.
12,234. Single-trigger Double-barrel Guns, G. Bouckley, jun., London.
12,235. Capsuled Bottles and Vessels, L. Lowndes, London.
12,236. Engines, H. Richardson, Birmingham.
12,237. Manufacture of Armour Plates, J. W. Spencer, London.
12,238. Puzzle Box, J. A. Mannell, London.
12,239. Chain Wheels, C. H. Guest, London.
12,240. Construction of Cigarette Cases, F. Horton, London.
12,241. Apparatus for Killing Fishes, H. Buchan, London.
12,242. Frames of Cycles, J. E. Webb and M. F. Purcell, London.
12,243. Cycle, &c., J. E. Webb and M. F. Purcell, London.
12,244. Electrical Lighting Apparatus, E. Oldenburg, London.
12,245. Separation of Gases, W. P. Thompson, Liverpool.
12,246. Shafts of Vehicles, J. K. Pilkington and H. Tate, Liverpool.
12,247. Saddles for Cycles, &c., S. D. S. Ross, London.
12,248. Automatic Switches, W. J. Davy, London.
12,249. Electric Arc Lamps, W. J. Davy, London.
12,250. Secondary Galvanic Batteries, C. Marschner, London.
12,251. Self-sustaining Pulley Blocks, R. E. B. Crompton and E. A. N. Pochin, London.
12,252. Wheels for Velocipedes, C. A. and W. H. Chapman, London.
12,253. Water Chambers for Water-tube Boilers, H. H. Lake.—(*J. and A. Jensen and Dahl, Norway.*)
12,254. Protecting Animals from Insects, A. J. Boult.—(*C. L. Durand, France.*)
12,255. Precipitation of Precious Metals, M. B. Zerener, London.
12,256. Bending Ship Frames, M. H. C. and R. E. C. Shann, London.
12,257. Socks for Boots and Shoes, H. A. Thornton, London.
12,258. Pressure-controlling Apparatus, A. Hora and V. Wenzel, London.
12,259. Dynamo-electric Machines, V. A. Fynn, London.
12,260. Preventing the Falling of Draught Horses, D. M. Lindwall, London.
12,261. Shuttle-threaders, S. A. Brodeur, London.
12,262. Perfume Cushion, H. H. Lake.—(*O. Lepraux, France.*)
12,263. Operating Steering Wheels, D. S. Christison, London.
12,264. Chain Gearing for Cycles, &c., S. Bennett, London.
12,265. Spinning Top, W. H. Hawkings, London.
12,266. Electricity Meters, W. M. Mordey, London.
12,267. Machine Tools for Drilling, &c., R. G. Brooke, London.
12,268. Pneumatic Tires for Cycle Wheels, H. Faulkner, London.
12,269. Fabric for Pneumatic Tires, H. Heaton, jun., London.
12,270. Attaching Valves for Pneumatic Tires, H. Heaton, jun., London.
12,271. Separating Light and Heavy Substances, H. Seck, London.
12,272. Automatically Encashing News-deliverer, F. Klein, Cologne.
12,273. Car-coupling, F. Grün, Cologne.

5th June, 1896.

12,274. Internal Combustion Motors, J. W. Hunter, London.
12,275. Self-lighting and Part Driving of Bicycles by Electricity, M. Twomey.—(*M. Twomey*, ——.)
12,276. Supply of Oil to Vapouriser, W. Henderson, Tyrone.
12,277. Self-acting Damper for Hot-water Apparatus, R. Heaton, Birmingham.
12,278. Securing Bedstead Knobs, &c., J. Caulton, Derby.
12,279. Pedals for Velocipedes, J. Greenall and A. Jones, Leeds.
12,280. Securing the End Loops of Ropes, M. S. Meldrum and E. Clarke, Newcastle-on-Tyne.
12,281. Additions to Small-arms, A. Tunstall, Birmingham.
12,282. Mole Traps, W. Glover, Wednesfield.
12,283. Manufacture of Bread, W. Poole, Leicester.
12,284. Propulsion of Horseless Carriages, A. L. Fyfe, London.
12,285. Deposited Cash Protector, T. Jefferies, Birmingham.
12,286. Rotary Painting Machine, G. Thomson, Fife.
12,287. Metal, W. V. Wart, F. W. Popp, and J. J. Bradley, Birmingham.
12,288. Winding Cotton, &c., G. H. Strutt, J. Hunter, and P. Knowles, Derby.
12,289. Harbour, &c., Lights, E. de V. du Boulay, Isle of Wight.
12,290. Internal Combustion Engines, R. J. Urquhart, Manchester.
12,291. Bicycle Stand, J. D. Johnson, Manchester.
12,292. Stop Valves, S. E. Alley, Glasgow.
12,293. Carbonising Machines, J. E. Tolson, Dewsbury.
12,294. Shirts, A. Graham, Glasgow.
12,295. Bearings for Rotating Shafts, T. R. Wollaston, Manchester.
12,296. Thoroughly Ventilated Hat, H. J. Stanbury, Exeter.
12,297. Bicycle Sun, &c., Screen, W. Grosvenor-Bradley, Manchester.
12,298. Indicator for Vehicles, R. Platz and A. Packscher, Glasgow.
12,299. Specially Prepared Towel, W. Grimshaw, Manchester.
12,300. Ladies' Saddles for Cycles, &c., A. Fawsitt, Manchester.
12,301. Continuous Automatic Brake, C. Luyers, Brussels.
12,302. Railway Rail, H. Biermann, Liverpool.
12,303. Machines for Washing Ores, &c., C. E. Hall, Sheffield.
12,304. Elastic Tires for Wheels of Auto-cars, S. Griffin, Bath.
12,305. Adjustable Handle-bar, T. A. and C. D. Marshall, London.
12,306. Pneumatic Tires for Cycles, E. H. Simpson, Birmingham.
12,307. India-rubber Clip, A. Rawlinson, Horwich, near Bolton.
12,308. Tuyeres, &c., A. Ogden and R. R. Lawson, Cumberland.
12,309. Hydraulic Motor, L. Grote, London.
12,310. Boats, &c., W. H. FitzGerald, London.
12,311. Pneumatic Tires, A. Norreys, London.
12,312. Electrically Smelting Metals, J. L. Dobell, London.
12,313. Bicycle, S. F. Smith, London.
12,314. Tires for Cycles, E. J. Smith, Birmingham.
12,315. Domestic Fire-ranges, D. Harling, London.
12,316. Door Handles, W. Rayment, London.
12,317. Disinfecting Fluid, H. H. Perkes, London.
12,318. Shirt Sleeve Adjuster, H. Collings, London.
12,319. Overhead Lamps, C. Richards, London.
12,320. Sewing Machine, T. J. Roome, London.
12,321. Brakes for Cycles, J. H. Rusby, London.
12,322. Stopping Leaking Boiler Tubes, H. Jordan, London.
12 323. Puzzle, A. Hunt, London.
12,324. Flushing Cisterns, F. Price, London.
12,325. Driving Gear for Cycles, F. Müller, London.
12,326. Pneumatic Tires for Vehicles, J. H. Barry, London.
12,327. Device for Making Bread, &c., S. Murray, London.
12,328. Alloys, J. C. Bull, London.
12,329. Electrical Switches, G. Binswanger, London.
12,330. Electrical Switches, G. Wilkinson, London.
12,331. Spanner, J. P. Funt, London.
12,332. Hold-fast Hair-pin, C. A. H. Graves, London.
12,333. Hand Grips for Cycles, H. H. Grenfell and W. Tyree.—(*J. C. Alexander, Australia.*)
12,334. Lids for Hot-water Cans, &c., G. Platt, jun., London.
12,335. Axle-boxes, E. T. Hughes.—(*H. A. Byle, United States.*)
12,336. Securing Cycle Handles, A. G. Alexander, London.
12,337. Portable Engines, The British Motor Syndicate, Ld.—(*W. Maybach, Germany.*)
12,338. Oil or Vapour Burners, H. H. Lake.—(*T. R. Browne, United States.*)
12,339. Rotary Pumps, A. P. Kilpatrick, London.
12,340. Bag Handles, S. Llewellen, London.
12,341. Hopper Dredgers and Barges, W. Brown, London.
12,342. Feed Apparatus for Printing Machines, H. C. Watson, London.
12,343. Paper Folding Machines, H. C. Watson, London.
12,344. Method of Indicating at a Station whether the Telephone Lines are Engaged or Not, E. Naglo, London.
12,345. Working of Telephone Stations, E. Naglo, London.
12,346. Pencils, W. P. Thompson.—(*B. B. Goldsmith, United States.*)
12,347. Ink Erasers, W. P. Thompson.—(*B. B. Goldsmith, United States.*)
12,348. Hose Pipe Nozzles, W. P. Thompson.—(*R. Wise, United States.*)
12,349. Garment for Ladies' Wear, G. Jackson, Manchester.
12,350. Tightening Straps or Bands, F. L. Moore, Liverpool.
12,351. Incandescent Gas Lighting, W. W. Baggally, London.
12,352. Feed Trough for Poultry, J. J. Cousins, London.
12,353. Perfumed Carbonic Baths, H. Mack, London.
12,354. Flower Pot, C. J. Watts, London.
12,355. Bridle Bits, C. F. Mansuy, London.
12,356. Protective Walls for Guns, J. Vavasseur, London.
12,357. Bicycle Stands, I. V. E. Thompson, London.
12,358. Lamps, F. Clark and The Southend Gas Lighting Coke Company, London.
12,359. Rotating Boiler Grates, C. G. P. de Laval, London.
12,360. Motor Car Gearing, F. F. Wellington and E. P. Allam, London.
12,361. Means for Preventing the Improper Removal of the Contents of Letter Boxes, J. C. Sigsworth, London.
12,362. Electrical Accumulators, J. Tabrar, London.
12,363. Wheels for Cycles and Vehicles, J. Tabrar, London.
12,364. Monogram Writing Paper and Envelopes, J. E. Catty and Mansell, Hunt, Catty, and Co., Ld., London.
12,365. Chair, F. Ulrich, London.
12,366. Making Laxative Bonbons, A. and A. Müller, London.
12,367. Stays for Wire Fences, R. Haddan.—(*S. C. Davis, United States.*)
12,368. Making Artificial Stone, &c., W. Owen, London.
12,369. Construction of Cycle Wheels, F. J. Goad, London.

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12,370. Cycle Cranks, J. Ardley and V. Hughes, London.
12,371. Brakes for Vehicle, &c., Wheels, F. Hughes, London.
12,372. Taps for Drawing-off Liquids, D. McLachlan, London.
12,373. Cycle Tires, W. Hallett and C. J. Winterbourne, London.
12,374. Sauce, E. Jackson, London.
12,375. Mixture for Use in Cookery, E. Jackson, London.
12,376. Trap for Catching Rabbits, &c., I. N. Tabet London.
12,377. Cleaning the Rails of Tramways, J. Pepper, London.
12,378. Bottles, L. Classey, London.
12,379. Road Locomotives, &c., E. K. Dutton, Harrogate.
12,380. Rubber Ball Inflation Valve, H. W. Verdon, London.
12,381. Lock, R. T. Shelley, London.
12,382. Toe Clips for Cycles, E. Brown, Birmingham.
12,383. Locking Hold-fast Bolts, J. Hazlitt, Dublin.
12,384. Pneumatic Tires for Bicycles, &c., S. Sharpe, Dublin.
12,385. Stud Bottle Stopper, W. S. Malkin, Manchester.
12,386. Gymnastic Apparatus, A. McDonald, London.
12,387. Cleats, J. Linkleter and E. Kipling, Tynemouth.
12,388. Folding Step Ladders, T. T. Mercer, T. Woolfall, and The Cherry Tree Machine Company, Manchester.
12,389. Cycle and other Frames, J. Aylward, Coventry.
12,390. Ampere Hour Meter for Continuous, &c., Currents, A. W. Staveley, I. H. Parsons, and T. J. Murday, Leicester.
12,391. Sliding Pen and Pencil, A. J. Hazledene, Birmingham.
12,392. Elastic Tires for Wheels, R. Hunt, Liverpool.
12,393. Ball Bearings for the Wheels of Cycles, &c., Wolseley Sheep Shearing Machine Company and H. Austin, Wolverhampton.
12,394. Framings of Auto-cars, &c., Wolseley Sheep Shearing Machine Company and H. Austin, Wolverhampton.
12,395. Tobacco Pipes, R. H. Campbell, London.
12,396. Fusing of Chromium, &c., E. A. G. Street, London.
12,397. Horse Clippers, &c., D. Hillhouse, Dumbarton.
12,398. Covering for Electrical Conductors, L. Davis, London.
12,399. Pneumatic Riveting Apparatus, H. D. Earl, Manchester.
12,400. Boots and Shoes, F. Rigby, Manchester.
12,401. Boots and Shoes, F. Rigby, Manchester.
12,402. Displaying Cloth, &c., T. and W. Griffiths, London.
12,403. Bicycle Supports, R. O. Rowland, London.
12,404. Guards for Pneumatic Tires, R. O. Rowland, London.
12,405. Looms, J. Stukley and G. Holden, Liverpool.
12,406. Boiler Settings and Furnaces, W. Hampton, Bilston.
12,407. Forewhales of Horse Collars, G. F. Bradley, Moseley.
12,408. Boot Trees, G. H. Sankey, Wolverhampton.
12,409. Captive Golf Ball Apparatus, J. S. Porter, Edinburgh.
12,410. Saddles, S. Hancock, Nottingham.
12,411. Stretching Frame for Picture Canvas, R. C. Ertel, Hamburg.
12,412. Ladder-shaped Safety Apparatus, F. Subatzus, Hamburg.
12,413. Lifeboat with Mechanical Propulsion, R. J. Plunkett, Bristol.
12,414. Cooling Journal Bearings, P. R. J. Willis.—(*The Cook Cooler Company, Ld., United States.*)
12,415. Oil Lamps, W. Fletcher, London.
12,416. Check Pessarium, P. Wolfrom, Berlin.
12,417. Advertising Apparatus, A. E. Atkinson, Newcastle-on-Tyne.
12,418. Cycle Saddles, W. Vale, Birmingham.
12,419. Adjustable Spanner, J. Reid and W. H. Laidlaw, Glasgow.
12,420. Fixing Cuffs, F. A. Hallsworth, Gloucester.
12,421. Wheel, C. Harris, jun., and B. Ware, Dunstable.
12,422. Double-lap Pneumatic Tire, A. E. Webb, Leicester.
12,423. Movable Handle-bar for Bicycles, F. Bailey, Chichester.
12,424. Spring Tire, W. M. Bevan, Sevenoaks.
12,425. Quick-setting (Hardening) Mortar, L. Mack, Stuttgart.
12,426. Cycles, T. F. Cashin, London.
12,427. Mechanical Stud, A. Pick and M. Fleischner, London.
12,428. Slaughtering Oxen, &c., A. D. Butler, London.
12,429. Milling Woollen Fabrics, S. and B. Preston, London.
12,430. Gas for Illuminating Purposes, A. Arter, London.
12,431. Mowing Machines, H. M. Deming, London.
12,432. Cycles, G. Brand, London.
12,433. Bicycle Support and Brake, W. J. S. Strange, London.
12,434. Compound of Salicin, &c., W. P. Thompson.—(*Ludwig, Sell, and Co., Germany.*)
12,435. Parabolic Churn, A. H. Randolph and G. Gilkes and Co., Ld., London.
12,436. Moulding or Pressing Wood, W. P. Thompson, Liverpool.
12,437. Elevating and Storing Beer, M. McSwiggan, London.
12,438. Machines for Sharpening Drills, O. Larson, London.
12,439. Oil Engines, D. Clerk, London.
12,440. Tool and Air Pump, W. G. A. Edwards and E. Rüntz, London.
12,441. Power Transmitting Mechanism, P. Auriol, London.
12,442. Guard for Wheels of Cabs, F. J. Singleton, London.
12,443. Tires, H. W. Tyler, Knight, and J. F. Dowding, London.
12,444 Pneumatic Tires and Tire Covers, J. C. Grant, London.
12,445. Tires, J. Harvey, London.
12,446. Explosion Engines, J., S., F., and E. Carter, London.
12,447. Pastes, A. J. Boult.—(*C. M. Higgins, United States.*)
12,448. Cycle Lock and Foot Rest, W. James London.
12,449. Utilising Horseless Vehicles, E. Starmer, London.
12,450. Shoe Horn and Paper Knives, F. A. A. Rowland, London.
12,451. Plastic and Incombustible Material, E. Cadoret, London.
12,452. Pneumatic-tired Velocipedes, F. H. Ninlim, London.
12,453. Outer Coverings of Tires, J. Pakeman, London.
12,454. Pince-nez, Spectacles, &c., J. Pakeman, London.
12,455. Gas Burners for Laboratory Work, F. Lamplough, London.
12,456. Clearing Apparatus for Threads, B. J. B. Mills.—(*P. Perret, France.*)
12,457. Motive Power Engines, O. G. Pante, London.
12,458. Ladder Scaffolding, C. A. Sabow, London.
12,459. Mechanical Propelling Power, J. Gandon, London.
12,460. Utilising Escaping Heat of Furnaces, E. Fettweis, London.
12,461. Wheels, F. E. Harnett and G. J. R. Millington, London.
12,462. Closet Cover, J. B. V. Hosstrup, London.
12,463. Gloves, H. Charbonnier, London.
12,464. Ticket Punching, &c., Devices, D. McGill, London.

12,465. Protecting Submerged Surfaces, J. Gordon, London.
12,466. Valve Gear for Steam Engines, F. E. Andé, London.
12,467. Alloys, E. A. G. Street, London.
12,468. Nosebags, M. R. Lynch, London.
12,469. Flying Machines, G. L. A. Davidson, London.
12,470. Pistols and other Small-arms, G. V. Fosbery, London.
12,471. Feeding Envelope Blanks, J. Liebhardt and E. Fischer, Barmen.
12,472. Cycle Attachments, W. A. D. Keys, London.
12,473. Scraping Hides and Skins, C. Poullain-Beurier, London.
12,474. Voice or Speaking Tubes, J. D. Churchill, London.
12,475. Wheels, S. W. Carlton, London.
12,476. Ventilated Handles for Velocipedes, J. Gale, jun., London.
12,477. Self-propelling Road Vehicles, Société des Générateurs à Vaporisation Instantanée (Système Serpollet), London.
12,478. Portable Buildings, D. Brümmer, London.
12,479. Chain Wheels of Velocipedes, P. C. Lawless, London.

8th June, 1896.

12,480. A Mechanical Toy, F. Marsh, Manchester.
12,481. Chandelier Arms for Gas, S., T., and S. Eaton, jun., Birmingham.
12,482. Steadying Cycle Wheels, T. H. Simmonds, London.
12,483. Holding Window Blind Cords, W. Dawson, Halifax.
12,484. Beaming Mills, B. Frankland, J. W. and L. Banister, Halifax.
12,485. Puncture Resisting Appliances for Cycles, A. Koch and O. Hetterich, London.
12,486. Seating Breeches, &c., H. J. Messent, Nottingham.
12,487. Machines for Washing, J. McAllister, Glasgow.
12,488. Umbrellas, I. R. Hayes and W. Knowles, Manchester.
12,489. Locomotive Foot-plates, W. McDonnell and H. V. Morony, Limerick.
12,490. Self-starting Cycles, J. G. Inshaw, Birmingham.
12,491. Quarrying Machinery, J. Thomas, W. Stainton, and F. C. Sanders, Liverpool.
12,492. Oil Cans, A. C. Vice, Nottingham.
12,493. Friction Clutches for Cycle Axles, J. Walker, Bradford.
12,494. Polishing Military Buttons, A. T. Hackett, Birmingham.
12,495. Rail Joint for Tramways, &c., W. Roberts, London.
12,496. Self-closing Air Tire, T. Green, Kidderminster.
12,497. Gate and Door Stop, J. H. Hawksworth, London.
12,498. Fastener for Windows, J. H. Hawksworth, London.
12,499. Air-tight Casks, W. T. Bridge and G. Watson, Derbyshire.
12,500. Dyeing Apparatus for Textile Goods, H. Schirp, Germany.
12,501. Bottles, A. C. R. King, British Columbia.
12,502. Seamed Tubing, O. Pihlfeldt and W. G. Garnett, Birmingham.
12,503. Conveying Rotary Motion, J. F. Dowling, Dublin.
12,504. Transmission of Electricity, B. P. Scattergood, Leeds.
12,505. Bicycles, S. F. Smith, London.
12,506. Automatic Music Desk Book, H. R. Nathan, Devonport.
12,507. Securing Hammers, C. N. Wood, H. Stannard, and C. A. Barnard, London.
12,508. Improved Clip for Trousers, G. Grice, London.
12,509. Tires for Cycles, A. Milnes and E. Smith, London.
12,510. Teapot, J. W. Oakford, Norfolk.
12,511. Catch for Window Blind Cords, G. F. Hare, London.
12,512. Register Lock for Cycles, J. F. Jamieson, London.
12,513. Propelling Floating Vessels, F. H. Alexander, London.
12,514. Trouser Attachment for Cycling, G. T. Harrap and E. Hewett, London.
12,515. Gas Burners, &c., F. W. Golby.—(*O. Lindner, Belgium.*)
12,516. Tires for Road Vehicles, H. F. Pattinson, London.
12,517. Tempering Metallic Articles, J. S. Fairfax, London.
12,518. Surveying, &c., N. Browne.—*P. C. Neville, India.*)
12 519. Preventing Sickening of Mercury, J. T. Penny and J. Dungey, London.
12,520. Construction of Clutches, C. B. Schultz, London.
12,521. Doors, C. M. White.—(*The Flexible Door and Shutter Co., United States.*)
12,522. Bearings, M. C. P. and C. V. Thierry, G. D. Sturrock and F. F. H. L. Mennons, London.
12,523. Vegetable Soups, T. F. Garrett and W. M. Spouse, London.
12,524. Connecting Parts of Cycles, J. Ardley and V. Hughes, London.
12,525. Driving Gear for Velocipedes, J. Anderson, London.
12,526. Driving Gear for Velocipedes, J. Anderson, London.
12,527. Treatment of Air, D. Hancock, J. B. Craig and A. H. Hancock, London.
12,528. Hanging of Window Sashes, T. R. Fuller, London.
12,529. Lasting Machines, H. H. Lake.—*W. Shaw, United States.*)
12,530. Automatic Measuring Tape, G. Hildebrandt, London.
12,531. Switches, &c., A. Slatter and W. Rixon, London.
12,532. Cradles, W. Slight, London.
12,533. Railway Signalling Apparatus, R. Gascoigne, London.
12,534. Indelibly Marking Paper, H. W. Langbeck, London.
12,535. Coke Ovens, O. Imray.—(*The Firm of F. Brunck, Germany*)
12,536. Apparatus for Drying Tea, W. W. Wardle, London.
12,537. Caps, R. Thomas, London.
12,538. Automatic Lubricator, S. S. Bromhead.—(*T. H. Popp, Germany.*)
12,539. Fly Wheel for Motor Cars, &c., A. Paget, London.
12,540. Steering Mechanism for Motor Cars, A. Paget, London.
12,541. Pneumatic Tires, S. Bunting, Birmingham.
12,542. Burners, W. P. Thompson.—(*The Gesellschaft für stossfeste Glühlicht Brenner, "Patent Fritz," G. M.B.H., Germany.*)
12,543. Steam Boilers, G. J. N. Carpentier, London.
12,544. Machinery for Cutting Leather, W. P. Brough, London.
12,545. Driving Crank for Cycles, A. Appleby, Birmingham.
12,546. Automatic Air Inlet Apparatus, E. S. Price, London.
12,547. Printing Presses, M. L. W. Hallenbeck and J. B. Gibbs, London.
12,548. Patent Pedal and Pedal Crank, J. Stanley. London.
12,549. Secondary Batteries, D. G. Fitzgerald, London.
12,550. Electrical Circuit Closing Thermometers, A. Luraschi, London.
12,551. Relief of Rheumatism, &c., E. H. Green, London.
12,552. Jointing of Aluminium Tubes, T. Shepherd, London.
12,553. Manufacture of Cigarette Tubes, E. Brissaut, London.
12,554. Securing Cycle Handle Bars, G. Gilbert and E. Mushing, Birmingham.
12,555. Tipping Wagons, R. H. Fowler, J. Robinson, and J. Gozney, London.
12,556. Violet Dye-stuffs, S. Pitt.—(*L. Cassella and Co., Germany.*)
12,557. Compressing Air, S. J. Norton and H. A. Stenning, London.
12,558. Driving Chains, W. G. Birkinshaw, London.
12,559. Note-book, R. H. Baxter, London.
12,560. Rims and Tires of Cycle Wheels, S. Rowland, London.
12,561. Pneumatic Tires for Cycles, C. W. Robbins, London.
12,562. Watering Jets or Nozzles, T. Roovers, London.
12,563. Pulping Engines, J. and G. Bentley, and J. Nuttall, London.
12,564. Metallic Wheels, I. Davis, London.
12,565. Tires, H. M. Genese, London.
12,566. Attaching Cranks to Cycles, H. M. Genese, London.
12,567. Frames for Cycles, &c., H. M. Genese, London.
12,568. Handle Bars for Cycles, H. M. Genese, London.
12,569. Crank-driving Gear for Cycles, H. M. Genese, London.
12,570. Driving Gear for Cycles, &c., J. Küster, London.
12,571. Machines for Making Wire Chain, C. W. Ward, London.
12,572. Condensers, S. G. Merrick and H. L. Washburn, London.
12,573. Urinals, S. J. Putnam, London.
12,574. Bicycle Tires, J. R. Moore, London.
12,575. Canopies, W. Cole, jun., London.
12,576. Making Eyelets, S. D. Hanney, London.
12,577. Binders, J. L. Hutchinson, London.
12,578. Fitting of Switches, A. Wagner, London.
12,579. Musical Instruments, M. O. Claus, T. B. Puttmann and H. E. C. Felix, London.
12,580. Tires to Prevent Puncture, J. W. and J. Turner, London.

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12,581. Supplying Electricity, P. J. Pringle and J. M. V. Money-Kent.
12,582. Stove Guards, Fire Guards, &c., W. R. Hatton, London.
12,583. Traction Horse, A. M. Wood, Surrey.
12,584. Door Curtain Rods, A. Schmitt and L. Raiss, London.
12,585. Elevators, W. E. Langdon, Belper.
12,586. Bottle Stoppers, H. Mellars and J. D. Owen, Cardiff.
12,587. Supporting Telephone Transmitters, R. Baker, J. Filmer, E. L. Ryder, and A. Gartner, London.
12,588. Telephone Receivers, R. Baker, J. Filmer, E. L. Ryder, and A. Gartner, London.
12,589. Motors for Driving Machinery, J. McAllister, Glasgow.
12,590. Adaptable Pneumatic Handle, R. Palmer, Manchester.
12,591. Treatment of Gold, &c., Ores, J. B. Torres, London.
12,592. Shuttle Changing Mechanism for Weaving Looms, A. Johnstone and J. W. Parker, Bradford.
12,593. Disposal of Sewage, R. Johnston, Glasgow.
12,594. Manufacturing Cranks, A. J. Thurman, Birmingham.
12,595. Tea Infusers or Steepers, J. H. Sutthoff, Manchester.
12,596. Tools for Drilling Holes, E. Chatham, Manchester.
12,597. Binders for Bank Books, J. T. King.—(*J. T. Haugh and H. Reiber, United States.*)
12,598. Furnace and Grates, J. G. Sanderson, Glasgow.
12,599. Cycles, R. J. Alpe, Birmingham.
12,600. Means for Superheating Steam, A. Alison, Bolton.
12,601. Motor Carriages, J. Johnston, London.
12,602. Tricycles Actuated by Compressed Air, W. Stilton and R. A. McLellan, Birmingham.
12,603. Wheels for Velocipedes, &c., A. Daw, Birmingham.
12,604. Pneumatic Tires, W. Fletcher, London.
12,605. Protecting Parts of Trousers, C. E. White, Manchester.
12,606. Basket Lid, A. Mitchell, Guernsey.
12,607. Adjusting Chain-wheel of Cycles, H. Hind and J. Barlow, Nottingham.
12,608. Pipes for Smoking, G. McIntyre, Glasgow.
12,609. Bridging the Joints of Railway Rails, T. S. McKinnie, Glasgow.
12,610. Gas Burners, J. Schuch and H. Kneidel, Glasgow.
12,611. Cutter for Covered Wire, W. Wilkinson, Penketh, near Warrington.
12,612. Incandescent Mantel Protectors, J. W. Lea and J. H. Perrins, Birmingham.
12,613. Double-action Driving Leverage, R. Groom, Ford, near Shrewbury.
12,614. Castors for Furniture, &c., J. H. Betteley, London.
12,615. Separating Water from Steam, W. and T. W. B. Durant, Barnsley.
12,616. Treating Calendar Bowls, J. A. Holmes, Leeds.
12,617. Watches, F. Hotton, London.
12,618. Adding Machine, D. Swan, Falkirk.
12,619. Match-boxes, G. Nathan and R. Hayes, Birmingham.
12,620. Handles of Spades, &c., J. Potts, Birmingham.
12,621. Weft and Twist Cans, T. Isherwood and T. Moore, Manchester.
12,622. Spring Soles and Heels for Boots, S. S. Hazeland, Penzance.
12,623. Tramway Cars, J. Milnes, Lancashire.
12,624. Pegs for Shuttles, J. Wilson and J. Lumb, Leeds.
12,625. Attaching Brush Heads to Handles, N. Eastwood, London.
12,626. Tire for Cycles, S. J. Barnes, Birmingham.
12,627. Washing Machines, W. Geldard, London.
12,628. Universal Fuel Injector, A. Bryce, Birmingham.
12,629. Gloves, E. Oberländer, London.
12,630. Sewing Machines, F. W. Farr, London.
12,631. Combined Bicycle Pump and Rest, E. X. Damman, London.
12,632. Gas Incandescence Lamps, J. Spiel, London.
12,633. Oil Engines, J. A. Drake, London.
12,634. Driving Gear for Motor Carriages, J. A. Drake, London.
12,635. Electrical Switches, G. Senior, jun., and T. D. Dundas, London.
12,636. Drying Printers' Matrices, &c., G. Hallett, London.
12,637. Electric Machines, W. H. Cooley, London.
12,638. Looms, P. M. Justice.—(*The Weaver Jacquard and Electric Shuttle Company, United States.*)
12,639. Cycles, J. W. Ross, London.
12,640. Pneumatic Tires, E. Harris, London.
12,641. Elastic Bands for Girdles, A. and E. Hücking, Germany.
12,642. Rifle and Range Finder, A. G. B. Scuri, London.
12,643. Compressing Sulphurous Acid, E. Porák, London.
12,644. Operating Skylight Sashes, J. Woodall, London.
12,645. Colour Photography, J. W. McDonough, London.
12,646. Velocipedes and other Vehicles, B. C. Hicks, London.
12,647. Wick Tubes for Petroleum Lamps, N. D. Ingram, London.
12,648. Vehicle Wheels, J. R. Terry, London.
12,649. Devices for Sealing Bottles, L. Kalling, London.
12,650. Thermo-electric Generators, H. B. Cox and The Cox Thermo - Electric Company, Limited, London.
12,651. Inflating Pneumatic Tires, B. R. Adkins and C. Windsor, London.
12,652. Wheel Tires, T. Gee and S. Burge, London.
12,653. Surgical Belt for Women, L. Jouatte, London.
12,654. An Attachment for Cycles, A. J. Southey, London.
12,655. Children's Teething Pads, M. M. Williams, London.
12,656. Devices for Lifts and Hoists, J. T. Clifton, London.
12,657. Cycles Brake Mechanism, T. R. Johnston, London.
12,658. Hydraulic Brakes, E. J. Clubbe, A. W. Southey, and the Electric Motive Power Company, Ld., London.
12,659. Steam Pumps, H. E. Newton.—(*C. C. Worthington, United States.*)
12,660. Wrapping Newspapers, H. E. Newton.—(*R. Hoe, United States.*)
12,661. Metal Polish, H. Mason, London.
12,662. Generating Acetylene Gas, A. Tobler, London.
12,663. Turbines, &c., C. F. de Kierzkowski-Steuart, London.
12,664. Ships, M. P. Duggleby, London.
12,665. Indicator or Signal Clock, K. Haldenegg, London.
12,666. Lubricator, G. S. Eckford, London.
12,667. Gear and Chain Wheels, L. E. Mongiardino, London.
12,668. Window Fastener, W. F. Taylor and J. McLeod, London.
12.669. Brake for Bicycles, &c., J. T. Todman, London.
12,670. Hoisting Device, C. A. Jensen.—(*A. F. Regan, United States.*)
12,671. Switches, W. D. Murphy, London.
12,672. Cranks for Velocipedes, &c., J. Hutson, London.
12,673. Cement for Plastering on Walls, C. Marson, London.
12,674. Covering Walls with Plaster, C. Marson, London.
12,675. Pins, C. Wenigmann, London.
12,676. Dynamometer, J. B. Granjon, London.
12,677. Injection Syringes and the like, F. Freienstein, London.
12,678. Transmitting Force, S. Hartmann and H. Bultmann, London.
12,679. Substitute for Wadding, M. Rosenbaum, London.
12,680. Elastic Wheel Tires, E. Girod and F. J. Wich, London.
12,681. Buckles for Wagon Springs, W. G. Moreton and J. Mitchell, London.
12,682. Multiple Pulp Papers, W. A. Kershaw and the Medway Paper Mills Company, Ld., London.
12,683. Acetylene Gas, H. A. Deroy, London.
12,684. Driving Cycles, A. M. A. Struben, London.
12,685. Rail Bonds, L. Cook, London.
12,686. Metal Belting for Pulleys, &c., L. Othon, London.
12,687. Non-slipping Devices for Tires, E. J. Pennington, London.
12,688. Self-propelled Vehicles, E. J. Pennington, London.
12,689. Explosion Engines, H. Clifford and W. Baines, London.
12,690. Pattern Cards, L. Kleinberg and J. Szczepanik, London.
12,691. Discharging Cargo, A. J. Boult.—(*J. W. Glaholm, Canada, and C. Salmond, United States.*)
12.692. Driving Gear for Bicycles, J. Westaway, London.
12,693. Treatment of Wood, Paper, &c., S. Bennett, London.
12,694. Water Wheels, A. M. Pascault and J. F. M. H. de Coursac, London.
12,695. Bicycles, A. B. Lewis, London.
12,696. Accumulators, X. M. Roux, London.
12,697. Fire-grates, H. H. C. Jürgens, London.
12,698. Culinary Vessels, R. C. Cole, London.
12,699. Cartridges, C. Trossy, Liverpool.
12,700. Gun Wads, C. von Witzleben and M. Thorn, Liverpool.
12,701. Stopcocks, J. Watkinson, Liverpool.
12,702. Draught Ropes of Steam Trawlers, W. B. Brown, Liverpool.
12,703. Adjusting Saddles to Cycles, J. S. Reynolds, Wolverhampton.

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12,704. Match Striker on Pipes, S. B. Porter, Portsmouth.
12,705. Bicycle Brake, L. Hopcraft, Brentwood.
12,706. Effervescing Beverages, J. R. Nixon, Gateshead.
12,707. Fluid Weighing Machine, E. F. Shannahan, Abbeydorney.
12,708. Oil Cans, J. W. Kaye, Bradford.
12,709. Chain Wheels, E. and E. Hodgson, Manchester.
12,710. Double-handed Locks, G. H. Burrows, Wolverhampton.
12,711. Curtain Suspender, V. Bennett, Swansea.
12,712. Frames for Photographic Pictures, B. Hodges, London.
12,713. Cycles and other Vehicles, &c., W. Rourke, Croydon.
12,714. Pedestrial Locomotion, J. C. and M. C. Hall, London.
12,715. Pneumatic Tires for Vehicles, E. Dutch, Manchester.
12,716. Venetian Blinds, W. L. Duncan, Glasgow.
12,717. Printing on Match Boxes, R. Hannan, Glasgow.
12,718. Tobacco Pipes and Cigar Holders, J. R. Boulcott, Birmingham.
12,719. Gear Cases for Cycles, M. H. Galsworthy, Birmingham.
12,720. Wheel Tire and Rim, A. Appleby, Newcastle-on-Tyne.
12,721. Machine Rest and Tool Holder, H. Sutcliffe, Halifax.
12,722. Tobacco Pipes, E. Stocks, Halifax.
12,723. Lamp Glasses, G. Hookham, Birmingham.
12,724. Picking Mechanism, J. Smith, J. Whitaker, and N. Wilkinson, Bradford.
12,725. Turning Taps, F. S. Smith and J. H. Smith, Derby.
12,726. Hygienic Crossed Legged Bed, E. Martyn, Southwold.
12,727. Clothes-prop, W. F. Horn, Liverpool.
12,728. Mowing and Reaping Machines, E. Hewitt, Buxton.
12,729. Travelling Case for Bicycles, B. F. Cocker, Sheffield.
12,730. Portable Shaving Appliance, T. F. Senior, Sheffield.
12,731. Cop Winder, B. M. Knox, Glasgow.
12,732. Pneumatic Tires, T. Wright, Glasgow.
12,733. Preventing Clock Weights Falling, F. S. and J. H. Smith, Derby.
12,734. Cycle Automatic Alarms, H. Hind and J. Barlow, Nottingham.
12,735. Filtering Sewage, W. T. Whitehead and J. Wolstenholme, Manchester.
12,736. Manufacture of Tobacco, R. Pserhofer, Manchester.
12,737. Twisting Fibrous Substances, G. Whitaker, E. Feather, and J. B. Ratcliffe, Keighley.
12,738. Distributing Electric Light, V. Planques, Brussels.
12,739. Disinfecting Fountain, W. G. Ashburner, Dalton-in-Furness.
12,740. Wire Fabric for Mats, F. W. Crossley and S. H. Shenstone, Birmingham.
12,741. An Improved Gear, H. G. Cadney, London.
12,742. Sanitary Infant's Bib, &c., L. B. Baldock, London.
12,743. Fasteners and Binders, &c., E. B. Parnell, London.

SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

555,486. Bleaching Keir, *G. L. and W. P. Allen, Worcester, Mass.—Filed July 15th*, 1895.

Claim.—In a bleaching keir, the combination, as described, with the main body shell, and the grating separating the interior into an upper and lower space; of the series of vomit pipes leading from the lower to the upper space, disposed adjacent to the exterior of the main body with their inwardly curved ends attached to said body shell, the central grate supporting column below and terminating at the grate, and having the supply head with interior steam chamber therein, a steam supply pipe connected with said steam chamber, a series of radial steam pipes underlying said grate and leading from said steam chamber into the respective vomit pipes and fitted with upwardly directed injector ends therein, and the inwardly directed flat-mouthed delivery nozzles at the upper ends of said vomit pipes, for the purpose set forth.

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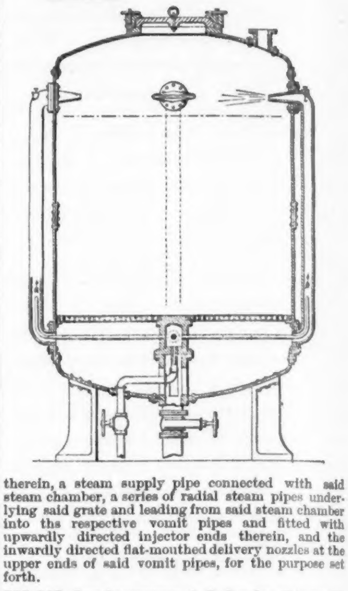

555,567. Saw Sharpener, *C. H. Douglas, Chicago, Ill. —Filed July 16th*, 1895.

Claim.—(1) In a machine for sharpening the teeth of saws, the combination with the main frame, of the plate D attached thereto and arranged to rest upon the back of a tooth; the cutter C, constructed to fit the circularly grooved face or front of the tooth and arranged to act in conjunction with said plate D in removing the metal from the point of the tooth, thus giving the required angle to the point of the tooth, and avoiding the formation of a burr on the cutting point; and means for keeping the cutting tool up to its work while in operation, substantially as described. (2) In a machine for sharpening saws, the combination with a main frame, of plate D, the cutter C, co-operating with said plate, and movable handle *b*, pivoted to the main frame, and provided with the forked end, one fork being the projection *d*, and the other the thumbscrew *e*, substantially as specified and described. (3) In a machine for sharpening saws, the combination with the main frame, of plate D, cutter C, movable handle *b*, provided with the clamping device; and the adjustable plate E, mounted eccentrically upon the main frame, substantially as described.

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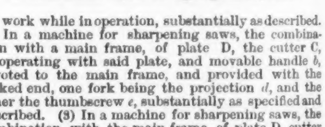

555,915. Flue Expander, *J. T. Fuhrmann and J. M. Daugherty, St. Paul, Minn.—Filed June 9th*, 1893.

Claim.—(1) In a tube expander, the combination of the cylindrical rolls adapted to be brought into contact with the tube on each side of the sheet, and the intermediate rolls bridging the space between the first-named rolls and having half the taper in an opposite direction of that of the mandrel, substantially as described. (2) In a tube expander, the combination of the series of rolls having end gudgeons journalled in the expander case, and the other end in contact with the tube at the outer edge of the sheet opening, for expanding the outer end of the tube, the series of rolls similarly journalled in the outer end of the expander case, and having shoulders adjacent to the inner edge of the sheet opening for expanding the tube on the inside of the sheet, and the series of rolls more than bridging the space between said other two series for expanding the tube in the sheet opening.

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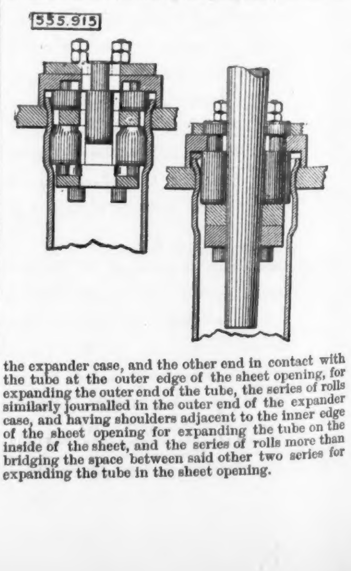


THE CONVENTION OF THE MUNICIPAL ELECTRICAL ASSOCIATION.

As promised in our last impression, we conclude our report of the proceedings at the Convention. The third paper was on

THE CONTROL BY MUNICIPAL AUTHORITIES OF CONSUMING DEVICES AND THE WIRING CONNECTING THEM TO THE MAIN,

by C. H. Wordingham, the city electrical engineer of Manchester. It was taken as read, the author merely giving the headings of the subject. The following is an abstract of the paper:—The author stated that the subject of regulations as to carrying out the connection within a consumer's premises of his consuming devices to the electric supply mains is one which has engaged the attention of electrical engineers since the early days of electric lighting. The points with which the author desired to deal were those especially affecting municipalities, the questions of the regulations themselves might be thrashed out by such societies as the Institution of Electrical Engineers or the Northern Society of Electrical Engineers. Before making regulations it is well to see whether the body making the regulations has power to enforce them. By the Board of Trade regulations, supply must compulsorily be discontinued if the insulation resistance of an installation does not reach 10,000 ohms, but most certainly if the insulation resistance exceeds this amount the undertakers cannot of necessity be compelled to connect, although most wiring contractors seem to suffer from the delusion that this is the case. It is, however, most clear that municipal bodies under their provisional orders have the power to make such regulations as to work on a consumer's premises as shall prevent him becoming a source of danger or unsatisfactory supply to any other consumer, and the author quoted the clauses in the order as follows:—"Provided also that if the owner or occupier of any such premises as aforesaid uses any form of lamp or burner, or uses the energy supplied to him by the undertakers for any purposes, or deals with it in any manner so as to unduly or improperly interfere with the efficient supply of energy to any other body or person by the undertakers, the undertakers may, if they think fit, discontinue to supply energy to the premises as long as such user continues." "Provided also that the undertakers shall not be compelled to give a supply of energy to any premises unless they are reasonably satisfied that the electric lines, fittings, and apparatus therein are in good order and condition, and not calculated to affect injuriously the use of energy by the undertakers or by other persons." Supply station engineers may wish that the Board of Trade would allow a municipality to draw up regulations and to submit them to the Board for approval, such regulations being endorsed by the Board and becoming binding on consumers.

Municipal authorities already interfere to a large extent with the consumers' premises, notably in the case of sanitary arrangements, and water and gas supply; and, from the author's experience, there can be little doubt that consumers of electric current would gladly welcome some efficient supervision on the part of the municipal authorities. It must be notorious to all present that in every town there are many contractors whose one aim and object is to obtain work at any price, and then by scamping the work to make some profit. The last thing they think of is to make a good, durable, and efficient job. Cheap and inefficient wiring is a crying evil at the present time. Other means must be sought for preventing bad work than those now held under the provisional order. Glasgow has obtained it by a side wind in the most ingenious manner. Clause 65 of the Glasgow Buildings Regulation Act, 1892, runs as follows:—"Any installation for electric light in any building shall be subject to such regulations and conditions for securing the safety of the public, and for the prevention of fire, as the Lord Provost, magistrates, and Town Council of Glasgow, being the Authority empowered to supply gas and electric light within the city, may reasonably require."

The author thinks it would be desirable for the Corporation to be able to constitute themselves through their engineer an advisory body to the consumer who chose to avail himself of their advice; that is to say, any consumer, no matter how small, could, by the payment of a fee, small in the case of very small consumers, obtain the services of the Corporation to draw up a specification for the wiring, and to watch the carrying out of the work, power being given as in an ordinary specification to have the work done in a definite predetermined manner. The author then said that many possible consumers are lost—some because the matter is not properly put before then, others because they do not care to trust to an ordinary contractor, others because they are so trusting to as think that a supply can be produced more cheaply by their own plant, and lastly those who seek expert advice, but who are unable to distinguish a consulting engineer from a contractor masquerading as such. Who could be a better qualified person to give advice than the engineer to the Corporation, who is presumably endowed with the same feelings that actuate the members of the Corporation, viz., that a Corporation exists for the good of the citizens generally? The author is quite aware that the proposal here made is likely to lead to violent opposition from consulting engineers, and this raises the whole question of municipal control *versus* private enterprise. Once the principle is admitted that certain undertakings are best placed in the hands of the Corporation, it is difficult to see why the idea should not be carried out in its entirety, and consumers not only supplied with current but guarded in such a manner that they can make proper use of the supply. The fee charged, except in the case of very small consumers, would be comparable to the fees charged by consulting engineers, and the author believes that the practice of the latter body would be increased.

Another remedy would be for the Corporation itself to employ a staff of workmen, and carry out the wiring. This he thought unwise, as there would be considerable risk of financial loss. The consumer would regard the work as guaranteed; there would be difficulty in enforcing regulations upon contractors: and such objections to competition as apply to consulting engineers would apply still more to wiring contractors. It is desirable for the Association to draw up rules, and these should include all the points desired by the supply station engineers, and also by the fire offices. Insulation need not be so high on alternate current systems, where there is a separate transformer in each house, or where a number of consumers are fed from a sub-station, as where a direct current supply is given. The task of drawing up rules should devolve upon a committee of the Association, and he suggested points to be discussed. The insulation resistance should be decided, and it is no use requiring such a standard as can only be attained by drying the switches and fittings with calcium chloride, and warming the ends of the cables with blow lamps. Allowance should be made for exceptional circumstances, and the standard should not be enforced in new buildings with wet plaster until the plaster has had time to dry. Quality of cable, the nature of its insulating covering, and the method of supporting the wires should also be defined. Secondly: The distributing boards must be so arranged as to allow of efficient balancing; regulations should be made as to starting and stopping motors and the adjusting of arc lamps, so that excessive currents at starting shall not be required. Thirdly: As one of the conductors will probably be earthed, precaution must be taken to prevent a consumer getting an electric shock. Motors should be so designed that the brushes will not require attention.

Notice should be given to the Corporation before the work of wiring is begun, so that proper tests may be made; also, samples of the materials should be submitted for tests, and samples of switches, cut-outs, distribution boards submitted for approval, and the more important, if not all, should be tested and stamped by the Corporation, as is done with water fittings. Much might be done to raise the standard of work done by wiring contractors were a system of authorising electric light fitters to be drawn up. There are practical difficulties in the way, and questions would arise such as—Should the contracting firm or the individual workman be authorised? Should the municipal authority make the inquiries, and, if necessary, hold an examination? Or should it accept the examination of such a body as this Association, or the Institute of Electrical Engineers, or the Northern Society of Electrical Engineers? What power has the municipal authority to insist upon the authorisation of such fitters?

The following resolutions were proposed for adoption by the Convention:—

Resolved: "That this Convention of the Municipal Electrical Association is of opinion that the need of a standard set of regulations for controlling the fixing and connecting of consuming devices supplied from municipal electric supply stations is urgent, and that such regulations should be drawn up and adopted by the members of this Association."

Resolved: "That a sub-committee of members of this Association be formed to draw up a draft set of regulations, and to inquire what powers exist for enforcing such regulations, when made, and also to ascertain how further powers for this purpose may be obtained, if necessary. The sub-committee to have power to confer with any person or body of persons having special knowledge of or interest in the matter, and subject to the approval of the Council of this Association, to obtain legal advice on the matter. The sub-committee to present a full report of the work to the next Convention."

The discussion then followed.

Mr. Taylor, of Liverpool, said that, according to the author's views, both the consulting engineer and the contractor were to be improved out of existence. In Liverpool all the important work was done by the Supply Company; there are, however, a large number of contractors who take the work at very low prices, and cannot do the best work. The speaker stated that he was an inspector for the Supply Company, and remarked that the fire offices could not stop bad work, as the majority of the consumers do not pay sufficient premium to recoup the fire offices for inspection. If there were more fires the inspection would not be improved, but the rates demanded would be higher. Rules should be drawn up so as to form a specification, as it is an invidious task for an inspector to have to go to an experienced engineer and tell him his work is bad.

Mr. Hammond said that at the Westminster Conference summoned by the Board of Trade electrical engineers did not get all they desired. This association would, however, be able to put the matters before the Board. The bad wiring contractor should be got rid of. The municipality should draw up stringent rules, and the municipal engineer should have the power to inspect work and to be paid for it. Opposition from consulting engineers need not be feared, as the better the class of work the greater would become the demand for consulting engineers.

Mr. Chamen—Messrs. Crompton and Co.—said that the firm with which he was connected were dropping out of electric wiring. They should, however, like to have a strong set of rules. He thought it a bad plan for the Corporation to take up the actual work of wiring, but they should have full control over the work done.

Mr. Raworth—Brush Company—said electrical installations require very little regulations; the very worst was much better than the best gas installation. The business of fire offices was to collect fees, and not to inspect. In 1881 some winter gardens were lighted by electricity, and 20 per cent. reduction was allowed on the fire insurance premium, but no such reduction could now be obtained, so that it paid the offices better than formerly. On the Continent the work was so bad, engineers would have a fit on the spot if they saw it. The best work was worse than the worst English work. A combination of skill was required to produce such effects as those shown by Mr. Wordingham. He thought rules should not be forced on to consumers. In gas-fitting perfect freedom was allowed. The Municipal engineers' services might perhaps be made available on payment of a fee.

Mr. Manville thought a consensus of opinion ought to be obtained as to rules. The question as to whether local authorities should fit up houses was a very delicate one, as they would compete with the present contractors. Penny-in-the-slot meters for electricity would doubtless soon be employed. Progress was hindered in electric lighting by the fact that many leases had only a short period to run; perhaps the local authorities might fit up such houses on rental.

Mr. Arnot, Glasgow, agreed that the standard of certain contractors was very low, but he thought municipal engineers should not have any further responsibility thrown upon them; it was impossible to inspect while wiring was going on, and he thought they should not undertake to stamp instruments and fittings.

The meeting then adjourned, and in the afternoon the members paid a visit to the Deptford station of the London Electric Supply Corporation, Limited, and were received by the chief engineer, Mr. P. W. d'Alton, and by the manager and secretary, Mr. R. Stewart Bain.

On Thursday, 11th June, the first paper taken was on

THE COST OF ELECTRICITY SUPPLY,

by Arthur Wright, borough electrical engineer, Brighton, and President of the Association. We give the following abstract:—The author pointed out that no manufacturing undertaking can be considered to trade on a sound commercial basis, unless it has ascertained with some degree of accuracy the cost of supplying the commodity it produces; but although electricity has been regularly supplied by large undertakings for five or six years, no definite basis has yet been agreed upon by which the cost of energy wasted in feeders, transformers, shunted meters, &c., can be estimated, or tariffs arranged for such varying classes of consumers as street lamps, motors, business premises, electric tramways, &c. The author points out how charges vary; in one town discounts are given on the total consumption, and in others the price depends on the time of day during which light is used. Current for motors is charged at a lower rate than for light, and street lamps are charged for in all sorts of ways. No proper method of profit-and-loss account has yet been agreed upon by central station managers. One method is, of course, to take the total cost and divide it by the total units supplied, and take that as the basis; but this is not a correct method for the different classes of consumers. Dr. Hopkinson pointed out that the cost of supplying electricity cannot be correctly defined at so much per unit unless the *rate* of supplying that unit be also stated. The author believes that no one has yet made public the results of applying the Hopkinson method to actual accounts. He, therefore, described modifications of the method as applied to the accounts of the Brighton Corporation.

Costs are divided into "running costs" and "standing-by costs." Under the former heading are included coal, oil, and water, and a few other engine stores, besides those repairs to the steam and electricity generating plant which are caused by the continued supply of electricity to consumers. Under "standing-by costs" must be included all coal and oil used in getting up steam, and in keeping the machinery and mains in a position to supply electricity to the consumers at any time; also all stores used in the station or on the mains; all the wages debited to revenue account, as in practice these do not vary from month to month with the output of electricity; repairs to buildings, mains, meters, and those repairs to plant, &c., which are due to it having to be kept in a position to supply electricity; all rates and taxes, management expenses, insurances, and all provisions for redemption of capital and interest on them, and for the creation of any reserve or depreciation fund it may be decided to form for the purposes of preventing any cessation of the supply at any future time. The figures for the Brighton undertaking were as follows:—

	The amount spent in coal.	Engine stores.	The units sold durin these months.
In the three months of October, November, and December in 1895	£ 990	£ 201	366,040
In the three months of May, June, and July	365	133	109,662
The differences between the figures are	625	68	256,378

By the rule described in detail by the author in the paper, the running cost for coal during these six months was,

$$\frac{625 \times 240}{256{,}378} = 0{\cdot}584\text{d. per unit.}$$

For oil and stores,

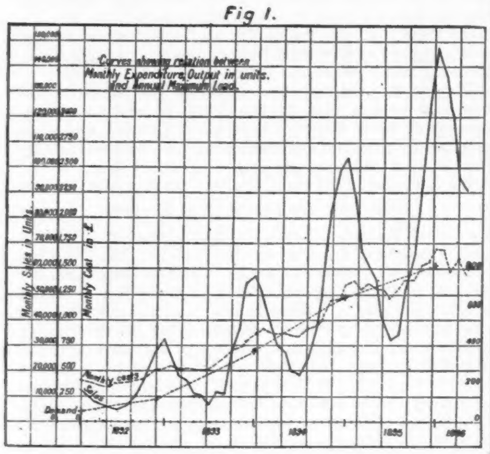
$$\frac{68 \times 240}{256{,}378} = 0{\cdot}063\text{d. per unit.}$$

Division of the Debtor Side of the Brighton 1895 *Revenue Account into Running and Standing-by Items.*

Item.	Rate per unit for running costs determined by above method.	Total running costs for the 867,500 units sold.	Total standing-by costs.	Total amount spent on the items during 1895.
	d.	£	£	£
Coal	·584	2111	485	2596
Stores	·063	230	302	532
Repairs to plant	·063	230	147	377
Repairs to buildings ..	—	—	59	59
Repairs to meters	—	—	69	69
Repairs to mains	—	—	463	463
Wages	—	—	1719	1719
Rates and taxes	—	—	327	327
Management	—	—	1838	1838
Insurance	—	—	69	69
Interest and sinking fund	—	—	7777	7777
Totals	·71	2571	13,255	15,826

The author states that the foregoing values are closely confirmed by quite a different method described later on based on the analysis of the different years' expenditure curves into the different terms of an equation obtained empirically. If the total monthly expenditures as above defined from soon after the starting of the undertaking be plotted in the form of a curve, such as the dotted curve in Fig 1, the corresponding sale of units is discernible but if the maximum annual load taken off the mains be plotted on the same diagram, as shown by the crosses, then an obvious tendency is apparent after the first or second year for the monthly total expenditure to follow this line. At Brighton the original unproductive outlay incurred on starting the undertaking was 6·3 per cent. of the total.

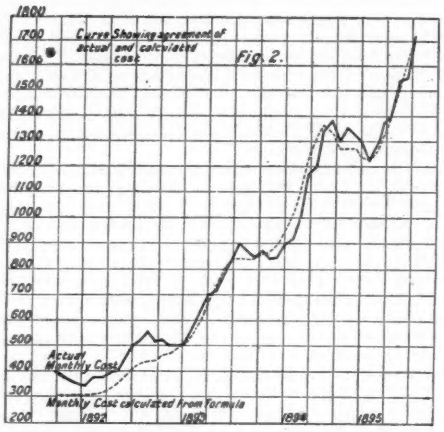
Fig 1.



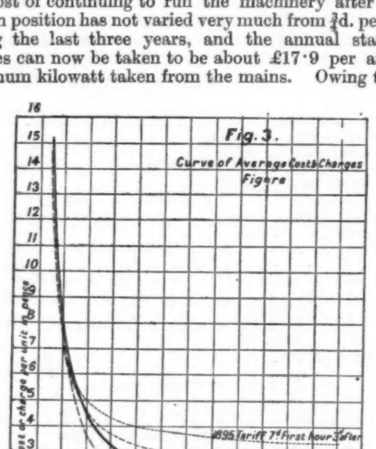
The running costs were 16·3 per cent. of the total, and if coal could there be obtained for 10s. per ton, as in the North, the cost would fall greatly. Hence there is greater necessity for a differential tariff in towns where coal is cheap than where it is dear.

The formula from which the dotted line in Fig. 2 is calculated is that found most nearly to fit the last three years' curves, and is as follows:—

$$\text{Total monthly expenditure in } £ = £190 + 1{\cdot}25 \times \text{D} + \frac{\text{units sold per month}}{300},$$



where D is the value in kilowatts on the gradually increasing maximum load-line of Fig. 1. The cost of continuing to run the machinery after it is once in position has not varied very much from ¾d. per unit during the last three years, and the annual standing charges can now be taken to be about £17·9 per annual maximum kilowatt taken from the mains. Owing to the varying time of day at which the different consumer's heaviest loads are taken, the maximum load is now only 66 per cent. of the sum total of the consumers' maximum demands. Therefore, the Corporation assumes that each kilowatt costs 66 per cent. of the £17·9, or £11·8 per annum, which works out to nearly 7¾d. per day per kilowatt, and the previously determined figure of 0·71d. per unit for running expenses enables the cost of supplying electricity to any consumer in Brighton this year to be very closely ascertained, and from these data the curve of costs Fig. 3 has been drawn. It follows from the above calculations that if all consumers paid 8½d. per unit for the first 365 hours in the year they used their demand, and ¾d. for all units consumed afterwards in the year, the undertaking would be in a self-supporting condition. The maximum charge for Brighton is, however, fixed at 7d., so by the tariff now in force, each consumer pays 7d. per unit for the first 365 hours in each year he uses his demand, and 3d. afterwards. The author finds that loss was incurred in supplying all consumers at Brighton during 1895 who used their demands less than 600 hours per annum. The result of the method of analysis used by the author is to confirm Dr. Hopkinson's startling conclusions.



The author draws a number of conclusions, some of which are as follows:—It is the duty of municipalities to charge a uniform rate of profit on the cost of supplying electricity, rather than a uniform price to all consumers, and much more so in the case of electricity than with gas, because of the much greater percentage the standing charges bear to the total cost in the former than in the latter case. The extremely low price at which electricity can be profitably supplied to consumers after they have paid off their proportion of the standing charges much more than compensates for the difficulty of understanding a uniform rate of profit tariff, as shown by the increasing rate of receiving applications for electricity in towns where differential charges and low prices to long users are in vogue. It costs two and a-half times as much to supply a unit to a consumer who uses his lights on the average only one hour per day, as it does to another who uses them three hours. It is much more worth while trying to improve the load factor than to reduce the coal bill. The rapid fall in the cost of supplying electricity as the average time of use increases makes the small householder a much more profitable class to supply both in his residential and shopping districts than the residences and shops where the wealthy dwell, owing to the frequent absence from home of this class and the early closing of their shops. One of the most important consequences of the fact that electricity can be profitably supplied from central stations to consumers at the rate of 8½d. per unit for the first 365 hours in each year they use their demand, and for something between ½d. and 1d.—according to the price of coal—for any electricity consumed afterwards in the same year, is that street lighting and that of basements or dark buildings lighted all day long can be more cheaply done by electricity than by any form of artificial light, as in those cases where the use is on the average eleven hours per day, or 4000 hours per annum, the inclusive cost for the electricity consumed will not generally exceed 1½d. per unit. The fact that up to the present only the very fringe of street lighting has been touched by the electricity supply undertakings appears to the author a sure sign that Dr. Hopkinson's conclusions have been hitherto ignored by most of the responsible managers, and again to direct and urge them to give their closest attention to these conclusions has been the object of the author in writing the paper. The discussion upon the paper then followed.

Mr. Mavor said he believed differential rates were useful, but thought Mr. Wright's system very complicated; he thought his own system better. For example, he would use a recording current meter, and suppose a person had an installation of 1000 lights, he should divide the total record by 500 ampères, and so get the average hours per light; then for, say, 1000 hours' consumption the consumer would get a discount of 10 per cent., for 2000 hours' 20 per cent., and for 3000 hours' 50 per cent. Some would get current under 3d. per unit. Large telephone stations were relatively more expensive to work than small ones, and this applies to electricity stations; also street lighting by arcs costs much more than gas lighting; incandescent lighting can be carried out at the same price as gas, but the speaker saw no advantage in it.

Mr. Sayers, Bournemouth, said he had got his company to adopt Mr. Wright's plan, and they had had an increase in the number of units sold, showing that a greater value was taken at the reduced price. He thought Mr. Mavor's system impracticable, as notice was not always given of alterations in lights and deception was easy. The general use of the light by the poor should be encouraged. At Bournemouth an extra unit costs 0·8d. If the extra units were sold at 1·5d. to 2d. per unit, a profit would be made if the maximum demands were not increased. In the first quarter of the present year they received 15 per cent. more with Wright's system than for the first quarter of 1895, although the price is now lower.

Mr. Alexander Siemens said he was quite surprised to find how dear electricity was; he had no idea of it until he had supply from the public mains in his own house. He had all the servants' rooms and the basement lighted, and found his electricity bill at 8d. per unit exactly the same as his gas bill at 3s. per 1000 cubic feet previously.

Mr. Ellis, Southport, said that at first all customers got the same rate of discount. In 1895, however, the demand system was adopted, and 30 per cent. of their customers got the current at the low rate of 7d. per unit for the first two hours, and after that 4d. per unit. The small tobacco shops and small grocers' shops paid the best. The maximum demand is now reduced to one hour, and they were afraid their income would be reduced; but it had increased 18 per cent.

Mr. Wordingham thought Wright's system good with a fixed charge of, say, £12 a-year per kilowatt demanded; that is, reckoned on the total lamps, and then a charge of 2d. per unit actually consumed; but when the system is founded upon the maximum lamps, it discourages the fixing of new lamps. In Manchester they could not spread their accounts over two quarters, which was necessary with Wright's system. Mr. Mavor's system he thought very bad, as a consumer could actually diminish his bill by using more current. Mr. Wright's figure of £11 8s. was very similar to his figure of £12 in Manchester.

Mr. Dawbarn would like to see a table setting forth the relative value of the various classes of consumers; they would be able to get the probable maximum demand, and therefore the revenue.

Mr. Geipel thought the first capital cost was a very important item, and this varied per kilowatt from £125 at Brighton to £50 at Bradford and Leicester. In many private houses 75 per cent. of the electricity account would be found to be due to the consumption in the basement.

Mr. Proctor, Bristol, thought a day load meter better than that of Mr. Wright. In Bristol the figures had been improved solely by the education of the users in the matter of switching off their lights when not required.

Mr. Hammond said the paper brought forward by Mr. Wright was a most important one; it showed clearly that the poor man was the consumer who was profitable, and not the rich man. He then illustrated this by reference to the Bowery district of New York, and by the case of Brighton itself. The Hove district did not pay.

The sixth paper was then taken on

CABLE SPECIFICATIONS AND TESTS,

by Joseph A. Jeckell, Borough Electrical Engineer, South Shields.

The author divided persons who issue specifications for cables into various classes, but only referred to one class, viz., those who know what they want and are desirous of obtaining it on the most favourable terms. It is not at all fair to contractors for an engineer to issue an open specification when he has a very clear idea what cable he intends to have. The manner of clearly specifying what is wanted seems to be best for all parties. Another reason for clearly stating what manner of cable is required is that there will be much less difficulty in stating what tests the cable will be required to stand, for those which are suitable for a rubber cable are unsuitable for a compound cable, and *vice versâ* perhaps. The best makers of copper wire are prepared to guarantee 100 per cent. when gauged over the tin. If the price lists of the various makers are examined, it will be found that there is a very considerable difference between the conductive resistance of cables. A very simple way to get over all difficulties, and to obtain just what is wanted, is not to give the number of strands and their size in the specification, but simply to specify what resistance per mile the conductor is to have, and the number of strands of which it is to be composed, and if desired, the conductivity of the copper. But this does not much matter, because it makes no difference to the engineer whether the cable manufacturer uses 98 per cent. copper and puts more in, or 100 per cent. and puts in less. What he does want is that the cable shall have a certain conductivity per mile, and he has based all his calculations on this. All strands should be cabled and not twisted, as by the latter process the wires are hardened. If concentric cable is to be used care should be taken to specify that the outer conductor must have the same copper resistance as the inner, for if the outer has the same sectional area as the inner, its resistance will certainly be more than that of the inner. It has been known to be as much as 7½ per cent. more, but this is rather an outside figure. As to insulation, if rubber is to be used it is well to specify that the layers should be well vulcanised together, and the tape next the rubber must be broad. High insulation resistance *per se* is no use; insulation is required which will not deteriorate.

About 5000 megohms per mile is a very fair insulation to require for a first-class rubber cable; and, of course, this test should be made with a battery having at least 500 volts. It is very undesirable to insist on high insulation resistance in compound cables. Great care should be taken in accepting a compound cable having a high insulation resistance; a pressure test is of much more value. Bending tests are necessary for compound cables; it must be proved that the insulation is not damaged by any bending that does not damage the lead.

The makers of the cables should also lay them, otherwise they could not guarantee them. The author, however, does not advocate letting the trench work to the cable manufacturer. It is difficult to specify what the insulation resistance of compound cables should be, because it varies with the insulating substance. It seems desirable that the life of a cable should be guaranteed; but most makers will not guarantee unless their own men make all joints after the cable has been put down.

The discussion followed. Mr. Wordingham, Manchester, said a good specification was essential. A high insulation resistance test does not prove that one contractor should not be allowed to lay the pipes and another to draw in the cables. Samples of the cables should be tested to destruction to find the breaking stress.

Mr. Talbot, Nottingham, speaking of guarantee, said he had £8000 worth of cable guaranteed for three years, and after two years his corporation still owed £800.

Mr. Alex. Siemens said rubber cables unless covered with lead were no good in places where they are alternately wet and dry. There was a crazy desire for high insulation resistance tests. Pure rubber deteriorates much more rapidly than vulcanised rubber. The use of pure rubber next the wire is a mere fad, and costs a great deal. Jute insulated lead-covered cables last splendidly; this material, and also paper, do not offer so high a resistance to sparking through as some other types. His firm had just brought out a new material which offers great resistance to sparking through, and he added particulars of the tests.

Mr. Arnot, Glasgow, said the life of the lead was the life of the cable. Mr. A. H. Preece had drawn up an equation for determining the proper thickness of lead for a given outside diameter of cable.

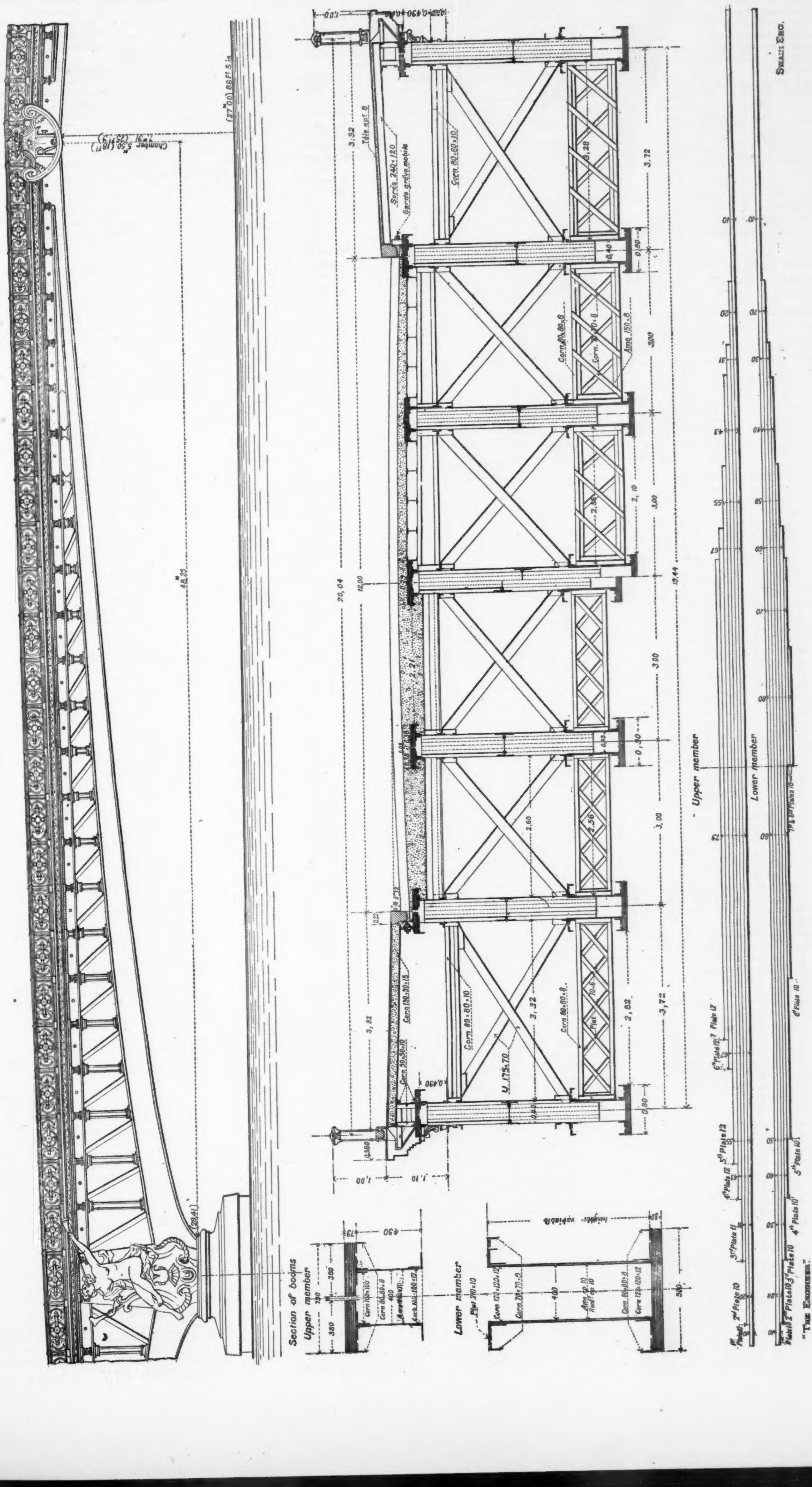
Mr. Callender desired to have a specification stating that the cable must pass certain tests; the conductivity per 1000 yards should be specified. He had made fibre cables up to 15,000 megohms per mile. Armouring should be carefully specified.

Mr. Crompton said the rapid deterioration of rubber

THE MIRABEAU BRIDGE OVER THE SEINE

M. RESAL, PARIS, ENGINEER

(For description see page 615)


Chamber 5.50 (18ft)
2x16 (52ft)
(27m00) 88ft 5in
48.25
Tôle ep. 8
Sorge 240x120
Garde grève mobile
Corn 80x80x10
Corn 80x80x8
Âme 150x8
U 175x70
3.92
3.32
3.28
3.72
3.00
2.82
2.60
2.56
20.04
12.00
13.44
Section of booms
Upper member
Lower member
Upper member
Lower member
SWAIN ENG.
"THE ENGINEER"

was due to chemical action, and the full details were only known to the cable makers; if vulcanising were not carried out properly the results were bad. In India he knew rubber cable never lasted over two years. Callender's was the only type he had found to stand; the cables he had put down in 1882 were still in use.

The meeting was then adjourned, and the members were received in the afternoon at the Vestry Hall, Upper-street, Islington, by the Electric Lighting Committee. The following paper was then taken as read:—

Combined Electric Lighting and Traction Plants,

by John Hesketh, Electrical Engineer to the Government of Queensland, late Borough Electrical Engineer, Blackpool; and John H. Rider, Borough Electrical Engineer, Plymouth.

The author points out that the one thing operating against the cheaper production of electricity for lighting purposes is the smallness of the load factor. No suggestion for improving the factor has found such favour as the one for providing a load for the plant during the hours of daylight.

Many corporations own but do not work their tramways, and in the near future it may be safely prophesied that those corporations who willingly lease their lines will be in a minority. When a revision comes, electricity will no doubt be considered as a source of motive power, but there will be one important question to decide, viz., shall the plant be separate and distinct, or shall it be combined with a plant for electric lighting? As the plant will already exist in many cases for electric lighting upon a system unsuited for direct application to tramway purposes, the tendency may be to keep the plants separate. To show that this tendency is wrong is the object of the paper. Such a combination has already been used in America, Europe, and elsewhere. In cases where low tension direct current is in use for lighting, the question is very simple—motor transformers can be used; in fact, be the voltage and current what they may, this method can be adopted and produce a suitable direct current at 500 volts for the cars.

Such a combined plant, worked economically, ought to produce current for all purposes at 1½d. to 3d. per unit, according to the demand, simply due to the better load factor. The authors then quote facts from continental work. In Geneva the street car company takes a minimum of 500,000 units per annum, and pays 1·15d. per unit. In Hamburg the street car company guarantees a minimum annual consumption of 2,500,000 units, and their whole expenses are 3·95d. per car mile. The number of persons carried has increased 32 per cent. over that when horse cars were used, and the receipts have increased nearly 35 per cent. In Havre 1·75d. per unit is paid by the tramway company. There are two systems applicable: (*a*) A separate and distinct tramway plant within the same station buildings as the lighting plant, and under the same management; or, (*b*) the existing lighting machinery may be employed. The authors give curves showing that if the same plant be used for lighting and for the tramway work, a fairly steady load is obtained in the day-time, but the usual peak of the curve is largely increased.

The power required for driving the cars during the period of heavy lighting load may be obtained from accumulators. These would be charged direct from the station machinery, if suitable, or from the same motor generators which supply the cars. The authors show the result by means of a curve, and favour the use of accumulators. They are aware that cells have been carried on the cars and found unsatisfactory; but by their system the cells would only need to give an output of about 25 per cent. of the total power required.

This paper dealt with a most important subject, and elicited a very valuable discussion, but our space will not allow of its reproduction, except to say that the general opinion appeared to be that separate plant for lighting and tramway work was desirable.

Mr. E. S. Ruthven-Murray's paper, "On the Organisation of an Electricity Works Staff," was also taken.

The paper on "Electricity Works' Records," by A. B. Mountain, borough electrical engineer, Huddersfield, was taken as read, and the consideration of the various matters dealt with by the author was referred to a Committee of the Association which is about to be formed to consider various subjects in greater detail than is possible in a public meeting.

The members then inspected the fine electric lighting station of the Islington Vestry, which we described in our issue of May 29th last.

On Friday morning there was a business meeting for members only, and Mr. Wordingham, Manchester, was elected President for the next year.

The members left about 2 p.m. for Brighton, and were received at the Pavilion by the Mayor and the Electric Lighting Committee.

The paper on

Extensions to Outlying Districts

by A. H. Gibbings, Borough Electrical Engineer, Bradford, was then taken as read. It dealt with the cost of extending supply into the suburbs and houses scattered over a large area. The author gives a useful table of rentals of houses, shops, &c., in one particular street with the gas bills for each particular rental. He gives curves showing the effect of the addition of outlying district loads to the loads in the central area. The paper was followed by a good discussion. Some speakers, notably Mr. Giles, Blackburn, advocated the payment of 6 per cent. interest on the cable outlay by consumers in the outlying districts. The majority of the speakers, however, considered the cable itself as "the best canvasser," and advocated the laying of the mains without waiting for demands, believing business was certain to follow

After the meeting the members were conducted by Mr. Arthur Wright over the new electric light station. The old building was found far too small, and the present one is not yet completed, but the plant is being put in place rapidly. We shall take an opportunity of dealing with this station at a future time. One of the most interesting points is, that at Brighton the day load is taken by direct current, and at a certain hour rotary transformers are brought into operation which produce alternating current, and during the hours of heavy load this is used in place of direct current.

We can only add, in conclusion, that the meetings of the Convention of this new Association were most interesting, and we feel sure that the body will materially assist the more general use of electricity, and also the acquisition by public bodies of the means of supply.

THE NUREMBURG EXHIBITION.

(*From our Special Commissioner.*)

In 1882 The Engineer gave some account of an interesting and successful Exhibition held in Nuremburg that year. It was the first Bavarian National Exhibition, and was conducted under the auspices of the Bavarian Industrial Museum. This institution has this year entered its twenty-fifth year, and to celebrate the occasion, mindful of its previous success, determined to arrange and conduct a second Bavarian National Exhibition. To make it as representative as possible, the various provinces of Bavaria were invited to participate in the enterprise, which they did in a half-hearted sort of way; but yet in a short time the necessary guarantee fund was obtained, Nuremburg and neighbourhood contributing 1,085,000 marks, the rest of Bavaria 133,500 marks. The site selected was the beautiful Stadt Park, situated to the north-east of the town, and a penny tram ride from the centre of it; a spot familiar to all readers of "Faust." In a year and a-half the various buildings were erected; they are all timber structures, stuccoed outside, dazzling in their whiteness and pleasing in their architecture. The appearance of the main buildings may be gathered from the illustration, which shows the commercial and industrial building on the left, the three-aisled machinery hall on the right, and the transport and educational departments in the centre. The industrial and commercial building covers 31,200 square yards, the educational and transport 6960 square yards, and the machinery hall 111,600 square yards; the central aisle of the industrial is about 60ft. high, 670ft. long, and over 80ft. wide, and stretching at right angles from it are side aisles 200ft. long. Besides these there is the art gallery, covering an area of 2760 square yards, and many smaller buildings dotted here and there over the Exhibition grounds, which in all comprises an area of 194,880 square yards. Of the minor buildings, the wine house, the Nuremburg, Culmbach and Munich beer halls are prominent in the picturesque quaintness of their architecture, being reproductions of old-time buildings, and they prove very attractive for other reasons.

The general arrangement may thus be sufficiently gathered from the illustration. There are about 3000 exhibits. The main building with its side aisles is devoted to industrial products arranged territorially, each of the aisles having been allotted to one of the provinces into which Bavaria is divided politically, the decoration of each hall and arrangement of the collection having been done in each case by the particular province. This section of the Exhibition presents points of particular interest and attractiveness, and the points of difference and distinction, in so far as they interest your readers, will be referred to later on. In the educational section there is the usual display of diagrams and appliances, too many to enumerate, and none of sufficient prominence to attract during a preliminary inspection of the Exhibition. The transport department includes the postal and railway sections. The latter is perhaps the most important section in the Exhibition, as the whole range of the railway industry is included, and not alone is the present-day practice well represented by rolling stock and other appliances, but also a series of highly-finished and beautiful models and diagrams illustrate in a striking manner the development of this industry in Bavaria since the year 1844. I hope in a future letter to call attention to this unique collection, and to many other exhibits of interest in this section. What may be mentioned particularly now are electrically-worked turntables and traversing tables, compound locomotives, duplex-compound locomotives, and four-cylinder compound locomotives; whilst to the general public the panting, puffing, and gasping of a Westinghouse brake installation for fifty carriages proves an irresistible attraction.

The brewing department is a special feature. There are several plants that have a strong family likeness, so that a closer inspection only will reveal the differences between them. One, however, is worked by electricity.

The machinery hall is an imposing structure, rather marred by lack of finish; the central aisle is 500ft. long and 60ft. high. The most important exhibit in this hall is that of the Elektricitäts Actiengesellschaft, formerly Schuckert and Co., of Nuremburg. They have an excellent display of engines—vertical, horizontal, marine—and of dynamos, motors, and other electrical appliances. They, in fact, supply from their steam engines and dynamos the 2700-horse power required by the machinery in motion and various other operations conducted in this hall. Other machinery exhibits of note are those of the Maschinenfabrik Augsburg, the Dinglersche Maschinenfabrik, and others; whilst the Schmidt superheated steam compound engine, and display of pumping machinery of the Maschinen and Armaturfabrik, formerly Klein, Schanzlein, and Becker, are conspicuous. What, however, may be regarded as the characteristic features of this part of the Exhibition are various local industries in operation along the side aisles. There are twenty-three at work, and, with few exceptions, are worked by electromotors, of which, therefore, a great number of patterns and sizes can be seen working, sometimes boxed in, sometimes open, sometimes alongside the worker, sometimes hidden away in some corner, or in some out-of-the-way shelf, or under the table. The quietness, cleanness, comfort and convenience of the general introduction of electricity in small industries is most strikingly demonstrated. These portable electromotors for agricultural purposes, electrically driven saws, lathes, sausage machines, &c., further illustrate how keenly alive the Nuremburgers and their neighbours are to the capabilities of electricity, and consequently the construction of such electrical appliances has become one of the staple industries of the district.

Another industry of no small importance is the making of printing presses, of which a good number are exhibited; and, moreover, two daily papers are printed in the Exhibition. There are other machines for metal, wood, glass, stone, clay, and leather working, and for milling and agricultural purposes—the latter not important; and as is expected in connection with the large brewing industry, there are a few ice-making plants, the Linde system being to the fore. They do the freezing for theartificial ice-rink.

The Exhibition was opened on the 15th of May, and will remain open until the 15th of October. Up to the 10th of June 190,000 admission fees had been taken at the gates, and 11,000 season tickets had been issued, and this in spite of the fact that the Exhibition had not been well advertised.

The object of this Exhibition is to demonstrate the productive power of Bavaria, and as I have already indicated, this power extends over a wide and varied industrial field; and, as might be imagined, the main object of this activity is the supply of the wants of the people at home and abroad. It is achieved, not by striving to make new discoveries, but by employing discoveries already known to the best advantage, and adapting them to the varying circumstances of industry and commerce. This position of affair is well illustrated at the present Exhibition, for things of striking novelty are not to be found, but adaptations and improvements may be everywhere observed. Take, for example, the electromotors already referred to, whilst the historical collection of railway rolling stock illustrates thisstill better.

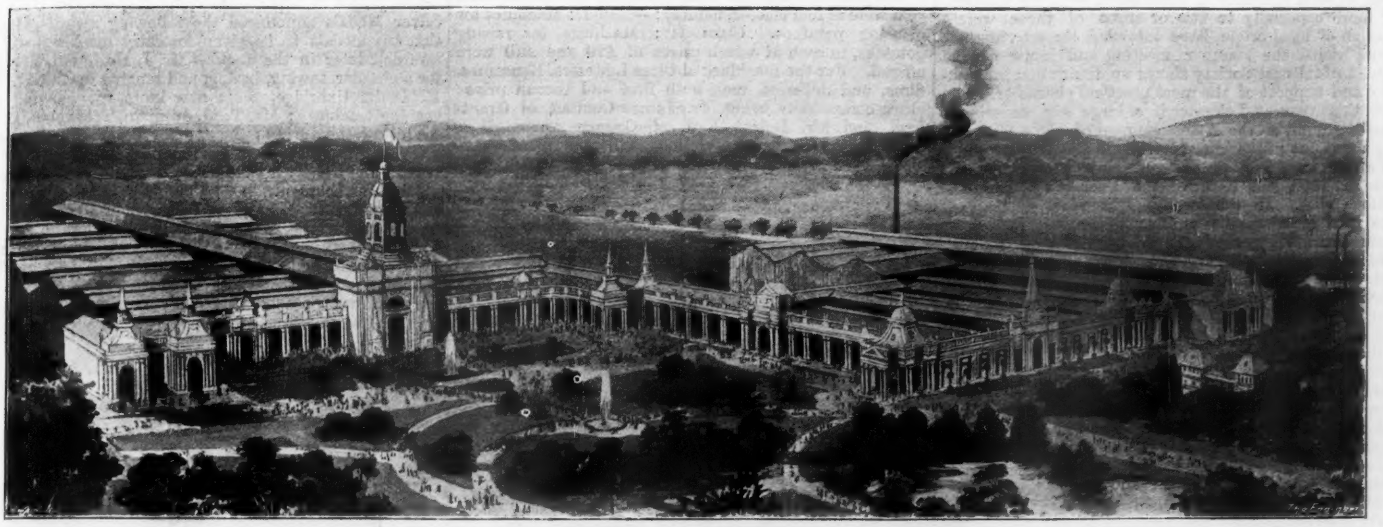
Therefore, I did not search particularly for novelty in looking round the provincial exhibits, and was not disappointed at not finding it. All provinces produce various articles of food, solid and liquid; of clothing, household utensils, some more, some to a less extent, and various sundries unnecessary to enumerate. But it may be interesting briefly to note what appears to be characteristic of each province. Upper Bavaria seems great in artistic and ornamental objects in gold, iron, leather, enamel, marble, and zinc; produces peat-moss litter, peat-moss machinery, and cement. Lower Franconia is prominent in wine and fruit; Upper Franconia in glazed tile work, cement, basket work, and textile goods, having the only exhibit of flax, also hops. Middle Franconia specialises in toys and models, iron, steel, and metal work, pencils, soap, and "Sanitas" appears in this section. Swabia makes a good exhibit of cotton spinning, wrought iron, bronze and brass work. Lower Bavaria, woodwork and all kinds of glass. Oberpfalz and Regensburg, the only mining and metallurgical exhibit worthy of note; the Bayerische Braunkohlen and Briket Gewerkschaft have built a very realistic mining gallery, showing brown coal working, and an excellent model of a lignite washing and drying plant and briquette machine. The lignite is washed free from woody fibre, dried to a specified degree, and submitted to a pressure of 1500 to 1800 atmospheres per 100 square centimetres of surface; and yields a good briquette without any admixture of tar or other cementing material. The Eisenwerkgesellschaft Maximillianshütte have a fine exhibit: wall diagrams showing their iron mines, blast furnaces, steel and rolling mills, and an excellent display of products; sections of rails, girders, angles, T's, channels at the various stages of rolling, and single girders, rails, channels, varying in other dimensions, but 170ft. long; besides sleepers, ores, &c., both work and material good. The province of Rheinpfalz is distinguished by enamelled iron utensils, wire gauges, gas and water meters. Brewing utensils and plants are frequently encountered, so too pianos and furniture, and bicycles occasionally. There are special light refreshment bars in each provincial exhibit—in some situated in picturesque representations of local scenery. In the Swabian garden there is a charming little cheese, dairy, and factory.

Lithographic stone from Solnhofen is shown, and Faber's pencils are not forgotten. The following table shows the distribution of industries in Bavaria in 1896:—

Gruppe.	Upper Bavaria.	Lower Bavaria.	Pfalz.	Upper Pfalz.	Upper Franconia.	Middle Franconia.	Lower Franconia.	Schwaben.	Total
I. Mining & metallurgy	7	12	1	16	6	5	5	4	56
II. Food, &c.	30	17	30	24	31	140	48	17	337
III. Textile, clothing	18	19	17	14	40	36	13	72	229
IV. Paper	3	2	4	1	3	12	6	5	36
V. Leather	45	14	7	8	14	41	11	15	155
VI. Glass	8	8	3	5	2	40	2	2	70
VII. Clay (tiles, &c.)	3	4	3	6	8	11	2	—	37
VIII. Stoneworking ...	9	6	6	16	16	26	29	6	114
IX. Metal ware	47	17	23	35	18	197	41	39	417
X. Wood	56	76	27	46	38	184	61	48	536
XI. Artistic	31	5	7	13	21	71	19	9	176
XII. Scientific	17	1	7	3	3	33	7	12	83
XIII. Musical instrum's	16	3	3	3	4	8	7	2	46
XIV. Chemical	12	4	4	5	8	22	12	7	74
XV. Engineering and buildings	16	8	9	7	4	33	5	6	88
XVII. Transport and fire extinction ...	8	4	2	7	8	32	7	7	75
XVIII. Machinery ...	26	12	20	6	17	74	21	28	204
XIX. Sundry	12	3	8	3	2	21	12	2	63
XX. Ministerial and Communal	8	1	—	1	—	—	1	1	12
	372	216	181	219	243	986	309	282	2808

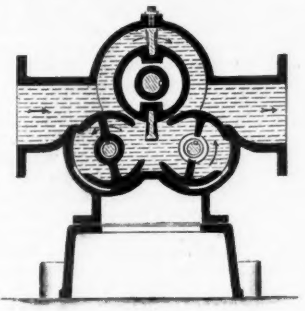
The educational section shows clearly that great importance is attached to technological instruction, and this perhaps in some way accounts for the prominent position occupied by Bavaria in so many industries. The brewing plants all consist of boilers, mashing tuns, and strainers, with the necessary pipes, pumps, and agitators, stirrers. All present a highly finished appear-

THE EXHIBITION BUILDINGS AT NUREMBURG

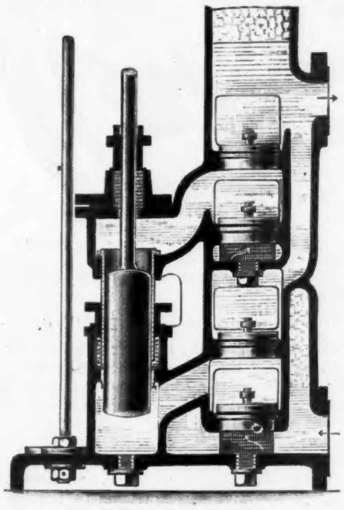


ance, and merely differ from one another in details of arrangement or mode of applying the mechanical power.

In the machinery hall there are several creditable exhibits; but perhaps an idea of this section will best be gathered by briefly stating the objects included in the chief display, that of the Elektricitäts-Actiengesellschaft, formerly Schuckert and Co., a collection of dynamos and collections of alternating motors of one, two, and three phases, various searchlights, movable and fixed, and appurtenances; a collection of reflectors in different stages of manufacture; reflectors for illuminating fountains; regulating, releasing, reversing, and safety appliances for motors, arc lamps, &c.; electric counters and measuring instruments of all kinds; complete apparatus for accumulator installations; electric lighting appliances for both arc and incandescent; lightning conductors; telegraphic appliances, &c. &c.—in all thirty different groups of exhibits, to which attention may be drawn later on. Another good exhibit is the display of pumps by the Maschinen und Armaturfabrik, formerly Klein, Schanzlin, and Becker, their main feature being the use of a single stuffing-box for plunger pumps, horizontal or vertical, packed from the outside, so that the packing can always be attended to without much inconvenience. They show a rotary pump, the character of which will be seen from the illustrations, and had a model of Pohle's air jet water-raiser; all these were working satisfactorily. The various small industries being successfully carried on round the machinery hall comprise enamelling, writing materials, india-rubber webbing, engraving, small metal articles, goldsmith's work, sewing and embroidery, lithography, making steatite gas nipples, with little electrical lathes, printing, glass painting and etching, needles, soap, and candles; whilst Jean Schoenner exhibits the making of metal automatic toys, and has an enormous penny-in-the-slot machine, measuring 30ft. long by 12ft. high, and including steamships, cranes, engineering workshops, railways to run in and out of tunnels, over bridges, and up and down inclines; aërial rope lines laden with trucks, inclined railways, boilers, engines, &c.; but I never saw it at work, although the reddened eyes and downcast look of many a child showed that the little nickel coin had disappeared down the deceptive slot.



ROTARY PUMP—See below



PLUNGER PUMP—See above

I have already referred to printing presses.

Finally, it may be noted that the travelling crane used in erecting the machinery has been converted into a passenger crane, and is worked by electricity. The steam for the machinery hall is supplied from five boilers, by as many different firms, having 780 square yards of heating surface, and worked to ten atmospheres. The Linde plant for the ice rink is worked by a 100-horse power Schmidt superheated steam engine; there is also a Linde liquid air plant. It is noteworthy that "Gradirnwerk" is very generally used for condensing.

The Bavarian Home-office exhibits drawings, plans, models, and objects, and statistical diagrams and tables in reference to Government buildings, watersheds and water-storing works, protection from fire and storms. mining matters, drainage works, and weights and measures, upon which I have not space now to comment, beyond saying that they are excellent, interesting, and instructive. The most striking exhibit of all is, however. without doubt that of the Bavarian State Railways; it includes ninety-eight exhibits, and some locomotives and carriages by the Etablissements für den Bau von Lokomotiven and the Eisenbahnwagen and the Maschinenbau Actiengesellschaft, Nuremburg. It is divided into four main sections:—(1) Railways. (2) Luding Donau-Main Canal. (3) Lake Constance Steamer Service. (4) Other show objects.

The railway matters are treated in the following order:—Two wall diagrams E relating to the *personnel* of the railway, giving numbers working, superannuated, sick, and pensioned; the second, the number of cases of old age, sickness, and accident; eleven wall diagrams, plans, and photographs of bridges, railway systems and stations: twenty exhibits of models, materials, and mechanical appliances relating to construction work of special interest; five diagrams relating to the working of the railways; the amount and the character of the traffic, whether passengers, luggage, goods, or live stock; the length, weight, and number of trains; tickets issued, time-tables, &c. The engineering department is represented by diagrams, drawings, photographs, models, and actual representations; the diagrams relate to statistics of the department and detail plans of workshops and workmen's dwellings, the drawings to new locomotives and carriages, the models are of locomotives, carriages, under-carriages, workshops, turntable—all to scale—of wheel press, gas furnace for heating, wheel for pressing of hydraulic press, Jauney coupling, transport carriage for narrow gauge, and specimens of brake installations, injectors, lamps, lubricants, and lubricating appliances, pressure gauges, telephones, whistles, sand boxes, ventilators, various batteries, and other arrangements on telegraphs, specimens of fuel, &c.; also chemical testing appliances, being the materials and means actually used, lends special significance to the exhibits. The most attractive exhibit of all is that showing the development of the rolling stock construction in Bavaria since 1844, the year of the opening of the State Railway; it is effected by sixteen models of locomotives one-tenth actual size, and thirty carriages, wagons, and trucks. It would be useless to attempt a description of all these in this notice; I shall therefore restrict myself to the earliest and latest. The earliest locomotive represented is on Stephenson's system, with centre driving wheel and four running wheels and six-wheeled tender; it was built by Maffei in Munich in 1844, cost £2320, and was taken off in 1871. The diameter of the driving wheel was 1·52 metres, the steam pressure $5\frac{1}{3}$ kilos. per square centimetre, the adhesion $6\frac{1}{10}$ ton, heating surface 46·5 square metres, total weight of locomotive and tender $23\frac{1}{2}$ tons. The last model represents a locomotive with four driving wheels and two leading wheels, built in 1895 by Krauss at a price of £3180, the driving wheels having a diameter of 1·16 metre, with adhesion of 56 tons, and a steam pressure of 12 kilos. per square centimetre.

There are exhibited, in addition, eight of the most recently constructed locomotives, and various carriages and wagons. A six-coupled express engine, compound, with four cylinders, by J. A. Maffei, of Munich, has a four-wheeled bogie in front; the high-pressure cylinders are inside, and work on the axle of the foremost driving wheels; the low-pressure cylinders are outside. There are all new arrangements for facilitating starting, stopping, controlling, &c., even to blast for sand. Another Maffei express locomotive has four driving wheels, a four-wheeled bogie and six-wheeled tender, and all accessories. A third has eight driving wheels, coupled in fours, the front four being driven by the two low-pressure cylinders, the back four by the high-pressure cylinders; all the cylinders are outside. Krauss and Co., of Munich, show a double-cylinder compound goods locomotive; the cylinders are outside, and are arranged tandem fashion, with working surfaces of high and low-pressure cylinders duly apportioned; an express locomotive with auxiliary driving gear, consisting of a one-metre wheel worked by special cylinders. In ordinary working the wheels are kept off the rails by springs, and only come into use when required for specially heavy work, starting, or up inclines for instance. The arrangement of wheels is a four-wheeled bogie in front, the auxiliary driving wheels, the main driving wheels 1·86 metre in diameter, two running wheels behind. The adhesion of the four driving wheels is 28 tons. The arrangement is regarded as very economical. Krauss and Co. have three other locomotives. In a future letter I shall possibly draw attention to the special features of the Bavarian locomotive, and refer to the other rolling-stock and the station equipment exhibited at this Exhibition. A noteworthy point in connection with the Bavarian State Railways is the technical instruction department, which from evidence adduced at the Exhibition appears to offer a very thorough course of instruction.

Departments not so well represented are those of machine tools, agricultural and mining machinery, and water-power moters, although it would seem that there should be plenty of water power.

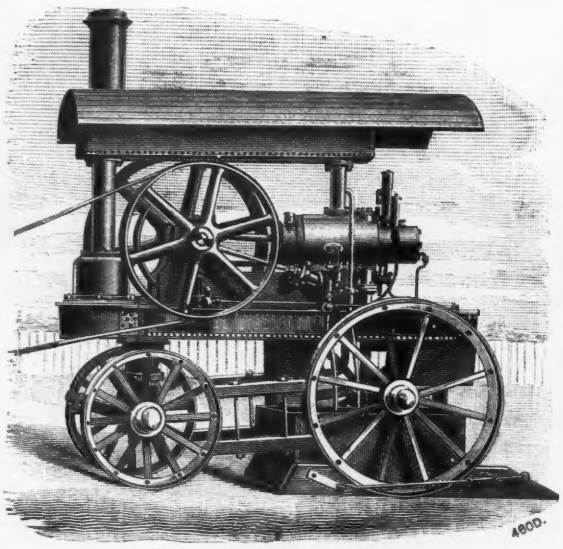
I ought not to close this notice without reference to the exhibit of the chemical town and works of the Badische Anilin und Sodafabrik, at Ludwigshafen on the Rhine. It is a very extensive exhibit, not alone of raw materials, finished products, and dyed fabrics and articles, but also of models, plans, and drawings of the whole settlement, the works, workmen's houses, hospital, &c. &c. The area controlled by the company is 960,000 square yards, of which 295,200 are covered by factory buildings, about 600 by workmen's dwellings, and more than 90 by the officials' residences; here, 30 engineers, 100 scientifically trained chemists, 230 clerks, and about 4800 workmen and others, find employment. 19,000 tons of coal are consumed yearly. There are 14,500 square yards of boiler-heating surface, and steam engine power amounting to 6500-horse power. There are private gasworks, waterworks, electrical installations, and railways and workshops, the latter covering 13,200 square yards. This is another example of what can be done by attention to efficient, systematic, thorough technological and technical training.

A word must be said for the excellent guide books, well printed, convenient in size, with headings and numbers of the rooms in bold thick type, which numbers correspond with black labels with silver figures conspicuously placed in each room. The plans, too, are very distinct, each adjacent department being of a different colour, whilst to facilitate progress through the rooms, and to avoid complicating visits an itinerary is indicated by a single red line and arrow heads.

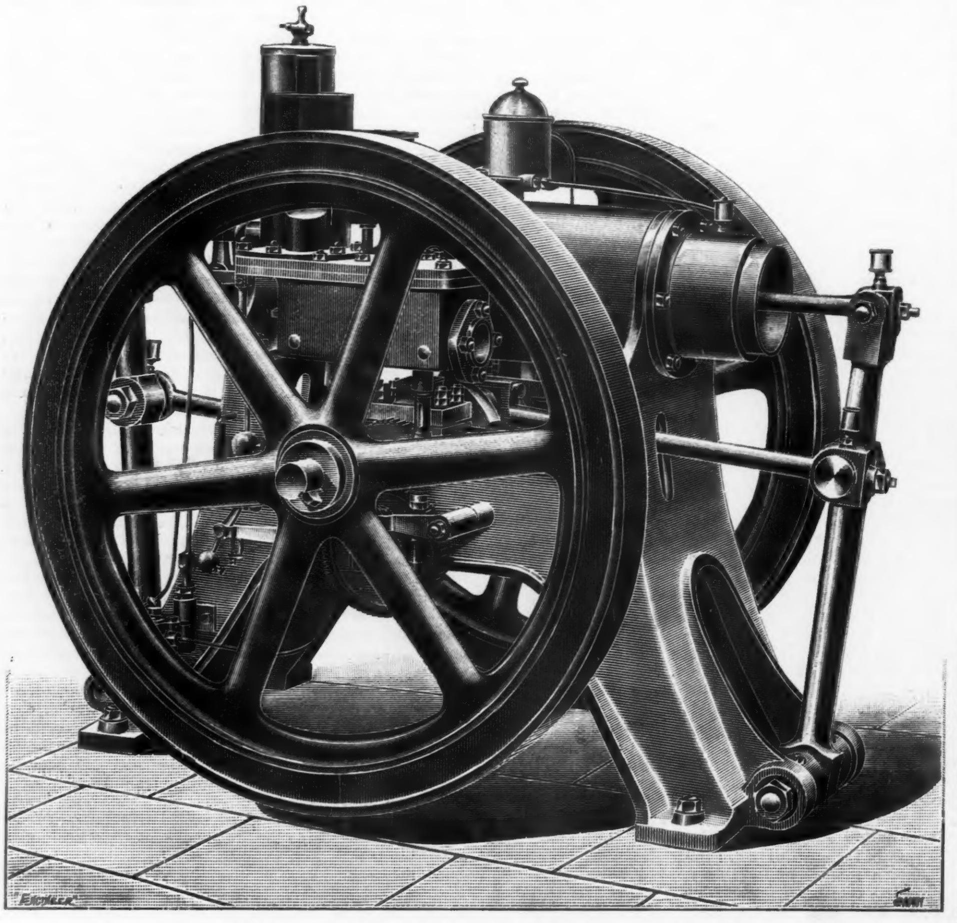
The Exhibition evidently shows that Bavaria has not only a praiseworthy past, but also a remarkably promising future, and must and will be the consumer of many materials that it has to import, iron, copper, &c., and a purchaser of many machines that it does not at present appear to make for itself in sufficient quantities, that is, if one may judge from the exhibits at the Nuremburg Exhibition, which adds a by no means insignificant attraction to the already delightful old world town.

THE ROYAL AGRICULTURAL SOCIETY'S SHOW AT LEICESTER.

Notwithstanding the growing support given by the public to local agricultural societies all over the country, and more especially to two or three of those which, although of local origin, have extended the area of their annual visits, the summer meeting and show of the Royal Agricultural Society shows no diminution in popularity and support of the most practical character. The show this year at Leicester is a large one, covering a piece of ground on the Aylestone-road of about 90 acres. It is about one mile from the Midland station, and about half a mile from Victoria Park, which was the site of the show in 1868, the date of the Society's previous visit. In the twenty-eight years since that meeting, the number of implements entered has only increased from 6369 to 6447, but the number of entries of live stock has nearly doubled, namely, from 994 to 1883. The area occupied by the implement department has, however, increased very largely, and the increase makes it by far the most important part to the Society as means of revenue, and the number of feet of shedding for implements is exactly the same as the total number used in 1868 for implements and stock together. The total length of shedding occupied at Leicester this year—including ordinary shedding, 8506ft.; machinery in motion, 2732ft.; and special shedding, 2692ft. — is 13,930ft., which is nearly 400ft. more than last year at Darlington, and over 500ft more than at Cambridge in the previous year. The special shedding includes that used for seeds, models, &c., as in previous years, but the ordinary and machinery-in-motion shedding occupies a little more space than in any year since 1889, when the Queen was president of the Windsor meeting. The most important addition is in the machinery-in-motion, which occupies nearly as much length as at the phenomenal Windsor Show, and is 264ft. more than at Cambridge in 1894, which was, with the exception of Windsor, the greatest. The growth of the implement department, the backbone of these shows, in the last few years has not been very great, probably because of the exclusion of duplicates, and because the show is already big enough, the number of things exhibited being much larger than can be seen by any visitor in the day or two at his disposal. The number of implements entered this year as new implements is not much less than last year, but the word implement is used in this list in a very wide sense, and includes a number of small interest to engineers, and only two or three of any striking novelty. The list includes such things as tidal valve interceptor, syphon interceptor tap for milk churns, spring lock and key for railway churns or milk cans, "rougher for sharpening horses," chicken brooder, and automatic vent for butter churns. On the other hand, it comprises important things, such as Cooper's new steam digger, to which a special silver medal has been awarded; a mechanically-propelled car by Messrs. Mulliners, of Birmingham; and several novelties which are not exhibited, including a similar car for merchandise, which Messrs. Howard were unable to finish in time.



CLAYTON AND SHUTTLEWORTH'S PORTABLE OIL ENGINE



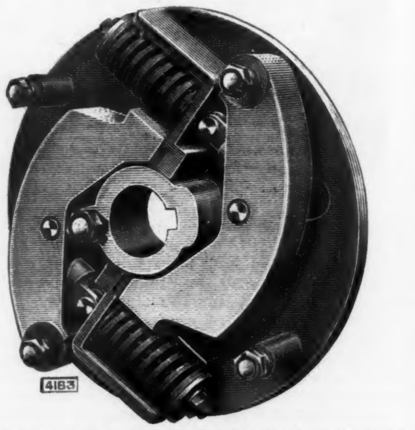
DUPLEX OIL ENGINE, BY CLARKE'S CRANK AND FORGE CO.

The prizes offered for competition by the Society this year were of four classes, namely:—Class I.: Machines for planting potatoes. Class II.: Machines for raising potatoes, in each of which prizes of £20 and £10 were offered. For the machines of Class I. Messrs. Ransomes, Sims, and Jefferies, took both first and second prize; other competitors being Mr. James Coultas, of Grantham, and Mr. Robert Kyd, of Coupar Angus, N.B. For Class II. the competitions will take place about October, in the neighbourhood of Leicester. The names of the competitors are Messrs. Coleman and Morton, Chelmsford; Messrs. John Wallace and Sons, Glasgow; Messrs. Powell Brothers and Whitaker, Wrexham; Messrs. Alexander Jack and Son, Maybole, N.B.; Messrs. Ben Reid and Co., of Aberdeen; Messrs. Woodroffe and Co., Rugeley; Messrs. Ransomes, Sims, and Jefferies, Ipswich Messrs. J. Bisset and Sons, Blairgowrie, N.B.; and the Lancashire Agricultural Implement Company, Liverpool. Class III. is of machines for gathering and sorting potatoes, the amount of prizes not being mentioned. Messrs. Keeble and Moulton are the exhibitors in this class. Class IV. is hand-power butter drying machines, for which the first prize is £5, and the second £3, the competition taking place in the dairy in the showgrounds. Messrs. R. A. Lister and Co., Derby; Thos. Bradford and Co., Salford; and the Dairy Supply Company, London, are the competitors.

The competitive trials are thus of limited interest, and for prizes of small value, as compared with those for the self-propelled vehicles next year, when the prizes will be two of £100, and two of £50.

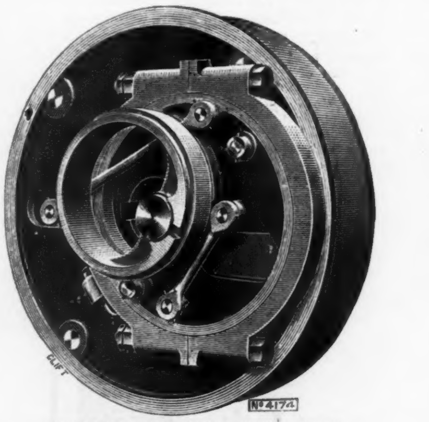
The judges of implements competing for the Society's Silver Medals announced the following awards, stating that any medals to be given for dairy machines will be awarded later in the week:—Mr. J. Hardman, Preston, for a circular sawing, boring, and tanging machine; Mr. E. Pratt, Uxbridge, for a new knife for mowing and reaping machines; Mr. T. M. Jarmain, Tetsworth, Oxon, for his swathe turner; the Cooper Steam Digging Company, for their steam digger and traction engine combined; and H. P. Saunderson, Bedford, for a mowing machine attachment.

When the Society visited Leicester in 1868, the Duke of Richmond was president. The population of the town was between eighty and ninety thousand, but now with an extended borough it approaches two hundred thousand. As the 1868 visit resulted in a profit of £488, the treasurer will probably this year return with a very large balance, which will help to make memorable Sir Walter Gilbey's year of presidency, and provide for the prizes for and cost of the trials of self-moving vehicles, which are to be held at the Society's meeting next year at Manchester. The weather during the week will, however, affect the balance for better or worse.



RANSOMES, SIMS, AND JEFFERIES' SHAFT GOVERNOR

The showyard at Leicester is conveniently situated, and the ground will be in excellent condition if moderate weather prevails. Some of it was, however, until preparations were made for this show, used as market gardens or allotments for gardening, so that although levelled, drained, and sown with grass, it is in some parts none too hard to carry heavy machinery, and would with wet weather soon be very unpleasant. The implement department is, as usual, assumed to be that which is most generally attractive, and is, therefore, arranged immediately in front of the main entrance, the royal and the members' pavilion being in the centre of the grounds, and the horses and stock surrounding at the greatest distance from the entrance, the horse ring being about 2000ft. therefrom.



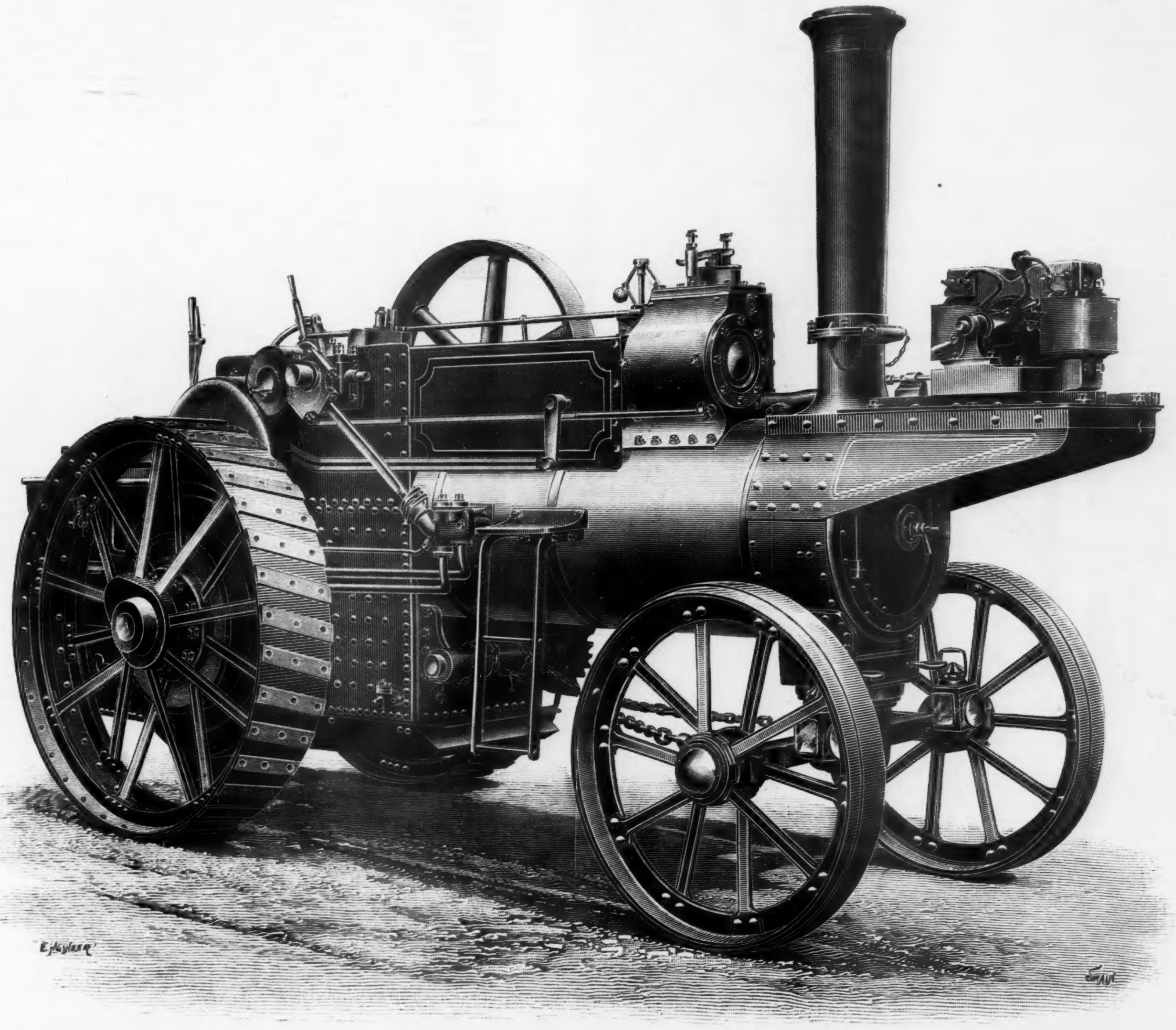
RANSOMES' GOVERNOR—INSIDE VIEW

STEAM, OIL, AND GAS ENGINES.

It is noteworthy that the number of exhibitors of gas engines is now less than the number of those exhibiting oil engines, and considering the important part taken by Messrs. Priestman Bros., of Hull, in the development of this now very popular and promising engine, it is regrettable that that firm is not exhibiting. In few cases in the invention and construction of a new machine have the labours of two or three pioneers done so much to provide competitors in their own field as in the case of the oil engine. For a good many years the development of the oil engine was quite at a standstill. The original ideas took form, but the difficulties met with in practical working were for a long time apparently insuperable. Then the problem was attacked by one or two men who were unfettered by a complete knowledge of the difficulties met with by the earlier men, but who knew something of the general design of the motor they had made. They proceeded on different lines, and were successful. They invented and they patented, and they showed others what to do, or, at least, what they had done; and what is of still more importance, what not to do. They had by this time got into a groove from which it was very difficult to

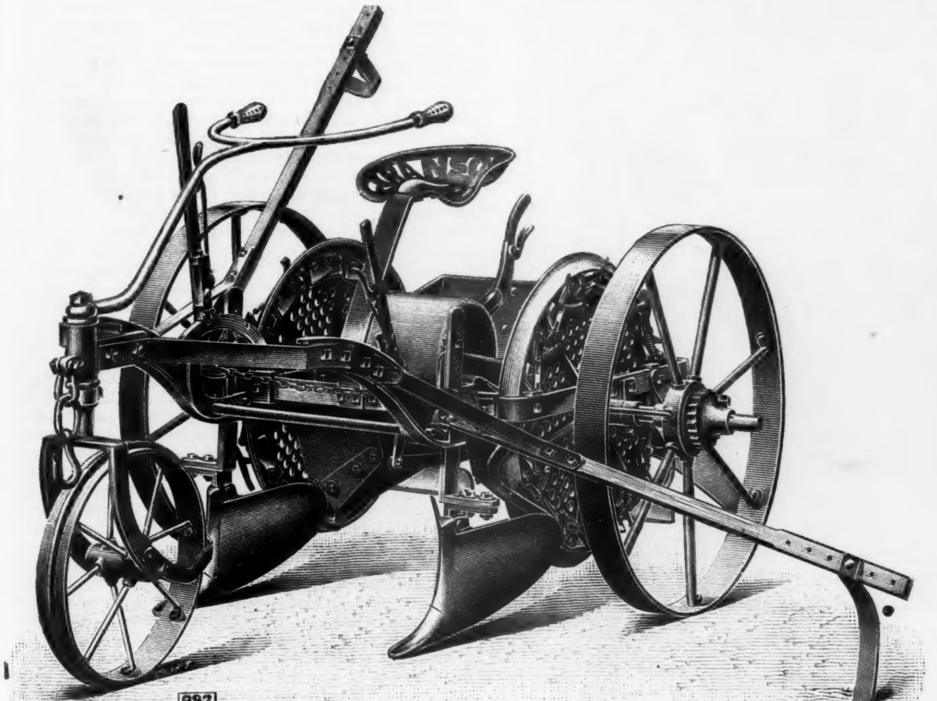
THE SHOWMAN'S ROAD LOCOMOTIVE

MESSRS. RANSOMES, SIMS, AND JEFFERIES, IPSWICH, ENGINEERS



extricate themselves; and then came a number of people who, being so far taught, found modification easy, and by using the preceding experience of others in oil and gas engines have produced the numerous forms working on similar lines, which we now see, and to some of which we shall refer.

In steam engines there are not likely to be any radical departures for agricultural work, although much higher pressures, different boilers, suitable designs for higher speeds, and for evaporator condensers, offer tempting fields for departures on lines already worked to some extent but not followed.



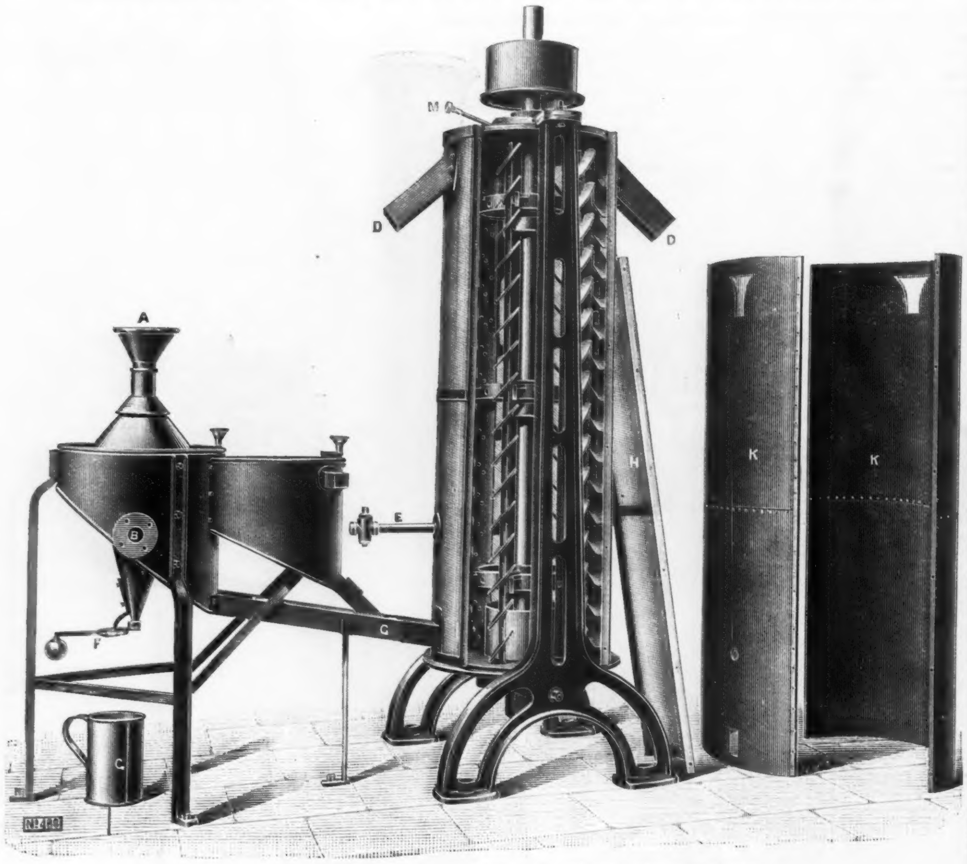
RANSOMES, SIMS, AND JEFFERIES' POTATO PLANTER

Amongst the steam engines exhibited is the vertical high-speed engine for electric lighting and other purposes, shown by Messrs. Ransomes, Sims, and Jefferies, which we shall illustrate. This firm also exhibit a road locomotive, illustrated above.

The travelling showman has secured many advantages by adopting the useful road locomotive for hauling his merry-go-rounds and numerous vans by road from town to town. The same engine is employed for placing the apparatus in position at its destination, and for lighting up the show at night. The road locomotive hauls these goods from county to county at a greater speed and at much less cost than if horses were employed. If the show vans are sent by rail, a number of horses must be hired for drawing them to the station, and for loading them on the trucks. By the possession of a traction engine, as soon as the display is over the showman can betake himself to another district without delay. Moreover, it has been proved by actual practice that there is a clear saving of time by using the road engine for this purpose, in preference even to the railway, for the moderate distances that are usually required. When travelling by road, the showman can call at small towns out of the reach of the main line of railway. The engine illustrated by Fig. 4 is one built by Messrs. Ransomes, Sims, and Jefferies, and is similar to those intended for the work described. It is mounted on buffer springs at the fire-box end, and on a plate spring at the smoke-box end. It is capable of travelling with a heavy load at four or six miles an hour. At the smoke-box end a neat platform is provided for carrying a dynamo, which is driven by a belt from the fly-wheel. The motion work of the engine is hidden by deep side plates, and the fly-wheel is also plated, so as to lessen the risk of frightening horses when travelling on the road. Mud guards are fitted over all the gearing, and the lamps are placed near the road.

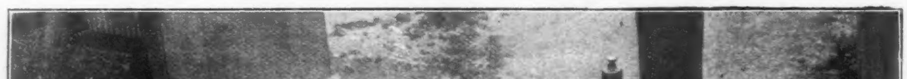
Messrs. Foden and Sons, of Sandbach, show the powerful road locomotive illustrated by the engraving on page 644. It is intended for heavy work, and is a twin compound of 10-horse power nominal. Its road wheels are 7ft. 2in. diameter on a 6in. axle, driven through their usual arrangement of gearing by a 4in. crank shaft. The cylinders are arranged as shown in the engraving, and so that high-pressure steam can be admitted to the low-pressure cylinders, both cylinders exhausting independently, thus giving the engine very great power for short periods when wanted. The engine is carried on three laminated springs, one carrying the

EXHIBITS AT THE R.A.S.E. SHOW, LEICESTER



MESSRS. E. R. and F. TURNER'S WHEAT WASHER AND WHIZZER

fore part. It weighs 17 tons, and is intended for hauling 50 tons on ordinary roads. We are informed that it hauled the two 6-horse power traction engines and the 54in. thrashing machine, also exhibited by Messrs. Foden and Sons, from Sandbach to the Show, a distance of about 80 miles, on a consumption of 14¼ cwt. of coal, or only about 20 lb. per mile. It is fitted with a steam brake, namely, a steam piston acting through levers on a hand brake on the ring of the compensating gear.



THE COOPER STEAM DIGGER—VIEW OF VALVE AND DIGGER GEAR

Messrs. Burrell and Sons, Thetford, exhibit several of their traction engines, including some showman's road locomotives, one, a very fine engine of 10-horse power nominal, being fitted with a very powerful steam brake, the long brake blocks of which act on the inside of an angle steel ring inside the large road wheels, and nearly of their diameter, the rings being turned inside. The brake blocks act on both wheels, pressed on by a 7in. piston, with a leverage of about 3 to 1, so that it is a very powerful brake, and as it acts on both wheels it holds the engine immovably on the road, not only against the fair push of a load down hill, but against the side push of a snaked train of wagons. When this brake is in use the compensating gear is, of course, rendered inoperative, so that a side-pushing down-hill load cannot make either wheel overrun under its influence. The ordinary brake applied to the compensating gear ring is also fitted to the engine, so that either or both may be used, the steam brake being mainly for heavy loads and heavy hill work, but the valve for actuating it is so conveniently situated and so easily used that no doubt the drivers will generally prefer to use it, and acquire facility in its use for slightly checking the engine and feeling their way down all hills.

Messrs. Ruston, Proctor, and Co. have a large show of their well-finished engines and thrashing machines, including a horizontal engine with a piston 17in. diameter and 32in. stroke. It is fitted with a large Porter governor which controls the expansion valve by means of a slotted link and separate excentric. Its ordinary speed is 80 revolutions per minute, and it is excellent in design and in workmanship, and the long stroke commends it for many applications. Messrs. Ruston, Proctor, and Co. are not exhibiting any of the Corliss type of engines, of which they are now building so many.

Messrs. Marshall, Sons, and Co. have an extensive collection of their engines on exhibition, some in motion, and several of their engines are also used for driving the machinery of other makers. They show one of their high-class long-stroke horizontal fixed engines with Proell's patent governor and automatic cut-off gear and Corliss exhaust valves. It has a steam jacketted cylinder 10in. diameter by 24in. stroke and is capable of from 40 to 67 indicated horse-power with 100 lb. boiler pressure. The governor is driven by a very strong silent chain running on cut toothed wheels, and formed with links which close upon the teeth as they bend round, so that there is no backlash.

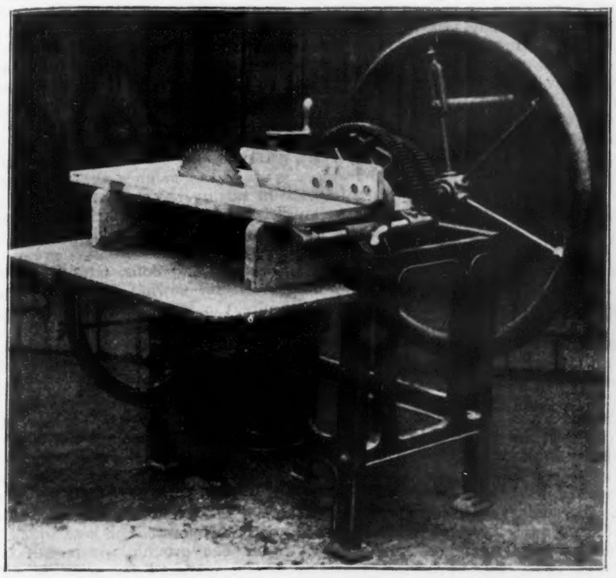
Messrs. Robey and Co. are also exhibitors of a large collection of steam engines, including an open-fronted high-speed vertical with shaft governor, oil and gas engines, and thrashing machines.

The Cooper Steam Digger Company exhibit the steam digger which is illustrated on page 644. This is the perfected form of the digger upon which Mr. T. Cooper has been engaged some years, during several of which he has been able to cultivate by digging at a profit on the digging, as compared with other modes of cultivation, and to prepare the land so well conditioned by aëration that the crops have confirmed the favourable opinion always held of land so prepared. The machine as now made effects the same end, but it is made in a more simple and stronger form in several of the details, and the wearing parts are easily removed and renewed. The tines are carried on arms mounted upon three pairs of cranks. One crank, as shown in the engravings, is driven by gearing from the engine. This crank has three pairs of throws. To these are connected the steel castings carrying the heads for the tines. The cranks are set at 120 degrees, and the frame which carries their bearings is pivoted and adjustable as to height, and the depth of the digging is determined by a pair of pads on stems which rest on the ground at the moment of the descent of the tines. The gearing drives the main crank, so that the tendency of the drive is to force the tines into the ground, and very little weight is required to enable them to enter even very hard soil. The difficulties as to the wear of the crank and other bearings have been overcome by Mr. Cooper's arrangement of dirt-excluding collars at both ends of every bearing, and breakage is prevented by making everything which is subject to heavy stress of steel and so strong that it can pull up the engine rather than break. Messrs. John Fowler and Co., are now also makers of the Cooper digger, and it is a pleasure to know that at last the Royal Agricultural Society has awarded it a special silver medal. The engraving on this page gives a good view of the valve gear from above, and of the arrangement adopted for the steering gear. The single excentric reversing gear, which we have already illustrated, is used, and works exceedingly well. The boiler is by an ingeniously arranged steam cylinder made to lift at the fore end to suit any level of the ground, and the engine is self-moving as a road locomotive for traction purposes, or for thrashing and other work.

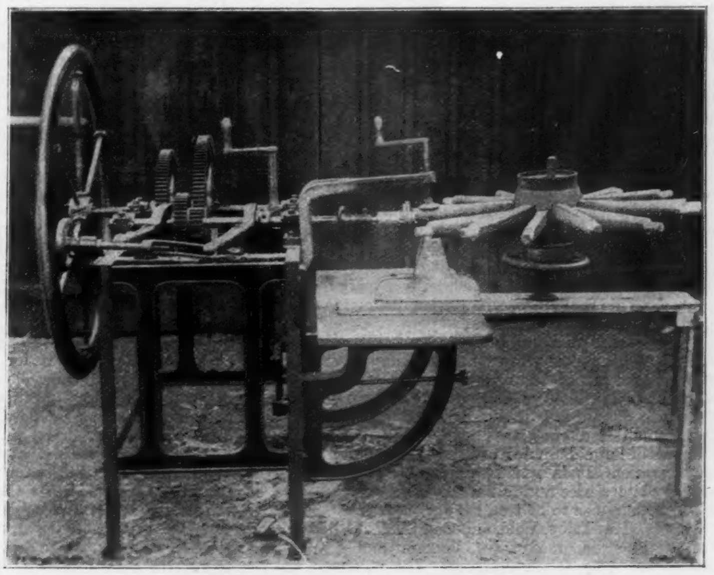
Messrs. Clayton, Shuttleworth, and Co., have, as usual, a good display of engines, fixed, portable, and traction, and in particular attention may be drawn to their Trusty oil engine, in which they have made some improvements. They have given a parallel movement to the lever which moves the oil pump and the vapour valve, and this works well, and they have modifications of the igniting apparatus, by means of which the ignition is automatically effected without either lamp or ignition tube. The engine is fitted with a rotary dashpot governor on Tyrrell and Deed's system, and the pusher finger is allowed to come into play or prevented by a lever moved by the governor, the end of which carries a roller which leaves or presses upon the pusher. The new arrangement for effecting ignition of the charge works satisfactorily, and the vaporiser exterior remains remarkably cool. We are not yet at liberty to describe this device, and must return to it on another occasion. The engine is shown driving a 6in. Hett's patent accessible centrifugal pump, and is of 7 brake horse-power, and has a piston 7·5 diameter and 14in. stroke. The valves are arranged at the bottom of the cylinder in a separate casting and can be lifted out through the top for repairs. The engine as now made in the portable form is shown by the accompanying engraving, Fig. 7, the water cooler being seen beneath the canopy which covers the engine. The cooler consists of three trays, over which the water from the jacket runs as forced up by the circulating pump. The trays are perforated with a few rows of holes, and air is drawn by the blast over the trays, so that the water is very much cooled, one charge lasting half the day. Messrs. Clayton and Shuttleworth are now the makers of the Hett centrifugal pumps, and they exhibit a 21in. pump for land drainage and irrigation, and capable of raising from 7500 to 11,250 gallons per minute according to lift.

Messrs. Robert Stephenson and Co. exhibit several of their Rocket oil engines, in which they have made some slight modifications, the chief one being in the ignition tube, which, as before, is heated with a lamp with a Swedish burner. This ignition tube is made according to Mr. Armstrong's invention, as shown in the annexed sketch. The tube T, of cast iron, is fixed by the flanges to a back projection from the cylinder, and part of the

EXHIBITS AT THE R.A.S.E. SHOW, LEICESTER

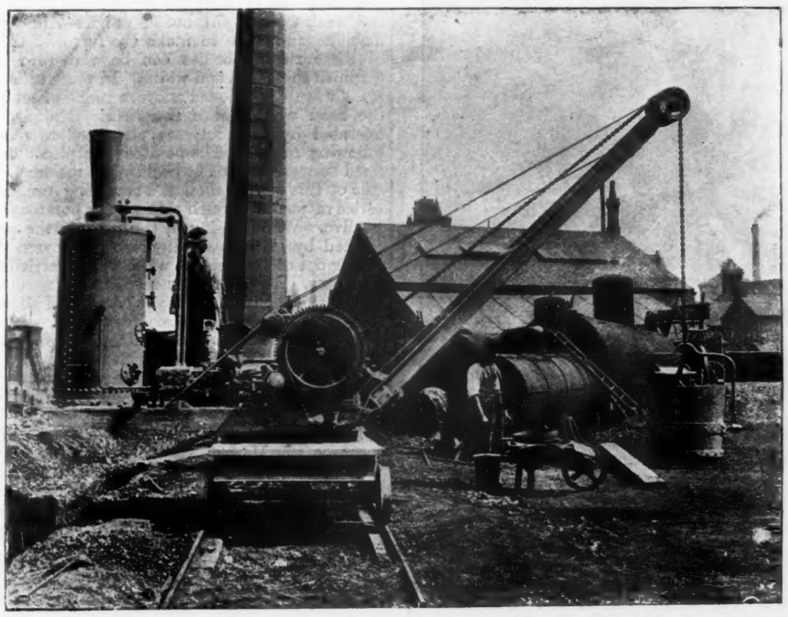


HARDMAN'S MACHINE SET FOR SAWING



HARDMAN'S MACHINE SET FOR TANGING

bottom of it has a hole made through it, and it is flattened to receive a small steel embossed plate P, fastened on by screws — not shown — with a piece of asbestos sheet between the steel inwardly embossed plate and the cast iron of the tube. A similar tube is made of steel, the thin embossed part being formed as part of the tube. The flame of the lamp plays into this "bulls'-eye," and keeps it hot enough for ignition, and very great advantages are said to arise from the use of this tube, including a not easily explainable increase in the power of the engines of 4-horse power to which it has been fitted.



TAYLOR AND HUBBARD'S STEAM CRANE

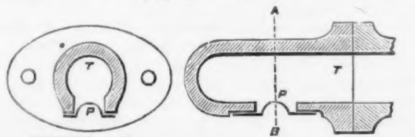


FIG 9

THE STEPHENSON-ARMSTRONG IGNITER

Messrs. Richard Hornsby and Sons exhibit a large collection of oil engines, including a portable engine with the frictionally driven pulley, which enables the work to be put on after the engine is started. Messrs. Hornsby's oil traction engine is not exhibited at Leicester, but particulars were there distributed concerning the engine, with which numerous trials have been made, including hauling loads up Spittlegate Hill. The engine is of 16 brake horse-power, weighs about 6 tons, and will, it is said, haul from 20 to 25 tons on the level, 8 to 10 tons on a gradient of 1 in 16, and 6 to 7 tons on 1 in 12. The engine is, in general appearance, much like an ordinary traction engine. Messrs. Hornsby have also made an oil tramway locomotive for narrow gauge, and of 12½ brake horse-power.

The Trusty Engine Works, Cheltenham, are exhibiting fixed and portable Weyman and Hitchcock oil engines, in which some slight modifications have been made, including the use of rotary, instead of Holt governors, for the larger sizes.

Messrs. Crossley Bros. have as usual a very large collection of gas and oil engines, and much attention was paid to the portable engine, which has received important improvements since the Cambridge trials, when it was awarded one of the Society's medals.

Tangyes Limited have also a large collection of their gas and oil engines.

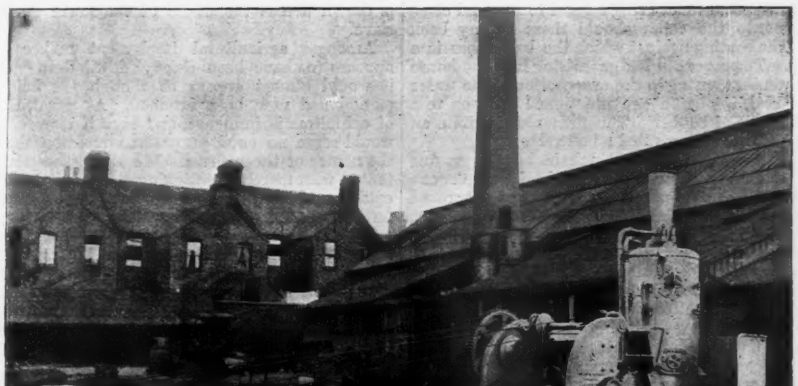
A very cheap oil engine is exhibited in two small sizes by Messrs. Carson and Toone, of Warminster, and the National Gas Engine Company, of Ashton-under-Lyne, show one with their gas engines.

Messrs. Fielding and Platt exhibit some of their oil engines at work, and almost precisely like those of which we have previously given particulars.

The Clarke's Crank and Forge Co., Lincoln, exhibit several oil engines made under Beverley's and Roots' patents, the Beverley arrangement of duplex balanced two crank engine being illustrated by the accompanying engraving. The charge is compressed and ignited between the two pistons, which move in opposite direction, actuating the rocking levers seen at either end of the engine, page 640, and from them by connecting-rods pivoted at about one-third of the length of the rocking arms from the top. The engine is compact, as shown by reference to the fly-wheels in the illustration. The pistons are 7in. diameter, and the combined strokes 15in. and the brake horse-power is stated to be about four.

MISCELLANEOUS EXHIBITS.

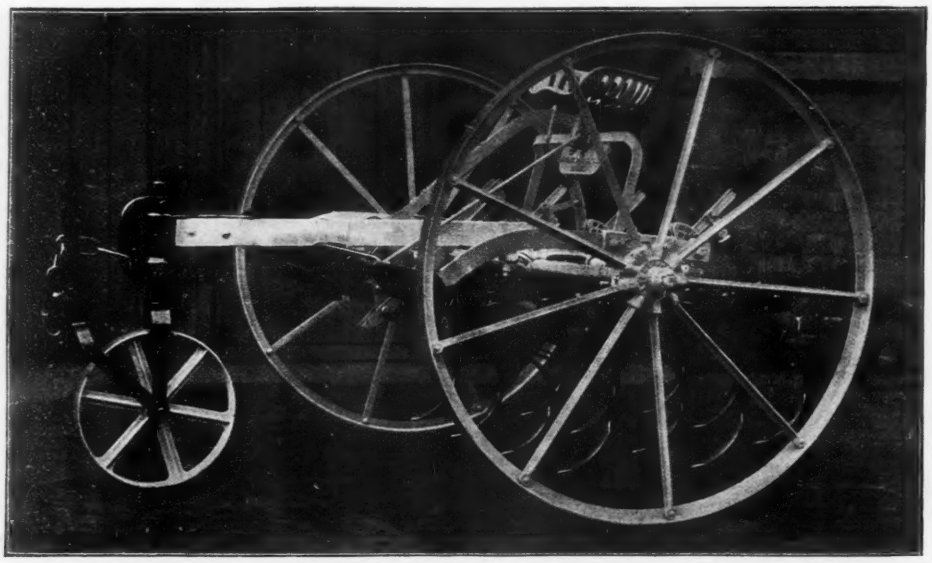
The illustrations herewith represent a steam crane with the jib in different positions, made by Messrs. Taylor and Hubbard, Kent-street Works, Leicester, which comprises several valuable features. It is designed to handle loads of one ton, and will haul on the level a train weighing 14 tons. Steel has been almost exclusively employed in the construction, and the travelling is effected by bevel gearing. As will be seen the jib can be lowered into a horizontal position for inspection and oiling without being supported from the ground, while it can be again raised to its maximum height in about twelve seconds. The boiler, of steel, is constructed for a pressure of 70 lb., and is provided with a feed pump worked from the piston-rod crosshead. The crane will slew a complete circle in seven seconds, or more than eight turns a minute, but it can be regulated to slew steadily and evenly as slowly as desired. It will derrick easily with the full load suspended, and will remain in any position. Special attention has been given to facilitate the erection and taking to pieces with-



TAYLOR AND HUBBARD'S CRANE, WITH JIB LOWERED out necessitating the employment of skilled labour, and crane users will appreciate the fact that all parts are made on the interchangeable system, so that a stoppage due to the breakdown of any part need only be of very short duration.

A useful and inexpensive tool for wheelwrights in a small way of business is that exhibited by Mr. Hardman, Adelphi-street, Preston. This machine, which is shown on page 641, is a hand-power circular sawing, boring, drilling, and spoke-tanging machine. The last-named function is probably the most important from a labour-saving point of view, and it is stated that the spokes of a pair of light cart wheels can be treated in less than half an hour. Separate rise and fall tables, easily removable, are provided for the different operations, and the gear is arranged for two speeds. The machine might be rendered still more serviceable if a chuck were provided for boring and turning up hubs, while, without necessitating a great increase of cost, the wooden table might with advantage be replaced by something giving greater rigidity. This tool has been awarded one of the Agricultural Society's silver medals.

Messrs. Isaac Hill and Son, Derby, exhibit some very useful machine tools shown in operation. Perhaps the most interesting of these is the automatic circular saw sharpener; this is a useful and efficient labour-saving tool where hot or cold saws are used. It it applicable for saws of the smallest diameter as used for brass work, and also for saws of large diameter as used in iron and steel and other works. It is readily adjustable to any pitch of tooth, while a rise-and-fall work table enables saws of wide range in size to be treated.



NICHOLSON'S SPRING STEEL TINE CULTIVATOR

Messrs. Hawksley, Wild, and Co., Sheffield, had a good show of boilers, feed-water heaters and filters, and specimens of hydraulic flanging. The "flanged flued" boiler of which this firm are the makers is made to withstand the high pressures now so much in use. In the feed-water heater perfect freedom is allowed for the expansion of the tubes, and the general construction is such that the whole can be taken to pieces by unskilled labour and cleaned easily and quickly. Messrs. G. and F. Couzens, 14, Tudor-road, Cardiff, show for the first time a newly patented device for preventing the flooding of basements or cellars by storm water or tidal causes. This is called a ball trap gulley, and is manufactured by Mr. Henry Dennis, Ruabon. The action of the trap is automatic, a floating brass ball being caused to rise and close the opening into the cellar should there be any back pressure. The seating against which the ball closes is a rubber ring. To prevent sewer gas arising into the house during dry weather, owing to the evaporation of the water making the seal, the ball above mentioned falls on to a lower seating also of rubber. This firm also exhibits an interceptor in which is provided a ball valve.

Messrs. W. and T. Avery, Birmingham, have a very fine display of weighing machines and weighbridges. On one of the latter there is provided a new and improved printing device for recording weights by means of a tape, instead of using tickets. Messrs. Christy and Norris, Chelmsford, are represented by grinding machinery, to which we referred in connection with the Bath and West of England Show. Messrs. E. and H. Bentall and Co., Heybridge, Essex, exhibit amongst a very large display of implements, a new grinding mill. These machines have flat grinding plates of larger diameter than usual, which are reversible, giving double grinding surface, and with these plates are combined conoidal cracking plates. The process of reversing requires no skilled labour, and only occupies a few minutes. The driving pulleys are arranged to run either inside the frame of the machine or on the end of the shaft. On the larger machines the feed is effected by a worm.

Messrs. E. R. and F. Turner, Ipswich, have a more than usually interesting group of exhibits, including a patented "concentric" wheat washing and stoning machine combined with a vertical whizzer. This appliance is shown by engraving on page 640. The principal parts of the washer and stoner are: A feed hopper, with adjustable distributing pipe and cone; a central vessel in the shape of an inverted cone; an annular V-shaped channel formed between the edges of the two cones; and two tanks. Water enters the central vessel by means of a pipe, and filling this vessel, passes upwards through the open bottom of the annular channel. The wheat, falling from the distributing cone, strikes the water and is carried with it over the edge of the channel into the first tank, stones and other matters of greater specific gravity than the wheat falling through the open bottom of the channel into the central vessel, whence they are removed through a valve. In the first tank the heaviest wheat sinks to the bottom, which being inclined as shown, delivers the grain to a discharge spout. The remainder of the grain is carried with the water through suitable openings into the second tank, where a further deposit takes place of all tolerably sound grain. The bottom of this tank slopes like the first, and delivers the grain in a similar manner. Hollow grains, chaff, and other light matter, float away with the waste water overflow, an arrangement being made to prevent sound grain so escaping.

The whizzer recommended to follow the "concentric" washer is a vertical machine of improved construction, shown on the right-hand side of the engraving. The inlet for wheat is at the bottom, and the outlet near the top. Superfluous moisture is said to be effectually removed without damage to the grain, and delivery is made at a convenient height for falling to an elevator. The washer and whizzer may be placed side by side, and the one will deliver to the other without any draining worm or elevator interposed between. The following is a key to the reference letters on the engraving:—A, inlet for wheat; B, inlet for water; C, spout leading from washer to whizzer; D D, outlet for wheat from whizzer; E, inlet for fresh water to rinse the wheat, required only when the water is returned for re-use in the washer; F, weighted valve which opens when a sufficient quantity of stones, mud, &c., have collected in the hopper; G, can to receive stones, mud, &c.; H, perforated cover, taken off to show the interior of the whizzer; K, sheet iron covers for the whizzer to prevent the water being thrown about; M, cup and pipe for lubricating the top bearing of the whizzer. Another interesting exhibit of Messrs. Turner's is a "vibromotor" scalper and sifter with two sieves, each 5ft. long by 3ft. wide. In this apparatus a novel arrangement of brushes is provided below the sieves for cleansing them. At either end of each sieve is an iron ring resting on lugs, but free to revolve by the gyratory movement of the apparatus. Each pair of rings is connected by a brush, so that as they revolve the brush is drawn across the whole of the lower surface of the sieve.

Amongst agricultural implement makers attention appears to have been chiefly devoted to details, and it would almost appear as though the height of perfection had now been attained. As usual, the number of exhibitors is immense, and even if it were possible it would serve no good purpose to mention the whole of the names of these firms. We shall, therefore, be contented with merely mentioning a few of the most novel exhibits which attracted our attention. One of the foremost of these was the "Hercules" spring steel-tine cultivator with reversible points. A description of one form of this appliance will be better followed by reference to the illustration, above. In the "Hercules" cultivators, the tines are mounted in groups upon separate frames, each jointed to the main frame of the machine in such a way that it can be individually and instantly lowered or raised to suit the inequalities of the land, and the exact amount of pressure applied which the state of the soil demands. The mechanism for effecting this is simple, and it has the advantage of allowing the amount of an adjustment to be accurately gauged and quickly varied. It consists of a hand lever with a spiral spring upon a connecting-rod, and a quadrant, pierced with a series of holes, to receive a cotter pin, which retains the hand lever at any angle. The tension of the springs can be relaxed or increased at will by simply turning a slotted ferrule on the connecting-rods. Thus the tines are made automatically to conform to uneven ground, and a constant pressure is maintained upon them, even should they drop into a hole or furrow. The main frame is raised or lowered as a whole and locked in any desired position by a main lever, fixed conveniently to the driver's hand, on the lifting axle of the machine. It acts on the frame through a slotted regulating link, furnished with an index marked "deep," "medium," and "light." The general depth of cultivating or working being determined, the regulator is set to correspond. Minor adjustments are readily made by means of the mechanism attached to the separate tine carrier frames above described. By use of the same main lever the tines can be raised off the ground for travelling, clearance, and turning. An adjustment at the back of the pole or shafts allows more or less lead to be given to the front tines. These machines can be supplied with single shafts and hooks for three horses abreast, or with pole and whippletrees for two or three horses, or with front swivel or castor wheel, as shown. It will be observed that the spring seat for the driver is pivoted in such a way that the driver's weight is utilised to balance the tine carrier frames, and to assist in raising them when required for adjustment, turning at the headland, travelling, or clearance. These cultivators are made by Messrs. W. N. Nicholson and Sons, Newark.

Messrs. Richard Hornsby and Sons, Grantham, also exhibit a new implement for sowing corn, clover, and grass seeds and manure, the latter being delivered into the same tubes as the seeds. It is a kind of twin drill with two boxes, in one of which the manure is broken up before being sown. Messrs. Hornsby's stand also comprises all conceivable kinds of implements for agricultural purposes.

Messrs. Ransomes, Sims, and Jefferies, Ipswich, have as usual a very effective display of implements, amongst which are the potato diggers with which they have carried off the first and second prizes offered by the Royal Agricultural Society. The first prize-winner is illustrated by engraving, page 639. The single and double-row planters can either be used for setting potatoes on land which has been ridged up, or on flat ground which has been previously ploughed and prepared for planting. For ridge work the furrows are previously prepared by a plough, and manure is deposited in them. The horses walk in the furrows, and the road wheel tires, which are of a concave form, run on the top of the ridges. In place of the single wheel shown in the cut, steel disc press wheels are used, which press the manure down, and prepare a suitable place for the potatoes to fall into. For flat work two ridging bodies are fixed in front of the machine, and serve to make the furrows. The position of these ridging bodies can be varied to increase or diminish the depth and width. In place of the steel disc press wheels mentioned above, a single wheel is used, and the road wheels have flat tires. Markers which are operated by the foot, are also used to mark out the following furrow. The potatoes are placed in a hopper, fixed between the road wheels of the machine. On either side of this hopper there is a revolving disc, fitted with a series of pockets, which take up the potatoes as the discs revolve. While resting in the pockets the potatoes are pierced by suitable needles, which prevent them from falling out of the pockets while being carried round with the discs. At the proper moment the needles are withdrawn and the potatoes are released, and allowed to drop into the furrows. The road wheels are adjustable to admit of planting potatoes in rows from 24in. to 30in. apart, and suitable change wheels are provided with every machine, by means of which the potatoes can be planted at distances of 12in., 14in., and 16in. apart in the rows, at pleasure.

Mr. T. M. Jarmain, of Tetsworth, Oxon, exhibits a new machine, the Haseley swathe turner, which, we are informed, has been successfully tested in light and heavy crops of clover and grass. This implement is constructed with a wrought iron frame on the same principle as the well-known Haseley tedder. It has two steel spring drums driven by an endless chain, which effectually turns over two swathes at one time, exposing what was the under part of the swathe to the sun and atmosphere, thereby facilitating the drying of the crop. The machine is well balanced, the draught is exceedingly light, and the gearing is entirely under the control of the driver when in his seat. The levers are close to his hand, whereby he can instantly start and stop the machine and regulate the height of the drums from the ground. The maker claims that a lad and cob with this machine will turn from four to five acres of grass per hour. The drums can be adjusted to suit the different widths of cut of mowers.

Mr. J. Roots, of East Dereham, Norfolk, is showing for the first time a convertible hay and straw press, weighing only about 7 cwt., which is inexpensive and can be worked by one man. The press is fitted with a main lever, to which is attached the top table, which is pivoted to allow it to tilt to meet the unevenness of the truss. After the main lever is brought into position, it has a main rack and pinion attached, by which the needed pressure can be instantly applied. When the truss is sufficiently pressed and tied, a catch is liberated, and the press is instantly relieved and ready for another truss. When used for straw, the top table is removed, and straw attachments are then placed into position to receive the material in its loose state. When the cradle is filled, the pressure is applied the same as for hay; the straw is then tied, the catch liberated, and the press is instantly relieved ready for refilling.

Another new implement is an adjustable self-cleaning flat corn screen—Cousins and Weathehoff's patent—made by Messrs. Penney and Co., Lincoln. It has the advantage of being very simple, and is said to be adaptable for dressing and separating corn and all kinds of cereals. This machine is fitted with an adjustable screening bed, the meshes of which can be opened to suit the largest barley or wheat by the simple turning of a hand screw, which may be done whilst the machine is in motion; or, by turning in the opposite direction, it can be closed fine enough to dress the smallest sample of wheat, barley, and other cereals.

Messrs. J. and F. Howard, Bedford, exhibit a spring steel tined cultivator, in which the tines are mounted on the through axle of the travelling wheels. They have thus an angular motion, and readily clear themselves of weeds and rubbish when raised.

RAILWAY MATTERS.

Writing in a railway carriage moving at high speed is now rendered possible through suspending a light desk from the roof by elastic bands, and the results have been so satisfactory that these desks are to be adopted generally on German lines, a small fee being charged for their use.

Mr. Eric G. Barker, Locomotive Superintendent of the Wirral Railway, Birkenhead, has designed, and Messrs. Beyer, Peacock and Co., have just completed a twelve-wheeled tank engine, No. 11, for that line. It has a leading bogie, four coupled wheels of 5ft. 2in. diameter, and a trailing bogie; cylinders, placed inside, 17 by 24; total weight, 59 tons 16 cwt. 1 qr. The double-bogie arrangement is found to give very satisfactory results. Boiler pressure 160 lb. per square inch.

The Second Soudan Battalion has been ordered to assist the Railway Battalion in carrying the extension line over the difficult river level at a point six miles beyond Ferket. It is now a matter of speculation whether the steamers at present at Wady Halfa or the Ferket Railway will be the first to reach Kosheh. That place is, however, being prepared for the advent of both. The end fort will probably be made the terminus of the line, and the other buildings be used as workshops and coal yards. Sites for quays and docks have already been assigned.

The London, Chatham, and Dover Railway Company announce that the night mail service from London to the Continent, *viâ* Dover and Calais, will, on and from July 1st, be accelerated by 45 minutes, and leave Victoria and Holborn at 9.0 p.m., arriving in Paris and Brussels, &c., at the same time as now. The company's fast new paddle steamers, Dover or Calais, have now replaced the smaller boats in this service. In connection with the above alterations there will be an appreciable acceleration of the P. and O. Indian mail service on Fridays. Passengers leaving Victoria at 9.0 p.m. will arrive at Brindisi at 6.20 p.m. on Sunday evening, an acceleration of over two hours.

At the summer meeting of the Institute of British Carriage Manufacturers, held in the Mansion House, Mr. J. Philipson, proposed that a letter should be forwarded to the directors of the North-Eastern Railway Company, calling attention to the injury Stephenson's historic engine, "Puffing Billy," was sustaining by being left at the end of the High Level Bridge exposed to the effects of the atmosphere at Newcastle. Mr. Hooper, in seconding the motion, said there were three historic engines. The first was carefully preserved at South Kensington, the second was cared for at Darlington, but the third was exposed at Newcastle to the effects of an atmosphere often laden with smoke and rain. He thought the sending of the letter would result in steps being taken to preserve Puffing Billy. The resolution was unanimously passed.

In order to determine the highest possible speed that may be attained on railways, trial runs were lately made between Berlin and Lübbenau on the Berlin and Görlitz line, states the *Rheinische Westphälische Zeitung*; and for these runs a special express engine of new design with four cylinders and driving wheels of 2 metres (6ft. 6in.) diameter has been constructed, thus giving the engine a much greater height above the rails than usual. For these runs the composition of the trains was very various, amounting sometimes to 100 axles. With a train of 30 axles the highest performance, viz., 106 kiloms. (65¾ miles) per hour was recorded, being 20 kiloms. (12 miles) more than the highest speed hitherto attained by the quickest German lightning train (Blitzzüge), viz., the Berlin Hamburg D-Zug, which runs through a distance of 286 kiloms. (177½ miles) in 3½ hours, while the speed of ordinary German expresses is only 70 kiloms. (43½ miles) per hour. Not any of the runs have hitherto been accompanied by accident, although the trains have run past all the intermediate stations without slackening speed. The portions of lines chosen for these runs have been tolerably horizontal over their whole length, and have very few curves.

A report from our Consul at Lorenzo Marquez, which has just been published, shows that the lack of adequate landing facilities at the port causes serious inconvenience to trade with the Transvaal, and is driving vessels to the Natal ports from Delagoa Bay. The steamers of the New Zealand Karri wood trade, for the mines on the Rand, are said to have decided to try Durban on account of the prolonged delays either at Delagoa Bay itself or on the railway up to the Transvaal, and many other vessels are mentioned by the Consul as having left Delagoa Bay to discharge elsewhere. Within a few days of the date of the report—March 6th—the British barque Shakespeare, with 1400 tons of Oregon pine consigned to Delagoa Bay, sailed from East London without breaking bulk, as it was useless to attempt to discharge her in reasonable time at Lorenzo Marquez. Another ship, the Blairgowrie, with 2300 tons of timber, was ordered by her consignee in Johannesburg to leave for Durban to discharge her cargo. The master of a British steamer, with 4000 to 5000 tons of railway material, lodged a complaint at the Consulate that, although he arrived at the port on February 11th, the work of unloading commenced only on the 24th, when but 20 tons were discharged, and then ceased altogether. As to the Delagoa Bay Railway, Mr. Casement observes that there is a perceptible need of ballasting at more than one point, and the engines do not appear to receive the careful handling necessary to their maintenance in an efficient state. But since their seizure of the line the Portuguese have made many improvements. The total receipts of the line last year amounted to £80,418, and the tonnage of goods carried to 88,276 tons. The profit of the line for the year was £33,690.

Lieutenant-Colonel H. A. Yorke, R.E., has reported to the Board of Trade on the accident that occurred on May 6th, near Banavie Junction, on the West Highland—North British—Railway. As the 7.35 a.m. passenger train from Glasgow to Fort William was running round the curve between Spean Bridge and Banavie Junction on that day the whole of the train, with the exception of the engine, left the rails and ran along the ballast for 115 yards before it came to rest. The permanent way had three rails bent, and 120 sleepers and 115 chairs more or less destroyed. Lieutenant-Colonel Yorke says he has no hesitation in attributing this accident, which by rare good fortune was unattended by any personal injuries, to the expansion and consequent distortion of the line produced by the great heat prevalent on the day of the occurrence. During the forenoon of May 6th the temperature registered at Fort William, by a thermometer placed in the sun 2ft. above the grass, was 128 deg. The accident happened at 12.38 p.m., when, the railway at the spot being entirely devoid of shade, the rails were exposed to the full glare of the sun. Driver Thornton says that when he was passing the 97¼ mile post he saw that the line a short distance in front of him was distorted to the left to such an extent that he anticipated that the train would leave the rails. He promptly applied the Westinghouse brake, and almost immediately after this the tender and vehicles composing the train left the rails towards the inside of the curve. Inspector Campbell had travelled over the line early that morning in the van of a ballast train, and noticed nothing wrong with it. The fact that the engine did not leave the rails, although the rest of the train did, may probably be attributed to the flexibility imparted to the engine by the leading bogie, which was able to adjust itself to the irregular curvature of the line produced by the expansion of the rails, whereas the tender, with its six wheels and rigid wheelbase, was most probably the first vehicle to leave the metals, and dragged the rest of the train after it. The mishap must be regarded as purely accidental, and there is no evidence to prove that any blame attaches to any servant of the company in connection with it. There are, however, the report adds, some indications that this portion of the line has not been maintained in a thoroughly first-class condition.

NOTES AND MEMORANDA.

The rainfall at Greenwich for the year ending 1896, April 30th, was 19·76in., being 4·78 below the fifty years' average. This is the smallest rainfall since the year 1884-85.

In a paper in the *Comptes Rendus* "On Molybdenite and the Preparation of Molybdenum," by MM. Guichard, it is stated that metallic molybdenum free from sulphur can be obtained by subjecting the mineral molybdenite in a carbon tube to the electric furnace—900 ampères, at 50 volts—for five minutes. The ingot contained about 92 per cent. of molybdenum, 2 per cent. of iron, and 7 per cent. of carbon.

New experiments on the distribution of velocities in tubes have been described by M. Bazin. No single expression can be given which will accurately represent the velocity of an air current at any point between the centre and circumference of the tube, the law being very complicated. At a distance from the centre equal to three-fourths of the radius of the tube the velocity was equal to the mean for the whole tube.

A recently issued number of the *Alembic Club Reprints*, published by Messrs. W. F. Clay, contains Faraday's papers on "The Liquefaction of Gases," 1823-1845, and an appendix consisting of papers by Thomas Northmore on the compression of gases, which were referred to by Faraday, in his historical statement in the following terms:—"The most remarkable and direct experiments I have yet met with in the course of my search after such as were connected with the condensation of gases into liquids, are a series made by Mr. Northmore in the years 1805-6." Students of physics, and every one interested in the subject of the liquefaction of gas, should, *Nature* says, possess a copy of this latest addition to the *Alembic Club Reprints*.

In a paper on the "Action of Acetylene upon Iron, Nickel, and Cobalt reduced to Hydrogen," by MM. H. Moissan and Ch. Moureu, it is stated that if acetylene, which has been allowed to suddenly impinge upon pyrophoric iron which has been reduced by hydrogen at the lowest possible temperature, the gas is decomposed with incandescence into its constituents. At the same time, owing to the high temperature, condensation takes place, and a liquid hydrocarbon, rich in benzene, is produced. The same phenomenon is produced by pyrophoric nickel and cobalt, and also by platinum black. No compound containing metal can be isolated, and the decomposition appears to be due to physical causes.

E. W. Parker, Statistician of the United States Geological Survey, has completed the compilation of the statistics of coal production in the United States during the calendar year 1895. The total output from all mines was 171,804,742 long tons, or 192,421,311 short tons, having a total value at the mines of 197,572,477 dols. The output of anthracite coal in Pennsylvania increased from 46,358,144 long tons in 1894, to 51,785,122 long tons in 1895, a gain of over 5.400,000 tons. The product of bituminous coal increased from 118,820,405 short tons in 1894, to 134,421,974 short tons in 1895. There was an increased production in all but five of the twenty-nine coal-producing States. The States in which a decreased product was shown were Georgia, Kansas, North Dakota, West Virginia and Wyoming. The principal loser was Kansas. The product among the other leading coal States was:—Illinois, 17,735,864, value £2,847,831; Ohio, 13,376,137, value £2,127,511; and West Virginia, 11,424,863, value £1,557,424.

Some rules are given in the *Aluminium World* for obtaining the best casting with aluminium bronze, in order to avoid the difficulties which are so frequently met with in melting. An essential point mentioned is the special care to be taken not to overheat the metal, the fact being that, if it be heated to too high a temperature, the aluminium will oxidise, the oxide which is thus formed making the entire casting what artisans term "dirty," and the metal will also be spongy from the presence of large amounts of occluded gases; the scum, too, which floats on top of the melted bronze in the crucible must be prevented from going into the body of the casting, this being practicable by providing the casting with suitable skim gates. The greatest trouble in making a bronze casting, however, arises from the shrinkage of the metal—which is very great—a difficulty which is overcome if the casting have a large sinking head and "risers," it being necessary, however, in many cases to make the sinking head fully as large as the casting.

The number of applications for British patents during the year 1895 was 25,065, this being a diminution of 321 on the number of applications for last year. This is so far remarkable, as it is practically the first year since the Patent Act of 1883 in which the number of applications has not shown an increase. In 1884, the first year under the new regulations, there was a larger number—17,110—than in 1885—16,101—but this is accounted for by the fact that a great number were held back in order that the applicants might take advantage of the reduced fees introduced by the Act. From 1885 to 1894 the increase was continuous. The highest number under the previous law was 6241 in 1882. It is mentioned in one of the appendixes that the total number of patents for inventions granted between 1617 and 1852, in which year what may be termed the first Patent Reform Act was passed, was 13,561, just about half the number now applied for in a single year. The Comptroller's report points out that the decrease of last year was only in applications accompanied by provisional specifications. From this it may be concluded that applicants find that the method of proceeding by provisional specification is less really advantageous than that of filing a complete specification at once. The total receipts for the year amount to the large sum of £187,012; the expenditure amounts to £100,671, leaving a surplus of £86,341. It should be mentioned that over £10,000 of the expenditure was in connection with the new buildings of the office.

A lecture on acetylene gas was lately given at Liége by Professor Raoul Pictet, of Geneva, in the course of which he lighted two candelabra each with nine burners, consuming together 270 litres = 9½ cubic feet of acetylene per hour, a quantity scarcely higher than that consumed by a single Benzel gas burner; and yet the brilliancy was so great as to make the electric light "pale as daylight doth a lamp." As the spectrum of acetylene approaches most nearly to the solar spectrum, the delicate shades of flowers arranged on the lecture table were in no wise altered. The lecturer observed that it was sufficient to throw water on carbite, or carbide of calcium, to obtain acetylene, the lighting gas *par excellence*; but in its impure state this gas is dangerous. Its impurities attack the metals, especially copper; and the salts thus formed are transformed into explosive acetylene of copper. Acetylene itself, an endothermic substance, has a tendency to explode if its impurities permit of molecular change. Professor Pictet, however, here takes advantage of the law as to critical temperatures, by virtue of which all chemical reaction, even the most active, may be arrested by a sufficient degree of cold; and he showed that sodium—which burns spontaneously on the simple contact of water—is uninfluenced by hydrochloric acid when cooled down to about 60 deg. below zero Cent., although it is attacked when the temperature is raised to 50 deg. below zero Cent. In the same manner acetylene, a product of carbite, is uninfluenced by sulphuric acid at 50 deg. below zero Cent., while all its impurities are arrested by that acid at the same temperature; and this physico-chemical filter thoroughly refines acetylene, while rendering it liquid and inoffensive. In this state the gas is stored in nickelised steel cylinders, and a small gasometer permits of its expansion and immediate utilisation, the illuminating power being fifteen, twenty, thirty, and even forty times that of ordinary lighting gas.

MISCELLANEA.

The Turkish authorities have decided to establish a naval station in the Gulf of Alexandretta. The object is to prevent the importation of arms into Armenia, and to watch the movements of foreign naval forces upon the Syrian coast.

Mr. Jeremiah Head, M. Inst. C.E., of Middlesbrough and London, and his son, Mr. Archibald P. Head, left Liverpool last Saturday in the Cunard mail steamer Lucania for the United States. Mr. Head is consulting engineer for the company which took over the works of the Otis Steel Company in the States. Mr. Head expects to return towards the middle or end of next month.

The medals and diplomas awarded to British exhibitors at Chicago have at length been issued to H.B.M. Ambassador at Washington, and have been transmitted by him to the Foreign-office. Sir Henry Trueman Wood has been requested by the Secretary of State to undertake the duty of distributing them, and this will be done at once. *The Society of Arts Journal* says all the exhibitors may expect to receive their medals within about a month from the present date.

The deep dock in which the Volage was placed has been pumped out, and it is now possible to see the character of the injuries the vessel sustained when running over the Denrie Ferrière Rocks, in the Channel Islands, on Monday afternoon. Amidships about 40ft. of the false keel has been carried away, and although the copper plating is jagged, the main keel over does not appear to have been damaged. Astern the false keel, forward of the propeller, has been carried away for about 20ft., and it is remarkable that the rudder escaped contact with the rocks.

The Vienna papers publish obituary notices of Mr. John Hardy, the inventor of the vacuum brake, who died in Vienna on Tuesday last. He was born in 1820, at Gateshead, near Newcastle-on-Tyne, his father being a modeller. He was apprenticed to a locksmith, and worked in various factories, for some time under George Stephenson. He left England at the age of twenty-one for France, and in 1860 went to Austria as head of the repairing shop of the Southern Railways. He brought out his invention in 1878, and in 1885 retired into private life. He is believed to have been the last of Stephenson's assistants.

The Spanish Minister of Marine has applied to the Spanish Council of Ministers for special credits to the amount of £920,000 for increasing the Spanish fleet and extending the Spanish arsenals and naval establishments. The special credits include an item of £80,000 for the new first-class cruiser Reina Regente. The Spanish Minister of Marine further contemplates the construction of an ironclad to have a displacement of 11,000 tons, and to cost £880,000; two cruisers of 6800 tons each, and two torpedo boat destroyers. The Minister further proposes to equip the Pelayo with rapid firing guns, and to convert the Numancia frigate into a floating battery.

The final documents to be filed by the parties in the Delagoa Bay Railway arbitration have now been lodged at Berne. The court has appointed as experts to advise it as to the value of the concession and on the technical questions involved in the dispute between the parties, M. E. Stockalper, of Sion, who was engineer in charge of the construction of the St. Gothard Tunnel, and M. Deitler, of Lausanne, one of the directors of the St. Gothard Railway. The court has left it to these two gentlemen to suggest the name of a third expert should they deem the appointment desirable. The *Railway News* says it is probable that a local inspection of the Lourenco Marques Railway and of its Cape and Natal competitors will be made by one of the experts.

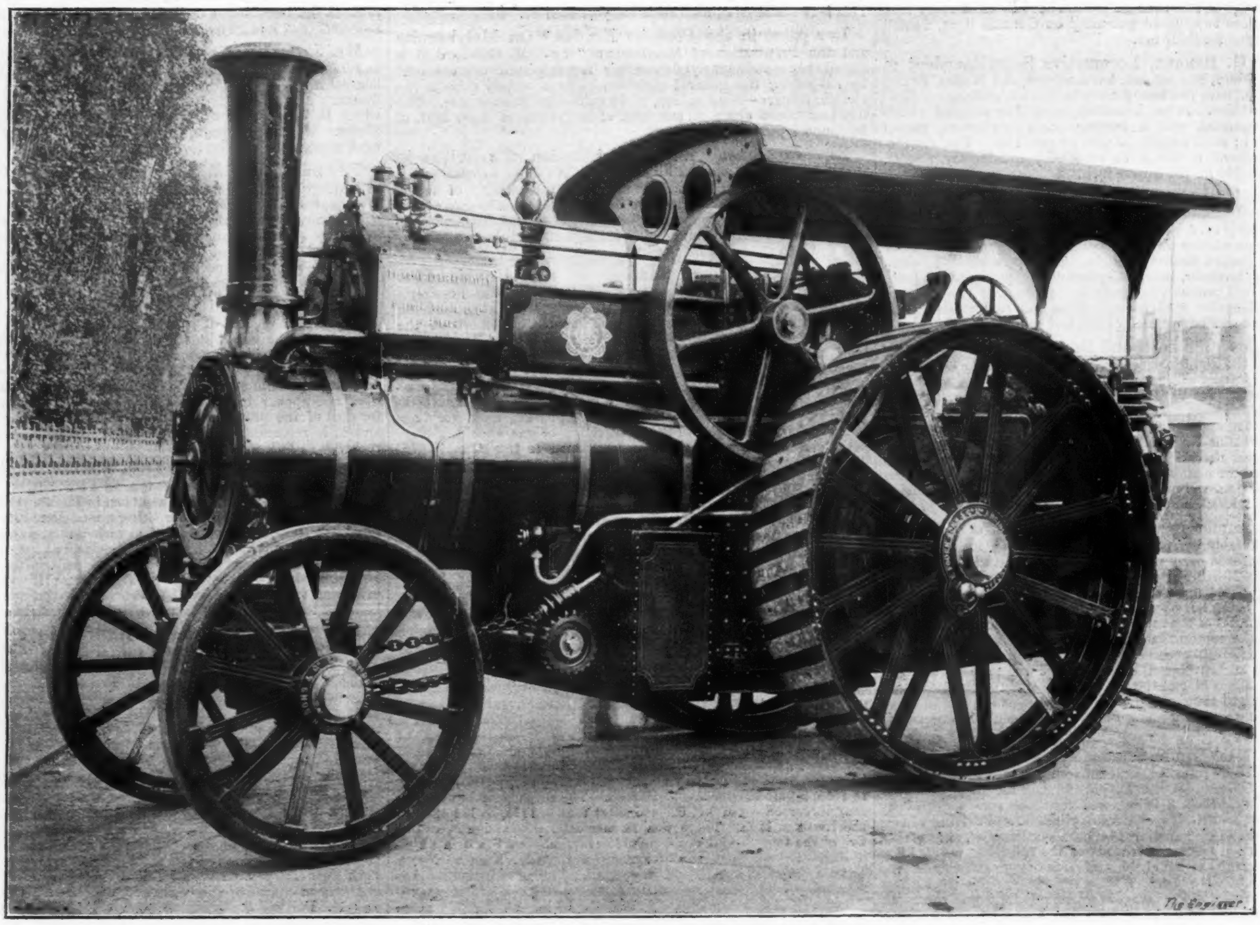
A French Commission was appointed in September, 1894, for examining under what conditions a ship canal could be made and worked between the Atlantic Ocean and the Mediterranean Sea, and what would be its utility as regards the navy, commerce, industry, and agriculture. By order of the Minister of Public Works, the *Journal Officiel* has published the report of the Commission, the conclusions of which are that a canal with eight metres depth of water would cost between two and three milliard francs, or from £80,000,000 to £120,000,000; the yearly interest on capital, with expenses of working, would amount to 93,000,000f., and that the receipts could not exceed 18,000,000f.; leaving an annual deficit of £3,000,000, while the indirect advantages would be very slight in comparison with the disadvantages of all kinds.

Her Majesty's cruiser Blake has arrived at Plymouth and reports that a fatal accident had occurred on board the ship. The Blake is one of the vessels of the Channel squadron on their way from Aberystwith to Portland. When nearing Land's End Capt. Bromley ordered a full-speed trial of the engines to be made. Soon afterwards an explosion occurred in No. 3 boiler-room, and the force of the explosion was so great that it was felt in every part of the vessel. The stokehold was immediately filled with steam, and boiling water was ejected from the boiler-tubes, severely scalding five or six of the stokers who were unable to make their escape. The *St. James's Gazette* says:—A stoker named George Evill was so severely scalded and burnt that he died soon after being got out of the stokehold, and five others were seriously injured about the face and hands. It appears that the crown of the combustion chamber of the foremost port boiler collapsed, let water out, and drove the flames into the stokehold.

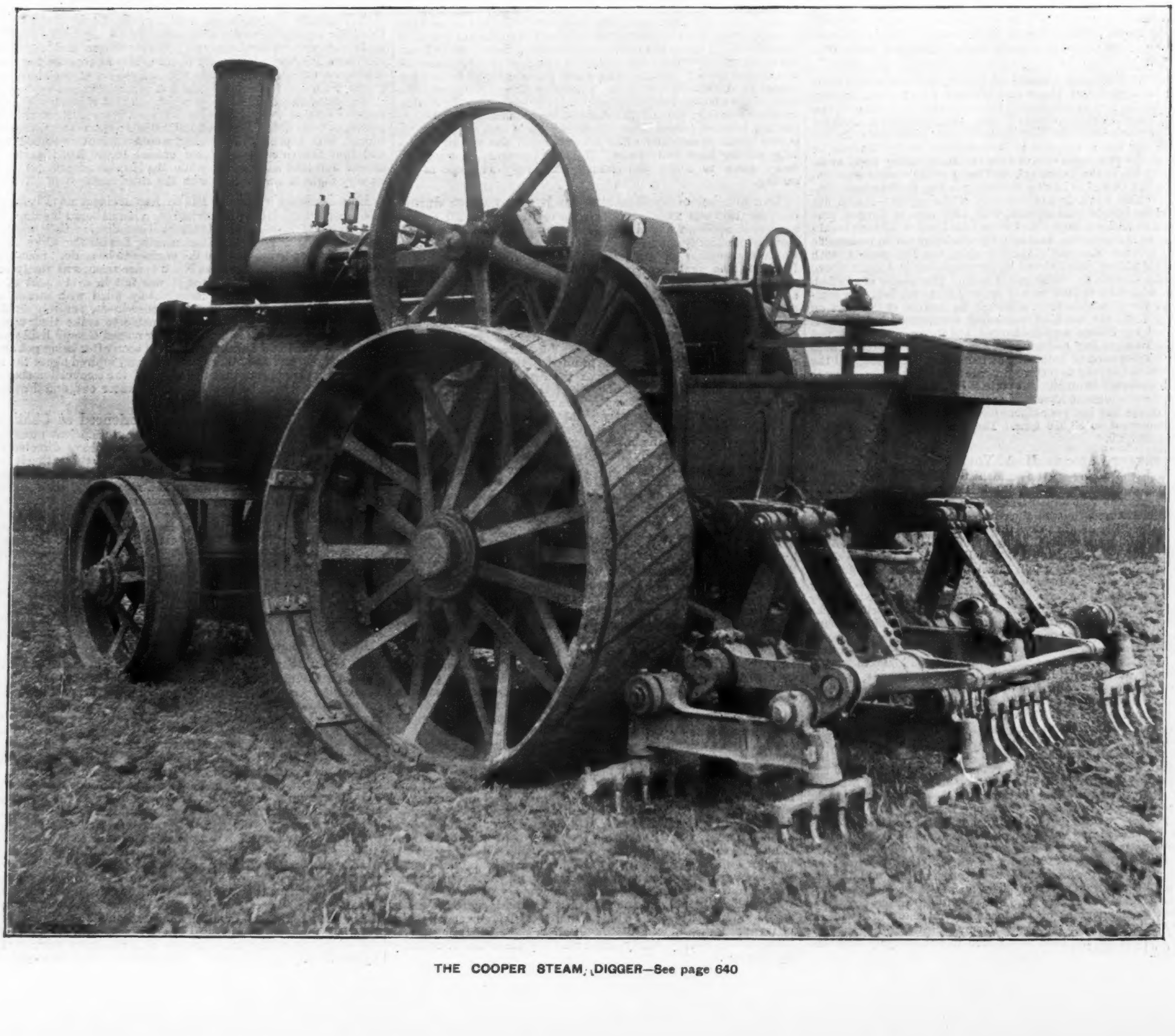
On account of the difficulty experienced at Chatham, Sheerness, and Portsmouth, in securing a sufficient number of stokers for entry into the navy, the Admiralty have directed that the standard height for candidates of all ages for this rating is to be reduced from 5ft. 4in. to 5ft. 3in. until further notice. Authority has been given to enter stokers at the rate of 690 each quarter, divided among the recruiting districts as follows:—Portsmouth, 349; Devonport, 172; Chatham and Sheerness, 169. Allowing for a wastage of 1000 men during the current year, the number of stokers in the service will be increased by 1762 by April next if the proposed entries can be effected. In this department of recruiting, the *Naval and Military Record* says, Devonport has been so successful that the recruiting officers of the district are frequently requested to stop further entries several weeks before the end of each quarter, and on this account alone it is to be regretted that the order to reduce the standard height has been made general instead of applicable only to districts where a difficulty is experienced in getting recruits.

At the ninth summer meeting of the Institute of British Carriage Manufacturers, held on the 24th inst. at the Mansion House, the President—Mr. George J. Jacobs, F.R.A.S.—read his address, which dealt at some length with the history of the improvements in carriage building. He mentioned that as far ago as 1846 the india-rubber pneumatic tire, on the principle of those so much in favour to-day, was applied to carriages by W. Thomson, C.E., of Adelphi-street, Strand, but the invention was not satisfactory, and was relegated to the long sleep from which it has but lately emerged. They stood that day, he continued, on the outer confines of a great departure. They were told that the horse would shortly be removed from its pedestal of autocratic rule and monopoly of possession of the roads for vehicular traffic. The autocar might be taken as the latest application of science to their manufacture. The leaders of their industry regarded the advent of that movement with much interest and expectation, but without panic or alarm. If the carriages of the future were increasingly light, easy, and elegant, they had nothing to fear from, but rather should welcome, the new comer. The result of any satisfactory progress in the adoption of self-impelled vehicles would be the liberation of the horse from its heavier and trade burdens, which would be to the advantage of the manufacturer of horse-drawn vehicles of the lighter kind.

TRACTION ENGINE AND STEAM DIGGER AT THE R.A.S.E. SHOW



MESSRS. FODEN AND SON'S TRACTION ENGINE—See page 639



THE COOPER STEAM DIGGER—See page 640

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TO CORRESPONDENTS.

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*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and bearing a penny postage stamp, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

C. E. H. (Wolverhampton.)—*Write to the secretaries of the Institution of Civil Engineers, Gt. George-street, Westminster, and of the Institution of Mechanical Engineers, Victoria-street, Westminster. You must have had a regular engineering training.*

"THE PIERRE BŒUF BOILER."

(*To the Editor of The Engineer.*)

Sir,—I should feel much obliged if you would kindly insert an inquiry in your correspondence column for the makers of a steam boiler known as the "Pierre Bœuf." It is described to us as a French make, and as being somewhat of the Lancashire type, with a multitubular arrangement on the top. Enquirer.

Pershore, June 22nd.

[Does our correspondent refer to a boiler or boiler parts made by Piedbœuf's, the tube and boiler manufacturers, of Dusseldorf.—Ed. E.]

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Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of The Engineer.

MEETINGS NEXT WEEK.

Dundee Institute of Architecture, Science, and Art.—The Annual General Meeting will be held in Y.M.C.A. Rooms, on Tuesday 30th instant, at two o'clock p.m., and the Council trusts there will be a large attendance of members. Business: (1) Annual Report and Balance Sheet. (2) Election of Office-bearers and Councilfor ensuing session. (3) Election of Committees.

THE ENGINEER.

JUNE 26, 1896.

THE DRUMMOND CASTLE DISASTER.

The appalling disaster which has befallen one of our model steamship companies by the wrecking of the Drummond Castle, and the loss of nearly two hundred and fifty passengers and crew who were entrusted to her captain's care, has once more raised the question whether nothing can be done to make navigation absolutely safe, or, if that be impossible, whether a ship cannot be built so as to afford a reasonable chance of escape to those on board when her last hours have come. Naval architects will reluctantly have to admit that no conceivable system of construction could make a steamer unsinkable; nor can even the best of navigators feel sure that under his command a ship would evade every danger to which she might be exposed. Much has been done to provide him with instruments and appliances of the greatest accuracy, but even these have not proved themselves to be uniformly trustworthy. Thus, in spite of the very painstaking marine surveys which our Admiralty are always carrying out, many a ship has been beforehand with them in finding an unmarked rock; and the compass, the log, the sextant, and the chronometer—good as they may be—are never depended upon absolutely by experienced men. Not only are they worked in duplicate, but the one set of instruments is used as a check on the others; and if the ship's position by the compass and log does not agree with the astronomical observations, an amount of caution is exercised by practiced navigators which to the younger members of that profession may seem ridiculous, but which are fully warranted by the circumstances.

While writing this article the cause of the loss of the Drummond Castle has not been ascertained, and we therefore feel at liberty to echo the general inquiry as to why she went out of her course, why the Ushant lights were not seen. As yet it is not known whether the voyage was made in good or bad weather, or, in other words, whether the steamer had been navigated by the log or by the stars; if by the former alone, her position would be one of considerable uncertainty, for not only might her course have been affected by temporary, and therefore unknown, ocean currents, but the log might have become deranged, possibly by striking a piece of wreckage, which would bend its blades, or by being fouled. There is also a possibility of the compass being out of order. It is well known that vessels which travel between the northern and southern hemisphere require to have their compasses specially adjusted so as not to be influenced by the change of dip due to variations of latitude, or else the ordinary compensations or corrections have to be modified as the vessel approaches either pole. As the Drummond Castle was built with her head pointing in a south-easterly direction, while her course from the Cape would be about north, a violent blow from an exceptionally heavy wave might have suddenly reversed her magnetism. Such cases are rare, but one was mentioned not so very long ago in which a steamer was severely struck by a wave, and immediately afterwards it was found that her compasses had acquired a deviation of 20 deg., and had the weather not been clear, she would most certainly have been wrecked on the Irish coast. But even without going so far in search of a possible reason, it is only necessary to recall to mind that in bad weather even the best equipped Atlantic liners sometimes find themselves far out of their correct course. This has occasionally resulted in strandings, but there are many more cases in which fortunately the errors were detected in time. Instances could be mentioned of mail steamers having been steered straight for Scotland or for France instead of for the south of Ireland, one of them nearly coming to grief where the Union steamer European was wrecked in 1877, and where the ill-fated Drummond Castle now lies. Of course, in such cases the sky has invariably been overcast all the way out; but it shows how untrustworthy the compass and log may prove themselves to be. The danger is in a way only increased by modern improvements professing to reduce the possible errors to infinitesimal amounts, because they inspire a confidence in their accuracy which is not warranted. Thus, for instance, in the above-mentioned case the compass was of the most approved pattern, and could be depended upon to indicate the correct course to within one-tenth degree, and yet one heavy blow from a tidal wave introduced an error of 20 deg., of which one would have had no suspicion if the night had not been clear.

Somewhat similar remarks apply to lighthouses; they too have been made so numerous, powerful, and easily distinguishable, that it seems almost impossible to approach a coast without seeing them, and yet as the wreck charts show, more ships are lost through strandings than through any other cause. Of course, when it is foggy one does not expect to see a light, and the most elaborate precautions are then taken to guard against accidents, but these are almost invariably relaxed a little when there is only a slight haze on. Yet mariners ought to know that the danger is then equally great, for a bank of fog may be surrounding the light and not reach to the ship. Of all the atmospheric conditions snow is admittedly the most dangerous; not only is it far more effective than fog in hiding a light, but it also deadens the sound of fog horns. Rain, particularly a fine drizzle, is almost as bad; for although it does allow some light to pass, it interferes with vision by being blown into the eyes and the face of the look-out man, who naturally seeks shelter, either by not looking straight into the wind's eye or by peeping out from behind any object which will intercept the rain a little. There is yet another danger, and one which may perhaps account for the fact that the Ushant light was not seen. The glare from the reflection of the two electric side lights of the vessel herself against the fine rain may have effectively hidden the lighthouse from view. The Drummond Castle, like most of the boats of her line, carries her side lights forward in so-called lighthouses; the more powerful these lights are, the stronger will be the halo of light in front of the ship when there is a fine rain, and the shore light would then be less easily seen than if everything were dark. It is for this reason that some ships have discarded electric side lights for those of oil, or have shifted them from forward to near the bridge-house. According to one of the first reports, but this has not been confirmed, she was distinctly seen from the lighthouse; and if this was really so, the fine rain could not have been sufficiently dense to hide the shore light; and if, as there is every reason to believe, it was shining brightly all the time, it could only have been hidden from view by some screen, and the most probable one would be the glare produced by the reflection from the side lights on the drops of fine rain. Perhaps before these lines go to press the mystery may have been solved by some other explanation; but the dangers which have been pointed out are none the less real, and have led and will lead to accidents.

As regards the sudden sinking of the ship, there is very little to be said. The Drummond Castle was 365ft. long, 43½ft. beam, and 32·7ft. moulded depth, with an underdeck tonnage of 3537. She had eight water-tight bulkheads, or nine compartments, including the forward peak, and she had a short double bottom aft of 40ft. length. A deep water tank of 20ft. length appears recently to have been converted into a hold space, so that out of a total length of 365ft. only 40ft., or a little more than 10 per cent., were protected against the dangers which attend a stranding. As regards the ship's subdivision, or floating capabilities when injured, it may be assumed that the load draught displacement would be about 7000 to 8000 tons, and that her spare buoyance to the upper deck would add another 2000 to 3000 tons. On an average, one of her nine compartments, if filled, would hold about 1000 tons, and the engine and boiler space would hold quite double that amount; so that it is quite conceivable that a hole in the ship's bottom, extending to either side of either engine-room bulkhead, would admit enough water to sink her, and as she sank so very quickly, it is only reasonable to suppose that the hole was a very large one, and may have extended over a length of three or more compartments. In fact, she probably ripped a great part of her bottom out. It should also be remembered that the vessel may have been travelling at a speed of 14 knots; the rock of the coast is granite, and one of the survivors heard a long grating noise. The amount of energy available for her own destruction, due to a mass of 8000 tons travelling at the rate of 14 knots, is 60,000 foot-tons. If we assume that the length of the hole in the ship's bottom was 150ft., a distance which she would travel in about seven seconds, then the available tearing force would have been 400 tons, a force which is amply sufficient to overcome any resistance which the skin plating and the ship's frames might have offered. No surprise need, therefore, be felt at the rapidity of the disaster; in fact, even if the vessel had only been going seven knots, the available destructive energy would still have been 15,000 foot-tons. There is no need in this case to inquire whether there were enough bulkheads, for, with a long hole in her bottom, no amount of vertical subdivision could have saved her; but there can be no doubt that if she had had a double bottom over her whole length, or even if it had extended over her forward length, there is every probability that she would have remained afloat. Most modern steamers are now built on this plan; for since it has been shown how to utilise these tanks for stiffening the hull, considerable concessions have been made as regards the scantlings and reductions of weight. The fact that the insurance premiums on double-bottomed ships and their cargoes are lower than on others has already led to their almost universal adoption even by the largest mail boat companies; and it is a significant fact that, with a view of reaping the full benefit of lower premiums on cargoes, and therefore higher freights, almost all these companies are now having their steamers built to class in one or the other societies in order that authentic information as to bulkheads, double bottoms, engine power, and many other items which affect the safety of a ship, may obtain a wide circulation. The travelling public are largely influenced by questions of comfort, but in view of recent terrible shipping disasters which could, perhaps, have been averted by proper constructions, it is more than likely that before embarking they will in future inquire whether their ship is sufficiently subdivided to keep afloat after a collision, and whether she has got a double bottom which would protect her against the dangers which attend grounding.

THE POSITION OF THE MECHANICAL DRAUGHTSMAN.

The mechanical draughtsman has been wittily but ungenerously styled a "necessary evil," and that he is so considered by a large number of employers is probably a fact. The reason is obvious. For the work done in the drawing-office there is no direct tangible return. The handiwork of the smith, the fitter, the turner, form part of a hard material mechanism which can be sold for a price. The work of the draughtsman—the actual sheets of drawings and tracings—are not for sale; the time and thought, absorbed, as it were, into solid brass and iron, are overlooked—forgotten. The thought is, indeed, embodied in the machine, but the machine is sold by weight and time of labour, not by the measure of thought. This is very illogical, but by no means incomprehensible. We have heard people grumble about the money spent on the police force. What is the policeman to them? A useless item; an absorber of taxes; one who wears out in useless peregrinations the boots of the ratepayer. Again, we say the position taken up by these good people is easy to understand. They see no direct return for their money, and, therefore, they question if the money is well spent. It must, indeed, seem to them like throwing bread upon the waters, and possibly there are moments when they long to be assaulted or burgled, that in the form of constabulary duty their bread may return to them after many days. It is not impossible that the employer has a somewhat similar way of considering his draughtsman. The draughtsman is not a man who asserts his position. He is a man who, as a rule, works and grumbles all the week, and smokes to forget his worry all Sunday. We should not be writing this inflammatory article if we anticipated that it would have the least effect on the draughtsman; but we feel that it is quite safe, and we address ourselves rather to the employers than the employed. Of course there are draughtsmen and draughtsmen. There are those who are barely worth what they receive, and we scarcely think it possible to be worth less; and there are those who should receive fivefold. We know there is a fancy amongst employers that they do all the work, or that their chief designer does it. It is easy to be so mistaken. A scheme resolved out of a hint given to a draughtsman looks exactly like the thing one had conceived in one's brain, but had allowed another to put on paper. The suggester imagines himself the designer and inventor, even though the draughtsman has spent weeks of thought and quires of paper in knocking a crude idea into shape. Let the same suggester take himself the board and the tee square, and try to lay down on paper the thing he has conceived, and he will find that at every point his imagination has deceived him. Here the thickness of metal prevents one arrangement, and there the thinness of it prevents another; here the impossibility of machinery is an insurmountable obstacle, and there the cost of forging or moulding needs deep consideration, and so on and so on. From the moment the first centre line is drawn on the paper to the time the drawing is ready for the tracer, it is unceasing thought and responsibility. Responsibility is, after all, the thing that has to be paid for; and the draughtsman is obliged to take more than his share. Whatever goes wrong, be it in shops or offices, the blame will if possible be thrown upon the drawing-office. The chief draughtsman bears the brunt of it, perhaps being held responsible for all work turned out by his staff; but he quickly dislodges the burden and drops it on to the shoulders of his subordinates. Theoretically he may be responsible for all drawings issued, actually that is impossible. It is the draughtsmen at the boards who are and must be of necessity the finally responsible persons, and in consideration of what that implies the remuneration is painfully inadequate.

It is a favourite argument with certain philosophers that a worker always receives what he is worth; this implies that the man who will do the work for the lowest possible wage is the standard of worth for all others. If an employer can get a draughtsman to do the work he wants done for 35s. a week we cannot expect him to pay more. At present the only known cure for inadequate wages is amalgamation. Now we are very strongly opposed to the combative amalgamation of the artisan class, and by no means do we wish to see draughtsmen binding themselves with any such treacherous cord, but there is an amalgamation of etiquette well understood in many professions which might be adopted, not without advantage, by draughtsmen. It may be well said that the standard among draughtsmen is not sufficiently high; that whereas in the professions alluded to a refined education has given men the necessary amount of pride and good feeling to make them ashamed of losing caste by lowering their own worth and that of their fellows, the draughtsman has not infrequently raised himself from the bench or marking-off table. This is to a large extent true, but at the same time if once the remuneration for good work was made fairer we should find better educated and more capable men ready to accept the draughtsman's position. As it is, there is a very large number of young men with college and shop experience compelled to work at the board for the same price as the man almost without education. We know very well that the college training is actually in many cases a drawback, but still advertisements may not infrequently be seen for draughtsmen with "scientific attainments preferred," and these men will perhaps be expected to work for a price per hour equal to or lower than the wage of a good mechanic. It must be understood that we refer here to actual draughtsmen, not chiefs or designers; these, as a rule, are more fairly paid, though we could mention cases of chiefs, with twelve to sixteen men under them, being paid about £150 per annum.

The standard of work done should, of course, be the measure of the pay given. If a man is only sufficiently competent to put together a general arrangement from the detail plans, or to make unimportant alterations in existing drawings, his pay should be made adequate to this class of work. If he is found capable of working up ideas unassisted, of doing all the necessary calculations, and of scheming the hundred-and-one little arrangements which a new design always necessitates, his pay should naturally be greater, and so indeed it is, but quite disproportionately. Thus the first will perhaps receive thirty-five shillings a week, and the second forty. It must be perfectly evident that the pay is totally disproportionate, both to the intelligence involved and the responsibility undertaken. Admit that the first man is worth thirty-five, and the second must be worth at the least twice that sum.

It might not be impossible to make some compensation to the draughtsman for the indifferent remuneration by certain polite concessions. His social position might be more regarded, by which we mean that he should expect and receive more delicate treatment than is accorded to mechanics, instead of less. His personal comforts, the sanitary arrangements of the drawing-office might be much improved. He might be allowed a little more liberty in the matter of time-keeping, and not find himself "docked" 3½d. for a quarter of an hour's leave. His pay should be a standing pay, and not dependent on his punctual attendance, and he should be allowed certain holidays in the year without the curtailment of his income. All these things are done in many drawing-offices, notably so, we understand, by the large railway companies, who work shorter hours and are less exacting than most offices. But, after all, the majority of employers, even very large companies, do not deal at all generously with their draughtsmen.

As we have said before, we only know of one accepted method of correcting these faults, and that is a way which, although good in itself, has become notoriously bad from misapplication. There are, however, throughout the country many draughtsmen's institutions, and if a collective appeal was made by these to the employers, we think it highly probable that the draughtsman could considerably better his condition. Let there be, however, no confusion between draughtsmen and tracers. Tracers probably earn very much what they are worth, the work is purely mechanical, and only in exceptional cases needs the application of mental powers. The draughtsman, on the contrary, must always bear a heavy burden of responsibility, must be continually exercising his brain, and must be dexterous with eye and finger. The tracer's craft may be learnt by a man of indifferent intelligence in a month or two; only a regular course of engineering training makes a thoroughly competent draughtsman, as only long experience produces first-class designers.

It is with certain misgivings that we write this article. Anxious as we are that the position and condition of the mechanical draughtsman should be more commensurate with the abilities demanded in him, we do not wish by the slightest hint to favour any rupture between the drawing-office and the employer. It must be evident to the latter, however, that there will be in time a draughtsmen's society, even as a medical doctors' society is mooted now; and as such things are generally the cause of some disturbance, would it not—we put the question to the employers—be prudent to meet matters half way and make certain concessions in the draughtsmen's favour before they are demanded with a show of arms?

THE NAVAL ARCHITECTS IN GERMANY.

Nothing could exceed the cordiality and enthusiasm with which the Institution of Naval Architects has been received in Germany. As Sir W. H. White aptly put the matter, all that were great or important in the social, scientific, or mercantile world in Hamburg welcomed the visitors on their arrival in that city; whilst in Berlin the directors of all the principal companies, the Secretaries of State, and many of their most influential officials, and, finally, the powerful and intelligent ruler of the vast empire of Germany himself, all vied with one another in holding out the right hand of friendship to the shipbuilders from across the North Sea. The time was opportune. As the Earl of Hopetoun hinted in his opening address, newspaper men had been stirring up—or trying to stir up—ill-will between the two countries. They were at the bottom of all the mischief that was done. The moment was, therefore, a happy one for bringing together men of two great nations, allied by ties of brotherhood, by ties of scientific knowledge, and by ties of commercial interest and trade industry. The occasion could not fail to indicate to them, when brought thus into juxtaposition, their common interests in trade and manufacture, more especially in the development of that great science of which the Naval Architects were the exponents—the art of shipbuilding. What that art can aspire to be was most happily put by Admiral Hollman in his address at Berlin. A ship was a thing of life as well as beauty. But the time was opportune in another sense. It was a graceful act on the part of Germany to call the Institution across the water to see what the country had done by following in the steps of her maritime sister. She was ready to admit that her new shipyards, her latest vessels, her most powerful battleships, her most recent specimens of machinery, were developed from British models. It was, therefore, due to that great country, which had given to Germany all those ideas, that she should contemplate the fruits of her instruction in the past, as an incentive to fresh exertions upon the part of the parent teacher in the future; and we confidently believe that, apart from the question of all the oil that has been poured upon the troubled waters of feeling in Germany and England, a great and lasting benefit will result to our own country. It has been shown to us that we cannot stand still. Whilst we are employing, in our manufactories and shipbuilding yards, plant that "might have been young and effective some forty years ago," Germany is starting afresh. It is the old story of the hand loom over again. There are men in our country who love nothing until it is old or unserviceable. Witness the scientists at Woolwich, who clung for eight years to the muzzle-loading gun. But trade and industry must not be trifled with in this way, however war may be carried on. The industries and trade of a nation will perish unless conducted upon the most recent and improved principles. Hence the visit to Germany of the Institution of Naval Architects, and the exhibition which it had of the development, the energy, and resources of the people of that country, should have the effect of stirring us up to see that our muscles are braced and our house in order. May this be the result of the summer meeting of the Naval Architects of 1896.

TRADE REVIVAL.

A trade revival of an undoubted character is appearing in some of the iron and steel and heavy engineering centres of the country. From the North of England, the West of Scotland, Barrow-in-Furness, Lancashire, and the Midlands reports come of an increased demand, stronger prices, and added activity at the works. All this is very satisfactory, and happily finds a reflex in some of the reports of the public companies connected with iron and steel manufacture which are just now being issued. John Brown and Co., of Sheffield, for example, announce this week that the improvement in the trade of the country has had a most beneficial effect on the general business of the company, and the various departments producing railway and shipbuilding material have done better than for some years past. The armour-plate department has been well employed, and the output of the collieries has been considerable. Similarly one of the leading Welsh coal and iron concerns, the Tredegar Coal and Iron Company, are able to advise this week that the output of coal during the year ended March last was the largest on record, namely, 910,288 tons. One of the rail mills has been started on the manufacture of light sections of rails, and the wagon repairing and other shops have been extended and fitted with additional machinery. The report of Nettlefolds Limited, Birmingham, one of the largest and most prosperous engineering and iron and steel concerns in Mid-England, contains a recommendation of a dividend of 10s. per share and a bonus of an equal amount on all the ordinary paid-up capital, in addition to the usual preference and other divisions. We give these instances as passing evidences of the improvement that seems to be setting in, but they might be multiplied many fold. The shipbuilding and steel plate and steel rail trades of the country are all looking better, and at most of the industrial concerns, particularly on the Clyde and the North-East and West Coast, concerned in these industries, the machinery is running almost constantly. Steel rails have advanced £1 per ton on the prices of eighteen months ago, and at some of the steel works in West Scotland, engaged mainly in the plate trade, the output is as high as 3000 tons weekly. Comment is made that the difference in prices at the moment of steel plates and iron bars should be only 5s. per ton, whereas under normal conditions 20s. per ton is the usual difference. The present position is, however, due to the fact that the production of plates has increased enormously, while that of iron bars and angles has not, and, if difficulty is prevented in the coal trade, everything points to a continuance of the trade revival for some months certain.

YORKSHIRE MINING IN 1895.

Some interesting particulars are published in the annual report of Mr. Frank N. Wardell, her Majesty's Inspector of Mines for Yorkshire and Lincolnshire. One is the immunity this great coalfield has happily enjoyed from disaster of any magnitude. With the exception of an explosion of gas near Wakefield, which caused the death of two persons, no single accident resulted in the loss of more than one life. Another point is the gradual decrease in the number of persons following the occupation of mining. In 1894 there were 91,154 people employed in the production of minerals in these two counties; in 1895 this number had been reduced to 88,879, showing a falling-off last year of 2275 persons—this, be it remembered, in the face of many new collieries, being opened out. The conclusion is that in the mine, as in other places of labour, the machine is displacing the man. This is one of the results of triumphant Unionism. "No reduction" sounds very well at miners' mass meetings, and the resolution to adhere to "a living wage"—which nobody has yet attempted to define—is enthusiastically endorsed. But it all comes to the same thing in the end. The amount paid in wages is maintained, but the work upon which wages is paid is diminished. At the week end the worker takes less home. The "living wage" is even less a living wage than if the coal-owners had been able to take more contracts by getting the cost of production lowered to that in other districts. At the same time the output for 1895 was considerably less than for 1894—sea-borne coal being placed so much cheaper on the metropolitan market. The weight of coal raised in the former year has been 22,807,507 tons, or 694,667 tons less than in the previous twelve months, including fire-clay, ironstone, and similar minerals, the total output in 1895 was 23,319,486 tons, which is 650,279 tons less than in 1894. Considering that many collieries during the year were not working more than three or four days a week, Mr. Wardell anticipated that the decrease would have been still greater. The number of deaths from falls of roof and sides again makes the heaviest item in the casualties, the figures being 56 and 39 respectively. In the year 1895 there was a proportion of one death to every 977 persons employed. Every 256,258 tons of mineral produced in the district costs a life. Of the 88,879 miners employed, 88,680 are in Yorkshire and only 199 in Lincolnshire.

THE SOUTH YORKSHIRE COKE TRADE.

In the present unprofitable and unsettled state of the coal trade, it is some satisfaction to learn that the coke trade so largely carried on in South Yorkshire is in such a state as to provide an outlet for the small coal, slack, and smudge raised, which sells freely at improved rates. This may be said to be about the only active branch of the coal trade. The activity of the coke trade and the short time worked at the collieries is causing small fuel to be somewhat scarce, and, of course, prices have increased to such an extent that secondary qualities of unscreened house coal can be procured at about the same prices as are demanded for best screened slack, which has reached 3s. 6d. to 3s. 9d. per ton, whilst smudge, which at the beginning of the year could be procured at 9d. to 1s. per ton, makes 1s. 6d. and 1s. 9d. per ton at the pits. The value of proper screening machinery is thus proving itself by a direct increase in the prices of the output everywhere. The output of coke throughout South Yorkshire is now large. All available ovens are at work, and within the past month a large number, which have been disused for years, have been relighted at Silkstone Common. New ovens are in course of construction at Cadeby Colliery, near Mexbro, and at the Barrow Colliery, Worsbro, near Barnsley. Makers, however, complain that supplies are becoming more plentiful, and the increased prices of fuel have a tendency considerably to curtail the profits derived from the advanced prices. A large portion of the coke made is sent to North Lincolnshire, Derbyshire, and Northamptonshire, at all of which places district makers have to compete with North of England producers.

LITERATURE.

La Règlementation de la Production du Charbon. By Emile Lewy. Paris: Librarie Française et Anglaise de J. H. Truchy.

The author of the above work has undoubtedly devoted a great deal of thought and time to his subject, and he propounds at considerable length his views with regard to the production of coal on lines which would, he maintains, be satisfactory alike to master and man. Mr.

Lewy has gained his experience of the miner and mining as managing director of a Belgian colliery, and the outcome of his reflections on the subject has resolved itself into a fixed conviction that he can solve the labour question, at all events as far as coal mining is concerned, if only the people interested would follow his advice. This is precisely where his difficulty has come in, nor is there the slightest probability of its being overcome. If perseverance, energy, and conviction of purpose are to be taken as indicating feasibility, then Mr. Lewy should succeed, for he brought out his first project some years ago, since which time he has submitted it in various forms and languages, and with unflagging persistence, to most of the trade union leaders connected with the European coal industry.

The first portion of his book tells us how these gentlemen received his propositions. Most of them sympathised with the scheme, and a few offered criticisms on it. Enough interest was taken in the subject to enable him to bring it before the various international mining conferences that have taken place of recent years, and an unimportant, and now defunct, labour paper in this country gave all the support and advertisement that it could to the project, and anything which the author chose to write on the subject. The international conferences, however, ruthlessly shelved the "projet Lewy," until at last the matter was discussed at the 1895 Paris conference. The result of the discussion left matters practically *in statu quo*, the delegates again offered their sympathy, but any attempt to get away from generalities and discuss the details caused so great a dissension of opinion that no progress could possibly be made.

Leaving all the sentiment out of the project, all the talk about the downtrodden miner, the living wage, the starvation prices at which coal is sometimes sold, and so on, Mr. Lewy's scheme, in a few words, may be described as a proposal to form a compact ring of the coal trade in all European centres, for the supposed benefit of man and master, and certainly at the expense of the coal-consuming public. The middleman is, as one might expect in such a book, strongly condemned, but, in the same breath, and with great inconsistency, the author holds up to opprobrium the large coal consumers, such as gas and railway companies, who purchase in sufficient quantities to enable them to do without the services of the middleman.

We are told, and we can quite understand it, that the masters were extremely unsympathetic with regard to the scheme. The most favourable answer which Mr. Lewy could obtain from them was, to quote his own words:—"First of all, you must come to some understanding with the men, and then we will see what can be done. Until then we can do nothing." Mr. Lewy's main argument is as follows: The miner demands a living wage, and it is his right to have it. To fix a minimum rate of wages the miner must be accorded 25 per cent. of the profits. The mineowners desire a reasonable return for their capital, and this is just too. This state of things is the cause of all the labour troubles in the trade, says the author, and it is due to a want of equilibrium between production and consumption. This causes undue competition, and sends first the miner and then the master to the wall. A remedy must be supplied which will relieve master and man alike. This remedy is to be the regulation of production to suit the market, and it is to be brought about by an international agreement between the men's representatives. The owners cannot agree, as their interests are too divergent, and so the men must carry out the plan. The interests of the men are so identical "that they cannot fail to be unanimous." The agreement the men are to come to is to the effect that they shall only work a few days a week according to the district, and that they are to be paid for one day more than they work. The eight hours day is to be universal, though Mr. Lewy ignores the fact that many British coal miners do not work anything like eight hours a day. No stocks are to be kept beyond the bare necessities of the trade, whatever that may mean, and the wages are to fix the price of coal. The master is to say to the consumer, "That is the price. You can take it or leave it." No doubt such a policy would often result in the customer leaving it; for, as Mr. Lewy justly remarks, the price of coal very often determines the profit or loss of gas and other large companies. So the natural result would only be that if such companies had continually to buy their coal at prices which would guarantee their always working at a loss, they would soon stop work. Thus the immediate result of adopting Mr. Lewy's scheme for a millennium in the coal trade would be the ruination of the best customers of the coalowners.

Mr. Lewy no doubt means extremely well, and is very convinced of what he says, but unfortunately his book is not in the least likely to prove convincing to any but the most unsophisticated student of labour matters. There is small matter for wonder that even the extremists in trade unionist and socialistic circles cannot as a rule bring themselves to believe in it. The author's arguments are at once fallacious and naïve, but the book in some ways is not without interest as a record of the different methods adopted for politely burking the question by the several well-known men in this and other countries to whom the scheme has been submitted. One naturally sympathises with any proposal to improve the lot of the coal miner, which is undoubtedly a hard one. But Mr. Lewy tells us that the wages earned by the British miner are at least three times as great as those of his Belgian *confrères*, and we cannot help thinking that Mr. Lewy has begun at the wrong end of the question. He might with less difficulty do much good in endeavouring to level up the wages and reducing the working hours of the continental miner to some figure more nearly approaching the English standard. This will be an absolute necessity before any scheme, good or bad, for an *entente cordiale* of an international character between coal miners can stand any chance of being seriously considered.

Computation Rules and Logarithms, with Tables of other Useful Functions. By S. W. HOLMAN. Large 8vo. pp. xlv.—73. New York and London: Macmillan and Co. 1896.

"IT would probably be within safe limits to assert that one half of the time expended in computations is wasted through the use of an excessive number of places of figures, and through failure to employ logarithms. This waste may be almost wholly avoided by following a few simple computation rules and practising slightly with logarithm tables." In order to facilitate the saving of time and labour indicated in the foregoing paragraph, the author has brought together a series of simple rules to enable the user to answer for himself the question, How many places of figures ought I to use in this computation? There are also explanations of the use of notation by the powers of ten, and instructions in many respects novel as to the use of the tables; these preliminary matters forming an introduction of forty-five closely printed pages to the tables which follow. The collection is designed to contain all the mathematical tables ordinarily required, *and nothing more*—the italics are our own—in practical work in all branches of the engineering profession, and by students of physics, chemistry, and engineering, for work of any degree of accuracy not exceeding 0·05 per cent., and it should therefore provide for many persons all the logarithmic and trigonometric tables needed for the entire range of their practice. The tables include ordinary and trigonometrical logarithms, both to four and five places, besides square roots reciprocals, and natural sines and tangents to four places. A table of slide wire ratios as used in electrical measurement, and a series of the more useful numerical contents, all of which are well selected, so that the promise to include nothing more than essentials has been fully carried out. There are several minor novelties in the arrangements calculated to make the use of the tables easier, and the introduction contains much information of which even experienced computers may be glad to be reminded at times. The work is excellently got up both as regards type and paper, although the latter is perhaps rather too thick to be quite agreeable in use, although this may not be a failing in a volume intended for hard and constant service.

Crystallography for Beginners; with an Appendix on the use of the Blowpipe. By C. J. WOODWARD, B.Sc. 8vo, pp. 164, with 4 plates. London: Simpkin, Marshall, and Co. 1896.

THIS volume contains a series of lessons on the simpler parts of descriptive crystallography, such as the different systems of notation, the notation of faces and forms, and the use of the spherical projection in determining the symbols of faces from their observed angles, &c., each lesson being accompanied by a series of exercises, and illustrated by models to be built up from their developed surfaces given in the accompanying plates, as well as by a small collection of characteristic, natural, and artificial crystals, which can be obtained from Messrs. White and Pike, of Birmingham, for 3s. 6d., and is intended, in addition to its principal purpose, to facilitate the performance of simple physical experiments, such as Senarmont's demonstration of the ellipsoid of heat conductivity in gypsum. The author has, we believe, been a successful teacher of the subject to elementary students, and therefore his method deserves attention; but a consideration of the book leads us to the conclusion that such success can only be obtained by the use of a larger amount of material than is here presented to us. So far as it goes the material is good, but the quantity is even scanty for elementary use, and the deficiency is made more apparent by two thoroughly incongruous additions in the shape of an appendix on the use of the blowpipe, and an abstract of Dr. Albin Weisbach's tables for the determination of minerals by other characters than form, which, considering the main purpose of the book, are most decidedly out of place, and take up space that might more usefully have been devoted to some of the simpler problems of determinative crystallography, such as the establishment of the fundamental axial ratios of a species from observed angles, the principles of twin structure, the use of linear projections, &c. In places the author's language is not remarkable for accuracy, as, for instance, where he talks of planes of symmetry contained in plane figures, cubic crystals of apophyllite, regular octahedra with 12, 14, or 18 edges indifferently, and gives as a method for drawing crystals in isometric perspective one that is palpably anisometric. Such slips as these are unfortunate in a work of this kind, as they are likely to be a trouble to students, especially those without much preliminary geometrical training, for whose use it has probably been designed. The sheets of models in the illustrations are rather roughly executed, and are scarcely likely to make up satisfactorily. Probably their best use will be as guides for re-drawing them, which should be done on the best Whatman paper, using a finely-pointed hard pencil for setting them out.

SHORT NOTICES.

The Great Eastern Railway Company's Tourist Guide to the Continent. Edited by Percy Lindley. Illustrated, and with maps. London: 30, Fleet-street. 1896. Price 6d.—This is the seventeenth annual issue of a useful little book. Amongst its new features are a chapter on cycling routes in Holland, Belgium, and Germany, and some continental maps, including one, large and clear, showing the continental railway systems.

The "Private Bills" Reports: A Record of Proceedings in Parliamentary Committees during the Session 1895, *including cases of locus standi in the House of Lords.* With maps and index. Compiled by Herbert Newbon, of the Inner Temple, barrister-at-law. London: Eyre and Spottiswoode. 1896. These records of the proceedings of Parliamentary Committees will be found very useful by the many engineers and solicitors, and many others who are frequently occupied upon or in connection with committee and private Bill work, and to others to whom precedents are of importance. On some matters, such as the London Water Supply and Roads Locomotives, for instance, the facts and figures quoted and the plans referred to will be of value to many. The Bills dealt with in this volume, which is well printed with large type, marginal notes, and dates, relates to railways and docks in Wales, except the Mersey Docks and Harbour Board Bill, and maps are given of the districts concerned in each case. The work of the compiler appears to be well done, and no doubt will be appreciated.

BOOKS RECEIVED.

Rivers and Canals. The Flow, Control, and Improvement of Rivers, and the Design, Construction, and Development of Canals both for Navigation and Irrigation. With Statistics of the Traffic on Inland Waterways. By Leveson Francis Vernon-Harcourt, M.A., in two volumes. Volume 1, rivers; volume 2, canals. Second edition, rewritten, enlarged. Oxford: At the Clarendon Press. 1896. Price 31s. 6d. the two volumes.

Proceedings of the Twenty-ninth Annual Convention of the American Institute of Architects. Held in the St. Nicholas Hotel, St. Louis, October 15th, 16th, and 17th, 1895. Published by the Board of Directors, A.I.A., under Direction Committee on Publication and Library. Alfred Stone, editor. Providence: E. A. Johnson and Co., Printers. 1895.

THE ROYAL INSTITUTION.

NIAGARA POWER WORKS.

ON Friday, the 19th inst., Mr. L. Commerford Marten, editor of the *Electrical Engineer* of New York, gave an address upon the Niagara power scheme in the theatre of the Royal Institution, Albemarle-street. Lord Kelvin presided, and there was a large and distinguished audience, including some of the principal engineers of the day.

The lecturer showed a fine series of lantern slides, and was anxious to impress upon his audience the fact that the Power Company had not injured the scenery of the place; when near the Falls it was impossible to see, even with an opera-glass, the works which have been carried out by the company to bring the water to their power-houses. Views of Niagara in its summer and winter aspects were then thrown on to the screen, and the lecturer stated that the total height of fall, including the Rapids, was 320ft., and there was 164ft. clear fall. In 1725 the first saw-mill was erected there and driven by water power. Sir William Siemens had estimated the available power of the Falls at 17,000,000-horse power, and Professor Unwin had given the much lower estimate of 7,000,000-horse-power.

Views were then shown of the canal, the power-house, turbines, dynamos, and tail race tunnel, and it was explained that the present scheme was for 10,000-horse power. Some amusing examples were given of schemes which were sent in for competition. One of these showed plant placed in chambers excavated behind the Falls, with vertical tubes so arranged that the water poured direct into them, and was intended to flow down to the turbines. The lecturer said that the author of the scheme was asked what he would do if icebergs dropped into the pipes. It appears that the power is being well taken up, and that three of the large units are now at work. Extensions are to be made at once; in fact, the contracts were let before the lecturer left New York, and one of the most interesting points mentioned was that several firms have tendered for dynamos to produce 10,000 volts at once, so that it will not be necessary to transform up for the line current. The author referred to the choice of 25 cycles per second for the alternating current, and pointed out that this frequency had been selected because the current was to be used specially for the distribution of power. It is, of course, rather a low frequency for incandescent lighting. The weight of each generator is 170,000 lb., of which 79,000 lb. are in the revolving part made up of the shaft, the driver to which the field ring is attached, the field ring with its pole pieces, and the collecting rings carried upon an extension of the shaft above the driver. The speed at which the shaft revolves is 250 revolutions per minute. The lecturer attempted rather to give a comprehensive view of the whole scheme than to enter into minute technical details. He showed views of the banks of the Niagara River below the Fall, and stated that the electric car line on the American side was carried on a track supported by brackets from the cliffs, and the fare of 25 cents was the cheapest "thrill" it was possible to get.

ENGINE POWER AND SELF-PROPELLED TRAFFIC.—In the article by Sir David Salomons which we published on page 610 of our last impression on this subject the words "good road" in line 68 should be "rough road."

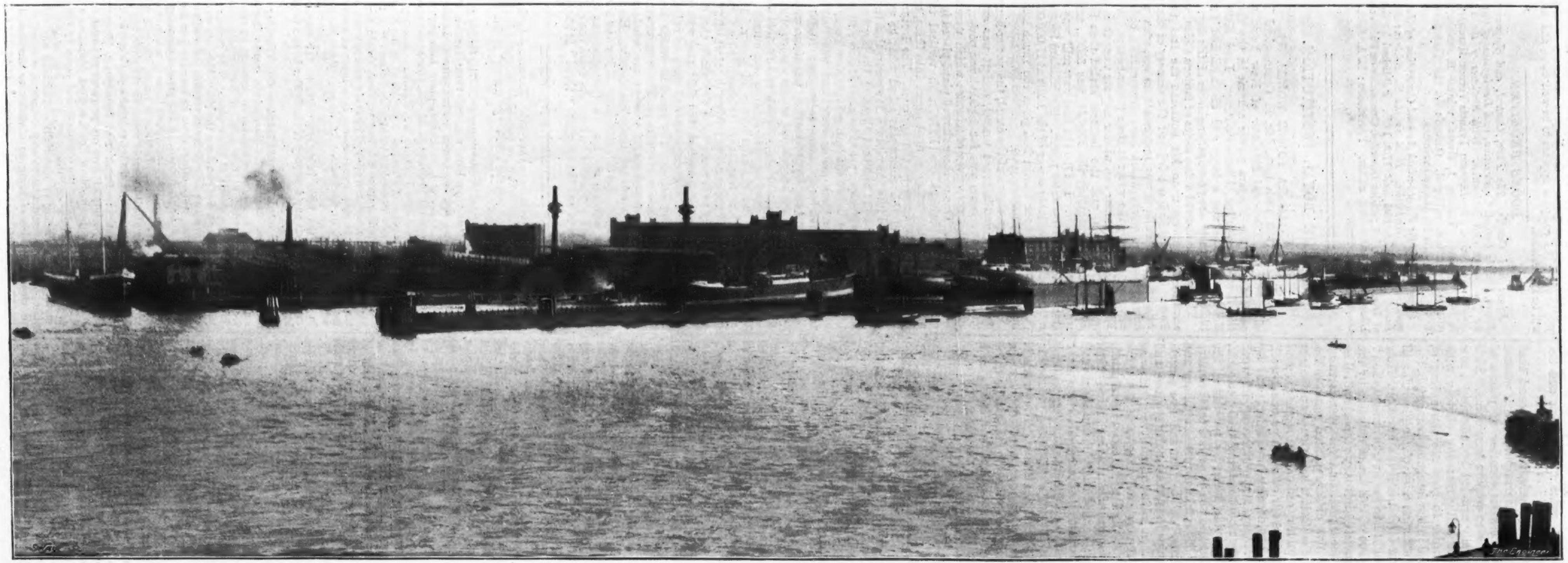
TRADE AND BUSINESS ANNOUNCEMENTS.—The Gandy Belt Company announce that they have removed their London house to larger premises at No. 97, Queen Victoria-street, London.—Mr. Charles E. Hogg, C.E., of 1, St. Helen's-place, Bishopsgate-street, sends notice of removal to offices at 34—36, Gresham-street.

A NEW METHOD FOR PULLING UP RAILWAY TRAINS, devised by Professor Koepeke, of Dresden, is employed on the Saxon State Railway, in the sidings used for making up trains. If a train or a single wagon, running down a falling gradient, should acquire too high a speed, the rails are allowed by lever action, which takes off their supports, to sink more or less in a layer of sand varying from 2in. to 5in. in thickness. Actual experience shows that a wagon or train is gradually brought to a standstill, the retardation in the case of the train being exerted on all the wagons simultaneously, without any tendency of the lighter to rise between the heavier.

OPENING TRIP OF LA MARGUERITE. — On Thursday in last week the Palace steamer, La Marguerite, made her opening run of the season to Boulogne and back. Starting by special train from Fenchurch-street at 8.35 a.m., a comfortable journey to Tilbury enabled the guests of the company to be on board shortly before 9.30. After a fast run down the river, Margate was reached about 12 p.m. With as little delay as possible those who wished to land went on shore, while others came on board to join the already large party so hospitably invited. A fast piece of steaming brought the passengers to Boulogne, where about three-quarters of an hour's run on shore was allowed. Returning home, Margate was again visited, and after an all too-rapid steam up the river, the arrival at Tilbury proved the end of a very enjoyable day's cruise.

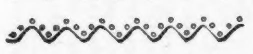
SOCIETY OF ARTS: PRIZE FOR INDUSTRIAL HYGIENE.—The Council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw Trust, a Gold Medal, or a prize of £20. The medal, under the conditions laid down by the testator, is to be given "For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means." Intending competitors should send in descriptions of their inventions not later than the 31st December, 1896, to the secretary of the Society of Arts, Adelphi, London, W.C. The judges will be appointed by the Council. The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the judges nothing deserving the full award is sent in.

GENERAL VIEW OF THE SHIPBUILDING WORKS OF MESSRS. BLOHM AND VOSS, HAMBURG



WORKS OF MESSRS. BLOHM AND VOSS, HAMBURG.

The engravings which we publish this week of the works of Messrs. Blohm and Voss, of Hamburg, give a general view of that establishment, and also a view of the machine shop for engine work. The principle upon which both engine shops and boiler-making sheds are constructed is like those of the Vulcan Works, at Stettin, a central aisle of great height running the whole length of the building, with travelling cranes crossing it at intervals, while the side aisles are fitted up with the most recent machines for planing and cylinder boring, lathes, shearing, &c., and, in the boiler part, special machinery and hydraulic tools for bending and flanging plates for boilers. The travelling cranes have a capacity of 30 tons each. All the boilers now under construction have ends with the flange outwards, as this facilitates the riveting by hydraulic power. The butt straps around the boilers are all cut with a deeply serrated edge, thus:



It distributes the bearing of the rivets over a larger surface, and prevents the curling up of the edges of the butt-straps. All the manholes and other large apertures are punched out with a huge vertical hydraulic press. Most of the boilers which we saw were of the double-ended type, and from 60 to 90 tons in weight. They were of 1¼in. steel. The motive power for the cranes is partly hydraulic, partly electricity. The cylinder boring and planing machines were of colossal size, and suited for the construction of a much larger class of machinery than any hitherto turned out in the yard.

Horseless Carriages in France.—*Le Gaulois* of the 19th inst. states that a Parisian company has ordered from the Compagnie des Forges et Chantiers, de la Mediterranée, two hundred horseless carriages. They will be worked by petroleum, presumably benzoline motors, and are all to be delivered by the end of the year. The last-received number of the French journal *La Locomotion Automobile* gives the names and addresses of several hundreds of dealers at whose premises light oils are on sale.

THE INSTITUTION OF NAVAL ARCHITECTS.

Our report upon the proceedings of this society last week left off at the conclusion of the reading and discussion of papers in the Aula, or Great Hall of the Technical High School at Charlottenburg, Berlin. It should have been mentioned that, owing to pressure of time, the reading of the paper upon "Weakness in Tank Steamers," by Herr Otto Schlick, put down for that day, was deferred to June 13th, not, however, by any means on account of its want of interest, but because it required time for due discussion.

After luncheon a few of the members proceeded to visit the works of Messrs. Siemens and Halske, for the construction of electrical machines for transmission of power and for lighting, which are at Charlottenburg. They were received with much courtesy and shown all over the establishment. A series of gigantic dynamos, for employment in the vicinity of Johannesburg in the Transvaal, especially attracted our attention. They were intended for transmission of power to mining and pumping machinery, and this was to be distributed over an area of twenty-five miles in extent. They were of the collective force of 12,000-horse power. They had somewhat of the appearance of the large wheel-like Ferranti dynamos, which have been erected at the Portsmouth and other electrical lighting stations, but they are of far greater power, and give off a continuous instead of an alternating current, so that the employment of separate rectifiers is not required.

The manufacture of the thin sheets of insulated iron strip, of which the field magnets for these huge dynamos was composed, was very simple. Broad sheets of iron, reduced to the required thinness, were passed between smooth rollers, upon which sheets of silk paper were wound. Paste was smeared over the silk paper just before the sheet iron entered the rolls, and the insulated sheets came out on the other side, ready, after drying, to be cut up into narrow strips for the purpose required, the silk paper adhering firmly to them.

Cables and insulated wire of every kind and description were in course of manufacture at these works, both for submarine and shore purposes. The methods of insulating and preserving cables has greatly varied during the past twenty-five years. At first it was accomplished by merely squeezing the wire under an hydraulic press, through a mass of soft gutta-percha, a coating of the latter being allowed to work its way out of the aperture through which the wire was drawn, and which accordingly surrounded the wire and adhered to it. Now insulation is carried on quite differently. The wire is first of all painted with an insulating composition, coated with a preserving envelope, again painted with composition, then covered with tape, two strips of which are wound round it diagonally off a large drum, and the whole is then painted again with composition. All this is to increase the certainty of absolute insulation.

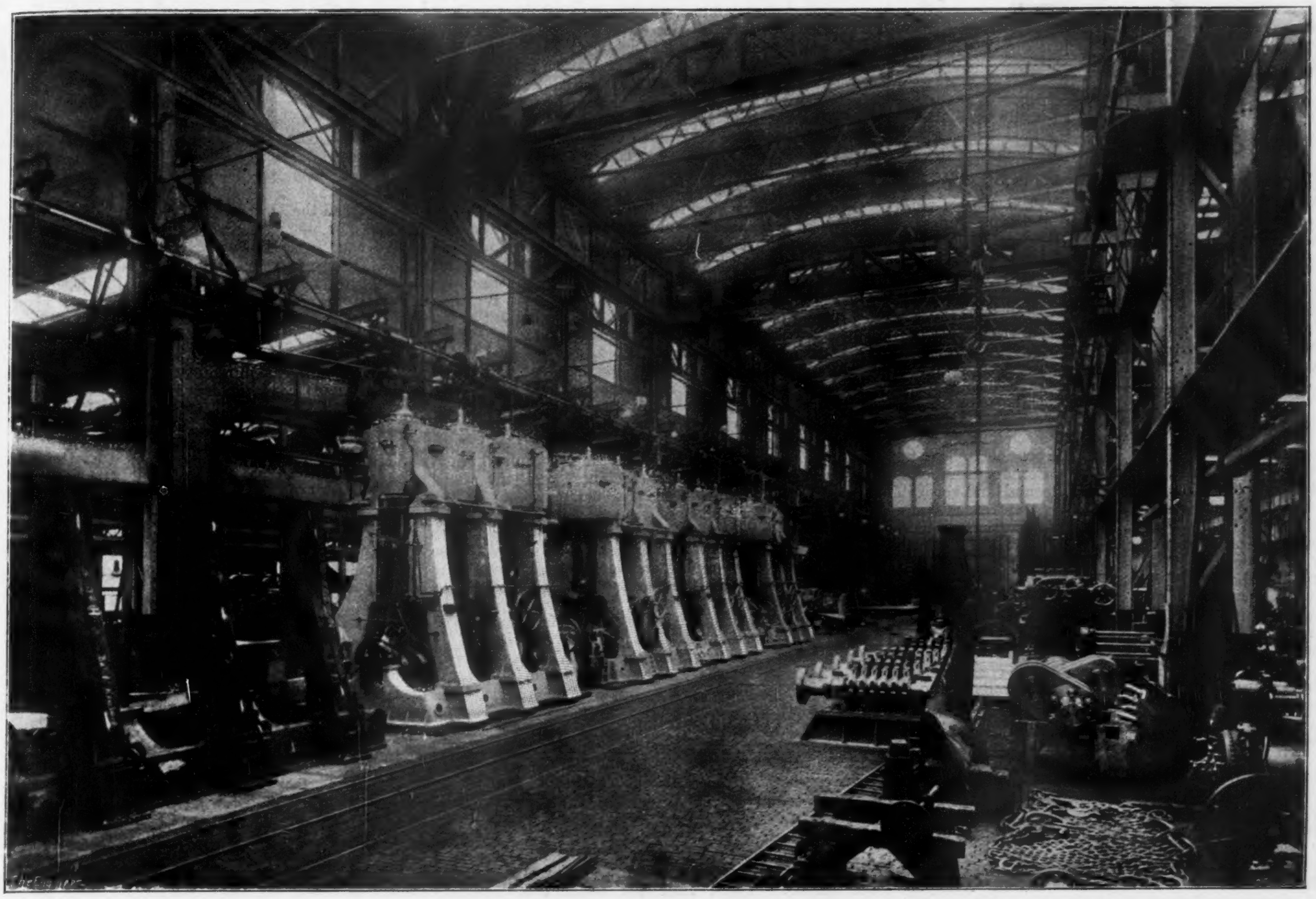
As, however, we propose to deal with the works of Messrs. Siemens and Halske separately in our columns, and to give illustrations of the various processes employed, we will now pass on to further events in the society's proceedings.

On Thursday evening the annual summer dinner of the Institution was held at the Hotel Kaiserhof, Berlin. The members of the Reception Committees at Berlin and Hamburg were the guests of the Institution. The kindly face of the Imperial Secretary of State for the Navy, his Excellency Admiral Hollman, literally shone with enthusiasm when he spoke of his personal "love of his Sovereign," whose health had been drunk with such a burst of cheering as surely never before shook the walls of the Kaiserhof Hotel. Then there was Herr C. Ferdinand Laeisz, President of the Chamber of Commerce, from Hamburg, whose courtesy and warmth of feeling had been displayed in ten thousand different acts of kindness, ever since the visitors had first stepped upon the Fürst Bismarck. Then there was Herr Kaselowski, General Director of the Berliner Maschinenbau-Actien-Gesell-schaft, who personally received us at his manufactory. Then there was the Constructor-in-Chief of the German Navy, Herr Dietrich, whose paper read in the morning had so excited and attracted our attention. Lord Hopetoun, as usual, set the example after dinner, in a few apt and emphatic sentences, of pointing to this occasion as one which went far to cement feelings of amity and friendship between two great nations. When he proposed the health of his Majesty the Emperor, alluding again to the honour that had been done to the Institution, the toast was received with unbounded applause.

After the reply of his Excellency the Minister, Lord Hopetoun, with the unanimous approval of those present, sent the following telegram to the Emperor:—"Lord Hopetoun presents his respectful duty to your Majesty, and begs to inform you that your Majesty's health has been drunk with enthusiasm." To this a reply was received by the Earl at the Kaiserhof Hotel later in the evening, which was shown to those members who were present:—"Whilst thanking you most warmly for your kind telegram, I would ask your lordship to tender my thanks to the Naval Architects, and to convey to them a most hearty welcome to my capital. I hope that the cordial reception which they have met with here has confirmed the truth of the saying that blood is thicker than water. It will, perhaps, interest the Constructor-in-Chief of her Majesty's Navy to learn that my yacht Meteor has by her fine lines beaten the Britannia by twenty-five minutes over a forty-two mile course." No opportunity was afforded to Lord Hopetoun of reading out the full text of the telegram to the assembled members till Saturday morning at the Exhibition Hall. It was there received with much applause.

The other speeches at the dinner were full of interest,

ERECTING AND MACHINE SHOPS—MESSRS. BLOHM AND VOSS' WORKS, HAMBURG



but we have no space to dwell upon them. Admiral Bowden Smith spoke as to the cordiality which had ever existed between officers and crews of German and English war vessels meeting abroad, and Mr. Dixon, in a most humorous speech, delighted them by the assurance that the Institute might expect a visit next year from its friends across the waters.

Friday was an off day until the evening, when the Institution was to have the honour of presentation to the Emperor at Potsdam. The entire morning was spent at the works of the Berlin Machine Works Company, Berliner Maschinenbau - Actien - Gesellschaft, formerly known as Messrs. L. Schwartzkopff and Co., famous for torpedoes. It is rather singular that the two great makers of torpedoes should have been "Whitehead" and "Blackhead." The work done at this factory is of the most varied and interesting character, the tools and machines employed are of the latest patterns, and they are worked by electromotors which receive power from a central station. The old shafting for steam power is still in its place in certain portions of the works, but is about to be removed entirely.

The electromotors which drive the various machines are arranged upon two different systems, according to circumstances. In some cases they are upon what is known as the "grouped impulse" system, when one motor works several machines; in other cases, the "single impulse" plan is employed. Both have their advantages. Most of the lathes, drilling machines, planing machines, slotting machines, milling machines, and other tools which we saw had an independent motor worked by power from the central station. A resistance switch with lever, which can accelerate or reduce the speed of the motor to any required extent, by putting it backwards and forwards round the periphery of a wheel, is attached to each machine. We personally tried many of these switches, and found that the control over the machine was perfect. In regard to the milling and slotting machines most of them were of duplex character, working from both ends of the beds, or at two points in a circle. We saw, for instance, as many as twelve or fourteen sets of axle-boxes for locomotives, all set end to end, being planed simultaneously, and side plates treated in this same manner. A large order for locomotives for Russia was in hand. The casings, for protecting the cylinders and cylinder gear from damage upon the rough lines employed in Russia, were very curious.

This firm is also employed in the manufacture of pumping machinery of an important character, and makes it a speciality; but the torpedo section and air-compressing machinery was that which perhaps interested the visitors most. The air-compressing engines were of the compactest make, quite different from anything that we have seen before. Phosphor bronze was the material of which the torpedoes were constructed, having a tensile strength of about 36 to 38 tons to the square inch. The engines are of the usual three-cylindered Brotherhood pattern, but there was a good deal of modification in the arrangement of the rudders and adjusting apparatus for the Schwartzkopff torpedoes, which were shown to the visitors. We observed that excessively thin discs of copper instead of india-rubber were employed in some cases for the hydrostatic valves.

The application of electromotors for the driving of machinery is, of course, quite familiar to the engineers of this country; but we do not think that in any English establishment it has assumed anything like the dimensions observable in the Berlin Machine-Works Company. But it is a question of the utmost importance. The immense rapidity of the work which has been done at Portsmouth and Chatham recently in the completion of the Prince George and other battleships has been very remarkable, and much of this rapidity has been due to the employment of electrically-worked drills, slotting machines, and other apparatus of a kindred nature.

On Friday evening a special train was provided to convey the members of the Institution to Potsdam. Here carriages were in waiting at the railway station to carry them to the palace, which was quite a short distance away. The park surrounding the latter, though very flat, like all the country in the vicinity of Berlin, is nevertheless beautiful. Groups of trees, with long avenues between them, stretching away into the distance, formed the background, as seen from the suite of magnificent apartments, and the terrace where the Emperor received the visitors at first. The Emperor did not keep his guests waiting a moment after the last arrivals had made their appearance, but, together with the Empress and the Princess of Hohenlohe, emerged upon the terrace, and after a graceful recognition of the members who stood around, the Kaiser was soon in his element, discussing shipbuilding with Sir W. White and other prominent members of the society.

As the day declined and darkness set in, supper was announced in one of the adjoining saloons, and the Empress and Princess retired, the Kaiser joining his guests in the supper room. Then the tramp of soldiers marching was heard, and a vast body of bandsmen, containing all the massed bands of the huge garrison of Berlin, was seen approaching the Palace through the great central avenue opposite the terrace. Each man was accompanied by a soldier carrying a magnesium torch; so the effect was splendid as they marched along to the rattle of drums. Then they deployed into a fan-like form around the rostrum which had been erected for the bandmaster, and a drum-major, of gigantic proportions, took up his position in front, and gave the time with his staff to the vast group of bandsmen.

Many familiar English tunes were rendered in an excellent style. But one feature particularly attracted attention. Just before the close of the military tattoo, whilst the fountains were streaming cascades of coloured light from the red fires which were burnt at intervals, there was silence for a moment. Then the Emperor bared his head, and all the vast assembly did likewise, whilst the trumpets softly rendered the old hymn, "Rock of Ages," that being now the national hymn of Germany. The roll of the drums increased in volume as the hymn proceeded, and at its conclusion, after three prolonged rattles, died gently away. Then all was over, and the tattoo was broken up. But the Emperor was not willing to see the last of his guests. When they had all been driven to the station, and the train was in readiness to depart, he drove down from the Palace and again waved his farewells from the railway platform. It was such an occasion as probably none of the visitors will witness again. We felt we were highly honoured. Not only as the members of an important scientific institution, but as the recipients of marked favour from one of the greatest sovereigns of the world, our position had truly assumed a national character.

On Saturday morning at 9.30 a m. special steamers conveyed the members of the Institution down the river Spree to the Berlin Industrial Exhibition, Treptow Park, by invitation of the President and Committee of the Representatives of Berlin Commerce and Industry. Steaming through the mercantile and business portion of the city suburbs, it was interesting to note the care observed in the arrangement of wharves and the great economy of space, land being exceedingly valuable here. On arrival in the Exhibition grounds the Institution was received in the amphitheatre by the President and Committee, and a short speech of welcome was delivered. Trade and industry recognised the influence of the Institution of Naval Architects. Perfect means of transport by sea had furthered the spread of civilisation. Lord Hopetoun replied, pointing out how shipbuilding, by spreading geographical knowledge, brought nations together; our Institution was working in that direction.

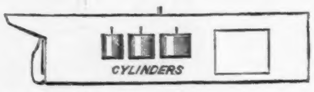
A paper was then read by Herr Otto Schlick, on "Signs of Weakness in Tank Steamers." This we publish elsewhere. It points out the fact that the position where tank steamers of ordinary construction may be expected to exhibit signs of weakness can be predicted to a nicety. It is marked in Fig. 1 with the letter A. The weakness is clearly, from its position, not due to longitudinal bending. Probably the great vibration in tank steamers has something to do with it. The paper went on to show the remedies which should be adopted.

In the discussion which ensued, Mr. Swan thought that the trouble with tank steamers had been often due to their injudicious treatment by the captains of them. Casting water adrift in the compartments was a sure way of loosening the partitions and rivets. Another speaker considered that water ballast was bad and corroded the rivets, so that they could not resist the strain and action of the oil.

Mr. Martell thought that Mr. Schlick deserved a vote of thanks for his excellent paper. It had somewhat surprised him. He was sorry that the particular vessels in which "shearing" had been noticed were not indicated. He thought that the weakness observed was due to the "panting" of the sides where vibration was greatest. The remedy appeared to be simple and should be applied at once.

Sir W. White remarked that the matter had been thoroughly taken up at the Admiralty, and the necessary calculations as to the strength of sides to resist shearing had been worked out. In old wooden ships which were subjected to great shearing strains the sides were strengthened with dowelled framing. He fully agreed with Mr. Martell that the shearing action in tank steamers was probably due to panting.

Mr. Otto Schlick, in replying, sketched the afterpart of a tank steamer upon the blackboard, showing that Mr. Martell's remark was most applicable, the position of the cylinders in these vessels—where, of course, the vibration must be greatest—being just opposite A in the figure.



Mr. Martell's paper on "Various Descriptions of Doors applicable to Water-tight Bulkheads" was then read. He considered that the question of the efficiency of water-tight bulkheads, as regards strength, was settled. The object of his paper was confined to drawing attention to the various plans which had been proposed and adopted for protecting openings through these bulkheads.

Mr. Dutton thought that the most effective form of water-tight door was not to have any at all. Mr. Gearing gave his own experience in driving a steamer across the Atlantic without permitting any of the water-tight doors associated with the engine and boiler-rooms to be opened. It was quite possible to do without them. It was merely a question of method and discipline.

Lord Charles Beresford would like if possible to have no doors at all. In the British Navy the patterns of doors could not be worse than they are, both horizontal and vertical. The belly of the ship should have no water-tight doors which cannot be closed from the deck. He agreed with Professor Elgar that a ship should be reasonably safe after a blow from a shell or a torpedo. He hoped that their able Director of Naval Construction would note what was being said.

Sir W. White said it was always a pleasure to follow Lord Charles Beresford. He should not retire from a single statement which he had made in the spring upon this subject. Since then he had had a cruise in the Channel Squadron. Naval officers generally did not share the opinion of Lord C. Beresford. At the Admiralty the best was done to meet the views of both sides—that of the naval constructor and that of the naval officer. The normal condition of water-tight doors should be closed. An imperative order to this effect has been issued by the Admiralty. A warm discussion as to this order took place. After the loss of the Vanguard voluminous experiments were made. Sir N. Barnaby invented a door which was to effect wonders. When fitted to the Inflexible it was found on a special occasion to refuse to work as a chock of wood was jammed into it. Discipline could effect more than alteration of door patterns. But, if considered necessary, why did not Lloyd's institute experiments with a view of deciding upon the best patterns?

Sir E. J. Reed said it is impossible to relieve Sir W. White from his responsibility as to the construction of water-tight doors. He must be responsible to beat down the demands of naval officers if too great. We want as few doors as possible. Lord C. Beresford should convert naval officers to a better opinion as to the consulting of their own convenience and that of their crews. We have recently received an object lesson from his Majesty the Emperor in this respect. He did not consult his own convenience last night in bidding us farewell at the station at Potsdam, when he had to be at the Templehof, Berlin, at 6 a.m.

Admiral P. Fitzgerald considered that the question was misunderstood. He utterly disagreed about converting naval officers to opinions other than their own. Naval officers must be consulted as to the arrangements of their ships; it is they who go down in the ships, not the naval architects. There is no parallel between the circumstances of mercantile steamers and those of warships.

Mr. Martell replied, and the discussion closed.

Herr F. Eickenradt then read a paper upon the "Use of Electricity on Board Ship." He considered that electricity had many advantages as a motive power on board ship, more especially perhaps as it admitted of a number of auxiliary engines placed in remote parts of the vessel, and whose connection with the boilers by pipes was most inconvenient, being driven by power from a dynamo. For ventilation, too, it was an excellent means of propulsion, as fans could be easily fitted, and heat was kept away. For winches it had already been adopted very generally with considerable success. Steering apparatus worked by a motor was difficult to arrange, but the difficulty might be got over in time.

Several speakers, including Sir W. H. White, spoke as to the value of the paper which had been read, and the writer briefly replied.

A cordial vote of thanks to Admiral Hollman and the Reception Committee was then proposed by Lord Hopetoun.

Admiral Hollman replied: "We are glad that you have found time to come over. We get the benefit of it. We are also delighted to see so many English ladies amongst us. Remember us kindly when you return home."

An excellent repast was then set before the members at the chief restaurant of the Exhibition Park, kept by Messrs. Adlon and Dressel, the Committee being untiring in their attention to our comforts. After all had enjoyed a hearty luncheon, there were the gardens and exhibition to explore. These are as yet somewhat incomplete, but promise to be a most important institution for the display of the industry and trade of Berlin later on.

On Monday morning all who had not been obliged to leave earlier started in a special train of corridor carriages, kindly provided by the Vulcan Company, for Stettin. Several representatives of the company were in the train, as well as other members of the Reception Committee, and the German Director of Naval Construction. On the arrival of the members at the railway station, Stettin, they were conveyed in special steamers at once to the Vulcan Works, and a large number of the staff of the establishment accompanied them round, explaining all objects of interest as they proceeded. The two great Atlantic liners, of 17,500 tons displacement each, were the first attractions exhibited. Then, close by them, was the keel of the new monstrous liner of 20,500 tons displacement—already rather more fully advanced than our engraving of June 12th showed—together with a considerable portion of its bracket bottom framing. The latter is about $1\frac{3}{4}$ metres in depth over the keel. Further on the visitors came to the engines for the great vessel, which are almost advanced to completion, in one of the erecting sheds. The engines for the other two liners are ready to be put into the ships.

On other building slips two large cruisers for the German Navy were to be seen in course of construction; their dimensions and various features were given in the paper read by Herr Dietrich, which was published in THE ENGINEER for the 12th of June. Three cruisers for China were also being built, and as their dimensions have not as yet been published, we will give them here. Length, 328ft.; beam, 41ft.; draught, 27ft. 7in.; displacement, 2950 metric tons; indicated horse-power, 7500; speed, $19\frac{1}{2}$ knots. Armament: three 15 cm., eight 10·5 cm., six 8·7 cm., all quick-firers; six Maxims; three torpedo tubes; armoured deck. The excessive draught will be very noticeable. After seeing the ships the visitors went through the various shops. These were fitted with the most recent patterns of milling, cylinder boring, planing, drilling, and other machines, and the sheds were very similar in plan and arrangement to the engine and boiler factory of Messrs. Blohm and Voss at Hamburg, a huge central aisle, with travelling cranes working up and down it, being flanked by side aisles for the heavy machines used in erection. The boiler-making plant was especially fine, and the arrangements for drilling rivet-holes and riveting by hydraulic power on even a more colossal scale than at Hamburg. The general appearance of some of the shops may be seen by a reference to our engravings of the Vulcan Works in THE ENGINEER for the 12th of June. The energy and enterprise displayed by this firm will be understood when we say that they have had enormous difficulties in creating a shipyard. The river is so narrow that the ships have to be launched diagonally and restrained with the utmost care, or they would in launching break into the opposite bank. The huge "liner" just commenced has a cofferdam built right out into the bed of the river around its stern. Without this a large part of the stern would be in the river.

After viewing the yard and shops, the members were driven off in carriages up to the town hall, where luncheon was served. Then, after the usual complimentary speeches, the members were again driven to the railway station, and started for Berlin, amidst a storm of cheers from our party for the directors and employés of the Vulcan Works, who were waving their farewells to us from the platform.

Thus ended the visit of the Institution of Naval Architects to Germany, a visit which was not merely an exchange of courtesies between the members of two great scientific bodies in Germany and Great Britain, but one in which our brotherhood in the great Teutonic race was emphasised by the genuine cordiality and kindness of our hosts, so emphatically, that its effects cannot fail to be lasting upon our memories and upon our hearts.

To H. E. Dr. von Bötticher, Secretary of State; to H. E. Admiral Hollman, whose genial hospitality cannot be forgotten; to Herr Dietrich, Constructor-in-Chief; to the active and energetic chairman of the Hamburg Chamber of Commerce, Herr C. F. Laeisz; to Herr John Meyer, and the directors of the Hamburg-American Line, through whose courtesy the voyage across was rendered delightful; to Herr Kaselowski, Director of the Berlin Machine Works Company; to Herr Hermann Blohm and Herr Ernest Voss; to Herr H. Stahl and the courteous establishment at the Vulcan Works; and to all who so warmly furthered the efforts of the Reception Committee our thanks are due. Lord Hopetoun's tact and his interest in all that has been going on has drawn most closely to him the respect and admiration of every member of the society. The Institution owes a debt of gratitude to Mr. S. Holmes for the pleasantest and most successful expedition that has ever been undertaken.

THE NORTH-EAST COAST ENGINEERS AT CARDIFF.

THE North-East Coast Institution of Engineers and Shipbuilders has visited Cardiff and Newport this week, in response to a very cordial invitation. This is, we believe, the first time that the Institution has gone so far south; but there is good reason for saying that the visit will be repeated. It will certainly not be the fault of their Welsh hosts if the members do not find their way again south. Nothing can exceed, indeed, the warm hospitality extended by the shipowners and engineers of Cardiff and Newport to their northern guests.

The proceedings commenced on Tuesday, when Lord Windsor, Mayor of Cardiff, invited to breakfast at the Angel Hotel the members of Council of the Institution, the Committee of Management, and a few selected guests. Subsequently Lord Windsor received in the Town Hall the great body of the members, presented by Mr. C. A. Heywood, Chairman of the Executive Committee, who made a very short and excellent little speech, in which he said that engineering and shipbuilding together had made Cardiff, and that the city was bound up in interest with the northern ports, wherever the ships were constructed that did the trade with Cardiff. Lord Windsor, in reply, said that one of the pleasantest duties of a mayor consisted in extending hospitality. He referred to the greatness of the coal industry of South Wales, and the important part which had been played by northern shipbuilders in producing the vessels which enabled their trade to be carried on. Shipbuilders would keep England in the fore front. He trusted that the visitors would enjoy themselves. He referred to the proposed visit to Newport, and he assured his hearers that there was no ground for jealousy among the Welsh ports on the Bristol Channel. Mr. Thomas Richardson, M.P., as past president of the Institution, replied. He thanked Lord Windsor for the great honour conferred on the Institution. Cardiff had been an excellent customer for the North, and he was glad to see the relations between North and South strengthened by such a visit. After a few well-chosen words of welcome from Mr. Gunn, the party proceeded to the Great Western Railway Station, where a special train had been provided to convey the visitors to Newport. The train started at a quarter past eleven, and reached the Alexandra Docks, Newport, a little before noon. The members were received, in the unavoidable absence of Lord Tredegar, by Mr. Albert Spicer, Mr. T. E. Watson, president of the Newport Chamber of Commerce, and other members of the local reception committee. The most interesting feature about the docks is the way in which hydraulic power has been used for every conceivable purpose. There are six pumping engines in various places, and these deliver water through miles of piping at a pressure of 700 lb. per square inch. The arrangements for hoisting and tipping coal wagons are extremely complete. One ship recently took in a cargo of over 11,000 tons in thirty-six hours, a feat which is, we believe, unprecedented. A number of brakes were in readiness, and conveyed the visitors, first to the works of the Uskside Engine Company, a very old place, yet turning out excellent machinery, and largely employed just now in the production of the smaller class of winding engines. Thence the party proceeded to the dry docks and shipbuilding yard of the Mordey Dry Dock Company, where there is much work in progress. Thence the party proceeded to the electric light works of the Municipality, a very fine installation, of which we shall probably have more to say. The current is supplied by five Hall alternators, each taking about 120 indicated horse-power, rope-driven each by one compound engine, by the Uskside Engine Company. The engines are compound. Steam is supplied by four large Lancashire boilers, fired by Proctor's mechanical stokers, and fitted with Meldrum's induced air current. A Worthington separate condenser deals with all the exhaust steam. Current is generated at 2000 volts, and let down on the consumers' premises to 100 volts. There are now about 9000 lights on, but the number is rapidly augmenting.

From this the company proceeded to the Tredegar Hall, where an admirable luncheon was served, and after some very short and very good speeches the whole party went on board the Lady Margaret paddle steamer, a very fine vessel of the Clyde type, and were conveyed down the Usk to Cardiff and Penarth.

On Wednesday morning the members of the Institution were conveyed by special train from Rhymney Station, Cardiff, to the Dowlais Steel Works, where about an hour and a-half was spent. The visitors were received by Mr. Martin, who is President of the South Wales Institute of Engineers. It would obviously be impossible to say much in the way of description of these works within the limits of space at our disposal. They are probably the most perfect works, taken all round, in Great Britain, and the output of the two furnaces at present in blast is largely in excess of that of any other furnaces in the kingdom. The pressure of blast is $5\frac{1}{4}$ lb. on the square inch, and the limit of output is the capacity of the men employed in charging. All the ore used is Spanish. As it is delivered in the works it is raised by water-balanced lifts and stowed in huge cylindrical bunkers. From the bottom of these it is run into the charging barrows, which are raised to the top of the furnaces by water-balance lifts. Handling the ore is reduced to a minimum, as will be understood when we say that one man deals with about 120 tons per day of twelve hours. These men are paid by the ton, and earn good wages. They are picked men. During the visit one of the furnaces was tapped, and it may not be without interest to say that not long since a steamer came in with a cargo of ore, and took away as her return cargo the same ore converted into pig iron. We have before now referred to the arrangements for handling the pig iron, and we hope to have more to say on the subject in an early impression.

From the blast furnaces the visitors proceeded to the steel works. Nothing but open-hearth steel is made, and the appliances are all the most recent and on the best principle. A 40-ton heat was tapped, and then a seven-ton ingot was taken from the soaking pit and passed on to the cogging mill, and thence to the plate mill, and rolled into a couple of large boiler plates. The rolling and cogging mill engines, by Daniel Adamson and Co., are splendid examples of mechanical engineering, and the tremendous pace at which the plate mill engines are run excited no small surprise among the visitors. We believe that they are run at the highest speed yet attained by reversing rolling mill engines of their size. They have 48in. cylinders and 5ft. stroke. All the arrangements for handling the ingots by hydraulic power are very perfect, and in many respects novel. We regret that for the moment we must rest content with this brief mention of them.

After Mr. Richardson, M.P., had expressed the thanks and gratification of the visitors in a graceful speech delivered from the step of one of the railway carriages, the train proceeded to the Bute Docks. To walk round there is to learn that Cardiff has one export trade—and one only—coal. Everything is arranged for coal. We had almost said that everything is sacrificed to it. It is not exaggeration to say that the visitors saw thousands of trucks of coal on the acres and miles of sidings awaiting shipment. As one man said, "Why they are sending Wales away." The centre of attraction was, however, the new dry dock being constructed by Messrs. S. Pearson and Co. for the Cardiff Channel and Dry Docks

Engineering Company. We have on more than one occasion referred in some detail to the improvements being effected in Cardiff. The dock in question is being constructed at the head of an artificial basin, an excellent bird's-eye view of which can be obtained from the heights of Penarth. The dock commences by a junction with the existing Roath Dock at its south-western corner. A communication passage runs from this point for about 700ft., with a width of 80ft., and for a further length of 700ft., with a width of 300ft. The level of the sill of the communication passage will be the same as the sill of the Roath Dock, *i.e.*, 43ft. 6in. below coping. The length of the proposed new dock will be 2570ft., and its width 650ft., with a depth of 46ft. 6in. below coping. The area of this dock is 42 acres, being nearly as large as the Bute East Dock, and 33 per cent. larger than the Roath Dock. The entrance lock will be 700ft. in length between the gates, its width at gates 80ft., and the remainder 160ft. wide. The length of the entrance lock will be double that of the entrance lock to the Roath Basin. The level of the sill will be 50ft. below the coping, which is 6ft. 6in. below the deepest existing sill at the Bute Docks, and 7ft. below the sill of Penarth Dock. The increased depth of sill will give a depth of 5ft. of water at low water of spring tides, and 15ft. of water at low water of neap tides, so that vessels will have little or no time to wait for the tide in entering or leaving the dock, thus saving anchoring in the roads, and avoiding necessity of waiting for higher tides. The depth of water over the sill will be 32ft. at high water of ordinary neap tides, and 42ft. at high water of ordinary spring tides. For the protection of the entrance to this dock from easterly or south-easterly winds, an embankment 1800ft. in length, forming the basin to which we have just referred, is being constructed. This embankment will make a splendid shelter, with smooth water for vessels entering or leaving the docks during south-easterly winds. From other winds the entrance to the dock will be protected by Penarth Head and the other high lands running north and west of Penarth. The entrance is situated nearly a mile below the East and West Dock entrance, and thus vessels for these docks will not interfere with those making for the other entrances to the Bute Docks. It is intended to lay out and equip the dock with all the latest and most improved machinery for dealing expeditiously with both imports and exports. The north side of the dock will be reserved for the import trade; and sufficient room will be found here to double the existing import capacity of the Bute Docks. The railway communications will be most convenient; and ample storage and warehouse accommodation, equipped with all the latest appliances, such as hydraulic machinery, cranes, and elevators, are provided for. The south side of the dock will be laid out for the shipment of coal by Messrs. Lewis and Hunter's patent coaling cranes, with the necessary sidings for continuous shipment into three or four hatchways simultaneously once vessels are in berth. The Great Western, Midland, London and North-Western, Rhymney, Taff Vale, and other railway companies have direct access to the dock, and the import traffic can be taken straight away from the dock side to any part of the country.

For the purpose of enclosing a sufficient area of foreshore to allow of the dock being constructed with the least possible delay, the embankment has been commenced, and although the work has only been started between four and five months, very remarkable progress has been made. Two lines of railway have been joined the whole way round, the length of each being more than a mile and a-half, and over a thousand tons of slag and ballast is cast out from trucks on these railways every day. Altogether, 150,000 tons have already been discharged, and it is anticipated with confidence that the embankment will be completed, and the foreshore to an extent of nearly 300 acres enclosed, in less than another twelve months. The mode of constructing the embankment is in three sections, an outer and inner bank of heavy ironwork slag, which settles down gradually in the mud, and is not easily washed away, and the centre is formed of ballast and clay to make the whole water-tight. The estimated cost of constructing the dock and embankments, exclusive of equipment, is nearly three-quarters of a million pounds.

When computing the capacity of docks for handling freight, regard must be had to the improvements which are continually being made in the means of lighting the docks, of loading and discharging and transhipping cargoes, and in other respects. For example, a steamer has taken away from the Roath Dock 9234 tons, this huge quantity being put in by several of Messrs. Lewis and Hunter's patent coaling cranes working simultaneously in the short space of twenty-eight hours. By means of hydraulic cranes very quick despatch is given to vessels arriving with cargoes of iron ore, &c. Vessels can be unloaded at the rate of 50 tons an hour per crane, and frequently vessels of over 2000 tons are discharged in fourteen hours. Since the starting of the blast furnaces of the Dowlais (Cardiff) Steel Works, iron ore arriving at the Roath Dock has been discharged, taken to the furnaces, converted into pig iron, and sent away in less than twenty-four hours. A cargo containing 1020 standards of deals was discharged a short time ago in fifty-eight hours. This is only one example of quick despatch. On the east side of the Bute East Dock a large grain warehouse, seven stories in height, has just been completed, and this building has been fitted by Messrs. Sir W. Armstrong, Mitchell, and Co. with their latest machinery for elevating and loading grain, hoisting and distributing on the various floors as required. Altogether, accommodation is provided for the storage of about 600,000 quarters of grain. The cellars of one of the warehouses at the Bute Docks, Cardiff, are used by H.M. Customs, and form the largest floor used for a bond under one roof in the United Kingdom. There is at present stored there a large cargo of rum, containing 150,000 gallons, which is being sent to all parts of the country.

The Bute Docks Company, taking into account the increasing size of vessels, are, in renewing its coal shipping staiths, making them of a greater height, so that the largest vessels may be loaded at any of them.

The cofferdam timber work of the new dock is worthy of special attention. It is one of the finest pieces of work of the kind ever carried out.

After the works had been inspected the visitors were provided with an admirable luncheon by the Cardiff Channel Dry Dock Company, and Messrs. Pearson. Mr. J. Cory, M.P., was in the chair, and some excellent speeches were made by Mr. Cory, Mr. Richardson, Colonel Guthrie, Mr. Radcliffe, Mr. Squire, and Mr. Blow. The visitors then were left to their own devices, many of them going to the Exhibition until the evening, when a smoking concert was given in the Park Hall by the President and members of the Bristol Channel Centre of the Institute of Marine Engineers.

It will not have escaped notice that we have said nothing on the subject of papers. Two, however, were read on Thursday—yesterday—forenoon, one on "The Maintenance and Repair of Marine Boilers," by Mr. J. F. Walliker, and the other on "Coal Consumption," by Mr. Fothergill. We must postpone our account of these until a future impression.

Subsequently the Barry New Dock was visited. Of this we need say but little, it has so recently been described and illustrated in our pages.

THE FOUDROYANT.

ON Saturday afternoon a number of ladies and gentlemen were taken by special steamer down the river to Woolwich, for a private view of the Foudroyant. Most of our readers have, perhaps, seen the Victory lying in Portsmouth harbour, and, if not the real ship, then the model at the Naval Exhibition at Chelsea. The Foudroyant—the Thunderer—is far more interesting than the model of the Victory, and is, indeed, in some respects more attractive than the Victory herself.

She is one of a very favourite class, a two-decker carrying eighty guns. The Victory is a three-decked ship. The Foudroyant, laid down in Plymouth in the winter of 1789, and launched in the spring of 1798, is named after and closely follows the lines of a French ship of the same name, captured by the Monmouth in 1758. She is a combination of an old and a new type. She has a lower deck extending from stem to stern, mounting thirty 32-pounder cast iron guns. On the main deck, also extending from stem to stern, she mounts thirty-two 24-pounder cast iron guns. The waist of the ship is open, and on the deck beams here were stowed all her boats and her spare spars and booms. The quarter deck extends to the open waist, and is therefore very long. On each side are mounted seven cast iron 12-pounders, on the forecastle are mounted four of the same 12-pounders, and two carronades, 32-pounders, very much out of place on the forecastle. Indeed, they were probably intended for sweeping the ship's own deck with grape, if she were boarded, or for clearing an enemy's deck for boarders in the same way. She has, furthermore, a very high poop, mounting three 18-pounder carronades on each side. The bow of the ship is very old-fashioned—much more so than that of the Victory—and the bowsprit is set with a great rake, and is provided with a spritsail yard, and carried a spritsail. Her bottom is beautifully moulded, and it is said that with a stiff breeze, all plain sail and weather sternsails, she could sail 14 knots. She was, no doubt, one of the fastest ships of the class in the world, if not the fastest.

Most old men-of-war having any spars at all, have jury masts about half the proper size, but the Foudroyant has been fully sparred, save that she has no royal masts. The enormous lift of her topsails is thoroughly French. The lower masts now in her are of iron, and rather less in diameter than the built-up wooden masts. The original mainmast was 3ft. in diameter. The rigging is all, with a very few exceptions, of hemp, and enough of her old blocks existed, or were forwarded from other ships, to suffice for her refit. She is quite sound, notwithstanding her great age, having been built of the right kind of English oak. The work of restoring her has been carried out by Mr. Shuttleworth, at Erith, Mr. Ratsey, jun., son of the eminent yacht builder, being placed in charge of the work. It has in all respects been admirably carried out, and we strongly advise all those of our readers who have the opportunity to visit the old ship.

As to how the Foudroyant got to Woolwich, we cannot do better than quote from a pamphlet supplied to the visitors on Saturday:—

"On the 11th August, 1892, there was quietly towed away from Plymouth Harbour what was, with a single exception, the most famous ship of the British Navy that has survived to the present day. A voyager down Channel, meeting the stately old line-of-battle ship in tow of a tug, travelling eastward in the glow of a summer evening, would have been reminded of Turner's "Fighting Téméraire," and have guessed that this, too, was the last voyage of a blind and helpless warrior. How vastly would the interest and pathos of the sight have been increased had he known that the ship before him had been launched in the same year as the Téméraire, that she had carried the flag of Nelson as commander-in-chief in the Mediterranean, that she had been the home of a king and queen, the latter the sister of Marie Antoinette, that to her had struck the only two line-of-battle ships that had escaped the clutch of Nelson at the Nile, and that on board her had expired a hero of the sister service, who died like Nelson in the arms of victory, the good and gallant Sir Ralph Abercromby.

"Even this, however, was not all. It would still have remained to be told that the ancient craft, freighted with so many memories, was not, like the Téméraire, passing to an honoured end on the shores she had so well defended; but that, after passing out of the hands of the Admiralty, she had been sold to a foreigner, and was on her way to a German port to close her career in exile and ignominy, forgotten by the countrymen of Nelson.

"In no other navy could a ship have been found with such a record. In no other country, it may be added, would she have been allowed to meet with such a fate.

"Happily, before her doom was sealed, the facts relating to her were made public, and it was seen that at all hazards so ignominious a fate must be averted. That a favourite ship of our greatest sea hero should come to such an end was felt to be nothing else than a national disgrace. Every newspaper in the country demanded her rescue, and Mr. Conan Doyle's spirited verses, and Mr. Linley Sambourne's cartoon in *Punch*, gave expression to the universal feeling that the Foudroyant must be saved. The Lord Mayor expressed his willingness to open a Mansion House Fund for the purpose of buying her, but time did not admit of this, and when the German owner telegraphed that the demolition had been commenced and would be proceeded with unless the price he asked were at once forthcoming, the amount was privately paid and the ship was forthwith towed back to the Thames."

It is to be noted that as a typical ship of the Nelson period the Foudroyant holds a place not second to that of the Victory herself. At the time when she was the great Admiral's flagship, the Victory was an old ship, and small for a first-rate, and only her splendid sailing qualities kept her in commission. The Foudroyant, on the other hand, was a new ship of a very formidable type, combining the fighting power of the 98-gun three-decker with the cruising qualities of the 74-gun two-decker. The 80-gun ship of 1800 occupied, in fact, the place filled by the Renown, Barfleur, and Centurion in the navy of to-day.

The following are the principal dimensions, &c., of the Foudroyant:—

	ft.	in.
Length of gun-deck	183	8½
" keel	151	5⅝
" over all	219	0
" on water-line	193	6
Breadth extreme	50	7¾
Depth	22	6
Draught forward	23	4
" aft	25	7
Height of midship port above water	5	3
Tonnage B.O.M.	2062 tons.	
Displacement, probably about..	3500 tons.	
Number of crew	713	

In about ten days she will sail for Kiel Maritime Exhibition, and subsequently she will visit Dublin and various other ports. Then once more will be seen that splendid spectacle, once so dear to the hearts of all Englishmen, a line-of-battle-ship under full sail.

ON SIGNS OF WEAKNESS IN TANK STEAMERS.*

By HERR OTTO SCHLICK, Member.

IT is generally known that signs of weakness in steamers mainly appear near the midship section, and it is generally only here that loose rivets in the butts of sheerstrake and upper-deck stringer plates, or even cracked plates appear, and this perfectly agrees with the theory of strength.

It must, therefore, naturally surprise us if analogous symptoms manifest themselves in the ends of ships in such strakes of the outside plating as are about in half depth of the vessel.

This is, in fact, frequently noticed in tank steamers. Experience has shown that in many tank steamers the riveting of butts and longitudinal seams which are situated about half-way of the depth of the hull and pretty near the after end get loose, and that in certain places the outside plating is torn right through.

This occurs with such regularity that it is possible to fix in advance the exact spot where, in the course of several years, the outside plating of certain tank steamers will tear. The place where this generally happens is marked in Fig. 1 with the letter A.

The crack at first generally becomes observable in a rivet hole, and very soon extends over the whole width of the plate. It occurs always exactly in the place where the frames change their convex shape into the concave; in other words, where they form a nearly straight line, and consequently have their greatest rigidity—see Fig. 2.

Fig 2

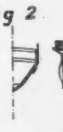


Fig 1.

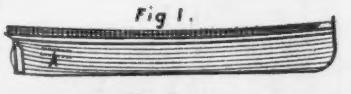
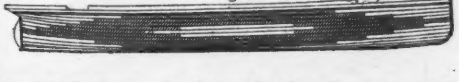


Fig 3.



The fact that the cracking of the plates occurs at a great distance from the midship section, and that this is regularly the case in that strake of outside plating situated at about the half depth of the ship, plainly shows that we have not to deal with the tensile strain produced by longitudinal bending. One must indeed necessarily come to the conclusion that it is here simply a question of the shearing forces which occur in the longitudinal seams of the plating.

It is notorious that in a loaded girder supported at both ends the shearing forces have their greatest effect at the extremities and in the neutral axis; nearly the same applies to a ship's hull. There is only this difference, that the maximum shearing forces are not at the extreme ends, but that these take effect at a larger or smaller distance from the ends, according to the distribution of weight in the longitudinal direction, and to the fineness of the lines, but the maximum shearing strain always exists at the level of the neutral axis.

In wooden vessels it is the wrinkling of copper sheathing that shows the effects of the shearing forces; in iron or steel ships the symptoms of weakness produced by the same cause are nearly unknown, except in the cases mentioned above.

In the cases which have come under my observation the strakes of the outside plating were of an exceptionally great width—over 5ft.—and it is to be assumed that this has something to do with the cracking of the plates; for, as theory teaches us, the shearing forces occurring in the longitudinal seams gradually increase with the greater width of the plates.

Very likely the strong vibration in tank steamers helps towards the cracking of the plates. The fact that similar symptoms have not hitherto been noticed in the forepart of ships—or only to a small extent—is explained, partly by the smaller strain which occurs in the forepart of the ship, and, on the other hand, by the greater thickness of the bow-plates, which latter, in the cases considered here, are mostly thicker than usual, in order to form a strong bow against ice.

The symptoms just named in every way confirm theory, and we can conclude therefrom that it is not always permissible to leave the effect of the shearing forces entirely out of consideration, as has been generally done up till now.

Indeed, I believe that, in view of the continuous increase of the dimensions of ships, we must not, in future, neglect to give our attention to this point.

The conclusions to be drawn from these observations with regard to the construction of ships exposed to heavy strains are the following:—In the first instance, it will be useful to have the treble riveting of the butts which are situated in half the vessel's depth extended more towards the ends of the ship. Formerly double riveting was considered of sufficient strength. The extension of treble-riveted butts towards the ends will be particularly required in every case where exceptionally wide plates are used. The classification societies generally prescribe a stronger riveting of the butts whenever the breadth of the plates surpasses a certain limit.

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*Read at the summer meeting of the thirty-seventh session of the Institution of Naval Architects, 13th June, 1896.

It is evident, however, that in doing so the prevalent intention was to avoid the diminution of the strength at the middle of the ship arising from the use of broader plates.

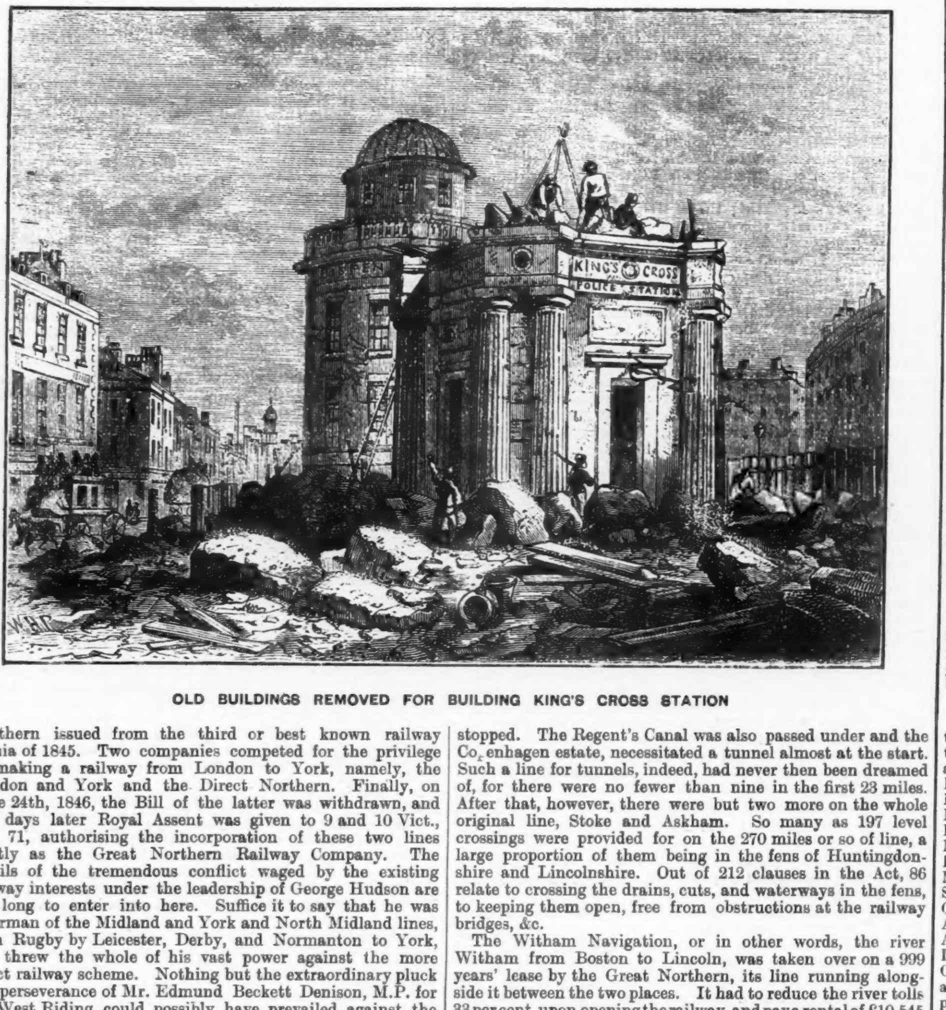
Whenever, in a ship, saving of weight is one of the most important points in the design, only single riveting for the longitudinal seams and double riveting of the butts of those strakes situated at the half depth should be permitted, but only for a certain distance in the middle of her length. But at the ends the riveting of the longitudinal seams should always be double, and treble in the butts. We further learn from these observations that it does not appear practicable to reduce the thickness of the strakes which are at half the height of the ship towards the ends. If looked upon from a merely theoretical point of view, it is advisable to arrange the thickness of the outside plating as illustrated in Fig. 3. The hatched part indicates the plates which are exposed to the greatest strain, and the thickness of which ought to be in consequence as large as possible, and the riveting as strong as possible. The doubling of the outside plating as a means for obtaining a greater strength in the direction of the longitudinal axis seems admissible only—for the reasons already given—in the upper and lower plating, because the shearing strain between two adjoining strakes of plating is here inconsiderable. At the ship's ends doubled outside plating should, as far as possible, be avoided, unless it is considered right to go so far as to apply butt straps to the longitudinal seams. I am quite aware that the object of the above considerations is neither unknown nor of great importance. I think, however, it will be of sufficient interest to be discussed here.

JUBILEE OF THE GREAT NORTHERN RAILWAY.

LIKE many other of our English railways, the Great Northern had a predecessor, although the fact is now little known. One of the products of the second railway mania, that of 1836, was a Great Northern Railway. It was to be a London and York line, constructed by Mr. Joseph Gibbs, an engineer of some note at the time. The project, however, came to nothing, and most of the money subscribed for preliminary expenses was lost. The present Great Northern issued from the third or best known railway mania of 1845. Two companies competed for the privilege of making a railway from London to York, namely, the London and York and the Direct Northern. Finally, on June 24th, 1846, the Bill of the latter was withdrawn, and two days later Royal Assent was given to 9 and 10 Vict., cap. 71, authorising the incorporation of these two lines jointly as the Great Northern Railway Company. The details of the tremendous conflict waged by the existing railway interests under the leadership of George Hudson are too long to enter into here. Suffice it to say that he was chairman of the Midland and York and North Midland lines, from Rugby by Leicester, Derby, and Normanton to York, and threw the whole of his vast power against the more direct railway scheme. Nothing but the extraordinary pluck and perseverance of Mr. Edmund Beckett Denison, M.P. for the West Riding, could possibly have prevailed against the clever and not too scrupulous Railway King.

As sanctioned on June 26th, 1846, the Great Northern was to be a line from London to York, with a loop from near Peterborough by Spalding, Boston, Lincoln, and Gainsborough to the main line again at Bawtry, and a branch from Sandy to Bedford. A sum of £5,600,000 was authorised to be raised in 224,000 shares of £25 each, whilst £1,868,000 more might be raised on mortgage when the whole of the first-named sum had been subscribed, and one-half of it paid up. This works out to about £27,660 per mile for the 270 miles or so of line just mentioned, but the sum includes the London terminus. Those shareholders who had subscribed £50 to the London and York Railway were to be given one £25 share in the Great Northern, whilst subscribers of £75 to the Direct Northern were to be credited with two Great Northern shares. Interest at a rate not exceeding 5 per cent. was allowed during construction. The original scheme, authorised just half-a-century ago, was never carried out in two important respects. The line from Lincoln and Gainsborough was not brought on to the main line at Bawtry, but more than five miles nearer Doncaster, whilst only four miles of the section between Doncaster and York were ever made. Long before the Great Northern was finished George Hudson's railway career had come to an end, and the York and North Midland had become friendly to the new-comer. Arrangements were made to run over about 10¼ miles of the Lancashire and Yorkshire from Askern to Knottingley, and over 20 miles of the York and North Midland from Knottingley to York. The latter company and the Great Northern gave each other the use of their York and Doncaster stations on easy terms. By this route the distance from King's Cross to York was 190½ miles. Many years later the North-Eastern constructed a line from near Askern through Selby to York, in virtually the course originally intended to be taken by the Great Northern. This being 2½ miles shorter, has been used by the latter ever since, and the Knottingley route discontinued for through traffic. The junction is at Shaftholme, 4¼ miles north of Doncaster. It thus happens that, after all, the Great Northern Company has never yet got to York by a line of its own, but only by running powers over other railways.

The site taken for the London establishment of the new line was in the filthy and insalubrious neighbourhood called Battle Bridge, at the north end of Gray's-inn-road. Vast mounds of ashes and rubbish, a quantity of dilapidated property of the worst class, and a couple of large hospitals for fever and small-pox rendered it a locality not fit for anything less utilitarian than a great station. From a ridiculous effigy of George IV., erected in 1829 upon the top of a police station placed at the junction of several roads—between the present Great Northern terminus and the Metropolitan station—the spot was also known as King's Cross, but the ancient name is still preserved in Battle Bridge-road, and is supposed to be of great antiquity. The Great Northern Act of 1846 appropriated the site of both the hospitals, but compelled the Company to find a fresh one not less than 1½ acres in extent for the Fever Hospital, as well as to erect a new building for it. Two years were allowed for building and handing over the fresh edifice, before ground could be broken for railway purposes. The Small-pox and Vaccination Hospital was also bought up, on similar arrangements as to time, but the Company was not compelled to rebuild it. Two large gasworks added to the delightful sights and smells of the neighbourhood of King's Cross, and much care had to be taken in making the line to prevent the gas supply being stopped. The Regent's Canal was also passed under and the Copenhagen estate, necessitated a tunnel almost at the start. Such a line for tunnels, indeed, had never then been dreamed of, for there were no fewer than nine in the first 23 miles. After that, however, there were but two more on the whole original line, Stoke and Askham. So many as 197 level crossings were provided for on the 270 miles or so of line, a large proportion of them being in the fens of Huntingdonshire and Lincolnshire. Out of 212 clauses in the Act, 86 relate to crossing the drains, cuts, and waterways in the fens, to keeping them open, free from obstructions at the railway bridges, &c.



OLD BUILDINGS REMOVED FOR BUILDING KING'S CROSS STATION

The Witham Navigation, or in other words, the river Witham from Boston to Lincoln, was taken over on a 999 years' lease by the Great Northern, its line running alongside it between the two places. It had to reduce the river tolls 33 per cent. upon opening the railway, and pay a rental of £10,545 per annum. A continuation termed the Foss-Dyke Navigation, extending to the Trent at Torksey, was also acquired on nearly as long a lease at £9570 5s. 4d. a year. Not only has the railway gained the traffic which these navigations have lost, but the latter provided the land at the side on which the line is made.

A company termed the East Lincolnshire Railway Company received its Act the same day as the Great Northern. Its line extends from Grimsby by Louth to Boston—forty-eight miles—and is leased in perpetuity to the Great Northern. This company leased the Louth Canal, which, of course, passed with it into Great Northern hands. The maximum tariff allowed to the Great Northern was 2d. per mile for first-class passengers, any portion of 6d. over on a fare calculated at this rate to be charged as 6d. Three half-pence a mile was the second-class rate, the coaches to be closed and to have glass windows. Third-class was to be one penny a mile, the vehicles to be covered and to have seats, and to be run as often and under such conditions as the Board of Trade might prescribe. Animals requiring separate vehicles might be charged 3d. per mile; sheep, pigs, poultry, fish, &c., alive or dead, 4½d. per ton per mile. The parcel rate was: under 14 lb. weight, for 25 miles or less, 6d.; if further, 1s.; not over 28 lb., any distance, 2s.; not over 56 lb., any distance, 2s. 6d.

Lines from Hitchin to Royston and from Grantham to Nottingham were also sanctioned within a month of the passing of the Great Northern Bill. Both have since been extended, but practically formed part of the original scheme.

Coming later into the field than most of the great lines, the Great Northern was able to profit by much of their experience. Its engineer was Sir Wm. Cubitt, M.P. for Andover, one of that talented family whose works will apparently endure to the end of time. The line was laid out especially with a view to high speed; and no one needs to be told how well it has answered that end. From the day it was opened throughout till now the Great Northern has been at the head of English railways for speed, two or three exceptional trains on the broad gauge hardly affecting the general truth of this. Curves, of course, were scrupulously avoided so far as possible. The hardest parts of the main line are the first twelve miles out of King's Cross, averaging 1 in 170, and about eleven more from Essendine to Stoke tunnel, at 1 in 178 to 1 in 200. The line was signalled throughout at its opening in the best possible manner, many of the signal posts being of open ironwork and great height. It was at first proposed to cross all the lines met with on the level. This was done at Newark and Retford, but not at Peterborough, where the London and North-Western branch and the river Nene happen to be side by side. The Newark and Retford crossings still exist, but it is to be hoped will be taken out some day.

The King's Cross Station was not finished till 1852, the line being opened from Peterborough to London in 1850 to a temporary station where the goods station now stands. Mr. Lewis Cubitt designed the passenger terminus, placing, as he generally did, an Italian clock tower upon the front of it. This façade, though not exactly beautiful, is well proportioned and perfectly suitable for its purpose. A very great merit of King's Cross is its ample lighting. The two long train sheds are almost wholly roofed with glass, and the large openings in the street front supply still more light. In its day King's Cross was far the finest terminus in London in every way, nor are there many which excel it now. Both spans of the roof, which are 105ft. 3in. wide, were originally supported by timber ribs formed of planks bound together, but have since been renewed in iron by Mr. Richard Johnson, the Company's present engineer. Of the engineering works on the main line the Digswell viaduct, about 21½ miles from London, is perhaps the finest. This comprises forty arches of 30ft. span, the highest about 90ft. high, the length of the whole being 1563ft. Two miles further is Robbery Wood viaduct, with seven arches 57ft. in height.

The Great Northern Company's principal locomotive, coach and wagon works have been at Doncaster from the first, the influence of Mr. Denison having easily procured that favour for his constituents. For a short time, 1848-50, whilst only some of the Lincolnshire lines were open, Mr. Edward Bury, the well-known builder of four-wheeled engines, supplied locomotive power by contract, and also acted as manager. He was succeeded, however, in 1850, by Mr. Archibald Sturrock, from Swindon, who was the first locomotive superintendent of the Great Northern. Not a little of the successful working of the line was due to Mr. Sturrock's employment of unusually high pressures of steam. He used 150 lb. from the first, at a period when 100 lb., and even less, was still very generally used.

It is impossible here to detail the growth of the Great Northern Railway from the original scheme of 270 miles to its present length—worked—of about 900 miles. It forms two-fifths of the East Coast route to Scotland, and is the shortest line from London to Leeds and the West Riding of Yorkshire. Its 8ft. engines are known the world over. By the latest returns—1894—it possessed 1015 engines, 2222 coaches, 660 other coaching vehicles, and 33,177 goods and ballast wagons. It ran over 10¼ million passenger train miles, and more than 9¼ millions with goods and coal traffic. It carried in 1894 upwards of 33½ million passengers, not reckoning season-ticket holders, and received £1,761,477 from all coaching sources. Goods and coal traffic, &c., brought in £2,408,152, and miscellaneous sources £68,344, or a total of no less than £4,237,974. The paid-up capital stood at £49,517,037. Save once, viz., December, 1856, the line has never failed to pay a dividend, which has several times been over 7 per cent. per annum, and has averaged about five. For keeping up with the times, not spasmodically but continuously, for persistent energy and "go," the Great Northern record of fifty years is a thing Englishmen may well be proud of.

INSTITUTE OF MARINE ENGINEERS.—The sixth annual dinner of the Institute of Marine Engineers took place in the King's Hall, of the Holborn Restaurant, on Wednesday evening, a company of about 300 being present, including the President (Sir Edwyn Sandy Dawes, K.C.M.G.), Sir George Nares, K.C.B., Sir James Mackay, K.C.I.E., Vice-Admiral E. Field, M.P., Lieut.-Col. Denny, M.P., Mr. T. Richardson, M.P., Mr. C. W. Cayzer, M.P., Mr. A. J. Durston, C.B., R.N., past-president, Mr. W. Ellison Macartney, M.P., Mr. W. Allen, M.P., Mr. J. Fortescue Flannery, M.P., his Excellency Commodore M. de la Camara, Spanish Naval Attaché, Mr. Duncan MacKinnon (chairman British India Company), Mr. Stewart Hall, Mr. Martin, Mr. Lind, Mr. King, Mr. G. Gomstone, Captain Chevalier Leopold Von Jedina, Austro-Hungarian Naval Attaché, Colonel Poretchkin, Russian Imperial Navy, Professor A. C. Elliott, D.Sc., Colonel Dawes, the Revs. W. D. Springett, D.D., and G. M. Capell, Captain Hodgkinson, Captain Hogg, Captain Hutchinson, Mr. C. Du Sautoy (president of the Southampton centre), Mr. A. Beldam and Mr. G. W. Manuel (past-presidents), Alderman G. W. Kidd, Mr. A. W. Robertson, Mr. W. H. Northcote (vice-president), Mr. J. H. Thomson (chairman of the council), Messrs. J. R. Ruthven, J. Richardson, U. G. Crichton, S. C. Sage, A. Campbell, F. W. Shorey, J. M. Gray, Blelloch, J. B. White, C. G. Newby, W. I. Taylor (convener), J. Adamson (secretary), and others.

RIBBED WINDOW GLASS.—The advantages and disadvantage arising from the substitution of ribbed glass for plain glass in factory windows were recently investigated for the Boston Manufacturers' Mutual Fire Insurance Company, by Mr. Charles L. Norton, of the Massachusetts Institute of Technology, says a writer in *Cassier's Magazine*. Mr. Norton points out that in both fair and cloudy weather the general resultant direction of light entering through a window having ordinary glass is downward at an angle of about 40 deg. or 50 deg. The brightest portion of the room is, therefore, the floor in front of the window. As a floor is not, as a rule, a good reflecting surface, a large amount of light is absorbed there and lost. Whatever light is reflected goes upward and backward toward the ceiling, and what light falls on the wall spaces between the windows must, therefore, be mainly light which is diffusely reflected from the floor and objects upon it. Early in the morning and towards evening the angle of the incident light with the horizontal is less, and the light, therefore, penetrates further into the room; but the wall spaces between windows gain but little by this greater obliquity. If panes of ribbed glass be substituted for the plain glass, the bright spot on the floor in front of the window disappears, and the entire floor, walls, and ceiling appear of sensibly the same brilliancy. The action of the ribbed glass appears to be prismatic, the greater part of the light falling on the ribbed glass at any point being refracted and spread out into a fan-shaped beam lying in a plane nearly perpendicular to the plane of the glass and to the direction of the ribs.

RECENT IMPROVEMENTS IN DOCKS AND DOCKING APPLIANCES.[*]

By Lyonel Clark, Associate.

(*Concluded from page* 624.)

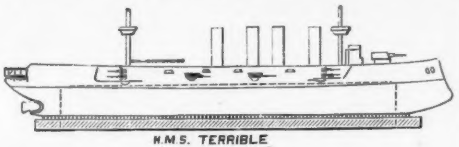
The question of bilge blocks has also had our attention. It is evident that since the ship has to be hauled on to the dock sideways, the ordinary running blocks could not be used. We have got over this difficulty by making special telescopic bilge blocks. These consist of long timbers pivoted at the centre of the dock, and supported, at a spot about under the bilge of a normal vessel, on a cast steel rack, which can be wound up and down out of a box built in the pontoon, by a worm worked from the top deck in a manner similar to the side shores. This system of berthing considerably shortens this generally rather long operation, and vessels of the largest size are completely berthed on these docks within five minutes. Other minor fittings have also had our attention, and many of the newer docks are very completely fitted with hot and cold water systems for washing down, filling, or testing tanks, &c. Hydraulic travelling cranes, capable of plumbing the ship on one side and the quays on the other, are provided on the top deck, and have proved to be of the greatest service. Indeed, we may claim that some of the most recent of our docks are as complete in this respect as they are rapid in their action, and we have been particularly fortunate in having to deal with dock owners who have been desirous of having their docks equipped in the most complete and workmanlike manner possible.

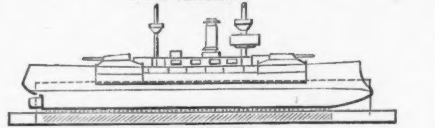
From what has been said it will be evident that I put forward the off-shore type of dock as the most perfect form of ship-lifting machine at present constructed. Its first cost is very small, owing to its lightness. [In the Appendix is given a list of various floating docks, with their weights and lifting powers.] As examples show, it can be adapted to almost any situation. It can be built and put in position with great rapidity; the Stockholm Dock, for whcih the drawings were only commenced in December last, will be at work within a few days from now. It is more rapid in its action than any other type of dock or lifting appliance known, whilst the advantageous situation in which the ship on it is placed shortens the time during which it has to remain on the dock, and still further increases its power for coping rapidly with a large fleet of vessels. Lastly, its self-docking facilities render its life, if properly looked after, practically unlimited, whilst its construction is such that at any future period it can always be extended in size, and that without putting it out of use beyond a day or so.

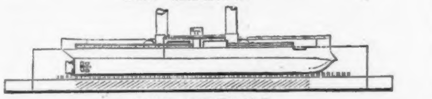
The docks described in the previous portion of my paper, although in some cases capable of lifting the smaller classes of ironclads, are primarily intended for merchant vessels. These vessels, however, are now attaining such dimensions that the step between them and even the heaviest vessels of our fleets is becoming rapidly smaller, and we have of late been repeatedly called on to design docks which in point of lifting power could deal with all but our largest battleships. The Spanish Government have at the present moment under consideration designs for a floating dock to lift ironclads up to 12,000 tons, of one of which we are the authors. This and other causes have led us of late to give a great deal of attention to the study of a dock which shall extend even to the heaviest of our battleships the many advantages of the floating type.

The problem is one that has required care and consideration, not so much on account of the mere weight of the vessels as on that of their very varied characteristics. Ordinary merchant vessels have a pretty constant weight per foot run, or unit weight, or, what comes to the same from our point of view, the shorter vessels have a less unit weight than the larger ones. Any dock, therefore, with a lifting power equal to the unit weight of the largest vessels it is built to lift, will always have a greater, or at least equal unit, lifting power when smaller ships are placed on it, so that weight and lifting power can be always equal and opposite. This is not the case with the ships of the Navy, where, on the contrary, we find that the shortest vessels have the greatest weight. To take three examples: the Terrible, of a length of 500ft., has a weight of 14,200 tons; the Magnificent, with a length of 390ft., has a weight of 14,900 tons; and the Inflexible, with a length of 320ft., has a displacement of 12,000 tons. In other words, the unit weights of these vessels vary from about 38 tons per foot in the case of the short to 28 tons in that of the long vessels.

If we design a floating dock with a lifting power and length to suit the Magnificent, it could certainly equally well lift the Terrible, but the latter would overhang each end to an extent that would probably not be allowed as a general rule. On the other hand, if we built a dock long enough to take the Terrible without overhang, and powerful enough to lift this vessel, although capable of lifting the Inflexible, it could only do so by utilising large areas of the dock each end on which the ship did not bear, and which would therefore act as cantilevers and have to be connected to the body, or supporting portion of the dock, by some powerful form of construction, or a serious strain would be put on the ends of the vessel. This strain would really be greater than indicated by the difference in length of the vessels; for, especially in modern vessels, the length of straight keel, that is, that which would bear on ordinary bilge blocks, is very considerably shorter than the length between perpendiculars. An ordinary floating dock therefore would require either to have sufficient longitudinal stiffness to convey the displacement of the unsupporting portion to the supporting portion, or its unit lifting power should be equal to the unit weight of the heaviest type of vessel, merely utilising that portion which came directly under the vessel. Either of these arrangements, however, would mean a much heavier and consequently more expensive form of dock than is really necessary.

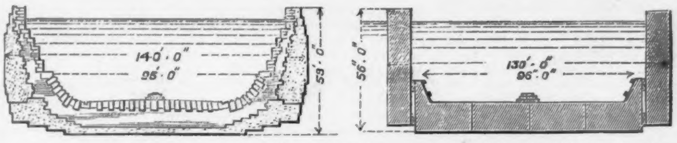

H.M.S. TERRIBLE


H.M.S MAGNIFICENT


H.M.S. INFLEXIBLE

The form of dock that we propose overcomes these difficulties in another manner; but, in order to make clear the reasons which have led us to adopt this design, it is well to contrast the action of the floating with the graving dock. A graving dock in its simplest form is merely a hole dug in the earth and lined with masonry round three sides and closed with a gate at the fourth. The masonry is not put in to support the weight of the ship, which may be regarded as being taken by the earth itself; but the greater part of it is merely to prevent the whole shell of the dock floating or rising from the water pressure beneath it when the pound is empty. If we always had a heavy ship in the dock the mass of this masonry might be much reduced, as the ship would counterbalance the upward thrust of the land water. Therefore we only need the mass of masonry in its entirety when the pound has to be emptied in order to get at the floor of the dock and prepare the berth. But it must be clear that as long as we can get at the floor of the dock it is indifferent to us how we do so; and, therefore, if the dock did float up when light, it would suit us just as well, providing, of course, that the shell of the dock were homogeneous enough to do so. A masonry dock could not, of course, stand this; but if we built it of iron or steel it could float without danger. Further, by constructing our invert on the cellular system, instead of making it solid, we could raise the floor above water level by merely pumping out from our cells an amount of water equal to the weight of our dock, and so dispense with the gates altogether.

But we can do better than this; for, if we construct our cells still larger, we could utilise their surplus buoyancy to support some of the weight of the vessel itself. If it were a light vessel, we should be able to lift it completely without having to use the gates at all; whilst even a heavy ship would be lightened to a proportional amount, and its draught consequently lessened. But if the draught is lessened, the height of the gates is reduced to a similar extent, and also the water pressure against them, so that they become much lighter and simpler structures. The point is, how far we can go with this surplus buoyancy of our invert without making it too large. It is interesting to note that in the case of the new docks now building at Portsmouth, if the shell were constructed of steel on the cellular principle, with the same outside dimensions as the masonry, there would be sufficient surplus buoyancy to lift the heaviest vessels of our Navy without having recourse to the gates at all. In short, if this dock were built of steel instead of stone, we should be able to utilise the displacement of what is practically a useless mass of masonry, to do away with the heavy gates, and reduce the pumping power to the strict minimum. The length of such a dock, however, would not allow us to use it for short ironclads, on account of the difficulty of giving it sufficient stiffness in the longitudinal sense, but it is interesting as showing the large amount of buoyancy wasted in a dock invert.



Transverse Sections of new Portsmouth Docks, and proposed Floating Graving Dock

We shall, however, if we examine the ships we have to deal with, find indicated the amount of surplus buoyancy that will give the best results. None of our heavy ironclads, that is, those running 38 tons to the foot, exceed a length of 400ft., and, on the other hand, the weight of none of our long vessels, cruisers or mail liners, exceeds the unit weight of the Terrible—that is, 28 tons per foot run. We should evidently therefore arrange to have a surplus buoyancy from our steel invert equal to this latter weight. In other words, we should give our dock a lifting power of 28 tons to the foot, which would be equivalent to making it the same length as that of the Terrible, and such a dock would, under these conditions, be really an ordinary floating dock without gates at either end, and we should have all the advantages of this system, and should not be restricted as to the length of vessel we could accommodate, but could deal with vessels of considerably greater length than the Terrible. Only when we had to deal with our short, heavy ironclads would the gates be required at all; but, as these ironclads would be lightened to the extent of 28 tons per foot run, that is, the unit lifting power of the dock, these gates, or rather, caissons, would be the very lightest and simplest of structures, standing barely 8ft. above the floor of the dock, and practically automatic in their action, as the dock would pick them up as it rose and leave them behind as it was lowered, whilst the water pressure against their outsides would in the worst of cases not exceed a couple of pounds per square foot. It will at once be noticed that this combination completely eliminates the need of great longitudinal stiffness in the dock. In the case of the long and lighter vessels, the dock would support them over their whole bearing length of keel, and, their unit weight and their unit lifting power of the dock being thus equal and opposite, there would be no longitudinal strains from this cause. The same will also obtain in the case of the shorter and heavier ironclads for the light caissons are not tied to any one particular position, such as the extreme ends of the docks, but slots can be fixed at various positions along the floor of the dock, and they can be inserted in that slot which most nearly approximates to the length of the vessel. For instance, in the case of the Magnificent they would be placed 390ft. apart, whilst in that of the Inflexible they would come as near together as 320ft. In this manner lifting power and weight are again kept equal and opposite, for we need only use the buoyancy of that portion of the hull of the dock which comes directly under the vessel, and make up our required balance of lifting power by utilising the displacement of the pound between the gates, which, being again equal to the length of the vessel, stills keeps our total lifting power and weight equal and opposite.

We term this combination of the two systems a floating graving dock, and we claim that it is a combination of the best points of each system. Used as a floating dock, we have, to get at its floor, only to lift by displacement the weight of the dock itself, instead of emptying the whole pound. Light ships are lifted at the expense of pumping out an amount of water equal to their own displacement, instead of having to empty the difference between that displacement and the contents of the pound. When used as a graving dock to lift the heaviest vessels a large portion of their weight is again lifted by direct displacement, and, even when the pound is called into use, its dimensions are as nearly as possible the same as those of the contained vessel, and therefore the surrounding water that has to be removed is at a minimum. Such a dock will be found to have numerous advantages. In the first place it can do all the work that a graving dock can do, and indeed more, for it is not restricted as to the length of vessels it could take in. The vessels lifted are on a raised platform, in the best of positions, well open to the air. Even when the caissons are in position this advantage is not altogether lost, as the ends are open above these low structures, and large gangways are left through the sides of the dock, giving free ingress to light and air, and affording an easy road by which to remove the different pieces that require alteration or renewal.

The choice of site for such docks is much larger, for they require no foundations, but can be put down complete in one piece in situations where a stone dock could not be erected, owing to the difficulty of keeping the site free from water. The amount of excavation is, as we have seen, less than that of a stone dock in the worst of circumstances. Such excavations, moreover, do not require to be made in the dry, but merely consist of a hole dredged out in the usual manner. They can be located as well in the water as on the land; indeed, in many cases such a position is more suitable, as the amount of dredging is reduced, and in those ports where the water is naturally deep can be dispensed with altogether. They are not tied down to any one situation, but can be moved from one port to another, if local changes render it necessary. In time of war this facility might be of special advantage. It has been advanced, in the case of the proposed docks for Gibraltar, that they will be open to the fire of the enemy. A floating dock would be in no worse position for being shelled than a stone one, but it would have the advantage that the position of a stone dock being fixed, once the range found the enemy could continue shelling it until silenced, whereas a floating dock could be easily moved from time to time, and, indeed, probably removed out of fire altogether, for it must be remembered that when the ship is once lifted, the dock will be only drawing some 15ft. or 16ft. of water. The ease with which such a craft could be moved might also be made use of for offence, for if the fleet were able to capture a port in the enemy's country, it might tow its own dock there and form a depôt in which to repair its ships, thus saving the home and out voyage.

I have already had to notice the advantage that a floating dock has, in being able to dock at all states of the tide, and not, as in the case of most of our graving docks, only able to receive vessels at high water; and I have already noted that the normal freeboard of the dock might be reduced and extra draught given if special occasion arose. I should like to most strongly insist on this point. In war time nothing is more likely than that ships will come into port leaking, down by the head, with decks nearly awash, or with a bad list. With vessels in this condition there is hardly a single graving dock in the world that is capable of receiving them. Our largest stone docks are described as having some 33ft. of water over the sill at the top of ordinary spring tides. This means that a ship of the type of the Revenge having her draught increased by as little as 6ft. could not get into the dock, even when on an even keel; and, if she were listed as little as 5 deg., an increase of draught of only 3ft. 6in. would block her, and if her heel were increased to the quite possible amount of 10 deg., a mere increase of 1ft. 6in. in her draught would make her bilge keels foul in the entrance of even our newest and largest docks, and that at high water spring tides. One can well understand that the depth of graving dock has been kept to the strict minimum. Greater depth means deeper excavation, greater water pressure, heavier inverts, and indeed increase in difficulties and in cost in every direction.

In a floating dock increased depth is obtained at the smallest of cost, and, as I have pointed out, an extra 3ft. or 4ft. could always be obtained in cases of emergency without special preparation. Similarly, in the case of a vessel with a list, nothing is more easy in a floating dock than to heel it also to the same angle, with the advantage that, ship and dock being adjusted to the same inclination, when the dock is put again on a level keel the ship also will be in the same condition. This adaptability, so to speak, of the floating dock should in itself alone be sufficient an argument in its favour, even were it replete with every other disadvantage. It is impossible to examine the disposition of most graving dock systems without being forced to the conclusion that, although capable of doing their work under normal conditions, or in time of peace, they run great risk of failing completely in time of war. At such a time what is wanted is not a dock situated at the head of a river or channel, along which the waterlogged ship, with tired-out crew and spent coal supply, would have to steam, at the eminent risk of foundering on the way, and blocking the whole navigation, to find on arrival that there is not enough water over the sill of the dock for it to enter; but a dock that can be sent to the mouth of the port or river, and receive the sinking vessel there, a dock with sufficient water over the sill to take in the largest ironclads, so long as their decks are above water; a dock with rapid pumping power, that could lift such vessels in a couple of hours, and let them be patched up and sent on to the arsenal without endangering the navigation; a dock which, when the mouth of the harbour became untenable, could be removed out of fire. For such work—and that such work will be required of a dock in time of war is indisputable—I venture to say that the floating dock is as superior to the older form of stone dock as the iron girder of to-day is to the stone arch of the last century.

Appendix.

The electric driving plant of the second North Shields Dock.—The pumps are of the horizontal centrifugal type, of 18in. aperture, eight in number, and placed at the bottom of the side of dock, close to their respective compartments. The shafts of the pump are continued upwards to the engine deck, and the electric motors drive them directly. The pumps, flyers, and shafts, run on special ball bearings. The motors are of the vertical type, one to each pump. They have a brake horse-power of sixty horses, and make 385 revolutions per minute. The motors are started and stopped by switches and regulating resistances placed in the house on the

Weight of Docks compared with Lifting Power.

Name of dock.	Designed or built by	Type.	Lifting power.	Weight of hull with machinery and fittings.	Weight of material required to lift 100 tons of vessel.	Date of opening.	Remarks.
			Tons.	Tons.	Tons.		
Carthagena	Mr. G. B. Rennie.	Double-sided.	6500	4400	68	1859	Admiralty Dock book and *Engineering*, March 19th, 1896.
Sourabaya..	Mr. Tromp and Mr. Strootman.	„ „	3000	2362	79	1866	*Engineering*, March 16th, 1896, and August 31st, 1866.
St. Thomas	Mr. F. J. Bramwell.	„ „	4000	3400	85	1867	*Engineering*, June 7th, 1867.
Nicolaieff	Clark and Standfield.	Depositing.	6000	3066	51	1877	—
Amsterdam	Union Co., Dortmund.	Double-sided.	4000	3350	84	1879	Estimated weight by light draught.
Barrow	Clark and Standfield.	Depositing.	3150	1614	51	1881	—
Vladivostok	„ „	„	2800	1167	42	1881	—
Rotterdam	Not given.	Double-sided.	6000	3452	58	1883	Admiralty Dock book for lifting, and date; weight from quantities supplied with specification.
Hamburg	Clark and Standfield.	Off shore.	5000	2087	41	1888	—
Cardiff	„ „	„	2500	1253	50	1890	—
North Shields No. 1 ..	„ „	„	3200	1458	45	1892	—
Flensburg..	„ „	„	2600	1119	48	1893	—
Zárate	„ „	Depositing.	5500	2481	45	Provisionally erected	Afterwards altered to North Shields No. 2.
Mexican	„ „	Self-docking. Double-sided.	2300	1200	52	Building.	—
North Shields No. 2 ..	„ „	Off-shore.	6500	2676	41	„	From Zárate material.
Stockholm	„ „	Ditto with outrigger.	2200	959	43	„	First half to be working this spring—1896.
Barcelona	„ „	Depositing.	6500	3380	52	„	To be completed in 1897.

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[*] Read at the summer meeting of the Thirty-seventh Session of the Institution of Naval Architects, June 9th, 1896.

top deck of the dock, where the hydraulic valve gear is also located, so that one man controls the entire working of the dock. The generating plant is fixed on shore at a distance of some 200 yards from the dock. It consists of two sets of direct coupled inverted double-cylinder compound engines, and shut wound dynamos, giving together 850 ampères at 500 volts. Each engine is of 314 brake horse-power, and runs at 350 revolutions per minute. This plant should pump about 16,000 tons of water per hour through a mean head of a little over 18ft. The dynamos are guaranteed to have a commercial efficiency of 95 per cent., and the motors one of 90 per cent., while the loss of the cables will be under 4 per cent., so that the total efficiency of transmission will be very high.

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

Bald tires on locomotive driving wheels.—It has been the general custom to use one pair of bald or flangeless tires on the driving wheels of locomotives with six driving wheels, and on two pairs of wheels of engines with eight or ten driving wheels; but in a discussion on this subject before the New York Railroad Club it was made evident that many roads are using or considering the use of flanged tires on all wheels of engines with six or eight driving wheels. With four pairs of such wheels, the distance back to back of wheels is usually about 53½in. for the first and last axles, and 53⅜in. on the two middle axles. This enables the engine to take curves, while on sharp curves the gauge is widened, being as much as $1\frac{3}{16}$in. wide on curves of 300ft. radius. Mr. E. E. Russell Tratman showed the varying practice on different roads. Of six Mogul engines—six drivers and two truck wheels—one had all wheels flanged, one had bald tires on front drivers, and four had bald tires on the second drivers. Of sixteen ten-wheel engines—six drivers and a four-wheel truck or bogie—five have bald tires on the second pair and eleven have them on the first pair of drivers. Of nine Consolidation engines—eight driving wheels and two truck wheels—one has bald tires on the third pair of drivers, one has them on the second and fourth pairs, two have them on the second pair only, and five have them on the second and fourth pairs. Of three twelve-wheel engines—eight driving wheels and a four-wheel truck—one has bald tires on the first and third pairs of drivers, and two have them on the second and third pairs. Decapod engines—ten driving wheels and two truck wheels—have bald tires usually on the second and third pairs. Some six-wheel switching and shunting engines have bald tires on the middle wheels, others have all wheels flanged. Eight-wheel engines—four drivers and a four-wheel truck—have usually flanged tires on all wheels, but some roads use bald tires 6½in. to 7½in. wide on the leading drivers of such engines in express service. He referred to the all-flanged eight-coupled engines of the London and North-Western Railway, and Paris, Lyons, and Mediterranean Railway; the all-flanged ten-wheel engines of the Gothard Railway, and to the ten-wheel engines of the Highland Railway, which latter have bald tires on the middle drivers.

Railway terminal at Philadelphia.—The Philadelphia and Reading Railroad some years ago replaced its passenger line on the street level in Philadelphia by a viaduct leading to the handsome terminal station on Market-street, but it has still maintained a surface line in another part of the city, which has a large freight traffic, and was originally built when this part of the city was open country. The dangers and inconveniences due to the numerous street crossings with several tracks has finally led to the adoption of a plan for lowering the railway about 25ft., and carrying the streets over it by bridges. The first work was the reconstruction of the sewer system, as many of the old sewers were too near the surface, and this work has been done by the city. The line will be about two miles long, the descent being made by a grade of 1·3 per cent., after which the grades are from level to 1 in 200, except that at the end the line rises by a grade of 2½ per cent. to the elevated approach or viaduct leading to the Market-street terminus. The branches into the yards and warehouses of manufacturing establishments along the route, including the Baldwin Locomotive Works, will be reached by inclines of about 1 in 25. There will be four main tracks, the tunnel portion being 52ft. wide, with a single arch. The open part will be 80ft. 3in. wide between retaining walls, with six tracks, columns being placed next to the outside tracks to support the plate girder street bridges, which will have a span of 51ft. 4in. between columns, and 14½ft. from columns to abutments. The headway will be 20ft. At two factories hydraulic lifts will be used instead of inclines, the lift raising a locomotive and three cars at one time. Great care has been taken in planning the arrangements for artificial ventilation, which will be by means of fans drawing air from the roof of the tunnel, and an air-supply conduit laid under the ballast. The work will cost 6,000,000 dols.

A compressed-air transmission plant.—In the construction of the Jerome Park reservoir near New York, which will cover 300 acres, and have a capacity of 2,000,000,000 gallons, the drills, cranes, pumps, &c., are being operated by compressed air from a central power station. The usual practice on contract work of this kind is to use a number of small boilers and to take little account of the fuel consumption question, but in this case a different method has been followed. In the pumping station is a duplex Ingersolt Sergeant air compressor of 600-horse power, with two tandem sets of steam and air cylinders, the steam cylinders driving a main shaft, on which is the flywheel. The air cylinders are fitted with automatic regulators, by which communication is opened between the ends of the cylinder when the receiver pressure uses alone 80 lb., the piston then making its stroke without doing any work, while the throttle valve of the steam cylinders is also closed at the same side. From the receiver an 8in. main pipe line extends with branches of diminishing size, the smallest being 1½in. diameter. A number of drills are used on the rock excavation work, and small horizontal pumps are used to pump out the trenches for the foundations of the core walls. In the erection of these walls, a number of boom derricks are used, placed in a row, and each operated by a winding engine. A branch pipe line is laid parallel with the work, and tapped for each engine, the pressure available being about 70 lb. Single isolated hoists are operated in the same way. Air reheaters are placed at intervals on the main pipe line. In spite of the leakages and losses due to the more or less rough and careless work inevitable in such a case, it is expected that a considerable net gain in cost of operating will be shown.

Pneumatic street-sweeping machine.—A street-sweeping machine, in which the dust and dirt are picked up by an air blast, is now in successful operation at Indianapolis. In external appearance it resembles a large four-wheeled wagon or cart, and it is drawn by four horses. Between the axles, and running on small wheels on the street surface, is a hood or box about 3ft. long and 6ft. wide, fitted at the front end with scrapers and wire brushes, which loosen the dirt. Behind the brushes is the mouth of the exhaust pipe, the powerful current in which draws the air and dirt up a vertical pipe, and then through a horizontal extension into a vertical cylindrical dust chamber 44in. diameter, and 40in. high, at the rear of the machine. The current strikes a baffle plate, which diverts it to the bottom of the box, where the dirt collects, while small steam jets moisten it so that it will not be drawn out by the air. The air, thus deflected and cleaned, passes out through a large pipe in the top of the box to the 12in. fan, and then down again to the hood, a hand pipe conducting a portion of the air to the furnace of the small boiler, 30in. diameter, and 5ft. high, which supplies steam for the fan engine in the front and the wagon body. Anthracite coal is used. The exhaust is turned into an iron tank, whence it passes to the jets in the dust box. At intervals the bottom of the dust box is dropped, and the pile of sweepings is picked up by a man, shovelled into a dump cart, and carried away. The machine weighs 6500 lb., or 8500 lb. with dust box full. It can clean about 1,360,000 square feet—or about thirty miles of travel of the wagon—in twelve hours. The force required consists of the cleaning machine with three horses and two men; and a two-horse wagon with one man for hauling the dirt away—or two such wagons to three machines.

A cargo unloader.—The Pennsylvania Railroad will erect at one of its freight piers on the North River a Brown double-cantilever machine for loading and unloading the freight and cargo of ocean steamers. The central supporting frame has a cantilever arm on each side, on which runs a hoisting trolley. The engine, boiler, and mechanism are mounted in a cabin on top of the machine, and all the operations are controlled by one man, who has a clear view in all directions. The lifting capacity is five tons, and the machine will handle package goods, crates, barrels, &c., and has also a special attachment for handling bulk goods, such as sand, ore, &c., and loading them into railway cars. The machine can lift five tons at a rate of 150 tons per minute, and run the trolley along the cantilever arms at 900ft. per minute, while the whole machine can move along the pier at the rate of 600ft. per minute.

LAUNCHES AND TRIAL TRIPS.

On Thursday, the 18th inst., the Brazilian passenger steel twin screw steamer Prudente de Moraes, which has been built to the order of Mr. William Brice by Messrs. Craig, Taylor, and Co., was taken to sea for her trial trip. The dimensions of the vessel are 230ft. by 33ft. by 20ft. depth moulded. The engines, which worked throughout with perfect smoothness, have been constructed by the North-Eastern Marine Engineering Co., Sunderland, and easily maintained an average speed of eleven and a-half knots per hour loaded, everything being highly satisfactory.

On Saturday, the fine new steel steamer, built by C. S. Swan and Hunter, of Wallsend-on-Tyne, for Messrs. Edmund Haslehurst and Co., of Billiter House, London, was taken to sea for her trial trip. The Claverhill is a spar deck steamer 310ft. between perpendiculars, by 42ft. by 27½ft. deep, and is designed to carry a deadweight cargo of 4600 tons; as well as a very large measurement cargo. She has a cellular double bottom throughout, and a trimming tank aft, with a complete equipment of the latest appliances for handling cargo. The accommodation for the captain, officers, &c., is in a steel house on the bridge deck, so that the whole of the bridge space is left clear for cargo or bunker space. The machinery has been constructed by the North-Eastern Marine Engineering Co., and consists of a set of their latest design of engines, with cylinders 23in., 38in., and 61in. diameter, by 39in. stroke; two steel boilers 14ft. 9in. by 10ft. long. During the construction the vessel has been superintended by Messrs. Jacobs and Barringer, of London, as well as by Captain Wigley. During the trial trip the machinery worked most satisfactorily, and after the trip the steamer proceeded direct to St. Petersburg, where she will load general cargo for Vladivostock.

On Tuesday last the new paddle steamer John Herron, which has been built by Messrs. John Scott and Co., under the superintendence of Messrs. Flannery and Sutton, of Liverpool and London, for the Wallasey Urban District Council, the launch of which we have described in a recent issue, proceeded on her trial trip on the Firth of Forth, previous to being despatched to the Mersey. The results were very satisfactory, the vessel being well within her specified draught, and attaining a maximum speed of upwards of 13 knots per hour, the machinery working without the slightest trouble. The vessel was also put to a severe test as to her steering capabilities, and proved to be exceptionally handy. The Wallasey Urban District Council were represented by the chairman, Captain John Herron—after whom the vessel has been named—and several members of the committee, who travelled up specially from Liverpool to be present at the trial, and who expressed their approval of the vessel. The smart appearance of the vessel, with the funnel amidships, and the long, airy saloons, which are tastefully decorated in carved wood and gold, were specially admired, and it is fully anticipated that this vessel and her sister boat now in progress will become the favourite vessels of this class on the Mersey.

On Monday, the 22nd inst., Messrs. Wigham, Richardson, and Co. launched from their Neptune shipyard a very finely modelled steel screw steamer, which they are building to the order of the Ungaro-Croata Steam Navigation Company, of Fiume, for their fast passenger service from Fiume along the coast of Dalmatia. The steamer is 220ft. in length by 29ft. beam, and is being constructed to take the highest class in Lloyd's register. She will be provided with very highly finished accommodation for a large number of passengers, including a handsome dining saloon and first-class state-rooms in the 'tween decks aft, with smoking room and entrance hall above them. The vessel is to be fitted with quadruple-expansion engines, self-balanced on the well-known Yarrow, Schlick and Tweedy system, which, with the boilers, are being constructed by Messrs. Wigham, Richardson, and Co., to give a speed of 15 knots per hour. Amongst the company present at the launch were Mr. and Mrs. Dendy, Mr. Mouton, superintending engineer, and Captain Baccarcich, representing the Ungaro-Croata Steam Navigation Company, and Mr. Alexander Rolland, Mr. Richardson, Mr. Christie, and Mr. and Mrs. Tweedy. As the vessel left the ways she was named the Pannonia, the ceremony being gracefully performed by Mrs. Dendy, of Newcastle-on-Tyne.

On Friday, the 19th inst., the s.s. Oilfield was taken to sea for her trial trip. This vessel is one of the most modern type of oil tank steamers designed and constructed for carrying oil in bulk, and represents the latest outcome in experience in the special trade. During a series of runs over the measured mile with several of her oil compartments filled, she attained a speed of nearly 12 knots per hour. She has been built by the Tyne Iron Shipbuilding Company, of Willington Quay-on-Tyne, for Messrs. Hunting and Son, of Newcastle-on-Tyne, and is the third steamer which this firm has built for this special trade. She is divided into small compartments, and is designed to meet the requirements for steamers carrying petroleum in bulk through the Suez Canal. She has a most efficient double system of pumping machinery so as to provide against possible contingencies, has the electric light fitted throughout, and special arrangements for ventilating and cleaning her oil compartments. She is over 355ft. in length, 47ft. in breadth, and carries nearly 6000 tons on a very light draught. Her engines are 27in., 44in., 71in., by 48in., with three single-ended boilers, and have been constructed by the Wallsend Slipway and Engineering Company, of Newcastle-on-Tyne. At the trial were present the owners and many of their friends, together with Mr. Taylor, inspecting engineer, and Captain Brunton, under whose superintendence and inspection the vessel has been built.

On Saturday morning there was launched from the shipbuilding yard of Messrs. C. S. Swan and Hunter, of Wallsend, a fine steel screw steamer, built to the order of Mr. W. R. Rea and Mr. Charles M. Legg, of Belfast. This steamer is of the partial awning deck type, with long full poop, raised quarter-deck forward, and top-gallant forecastle, thus improving upon the common design of these steamers, with a view to obtaining more measurement space at the after end of the vessel, and to ensure her trimming better when loaded with homogeneous cargo. The steamer has a cellular double bottom throughout the length for water ballast. She will also be fitted with powerful steam winches, as well as steam steering gear, steam windlass, &c., all by the best local makers. The dimensions of the vessel are:—312ft. between perpendiculars; breadth, 41ft.; depth, 23ft. 1½in. moulded; and she has been designed to carry deadweight cargo of 4350 tons on a moderate draught, as well as an unusually large measurement cargo. The machinery is being constructed by the North-Eastern Marine Engineering Company, of Wallsend, and consists of a set of their most recently designed engines, with cylinders 23in., 38in., and 61in., by 39in. stroke; two steel boilers, 14ft. 9in. by 10ft. During the construction the steamer and machinery have been superintended by Mr. Joseph Lewis, of Belfast, on behalf of the owners. On leaving the ways the vessel was named the Thornley by Mrs. Rea, who, together with Mr. Rea, travelled especially from Belfast for the purpose.

THE IRON, COAL, AND GENERAL TRADE OF BIRMINGHAM, WOLVERHAMPTON AND OTHER DISTRICTS.

(*From our own Correspondent.*)

In the finished iron trade the home consumption appears to be extending, and shipping houses are inquiring for heavy supplies. Best bar makers are doing a steady trade at £7, and for merchant bars there is a fair inquiry at £6 5s. The manufacturers of common bars have more work in hand at £5 7s. 6d. upwards, £5 15s. being the maximum. The high price of spelter continues to assist to strengthen the prices of sheets. June deliveries were quoted to-day—Thursday—in Birmingham at £19 2s. 6d. per ton, and forward deliveries £18 17s. 6d. The German galvanised sheet makers are declared to be getting their spelter at £1 per ton less than their English *confrères*, and their black sheet iron at also £1 per ton less. This handicapping has not yet much affected the English trade; in fact, British makers were never before sending away so much iron as now. But if the differences noted are maintained, they cannot fail to tell by-and-bye. In this district some merchants are already placing orders for galvanised iron for export with Germany instead of at local works.

Owing to the interference with the running of the mills by the hot weather, sheet iron makers cannot deliver orders to customers as rapidly as desired. £10 7s. 6d. to £10 10s. is quoted for ordinary brands of galvanised corrugated sheets of 24 gauge, delivered Liverpool, but superior brands are quoted £11 7s. 6d. to £11 10s. Black sheets are quoted £6 15s. to £6 17s. 6d. for doubles and £7 15s. for lattens.

This week certain of our iron and steel firms report the receipt of orders on Japanese account for iron and steel, in the form of bars, sheets, and hoops, and contracts for railway bridgework, railway fastenings, and allied material have also of late been received. The orders are being placed through the London agents of the Japanese Government. One train load of iron and steel was despatched last week. Some of the contracts have been secured in competition with Belgian and German makers, and early delivery is pressed for. Much of the bridge and railway work will be put together in Japanese yards.

In the pig iron trade demand is well sustained, and prices are kept steady by the limited make which still prevails. Northamptonshire forge pigs are quoted 41s.; Derbyshire, 41s. to 42s. 6d.; and Lincolnshire forge, 44s. net at stations; Northamptonshire foundry metal No. 3 is 43s. 6d. to 44s., and Derbyshire, 45s. 6d. to 47s. 6d.; Staffordshire cold-blast all-mine pigs are quoted 92s. 6d. to 95s.; hot-blast all-mine 55s. to 57s. 6d.; part-mine, 42s. to 45s.; and cinder, 35s. to 38s. At current prices orders will be accepted for delivery three and six months forward.

Steel in the form of tin bars and blooms and billets is in many instances still superseding pig iron in this district, as a raw material for the mills and forges in a manner which evidences to a certainty that consumers will never go back to the old material. They find steel, as now produced at the great works, so eminently suitable for rolling down in the iron mills for the manufacture of sheets, hoops, strips, small rounds, &c., that the saving on the puddling process is very considerable. Tin bars and billets were quoted to-day £4 5s. to £4 7s. 6d., and some sellers even talked about £4 10s. to £4 12s. 6d. Steel joists, of 10in. or 12in. by 6in. in size, the produce of Scotch mills, were quoted £5 17s. 6d. in good quantities, with more money for small lots; tees, ordinary sections, were £6 7s. 6d. upwards, and angles of approved specifications, £5 12s. 6d. Bolckow, Vaughan, and Co.'s steel plates for engineering purposes were £5 15s. and upwards, delivered in Midlands, and boiler plates, £6 5s. The Lilleshall Steel Company, Shropshire, quoted steel wire rolls, No. 6 and upwards, £5 15s.; plating bars, £5 5s.; and round and square, up to 2in., £5 15s. Cold-rolled and close annealed working-up steel sheets, the products of local mills, were quoted on the basis of £9 5s. to £9 10s. for singles.

The local coal trade is disturbed this week by the unsettled state of the Conciliation Board question, and the fervent hope is expressed that the difficulties which seem to be ahead may, by the exercise of mutual forbearance and caution, be if possible averted.

On Tuesday a large gathering of representatives of the cycle industries attended at the Holford Works of Messrs. Accles, Limited, Birmingham, to witness experiments in the new lu-mi-num metal, which it is claimed will supersede steel. The metal consists of 96 per cent. of aluminium and four of alloy. Cycle frames are cast complete in tubular shape without joints. The tests show the tube could withstand pressure of 3000 lb. without deflecting. The metal, which is incorrodible, is of equal strength to best wrought iron, but only one-third the weight.

The Staffordshire Institute of Iron and Steel Works Managers have just paid a visit to Woolwich Arsenal, the occasion being the annual excursion of the Institute. After inspecting the magnificent engine plant, the party had the privilege of witnessing the various processes of the manufacture of heavy guns. On all hands were to be seen ponderous armament, the heaviest being the 110-ton and 67-ton guns, the former of which is not now manufactured. A large number of the new 47-ton quick-firing breech-loaders were in course of construction, the special feature of these pieces being the wire lining introduced only two years ago. Each of these guns is bored out of solid cast steel, and is fitted with two cases, the inner one of which is encircled with about 13½ tons of wire, for the purpose of imparting additional strength to the weapon. Among the objects of special interest in this department were a 40-ton hammer, capable of striking a blow of 1000 tons, and a radial crane possessing a lifting power of the same tonnage.

The fact that there has been no boiler explosion at any works in the South Staffordshire district for a period of about eighteen months goes to show that local steam users generally are exercising careful supervision. There are, however, people who still manifest indifference, which might, if not carefully watched, bring about very regrettable results. In the report of the Chief Inspector of Factories and Workshops for 1895, it is narrated that one man bought a boiler and 4-horse engine for £10, including erection. Neither the man nor his employés knew anything about boilers, and no proper advice was obtained in the matter. The natural consequence was an explosion, killing one young person and injuring two men. Another boiler was found working minus water-feed, water gauge, and steam pressure gauge. The boiler is filled from the manhole, which is then screwed down. The safety valve is regulated by weights on a long lever, and from the time the fire is lighted there is no indication of the water or the pressure of steam.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—Except that the general activity throughout the engineering and iron-using industries does not bring about a corresponding improvement as regards prices, for raw and also for manufactured material, the position, taking it all through, continues satisfactory. As I have pointed out previously, the enormous means of production are more than sufficient to keep pace with any possible demand for home consumption, and no matter how active the iron-using trades of this country may be, unless a foreign outlet can be found for a large proportion of the production of raw material, excessive supplies will cause keen competition for business, which necessarily keeps down prices at a very low level. The result is that whilst the engineering industries are almost as busy as they possibly can be, makers of pig iron are unable to command any very remunerative prices for raw material; much the same applies to steel, both in its raw and manufactured condition, but finished iron is beginning to benefit from the activity in this branch of trade on the Continent, which is enabling English makers to export considerable quantities where they have hitherto been kept out by foreign competition.

A generally healthy tone characterised the Manchester Iron Market on Tuesday, and there was a full average attendance, with a fair inquiry both for raw and manufactured material. For pig iron a moderate demand comes forward, with prices steady at about late rates. Local makers are very firm at their full list rates, and are booking a tolerable weight of orders both in foundry and forge numbers. Some fairly good inquiries are stirring for forge Lincolnshire, and although the recent advance of 6d. per ton has not in all cases been made the official list price, it is quite exceptional where makers are now quoting under 41s. 6d., and one or two moderately large offers, based on the old list rates of 41s. net cash, delivered Manchester, have been declined. The Warrington forges especially are inquiring for considerable quantities, with about 41s. 2d. as the basis on which they are prepared to place orders for delivery in that district. Both Lincolnshire and Derbyshire foundry qualities remain firm at late quotations. Outside brands offering here are not appreciably affected by the further giving way in warrants, but there are low sellers of Scotch, with Middlesbrough not quite so strong as it has been. Makers' quotations, however, remain at about 45s. 10d. to 46s. 4d. for good foundry Middlesbrough delivered by rail Manchester, with Eglinton 46s. to 46s. 6d. delivered Lancashire ports, and 48s. 3d. to 48s. 9d. delivered Dock Quays, Manchester, and Glengarnock about 6d. to 9d. above these figures.

Manufactured iron makers are all full of work, and report new orders coming forward in increasing quantity, with a fairly good foreign trade being put through, owing to the advance of prices on the Continent. Lancashire bars have in one or two cases been advanced 2s. 6d. per ton, and £5 10s. to £5 12s. 6d. are now the general quotations, with North Staffordshire bars also hardening, and only in special cases to be bought under £5 12s. 6d. to £5 15s., delivered here. Sheets are firm at £7 5s. as about the minimum, and hoops at £6 2s. 6d. for random to £6 7s. 6d. for special cut lengths, delivered Manchester district, and 2s. 6d. less for shipment.

A fair business is stirring in the steel trade, with no change in prices. Hematites are firm at 57s. 6d. to 58s., less 2½; ordinary steel billets remain at £4 7s. 6d. net cash; boiler plates £6 5s.; any attempt to get more than this generally results in orders going elsewhere, whilst local-made steel bars, although quoted £6, might be bought at a trifle less.

The metal market continues strong, with an active demand for all descriptions of manufactured goods, at the advanced rates quoted last week, which have been readily got by manufacturers.

The activity which I have reported recently throughout the engineering trades is not only fully maintained, but in most of the leading branches new work comes forward in increasing quantity, until it is now with many of the leading firms more a question of delivery than of booking orders. Some of the tool makers, who have, perhaps, not been so full of work for many years past, are quite unable to book further orders, where anything like early delivery is required. Locomotive builders are also in much the same position, and are supplied with orders, both on home and foreign accounts, to keep them fully going over the remainder of the year, whilst new work still comes forward steadily, the Vulcan Foundry Company, of Newton-le-Willows, having during the past week booked sixteen heavy goods engines for the East India Railway. Boiler makers, are not perhaps getting quite so much work as a short time back, but are all still well engaged. Stationary engine builders, although they have no great pressure of work on home accounts, are very busy on orders for India, China, and Japan, the two last-named countries being just now much more important customers than India, and a good deal of heavy engine plant is being sent out, connected with the equipment of new mills, whilst the rapid development of the textile industry both in China and Japan has also placed large orders for machinery in the hands of local machinists, who are full of work for a considerable time ahead.

Messrs. Holden and Brooke, of Salford, have just completed an installation for heating the Manchester General Post-office, which is on rather novel lines. Hot water is forced through the entire building by means of four "exhaust" injectors, which are worked by the exhaust steam from either the electric light or pneumatic engines. The system has, I understand, been patented by Mr. Brooke, and was worked out in conjunction with Mr. J. W. Curra, of the Engineering Department, St. Martin's-le-Grand. It may be added that the injectors in question supply twenty-eight different circuits of heating pipe, the quantity of hot water supplied to each circuit being independently controlled by the man in charge, without interfering with the working of the injectors, or the quantity of water passing through the other pipes.

I had an opportunity the other day of inspecting the new electric lighting installation which has been put down throughout the Manchester and Salford Docks of the Ship Canal. The previous system for lighting the docks was to a large extent only of a temporary character, and was split up into three temporary stations, with portable engines, which proved to be not only expensive but inefficient. Acting upon the strong recommendations of Mr. Hunter, their engineer, the directors have at length decided to face the expenditure required to place the electric lighting on a permanent basis, in one central station, and this work has now been completed, with the result that nearly double the light is now obtained, and it is hoped that there will be a considerable reduction in the working expenses. The plant for the new electric installation includes two sets of 100 brake horse-power inverted cylinder engines by Goodfellow, of Hyde, and two sets of 30 brake horse-power similar engines by Browett and Lindley, of Patricroft, the engines being each fitted with ejector condensers. The lighting area includes the Manchester and Salford Docks, the Mode Wheel Locks, and the whole of the dock sheds and offices. The previous electric lighting consisted of 66 continuous current arc lamps. These have now been supplemented by 28 alternating arc lamps, 100 thirty-two-candle power, and 28 sixteen-candle power incandescent lamps, the latter being used entirely for lighting the offices and sheds, and this portion of the work has been carried out by Messrs. Baxendale and Co., of Manchester.

Another important addition to the equipment of the Manchester end of the Ship Canal is the additional hydraulic power put down for working the gradually increasing number of hydraulic cranes, and for operating the locks and bridges, which has become necessary owing to the steadily enlarging volume of traffic. At Mode Wheel supplementary hydraulic plant is being put down consisting of two sets of inverted cylinder jet condensing triple-expansion engines, each capable of giving off 20,000 gallons of water per hour at forty revolutions per minute, with a boiler pressure of 160 lb., supplied by the Glenfield Co., Kilmarnock. The steam power is supplied by a couple of steel Lancashire boilers 8ft. diameter, and 30ft. long, made by the Oldham Boiler Works Co. The boiler feed pumps have been supplied by Messrs. Frank Pearn and Co., and there are also two sets of horizontal duplex pumps for pumping water from the canal to the supply tank.

All descriptions of round coal remain in much the same depressed condition as reported last week. In the better qualities suitable for house-fire purposes heavy stocks are accumulating at most of the collieries, notwithstanding very few of them are working more than three to four days per week. Prices are without quotable change, but where business is concerned the tone is weak, and extremely low figures are taken to effect clearance sales, many of the collieries having a very large number of wagons under load at the sidings. Common round coals continue plentiful, and low in price, notwithstanding fairly large requirements for iron-making, steam, and general manufacturing purposes; and for ordinary steam and forge qualities not more than about 5s. 6d. to 6s. is being got at the pit mouth. The gas coal contracts for the ensuing season are now being gradually settled, and the general basis of prices is quite 3d. under last year's rates, the better qualities, in some instances, having been offered at extremely low figures. At the pit mouth ordinary Wigan 4ft. gas coal would seem to average about 6s., and ordinary Arley gas coal 6s. 9d. to 7s. per ton. As regards engine fuel, the limited supplies now offering move away readily, and in most cases colliery owners have no difficulty in getting some advance upon recent quotations, representing generally about 3d. to 6d. per ton. At the pit mouth, 3s. 3d. to 3s. 9d. are about the average figures for common, and 4s. 6d. to 5s. for better qualities of slack.

Rather more business is being done in the shipping trade, chiefly in the medium qualities of house coal for Ireland, but steam coal continues difficult to sell, and quite as low in price as ever.

Barrow.—The market for hematites in the West Coast district is unaltered, and makers are still busy on orders placed some time ago, while reporting a brisk inquiry at the immediate moment for forward as well as for prompt deliveries. Prices are, however, weaker so far as warrant iron is concerned. Sellers are doing business at 46s. 11½d. net cash, and buyers are offering 46s. 10½d. Makers, on the other hand, quote 48s. to 49s. per ton for parcels of mixed Bessemer numbers net f.o.b. During the week two furnaces have been blown out—one in Furness and the other in Cumberland, and there are now thirty-seven furnaces in blast, as compared with thirty in the corresponding week of last year. Stocks again show an increase this week to the extent of 950 tons. There is now in hand 314,093 tons, or an increase of 24,917 tons since the beginning of the year.

Iron ore is in rather smaller request consequent on the blowing out of furnaces, but prices are steady at 10s. per ton for ordinary sorts net at mines, best descriptions ranging up to 14s. 6d. per ton at mines. Spanish ores of 50 per cent. quality are at 12s., and 60 per cent. at 12s. 9d. per ton net at West Coast ports.

The steel trade is very briskly employed. The activity in the rail trade is very marked, and makers have not only secured good orders, but are in receipt of inquiries which justify hopes of a continuance for some months to come of the present run of activity. There is also a very steady business doing in steel shipbuilding material of all sorts, and the market is especially firm in plates and heavy steel castings. All other branches of the local steel trade show life.

Shipbuilders and marine engineers are busy, but report no new orders. The Powerful, first-class cruiser, was on view last week at Barrow in aid of the local charities, and £249 7s. 8d. was realised. This cruiser is now ready for delivery to the Admiralty, and is waiting for a navigating party to take her round to Portsmouth.

The coal trade is quiet, and the coke trade is a shade weaker.

Shipping shows an improvement. The exports of pig iron from West Coast ports during the past week amounted to 7790 tons, and steel to 11,655 tons, as compared with 3235 tons of pig iron, and 6897 tons of steel in the corresponding week of last year. The aggregate shipping returns this year so far show 147,752 tons of pig iron, and 226,054 tons of steel, as compared with 126,748 tons of pig iron, and 170,799 tons of steel in the corresponding period of last year, an increase of 21,004 tons of pig iron, and 55,255 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

QUIETUDE still marks the coal trade, with very little prospect of change either in manufacturing or household fuel. Various disputes are still dragging their slow length along at district collieries, and neither side appears particularly anxious for a settlement, as there is not any sign of a concession being made with that view.

The miner's union is actively supporting the men, and as trade is so very quiet, the miners find very little choice between "playing" with the union allowance and endeavouring to resume work for two or three days a week. As it is, with the diminished employment, household fuel is accumulating in almost all directions, while steam coal is more abundantly brought to bank than there is any likelihood of its being used. A small tonnage is being sent by rail to the metropolis, where the demand for inland coal is still further attenuated by the low rates charged from Cardiff and the North of England. A fair tonnage of South Yorkshire coal is being taken to the Eastern Counties, and a good demand for steam coal is still reported for the Humber ports, with the exception of Grimsby, where a decrease is exhibited. Although the quotations remain unchanged the tendency is undoubtedly downwards. Best Silkstones make from 8s. to 9s. per ton; secondary qualities from about 6s. 9d. per ton upwards; Barnsley house, 7s. to 8s. per ton; thin seam coal from 5s. to 6s. per ton. Steam coal, Barnsley hards, is purchaseable at 6s. 6d. to 7s. per ton; Parkgate and secondary qualities making from 5s. 9d. per ton. Gas coal is rather quiet at prices previously quoted. The Gas Committees of several corporations, with a lively recollection of what took place in 1893, have been asking the gas companies to consent to what is called the strike clause in their contracts. The effect of that clause is in the event of a strike occurring to make the colliery owners responsible for maintaining supplies to the extent at least of all the surplus coal on the pit banks. The suggestion has not been favourably received, and several coalowners have consequently refused to contract. An improvement in trade is shown in the demand for small stuff for coking purposes. In these qualities values are firm, and in several instances rather higher terms are obtained. Small nuts make 4s. 3d. to 5s. per ton; screened slack from 3s. 3d. per ton; pit slack from 2s. 6d. per ton; smudge from 1s. to 2s. per per ton, all at the pits. There is a better demand for coke in spite of the increased output from the new ovens. Values remain firm at 8s. 6d. to 10s. 6d. for ordinary qualities, up to 12s. 6d. for the highest grades. Although there is some anxiety as to the action which may follow the conference between the coalowners and the miners' leaders, very little doubt is entertained that the present condition of affairs will continue without any active hostility over the general coalfield.

In the pig iron trade there has been a distinct improvement following the lull of the last two or three months. Several heavy purchases have been made, covering periods as far forward as the beginning and the middle of 1897. An increasing desire to cover requirements for the next half-year, if continued, is certain to bring about a further stiffening in prices. Already in one or two instances local makes have been advanced 6d. per ton for future deliveries. There is a little more doing in railway material, which in its turn has affected the business in bar iron. Prices are as follows:—Hematites, mixed numbers, East Coast, 53s. to 53s. 6d.; West Coast, 57s. to 57s. 6d. At these quotations, which are delivered in Sheffield, a brisk business in proceeding. Derbyshire foundry, No. 3, 41s. 6d.; No. 4 forge, 37s. 6d. to 38s.; Lincolnshire forge, 39s.; foundry, No. 3, 41s. to 41s. 6d.; bar iron, £5 5s. to £5 10s.; sheets, £7 to £7 10s.; steel boiler plates, £6 5s. to £6 7s. 6d. An active business is reported in crucible steel, which is stated to be more briskly called for than at any time during the last sixteen years. As a result, competent steel melters are being wanted. Much of the steel thus called for is used up in the cutlery, edge tools, and file branches. The engineering establishments of the country are also making heavy demands, and the call from abroad is unusually important. As a consequence, the rolling mills, although not all fully occupied, are much better off than they were a month ago.

The thirty-second annual report of Messrs. John Brown and Co., Atlas Steel and Ironworks, Sheffield, is very satisfactory. The directors state that the improvement in the trade of the country has had a most beneficial effect on their general business, the various departments producing railway and shipbuilding material having done better than for several years. The armour-plate department has been well employed. The large expenditure recently incurred has enabled the company to execute all orders received for armour without difficulty; but the directors add that the means of production of armour in this country have so much increased that unless large orders are shortly placed it is feared this department will not be fully occupied. The output of the collieries has been considerable, but, owing to the competition of other districts, the price has been so low as to be almost unremunerative. Two of the seams at Car House could only be worked at a loss, and have, therefore, been closed. The directors add that the prospects generally of the South Yorkshire coal trade are at present exceedingly gloomy. The net profit of the year is £122,368 5s. 9d., out of which it is recommended that £25,000 be added to the reserve fund, which will then amount to £225,000, and that a dividend should be paid on the ordinary shares at the rate of 7½ per cent. per annum—as compared with 5 per cent. last year. A balance of £35,385 is carried forward. Lieut.-Col. Davies—late R. E.—has been appointed to fill the vacancy on the directorate caused by the death of Mr. H. D. Pochin.

Messrs. Thos. Stainforth and Co., Hackenthorpe, near Rotherham, are directing attention to Helliwell's patent safety appliance for shafts and pulleys, of which they are sole proprietors and manufacturers. They have this invention at their own establishment, and it is also in use at the Master Cutler's Works—Messrs. John Henry Andrew and Co., Toledo Steel Works, Sheffield. Captain Smith, Chief Inspector of Factories and Workshops, strongly recommends the appliance, for which it is claimed that when fixed it is impossible for any person, or for their clothes, to get caught with either the shafting or by the arms of the pulleys. As these are two main sources of danger and cause of accidents, the makers claim that the appliance renders all pulleys and shaftings quite safe, and thereby ensures immunity from accidents, besides effecting a saving and economy in belts. It can be easily adapted to any horizontal, vertical, or oblique shafting, in any situation, either on the floor, ceiling, or walls. "The very large number of fatal and other accidents caused by revolving shafting," says the chief inspector, "has always been a serious consideration," and he reports to the Home Secretary that the appliance invented by Mr. Halliwell for the fencing of shafting and drums would, if adopted, "save many lives."

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

WHILE almost all branches of the finished iron and steel industries and also the allied traders are showing improvement, and manufacturers speak cheerfully of their prospects, the pig iron market is dull and unsatisfactory, and prices are easier, not because of any change for the worse in legitimate trade, but because of the speculative operations in Glasgow. All the favourable statistics, the active deliveries, and the decreasing stocks go for nothing in face of a fall in warrants, however such fall may be brought about. It appears strange that Cleveland, which makes three times as much pig iron as Scotland, should be ruled by the latter in fixing the price of its iron. But Cleveland iron is not so much of a medium for speculation as Scotch, though it has to a great extent to follow the fluctuations in the latter. During the last few days the "bears" have been endeavouring to "cover," and to do this on the best terms they have been doing their best to force down prices, effecting this by offering small lots of pig iron at low prices, and this causes disquietude among the weak holders of warrants, and impels them to clear out. Ordinary consumers will scarcely buy at all in a drooping market, so that very little has this week been done in the way of distributing fresh orders for pig iron this week. But if sales of pig iron have been small, deliveries have been very heavy; in fact, altogether there have never been more favourable statistics in connection with the pig iron trade of the North of England, and these do not justify the prices that are now ruling. The production is the largest on record, yet it is more than equalled by the present requirements, and it is estimated that the stock of Cleveland pig iron at the close of the month will show a decrease of at least 5000 tons. The great activity in trade is also attested by the pig iron exports, which are the best on record; this is the more remarkable because June is usually a quiet period for exporting. It was generally predicted in the early part of the month that deliveries oversea would slacken, especially when they had been so much above the average during the previous three months; but instead of that they have further increased, and from the Cleveland district to Wednesday night they have this month reached 87,614 tons, as compared with 78,345 tons last month, 84,517 tons in April, and 82,774 tons in June, 1895, to 24th. The deliveries to local and inland works are also large, and are likely to continue so, judging from the reports of consumers respecting their business.

The production of pig iron this month will be smaller than it was last month, and a larger proportion will be of the commoner qualities. Hitherto this year it has been somewhat difficult at times to procure No. 4 foundry and all forge qualities, more especially white, because the furnaces were working so well that their output was chiefly Nos. 1 and 3. But the hot weather this month has brought about an alteration, and quantity and quality have suffered, so that some producers have found it difficult to fulfil promptly all their orders for No. 3.

Makers generally have this week kept to their last week's quotations for Cleveland pig iron; but merchants and some of the producers, influenced by the fall in warrants, have been accepting lower rates. Thus No. 3 Cleveland pig iron for prompt f.o.b. delivery has been obtainable at 37s. 3d., and some will accept 37s. 6d. for deliveries to be made over the next two months; but few consumers will buy for forward delivery when the warrant market is so flat. No. 1 is sold at 38s. 6d. Cleveland warrants, which last week fluctuated about 37s. 6d. cash, have this week been about 37s. 1d. The return of stock of Cleveland pig iron in the public warrant stores is satisfactory; in fact, it is some years since it was so much in favour of the sellers. Connals on Wednesday night held 199,152 tons, or 702 tons increase this month. No. 4 Cleveland foundry pig iron has dropped to 36s. 6d.; grey forge to 36s.; and white to 35s. 9d., all for early delivery. Cleveland pig iron, and especially the Redcar brand, is finding increasing favour in Japan. This week a very large four-masted sailing vessel, the Prince Robert—a Liverpool-built but Norwegian-owned ship—is taking in at Messrs. Walker, Maynard, and Co.'s wharf a cargo of their Redcar pig iron for Japan.

Mixed numbers of East Coast hematite pig iron are obtainable at 45s. 6d. per ton, but makers generally hold out for more. Rubio ore continues firm at the recent advance, and scarcely any can be procured under 12s. 9d. per ton, delivered at Tees wharves, or 7s. 4½d. f.o.b. Bilbao. Consumers are apprehensive that a tax on iron ore exported will be put on by the Spanish Government, so as to help to provide funds to quell the rebellion in Cuba.

The finished iron and steel industries are generally in an encouraging condition, work is plentiful and prospects good. Some of the bar manufacturers say they have never known the demand to be so brisk, and they have this week advanced their quotations 2s. 6d. per ton. The demand is specially good for the lighter descriptions of iron and steel, such as sheets, rounds, flats, rivets, bolts, wire rods, nails, &c., and the production of these has not for many years been so large as it is at present. Common iron bars are now £5 per ton, less 2½ per cent. f.o.t. Steel ship plates are at £5; steel boiler plates, £6; steel girder plates, £5 5s.; steel ship angles, £4 17s. 6d.; steel engineering angles, £5; iron ship plates, £4 17s. 6d.; iron angles, £4 15s.; all less 2½ per cent. f.o.t. Heavy steel rails are nominally at £4 10s. net at works, but producers have to be content with considerably less where the competition is keen. Cast iron chairs are in brisker request than has been known for some years, as there is now very little competition with steel sleepers, and something better in the way of prices should be realised; at present, £2 17s. 6d. net at works has to be taken.

The directors of Messrs. Head, Wrightson and Co., Teesdale Iron and Engineering Works, Thornaby-on-Tees, report that during the year ended April 30th last their gross profit was £15,467 11s. 1d.; to this they add £249 8s. 6d., and they propose to distribute the total as under:—£5122 1s. 7d. in interest on debentures, £5250 in a 2½ per cent. dividend for the year to the ordinary shareholders, £5166 13s. 4d. in direction and management fees, and a balance of £178 4s. 8d. is to be carried forward to next year. The contracts on hand are stated to be considerable and though prices are low, it is anticipated that a fair profit will be realised. In order to execute contracts within the stipulated time for delivery, the directors have, as already reported in these columns, rented the Eaglescliffe Foundry, near Stockton—a foundry which was established and worked by Messrs. H. Smith and F. W. Stoker, but has been idle for some years.

On Saturday last Messrs. Furness, Withy, and Co. opened a new graving dock at their shipyard at Middleton, near Hartlepool. The dock has been rendered necessary on account of the great extension of their business and the rapid growth of their fleet. It possesses every facility for the quick docking and undocking of vessels of the larger type, and being a tidal dock, it can be entered direct from the harbour without the vessel having to pass through locks of any kind. A large engine repairing shop, about 400ft. in length, has been built on the west side of the dock, together with copper and brass finishing shops. A "Goliath" crane, nearly 80ft. high, and capable of lifting up to 80 tons, has been erected. In connection with this yard a large new frame turning furnace and plant has been erected—one of the largest in the country—and with this and other new appliances Messrs. Furness, Withy, and Co. will be able to build similar steamers to the latest Cunarders. They have now some very large steamers in course of construction—one of about 6000 tons, for Messrs. Thomas Wilson, Sons, and Co., Hull. Within the last eighteen months the firm have reconstructed the whole of their works, and that without stopping in the least the building of vessels, for their last year's record was the largest in the company's records. The firm have put down a powerful electric installation to drive the whole of their machinery, and it is claimed that the Middleton shipyard is the only one in the country where the whole of the motive power is generated by electricity, and distributed from a central station over the entire works.

The death is recorded of Major Matthew Gray, the eldest son of Sir William Gray, the eminent shipbuilder, and also head of the Central Marine Engineering Works at West Hartlepool. Mr. M. Gray was connected with the shipyard, and was also proprietor of the West Hartlepool Iron and Steel Works; he was forty-one years old. Mr. John Atkinson, who has for many years been connected with the Seaton-Delaval Coal Company, died on the 19th inst.

The coal trade is dull, and is more so than usual this week, because in the Newcastle district the most of the collieries are idle owing to the races. Prices, however, are maintained, best Northumberland steam being at 8s. 6d. per ton f.o.b., and smalls 3s. 9d., whilst best Durham gas coals are 6s. 3d. to 6s. 6d. f.o.b. Coke can be bought at 13s. 6d. per ton delivered at Middlesbrough furnaces, and sellers are not so firm in their prices, owing to the plentiful supply.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Glasgow pig iron market was fairly active early in the week. On Monday about 60,000 tons of Scotch warrants were reported to have changed hands at from 46s. 1d. to 46s. 4d. cash. It was understood that considerable purchases were being made to cover over sales, but when these were completed, the prices reacted somewhat, and business was done in Scotch warrants down to 45s. 11½d. cash. There was comparatively little doing in Cleveland warrants, which sold between 37s. 1½d. and 37s. 0½d. cash. Hematite warrants were quiet from 46s. 11½d. to 47s., and down to 46s. 10½d. cash.

There is little or no change in the amount of the pig iron output. Ordinary pig iron is being made by thirty-eight furnaces, hematite by thirty-nine, and basic by three; the total of eighty furnaces now in operation in Scotland, comparing with seventy-five at this time last year.

Stocks of pig iron are accumulating, the addition in the Glasgow warrant stores in the past week amounting to 1194 tons, bringing up the total stock to 363,200 tons, compared with 282,220 tons at this time last year. The present cost of making pig iron is so moderate that merchants have little hesitation in purchasing for the store, and makers also appear to be of opinion that storing may ultimately be found to pay.

There is a fair demand for the different qualities of Scotch makers' pig iron. Prices, which had been nominally steady for a number of weeks, have, at length, given way a little, but in the circumstances of the trade the figures are still considered fairly satisfactory. Govan, and Monkland, f.o.b. at Glasgow, No. 1, are quoted 47s. 3d. per ton; No. 3, 45s. 9d.; Carnbroe, No. 1, 47s. 6d.; No. 3., 46s.; Clyde, No. 1, 49s. 6d.; No. 3, 46s. 6d.; Gartsherrie, Calder, and Summerlee, Nos. 1, 50s.; Nos. 3, 47s. 9d.; Coltness, No. 1, 52s. 6d.; No. 3, 48s.; Glengarnock, at Ardrossan, No. 1, 49s. 6d.; No. 3, 45s. 6d.; Eglinton, No. 1, 47s.; No. 3, 45s.; Dalmellington, at Ayr, No. 1, 46s. 6d.; No. 3, 44s. 6d.; Shotts, at Leith, No. 1, 52s.; No. 3, 48s. 6d.

Scotch made hematite pig is in steady demand, and merchants quote it at 50s. per ton free on trucks at the steel works.

The current imports of Cleveland pig iron into Scotland are not quite so good as of late, but there can be no question that the quantity of this iron going into consumption is large. The imports of the past week were 7551 tons, being 707 tons less than in the same week of 1895. Since the beginning of the year the total imports on the East Coast have been 208,460 tons, showing an increase for the year to date of 33,670 tons.

The demand for Scotch pig iron for shipment abroad is backward. The total shipments for the week, coastwise and foreign, reached 5565 tons, against 4359 in the same week of last year. Of the total the United States took 120 tons, Canada 262, South America 200, India 165, Australia 210, France 30, Italy 690, Germany 330, Holland 88, Belgium 25, Spain and Portugal 60, China and Japan 225, other countries 46, the coastwise shipments being 3114, against 2222 in the same week of last year.

The finished iron and steel branches are active, and makers and merchants report a good steady market for these materials, without appreciable change in prices.

Some very good shipbuilding and marine engineering contracts are at present in the market. Locomotive engineers, who were already very busy, working both day and night, have booked a number of fresh orders. Messrs. Dubs and Co., of Glasgow Locomotive Works, have contracted to build forty engines for the Cape, twenty for Natal, and twenty for India, and important locomotive contracts for the River Plate have gone to Newcastle.

There is not much alteration to note in the position of the coal trade. Shipments were good in the past week, reaching 164,637 tons, compared with 145,513 in the same week of 1895. Coals for manufacturing purposes at home are meeting with quite a brisk demand, but prices are still unsatisfactory. Main coal is quoted f.o.b. at Glasgow, 5s. 9d.; splint, 6s. 3d. to 6s. 6d.; ell, 6s. 3d. to 6s. 9d.; and steam, 7s. 6d. per ton.

The Corporation of Glasgow has purchased upwards of 400,000 tons of coals for the gasworks. These include 20,000 tons of first-class and 90,000 tons second-class cannel, and 70,000 tons steam coal. Splint coal was purchased at 6s. 3d. per ton. There is a reduction from last year's rates of 3d. to 6d. in the case of cannels and 1d. to 3d. in splints. The shipments have been good in Ayrshire, but coals are accumulating at the collieries there, and prices are kept down to the lowest point.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

LAST week was a good steam-coal week, and was characterised by large and steady outputs in various quarters, and a local shipment at the Cardiff ports alone of over 300,000 tons. Since then things have quieted down a little, and this week more interest is being taken in the visit of the Prince of Wales on Saturday than in ordinary business at docks and offices. Preparations are being carried out on a great scale to do honour to the event, and show the huge proportions to which Cardiff has arisen. After the furore, and when trade has got back into its old channels, I shall fully expect a good deal of activity, especially as regards best steam, the indication of this being in the large business booked for future delivery, and the firmness with which quotations are given for prompt shipment. Last week there was a fairly good coal trade at Newport. Swansea also indicated a good deal of activity, shipments to Italy being exceptionally good.

Mid-week coal quotations at Cardiff were as follows:—Best steam coal, 10s. 3d. to 10s. 6d.; special seconds, 9s. 9d. to 10s.; seconds, 9s. 3d. to 9s. 6d.; drys, 8s. 9d. to 9s.; best Monmouthshire, 8s. 3d. to 8s. 6d.; seconds, 8s.; best small, 4s. 9d. to 5s.; seconds, 4s. 3d. to 4s. 6d.; drys from 3s. 9d. House coal prices keep up fairly well. Cardiff figures are:—Best, 9s. 6d. to 10s. 3d.; No. 3 Rhondda, 9s. 6d. to 9s. 3d.; brush, 7s. 9d. to 8s.; small, 6s. to 6s. 3d; No. 2 Rhondda, 7s. to 7s. 3d. No. 2 Rhondda, 7s. to 7s. 3d.; through, 6s. to 6s. 3d.; small, 4s. to 4s. 3d. Swansea prices are:—Anthracite, best, 11s. to 11s. 3d.; second quality, 9s. to 10s.; ordinary large, 8s. to 8s. 9d.; small rubbly culm, 4s. to 4s. 6d.; steam coals, large, 9s. to 10s.; seconds, 8s. 3d. to 9s.; bituminous coals, No. 3, 9s. to 10s.; through, 8s. to 8s. 9d.; small, 6s. 3d. to 6s. 6d.; No. 2, 8s. 6d. to 9s. 6d.; through, 6s. 6d. to 6s. 9d.; small, 5s. to 5s. 3d.; patent fuel, 9s. 9d. to 10s. 3d. Cardiff prices are 10s. 3d. to 10s. 6d. Trade is fairly good at both places. Last week Swansea shipped over 8000 tons. Pitwood, Cardiff, 15s. 9d.; trade dull. Coke prices are firmly maintained. Cardiff quotations are:—Furnace, 12s. 9d. to 14s. 6d.; foundry, 15s. 6d. to 16s. 6d.; special foundry, 19s. 6d.

Iron ore market is active, and prices advancing. Cardiff prices: Best Rubio, 12s. to 12s. 3d.; Tafna, 11s. 6d. to 11s. 9d.; Garucha, 11s., c.i.f. Large quantities were received this week by the principal ironmasters. 3180 tons came into Swansea last week.

It is expected that Kenfig Hill Ironworks will start operations on July 1st. Preparations for lighting the furnaces are beginning. This is another indication of an improving iron and steel trade. In various districts the hope is expressed that the improvement will continue to spread, that there may be more activity at Tredegar, and a restart at Treforest, where everything is kept in capital order. Blaenavon and Ebbw Vale works continue busy, and at Cyfarthfa and Dowlais a better bar trade is being done, though amongst the mechanics at the latter works there is still a degree of friction which has resulted in the removal of a number of hands.

The Swansea Exchange report this week concerning the iron trade was very satisfactory. It was to the effect that the outlook in the finished iron and steel trades was better, that the principal works throughout the district were fully employed, and that the prospects of continued prosperity were assured. One good proof of this, I may add, is that the demand for Bessemer and Siemens bars are greater than the make, and in consequence prices have gone up 2s. 6d. per ton. Iron ore, too, is advanced, and quotations are 3d. per ton better. The annual report of the Ebbw Vale Company, given this week, is interesting, as giving an outlook from a thoroughly practical source.

In the matter of steel rails reference is made to the fact, tolerably well known to most business men, that quotations are not very rigidly kept, and are modified by circumstances and conditions. Heavy steel rails were sold in the first half of the year, states the report, from £3 7s. 6d., free on board, and it was impossible to conceive that any profit could be made. In the second half things took a turn for the better. This improvement was shown to a modified extent in the tin bar trade, which was an important factor at Ebbw Vale. The report admits that up to 1892 the company was unable to compete in the manufacture of tin bars, but a vigorous effort was made in cultivating the trade, and a new tin bar mill had been added. Dealing in retrospect, the report admitted that the close of the year indicated a very serious state of things. Many of the tin-plate manufacturers had been obliged to close down, and the Ebbw Vale Company found themselves at the end of the year with several thousand tons of orders on their books, for which they were unable to obtain specifications and give delivery. Within the last few days, however, there had been a marked improvement in the price of tin-bars, which encouraged the directors to hope for better things in the future. Touching upon coal, it had been stated that the selling price was 9s. per ton, but at Newport the figure for some time had been 8s., which meant 6s. at the pits, and yet the Ebbw Vale Company had been able to do better than some of their neighbours in the Rhondda and Aberdare Valley. In concluding, the report cites the Ebbw Vale Company as a sound, solid, and substantial concern, which it was not in 1892, and augured great things from the election of Sir Wm. Barley to the board. The appointment of Sir William having been confirmed, he stated in reply that he had been over the works at Ebbw Vale, and found thatmuch of the plant was out of date, and some of their processes were antiquated, but he was not without hope that the company would pay a good dividend before long.

The works at Dowlais are beginning to suffer from the drought, and unless there is a downfall greater part will be idle. This is annoying at a time when there is a good demand for bars.

Swansea quotations, iron and steel, this week indicate a reduction during the week of 9d. in Scotch pig, 6d. per ton in Cleveland, and 7d. in hematite. This shows that make exceeds demand.

On 'Change, Swansea, this week it was mentioned that there is a considerable strain on the capacity of the Bessemer works, and with the heavy rail orders which are being pressed for shipment, the deliveries of tin bars are delayed. Want of water too is beginning to tell. Quotations this week are:—Glasgow pig, 46s.; Middlesbrough 37s.; hematite, 45s.; Welsh bars, £5 10s. to £5 12s. 6d. Iron plates from £6 to £6 17s. 6d.; steel plates the same. Steel rails, heavy sections, £4 7s. 6d. to £4 10s.; light, £5 10s. to £5 12s. 6d. Bessemer steel, tin-plate bars, £4. Siemens best, £4 2s. 6d. Tin-plates, Bessemer steel cokes, 9s. 3d. to 9s. 6d.; Siemens, 9s. 6d. to 10s.; ternes, 16s. 6d., 17s., 18s. 6d., to 21s.; best charcoal, 13s. to 13s. 9d., according to finish.

Block tin is at £60 15s. to £60 17s. 6d. Copper, Chili bars, £49 10s. to £49 12s. 6d.

The tin-plate trade now justifies the belief expressed some weeks ago in this column, that the "corner was being turned," and if no rush takes place to start idle mills, I shall fully expect a steady improvement. Prices now are beginning to move up, signs of a gratifying improvement are becoming more general, and the very gradual way in which this has been brought about points to a continuance. Sudden and spasmodic movements, though exciting at the time, are generally short-lived. Large orders for black plates are being booked at several of the works at Llanelly, Morriston, and Portardulais, principally for the Continent.

At Briton Ferry a large meeting of tin-plate workers was held last week, and a resolution come to that no further reduction in wages should be conceded.

The shipments of tin-plates last week were 43,570 boxes; received from works, 50,702 boxes; present stock, 148,313 boxes.

The Cardiff tramway scheme has again been under discussion, but the matter is not yet brought to a point. Like the threefold scheme at Swansea it hangs fire.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

IRON producers report an active condition of things all round. Orders on home and on foreign account are plentiful, and quotations have been well maintained.

The Silesian iron business remains in entirely the same position as before, and there is consequently nothing of interest to be reported this week. Makers and manufacturers are all very busy, and will continue so for a considerable time. Prices are moving upwards; especially bars and girders show a rising tendency. From July 1st basis price for bars will be M. 140 p.t. at works. Output of pig iron in Silesia was, for May of present year, 53,783 t., of which 31,175 t. were forge pig, 3505 t. Bessemer, 13,448 t. basic, and 5655 t. foundry pig. Production in May, 1895, was 44,651 t. From January 1st to May 31st of the present year 250,488 t. were produced, against 213,515 t. for the same period the year before. Consumption of pig iron was, for May, 1896, 51,398 t., of which 815 t. foundry pig were exported. During the first five months of present year 254,965 t. were consumed; export amounted to 3437 t., of which Austria received 3002 t., Russia 405 t., and Roumania 30 t.

A comparatively quiet sort of trade is being transacted on the Austro-Hungarian iron market. The pig iron business is fairly active, and so is the malleable iron department, orders for bars and structural iron coming to hand pretty freely. In wire, wire nails, and axles only a moderate demand is experienced, but fairly good prices are on the whole realised. Consumption of coal on the Austrian State Railways was for 1895:—Brown coal, 700·55 t.; pit coal, 487·618 t.; and coke, 3133 t.

On the French iron market a healthy business has been done upon the week. Pig iron is selling briskly at satisfactory prices, and finished iron and steel manufacturers have also booked a considerable amount of orders, and will be able to keep their establishments in full operation for several months ahead. There is consequently no easing of prices; on the contrary, advances have, in several instances, been ventured, and with success, too. The French Northern Railway has tried, by reducing the tariffs for coke and coal from the North to the East Departments, to limit the imports of English, Belgian, and German coal. The following figures show this attempt to have been fairly successful:—

	1895. t.		1894. t.		Difference. t.
Coal from the North and Pas de Calais district	8,651,180	..	7,976,805	..	+ 674,375
Belgian coal	1,942,145	..	2,017,785	..	− 75,640
English coal	148,520	..	194,815	..	− 46,295
German coal	123,355	..	150,055	..	− 26,700
Totals	10,865,200	..	10,339,460	..	+ 525,740

General satisfaction is expressed with regard to the situation of the Belgian iron industry, and prospects are decidedly favourable. The Belgian State Railway Administration have submitted to the Chamber of Deputies a request to grant an extra sum of 36,712,290f. for the extension of railway lines, building of railway stations, and for heavy purchases in rolling material—24 locomotives and 1744 load wagons. As the Chamber is sure to consent, the activity in the engineering industries will be a very good one for several months to come.

The Rhenish-Westphalian iron market shows much briskness, while prices are generally rising; in all departments increasing employment is reported, home and foreign orders being numerous. There had been some little trace of a decrease in the demand for iron ore last week, but this week a brisk business is again transacted, and quotations are extremely firm, spathose iron ore fetching M. 9 to 9·60 p.t.; roasted ditto, M. 12 to 13 p.t.; calcined iron ore, M. 12 to 14 p.t., net at mines. Here and there orders for the first two quarters of 1897 have already been secured at advanced rates. Minette of Luxemburg and Lorraine is also well inquired for, and quotations seem inclined to rise; at date M. 240 and 260 p.t. is paid for common sorts, while the 40 per cent. grade stands on M. 320 p.t. at mines. The pig iron market does not present any perceptible change since last week, the activity at the blast furnaces being as good as can be. Both prices and demand exhibit an inclination to rise, and stocks are very small now. For spiegeleisen, 10 to 12 per cent. grade, M. 59 p.t. is quoted; forge pig, No. 1, M. 53 to 55 p.t.; No. 3, M. 42 p.t.; hematite, M. 65 p.t.; foundry pig, No. 1, M. 65 p.t; No. 3, M. 57 p.t.; basic, M. 54 p.t. Iron for making steel, M. 53 to 54 p.t. at works. Luxemburg forge pig is offered at 56f. p.t., free Luxemburg.

In all branches of the malleable iron industry the business done is most satisfactory. Some fairly good export orders have been coming in, which, added to the continually increasing demand on home account, promise good employment for the remaining part of the year. Bars continue very briskly called for, and are exceedingly firm in quotation; the South German Rolling Mill Convention raised basic prices for bars on M. 121 p.t., free Neunkirchen. Hoops are in lively request, and so are plates, which have been fetching better prices, an allowance of M. 5 p.t. having been agreed upon last week. The sheet mills are at present rather less active than during the previous month, but this does not affect the general tone, makers being just as confident as before, and expect a lasting improvement in demand to take place in a few weeks. The majority of the machine factories and construction shops are vigorously engaged, and report their prices to be in better proportion to those of the raw materials.

This week's list quotations per ton at works are as under:—Good merchant bars, M. 120 to M. 122; angles, M 130; hoops, M. 125; billets in basic and Bessemer, M. 85 to M. 86; heavy plates, for boiler-making purposes, M. 165 to M. 170; tank plates, M. 135 to M. 140; steel plates, M. 145 to M. 150; tank ditto, M. 120 to M. 125; sheets, M. 155 to M. 160; iron wire rods, common quality, M. 130; drawn wire in iron or steel, M. 120 to M. 138; wire rails, M. 127 to M. 130; rivet iron, M. 140 to M. 142; rivets, good merchant quality, M. 185 to M. 190; complete sets of wheels and axles, M. 280 to M. 290; axles, M. 220; steel tires, M. 200; steel rails, M. 118; steel sleepers, M. 110; fish-plates, M. 120 to M. 130; light section rails, M. 100.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, June 18th.

THE commercial situation is on the eve of an improvement, which will probably bring with it stronger prices for immediate deliveries of iron and steel products and general merchandise. The industries are not crowded. Prices are weak. The strongest possible inducements held out to consumers to anticipate fall requirements fail to bring out orders for more than current requirements. Pig iron production is declining, and stocks are slowly increasing. Billets are kept at combination prices, and coke and ore at their early spring figures. Various associations and combinations unite manufacturing interests in the maintenance of quotations a notch or two above what unrestricted competition would fix. The out look is encouraging. Iron reports from a dozen interior centres indicate an unsettled condition. The Amalgamated Association desire an advance in wages, which manufacturers are not inclined to grant. Bar iron makers have not effected a working association. The nail makers see breakers ahead in an accumulation of stock. The plate and structural material manufacturers count on a busy half-year, because of the large amount of construction and bridge work determined upon. If the announcements of the railroad and engineering journals are to be taken as true, there will be a very great increase during the next twelve months in the amount of general work involving plates and shapes. Boatbuilding on the Lakes is promising. Small bridge work for street crossings and small streams is quite a feature. Girder rails on tramways are now wanted for many lines. With the promulgation of a political platform this week at St. Louis, the business interests well know what is to be policy of the next Administration, and it it probable that much delayed work will then be taken in hand.

THE INSTITUTION OF CIVIL ENGINEERS.—Mr. J. H. T. Tudsbery, M. Inst. C.E., has been appointed secretary of the Institution. Mr. James Forrest who has so many years directed its affairs having now retired to enjoy a well-merited repose.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "comunicated" the name and address of the communicating party are printed in italics.

10th June, 1896.

12,744. Aerial Machines, F. W. Lanchester, London.
12,745. Horseshoes, S. Gillmah, London.
12,746. Two-pin Plug for Electric Lamps, W. J. Head, London.
12,747. Wheels for Tires of Bicycles, C. A. Rollason, London.
12,748. Breaking Balls of Tea Leaves, N. W. H. Sharpe, London.
12,749. Protecting Cover for Cyclists, R. Stead, London.
12,750. Hair-pin, A. C. Gibson, London.
12,751. Bottles for Preventing Fraud, E. M. Llewellyn, London.
12,752. Lamps, S. Galpin, London.
12,753. Rotary Strainers for Paper Pulp, H. Hobday, London.
12,754. Cycles, J. Brooks, Birmingham.
12,755. Electrical Insulation, The Telegraph Manufacturing Co., Ld., Helsby.
12,756. Brakes, D. H. Croll, Watford.
12,757. Driving Pulleys, T. C. Dennison, F. H. E. Shipton, and L. S. Carr, London.
12 758. Motive Power Engine, &c., H. M. L Crouan, London.
12,759. Facing Points for Permanent Way, H. Burnham, London.
12,760. Reservoir Attachment for Pens, M. A. Alves, London.
12,761. Reed Instruments, J. D. Brunton and H. Smith, London.
12,762. Attaching Labels to Bottles, F. B. Pye, London.
12,763. Air Guns, O. Will, London.
12,764. Drying Tea, W. A. Gibbs and G. W. Sutton, London.
12,765. Dissolving Drying Phosphates, J. Milne, London.
12,766 Brushes with Curved Backs, C. E. Flemming, London.
12,767. Casting Armour-plates, &c., H. V. Holden, London.
12,768. Pneumatic Tires for Cycles, J. C. Grant, London.
12,769. Felloes for Cycle Wheels, J. C. Grant, London.
12,770. Chains, M. A. Wier, London.
12,771. Producer and Water Gas, C. Whitfield, London.
12,772. Means for Producing Designs, T. Sardnal, London.
12,773. Petroleum Burners. H. Schneider, London.
12,774. Sprinklers, R. W. Newton, London.
12,775. Automatic Fire-extinguisher, R. W. Newton, London.
12,776. Rotary Explosion Motor, W. Hildebrand, London.
12,777. Attaching Air Pumps to Cycles, A. Stevens, London.
12,778. Vehicles and Boats, W. Ullrich and F. Biesecke, London.
12,779. Planting Trees and Posts, I. Panamá, London.
12 780. Pressing the Legs of Trousers, E. S. Doré, London.
12,781. Casting Stoppers, J. Hickling and T. Slater, London.
12,782. Carbonising Iron, A. Wilson and F. Stubbs, London.
12,783. Cover for Pneumatic Tires, E. S. Cook, London.
12,784. Pneumatic Tires, W. P. Thompson.—(*A. Fraipont, Belgium*.)
12,785. Reaping and Harvesting Machine, J. C. Moore, London.
12,786. Aerial Machines, H. S. Booth, Manchester.
12,787. Metallic and other Articles, T. P. Taylor, Birmingham.
12,788. Generating and Storing Acetylene, R. R. Gibbs, Liverpool.
12,789. Mouldings, J. Skegg, Manchester.
12.790. Driving Apparatus for Cycles, J. Higginbottom, Liverpool.
12,791. Cycle Tires, T. H. O'Brien and W. H. Sisson, Manchester.
12,792. Saucepan Brushes, C. Phillipsbourne, London.
12,793. Attachment for Drinking Vessels, C. C. Hull, London.
12,794. Propelling Cycles, G. S. Edwards, London.
12,795. Engines, E. J. Clubbe, A. W. Southey, and the Electric Motive Power Co., Ld., London.
12,796. Hammers, &c., M. Millar, C. Mossman, and S. Williams, London.
12,797. Velocipedes, A. Reyrol, London.
12,798. Lifts, I. Cizek and L. Maizner, London.
12,799. Stair Treads, F. Sage, London.
12,800. Driving Bands or Chains, W. G. Birkinshaw, London.
12,801. Gloves and Articles of Dress, P. E. L. Pedrizet, London.
12.802. Fasteners for Gloves, &c., P. E. L. Pendrizet, London.
12,803. Protective Advertising Covers, L. Echenard, London.
12,804. Cycle Variable Speed Gear, J. J. Truchot, London.
12,805. Oil Engines, G. J. Altham, London.
12,806. Sheave Mountings for Aerial Ropeways, J. P. Roe and The Ropeways Syndicate, Limited, London.
12,807. Nut-locks, C. C. Newton, London.
12,808. Brakes for Cycles, C. F. Rowe, London.
12,809. Gloves, E. Beck, London.

11th June, 1896.

12,810. Pneumatic Bearing for Cycles, W. S. Shreeve, Warwick.
12,811. Single Trigger Guns, F. Beesley, London.
12,812. Plaister for Dressing Wounds, T. D. Vint, Hastings.
12,813. Cog-wheels and Chain of Bicycles, &c., A. Hamilton, Belfast.
12,814. Burner for Incandescent Gas Lighting, J. Wilson, Birmingham.
12,815. Castors for Furniture, &c., H. S. Stewart, London.
12,816. Brakes for Bicycles, &c., J. R. Stoney, Dewsbury.
12,817. Steering Ships, T. A. Kennedy, Liverpool.
12,818. Machinery Granulating Oil-cake, J. Evans, Liverpool.
12,819. Chains for Cycles, E. D. Hopcroft, Kidderminster.
12,820. Motion for Working the Scrapers of Fuel Economisers, J. Pimbley, sen., and J. Pimbley, jun., Moses Gate, near Bolton.
12,821. Appliance for Attachment to Coats, R. E. Gribble, Bristol.
12,822. Rotary Engines, J. G. Whittles, S. H. Ogden, and S. Douglas, Manchester.
12,823. Protecting Pad for Backs of Picture Frames, J. Stewart, Glasgow.
12,824. Carriage Windows, E. H. Warden and G. P. Underhill, Birmingham.
15,825. Making Earthenware Jars, W. Ralston, Glasgow.
15,826. Coupling for Hose Pipes, J. Stuart, Glasgow.
12,827. Furnaces for Heating Floors, F. W. Knowles, Halifax.
12,828. Wood-sawing Machinery, G. Pickles, Halifax.
12,829. Castor Pegs for Metallic Bedsteads, &c., G. Dawes, Birmingham.
12,830. Removing Seeds from Raisins, G. Dawes, Birmingham.
12,831. Apparatus for Motor Carriages, W. G. Potter, London.
12,832. Illuminating Lamps of Cycles, L. Stokvis, London.
12,833. Clothing, Barbage, Friendship and Co., Ld., Plymouth.
12,834. Riding Saddles, A. C. Russell, Walsall.
12,835. Stretching Woven Fabrics, T. O. Arnfield, Manchester.
12,836. Method of Securing Letters, G. O. F. Hoffmann, Manchester.
12,837. Pneumatic Saddles for Cycles, W. S. Sharpe, London.
12,838. Elastic Tire, R Ashcroft and E. A. Sturgess, Birmingham.
12,839. Propelling Steam Ships, W. Evans, Swansea.
12,840. Manufacture of Artificial Fuel, H. Hellewell, Manchester.
12,841. The Moss Wirette, J. Moss, Birmingham.
12,842. Fabric Fastener, A. D. Macpherson and H. Hudson, London.
12,843. Puncture Proof Band, C. C. Hewett, London.
12,844. Water-proof Case or Shield, G. B. Smith, London.
12,845. Attaching Pneumatic Tires, J. P. Field, London.
12 846. Cigarette Case and Matchbox, G. Lieberman, London.
12,847. Cork Band Curvilinear, C. S. Urry, C. A. and L. W. Bangley, London.
12,848. Waste or Slop Water Closets, A. Hocking, London.
12,849. Driving Gear for Cycles, A. Davy and T. Wallace, Birmingham.
12,850. Raising and Dressing Turnips, T. Robson, London.
12,851. Transmitting Power, H. W. Handcock and A. H. Dykes, London.
12,852. Autocar Motors, R A. Marsh, London.
12,853. A New Letter Envelope, E. Rinzi, London.
12,854. Bicycle Tires, J. H. Loch, London.
12,855. Generating Vapour, T. Hawkins and A. Wellby, London.
12,856. Railway and Other Points, T. Glaister, London.
12,857. Road Locomotives, R. Ord, London.
12,858. Appliance for Turning Over Leaves of Music, A. Ruddock, London.
12,859. Electric Transformers, L. B. Miller, London.
12,860. A New Suspender for Stockings, F. Beckitt, London.
12,861. A New or Improved Purse, D. E. Beak, London.
12,862. A New Mudguard for Cycles, J. Bartlett, London.
12,863. Steering Bars for Cycles, C. F. Johnson and R. West, London.
12,864. Damping Postage Stamps, &c., A. Hewens, London.
12,865. Pneumatic Tires, &c., J. F. R. Wood, London.
12,866. Wheel Axles, R. Mielchen and G. Otto, London.
12,867. Valve Gear for Steam Engines, D. H. Williams, London.
12,868. Smoke Consumers, E. T. Thomas and A. Melhado, London.
12,869. Musical Top, R. B. Waters, London.
12,870. Production of a Polished Surface, P. J. Meissner, London.
12,871. Clip Attachment for Cycles, E. G. Tuteur, London.
12,872. Boots and Shoes, P. Vigano, London.
12,873. Labels, &c., K. Bainbridge, Newcastle-on-Tyne.
12,874. Incandescence Gas Burners, L. Denayrouze, London.
12,875. Centrifugal Governors, &c., J. Milner, London.
12,876. Fastening for Straps, &c., W. L. Preece, London.
12,877. Register Stoves or Grates, J. E. Russell, London.
12,878. Making Cases, R. Dalton and H. Mardon, London.
12,879. Wagons, The Bristol Wagon and Carriage Works Company, J. McDonald, and W. S. Hek, London.
12,880. Pneumatic Tires for Cycle Wheels, J. M. Boyer, London.
12,881. Score Recorder for Golfers, W. G. Forbes, London.
12,882. Velocipedes, F. G. Pickering, London.
12,883. Pneumatic Tires for Cycles, H. C. Sanders, London.
12,884. Lamp Globes, I. Reich, London.
12,885. Log for Recording Speed, F. W. Marriott, London.
12,886. Preventing Re-filling of Bottles, T. M. Dillingham, London.
12,887. Nets, J. Wilson, London.
12,888. Pneumatic Tires for Bicycles, E. A. Reeves, London.
12,889. Kilns for Burning Cement, W. S. Akerman, London.
12,890. Pens, O. Reich, London.
12,891. Can Opening Machines, R. W. Barker.—(*W. N. Anderson, United States*.)
12,892. Production of Pictures, T. R. Shillito.—(*B. Rosenbaum, Austria.*)
12,893. Velocipedes and other Vehicles, D. Cook, Surrey.
12,894. Apparatus to Form a Sieve, L. Tucker, Bucks.
12,895. Elevators, H. R. Smith, Chicago.
12,896. Bicycles, P. T. Gorst, Liverpool.
12,897. Finishing Waterproof Fabrics, M. Frankenstein, Manchester.
12,898. Lamps, A. M. Wade, Birmingham.
12,899. Appliances for Aligning Shafting, W. Alexander, Liverpool.
12,900. Manufacture of Acetylene Gas, S. Earl, London.
12,901. Propulsion of Tram-cars, &c., H. Lane, London.
12,902. Glove Material, J. Kershaw and Dent Allcroft and Co., London.
12,903. Rods, J. Bull, London.
12,904. Process for Smoking Salmon, C. Waldemann, London.
12,905. Hardening Plates, A. Wilson and F. Stubbs, London.
12,906. Taking Photographs, J. B. Medland and W. H. Wood, London.
12,907. Sieves of Machines for Flour, R. Lund, London.
12,908. Apparatus for Drying Materials, W. Crawford, London.
12,909. Bridges, &c., A. Lees and E. C. Jenkins, London.
12,910. Steam Boiling Apparatus, C. Kellner, London.
12,911. Runner Nipples for Pipes, E W. Beach, London.
12,912. Ball Bearing, P. F. Turner and E. Klahn, London.
12,913. Sash Fasteners, F. B. Townsend and H. R. Wheeler, London.
12,914. Pianoforte Actions, F. Newman and C. Parkinson, London.
12,915. Tobacco Pipes, W. H. Wheatley.—(*C. Lancon, France.*)
12,916. Dough Kneading Machine, J. Giering, London.
12,917. Tops, E. Gregory, London.
12,918. Delivering Supplies of Soap, J. C. C. Read, London.
12,919. Supports for Carrying Paper, J. C. C. Read, London.
12,920. Drawing Corks from Bottles, J. C. C. Read, London.
12.921. Attaching Tires to Wheels, C. F. A. H. Bagot, London.
12,922. Cotton Matters, A. G. Green and A. Wahl, London.
12,923. Shading Glass, B. A. Knappett and J. F. Charlesworth, London.
12,924. Gas Burners, A. J. Boult.—(*A. Wunderlich*, ———.)
12,925. Blocks for Paving Purposes, J. Russell, London.
12,926. Detachable Tires, W. Cross and W. M. Angus, London.
12,927. Stall for Bicycle Stables, E. S. Piper, London.

12th June, 1896.

12,928. Mechanism for Operating Counters, A. R. Fairer, London.
12,929. Pneumatic Tires, A. T. J. Cutmore and C. S. Furlong, London.
12.930. Covers, J. Bray, London.
12,931. Hubs, S. Cooper, Oldham.
12,932. An Adjustable Scarf, &c., J. C. Cook, Kent.
12,933. Treatment of Ores, C. Sharland.—(*L. R. Scammell, Australia.*)
12,934. Treatment of Ores, C. Sharland.—(*L. R. Scammell, Australia.*)
12,935. Treatment of Ores, C. Sharland.—(*L. R. Scammell, Australia.*)
12,936. Driving Belt for Bicycles, A. W. Murray, Dublin.
12,937. Examination Scale Indicator, G. Truslove, Birmingham.
12,938. Manhole Frames and Covers, F. C. Lynde, Manchester.
12,939. Pressure Intensifiers, O. Robinson, J. Whitelegg, R. F. C. Tonge, and J. Butterworth, Manchester.
12,940. Toys, J. Walker and W. Keach, Birmingham.
12,941. Wheel Tires for Cycles, S. Hancock, Nottingham.
12,942. Treating Acetylene, T. Thorp and T. G. Marsh, Manchester.
12,943. Gas Generating Apparatus, W. Rowbotham, Birmingham.
12,944. Tubular Kitchen Range Boilers, C. Boddy, Manchester.
12,945. Cocks, A. E. Mathewson, Sheffield.
12,946. Cycle Frame, H. Cooper, Bristol.
12,947. Manufacture of Hosiery, &c., S. Smith, Leicester.
12,948. Cycles, R. R. Newlove and H. W. Hill, Nottingham.
12,949. Buckles, J. Bidgood, Gateshead.
12,950. Ball Bearings for Tires, J. Wadham, Dewsbury.
12,951. Oilless Wick Safety Burner, R. P. Beattie, London.
12.952. Scissors Sharpener, H. Mellars and J. D. Owen. Abergavenny.
12,953. Soap or Cleansing Agent, H. W. Wilson, Manchester.
12,954. Spoke Cleaner, C. G. Mancha-Bennett, London.
12,955. Vehicle Wheels, F. S. D. Scott. London.
12,956. Anti-pneumatic Tire, A. Young, Edinburgh.
12,957. Pneumatic Tires for Cycles, J. W. Boyce, Cheltenham.
12,958. Elasticity of Compressed Rubber, S. S. Hazeland, Penzance.
12,959. Arc Lamps, F. W. Branson, Leeds.
12,960. Rag Pulling Machines, L. Glover and C. Wilby, Leeds.
12,961. Cleaning Bearings in Machines, B. Ryan, Brighton.
12,962. Stalk Fibres, K. T. Sutherland and G. Esdaile, Chorlton-upon-Medlock.
12,963. Construction of Cycles, &c., J. Murrie, Glasgow.
12,964. Rat Traps, W. Thompson and F. Buckland, Surrey.
12,965. Taking the Bridles of Trawl Nets, J. Norfolk, London.
12,966. Tiles, &c., E. Charlesworth and E. Parkin, London.
12,967. Cigars, Cigarettes, &c., C. and J. W. Hughes, Birmingham.
12,968. Safety Lamp Burner, W. S. Buckmaster, London.
12,969. Hay Tedders, J. and R. Stenner, London.
12,970. Fitting Handles to Tea-pots, H. J. T. Greaves, London.
12,971. Kettles, Saucepans, &c., H. J. T. Greaves, London.
12,972. Wheel Nave, G. Marie, London.
12,973. Spring Saddles for Cycles, E. P. Allam, London.
12,974. Pneumatic Tires, B. L. Mosely, Hastings.
12,975. Strengthening Pneumatic Tires, M. R. Ward, London.
12,976. Saddle for Cycles, R. P. Heilgers and P. C. Smith, London.
12,977. Apparatus for Tracing Drawings, E. T. Ward, London.
12,978. Nasal Respirators, D. Holloway, London.
12,979. Welding Furnaces, E. Blass, London.
12,980. Knitting Machines, &c., W. Start, Nottingham.
12,981. Prevention of Horses Running Away, R. Beel, London.
12,982. Scoring in Billiards, &c., W. Smetham, London.
12,983. Plate for Secondary Batteries, R. N. Lucas, Woking, Surrey.
12,984. Spanners or Wrenches, W. H. Tildesley, Birmingham.
12,985. Pneumatic Tires for Cycles, S. Bunting, Birmingham.
12,986. Tires, E. B. Ricketts and R. M. Cunningham, London.
12,987. Motor Cars, E. B. Ricketts and R. M. Cunningham, London.
12,988. Paper Cuff Protectors, &c., F. C. Watts, London.
12,989. Oil Lamps, F. J. Duggan and C. Isaac, London.
12,990. Device for use in Bottle Stoppers, F. J. Reinisch, London.
12,991. Fire Bricks, G. Kynoch and Co., E. Jones, and W. East, London.
12,992. Brakes for Cycles, W. Gilbert, London.
12,993. Attaching Door Handles to Spindles, N. Dawson, London.
12,994. Pneumatic Tires, J. Collbran, London.
12,995. Cycles, E. H. O. R. Ropner, Jun., London.
12,996. Vending Machines, E. Shaw, London.
12,997. Cycles, W. F. Williams, London.
12,998. Shirts, J. E. Jack, London.
12,999. Reservoir Attachment for Pens, M. A. Alves, London.
13,000. Process of Printing, R. A. Bolam, London.
13,001. Combined Back Rest for Cycles, J. Casey, London.
13,002. Stopping Run-away Horses, A. Howell, London.
13,003. Pneumatic Tires, J. C. Grant, London.
13,004. Discharge Valve, E. B. Caird and T. J. Rayner, London.
13,005. Multitubular Boilers, J. Brunlees and J. Walker, London.
13,006. Collecting Dust, W. P. Thompson.—(*Hofer and Küntzel, Switzerland.*)
13,007. Brakes for Cycles, F. J. Longton, Liverpool.
13,008. Covering for Steam Pipes, E. Jones, Manchester.
13,009. Apparatus for Sowing Maize, K. Puskas, Liverpool.
13,010. Manufacture of Anchors, E. Shore, Liverpool.
13,011. Cycles, H. C. Smith, London.
13,012. Incandescent Gas Lamps, R. Atchison, London.
13,013. Cycle Brakes, R T. Ford, London.
13,014. Diving Apparatus, J. and G. Day, London.
13,015. Stockings, H Ford, London.
13,016. Saddles for Cycles, W. H. M. Grimshaw, London.
13,017. Lock Furniture, A. Porter, London.
13,018. Tires for Vehicle Wheels, C. H. L. Poppe, London.
13,019. Changing Photographic Plates, J. W. Jeyes and A. L. Adams, London.
13,020. Washing and Drying Butter, T. Bradford, London.
13,021. Material for Surgical Bandages, E. Hirsch, London.
13,022. Screw Nail, J. B. Cummins, London.
13,023. Casings for Electric Conductors, H. Reason, London.
13,024. Tires of Cycles, J. J. Kempster, London.
13,025. Supporting the Backs of Cyclists, E. G. Fellows, London.
13,026. Separating Butter Milk, J. B. Alliott and A. S. Barham, London.
13,027. Toys or Games, H. Eschweger.—(*F. von Holzhausen, Germany.*)
13,028. Filler to Charge Reservoir Pens, W. T. Shaw, London.
13,029. Mucilage Bottles, W. P. Turner, London.
13,030. Toy and Game Devices, W. W. Flye, London.
13,031. Sharpening Scissors, &c., N. J. St. Hilairé, London.
13,032. Extinguishing Fires, R. A. Lewis, London.
13,033. Locks for Bicycles, C. Fussmann, Germany.

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13,034. Extracting Gold from Ores, J. B. Torres, London.
13,035. Velocipedes, W. Starley, Coventry.
13,036. Trouser Clip, W. D. Sheppard and A. J. Knowlman, Exeter.
13,037. Ball Bearings for Bicycles, G. J. Beedham, Sheffield.
13,038. Wood Working Machinery, J. Bradbury, Manchester.
13,039. Vehicle Lamps, C. Dunn and A. V. Taylor, Birmingham.
13,040. Adjustable Vignetter, A. Salmon, London.
13,041. Hose Connections for Water Taps, J. H. Clarke.—(*J. Jay. Australia.*)
13,042. Knitting Machine Mechanism, A. G. Brookes.—(*G. D. Mayo, United States.*)
13,043. Steam Engines, T. P. Rennoldson, Southampton.
13,044. Puncture Proof Pneumatic Tires, E. Oades, Berks.
13,045. Bacon Slicing Machine, H. Bennett, Darlington.
13,046. Cleats for Electric Wires, F. B. Evans, London.
13,047. Measuring Silks, Cloths, &c., R. E. James, Swansea.
13,048. Electric Lamp and Oil Can, J. Rhodes and J. Henderson, Wakefield.
13,049. Eye Fastener for Curtains, K. E. Neville, Dublin.
13,050. Pneumatic Boot Appliances, S. W. Fildes and C. Harrap, Manchester.
13,051. Lamp for Railway Drays, J. J. Smith, Wolverhampton.
13,052. Paper for Catching Flies, J. W. Dougal, Glasgow.
13,053. Handle Bars of Cycles, T. Shore, jun., Manchester.
13,054 Lock-up Liquor Frames, W. D. Lloyd, Birmingham.
13,055. Pneumatic Tires, A. Latimer, R. W. Edlin, and G. W. Hands, Birmingham.
13,056. Improved Rotary Motor, J. McCarthy, London.
13,057. Cycle Driving Gear, W. H. Baraclough, Birmingham.
13,058. Wallets or Pouches, A. Timpe and P. W. Deacon, Manchester.
13,059. Fast Warp-pile Fabrics, O. Drey, Manchester.
13,060. Burners for Incandescent Gas Lamps, A. MacDonald and A. Paterson, Glasgow.
13,061. Washing, &c., Potatoes, J. Robinson, Manchester.
13,062. Tires of Wheels for Cycles, M. A. Walton, London.
13,063. Cleaning Varnish Brushes, A. R. Pollard, Worthing.
13,064. Cycle Stands, M. Aspinall, Wigan.
13,065. Matches, A. A. Brown, Glasgow.
13,066. Mop, J. Mason and Sons and R. Stafford, London.
13,067. Securing Strings to Boxes, A. Truelove, Sheffield.
13,068. Nail Cutting Machines, J. Boothman, Manchester.
13,069. Miners' Lamps, T. Mawson and J. Peel, London.
13,070. Scissors with India-rubber Handles, A. J. Seabourne and A. M. Lee, London.
13,071. A New Toy, R. C. Leathem.—(*A. G. Murray, United States.*)
13,072. Files for Papers, P. W. Peckham, Glasgow.
13,073. Apparatus for Working Punkahs, F. Shirtliff, London.
13,074. Electrical Resistances, A. J. Marquand and D. Lowden, London.
13,075. Raising Window Blinds, W. Ford and G. Paterson, London.
13,076. Driving Gear for Cycles, J. E. Preston, London.
13,077. Manufacture of Bricks, &c., H. Wood, London.
13,078. Screw-cutting Machine, W. P. Thompson.—(*G. Siewerdt and Co., Switzerland.*)
13,079. Dry Batteries, W. P. Thompson.—(*C. C. Lesenberg, Germany.*)
13,080. Electric Meters, A. Lotz, Manchester.
13,081. Cycle Handle-bar Adjustment, H. Smith, London.
13,082. Bottle Stoppers, M. Smith and J. E. Freeman, Liverpool.
13,083. Collapsible Boxes and Lids, H. Taylor, Manchester.
13,084. Bicycles, A. Denton, Liverpool.
13,085. Velocipedes, W. D. Adnitt, London.
13,086. Forcing Hair, J. Wallace and J. Huddleston, London.
13,087. Handles for Velocipedes, J. H. and L. F. Papps, London.
13,088. Carts, S. Robson, London.
13,089. Gear Chains, L. Milne, London.
13,090. A New or Improved Cuff Link, H. Brazil, London.
13,091. Testing Postage Stamps, L. U. Gill and C. F. D. Hall, London.
13,092. Cycle Saddle, H. W. Dover and P. Phipps, London.
13,093. Improved Manufacture of Dyes, H. R. Vidal, London.
13,094. Machines for Haymaking, A. C. Bamlett, London.
13,095. Frictional Gearing, B. Blackburn, London.
13,096. Treating Waste Substances, T. H. Cobley, London.
13,097. Treadle Driving Gear, O. G. Bolitho, London.
13,098. Producing Animated Photographs, P. Gautier, London.
13,099. Surgical Mattresses, A. M. Heath, London.
13,100. Railway Signals, W. H. J. Lance, Middlesex.
13,101. Motor or Horseless Carriages, E. Roger, London.
13,102. Elastic Tire for Wheels, A. C. Brown, London.
13,103. Manufacture of Tea Chests, J. C. Roberts London.

13,104. Manufacturing Cranks, A. J. Thurman, Birmingham.
13,105. Slate Pencil Sharpener, C. A. Vignoles, London.
13,106. Metal Tubes, W. S. Simpson, London.
13,107. Wheel Tires, F. A. McRae, London.
13,108. Ordnance, D. B. Morison, London.
13,109. Manufacture of Wire, D. B. Morison, London.
13,110. Pie Dishes, F. H. Fogden, London.
13,111. Manufacture of Chromium, E. A. G. Street, London.
13,112. Bolting Machines, H. Seck, London.
13,113. Sprocket Wheels, A. T. Mason, London.
13,114. Dust Cap for Cycle Bearings, J. C. Wilson, Coventry.
13,115. Acetylene Generators, C. P. Choquette and A. M. Morin, London.
13,116. Polishing Devices, H. H. Lake.—(*G. H. P. Flagg, United States.*)
13,117. Velocipedes, E. Davies and H. M. H. Goodfellow, London.

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13,118. Producing Dye-stuffs, A. Bang.—(*G. A. Dahl, Germany.*)
13,119. Shuttle Tongues used in Hand or Power Looms, W. N. Brown, W. Caithness, jun., and T. Watson, Belfast.
13,120. Cycles, F. Wynne, London.
13,121. Lamps for Cycles, J. G. A. Kitchen, Manchester.
13,122. Treating Umbilical Hernia, F. W. A. Stott, Manchester.
13,123. Water Gauge Fittings for High-pressure Boilers, H. B. and J. S. Watson, Newcastle-on-Tyne.
13,124. Cycle Lamps, R. Whitehouse and D. H. Gill, Birmingham.
13,125. Supporting Cycle Saddle Frames, G. Salter, Birmingham.
13,126. Box for Aerated Water Bottles, W. Longden, Manchester.
13,127. Weighing Machines, T. Crossley, Blackburn.
13,128. Candle Holder, C. Maggs, Swansea.
13,129. Cycle Speed Indicating Apparatus, J. B. King, Stonehouse, Devon.
13,130. Cycle Driving Mechanism, W. D. Scott-Moncrieff, London.
13,131. Cyclists' Mechanical Pacemaker, S. F. Smith, London.
13,132. Cleansing and Reducing Yeast, S. H. Wright, Monmouth.
13,133. Syphonic and other Traps, G. Chisholm, jun., Glasgow.
13,134. Cleansing Receptacles having Bulbous Parts, E. Sergent, E. E. Lambert, and R. L. Hay, Newcastle-on-Tyne.
13,135. Folding Heads of Wagonettes, J. G. Harrison, Birmingham.
13,136. Cycle and Vehicle Lamps, W. E. Simpson, Birmingham.
13,137. Making Cycle Tubes, W. Ames and W. Stokes, Birmingham.
13,138. Chimney Cowl, T. A. Dove and T. Jamieson, Glasgow.
13,139. Graduated Measured Paper for Inter-rolling Ribbons or Laces on Rolls, E. L. Enoch, Swansea.
13,140. Cycle and Motor-car Wheels, B. J. Perryman, Birmingham.
13,141. Cooling Liquids, F. Stretch, E. J. Kennedy, and J. Watson, Manchester.
13,142. Winding and Doubling Frames, F. A. Holt, Manchester.
13,143. Basket Cover, P. E. Robilliard, La Piette, Guernsey.
13,144. Producing Motive Power, R. W. Pike, London.
13,145. Construction of Ammeters, T. J. Baker, Birmingham.
13,146. Device for Retaining Hats in Shape, J. W. Dawson, Bradford.
13,147. Making Acetylene Gas, J. E. Atkinson and J. M. Labouchere, Liverpool.
13,148. Preventing Tires Puncturing, G. C. Vernon-Inkpen and J. Hewett, Southsea.
13,149. Retaining Ladies' Dress in Position, F. W. and W. N. Harland, London.
13,150. Securing Toe-pieces to Shoes, B. Watkins, Birmingham.
13,151. Duplicating Phonographic Records, H. Rheinlander, London.
13,152. Explosives, M. I. E. Morris, London.
13,153. Cycle and Motor Carriages, W. J. Giblin, Glasgow.
13,154. Quadruple Centre Punch, W. Cuttell, Derby.
13,155. Hand Power Brickmaking Machine, J. Dormer, Alton.
13,156. Puncture Tire, D. A. Rischgitz, London.
13,157. Pneumatic Tires for Cycles, J. W. Smallman, Nuneaton.
13,158. Rotary Motor for Carriages, J. Maxfield, London.
13,159. Protecting Pneumatic Tires, E. Wells, London.
13,160. Camera Shutters, J. W. Jeyes and A. L. Adams, London.
13,161. Handle Attachment for Cycles, J. Davis, London.
13,162. Price and Weight Indicator, F. Williams, London.
13,163. Underlaying Enamel, C. C. Schirm and A. Silbermann, London.
13,164. Candle Clip for Candlesticks, D. Evans, London.
13,165. Window Sashes and Frames, &c., G. Ridout, London.
13,166. Hearth Rugs, C. S. Lestir, London.
13,167. Device for Brooms and Brushes, J. T. Halsey, London.
13,168. Portable Cycle Stand, F. L. Lee, London.
13,169. Treatment of Sulphide Ores, B. Mohr, London.
13,170. Pneumatic Tires for Vehicles, T. Ballinger, London.
13,171. Advertising on Wheels, Swan and Edgar, Ld., and W. Morford, London.
13,172. Brakes for Cycles and Vehicles, R. Lanham, London.
13,173. Locks and Latches, W. Perry, London.
13,174. Medicinal Confectionery, &c., O. Marcsch, London.
13,175. Steam Traps, W. Geipel, London.
13,176. Reflecting Telemeter for Vessels, A. Belleni, London.
13,177. Driving Mechanism for Cycles, R. B. Waters, London.
13,178. Cycles or Velocipedes, C. R. Binney, London.
13,179. Lubricating Cylinders, E. J. Clubbe, A. W. Southey, and the Electric Motive Power Company, Ld., London.
13,180. Vans for Conveying Fire-escapes, E. H Bayley, London.
13,181. Facilitating Use of Glass Paper, R. Milsom, London.
13,182. Supporting Drills, J. McCulloch and J. Shaw, London.
13,183. Disinfecting Chambers, A. B. Reck, London.
13,184. Pneumatic Tires for Cycles, W. E. Kieffer, London.
13,185. Tube and Pipe Cleaner, A. Jackson, London.
13,186. Refrigerating Apparatus, &c., W. Oliver London.
13,187. Weather-proof Gypsum Stone, P. Kleber, London.
13,188. Chain Gearing for Cycles, F. Purbrick, London.
13,189. Wheels, J. Evinof, London.
13,190. Cooking Utensils, A. G. Berchtold, London.
13,191. Tires, C. H. Gray, London.
13,192. Tires, C. H. Gray, London.
13,193. Violin Bows, P. C. Nelson, London.
13,194. Securing Tubes to Mains, &c., F. Albrecht, London.
13,195. Switches for Electric Lamps, W. J. Davy, London.
13,196. White Felt Hat Bodies, E. W. Hart, Luton.
13,197. Centrifugal Machines, W. P. Thompson.—(*H. Lanz, Germany.*)
13,198. Producing Gloss on Fabrics, E. Heberlein, London.
13,199. Window Frames and Sash Pulleys, E. Cox, Manchester.
13,200. Charging Accumulators, A. G. Strömberg, Liverpool.
13,201. Tires for Road Vehicles, F. W. R. Scott, Liverpool.
13,202. Driving Gear for Cycles, T. E. Nightingale, Liverpool.

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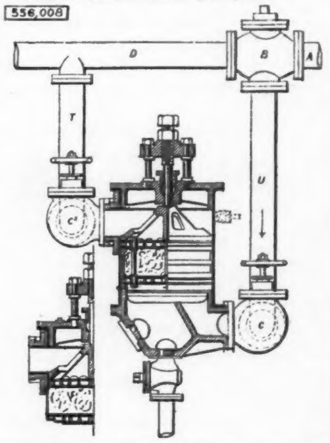
13,203. Pneumatic Tires, W. Meadows and J. Cooper, London.
13,204. Fittings for Incandescent Gas Lamps, F. S. Cripps, Surrey.
13,205. Scissors or Shears Sharpeners, J. Stewart, Fareham.
13,206. Food for Infants, &c., F. C. M. Powell, Manchester.
13,207. Attaching Pneumatic Tires to Rims, H. Garratt, Coventry.
13,208. Keeping Bicycles Upright, J. L. Kulp, Brighton.
13,209. Manufacture of Woven Fabrics, T. Ford, Glasgow.
13,210. Driving Gear for Cycles, T. I. Gray, Newcastle-on-Tyne.
13,211. Cutting Rolled Tobacco, W. H. Hamilton and G. J. Allan, Newcastle-on-Tyne.
13,212. Brake for Cycles, S. Jackson and C. T. Roberts, Keighley.
13,213. Driving Chain, &c., for Cycles, G. W. Laybourn, Birmingham.
13,214. Band Brakes for Bicycles, W. Skerry, Newcastle-on-Tyne.
13,215. Drain Joints, C. Foad and C. Gordon, London.
13,216. Propulsion, &c., of Rubber-tired Vehicles, F. E. Walker, London.
13,217. Hackling Machines, H. M. Girdwood, Manchester.
13,218. Fittings for Incandescent Gas Lamps, F. S. Cripps, Surrey.
13,219. Giving Signals on Railways to the Guard, &c., J. and E. Holding and J. Kilgarriffe, Brinscall, near Chorley.
13,220. Crutches, J. Liddle.—(*D. J. Kennelly, United States.*)
13,221. Speed Pulleys, W. M. McIntyre, Manchester.
13,222. Grinding and Polishing Knives, C. F. Ern, Glasgow.
13,223. Candles, F. Bougère, Manchester.
13,224. Teaching Mechanical Construction, T. Birnbaum, London.
13,225. Ventilators, J. West and J. T. Woodhouse, Sheffield.
13,226. Soles and Heels of Boots, G. Barnston, Dartmouth.
13,227. Mattresses, L. Johnston, Handsworth.
13,228. Clips for Securing Inflators, C. T. B. Sangster, Birmingham.
13,229. Spring Clip Attachment, H. T. Davis, Sheffield.
13,230. Drawing Presses, P. F. Holmgren, London.
13,231. Water Gauges, J. S. and J. Jennens, Birmingham.
13,232. Pneumatic Wheel Tires, E. L. Levetus, Birmingham.
13,233. Writing Ink, J. F. Williams, Liverpool.
13,234. Pedal Driving Mechanism, W. H. Dodd, Birmingham.
13,235. Stokers for Firing Boilers, Z. J. Parkes, Workington.
13,236. Tires, J. J. Kempster, London.
13,237. Type-setting Apparatus, G. Barker.—(*L. K. Johnson and A. A. Low, United States.*)
13,238. Waterproofing Solutions, K. A. Frosell, London.
13,239. Cricket Stumps, J. Rowley, London.
13,240. Gas Stoves, A. J. Boult.—(*A. Wunderlich, Belgium.*)
13,241. Speed Gear for Motor Cars, J. R. Rickard, London.
13,242. Artificial Whalebone, W. Hunkemöller, London.
13,243. Inflating Pneumatic Tires, H. South, London.
13,244. Ferric Oxides, A. Crossley and H. A. Allport, London.
13,245. Car Couplings, L. E. Redden, London.
13,246. Hat Beating and Cleansing Machines, C. E. Winterros, London.
13,247. Driving Gear for Cycles, A. B. Genese, London.
13,248. Driving Gear for Cycles, H. M. Genese, London.
13,249. Saddle Pillars for Cycles, H. M. Genese, London.
13,250. Telephonic Apparatus, C. Adams-Randall, London.
13,251. Liquid Measure and Bottle Stopper, H. D. Payne, London.
13,252. Rotary Engines, W. E. Prall, jun., London.
13,253. Sewing Needles, F. W. Golby.—(*J. Zimmermann, Germany.*)
13,254. Boots, F. W. Golby.—(*P. Schlesinger, Germany.*)
13,255. Mantles for Gas Lights, W. L. Voelker, London.
13,256. Mantles for Gas Lights, W. L. Voelker, London.
13,257. Driving Gear for Cycles, A. H. Edwards, London.
13,258. Tires, E. A. Grove, London.
13,259. Coating Surfaces, R. Wallwork and A. C. Wells, London.
13,260. Pneumatic Fire Alarms, A. Goldstein, London.
13,261. Pocket Filters, S. W. Silver and W. Fletcher, London.
13,262. Material for Brewing Beer, B. W. Valentin, London.
13,263. Holders of Electric Lamps, W. L. Preece, London.
13,264. Regulating Electric Motors, The British Thomson-Houston Company.—(*A. H. Armstrong, United States.*)
13,265. Pneumatic Wheel Tires, A. H. Vesey, London.
13,266. Brakes, M. B. Parrington, London.
13,267. Electric Switches, W. R. Daggett and W. H. Heinz, London.
13,268. Mechanism for Waxing Thread, R. Haddan.—(*The Goodyear Shoe Machinery Company, United States.*)
13.269. Production, &c., of Explosives, L. Kelbetz, London.
13,270. Manufacture of Explosives. L. Kelbetz, London.
13,271. Electric Switches, J. B. Verity, London.
13,272. Packing Fish, J. Clarke and J. T. Harvey, London.
13,273. Apparatus for the Manufacture of Inlaid Fabrics, A. S. Oetzmann and S. J. Narracott, London.
13,274. Devices for Opening Envelopes, F. E. Munn, London.
13,275. Lap Boards, S. M. Rivers, London.
13,276. Velocipede Wheels, G. J. Stevens and J. Hix, London.
13,277. Boot Treeing Machines, T. and T. H. Salmon, London.
13,278. Cycle Gear Cases, A. Hess and G. Wuth, London.
13,279. Centrifugal Dryers, R. A. Lister and G. E. Snoxell, London.
13,280. Brushes, C. A. Watkins, London.
13,281. Albumen Tannin, W. L. Wise.—(*Knoll and Co., Germany.*)
13,282. Heating Pipes, H. C. Platts and T. Lowther, London.
13,283. Storing and Transporting Cycles, A. MacGregor, London.
13,284. Photographic Cameras, A. J. Boult.—(*T. H. Blair*, ——.)
13,285. Handles for Cycles, G. H. W. Davis, Birmingham.
13,286. Brake for Cycles, A. L. Strange, London.
13,287. Fishing-rods, H. P. Mundey, London.
13,288. Bicycles and other Vehicles, G. E. Brown, London.
13,289. Tips for Boots and Shoes, J. E. Foort, London.
13,290. Advertising Car, M. Johnson, London.
13,291. Eye Shades, W. G. Honey, London.
13,292. Leaf Holder for Books, &c., W. Wilmore, London.
13,293. Keeping Liquors under Carbonic Acid, A. Friedeberg, London.
13,294. Machines for "Knotting" Nets, M. Woschyllo, London.
13,295. Electrically-controlled Railway Signals, W. P. Thompson.—(*F. McBrien, J. Wayland, and J. H. Fleming, United States.*)
13,296. Burners for Incandescent Gas Light, W. P. Thompson.—(*Niehusen and Zerning, Germany.*)
13,297. Electric Furnaces, R. Pignotti, F. Lori, S. Regnoli, M. Pandaleoni, and M. Besso, London.
13,298. Hernia Truss, H. Loewy, Liverpool.
13,299. Apparatus for Blowing Bottles, D. Laffan, Liverpool.
13,300. Automatic Fog Signalling, A. Jays, W. W. Warren, and R. H. Buckby, London.
13,301. Elevators for Grain, &c., W. R. Turton, Liverpool.
13,302. Apparatus for Tilting Barrels, F. C. Sharman, London.
13,303. Bicycles, W. Evans and G. G. Sharp, London.
13,304. Crank for Velocipedes, G. Clark, London.
13,305. Type-writers, E. von Hülsen, Germany.

SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

556,008. Feed-water Filter, *A. Harris, Middlesborough, England.—Filed May* 16*th*, 1893.

556,008

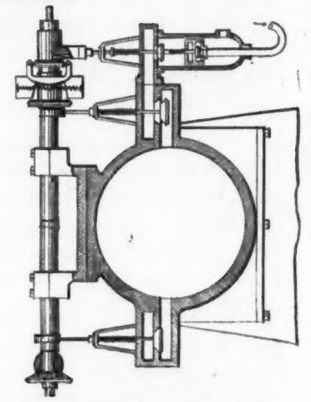


Claim.—(1) In combination with a pipe A D adapted to deliver water from the pump to the boiler, a branch U T from said pipe, a filter in said branch, and an automatic valve B placed in the water supply pipe between the pump and boiler, and weighted to the required resistance, whereby, when the resistance in the filter equals or exceeds the pressure to which the valve is adjusted, the filter is thrown out of action, the current reversed, and the water allowed to proceed direct to the boiler. (2) In combination with a filter for filtering feed-water, of the inlet pipe A, the valve B connected thereto, pipe U between said valve and the filter, pipe D also communicating with valve B, pipe T connected to the filter and also in communication with pipe D, and valves c c^1 and c^2 located as shown and described, whereby when the resistance becomes too heavy the filter is thrown out of action.

556,086. Gas Engine, *H. G. Carnell, Dayton, Ohio. Filed June* 22*nd*, 1895.

Claim.—(1) In a gas engine, the combination, with the gas inlet valve opening into an air-mixing chamber and an inlet valve for the mixture of gas and air opening outwardly, of a check valve opening inwardly, located between the inlet valves and the ignition chamber, with a cone-shaped cam operating upon said inlet valves to open the same, and a governor to shift said cam to vary the valve opening, substantially as shown and described. (2) In a gas engine, the combination, with the gas inlet valve opening into an air-mixing chamber and an inlet valve for the mixture of gas and air opening outwardly, said valves being provided with a common valve stem, of a check valve opening inwardly located between the inlet valves and the ignition chamber, with a cone-shaped cam operating upon said inlet valves to open the same, and a governor to shift said cam to vary the valve openings, substantially as shown and described. (3) In a gas engine, the combination, with the gas inlet valve opening into an air-mixing chamber and an inlet valve for the mixture of gas and air opening outwardly, of a check valve opening inwardly located between the inlet valves and ignition chamber, with a cam for opening said check valve, and a cone-shaped cam for opening said inlet valves, said cams being arranged to hold open said check valve until the inlet valves have been released, with a governor to shift said cone-shaped cam to vary the inlet valve opening, substantially as shown and described.

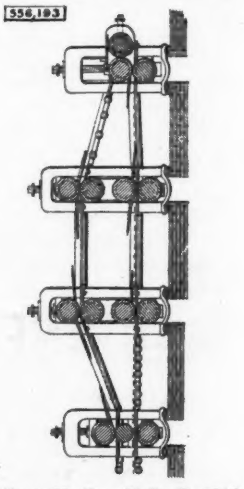
556,086



556,193. Sheet Metal Rolling Mill, *J. Matthews, Wyandotte, Mich.—Filed May* 20*th*, 1895.

Claim.—(1) In a rolling mill of the character described, the combination with the rear set of rolls, the curved plate and movable roll in rear thereof, of the pivoted guide plate having a roller at its inner end, and a downwardly-depending curved portion and the coiled spring, substantially as described. (2) In a rolling mill, the combination with the three-high and four-high sets, the rolls, platforms and boxes, the guide plates and pivoted guides, of the reversing set of rolls, the curved plate, and movable roll in rear thereof, the pivoted guide plate having a roller at its inner end and a downwardly-depending curved portion and the coiled spring, substantially as described.

556,193



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